ISSN 0973 - 5445

वार्षिक प्रतिवेदन
ANNUAL REPORT
2017-18

भाकृअनुप - केंद्रीय रोपण फसल अनुसंधान संस्थान
कासरगोड़ - 671124, केरल
ICAR-CENTRAL PLANTATION CROPS RESEARCH INSTITUTE
KASARAGOD - 671124, KERALA
(ISO 9001:2015)

ISSN 0973 – 5445

वार्षिक प्रतिवेदन
ANNUAL REPORT
2017-18

भा कृ अनु प - केंद्रीय रोपण फसल अनुसंधान संस्थान
कासरगोड़ - 671124 केरल, भारत

ICAR - CENTRAL PLANTATION CROPS RESEARCH INSTITUTE
KASARAGOD 671 124, KERALA, INDIA

Correct citation: ICAR-CPCRI, 2018. Annual Report 2017-18, ICAR-Central Plantation Crops Research Institute Kasaragod – 671124, Kerala, India, 196 p.

Published by

Dr. P. Chowdappa
Director
ICAR-Central Plantation Crops Research Institute
Kasaragod 671 124, Kerala, India
Phone : 04994 – 232893, 232894, 232895 & 232996;
Fax : 04994-232322
Email : directorcpcri@gmail.com, chowdappa.p@icar.gov.in
Website : http://www.cpcri.gov.in/

Compiled and edited by

Dr. M.K. Rajesh, Dr. V. Niral, Dr. S.V. Ramesh, Dr. A. Josephrajkumar
Dr. S. Jayasekhar, Dr. S. Paulraj, Shri H. Muralikrishna
Shri John George & Shri K. Shyama Prasad

Photo Credits

Shri K. Shyama Prasad
Shri E.R. Asokan

Hindi Text

Smt. K. Sreelatha
Dr. Alka Gupta

Cover Design

Shri K. Shyama Prasad

Cover Page Photo

Front cover
1. Mini tractor mounted air-blast sprayer for arecanut
2. Unmanned aerial vehicle (UAV) assisted arecanut sprayer
3. Gudanjali Dwarf coconut plot at ICAR-CPCRI, RS, Kayamkulam

Back cover
1. Centenary commemorative postal stamp released on ICAR-CPCRI
2. Aerial view of dwarf coconut plantation at ICAR-CPCRI, RS, Kayamkulam

Inside front cover
1. Kalpa registered trademark
2. Tissue cultured areca plantlets as inset.

Inside back cover
Cocoa intercropped in coconut garden

Printed at

Digantha Mudrana Ltd.,
Yeyyadi, Mangalore.
Mob: 9686675271, Ph: 2212551

June, 2018

CONTENTS

PREFACE

Plantation crops are the mainstay of a variety of tropical intercrops, which can enhance the livelihood of marginal and small farmers. It also forms a major component of household farming, encompassing mini and micro farming units. Coconut and arecanut, besides harbouring and supporting a number of intercrops in the plantation, also sustain the associated satellite units and their ancillary activities. An integrated cropping/ farming system followed by farming community as a whole and the interwoven lifestyles of millions of households engaged in farming as well as in the crop based value chain, form an integral part of the coastal tracts and adjoining peninsular India and other growing regions in the country.

I feel extremely happy to bring out this Annual Report covering the wide spectrum of activities of the Institute for the year 2017-18. At the research front, significant progress has been made in varietal improvement and breeding for abiotic and biotic tolerance/resistance. Over seven lakh quality planting materials has been supplied to the farmers, resulting not only in increased farm revenue, but also ensuring the future crop productivity in the country. Assembly and annotation of genome sequence of Chowghat Green Dwarf has been completed and constitutes a major landmark achievement to boost the genomics assisted breeding of coconut. Overall emphasis of research programmes has been tailored to achieve higher production targets to realize doubling farm level production by 2022, with a view to foster a self-reliant New India. Towards achieving this, recommendations for removal and replanting of senile plantations, soil test based fertilizer and integrated nutrient management and precision farming including irrigation water budgeting and use of GIS tools, have been given greater thrust. Two micronutrient formulations have been developed for coconut. Climatic adaptation potential of the coconut has been characterized and the performance of green dwarfs and the hybrids from the green dwarf combinations have been re-established, giving straight-forward indications for abiotic resistance breeding efforts. Considering the need for mechanization of spraying operations in arecanut plantations, a prototype of an unmanned aerial vehicle (UAV) assisted sprayer has been developed.

There is light at the end of the tunnel for integrated disease and pest management of the plantation crops, while safeguarding the natural environment. There was widespread invasion of rugose spiraling whitefly (RSW) of coconut in coastal regions of South India, which was monitored by the scientists, who could tackle the pests not with the chemicals, but using their wisdom and knowledge by identifying the natural enemies and sensitizing the public to desist from spraying of chemicals. Discovery of a scavenger beetle, which can bio-cleanse the palm leaflets infected by sooty mould fungus, is another timely scientific intervention that lays emphasis on the pest management approaches deploying eco-conservation principles. It is indeed worth mentioning, that technical bulletins, folders, posters, interface programmes, exhibition etc. were presented in an all-out effort to contain the menace of RSW and create awareness among the public, in collaboration with the State Department of Agriculture and Farmer's Welfare, of Kerala, Karnataka, Tamil Nadu and Andhra Pradesh.

Technology commercialization efforts could generate revenue of Rs. 17.26 lakhs and also create employment for the unemployed rural youth by engaging themselves with coconut based enterprises. Technology dissemination efforts have been made through training programmes, interfaces, exhibitions, publications and mass media as well as use of ICT for videoconferencing between outstations. On the digital initiative front, an android based mobile application 'e-kalpa' has been designed to deliver farm technologies at the finger tips of farming community, in five languages. To reach out to the masses and to demonstrate the various new technologies, policies, schemes and achievements, two major *Kisan Mela's* with Agri-Business Expo, were organized, on each at Kasaragod and Kahikuchi.

The farm science research and extension efforts of ICAR-CPCRI-KVK, Alappuzha gained recognition and received the ICAR award for the "Best KVK in Zone VIII". Recognition of the 100 years of establishment of the organization was also made by the Department of Posts and Telecommunication by releasing a commemorative postal stamp during the *Kisan Mela* at Kasaragod. The Govt. of Kerala awarding a project on coconut, with an outlay of Rs. 3.13 crores, is also a due recognition of the scientific expertise and values the Institute continues to inculcate.

At the instance of bringing out this report, I express my sincere gratefulness to Dr. T. Mohapatra, Secretary, DARE and Director General, ICAR for the encouragement and guidance. I place on record my sincere gratitude to the Deputy Director General (Horticultural Science) for his support, guidance in the activities and progress of the Institute. I thank the Assistant Director Generals in the Horticultural Science Division, ICAR for all the support received from them for driving the various tasks forward. I also thank the scientists, officers and all staff members of this institute for the significant contributions made in fulfilling the mandate of the institute. I also thank the editorial team for their whole hearted efforts to present this Annual Report in thematic mode.

31-5-2018

(P. Chowdappa)
Director

II

कार्य सारांश

भा.कृ.अनु.प.- केंद्रीय रोपण फसल अनुसंधान संस्थान, भारत के राष्ट्रीय कृषि अनुसंधान पद्धति में प्रथम कृषि अनुसंधान संस्थानों में एक है जो भारत में नारियल, सुपारी और कोको में अनुसंधान करने और समन्वित करने में अधिदेशित है। उत्पादन क्षमता बढ़ाना, कृषि पद्धति पहुँच, और मूल्य वर्द्धन आदि लघु जोत किसानों के रोपण फसल जैसे नारियल, सुपारी और कोको की उत्पादन क्षमता और लाभदायकता बढाने में सुलभ मुख्य मार्ग है। आनुवंशिक संसाधनोंके उपयोग, पुनः विन्यस्त फसल प्रबंधन कार्यनीतियॉं और मूल्य श्रृंगला तथा किसान भागीदारी पद्धति से प्रौद्योगिकी प्रसार में संबोधन महत्व सहित अनेक फलप्राप्ति अभिविन्यस्त पहल के माध्यम से वर्तमान वर्ष में सुधारित उत्पादन क्षमता और लाभदायकता प्राप्त करने की प्रौद्योगिकियॉं विकसित करने में प्रबल प्रयास किया गया है।

वर्ष 2017-18 में नौ बहु परियोजना और संस्थान का बाहरी निधि प्रदत्त परियोजना के शोध कार्य की प्रगति 7 तथ्य विषयक क्षेत्रों जैस आनुवंशिक संसाधन और सुधार, जैवप्रौद्योगिकीय और जैव सूचनात्मक अन्वेषण, उत्पादन प्रौद्योगिकी, रोग एवं सूत्रकृमि का समीकृत प्रबंधन शरीरक्रिया विज्ञान और कटाई उपरांत प्रौद्योगिकी, प्रौद्योगिकी हस्तांतरण आर्थिकी और ताड़ और कोको का सॉख्यिकीय मॉडल के अधीन रिपोर्ट किया गया है। इसके अतिरिक्त इस संस्थानके अधीन कार्य निष्पादित अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना और दो कृषि विज्ञान केंद्रों की गतिविधियॉं भी प्रस्तुत की जाती है। प्रत्येक विषय क्षेत्र के अधीन के मुख्य उपलब्धियॉं निम्नलिखत है।

आनुवंशिक संसाधन एवं सुधार

विशेष परीक्षणों के लिए जीन स्रोतों के साथ जननद्रव्यों को समृद्ध करने के प्रयास के परिणाम से नारियल 455, सुपारी 176 और कोको 505 तक संग्रहण बढ़ाया जा सका और नारियल औरसुपारी के आनुवंशिक संसाधनों के संरक्षण में भारत को वैश्विक नेता बनाया गया। कल्प हरिता, चौघाट हरी बौनी, कल्पतरु, लकाडीव आर्डिनरी लंबी, लकाडीव माईक्रो लंबी और पश्चिम तट लंबी से संग्रहित लगभग 150 भ्रूण प्रशीत परिरक्षण के अधीन है जिसको भाकृअनुप-एनबीजीआर के राष्ट्रीय प्रशीत जीनबैंक में आधार संग्रहण के रुप में दिया जा सकता है। महत्वपूर्ण कोको आनुवंशिक संसाधनों के सुरक्षित द्विगुणन के लिए कोको का वैकल्पिक प्रक्षेत्र जीन बैंक की स्थापना विभिन्न सस्य पारिस्थितिक अंचलों में, भाकृअनुप-केरोफअसं, अनुसंधान केंद्र, किडु, कर्नाटक में 61 प्रजातियॉं, तमिलनाडु कृषि विश्वविद्यालय कायम्बत्तूर में 57 प्रजातियॉं और वाई एस राजशेखर रेड्डी बागवानी विश्वविद्यालय, आंध्रप्रदेश में 39 प्रजातियों के रोपण के साथ की गई ।

संरक्षित नारियल जर्मप्लाजम मूल्यांकन परीक्षण में फेडरेटड मलय लंबी (132 गुठली प्रति ताड प्रति वर्ष) महत्वपूर्णता से उच्च फल उपज और पश्चिम तट लंबी से (101 गुठली प्रति ताड़ प्रति वर्ष) प्राप्त की गई ।उच्चउपज प्रदत्त प्रजाति फेडरेटड मलय स्टेट्स लंबी (एफएमएसटी) से उच्च खोपड़ा उपज (24.47 कि ग्रा प्रति ताड़ प्रति वर्ष) प्राप्त किया गया और इसके उच्च फलगुच्छ रस उपज क्षमताके साथ अच्छा डाब पानी गुण से केरल के नारियल वर्द्धित क्षेत्रों में वाणिज्यिक कृषि के लिए विमोचन हेतु सिफारिश किया गया है। दो संकर नारियल, सी ओडी डब्ल्यु x ए टी और सी ओ डी x एल सी टी विमोचन के लिए सिफारिश किया गया। जिससे 150 गुठली प्रति ताड प्रति वर्ष उत्कृष्ठ उपज प्राप्त किया गया और तमिलनाडु में प्रौद्योगिकी मूल्यांकन परीक्षण की स्थापना के लिए पौधों का वितरण किया गया ।

काहिकुची, असम में चन्द्र संकरा से 774.30 ग्रा प्राति गुठली के साथ गुठली भार और खोपड़ा मात्रा (176.67 ग्रा प्रति गुठली)का उच्च वार्षिक गुठली उपज (72 गुठली प्रति ताड़) प्राप्त किया गया। भाकृअनुप-केंरोफअसं, अनुसंधान केंद्र, मोहितनगर, पश्चिम बंगाल में संकर एवं बौनी प्रजातियों की तुलना में लंबी प्रजातियों से उच्च गुठली उपज और बीएआरआई नारियल1 (98 गुठली प्रति ताड़) उच्च वार्षिक गुठली उपज और अगाईल्जाहरा लंबी से (90गुठली प्रति ताड़) प्राप्त की गई। कायम्कुलम में जड़ मुर्झा रोग सक्षमता के लिए किए गए मूल्यांकन में सी जी डी xडब्ल्यु सी टी में कम जड़ मुर्झारोग लक्षण और उच्च उपज 85 गुठली प्रति ताड प्रति वर्ष और सी जी डी x एम वाई डी से 71 गुठली प्रति ताड प्रति वर्ष रिकार्ड किया गया । बौनी प्रजातियॉं नियु लेका बौनी और गंगाबोंडम पहले पुष्पित और उच्च उपज क्षमता वाली के रुप में पहचान की गई ।

नारियल प्रजातियों के बीच पुष्परस उपज और गुण के मूल्याकंन में पुष्परस उपज और गुण मापदण्ड पर जीनोटाइप और ऋतुओं का महत्वपूर्ण प्रभाव पाया गया। विभिन्न प्रजातियों से टेपिंग किया गया पुष्परस का गुण कुल शक्कर, फिनोल और प्रोटिन मात्रा के अनुसरण

के साथ महत्वपूर्ण रूप से भिन्न पाया गया। उपज एवं अन्य आर्थिक परीक्षणें के लिए विट्टल में मूल्यांकनाधीन संरक्षित सुपारी जननद्रव्यों के बीच वी टी एल 146, वी टी एल 100, वी टी एल 125 वी टी एल 126और वी टी एल 85 आदि क्रमश 3.88,3.80, 3.59 और 3.51 कि ग्रा प्रति ताड़ प्रति वर्ष सूखा अष्टी उपज के साथ उच्च उपज प्रदत्त पायी गयी। मोहितनगर में वी टी एल 60, वी टी एल 5,वी टी एल 29 और वी टी एल 27 से क्रमश 4.22,2.51, 3.71 और 1.04 कि ग्रा प्रति ताड़ प्रति वर्ष सूखा अष्टी उपज के साथ उच्च उपज प्रदत्त पायी गयी।

विट्टल में हिरेहल्ली बौनी(एच डी) का संकर एच डी xमोहितनगर, एच डी x सुमंगला और एच डी x मंगला सहित आठ बौनी संकरों के मूल्यांकन से उच्च वार्षिक उपज क्रमश 2.58, 2.38और 2.31 कि ग्रा प्रति ताड प्रति वर्ष रिकार्ड किया गया। मोहितनगर में उच्च वार्षिक उपज एच डी x मोहितनगर (1.046 कि ग्रा प्रति ताड) और मोहितनगर x एच डी (0.927 कि ग्रा ताड़) प्राप्त किया गया। काहिकुची में सुमंगला x एच डी (1.34 कि ग्रा प्रति ताड़) और मोहितनगर x एच डी से 1.29 किग्रा प्रति ताड़) उच्च वार्षिक सूखा उपज रिकोर्ड किया गया ।

विट्टल में उपज के लिए मूल्यांकनाधीन 16 लंबी संकर संयुक्तों के बीच श्रीवर्धन x सुमंगला से उच्चतम सूखा अष्टी उपज 3.85 कि ग्रा प्रति ताड प्रतिवर्ष और मोहितनगर न्सुगंगला से 3.58 कि ग्रा सूखा अष्टी प्रति ताड़ प्रति वर्ष रिकार्ड किया गया ।

अरिका काट्यु में कुल फिनोलिक मात्रा और एन्टि-ऑक्सिडेंट क्षमता और उससे संबंधित जेनेरा/जाती जैसे *एक्टिनोरिटिस कलाप्पारिया*, *अरिका ट्रियान्ड्रा* और *नौरमान्बिया नौरमान्बिई* के विश्लेषण से अरिका और *आक्टिनोरफिटिस* की विभिन्न जातियॉ फ्री राडिकल सफाई क्षमता औरऑक्सीकरण रोधी गुण युक्त पायी गयी । जो फ्री राडिकल निष्क्रिय करने में सहायक है और बायोलोजिकल मेम्बरेन में फ्री राडिकल मीडियेटड प्रतिक्रियाओं के प्रारंभ को रोकने में सहायक है ।

दोनों *ओरथोट्रोपिक* और *प्लागियोट्रापिक* प्ररोह के अतिरिक्त कोको क्लोन्स, प्रति कुशन फली का अधिक धारण पहचाना गया। नीचे की ओर लटका हुआ वृद्धि गुण के साथ जो उच्च घनता रोपाईऔर जाली घेर कतार पद्धति के लिए उचित है, पाँच क्लोन्स पहचाना गया और बी सूचकांक 1.5-2.0 के साथ क्लोन्स गुण सुधार के लिए पहचाना गया । विमोचित कोको प्रजाति कर्नाटक, केरल, तमिलनाडु और आंध्रप्रदेश में बहुस्थानीय परीक्षण में सुपारी और कोको दोने के अधीन वी टी एल सी एच 2 का अच्छा निष्पादन पाया गया ।

फोरास्टिरो टाइप के चार उच्च उपज प्रदाय कोको क्लोन्स (सी वाई टी - सी 9, एल ए एल-75 और एस टी-1-48 और चारट्रिनिटारियो टाइप (एएमएजेट-2, सीवाई टी -24, एम एल टी जी-6 औरबी-4-4-1) प्रति कुशन में 5-13 दर में अधिक फली के साथ पायी गयी जो शरीरक्रियात्मक/कॉलिफ्लोरस ओज, उच्च धारण और कम चिरेल्ले विल्ट प्रदर्शित किया जाता है इस वर्ष की अवधि में लगभग 7,13,730 रोपण सामग्रियों , नारियल में 70,223 सुपारी में 5,59,610, और कोको में 83,897 उत्पादन किया गया। एक नारियल पराग प्रशीतपरिरक्षित जिसकी क्षमता 6,000 पराग हो, की स्थापना क्षेत्रीय केंद्र, कायम्कुलम में किया गया। दक्षिण केरल में जड़ मुर्झा रोग प्रचलित क्षेत्रों के लिए कल्प संकरा के उत्पादन संवर्द्धन के लिए लगभग 220 चौघाट नारंगी हरी बौनी मातृ ताड संकरण कार्यक्रम के लिए उपयोग किया गया।

जैव प्रौद्योगिकीय और जैव सूचनापरक अन्वेषण

कृषिजोप कृषिजोप जातियों के बृहत स्रैं में नारियल भ्रूण प्रशीत परिरक्षण नयाचार का प्रमाणीकरण किया गया। अरिका ट्रियान्ड्रा x अरिका काटेच्यु (मंगला जाति)के संकर अंतराजातीय प्राप्त करने के लिएभ्रूण उद्धार तकनीकी सफलतापूर्वक उपयोग किया गया। सुपारी प्रशीत परिरक्षण अध्ययन में अधिकतम अनुजीवन और समजातिय भ्रूण रुपांकन प्रशीतपरिरक्षित भ्रूणोद्भावित कैलि 0.3 एम सूक्रोस और पी वी एस 3 तरल में 30 मिनिट के लिए निर्जलीकृत संवर्द्धन में पाया गया। इन प्रशीत परिरक्षित भ्रमणोंद्भावित कैली से पौध प्राप्त किया गया।

नारियल का पूर्ण जिनोम श्रेणीकरण का महत्वाकांक्षी कार्यक्रम अच्छी तरह प्रगति पर है । चौघाट हरी बौनी ताड़ का संयोजन पूरा किया गया। संकर श्रेणीकरण कार्यनीतिउपयोग कर प्राप्त किया गया गहरा श्रेणीकरण आंकडे का संयोजन।, इल्लुमिना से लघु रेड्स के साथ और पसिफिक बायोसाइन्सेस श्रेणीकरण से लंबी रेड्स का 59,328 स्काफोल्ड्स 86 एन बी एन 50 और जी 31.79 प्रतिशत जी सी परिणाम पाया गया ।इस संकर संयोजन पहल के परिणाम से सीजीडी जिनोम प्रतिनिधित्व करने अंतिम ड्राफ्ट जिनोम का 51953 पूर्वानुमेयित जीन के साथ1.83 जीबी का कुल आकार पाया गया। कुल 47,746 जीन (91.9 प्रतिशत) एनोटेट किया जा सकता है।

स्टार्ट कोडोन टारजेटेड पॉलिमोरफिसम और *अरिका काटेच्यु* और *अरिका ट्रियान्ड्रा* का अपूर्व मार्केर्स का उपयोग कर *अरिका काटेच्यु* और उसका जंगली नातेदार जैसे *अरिका कोनसिन्ना* और *अरिका ट्रियान्ड्रा* का चरित्र-चित्रण किया गया ।इस सीक्युवेंसस के आधार पर *अरिका काटेच्यु* और *अरिका ट्रियान्ड्रा* का विशेष स्कार मार्केर्स का रुपांकन किया गया। *अरिका काटेच्यु* और *अरिका ट्रियान्ड्रा* के बीच प्रामाणिक अंतराजातिय संकर का पहचान स्कार मार्केर्स का उपयोग कर किया जा सकता है।

उत्पादन प्रौद्योगिकी

नारियल आधारित मिश्रित कृषि पद्धति जिसमें नारियल, कालीमिर्च, केला डायरी एकक, मत्स्यपालन और दुग्धपालन सम्मिलित है, वार्षिक निवल प्रतिफल के रुप मे प्रति हेक्टर 6,72,725 प्राप्त किया गया। नारियल आधारित सघन बहु जातिय फसलनपद्धति जिसके साथ नारियल, काली मिर्च, केला, जातिफल, दालचीनी सम्मिलित जैविक चीज़ पुनचक्रमण से 7,71,725 रुपए प्रति हेक्टर वार्षिक निवल लाभ प्राप्त किया गया । सुपारी आधारित मिश्रित सस्यन पद्धति जिसमे सुपारी (0.16 हेक्टर) घास, डेयरी एकक, 6-7 दुधारी गाय और मत्स्यपालन से वार्षिक निवल लाभ के रुप में 5,27,227/- रुपए प्रति हेक्टर प्राप्त किया गया जिससे नारियल/सुपारी आधारित बहुजातिय फसलन/सस्यन पद्धति का लाभ अधोरेखित किया जाता है।

वर्ष में छह महीने के लिए या एकांतर वर्ष या एकांतर गुच्छ या प्रौढ गुठलियों की कटाई की तुलना में पिछले तीन वर्षों में (2015-2017) 25 दिनों के अंतराल में डाब गुठली की कटाई करने से महत्वपूर्ण उच्च उपज (167-195 गुठली प्रति ताड़ प्रति वर्ष) अंकित

किया गया। निरंतर डाब गुठली की कटाई से ताड़ की वृद्धि मापदण्ड पर कोई घातक प्रभाव नहीं पाया गया अन्य मूलकों की तुलना में नारियल पेड का पोटासियम मूलक उपयोगअधिक मात्रा में है। इसलिए मृदा पोटासियम स्थिति काफी समय तक मानिटरिंग करना चाहिए । 43 वर्ष के नारियल कृषि के बाद मृदा में भिन्न पोटासियम अंश पर किए गए अध्ययन से यह देखा गया कि नारियल रोपण में पोटासियम प्रयोग नहीं किया जाए तो लाटिस पोटासियम कम हो जाता है इसलिए मृदा से पोटासियम खनन कम करने के लिए और लंबी अवधि तक मृदा उर्वरता उत्पादन क्षमता बनाए रखने के लिए पौध निकालने के अनुसार पोटासियम का प्रयोग करना अत्यावश्यक है।

वर्मीकंपोस्ट और कायर गूथा कंपोस्ट का भण्डार और उपयोग करने की अवधि उसके वाणिज्यिक मूल्य महत्वपूर्ण है। दोनों प्रकार के कंपोस्टों में काफी समय तक अमोनिया ऑक्सीकारक की संख्या कम देखा गया। लेकिन कायर गूथा की तुलना में नैट्रिक ऑक्सीकारक की समष्टि घनत्व कम हो जाता है। मृदु और प्रौढ नारियल छिल्कों काकंपोस्ट बनाने की प्रौद्योगिकी का मानकीकरण किया गया है।

केरल के कोट्टयम और पत्तनमतिट्टा जिला में जड़ मुर्झा रोग के हाट-स्पॉट क्षेत्रों में स्थित स्वास्थ्य और रोग प्रभावित नारियल ताड़ के मूलपरिवेशके मृदा में संवर्द्धन आश्रित सूक्ष्माणुवीय विश्लेषण पर अध्ययन किया गया और यह देखा गया कि स्वास्थ्य ताड़ों के मूलपरिवेश मृदा में महत्वपूर्ण संख्या में फोसफेट विलेयकों की प्रमुखता है।

प्रधानता से घटित और मूलपरिवेशित, जड एन्डोफैटिकली संबद्ध सूक्ष्माणु, एसीसी डिअमिनेस और खनिज विलेय क्षमता पहचान लिया गया कि सुपारी पीला पत्ता रोग संयुक्त मृदा में *बुरखोल्डेरिया* जाति *बेसिलस* जाति और *एन्टरोबेक्टेर* है।

दो पोषण मिश्रण' कल्प पोषक' जो नारियल पौध और किशोर ताड़ के लिए है और 'कल्प वर्द्धिनी', प्रौढ फल देने वाले ताड़ों के लिए, विकास किया गया और विमोचित किया गया। चूना, डोलोमाइट, जिप्सम जैसे संशोधनों के साथ मुख्य,द्वितीय और सूक्ष्म पोषकों के प्रयोग से दक्षिण केंद्रीय लैटाराइट में विनिमय अम्लता में कमी का कारण और मृदा उर्वरता स्थिति में सुधार पाया गया।

रोग का समीकृत प्रबंधन

वर्तमान वर्ष की अवधि में संरचनात्मक लक्षण और सात जीनों जैसे इंटेर्नल ट्रानस्क्राइब्ड स्पेसर (आई टी एस) आक्टिन (एसीटी) *काईटिन सिन्थेस1* (सीएचएस1) *ग्लिसेराल्डिहैड-3 फोसफेट डिहैड्रोजेनेसस* (जीएपीडीएच) टुठिलन, हिस्टोन *स्पेसर* (एच आइ एस3) और एपीएमएटी का बहुस्थल अनुक्रमण के अधार पर सुपारी फूल शीर्षारंभीक्षय रोग और पत्ता चित्ती/शीर्णता रोग के साथ संबद्धित *कैलेटोट्रैकम* जाति को पहचाना गया ।

सात जीनों का अनुक्रमण का संयुक्त विश्लेषण और सुपारी फूल शीर्षारंभीक्षय रोग कलेक्टोट्रैकम ओटियोरा के साथ संबद्धित सभी 15 *कलेटोट्रैकम* एकलन को पहचान पुष्ठि की गई ।

पत्ता चित्ती शीर्णता से प्राप्त 12 *कलेटोट्रैकम* में से 5 *सी फ्रटिकोला* के रूप में, एक *सी कारस्टि* और बाकि छह *सी सियामेन्से* के रुप में पहचाना गया ।

सुपारी के तीर्व आर्थिक नाश का महत्वपूर्ण रोग कारक है। पिछले तीन वर्ष से भाकृअनुप-केरोफअसं,क्षेत्रीय केंद्र विटल और अनुसंधन केंद्र, कर्नाटक में 12 कवकानी रोगनिरोधी छिड़काव (मई अंत और 45 दिनों के बाद द्वितीय छिड़काव) सुपारी के फल सड़न रोग के प्रबंधनपर प्रक्षेत्र परीक्षण प्रगति पर है। 1 प्रतिशत बोर्डो मिश्रण या 0.5% मन्डिप्रोपमिड 23.3 एससी रोग निरोधी का फुहार सुपारी का फल सड़न रोग प्रबंधन में प्रभावी पायी गयी।

बलाल पंचायत के कोन्नकाड में नारियल का कलीसड़न रोग के प्रबंधन पर पिछले तीन वर्षों से प्रक्षेत्र परीक्षण किया गया. नौ उपचार का उपयोग कर जिसमें नारियल के अंतरतम पत्ता नाली में फफूंदनाशी निहित छिद्रित पॉलिथीन थैली रखा जाता है नारियल के अंतरम पत्ता नाली में 3 ग्रा 75 डब्ल्यु पी क्लोरोथालिनिल छिद्रित थैली में रखने से नारियल के कली सड़न प्रबंधन में अधिक प्रभावी पायी गयी ।

राईनोसेरस भृंग के द्वारा क्षति 88 प्रतिशत कमकरने के लिए पत्ता नाली और तर्कु पत्ते कीट रोध नाईलोन जाली से दो बार लपेटने से प्रभावी पायी गयी । पत्ता नाली में वनस्पतीय पेल्लेट्स रखना और तर्कु पत्ते और किशोर पौध के आसपास के वृंत पर लेप अंधाधुध मारने से 69.2% तक पत्ता क्षति कम की जा सकती है लेकिन क्लोरान्ट्रिनिलिप्रोल कण से 62.5% कम किया जा सकता है। नारियल पेड के पत्ता नाली में चार हफ्ते के लिए सिट्रियोडोरा तेल (5%) अंतर्भरित सोडियम अलजिनेट बेड्स डालने से लाल ताड़ धुन से संरक्षण मिला जाता है ।

कीट रोग जनक सूत्रकृमि, *स्टेइनेरनेमा कार्पोकाप्सेई* 1.5 बिलियन *आईजेएस* प्रति हेक्टर इमिडाक्लोप्रिड 0.004% के साथ और 2 कि ग्रा नीम केक प्रति ताड़ के जल रुपांकन का मृदा प्रयोग से मूल ग्रब *(ल्यूकोफोलिस* जाति) संख्या में 91.8% कमी अंकित की गई और सुपारी उपज में 62% महत्वपूर्ण वृद्धि कर्नाटक में तीन वर्षों की अवधि में पायी गई। प्रयोगशाला अध्ययन के अधीन लाल ताड घुन ग्रब के विरुद्ध कीटरोग जनक सूत्रकृमि जैसे *स्टेइनेरनेमा* जाति एस0804 और *हेटेरोराटिडटिस इंडिका* स्ट्रेन एच 0804 और *हेटेरोराटिडटिस इंडिका* स्ट्रेन एच 0701 उत्तम निष्पादन दिखाया (72 घंटों में 200 आईजेएस दर में 100 प्रतिशत मृत्युदर)

नारियल बाग में अंतर फसलों का स्पेक्ट्रम के साथ एक फसल आवास विविधिकरण से अस्थिर अधिमिश्रण और स्टिमुलो-डिटोरेंस प्रेरित होने से राईनोसेरस भृंग और रुक्ष पृष्ठी सर्पिल सफेद मक्खी का लक्षण कम हो गया और गुठली उपज में 161 गुठली प्रति ताड़ प्रति वर्ष वृद्धि पायी गयी ।

ताड़ और कोको में उत्पादन शरीरक्रिया विज्ञान, जैवरसायन और कटाई पूर्व एवं उपरांत प्रौद्योगिकी

कोको में जलवायु परिवर्तन परिवर्ती और जल कमी तनाव (50 प्रतिशत लभ्य मृदा आद्रता और उच्च पोषण (150प्रतिशत आर डी एफ) के साथ उन्नत ताप का प्रभाव पूरे पौध पर जल उपयोग क्षमता निरीक्षण किया गया । जलवायु परिवर्तन परिवर्ती (ई सी ओ 2) के अधीन वर्द्धित पौध में परिवेशी कारबनडायओक्साइड की तुलना में उच्च समावेश दर पायी गयी ।इसके कारण 550 पीपीएम में कुल सूखा लगभग 10% का और 700 पीपीएम में 29% हो गया।

स्टोमेटल कन्टक्टन्स जलवायु परिवर्तन परिवर्ती (ई सी ओ 2) में निम्न ह। दो सी ओ 2 उपचार में उपचारित पौध समान बाष्पोत्सर्जन दर केबावजूद कुल सूखा भार में अधिक भिन्नताएँ पायी गयी । जलवायु परिवर्तन परिवर्ती (ई सी ओ 2) के अधीन वर्द्धित अधिक जल सिंचित और कम जल सिंचित पौध का डब्ल्यु यु ई सी ओ 2 में वर्द्धित पौध की तुलना में क्रमश 28% और 33% उच्च था जल कमी तनाव में जलवायु परिवर्तन परिवर्ती (ई सी ओ 2) का अतिरिक्त फायदा दिखाता है।

700 पीपीएम का जलवायु परिवर्तन परिवर्ती (ई सी ओ 2) के अधीन वर्द्धित नारियल के पत्ते में पी एन 1400 $MEinm^{-2}s^{-1}$

साटुरेट्स होता है । जलवायु परिवर्तन परिवर्ती (ई सी ओ 2) के अधीन नारियल यह सुझाव दिया जाता है कि उत्तम सूर्य विकिरण अवरोधन, अवरोधित सूर्य विकिरण को रासायनिक ऊर्जा या प्रकाशसंश्लेषण में परिवर्तनकरने की क्षमता से उच्च जैव भार उत्पादन में परिणत हो जाता है ।

कृत्रिम वातावरण में (कांच के अंदर) उच्च ताप सक्षमता के लिए पराग अंकुरण तकनीकी का उपयोग 12 नारियल जीनोटाइप छानबीन के लिए किया गया। 23.5 से 29.5, 9.7 से 16.5 और 40.1 से 43.9 तक 12 जीनोटाइप के लिए मीन कारडिनल ताप संगण किया गया ।लंबी प्रजाति एफ एम एस टी, डब्ल्यु सी टी, एल सी टी, बौनी प्रजाति सी ओडी और संकर उच्च ताप स्वीकार्यता दिखाया । लेकिन बौनी प्रजातियों एम वाई डी में कम स्वीकार्यता पायी गई । पराग अंकुरण में जीनोटाइप में अधिकतम तापमान प्रदर्शित किया और ट्यूब वृद्धि फूलन की अवधि पर उच्च ताप तनाव का अधिकसक्षम पाया ।

मृदा और हाइड्रापोनिक दोनों मे वर्द्धित एक्सप्रेशनल परिवर्तन का अन्वेषण किया गया। परिणाम से यह देखा गया कि जीन जैसे ज़िंक ट्रान्स्पोटर मेटल-निकोटियानमिन ट्रान्स्पोटर, केशन / कैलशियम एक्सचेंजर 4-लाइक, कैलसियम ट्रान्सपोर्टिंग एटीपेज़4 (एन्टो प्लाज़्मिक रेटिकुलम) ओलिगोपेप्टिड ट्रान्स्पोर्टर)

मुख्य पौध ट्रान्स्पोटर जैसे मेटल सक्षम प्रोटिन, प्राकृतिक प्रतिरोध सह संबद्ध माक्रोफेज प्रोटिन परिवार ट्रान्स्पोर्टर थोडा सा एक्सप्रेशन दिखाया । रियल-टाइम पी सी आर आधारित सापेक्ष परिमाणीकरण – सेलेक्ट पोषण ट्रान्स्पोर्टर जीन्स मृदा में वर्द्धित ताड़ के पत्ते से डी एन ए उपयोगकर कालिब्रेटर के रुप में और जीन नॉर्मलाईज़र के रूप में *CnTUB* जीन पाया गया । कि जीन CnSERCA दोनों जातियोंमें नियंत्रित किया जाता है। जबकि CnCCX और CnOPT का विभेदीय विनिमय का निरीक्षण किया गया ।

कुल 26 एन्थोसयानिन संयुक्त नारियल चोल (बीज कवच) से पहचाना गया जो नारियल का एक उपोत्पाद, युपीएलसी-एमएस/एमएस उपयोग कर नारियल प्रक्रमण कारखाने में निकाला जाता है। चार मुख्य एन्थोसयानिन-माल्विडिन, डैल्फिडिन, सयानिडिन और पेलारगोनिडिन परिणामीकरण कियागया जिसमें सयानिडिन प्रबल पाया गया। जिसमें एन्थोसयानिन में अधिकांश प्रदाहक विरोधी, स्थूल विरोधी, ऑक्सिकरण विरोधी और विकिरण संरक्षण गुण है ।

अधिकतम पवर स्तर (900 वाट्स) और उच्च खुला समय के साथ माईक्रोवेव उपचार से कल्परस में सूक्ष्म जीवाणुओं निष्क्रिय कर देने के कारण 16 दिनों तक जीवन अवधि बढ जाता है ।लेकिन ओरगानोलेप्टिक गुण जैसे रंग, गन्ध और रुचि बनाए रखा जा नहीं सकता ।यह स्वीकार्यता पर प्रभावित है। सात दिन तक इष्टतम जैवरासायनिक संघटक, ओरगानोलेप्टिक गुणों का अनुरक्षण किया जाता है। जब कल्परस 600 वाट्स60 के विद्युत शक्ति पर उपचार करने से। और 4 डिग्री-6 डिग्री के तापमान में प्रशीतित किया जाता है। माईक्रोवेव उपचारित डाब पानी, 15 से 17 दिनों तक बिना रंग मिलाप से प्रशीतित परिस्थिति के अधीन – सोडियम मेटाबैसल्फैट (0.03 और 0.05 प्रतिशत) ये आठ हफ्ते केलिए सफलता पूर्वक भण्डार किया जा सकता है ।

नारियल दूध, शक्कर, मृदु नारियल पानीऔर पल्प का उपयोग कर शतीकृत नारियल मिठास और समान मिठास, लाक्टोस असहिष्णुता से पीडित और नारियल दूध का वसा मात्रा-11 प्रतिशत तक कम किया जा सकता है।

शारीरिक, सेंसरी और जैव रासायनिक परिणाम से यह देखा गया कि 50 प्रतिशत गेहुँ आटा, 20 प्रतिशत नारियल दूध अवशेष 30 प्रतिशत कटहल बीज आटा आदि बिस्कुट बनाने के लिए उत्तम संयुक्त है ।

प्रोटो टाइप एक लघु ट्राक्टर माउंट एयर ब्लास्ट स्प्रेयर ज़मीन स्तर से सुपारी ताड पर छिड़काव के लिए निर्माण किया गया । यह स्प्रेयर कीटनाशियों/फफूंदों का छिड़काव छत्र/गुच्छों पर सक्षम, स्वचालित छिड़काव किया जाता है। सुपारी रोपण में छिड़काव का यांत्रिकीकरणकी आवश्यकता के विचार में बिना मानव के एरियल वाहन सहाय स्प्रेयर का विकास जेनरल एयरोनोटिकल प्राइवेट लिमिटेड और भारतीय विज्ञान संस्थान, बैंगलूर के सहायोग के साथ विकास किया गया है ।इस यंत्र का पहला प्रोटोटाइप, 15 मिनिट का विमान सहनशीलता परीक्षण अधिकतम ऊंचाई 1 के मी और क्षमता 6 लीटर और छिडकाव ड्रापलेट नाली आकर 200-300 माईक्रान है और उसका उपयोग पर प्रदर्शित की गई ।

प्रौद्योगिकी हस्तांतरण,आर्थिकी एवं सॉख्यिकी विधि

रोपण फसल क्षेत्र में आय उत्पादन उद्यम 'फीड द फ्यूचर इंडिया ट्रायांगुलर' प्रशिक्षण कार्यक्रम और नारियल और कोको का मूल्य वर्द्धन और उपज विविधीकरण पर दो लघु अवधि प्रशिक्षण कार्यक्रम आयोजित किया गया। इसके अतिरिक्त नारियल उत्पादन प्रौद्योगिकियॉ पर एक दिवसीय दो प्रशिक्षण कार्यक्रम संस्थान / संगठन जैसे राष्ट्रीय कृषि विस्तार प्रबंधन संस्थान, हैदराबाद, इंडिया-आफ्रिका फोरम सम्मिट – III और भारतीय रोपण फसल प्रबंधन संस्थान, बैगलूर के सहयोग में आयोजित किया गया जिसमें 14 देशों से 75 विदेशी प्रतिनिधियों ने भाग लिया। रोपण फसल के लिए भागीदारी प्रौद्योगिकी हस्तांतरण पहल पर एक मोडल प्रशिक्षण कार्यक्रम दिनांक 12-19 दिसंबर 2017 को आयोजित किया गया ।जिसका प्रायोजन विस्तार निदेशालय, कृषि एवं किसान कल्याण मंत्रालय, भारत सरकार द्वारा किया गया । जिसमें तमिलनाडु, केरल , जम्मु काश्मीर और दिल्ली से 24 विस्तार अधिकारियों ने भाग लिया ।) नारियल, सुपारी और कोको से संबंधित प्रौद्योगिकियों का फसल सुधार, फसल उत्पादन, संरक्षण और मूल्य वर्द्धन सेसंबंधित प्रौद्योगिकियों पर किसानों के लिए 59 प्रशिक्षण कार्यक्रम आयोजित किया गया। (4059 प्रतिभागीगण थे) रोपण पसल पर विभिन्न विषयों पर 27 अभिमुखी कार्यक्रम आयोजित किया गया जिसमें 4 अभिमुख वीडियों सम्मेलन द्वारा आयोजित किया गया।

ई-कल्प, एक आन्ड्रोइड मोबाइल डिजिटल पहल हासिल करें, इसके साथ किसानों को किसी भी समय पर अन्तर/मिश्रित फसल, नारियल,सुपारी और कोको उत्पादनऔर मूल्य वर्द्धन परप्रौद्योगिकी और आधार ज्ञान मुफ्त प्राप्त करें। इस अप्लिकेशन प्रयोग सहाय पॉच भाषाओं जैसे अंग्रेज़ी, मलयालम, हिंदी, कन्नड़ और तमिल में प्राप्त किया जा सकता है। ई-कल्प उपयोगकर्ताओं की संख्या 2000 से अधिक हो गई है। प्रतिदिन 5 प्रक्षेत्र समस्याएँऑनलाइन रिपोर्ट किया जा रहा है। इस मोबाइल अप्लिकेशन के रेटिंग स्केल में 4.6 और 0 से 5 तक है ।इससे इसकी प्रायोगिकता और उपयोगकर्ता मैत्री सूचित कियाजाता है।

किसान सम्मेलन और कृषि व्यापार प्रदर्शनी 2018 छह दिन लंबी घटना (5-10 जनवरी 2018) संस्थान का स्थापना दिवस और कृषि विज्ञान केंद्र , कासरगोड की रजत जुबिली समारोह की यादगार में (जनवरी 5)आयोजित किया गया । केरोफअसं के शत वर्ष की यादगार में एक डाक टिकट-डाक विभाग, भारत सरकार की ओर से निकाला गया और किसान मेला के अवसर विमोचित किया गया। भाकृअनुप-केरोफअसं, एन ए आर एस के अधीन तीसरासंस्थान है जिसे भारतीय डाक टिकट में छापा है। उत्तर-दक्षिण क्षेत्रों में कृषक समुदाय के लाभ के लिए प्रौद्योगिकीय फायदा दिखाने के लिए फरवरी 19-20, 2018 को काहिकुची में किसान मेला आयोजित किया गया।

देश के विभिन्न स्थानों में आयोजित 26 प्रदर्शनियों मे संस्थान ने भाग लिया । नौ नूतन प्रौद्योगिकियों से संबंधित सूचनाँ अर्जित करने के लिए 5892 किसान, 166 विस्तार कार्मिक, 3232 छात्र और 212अन्य हितहितधारी ने संस्थान का संदर्शन किया। उत्तम प्रबंधन पर किसान भागीदारी प्रदर्शनी, मृदा स्वास्थ्य प्रबंधन, नारियल में उत्पादन क्षमता बढ़ाने के लिए 60 किसानों के बागों में आयोजित किया गया । केरल राज्य के 6 कृषि पारिस्थितिक एककों में फैले हुए (तिरुवनन्तपुरम, कुलशेखरम-कोल्लम, आलप्पुषा में चेरतला, पतनमतिट्टा में नेडुम्पुरम, कोट्टयम में कूरोप्पादा, त्रिचूर में वेल्लंगल्लूर और कोषिकोड में पाराक्कडवु) ।सुपारी आधारित बहुजातिय फसलन पद्धति में किसान भागीदारी प्रदर्शनी कार्यक्रम 8 प्रक्षेत्र में प्रांरभ किया गया।

किसानों की आजीविका सुरक्षा सुनिश्चित करने और भागीदारी प्रौद्योगिकी और संसाधन उपयोग सशक्तीकरण के लिए पथियूर पंचायत मे फार्मर फस्ट (फार्म, नवीनता, संसाधन और प्रौद्योगिकी)प्रदर्शित की गयी।

कीट एवं रोग आकलन के लिए उत्तम नमूना विधियॉ पहचानने के लिए सुपारी मेमुख्य रोग एवं कीट लक्षण का स्थानिक वितरण पर अध्ययन किया गया ।

बौद्धिक संपदा प्रबंधन और हस्तांतरण/वाणिज्यिकीकरण

नारियल चिप्स टुकड़ा करने की मशीन के लिए इस वर्ष एक राष्ट्रीय पेटेंट संस्थान को प्राप्त किया गया (पेटेंट सं 285418) 285418) संस्थान को तीन ट्रेड मार्क पंजीकरण जैसे केरोफअसं प्रतीक चिह्न (सं 2574582) कल्प लोगो (सं 2320116) और कोको प्रोबायो (सं 2813920) भी प्राप्त किया गया ।इस वर्ष 2017-18 की अवधि में कुल 55 प्रौद्योगिकी हस्तांतरण किया गया है और 16.26 लाख रूपए राजस्व प्राप्त किए गए ।कल्परस उत्पादन की प्रौद्योगिकी उन्नयन के लिए तीन वृत्तिभोगियों, कृष्णा प्लांटेशनप्राइवेट लिमिटेड, गोवा, पालघाट कोकोनट प्रोड्यूसर कंपनी और श्री राम मोहन तिरुप्पूर को सहाय दिया जा रहा है। ठंठा जमा नारियल मिठास पर तकनीकी जानकारी श्री हांगयो आईसक्रीम प्राइवेट लिमिटेड को बड़े पैमाने पर उत्पादन के लिए दिया गया। प्रौद्योगिकी नवीनता और उद्यमशीलता पर विद्यार्थियों और युवकों के बीच जागरूकता पैदा कराने के लिए कासरगोड में दो कार्यक्रम, विज्ञान पर अभिमुख,नवीनता और उद्यमशीलता (15 सितंबर 2017) और स्टार्ट अप ग्रीन 2018 (7 जनवरी 2018) आयोजित किया गया ।

कृषि विज्ञान केंद्र

भाकृअनुप-कृविके, कासरगोड की ओर से मुख्य अनिवार्य गतिविधियों जैसे प्रौद्योगिकी निर्धारण और परिष्कार के भाग के रुप में 6 फार्म परीक्षण और10 विशेष अग्रणी प्रदर्शनियॉ 2017-18 की अवधि में आयोजित की गई । भाकृअनुप-कृविके, कायम्कुलम की ओर से 55 कैंपस प्रशिक्षण कार्यक्रम और कैंपस के बाहर 37 प्रशिक्षण कार्यक्रम और ई डी पी मोड पर 13 प्रायोजित कार्यक्रम और तीन व्यावसायिक प्रशिक्षण कार्यक्रम 2017-18 की अवधि में आयोजित किया गया ।

III EXECUTIVE SUMMARY

ICAR-Central Plantation Crops Research Institute (ICAR-CPCRI), one of the premier agricultural research institutions in the National Agricultural Research System of India, is mandated to conduct and coordinate basic and applied research on coconut, arecanut and cocoa. Productivity improvement, farming systems approach and value addition are important avenues available to enhance the production and profitability of small holder's plantation crops like coconut, arecanut and cocoa. In the current year, thrust has been given to develop technologies to achieve improved productivity and profitability through several result oriented initiatives, including utilization of genetic resources, re-orienting crop management strategies and addressing concerns in value chain and technology dissemination through farmer participatory mode. The progress of research work in nine mega projects and externally funded projects of the Institute during the year 2017-18 is presented in this report under seven thematic areas *viz.*, genetic resources management and utilization, biotechnology and bioinformatics, cropping systems and bioresource management, integrated management of diseases, pests and nematodes, physiology, biochemistry and value chain management, technology transfer, economics and statistical methods. Besides, the activities of AICRP on Palms and the two *Krishi Vigyan Kendra*s (KVKs) functioning under this institute are also presented. The salient findings, under each thematic area, are as follows:

Genetic Resources Management and Utilization

Efforts to enrich the germplasm with gene sources for specific traits resulted in enhancing the collections to 455 in coconut, 176 in arecanut and 505 in cocoa, making India a global leader in conservation of genetic resources of coconut and arecanut. About 150 embryos each from Kalpa Haritha, Chowghat Green Dwarf, Kalpatharu, Laccadive Ordinary Tall, Laccadive Micro Tall, and West Coast Tall are under cryo-conservation, to serve as a base collection in the National Cryo Genebank at ICAR-NBPGR, New Delhi. Establishment of alternative field gene banks of cocoa, for safety duplication of core cocoa genetic resources, was taken up in different agro-ecological zones, with planting of 61 accessions at ICAR-CPCRI, Research Centre, Kidu, Karnataka, 57 accessions at TNAU, Coimbatore and 39 accessions at YSRHU, Andhra Pradesh.

In the conserved coconut germplasm evaluation trial, Federated Malay States Tall (132 nuts palm^{-1} year^{-1}) recorded significantly higher fruit yield over West Coast Tall (101 nuts palm^{-1} year^{-1}). The high yielding selection of Federated Malay States Tall (FMST) also recorded higher copra yield (24.47 kg palm^{-1} year^{-1}), higher inflorescence sap yield potential, along with good tender nut water quality, and is recommended for release for commercial cultivation in the coconut growing tracts of Kerala. The two coconut hybrids recommended for release, COD x WAT and COD x LCT, continued to show superiority in yield with more than 150 nuts palm^{-1} year^{-1}, and seedlings have been distributed for establishment of technology evaluation trial in Tamil Nadu.

At Kahikuchi, Assam, Chandra Sankara recorded relatively higher annual nut yield (72 nuts palm^{-1}) along with nut weight (774.30 g nut^{-1}) and copra content (176.67 g nut^{-1}). At ICAR-CPCRI Research Centre, Mohitnagar, West Bengal, the tall accessions recorded higher nut yield as compared to hybrids and dwarfs, with relatively higher annual nut yield in BARI Narikel 1 (98 nuts palm^{-1}), followed by Agailjhara Tall (90 nuts palm^{-1}).

At Kayangulam, in the evaluation for root (wilt) disease tolerance, CGD x WCT continued to record less root (wilt) disease incidence and highest yield of 85 nuts palm^{-1} year^{-1} followed by CGD x MGD with 71 nuts palm^{-1} year^{-1}. Dwarf accessions, Niu Leka Dwarf and Gangabondam were identified as early flowering with higher yield potential.

Evaluation for inflorescence sap yield and quality among coconut accessions indicated significant influence of genotypes and seasons on inflorescence sap yield and quality parameters. The quality of inflorescence sap tapped from different accessions

varied significantly with respect to total sugars, phenol and protein content.

Among the conserved arecanut germplasm under evaluation for yield and other economic traits, accessions, VTL-146, VTL-100, VTL-125 VTL-126 and VTL-85, showed high yielding tendency with dry kernel yield of 3.88, 3.80, 3.64, 3.59 and 3.51 kg palm^{-1} year^{-1}, respectively, at Vittal. At Mohitnagar, VTL-60, VTL-5, VTL- 29 and VTL-27 exhibited superiority for yield, with dry kernel yield of 4.22, 2.51, 3.71 and 1.04 kg palm^{-1} year^{-1}, respectively. At Vittal, evaluation of eight dwarf hybrids involving Hirehalli Dwarf (HD), the hybrids HD × Mohitnagar, HD×Sumangala and HD×Mangala recorded comparatively higher annual yield of 2.58, 2.38 and 2.31 kg palm^{-1} year^{-1}. At Mohitnagar, higher annual dry kernel yield was recorded in HD× Mohitnagar (1.046 kg palm^{-1}), followed by Mohitnagar× HD (0.927 kg palm^{-1}). At Kahikuchi, relatively higher annual dry kernel yield was recorded in Sumangala × HD (1.34 kg palm^{-1}), followed by Mohitnagar × HD (1.29 kg palm^{-1}). Among the 16 tall hybrid combinations under evaluation for yield at Vittal, Shriwardhan×Sumangala recorded highest dry kernel yield of 3.85 kg palm^{-1} year^{-1}, followed by Mohitnagar × Mangala with 3.58 kg dry kernel palm^{-1}year^{-1}.

Analysis of the total phenolic contents and the anti-oxidant potential in *Areca catechu* and its related genera/species like *Actinorhytis calapparia*, *Areca triandra* and *Normanbya normanbyi* showed that different species of *Areca* and *Actinorhytis* possess free radical scavenging capacity and antioxidant property that can help neutralize free radicals and also prevent the initiation of free radical mediated chain reactions in biological membranes.

Cocoa clones, with more retention of pods per cushion and distribution of more pods over both orthotropic and plageotropic shoots, have been identified. Five clones with pendulous growth habit suitable for high density planting and trellis hedge row systems have been identified and clones with bean index 1.5-2.0 are identified for quality improvement. Released cocoa variety VTLCH 2 was found to perform well, under both arecanut and coconut, in the multi-location trials at Karnataka, Kerala, Tamil Nadu and Andhra Pradesh. Four high yielding cocoa clones of Forastero types (CYT-C9, COMP-24, LAL-75 and ST-1-48) and four Trinitario types (AMAZ-2, CYT-24, MLTG-6 and B-4-3-1) were identified with more pods per cushion in the range of 5-13, which exhibited physiological/ cauliflorous vigour, high retention of fruits and less cherelle wilt.

About 7,96,580 planting material units were produced during the year, including 70,823 in coconut, 6,41,860 in arecanut and 83,897 in cocoa. A coconut pollen cryo-preservatory with a capacity to store 6,000 pollen vials was established at Regional Station, Kayamkulam. About 220 Chowghat Green Dwarf mother palms were utilized in crossing programme for augmenting the production of 'Kalpa Sankara' hybrids for the root (wilt) disease prevalent tracts in southern Kerala.

Biotechnology and Bioinformatics

The coconut embryo cryopreservation protocol has been validated in a wide range of cultivars. Embryo rescue technique has been successfully utilized for retrieving interspecific hybrids of *A. triandra* x *A. catechu* (Mangala cultivar). In arecanut cryopreservation studies, maximum survival and somatic embryo formation in cryopreserved embryogenic calli was observed in cultures pre-grown at 0.3 M sucrose and dehydrated for 30 minutes in PVS3 solution. Plantlet recovery from these cryopreserved embryogenic calli was achieved. The ambitious programme of whole genome sequencing of coconut has progressed well. Assembly and annotation of Chowghat Green Dwarf palm has been completed. Assembly of deep sequencing data obtained using hybrid sequencing strategy, with short reads from Illumina and long reads from Pacific Biosciences sequencing, resulted in a total of 59,328 scaffolds with a N50 of 86 Kb and G+C % of 31.79. As a result of this hybrid assembly approach, the final draft genome representing CGD genome had a total size of 1.83 Gb with 51953 predicted genes. A total of 47,746 genes (91.9%) could be annotated.

Areca catechu, Areca concinna and *Areca triandra* were characterized using Start Codon Targeted polymorphism (SCoT) and markers unique to *A. catechu* and *A. triandra* were identified. SCAR markers specific to *A. catechu* and also to *A. triandra* were designed. Now, authentic inter-specific hybrids between *Areca catechu* and *Areca triandra* could be identified utilizing these SCAR markers.

Cropping Systems and Bioresource Management

The coconut based mixed farming system involving coconut, pepper, banana, dairy unit, fisheries and poultry realized an annual net return of Rs. 6,72,725/-ha^{-1}. The coconut based high density multi species cropping system with organic matter recycling involving coconut, pepper, banana, nutmeg, cinnamon realized an annual net return of Rs. 7,25,000/- ha^{-1}. The arecanut based mixed farming system involving arecanut (0.16 ha), grass, dairy unit, 6-7 milching cows and fisheries realized an annual net return of Rs. 5,27,227/- ha^{-1}, underscoring the profitability of coconut/arecanut based multispecies cropping/farming systems.

Harvesting of tender nut throughout the year, at 25 days interval, recorded significantly higher yield (167-195 tender nuts palm^{-1} year^{-1}), for the last three years (2015 to 2017), as compared to the practice of harvesting for six months in year or alternate year or alternate bunches or harvesting mature nuts. There was no deleterious effect of continuous tender nut harvesting on growth parameters of the palms.

Potassium is the nutrient element which is taken up by coconut in larger quantity compared to any other elements. This warrants monitoring soil potassium status over time. The changes occurred in the different potassium fractions in soil after 43 years of coconut cultivation were studied from a long term fertilizer cum manurial experiment and the results revealed that the lattice potassium is depleted in the long run when potassium application is not taken up in coconut plantations. Hence, it is imperative to apply potassium according to the plant removal, in order to reduce potassium mining from soil and to sustain soil fertility and productivity in the long term.

The shelf life of the vermicompost and coir pith compost is important for their commercial value. Quantitative estimates showed decreased number of ammonia oxidizers over time in both types of composts. However, decline of population density of nitrite oxidizers was quite rapid in vermicompost as compared to coir pith compost. Technology for composting tender and mature coconut husk has been standardized.

Studies on culture dependent microbial analysis conducted in the rhizosphere soils of healthy and diseased coconut palms, located in the hot spot areas of root (wilt) disease in Kottayam and Pathanamthitta districts of Kerala, indicated the dominance of phosphate solubilizers in significant numbers in rhizosphere soils of healthy palms.

The predominantly occurring and rhizospheric, root endophytically associated microbes with ACC deaminase and mineral solubilization potential were identified as *Burkholderia* sp., *Bacillus* sp. and *Enterobacter* sp. in arecanut YLD disease complex soils.

Two nutrient mixtures, 'Kalpa Poshak' for seedling and juvenile palms of coconut and 'Kalpa Vardhini' for adult bearing palms were developed and released. Application of major, secondary and micronutrients along with amendments such as lime, dolomite and gypsum was observed to cause reduction in exchangeable acidity in South Central Laterite along with improvement in soil fertility status.

Integrated Management of Diseases

During the current year, *Colletotrichum* species associated with arecanut inflorescence dieback disease and leaf spot/blight disease were identified based on morphological characters and multilocus sequencing of seven genes *viz.*, internal transcribed spacer (*ITS*), actin (*ACT*), chitin synthase 1(*CHS-1*), glyceraldehyde-3-phosphate dehydrogenase (*GAPDH*), β- tubulin (*β-Tub*), histone spacer (*HIS3*) and *ApMat*. Combined analysis of sequences of seven genes and morphological data confirmed the identity of all the 15 *Colletotrichum* isolates associated with arecanut inflorescence dieback disease as *Colletotrichum aoteora*. Out of 12 *Colletotrichum* isolates obtained from leaf spot/blight disease, five were identified as *C. fructicola*, one as *C. karstii* and the remaining six identified as *C. siamense*.

Fruit rot disease of arecanut caused by *Phytophthora meadii* is another important pathogen of arecanut causing severe economic loss. A field trial on management of fruit rot disease of arecanut has been in progress for the last three years at ICAR-CPCRI, Regional Station Vittal and ICAR-CPCRI, Research Centre Kidu in Karnataka using 12 fungicides (prophylactic spraying during May end and second spray after 45 days). Prophylactic spraying of 1 % Bordeaux mixture or 0.5 % mandipropamid 23.3 Sc was found be effective in management of fruit rot of arecanut.

Field trial on management of coconut bud rot disease was conducted in Konnakkad of Balal panchayat for the last three years, using nine treatments which

involved the placing of two perforated polythene sachets containing fungicides in the inner most leaf axils of coconut palm. Placing of perforated sachets containing 3 g of Chlorothalinil 75 WP in the inner most leaf axil was found to be more effective for the management of bud rot in coconut.

Integrated Management of Pests

Multiple wrapping of leaf axil and spear leaf with insect proof nylon nets was effective in reducing rhinoceros beetle damage by 88%. Placement of botanical pellets on leaf axil and swiping of paste on the spear leaf and adjoining petiole of juvenile palms indicated significant reduction in leaf damage by 69.2%, compared to 62.5% with chlorantraniliprole granules. Citriodora oil (5%) impregnated sodium alginate beads provided protection from red palm weevil for four weeks when applied in leaf axils of coconut palm.

Soil application of aqua formulation of entomopathogenic nematodes, *Steinernema carpocapsae* @ 1.5 billion IJs ha^{-1} with imidacloprid 0.0045% and neem cake 2 kg $palm^{-1}$ recorded 91.8% reduction in root grub (*Leucopholis* spp.) population with significant increase in arecanut yield (62%) in a period of three years at Karnataka. Entomopathogenic nematodes *viz.*, *Steinernema* sp. strain S0804 and *Heterorhabditis indica* strain H0701 showed better performance (100% mortality @ 200 IJs in 72 hours) against red palm weevil grubs under laboratory studies.

A crop habitat diversification, with a spectrum of intercrops, in coconut garden induced volatile admixture and stimulo-deterrance resulted in reduced incidence of rhinoceros beetle and rugose spiralling whitefly and increased nut yield to 161 nuts $palm^{-1}$ $year^{-1}$.

Physiology, Biochemistry and Value Chain Management

In cocoa, interactive effects of climate change variables [ECO_2] and elevated temperature with water deficit stress [50% available soil moisture (ASM)] and high nutrients (150% RDF) on whole plant water use efficiency (WUE) were observed. Seedlings grown under [ECO_2] had higher assimilation rates than seedlings in ambient CO_2, and this caused an increase in total dry mass of about 10% at 550 ppm and 29% at 700 ppm. Stomatal conductance was lower in [ECO_2]. Seedlings subjected to two CO_2 treatments showed similar transpiration rates despite large differences in total dry mass. WUE of well-watered and water-stressed seedlings grown under [ECO_2] was 28% and 33% higher, respectively, than WUE of seedlings grown in ambient [CO_2], suggesting additional advantage of [ECO_2] during water deficit stress.

The leaves of coconut grown under [ECO_2] of 700 ppm, revealed that Pn saturates at 1400 μEin m^{-2} s^{-1}. It thus suggests that coconut under [ECO_2] exhibits better solar radiation interception, conversion efficiency of intercepted solar radiation into chemical energy or photosynthesis, and would result in higher biomass production.

An *in vitro* pollen germination technique was used to screen 12 coconut genotypes for high temperature tolerance. Mean cardinal temperatures calculated from the bilinear model for the 12 genotypes ranged from 23.5°C to 29.5°C, 9.7°C to 16.5°C and 40.1°C to 43.9°C for T_{opt}, T_{min} and T_{max}, respectively. Tall cultivars, FMST, WCT, LCT, the dwarf cultivar COD and the hybrids showed better adaptability to high temperature, while the dwarf cultivar, MYD was the least adaptable. The genotypes that exhibited higher T_{max} for pollen germination and tube growth could plausibly be more tolerant to high temperature stress during flowering.

Expressional changes of nutrient transporter gene families of Malayan Yellow Dwarf and Kalpatharu grown in both soil and hydroponics were investigated. The results show the expression of genes such as zinc transporter (*cnZIP*), metal-nicotianamine transporter *YSL9* (*cnYSL9*), cation/calcium exchanger 4-like (*cnCCX4*), calcium-transporting ATPase 4 (endoplasmic reticulum Ca^{2+}-ATPase) (*cnSERCA*), oligopeptide transporter (*cnOPT*). Interestingly, the major plant transporters such as metal tolerance protein (*MTPA2*), natural resistance-associated macrophage protein (NRAMP) family transporter (*NRAMP3*) showed little expression. Real-time PCR (RT-qPCR) based relative quantification of select nutrient transporter genes using the cDNA from leaves of soil grown plants as calibrator and *CnTUB* gene as a normalizer revealed that gene *CnSERCA* is down regulated in both the cultivars whereas, differential regulation of *CnCCX* and *CnOPT* genes were observed.

A total of 26 anthocyanin compounds were identified from coconut testa, a by-product of coconut

processing industries, using UPLC-MS/MS. Four major anthocyanins namely malvidin, delphinidin, cyanidin and pelargonidin were quantified, of which cyanidin was found to be predominant followed by delphinidin. Most of these anthocyanins identified are reported to possess anti-inflammatory, anti-obese, anti-diabetic, anti-oxidant and radiation protection properties.

Phytosterols are plant sterols structurally similar to cholesterol and act in the intestine to lower the cholesterol absorption. VCO prepared following the hot process, fermentation and direct dry expelling contain phytosterol (expressed as mg beta-Sitosterol) in the range of 60.1 mg to 95.4 mg 100 g^{-1} oil with the mean average of 73.4±8.0 mg 100 g oil^{-1}.

Coconut sugar at the dose of 2g kg^{-1} body weight exerted comparable effects with the control animals with regard to change in body weight, hematological parameters and organ weight. This information will be used to study the anti-diabetic and hypolipidimic activity of coconut palm sugar.

Microwave treatment with maximum power level (900 W) and high exposure time (120 s) inactivated the spoilage causing microorganisms in *Kalparasa*, thereby increasing its shelf life to 16 days, but could not maintain the organoleptic characters like colour, flavour and taste of *Kalparasa*, detrimentally affecting the overall acceptability. Optimal biochemical constituents and organoleptic properties were maintained for up to seven days when *Kalparasa* was treated at the power level of 600W for 60s and stored at refrigerated temperature of 4°C - 6°C. Microwave-treated tender coconut water (TCW) with sodium metabisulfite (SMS) (0.03% and 0.05%) could be successfully stored for eight weeks under the refrigerated condition and 15 to 17 days under ambient condition without any discoloration.

Frozen Coconut Delicacy is a unique delicacy made using coconut milk, coconut sugar, tender coconut water and pulp and it is a vegan product, best for those suffering from lactose intolerance, and the fat content of coconut milk has been reduced to 11%. The physical, sensory and biochemical results showed that 50% wheat flour, 20% coconut milk residue and 30% jackfruit seed flour was found to be the best combination for biscuits. Coconut milk powder with 10% egg albumin and 0.5% coconut milk cake was found to be the best based on the parameters *viz.*, solubility (min), ability to flow and particle size distribution (mm).

A prototype of a mini tractor mounted air blast sprayer, to spray the arecanut palms from the ground was fabricated. This sprayer produces efficient, atomized spray of insecticides/fungicides on the crown/bunches of the arecanut palm. Considering the need for mechanization of spraying operations in arecanut plantations, an Unmanned Aerial Vehicle (UAV) assisted sprayer was developed in collaboration with M/S General Aeronautics Pvt. Ltd., IISC, Bangalore. The first prototype of this machine, with flight endurance of 15 minutes, maximum height of 1 km, payload capacity of 6 litre and spray droplet nozzle size of 200-300 micron, has already been fabricated and its utility demonstrated.

Technology Transfer, Economics and Statistical Methods

Two short-duration training programmes, "Feed The Future India Triangular Training (FTF ITT) programme" on Income Generating Enterprises in Plantation Sector and the training programme on "Value Addition and Product Diversification of Coconut and Cocoa" and two one-day training programmes on "Coconut Production Technologies" were conducted in the year with the participation of 75 foreign delegates from 14 countries, in collaboration with institutes/organizations *viz.*, National Institute of Agricultural Extension Management (MANAGE), Hyderabad, India-Africa Forum Summit-III (IAFS-III) and Indian Institute of Plantation Management, Bangalore. A Model Training Course on 'Participatory technology transfer approaches for plantation crops' sponsored by the Directorate of Extension, Ministry of Agriculture and Farmers' Welfare, Government of India was conducted during 12-19 December 2017 with the participation of 24 extension officers from Tamil Nadu, Kerala, Jammu & Kashmir and Delhi.

A total of 59 training programmes for farmers (4059 participants) and nine programmes for extension personnel (279 participants) on technologies pertaining to crop improvement, crop production, protection and value addition of coconut, arecanut and cocoa were conducted. Twenty seven interface programmes on various aspects of plantation crops were conducted which includes four interface programmes conducted through videoconferencing.

'e-kalpa', an android based mobile digital initiative, was launched to facilitate hassle-free access to the knowledge base and technologies on production and value addition of coconut, arecanut and cocoa, along

with inter/mixed crops at any time convenient to farmers. The application supports five languages at present (English, Malayalam, Hindi, Kannada and Tamil). The user base of e-kalpa has exceeded 2000 and every day 3 to 5 field problems are being reported online. Rating of this mobile application is 4.6 in scale of 0 to 5, indicating its practical relevance and user friendliness.

'Kisan Conference and Agri Business Expo 2018' a six-day long event (5-10 January 2018) was organized to commemorate the Foundation Day of the Institute (January 5) and the Silver Jubilee celebrations of the Krishi Vigyan Kendra, Kasaragod. The postage stamp brought out by the Department of Posts, Government of India to commemorate the 100 years of CPCRI was released during the *Kisan Mela.* ICAR-CPCRI is the third institute under NARS to get imprinted in an Indian Postal Stamp. ICAR-CPCRI also organized a *Kisan Mela* at Kahikuchi from 19-20 February 2018 to showcase the technological advancements for the benefits of farming community in the NE region.

The Institute has participated in 26 exhibitions held in various places across the country. Large number of farmers (5892), extension personnel (166), students (3232) and other stakeholders (212) visited the institute to acquire information related to novel technologies.

Participatory technology and resource utilization to empower and ensure livelihood security of farmers was demonstrated under Farmer FIRST (Farm, Innovation, Resources, Science and Technology) program in Pathiyoor panchayat covering an area of 1657 ha.

Spatial distribution of major disease and pest incidence in arecanut were studied to find out the best sampling procedure to estimate the pest and disease incidence and the results reveals that the spatially balance stratified sampling technique performs better in the case of YLD and mites, where the data is auto-correlated or in cluster form

The Institute received one national patent this year for "Coconut chips slicing machine" (Patent No.285418). The Institute also got three trade mark registrations viz., CPCRI emblem (No. 2574582), Kalpa logo (No. 2320116) and Cocoa Probio (No. 2813920). A total of 47 technology transfers took place in the year 2017-18 and a revenue of Rs. 16.26 lakh was realized.

Support for technology scaling up of production of 'Kalparasa' is being extended to three incubatees: M/s Krishna Plantations Pvt. Ltd., Goa; M/s Palakkad Coconut Producer Company and Sri. Ram Mohan, Tiruppur. In the case of technology know-how on frozen coconut delicacy, M/s Hangyo Ice Cream Pvt. Ltd., is provided assistance for large scale production.

All India Coordinated Research Project on Palms

'Abhaya Ganga' and 'Gauthami Ganga' coconut varieties have been recommended for cultivation in Andhra Pradesh. For managing problem of black headed caterpillar in Southern States, AICRP Centres could produce parasitoids viz., *Goniozus nephantidis* (624,150 nos.), *Bracon brevicornis* (1,72,000 nos.) and *Bracon hebetor* (1,61,090 nos.) and supply them to farmers so that the pests could be managed without resorting to pesticide application. Among the oil palm tenera hybrids being evaluated in Tamil Nadu, the FFB yield realized was significantly higher with NRCOP 17 (37.1 t ha^{-1}), and was on par with NRCOP 20 (36.0 t ha^{-1}).

Krishi Vigyan Kendras (KVKs)

ICAR-KVK, Kasaragod had undertaken six On Farm Trials (OFTs) and 10 Front Line Demonstrations (FLDs) during 2017-18 as a part of its mandatory activities *viz.*, technology assessment and refinement. ICAR-KVK, Kayamkulam organized 55 on-campus training programmes and 37 off campus training programmes and 13 sponsored programmes on EDP mode and three vocational training programmes were organized during 2017-18. ICAR-KVK, Alappuzha was awarded the for Zone XI for its achievements as the knowledge and resource centre in the field of Agriculture and allied sciences for the district. The KVK has taken up many relevant on farm trials, Frontline demonstrations, farmer field schools, training programmes and method demonstrations during the year and organized awareness programmes such as Sankalp Se Sidhi, Mahila Kisan Diwas, World Soil day etc as per guidelines of the Govt. of India. Moreover the KVK promotes a Farmer Producer Company of Spice farmers and implement the technology demonstration component of the prestigious NICRA project of ICAR in Kuttanad region.

IV

VISION MISSION AND MANDATE

VISION

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

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

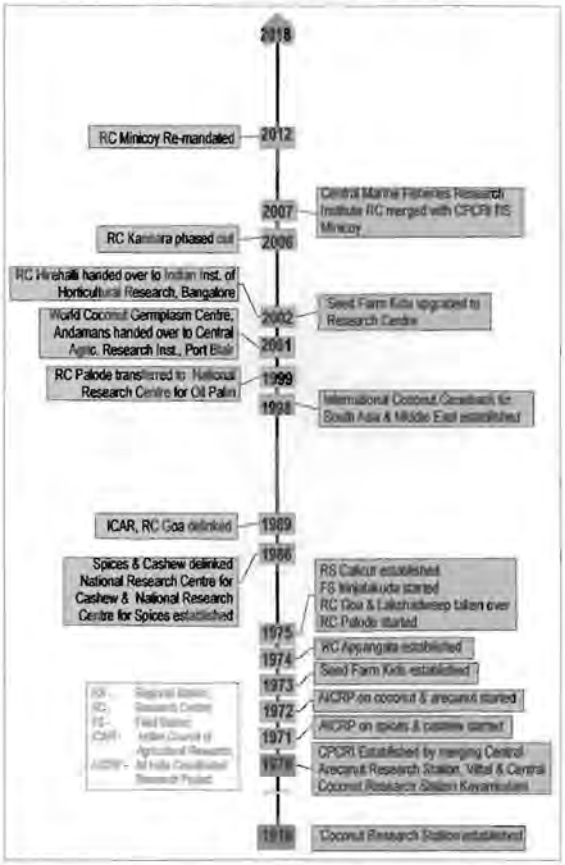
ICAR-Central Plantation Crops Research Institute (ICAR-CPCRI), the premier research institution in the National Agricultural Research System of India, is presently mandated to conduct research in plantations crops (coconut, arecanut and cocoa). It had a modest beginning with its lineage tracing back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

i. Historical perspective

The Coconut Research Station at Kudlu (Kasaragod) was subsequently taken over by the Indian Central Coconut Committee and established the Central Coconut Research Station (CCRS), Kasaragod in 1947 and a little later in 1949, the Central Coconut Research Station (CCRS) at Kayamkulam was also established exclusively for tackling diseases in coconut. Coconut research became an integral part of the national agricultural research system in 1966 when the Indian Central Coconut Committee was abolished and the coconut research was taken over directly by the Indian Council of Agricultural Research. In 1970, the Central Plantation Crops Research Institute was established with 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.

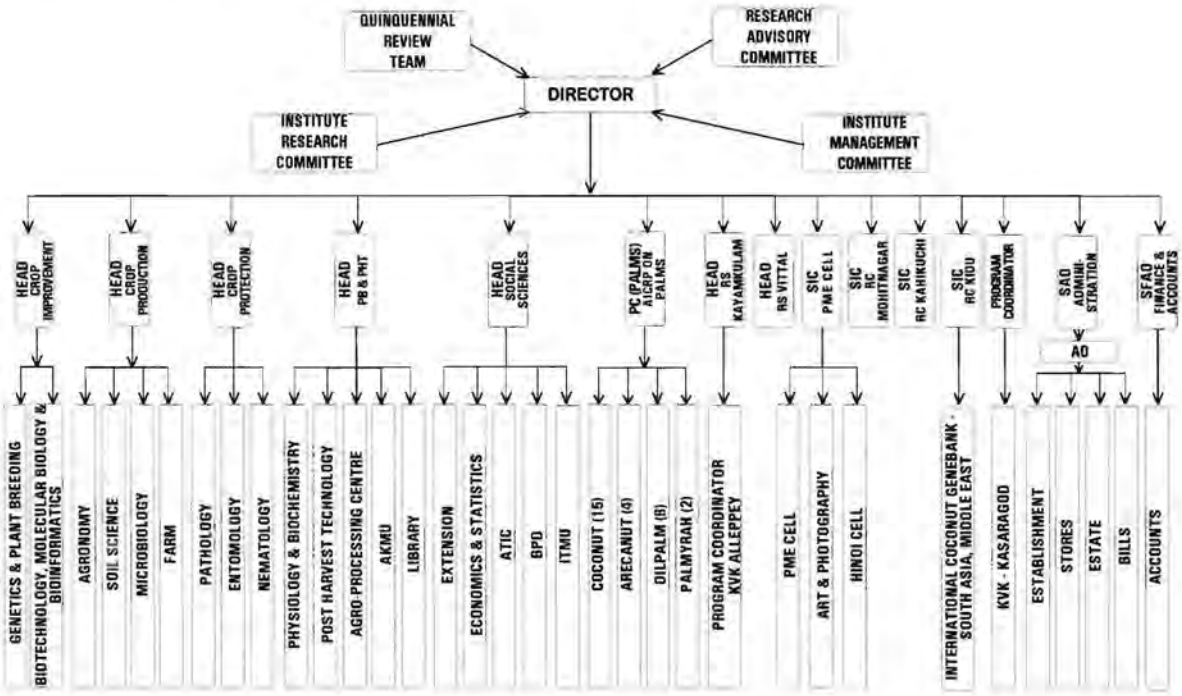
Since 1986, crops like spices, cashew, and oil palm were taken out of the ambit of the institute with the formation of dedicated research institutions like Indian Institute of Spices Research, Kozhikode, Directorate of Cashew Research, Puttur and Indian Institute of Oil Palm Research, Pedvegi. Some of the erstwhile Research Centres at Hirehalli, Palode, Appangala, Kannara, Port Blair and Minicoy were

MILESTONES IN THE TIMELINE OF ICAR-CPCRI



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

ii. Organogram



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, eight on oil palm and two on palmyrah.

iii. Achievements at a Glance

Plant genetic resources

ICAR-CPCRI maintains the world's largest repository in coconut with 455 accessions (323 indigenous and 132 exotic genotypes) from 28 countries, 176 germplasm collections in arecanut of which 23 are exotic and 141 indigenous and 505 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, 19 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. Eleven improved varieties of arecanut, including nine selections and two dwarf hybrids, have been released. The improved varieties with annual average yield of 2.54 to 4.15 kg dry kernel $palm^{-1}$ yr^{-1} and higher dry kernel recovery, in comparison to South Kanara Local (2 kg dry kernel $palm^{-1}$ yr^{-1}), have significantly improved arecanut productivity in the country. In cocoa, eight high yielding varieties have been released from the institute, which include three elite clones and five hybrids, which yield up to 3.0 kg dry bean $tree^{-1}$ yr^{-1} with varying processing qualities, as compared to 1.0 kg dry bean $tree^{-1}$ yr^{-1} in existing cocoa plantations.

The institute has been producing quality planting materials in coconut, arecanut and cocoa for distribution to farmers and other stakeholders. Seed gardens of improved varieties have been established

in the Institute as well as in farmer's garden to augment planting material production. ICAR-CPCRI nurseries at Kasaragod, Kidu, Kayamkulam and Vittal were graded with 'four-star' status in the five star scale by National Horticultural Board. Quality planting materials are produced to an extent of 1.3 lakh coconut seed nuts including 59,000 hybrids, 5.5 lakh arecanut seed nuts including 1.4 lakh seedlings and 86,000 lakh cocoa seedlings annually.

Biotechnology and bioinformatics

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

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

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

Cropping and farming systems

Coconut or arecanut based inter/ mixed, multi-storied multi-species cropping as well as mixed farming systems have been developed by integrating livestock to increase total productivity. The coconut based cropping system using multi-species cropping of coconut with black pepper, banana, nutmeg, pineapple, ginger, turmeric and elephant foot yam generated a net income of Rs. 3.7 lakhs ha^{-1}, which is 164% higher than that of coconut monocrop (Rs. 1.4 lakhs), while the coconut based mixed farming system (CMFS) comprising coconut, black pepper, banana, cross bred cows, poultry birds, goat, and pisciculture generated a net return of Rs. 5.5 lakhs ha^{-1}, reflecting 293% higher than coconut monocrop.

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

Drip irrigation in arecanut, coconut and cocoa has reduced the use of water to the extent of 35-40 per

cent, with increase in yield by 30-40 per cent. Drip fertigation in these crops has reduced the use of chemical fertilizer from 50 to 75 per cent, with increase in yield by 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 can be generated that adds more than Rs. 50,000 per year to the farmer's income. 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. This will make sorting of earthworms easy and labour-friendly and reduce labour requirement of the farmers who have taken up vermicomposting technology. Vermiwash, produced from coconut waste vermicomposting unit, is a good liquid fertilizer for organic farming. On farm coir pith composting technology has been developed to produce organic input to the plantation 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}. The yield of arecanut can be sustained at 26 q ha^{-1} by recycling waste as vermicompost. A net income of about Rs.30,000 could be generated from vermicompost production from wastes of one hectare arecanut garden, while arecanut leaf sheath and bunch waste can result in production of 643 kg fresh mushroom with a net income of about Rs.30,000. 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.

Random survey conducted in coconut gardens in Kasaragod district of Kerala has shown about 0.9 % bud rot incidence during the year 2016. 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.

Survey of arecanut gardens in Dakshina Kannada, Udupi and Uttara Kannada districts of Karnataka and Kasaragod district of Kerala during the monsoon season (July-August, 2016) indicated less than 5 % fruit rot incidence. Self-grown colocasia (*Colocasia esculenta*) in the arecanut gardens was confirmed as a collateral host of *Phytophthora meadii*, the causal organism of fruit rot of arecanut based on PCR-based identification and cross inoculation studies. Out of the 12 fungicides screened for management of fruit rot, spraying of Bordeaux mixture (1 %) or mandipropamid (0.5 %) was found to be significantly effective in reducing the fruit rot incidence compared to ten other fungicides tested. Among the arecanut accessions screened, only two wild species *viz.*, *Areca triandra* and *Areca concinna* were found resistant to fruit rot. 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.

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. Random survey conducted during December 2016 indicated up to 27 % incidence of inflorescence die back in arecanut. Survey conducted in coconut growing areas of Karnataka and Tamil Nadu during September 2016 revealed highest leaf blight disease incidence (80%) in Tirupur district of Tamil Nadu followed by Tumkur district of Karnataka (20%). A total of 20 *Lasiodiplodia* isolates were obtained from coconut leaf blight samples collected from Tamil Nadu and Karnataka and identified as *L. theobromae*.

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. The phytoplasma causing phyllody in wild *Sesamum* sp. and *Cleome viscose*, a common weed in coconut plantations, was identified as "*Candidatus Phytoplasma* australasiae"-related strain belonging to subgroup 16SrII and these weeds do not act as hosts for coconut root (wilt) phytoplasma belonging to 16 SrXI-B group. Integrated disease management strategies involving farm and palm hygiene, application of soil test based nutrients NPK (N: 500 g, P: 300 g K: 1250 g palm^{-1} yr^{-1} in two splits in May –June and August – September), 250 g $MgSO_4$ palm^{-1} yr^{-1}, irrigating the palms (250 L water palm^{-1} week^{-1}) during summer months, basin management with green manure crops like cowpea and control of leaf rot by application of hexaconazole 5 EC @ 2ml in 300 ml water, which have been developed for root (wilt) and leaf rot affected coconut gardens, could increase the yield by 25-83% depending on severity of the disease.

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

Clean and green innovative pest management technologies have been developed and field validated for the bio-suppression of rhinoceros beetle, red palm weevil, leaf eating caterpillar and eriophyid mite infesting coconut. 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/

high pollen germination while it was least in MYD (37%). A clear contrast was observed between talls and dwarfs in terms of pollen germination at high temperatures, which can be an important selection criteria in evolving varieties with tolerance to high temperature. As a climate change mitigation strategy, potential areca based HDMSCS in North East significantly sequestered the carbon into the soil and SOC increased to 52.796 t ha^{-1} as against 44.541 t ha^{-1} of fallow lands. Similar sequestration was also seen in coconut based cropping systems.

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

Product diversification, value addition and mechanization

Value addition and product diversification can ensure the sustainable livelihood of plantation farmers and entrepreneurs. In this context, the recently developed 'coco-sap chiller' technology for collecting fresh, hygienic and unfermented coconut inflorescence sap (Kalparasa) is very promising. Other value added products like virgin coconut oil, coconut chips could improve the profitability and employment generation in coconut sector. In an effort towards product diversification and value addition, coconut milk residue based extrudate ('Kalpa Krunch'), pasta, rusk and fried snacks have been developed. Similarly, 'Kalpa Bar' (coconut sugar based dark chocolate) and 'Kalpa Drinking Chocolate' have been developed in collaboration with CAMPCO Limited, Puttur. For effective utilization of by-products, the process of vinegar production from mature coconut water and fermented neera, jelly and squash production from mature and tender coconut water, muffins cake production from virgin coconut oil cake, and low fat desiccated coconut flour production from coconut milk residue have been standardized.

Farm mechanization and various processing machineries developed at the institute could contribute substantially in reducing the production cost, increased labour efficiency and enhanced product output and quality. The safety attachment incorporated by ICAR-CPCRI to Chemberi Joseph model of climbing device has become an effective solution since it could be operated even by women with proper training. This gives much required confidence to the climbers, especially the beginners. Apart from this, machineries and gadgets developed for labour saving and gender main streaming *viz.*, power operated coconut and arecanut husking machines, coconut de-shelling and shell removing machines for copra making and wet processing respectively, tender coconut punch and cutter, copra and coconut chips dryers of varying capacities and using different fuel sources, testa remover, manual and power operated coconut slicing machines, coconut milk expellers of various capacities, VCO cookers, VCO fermentation tank and copra moisture meter are the other major contributions from the institute. A recent addition to this impressive array of gadgets is the gender-friendly self loading arecanut dehusking device (with dust control) along with the arecanut grading attachment. During the year, ten post harvest technologies developed by the institute have been successfully transferred to 49 entrepreneurs, which generated a revenue of Rs.9,49,500.

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. Commemorating the centenary year, Mega Expo and Kisan 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 develop linkages with various stakeholders were implemented. Statistical Databases created, technical

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

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

For the bio-suppression of leaf eating caterpillar, augmentative release of stage-specific parasitoids *viz., Goniozus nephantidis* and *Bracon brevicornis* @ 20 parasitoids per palm, removal of heavily damaged outer three leaves and improving soil and palm health of infested palms reduced the leaf damage to 95.3% in a period of 12-15 months. Area-wide field validation and demonstration experiments conducted at Vechoor 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 20EC @ 2.5 ml L^{-1} or imidacloprid 17.8 SL @ 675 ml ha^{-1} or bifenthrin 10 EC @ 20 litre ha^{-1} and entomopathogenic nematodes (EPN), *Steinernema carpocapsae* @ 1.5 IJ ha^{-1} during May-June and September- October reduced the areacanut white grub population significantly. Placement of the neonicotinoid, thiamethoxam (2 g) in perforated poly sachets on the innermost two leaf axils of areca palms during April-May safeguarded arecanut palms from spindle bug damage. IPM strategies, developed for phytophagous mites and pentatomid bugs, involves the spraying of neem oil emulsion (0.5%) has been found effective in controlling these sporadic pests on arecanut.

Climate resilient technologies

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

At the reproductive phase, pollen germination was found to be very sensitive to high temperature. It was 63% at 30°C and got drastically reduced to 14% at 45°C. Across all the temperatures, WCT (58%) had

bulletins, CD ROMs, extension pamphlets, information brochures published. Krishi Vigyan Kendras under the institute catered to the training needs of farmers of Kasaragod and Alappuzha Districts in Kerala State. Cyber extension programmes were further strengthened with the addition of mobile video conferencing unit. Mobile video conferencing unit is being utilized for facilitating the Research-Extension-Farmer interface. The Institute website (http://www.cpcri.gov.in) is being updated regularly with latest information. 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 prepared, suggestions of which were incorporated in price fixation of arecanut for the year 2016-17. 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/panchayath level hubs with forward and backward integration along with unit level collection centers under the supervision of CPS networks.

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

Statistical models to improve field experiments

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

Impact of ICAR-CPCRI technologies

In the case of coconut, studies on rate of adoption of the selected technologies showed that about 12 per cent of farmers in Kerala adopted coconut hybrids and improved varieties. Around13.6 per cent of total area in Karnataka is presently under released arecanut varieties. The economic impact of released arecanut varieties in monitory terms was estimated to be Rs. 421 million yr^{-1}. The impact assessment of arecanut based cropping systems in coastal region of Karnataka revealed that total economic impact in monetary terms due to adoption of cropping systems in the region was around Rs. 1022 million yr^{-1}. There would be an economic impact to the tune of Rs. 1604 lakhs yr^{-1} from the planting materials supplied from the institute, considering the fairly long economic life span of coconut palms.


CPCRI-ASPEE
ARECANUT SPRAYER

STATIONS, CENTRES & PRIORITY AREAS OF RESEARCH

Headquarters

KASARAGOD

(Estd.: 1916), Crop: Coconut, Area: 78 ha, 10.7 m MSL
Priority areas of research: Genetic resources management, breeding, biotechnology, water and nutrient management, organic cultivation, cropping/ farming system, microbiology, pests and diseases management, physiology and biochemistry, value addition and farm mechanisation, economics, statistics and transfer of technology. Various activities are envisaged under five divisions *viz.*, Crop Improvement, Crop Production, Crop Protection, Physiology, Biochemistry and Post Harvest Technology and Social Sciences.

Regional Stations

KAYAMKULAM

(Estd.: 1947), Crop: Coconut, Area: 24.17 ha, 3 m MSL
Priority areas of research: Etiology and management of root (wilt) and other diseases, pests and nematodes management.

VITTAL

(Estd.: 1956), 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), Crop: Arecanut, Area: 15.76 ha, 48 m MSL
Priority areas of research: Cropping systems, 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.

ICAR-CPCRI LOCATION

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

△ KVKs

◆ AICRP ON PALMS CENTRES

STAFF STRENGTH

As on 31-3-2018

ICAR-CPCRI

Category	Sanctioned	In position	Vacant
Scientific	84	77	7
Technical	113	84	29
Administrative	89	50	39
Supporting	256	106	150
Canteen	10	5	5
Total	**552**	**322**	**230**

ICAR-KVK, KASARAGOD

Category	Sanctioned	In position	Vacant
Scientific	1	1	-
Technical	11	7	4
Administrative	2	1	1
Supporting	2	1	1
Total	**16**	**10**	**6**

ICAR-KVK, ALAPPUZHA

Category	Sanctioned	In position	Vacant
Scientific	1	1	-
Technical	11	10	1
Administrative	2	1	1
Supporting	2	2	0
Total	**16**	**14**	**2**
Grand Total	**584**	**346**	**238**

BUDGET AND EXPENDITURE 2017-18

(Rs. in Crores)

Head	Allocation	Expenditure
Plan	73.261	72.036
Revenue generation	6.225	

VI. RESEARCH ACHIEVEMENTS

1 GENETIC RESOURCES MANAGEMENT & UTILIZATION

Germplasm enrichment and conservation

Coconut

In coconut, 455 accessions collected over the years have been conserved and are being evaluated in the field gene bank of ICAR-CPCRI. Simultaneously, efforts for complementary conservation of core germplasm are underway, in collaboration with ICAR-NBPGR, New Delhi. During the year, about 150 embryos each from Kalpa Haritha, Chowghat Green Dwarf, Kalpatharu, Laccadive Ordinary Tall, Laccadive Micro Tall and West Coast Tall were stored in liquid nitrogen for transportation to ICAR-NBPGR to serve as base collection. DNA has been isolated from leaf tissues of six accessions viz., Chowghat Green Dwarf, Chowghat Orange Dwarf, Kenthali Orange Dwarf, Laccadive Ordinary Tall, Laccadive Micro Tall and West Coast Tall towards conservation of genomic resources.

Seedlings of 16 accessions, including germplasm collected from Andaman and Nicobar Islands, are ready for conservation in the field gene bank. For regeneration/safety duplication, 277 seed nuts of 19 WCGC accessions received from ICAR-CIARI, Port Blair has been sown for seedling production. Further, controlled pollination was undertaken in 16 accessions for production of seed nuts and 2518 seed nuts of 31 accessions were sown in the nursery for seedling production.

Arecanut

A total of 176 arecanut accessions are under evaluation for yield and other economic traits. During the year, a rare type of arecanut was identified in South Kanara Local population in a farmer's plot at Karkala in Karnataka, and collected for conservation. In this novel palm, the plantlets arose directly from the inflorescences (Fig. 1). *In situ* characterization has been undertaken based on standard descriptors, considering the morphological and nut traits.

Twelve accessions collected from North East region of India have been conserved in the field gene bank at ICAR-CPCRI, Regional Station, Vittal. Replanting of 10 accessions from North East region and 12 accessions from Konkan region have also been undertaken. A total of 4850 female flowers were pollinated in nine accessions from Konkan region for generating *inter se* materials for replanting as well as screening against YLD.

Cocoa

A total of 505 cocoa accessions are being conserved in the field gene bank of ICAR-CPCRI, Regional Station, Vittal. Establishment of alternate field gene banks in different agro-ecological zones, for safety duplication of core cocoa genetic resources, have also been taken up, with the planting of 61 accessions at ICAR-CPCRI, Research Centre, Kidu, Karnataka, 57 accessions at TNAU, Coimbatore and 39 accessions at YSRHU, Andhra Pradesh.

Fig. 1. Plantlets arising directly from the inflorescence of the arecanut palm in farmers field

During the year, the cocoa germplasm base was enriched with the collection of 17 exotic and two local accessions (Table 1), which includes white beaned types rich in flavor components, high in bean index and shade tolerance.

Table 1. Cocoa germplasm collected during 2017

Clones collected	Collection no./ Place of collection
BE 5	EC 914993
CRIOLLO 11 (CRI)	EC 914994
CRIOLLO 21 (CRI)	EC 914995
EET 387 (ECU)	EC 914996
EET 399 (ECU)	EC 914997
ICS 12	EC 914998
ICS 41	EC 914999
ICS 48	EC 915000
ICS 63	EC 915001
MA 13 (BRA)	EC 915002
PA 88 (PER)	EC 915003
SHRS 01	EC 915004
SHRS 02	EC 915005
SHRS 05	EC 915006
SHRS 08	EC 915007
UF 168	EC 915008
UF 273	EC 915009
Criollo	Kallar
Trinitario	Balehonnur

Germplasm characterization and evaluation

Coconut

Maintenance, characterization and evaluation of conserved germplasm was undertaken in the National Gene Banks (NCGs) at Kasaragod/ Kidu, the International Coconut Gene Bank for South Asia (ICG-SA) at Kidu as well as in the germplasm lines under conservation/ field evaluation at Mohitnagar and Kahikuchi.

Descriptor traits

Descriptor traits were recorded in 19 accessions, including 11 accessions collected from Andaman and Nicobar Islands. Of these, vegetative and inflorescence characters were recorded on eight accessions, including six tall and two dwarfs. In the National Coconut Genebank at Kidu, stem and leaf characters, tender nut traits as well as fruit component traits were recorded for 12 accessions, including 11 accessions from Andaman and Nicobar Islands. Wide variation was recorded for the traits studied, with greater variability for fruit weight, husk content, endosperm content and tender nut water content. Higher fruit weight, tender nut water as well as copra content was recorded in Burmanella Giant Tall, while Arasampatti Tall and Champin Micro Tall recorded smaller fruits with lesser tender nut water and copra content. Oil content ranged from 61% in Champin Micro Tall to 75% in Malaca Tall.

Wide variation for growth characters were recorded in juvenile germplasm conserved in the field gene bank. In the comparative evaluation of 17 dwarf accessions at Kasaragod, planted during 2011, higher plant height (607.14 cm), greater petiole (130.95 cm) and leaf length (439.10 cm), as well as higher number of leaflets (94 pairs) was recorded in IND049S. INGR13065 recorded higher stem girth (131.83 cm). Leaflet length was observed to be longer in IND112S (118.89 cm), while IND089S recorded broader leaflets (5.30 cm). IND102S, a yellow dwarf, in general, recorded lesser plant height (455.56 cm). Shorter and lesser number of leaflets (66 pairs) was observed in IND395. Significant variation in inflorescence characters were also recorded, with inflorescence length ranging from 65.75-126.50 cm. Highest number of female flowers per inflorescence was recorded in IND116S and IND089S (>23 female flowers inflorescence^{-1}).

Sweet endosperm trait

Among the 22 seed propagated progenies of Mohachao Narel of Ratnagiri (Maharashtra), conserved at Kasaragod, nine palms were found to produce fruits possessing the sweet endosperm trait, with percentage of sweet kernel fruits in a palm varying from 4.6 to 60 percent (Fig. 2). It was further observed that among the families, NSD4 showed higher number of progenies (three) with sweet kernel fruits, with NSD26 recording highest percentage of sweet kernel fruits. Only one sweet kernel producing progeny was recorded in NSD1, NSD6, NSD10, NSD15, NSD27 and NSD28.

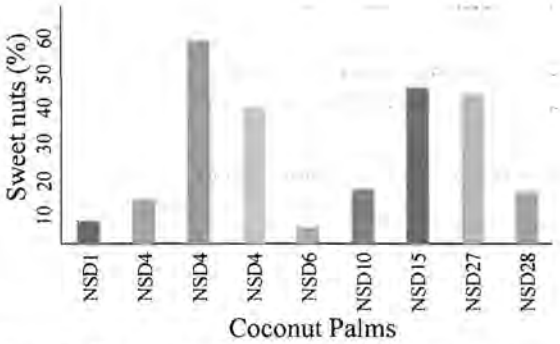


Fig. 2. Per cent of fruits with sweet endosperm in different palms of Mohachao Narel

Inflorescence sap trait

A study was carried out in five tall accessions to find out the influence of genotypes and seasons on inflorescence sap production and quality. The genotypes showed significant variations with respect to the yield of inflorescence sap, as Jamaica Tall recorded high inflorescence sap yield of 3.6 L day^{-1} followed by Orissa Tall (3.05 L day^{-1}) (Fig. 3). Among the seasons, highest sap yield was recorded during post-monsoon (Oct-Nov) and monsoon (June-Sep) and lowest yield during winter season (Dec-Feb) in all the genotypes studied. The quality of inflorescence sap tapped from different accessions also varied significantly with respect to total sugars, phenol and protein content. Total sugar content was higher in sap from Jamaica Tall (15.93 g 100 ml^{-1}) followed by Orissa Tall (14.50 g 100 ml^{-1}). Total soluble solids content (TSS) and reducing sugar content of the sap ranged between 15.0 to 16.9° Brix and 0.4-0.8 g 100 ml^{-1}, respectively, but did not vary significantly among the genotypes. Highest protein content of 0.42 g 100 ml^{-1} was associated with sap

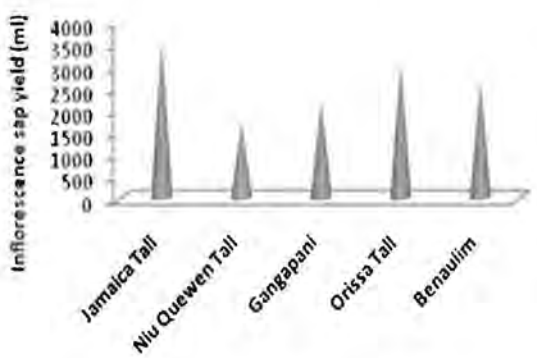


Fig. 3. Inflorescence sap yield (ml day^{-1}) in different accessions

from Benaulim Tall, which was on par with Jamaica Tall (0.36 g 100 ml^{-1}). Highest phenol content was observed in sap from Niu Quewen Tall (4.14 mg 100 ml^{-1}) which was on par with Jamaica Tall (4.02 mg 100 ml^{-1}) (Fig. 4). The results obtained from the present investigation indicated that there was significant influence of genotypes and seasons on yield of inflorescence sap and quality parameters, and the possibility of selection of high sap producing lines through further evaluation of conserved germplasm.

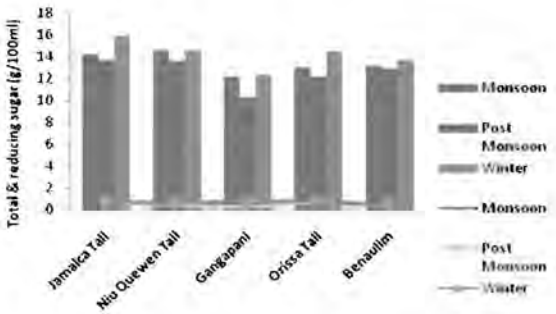


Fig. 4. Total sugar (bar) and reducing sugar (line) content (g 100 ml^{-1}) in different accesions

Nut/copra yield trait

Among the conserved germplasm in stabilized bearing phase at Kasaragod, higher copra yield of >22 kg palm^{-1} year^{-1} was observed in Federated Malay States Tall, Kenya Tall, San Ramon Tall, Palawan Tall, Fiji Tall, Laguna Tall, Philippines Lono Tall, Kappadam Tall, New Guinea Tall, Guam Tall II, Jamaica Tall, Surinam Tall, Kongthieyong Tall, Nigerian Green Dwarf, Zanzibar Tall and Jamaican San Blas Tall. Among the conserved dwarf germplasm, Chowghat Orange Dwarf, Malayan Orange Dwarf, Malayan Yellow Dwarf, Malayan Green Dwarf, Cameroon Red Dwarf, Niu Leka Dwarf, Laccadive Orange Dwarf and Nikkore Dwarf showed higher fruit yield potential. Amongst the Odisha germplasm, higher annual fruit yield, ranging from 9-132% over the local control (WCT), was recorded in Goja Tall, Orissa Giant Tall, Dhanei Tall, Narangi Tall, Gole Tall, Sakhigopal Tall as well as Jahaji Tall. Among the conserved germplasm of the Pacific region, higher potential for yield and yield component traits was recorded in Niu Bulavu Tall, Niu Hake Tall, Kavieng Tall, Tutiala Tall, Solomon Tall and Rennell Tall.

Among the indigenous germplasm at ICAR-CPCRI Research Centre Kidu, higher annual nut yield was

recorded in Laccadive Micro Tall (uniform nut size), Nicobar Beak Tall, Kodiaghat Big Round Tall, Laccadive Micro Tall (very small nut), Laccadive Ordinary Tall (Agatti), Katchal Micro Tall, Laccadive Small Tall (with round nut), Ponnani Yellow Tall, Achamthuruthy Tall, Laccadive Ordinary Tall (Kavarati), Sendagan Tall, Arasampatti Tall, Chandan Nagar Tall, Tinisera Tall and Barajaguli Tall, indicating their potential for utilization in breeding for higher productivity.

Yield and yield attributing traits were recorded in the accessions conserved in ICG-SA and Indian germplasm conserved at ICAR-CPCRI Research Centre Kidu. Higher annual nut yield was recorded in Tiptur Tall, Andaman Ordinary Tall, Laccadive Ordinary Tall, Ayiramkachi Tall, Andaman Ranguchan Tall, Calangute Tall, Car Nicobar Tall, West Coast Tall, Benaulim Tall, Sakhigopal Tall, East Coast Tall, Spicata Tall and Kappadam Tall among Tall accessions of indigenous origin. Among the dwarf indigenous germplasm conserved in the ICG-SA, Kulashekaram Orange Dwarf, Kulashekaram Yellow Dwarf, Chowghat Orange Dwarf and Chowghat Green Dwarf recorded higher nut yield. Among the other germplasm of exotic origin, regenerated from the Indian collection, Federated Malay States Tall, Blanchissues Tall, Lifou Tall, Philippines Ordinary Tall, British Solomon Islands Tall, Borneo Tall, Straits Settlement Apricot Tall, Rotuma Tall, Standard Kudat Tall, Straits Settlement Green Tall, Philippines Lono Tall, Malayan Yellow Dwarf, West African Tall, Zanzibar Tall, Cameroon Red Dwarf, King Coconut, Panama Tall, Jamaican Sanblas Tall, Niu Hake Tall, Guam Tall, Pao Pao Tall and Fiji Tall showed relatively higher nut yield. Higher fruit yield potential was also observed in Sambava Green Tall, Sambava Tall, Comoros Green Tall, Kadedhdhoo Oblong Tall, Hanimaadhdhdoo Green Tall, Hanimaadhdhoo Medium Round Tall, De La Reunion Tall, Coco Bleu Tall, Pemba Red Dwarf among Indian Ocean accessions, Agailjhara Tall, Bagharpara Tall, Uzirpur Tall, Kayemkola Tall, Rupadia Tall, BARI Narikel, Chinashukhania Tall and Khairthala Tall, among Bangladesh accessions and Gonthembili, among Sri Lankan accessions.

Analysis of the average yield data from the germplasm evaluation trial planted in 1990, with 10 accessions, and West Coast Tall as local control, indicated significant variation for mean annual copra yield, female flower production as well as nut yield. Highest mean fruit yield was recorded in Federated Malay States Tall (132 nuts palm^{-1} year^{-1}), while significantly lowest fruit yield (46 nuts palm^{-1} year^{-1}) as well as copra yield (5.54 kg palm^{-1}year^{-1}) was recorded in King Coconut Tall. Higher copra yield of 26.93 kg palm^{-1} year^{-1} was recorded in the accession San Ramon Tall, and was on par with Palawan Tall, Philippines Lono Tall, Federated Malay States Tall, Fiji Tall and Kenya Tall. The high yielding selection of Federated Malay States Tall (132 nuts palm^{-1} year^{-1}) with significantly higher fruit yield over West Coast Tall (101 nuts palm^{-1} year^{-1}), also recorded higher copra yield (24.47 kg palm^{-1} year^{-1}), and showed higher inflorescence sap yield potential (32 l inflorescence^{-1} 33.33% more than WCT) and is suitable for commercial cultivation in the coconut growing tracts of Kerala.

Cold tolerance trait

Fifteen coconut genotypes (planted during 2003), at ICAR-CPCRI Research Centre, Kahikuchi, Assam were evaluated for yield and fruit characters and the current year results of experiment indicated comparatively higher annual nut yield (72 nuts palm^{-1}) in Chandra Sankara (COD x WCT), along with nut weight (774.30 g nut^{-1}) and copra content (176.67 g nut^{-1}). Overall, the performance of the dwarf as well as tall genotypes and hybrids were poor and on par with the local check, except Chandra Sankara (Table 2).

At ICAR-CPCRI Research Centre, Mohitnagar, West Bengal, 31 accessions, planted during 2004, showed significant difference in annual nut production (Table 3). Higher annual nut yield was recorded in BARI Narikel 1 (98 nuts palm^{-1}), followed by Agailjhara Tall (90 nuts palm^{-1}). Overall, the tall genotypes showed better yield performance as compared to the hybrids and dwarfs under evaluation. Among the five dwarf accessions, higher fruit yield was recorded in MOD (58 nuts palm^{-1} year^{-1}), while there was not much variation in fruit yield of the other four dwarf types. Among the five hybrids, higher yield was recorded in Kera Ganga (42 nuts palm^{-1} year^{-1}). Intensity of cold injury symptoms on leaf, nut and inflorescence was also recorded. Almost all genotypes showed cold injury symptoms on leaf/fruits, except Andaman Giant Tall, Chinnasukhania Tall, Fiji Tall and Chowghat Green

Dwarf (Table 3).

Annual growth characters were recorded on the progenies of 15 putative cold tolerant palms identified in West Bengal under evaluation at Research Centre Mohitnagar (Table 4). Higher plant height and girth was recorded in Lataguri-II, followed by Mohitnagar-III. The number of leaves and leaf characters was better in Mohitnagar-III. Progenies of the putative cold tolerant lines, showed comparatively less cold injury symptoms (Table 4).

Among the 21 genotypes, planted during 2016, along with Mohitnagar-III as local check, significant differences were observed for the vegetative growth characters recorded, except annual leaf production. Higher height (260 cm) was recorded in SNRT followed by MVT (257 cm) whereas maximum girth (48 cm) was recorded in MVT.

Table 2. Performance of genotypes at Kahikuchi (2005 planting)

Genotype	Nuts (palm year^{-1})	Fruit weight (g)	Copra content (g nut^{-1})
WCT	39.13	1026.45	168.94
FJT	32.41	865.00	105.83
Assam Green Tall (check)	31.77	1041.67	134.16
LCT	45.33	976.67	165.83
GBGD	51.83	938.33	149.16
COD	47.16	886.67	113.33
MOD	42.82	826.67	71.66
MYD	20.00	868.88	98.33
MGD	53.67	870.00	143.33
WCT x GBGD	55.83	1030.00	107.50
COD x WCT	71.60	1166.66	176.67
LCT x GBGD	57.16	668.33	104.16
WCT x COD	60.83	788.33	150.00
LCT x COD	61.33	908.88	117.77
WCT x MYD	36.00	842.56	146.28
C.D (1%)	29.94	275.78	44.06

Karyotyping studies in coconut

Cytological studies were initiated in two tall and five dwarf accessions. Root tips collected from seedlings in coir dust media were soft and gave good chromosome spread (Fig. 5). Good chromosome spread was observed in the root tips collected during 10-10.30 A.M. in all accessions.

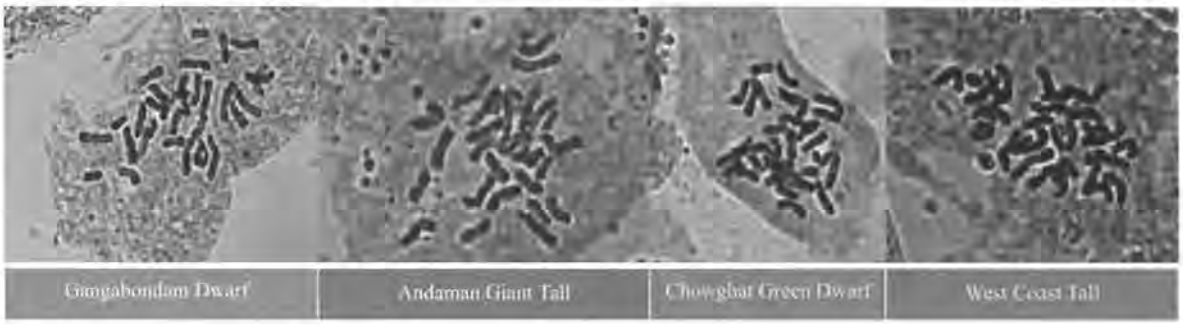


Fig. 5. Chromosome spread in different accessions

Table 3. Performance of genotypes at Mohitnagar (2004 planting)

Genotype	Annual yield (nuts palm^{-1})	Number of leaves on crown	% leaves with cold injury	Severity of cold injury	Cold injury on fruits
Talls					
PHOT	65	24	20	Mild	Black spots on immature and tender fruits
WCT01	55	26	26	Mild	Black spots on immature and tender fruits
AGT	36	25	Nil	Nil	Nil
ZAT	62	26	61	Severe	Black spots on immature and tender fruits
ADR	85	25	16	Mild	Nil
SKGT	40	22	32	Mild	Black spots on immature and tender fruits
BARI Narikel 1	98	26	7	Mild	Black spots on immature and tender fruits
SLT	65	26	61	Severe	Black spots on immature and tender fruits
Chinashukhania	75	24	Nil	Nil	Black spots on immature fruits
ASGT	42	22	Nil	Nil	Black spots on immature and tender fruits
Agailjhara Tall	90	23	9	Mild	Black spots on immature fruits
RKBT	55	23	9	Mild	Black spots on immature fruits
LMT	35	26	35	Medium	Black spots on all fruits, nut cracking
JAMT	65	24	42	Mild	Fruit drop, Black spots on immature and tender fruits
FJT	45	20	Nil	Nil	Black spots on immature fruits
JVT	26	20	30	Mild	Black spots on immature fruits
SYT	31	26	54	Severe	Black spots on immature and tender fruits
ADOT	75	22	41	Medium	Black spots on immature fruits
KPDT	25	28	57	Medium	Black spots on immature and tender fruits
WCT	29	23	30	Mild	Black spots on immature and tender fruits
LCT	65	25	60	Severe	Black spots on immature and tender fruits
Hybrids					
Kera Ganga	42	25	40	Mild	Black spots on immature and tender fruits
Chandra Laksha	35	23	43	Mild	Black spots on immature and tender fruits
Kera Sankara	32	26	38	Mild	Black spots on immature and tender fruits
Chandra Sankara	28	24	38	Mild	Black spots on immature fruits
Laksha Ganga	38	22	50	Severe	Black spots on immature and tender fruits
Dwarfs					
MOD	58	22	41	Mild	Black spots on immature and tender fruits, nut cracking
MGD	45	22	59	Medium	Black spots on immature and tender fruits
MYD	42	24	38	Mild	Nut fall, nut cracking, Black spots on immature and \ tender fruits
CGD	32	22	---	----	Black spots on immature and tender fruits
COD	43	20	45	Mild	Black spots on immature and tender fruits, inflorescence blackening
CD 0.05	11.4	-	-	-	-

Table 4. Vegetative growth of different cold tolerant accessions

Line	Plant Height (cm)	Girth (cm)	Length of leaf (cm)	Length of leaflet bearing portion (cm)	No. of leaflets (on one side of the leaf)	Leaflet length (cm)	Leaflet width (cm)	% palms affected by cold	% leaves affected by cold
Mohitnagar-III	518	118	491	310	99	113	5.8	5	10
ECT-Mohitnagar	466	99	448	272	93	96	5.4	0	0
WCT-Mohitnagar	431	77	441	298	97	111	6.2	5	12
ECT-Kasaragod	492	97	432	271	87	98.3	5.6	25	30
Malbazar-II	392	83	363	248	91	94.7	5.8	15	10
WCT-Kasaragod	415	90	394	273	90	99.3	5.3	20	25
Mohitnagar-II	472	97	463	306	93	96.3	5.1	5	50
Malbazar-III	413	83	408	261	104	92.3	5.9	0	0
Nagrakata	419	89	384	258	93	99.7	6	5	20
Gorubathan-1	405	76	400	269	80	98.3	5.4	5	35
Mohitnagar-IV	380	85	346	261	69	98	5.5	10	10
Garubathan-II	459	97	429	272	71	85	4.7	0	0
Lataguri-II	551	119	471	227	93	73	5	0	0
Garubathan-III	325	79	300	185	82	60	5	0	0
North Bengal-1	456	88	437	283	92	92	5	0	0
CD	**	**	*	*	**	**	**	-	-

Pollen and nectar compatibility trait

Pollen and nectar compatibility was studied in 10 accessions *viz.*, WCT, PHOT, LCT, CCNT, COD, MOD, MGD, MYD, CGD and GBGD. Absence of germination and shrinkage of pollen grains was observed in undiluted nectar. On the other hand, >55% pollen germination was obtained on 1:50 dilution of nectar. Pollen of certain accessions showed good germination in nectar of all accessions, while a few accessions recorded differential germination depending on the source of nectar (Fig. 6, 7).

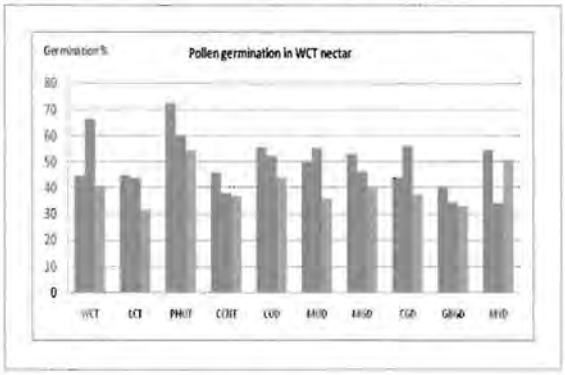


Fig. 6. Pollen germination (%) in WCT nectar

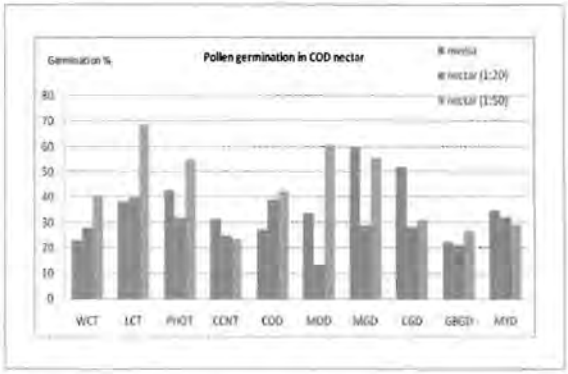


Fig. 7. Pollen germination (%) in COD nectar

Arecanut

Yield potential trait

A total of 176 accessions are under evaluation for yield and other economic traits. Accessions VTL-146, VTL-100, VTL-125, VTL-126 and VTL-85, showed high yielding tendency with dry kernel yield of 3.88, 3.80, 3.64, 3.59 and 3.51 kg palm^{-1} year^{-1}, respectively (Fig. 8).

VTL- 100 VTL-146 VTL-126

Fig. 8. Arecanut accessions with high yield potential

In the alternate field gene bank at Mohitnagar, yield components were recorded for 71 accessions, planted in different batches. Among the accessions, VTL-60, VTL-5, VTL - 29 and VTL-27 exhibited yield superiority , with dry kernel yield of 4.22 and 2.51, 3.71 and 1.04 kg palm^{-1}year^{-1}, respectively.

At Kahikuchi, evaluation of 18 accessions from North East for growth characters showed that Borehat recorded higher plant height (3.10 m), while Sarugaon 1 recorded the lesser height (2.03 m) at first flowering. On other hand, more number of nodes (20.06 palm^{-1}) at first flowering and higher inflorescence production (4.33 palm^{-1}) was recorded in Salshilla, six years after planting.

Molecular characterization and genetic diversity analysis

A total of 24 accessions, including North East and Konkan collections, have been described based on morphological, yield and fruit components. Molecular characterization and genetic diversity analysis was carried out in these 24 accessions using simple sequence repeat (SSR) markers (Fig. 9).

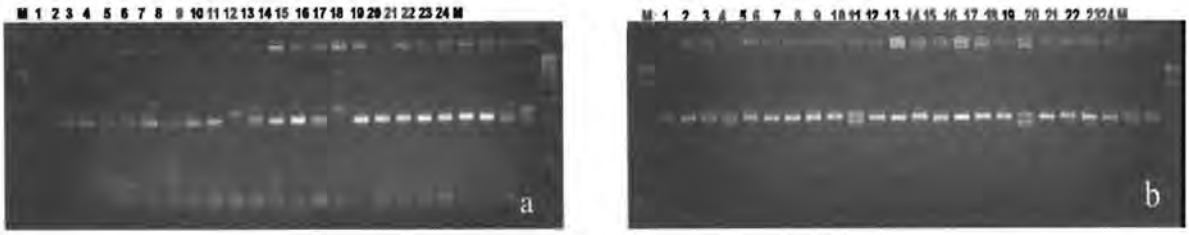


Fig.9. SSR banding profiles of 24 arecanut accessions, standard 100 bp ladder (M) used as a reference; (a) Primer AC23 and (b) Primer AC29

Variegated nut trait

Biochemical components like total sugar, reducing sugar, total phenolic content, non-tannin phenolic content and antioxidant capacity of variegated and normal arecanuts (Fig. 10) were estimated. Physiological parameters of variegated and normal arecanut was studied *in situ*.

Fig. 10. Variation in kernel of variegated nut (A) and normal nut (B)

Biochemical traits

Studies on total phenols, fats, antioxidant properties have been initiated in 21 accessions. The total phenolic contents present in *Actinorhytis calapparia*, *Areca triandra, Normanbya normanbyi* and *Areca catechu,* were found to be 22.25±1.2%, 18.19±2.1%, 23.32±2.4% and 25.45±3.5%, respectively. Condensed tannin contents in *Actinorhytis calapparia*, *Areca triandra, Normanbya normanbyi* and *Areca catechu*, were found to be, 8.5±4.2%, 7.6±4.5%, 9.4±2.4%, 10.21±2.3%, respectively.

The anti-oxidant potential was studied in different species of *Areca*. The DPPH radical scavenging (IC_{50}) values estimated for *Actinorhytis calapparia*, *Areca triandra, Normanbya normanbyi* and *Areca catechu* showed 11.58±2.55, 11.27±8.2. 10.95±2.3 and 10.79±4.2. µg mL^{-1}, respectively. Hydroxyl ion scavenging activity (IC_{50}) values were assayed for *Actinorhytis calapparia*, *Areca triandra, Normanbya normanbyi* and *Areca catechu*, found to have, 11.86±2.12, 9.271±1.57, 11.78±1.98 and 10.25±2.54 µg mL^{-1}, respectively (Fig. 11). The ABTS scavenging activity (IC_{50}) values estimated for *Actinorhytis calapparia*, *Areca triandra, Normanbya normanbyi* and *Areca catechu* showed 9.61±2.21, 10.8±1.21, 9.44±2.20 and 10.59±2.34, respectively (Fig. 12). Metal chelating scavenging activity (IC_{50}) values were assayed for *Actinorhytis calapparia*, *Areca triandra, Normanbya normanbyi* and *Areca catechu*, and found to be 9.61, 9.08, 10.15 and 10.29 µg ml^{-1}, respectively. The results showed that, different species of *Areca*, *Normanbya* and *Actinorhytis* possess free radical scavenging capacity and antioxidant property that can help neutralize free radicals and also prevent the initiation of free radical mediated chain reactions in biological membranes.

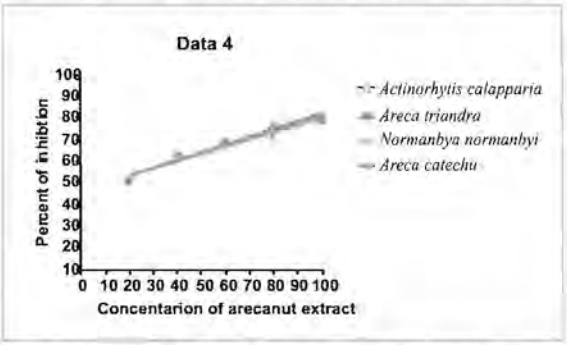


Fig. 11. Hydroxyl ion scavenging action of different arecanut species

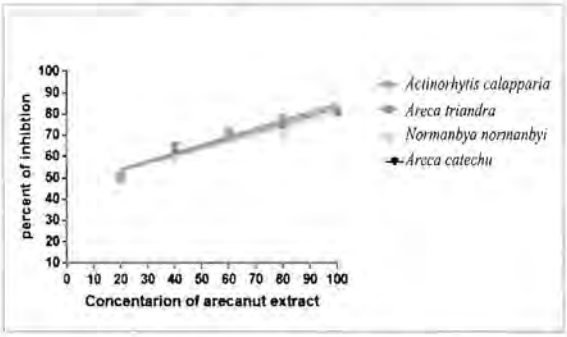


Fig. 12. ABTS radical scavenging action of different arecanut species

YLD tolerance/resistance trait

Recording of morphological traits and disease indexing were undertaken in YLD screening trial in the endemic area comprising of three *Areca* species and related genera, *Actinorhytis calapparia,* and indicated absence of YLD symptoms in these palms, during the current year also (Fig. 13 a,b).

Fig. 13. *A. triandra* Roxb. (a) and *Actinorhytis calapparia* (b) in disease endemic area, with no symptoms of YLD

Cocoa

Pod shape trait

Morphological characterization of 20 year old trees of 19 local cocoa clones showed distinct pod shapes from their length and width ratio and categorized into oblong, ovate, obovate, elliptic and circular shapes and also fit into Cundeamor, Amelonado and Angoleta types, combined from surface rugosity, apex form and bottle neck or basal constriction. These will be utilized as reference varieties for development of DUS guidelines for cocoa.

Pendulous stem growth trait

Cocoa clones ST-2-86, MLTG-84, ST-1-86, CYT-158, COMP-86 and MLTG-197, with pendulous growth habit, suitable for high density orchards, trellis hedge row system of planting and mechanization, were identified (Fig. 14).

Fig.14. Cocoa clones with pendulous stem growth trait

Yield potential trait

Evaluation of new cocoa collections of Central and South America over 10 years identified SCZ-20, TSH-518, RB33/3 and RIM-21 as high yielders with >50 pods tree^{-1}year^{-1}. Among another set of exotic collections, Peruvian T85/799, ICS-84, French Guiana GU 241, Papua New Guinea PNG 418 and Ghana Red clones exhibited high yielding potential. Evaluation of local collections of Wayanad region WYN-3, 5, 6, 12, 13 continued to bear beans of >1.15 gram. Among the old collections of Malaysia, Nigeria, Trinidad and Kew clones of >20 years, 17 clones recorded >120 pods tree^{-1}year^{-1} and >3 kg dry bean yield, which will be utilized for quality planting material production and area expansion programs of Govt. of India in all cocoa growing states. High yielding cocoa clones of Forastero types CYT-C9, COMP-24, LAL-75, ST-1-48 and Trinitario types AMAZ-2, CYT-24, MLTG-6 and B-4-3-1 were identified with more pods per cushion in a range of 5-13 (Fig.15). which exhibited physiological/ cauliflorous vigour, high retention of fruits and less cherelle wilt. In clones VTLC-1, VTLCC-1 and VTLC-200 the high yielding nature contributed by distribution of more pods per orthotropic and plageotropic branches, which exhibited medium vigour of trees, big pod size, less borer and pod rot incidence. For the qualitative improvement, clones with high bean index ranging from 1.30 to 1.92 g were identified among different collections. Selective beans of progressive farmers from Kerala and Tamil Nadu were sent for Cocoa Excellence Award conducted by Bioversity International and Tamil Nadu bagged an award, one among 18 awards, from over 166 bean samples of 40 countries.

Fig.15. Cocoa clones with more pods per cushion

Root stock potential trait

Ten clones are screened for use as root stock for cocoa and seven clones with tolerance to low moisture stress are under evaluation with 100%, 50% and 20% field capacity. Auto and hetero clones are also being compared. Seedlings of the eight varieties are field planted for screening for shade tolerance with 50%, 75% and 95% shade levels. Nigerian clones, NC-56, NC-25 and NC-41 continued to be free of tea mosquito bug (TMB) damage for the consecutive second year amidst of highly infected trees. In general, red coloured genotypes are found to be free of TMB. Black pod rot damage was observed as 10% among Malaysian clones, 15% in Nigerian and 20% in Trinidad clones during August in the post monsoon season. Since rainfall continued upto November, 26 new collections were affected with pod rot. ICS-6, SCA-6 and their hybrid progenies ICS-6 x SCA-6 and SCA-6 x ICS-6 showed less incidence of pod rot, in line with the observations in other international gene banks.

Genetic investigation and breeding

Coconut

Hybrid evaluation

The two coconut hybrids recommended for release, COD x WAT and COD x LCT, continued to show superiority in yield with more than 150 nuts palm^{-1} year^{-1}. Seedlings of these hybrids were distributed for establishment of technology evaluation trial in Tamil Nadu.

In the hybrid evaluation trials (planted during 2013 and 2014), comprising of 28 D x T hybrid combinations at Kasaragod and Kidu, flowering was observed in MYD x CCNT, CGD x CCNT and GBGD x CCNT hybrids.

In Dwarf x Dwarf trial planted at Kidu, MYD x CGD, COD x GBGD, MYD x NLAD, MYD x GBGD continued to be better for bunch production and tender nut traits. Seedlings of MYD x NLAD palm were established in polybags for progeny studies. D x D hybrid evaluation trial planted at Kasaragod in the year 2016 was observed for juvenile growth characters and significant variation was observed among the hybrids.

In the trial involving T x T hybrids and four parents, FJT x WCT recorded higher nut yield followed by WCT.

In the trial involving selfed progenies planted at Kidu, early flowering was recorded in dwarfs. Difference in growth characters were observed in S_1 progenies, planted along with COD, WCT and LMT.

Studies on segregation pattern in self pollinated progenies of hybrids like MYD x CGD and MYD x NLAD is progressing. Selected LMT palms were used as female parents for pollination with COD to develop mapping population for linkage studies. Observation on seedling characters were recorded in LMT *inter se* mated progenies planted at Kidu.

Parent-progeny studies in West Coast Tall population

The variability in parental palms of WCT and their progenies were studied and genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (h^2) and genetic gain (GA) for individual quantitative characters were computed. In WCT progenies, all the vegetative and reproductive characters, except length of leaves, recorded high PCV (>20%). Estimates of PCV were greater than corresponding GCV for most of the characters, indicating the role of environment in the expression of characters (Table 5). High GCV as well as PCV values indicate the existence of wide variability in the population for these traits. This also indicates broad genetic base, less environmental influence and these traits are under the control of additive genes.

Low broad sense heritability (<30%) was recorded for plant height, plant girth at base, number of leaflets and number of spikelets per inflorescence. Medium heritability (30-60%) was recorded for the length of 10 internodes. High heritability (>60%) was recorded for stem girth (at 1 m and 1.5 m height), number of leaves, length of leaves, length of leaflet bearing portion, length and breadth of leaflet, length of spikelet bearing portion, length of spikelet, number of female flowers/inflorescence, length of inflorescence and total number of bunches on the crown, denoting the lesser influence of environmental factors on these characters (Table 6). High heritability and high genetic advance (GA) as percentage of mean was recorded for stem girth at 1 m height, number of leaves, length of leaves, length of leaflet bearing portion, length and breadth of leaflet, length of spikelet bearing portion, number of female flowers/inflorescence, length of inflorescence, indicating that most likely the heritability is due to

Table 5. Genetic parameters for some morphological and reproductive traits in a WCT population

Characters	Mean	Range	PCV (%)	GCV (%)	Heritability (h^2)	GA (%)
Plant height (cm)	117.56	664-1799	598.31	277.58	21.52	7.74
Stem girth at base (cm)	120.05	75-200	170.25	162.46	26.65	33.49
Stem girth at 1 m height (cm)	81.58	63-114	122.98	109.28	91.06	22.15
Stem girth at 1.5 m height (cm)	76.72	61-103	96.90	78.00	78.96	4.77
Total leaves on the crown	28.01	15-37	54.57	78.62	207.6	44.09
Total length of leaves (cm)	491	3.1-6.32	20.01	87.63	1916.22	356.72
Length of leaflet bearing portion (cm)	354.60	264-452	163.27	402.38	607.34	108.48
No. of leaflets	242.98	204-293	112.49	50.20	19.92	2.96
Length of leaflet (cm)	118.54	87-180	163.47	219.99	181.11	56.01
Breadth of the leaflet (cm)	6.30	2.2-9	67.78	60.27	79.07	43.99
Length of 10 internodes (cm)	71.5	45-117	177.18	136.36	59.23	25.56
No. of leaf scars in 1m	14.68	9-26	294.93	272.93	85.46	130.25
Length of inflorescence (cm)	108.24	75-180	145.49	181.65	155.89	44.91
Length of spikelet bearing portion (cm)	38.23	22-55	109.91	88.95	65.49	23.98
Length of spikelet (cm)	37.20	26-57	89.48	71.88	64.53	19.50
No. of spikelets per inflorescence	36.11	25-61	120.17	62.95	27.44	11.30
No. of female flowers per inflorescence	22.85	8-48	172.32	134.35	60.78	45.43
Total no. of bunches on crown	15.87	6-21	61.40	35.26	155.89	10.47

additive gene effects and thus the chances of fixing by selection will be more.

Parent-offspring regression analysis was used for estimating narrow sense heritability of quantitative characters and it provided information about resemblance between parents and their offspring. Heritability (narrow sense) values for stem girth at 1.5 m height, number of leaves and length of spikelet bearing portion were high (Table 6). Hence selection for stem girth at 1.5 m height, number of leaves and length of spikelet bearing portion will help in reducing the instability. High heritability values indicate that the genetic variance is probably due to additive nature, hence simple selection methods can lead to satisfactory genetic gains.

Genetic similarity resemblance between the parental and progeny populations of WCT was also investigated using 14 SSR markers. The PCR amplification using 14 primers in 11 parents and 93 progenies yielded 30 reproducible amplified bands. The number of amplified bands varied per primer from 5-7. Out of 30 bands, 26 were polymorphic (86.6%) and the Polymorphic Information Content (PIC) value as a relative measure of polymorphism level ranged between 0.19-0.23 (Table 7). The similarity matrix was computed based on Jaccard's coefficient using NTSYS-PC and the similarity coefficient ranged from 0.54 to 0.96. Sequential Agglomerative Hierarchical Non overlapping (SAHN) UPGMA was used to generate dendrogram, with similarity index of 0.73.

Table 6. Mean and heritability estimates, based on parent progeny regression, in WCT populations

Character	Mean		Heritability (h^2)
	Parent	Progeny	
Plant height (cm)	1524.9	1174.56	0.267
Stem girth at 1 m height (cm)	75.2	81.58	0.636
Stem girth at 1.5 m height (cm)	74.95	76.72	0.735**
No. of leaves	26.1	28.01	0.729**
Length of the leaf (cm)	424.0	491.0	0.615
Petiole length (cm)	57.8	115.61	0.586
Length of leaflet bearing portion (cm)	273.2	354.6	0.721
No. of leaflets	208.6	242.98	0.540
Length of leaflet (cm)	101.4	118.54	0.658
Breadth of leaflet (cm)	4.79	6.30	0.343
Length of 10 internodes (cm)	50.8	71.5	0.523
No. of internodes in 1m (cm)	21.1	15.89	0.201
Spikelet bearing portion of inflorescence (cm)	25.1	38.23	0.851**
Stalk length of inflorescence (cm)	24.05	48.13	0.151
Spikelet length (cm)	34.3	37.21	0.586
No. of spikelets per inflorescence	30.5	36.11	0.725
No. of female flowers per inflorescence	14.6	22.55	0.813

**Significant P<0.01

Table 7. PIC value and marker index for WCT parents and progenies using five microsatellite markers

Primer name	No. of amplified bands	No. of polymorphic bands	Polymorphic ratio in %	PIC value	Marker Index	Expected heterozygosity (He)
CnCirB12	6	5	83.3	0.16	0.80	0.822
CnCirC3	6	6	100	0.19	1.14	0.779
CnCirE2	7	7	100	0.23	1.61	0.745
CnCirF2	5	4	80	0.22	0.88	0.750
CnCirG11	6	4	66.7	0.19	0.76	0.776

Breeding for resistance/tolerance to coconut root (wilt) disease

Survey to locate high yielding and disease-free Chowghat Green Dwarf (CGD) and West Coast Tall (WCT) palms, was continued in the 'hot spots' of four root (wilt) disease prevalent districts of Alappuzha, Kollam, Kottayam and Pathanamthitta. During the reporting period, a total of 75 CGD mother palms were subjected to serodiagnosis and 44 palms were found to be free of disease and showed negative reaction.

In the evaluation trial involving different dwarfs and its hybrids planted during 2009, CGD X WCT (15.6%) and CGD X MGD (17.8%) recorded less root (wilt) disease incidence. Nut yield recorded from

the same experiment revealed that CGD X WCT (85 nuts palm^{-1} year^{-1}) and CGD X MGD (70.5 nuts palm^{-1} year^{-1}) were superior compared to other dwarfs / hybrid combinations. In general, the nut yield of hybrid combinations was significantly superior compared to dwarfs.

In the evaluation trial involving six green dwarf varieties of coconut planted during 2013, Gudanjali Green Dwarf, Kalpasree and Gangabondam Green Dwarf (GBGD) were more precocious and the average yield was highest in Gudanjali Green Dwarf (122 nuts palm^{-1} year^{-1}) followed by Kalpasree (105 nuts palm^{-1} year^{-1}). Nut character studies conducted revealed that the highest fruit weight (1.3 kg), dehusked nut weight (680 g) and copra content (144 g) were recorded in GBGD followed by Niu Leka Dwarf. The quantity of tender nut water (476 ml), TSS (7.13^{0} Brix) and organoleptic score (4) were highest in GBGD.

In the evaluation trial planted during 2014 involving 13 promising Talls, including the recently released Tall varieties, Kalpa Haritha, was the most precocious with 37.5% flowering within three years after planting. Initial symptoms of root (wilt) disease were noticed in few tall accessions (FMST - 12.5% Disease Incidence (DI), San Ramon Tall - 8.33 DI, Java Tall - 8.33% DI, Guam Tall- 4.17% DI, Philippines Laguna Tall - 4.17% DI and St. Vincent-Tall 4.17% DI).

Evaluation of second generation progenies of disease free West Coast Tall (WCT) mother palms showed that 70% of the progenies started flowering within 60 months after planting, as compared to 62.4% in the *inter se* mated WCT population. However, the initial nut yield trend revealed that the self and *inter se* mated WCT progenies were on par. Symptoms of root (wilt) disease were noticed in both self (1.2%) and *inter se* mated progenies (2.4%).

The season wise variation in floral visitors was recorded from Malayan Green Dwarf, Malayan Orange Dwarf, Malayan Yellow Dwarf and Chowghat Green Dwarf varieties. In general, the insect density was significantly more in dry season (months without rainfall) whereas insect diversity was more during rainy season. During the previous reporting period also, the diversity and density of floral visitors (including different bees, ants, flies, wasps and weevils) were higher in MGD compared to other dwarf varieties. However, during the month of March alone, the density and diversity of floral visitors were higher in CGD variety.

Production and distribution of Kalpa Sankara hybrid was carried out using already selected visually disease-free and serologically negative CGD mother palms located in 'hot spots' of root (wilt) disease. A total of 240 CGD mother palms located in Karunagappally, Haripad, Muttom, Chennithala, Mavelikkara, Kadapra, Niranam and Thiruvalla (spread over three districts) were utilized and artificial pollination was carried out on 1,192 inflorescence involving 27,623 female flowers. A total of 5,833 CGD xWCT seed nuts were harvested from previous years pollination and sown in nursery. Decentralized hybridization units for production of Kalpa Sankara hybrids have been established in six locations. A total of 19,578 CGD seed nuts have been collected and sown in nursery for raising CGD seedlings for distribution among farmers in the root (wilt) disease prevalent tract.

Arecanut

Genetic investigations and breeding

Among the 16 tall hybrid combinations under evaluation for yield traits, Shriwardhan x Sumangala recorded highest dry kernel yield of 3.85 kg palm^{-1} year^{-1} followed by the hybrid Mohitnagar x Mangala with 3.58 kg dry kernel palm^{-1} year^{-1}(Fig. 16-17).

Screening of six dwarf hybrids along with parents for yellow leaf disease tolerance/resistance is in progress in the farmer's garden at Sampaje. None of the hybrids showed symptoms of yellowing of leaves after six years of planting.

Fig. 16. Mohitnagar x Mangala

Fig. 17. Shriwardhan x Sumangala

Arecanut hybrids

A total of 6,503 hybrid nuts have been produced in 16 different combinations involving Hirehalli Dwarf and released high-yielding varieties. Production of new hybrids involving Hirehalli Dwarf and recently released varieties has been initiated and a total of 27,350 female flowers were pollinated.

Under Multi-location trial on arecanut at Kahikuchi, consisting of six parents and eight hybrids combination, Kahikuchi local variety recorded higher plant height (6.17 m), number of leaves (9.18), fruits (268.88 nuts palm^{-1}) and fresh kernel yield (10.04 kg palm^{-1}) among the parents. In case of hybrids combination, Mohitnagar x HD recorded the maximum number of nuts palm^{-1} (169.16) and yield (5.38 kg palm^{-1}) (Fig. 18-19).

Fig. 18. HD x Mohitnagar

Fig. 19. HD x Mangala

Inter-specific breeding of arecanut

Inter-specific crossing between *Areca triandra* and high yielding varieties (*Areca catechu*) has been attempted for screening against fruit rot and YLD. Twenty seedlings of inter specific hybrid of *Areca catechu* x *Areca triandra* have been planted in the field for evaluation.

Cocoa

Comparative yield trial of cocoa hybrids under palm based cropping systems

Among the hybrid progenies evaluated under coconut at Vittal and Kidu NA-33 x ICS-89 and I-56 x III-35 recorded >100 pods and 3 kg dry bean yields at the age of 16 years. Under arecanut, three progeny clones recorded 100 pods tree^{-1} year^{-1} and seven progenies yielded 50 pods tree^{-1} year^{-1} with 1 kg dry bean yield. All progenies as seedlings recorded 50 pods and 1 kg dry bean yields at the age of 13 years. Nine 9 trees of Malaysian hybrid PBC-123 x LAF-17 yielded in the range of 100-134 pods and three trees of hybrid QH-22 x NA-33 yielded 135 pods each with 1 g dry bean weight and 2.5 kg dry bean yield. The average pod yield is 55 pods tree^{-1} year^{-1} in these hybrids. Eight year old Philippines hybrid BR-25 x K-2 yielded a maximum of 110 pods with 1.15 g dry bean weight whereas, BR-25 x S-5 yielded 50 pods tree^{-1} year^{-1} with 1 kg dry bean yield. The average pod yield is 45 pods tree^{-1} year^{-1} in these hybrids.

Multi Location Trial of cocoa clones and hybrids

Cocoa clones and hybrids that performed well in different locations are listed below:

Kahikuchi, Assam	:	VTLC 19 (58 pods), VTLC 61 (1.17 g dry bean weight) (under arecanut)
Mohitnagar, West Bengal	:	VTLC 5 (120 pods) (under arecanut), VTLC 5 (115 pods), VTLCH 1 (107 pods) (under coconut)
Kasaragod, Kerala	:	VTLCH 2 (2 kg dry beans)
Ambajipeta, AP	:	VTLCH 2 (1 kg dry beans)
Aliyarnagar, TN	:	VTLCH 2, VTLCH 3 (1 kg dry beans)
Vijayarai, AP	:	VTLCH 4 (0.9 kg dry beans (under oil palm)

At Mohitnagar, West Bengal, all cocoa plants were affected with cold injury in the month of January 2018 with severe leaf scorching, leaf fall and pod blackening and are now recovering.

At Kahikuchi, among the 13 genotypes studied for growth, yield and pod characters, VTLC 11 recorded the maximum plant height (2.61 m), circumference (26.33 cm) and canopy spread. VTLC 19 recorded the maximum number of pods per tree (57.60), while, VTLC 61 recorded the maximum dry bean weight (1.17 g).

Studies on compatibility reaction in selected cocoa clones

Compatibility reaction was studied in 11 cocoa accessions. Based on the frequency of flower retention after manual protected pollination, trees were classified as self-incompatible or self-compatible. Trees with flower retention (FR) of 10%

or less, 15 days after pollination were classified as self-incompatible, whereas trees with 30% or more flowers after the same span of time were considered as self-compatible. Among the 11 accessions studied flower retention varied from 0% to 10%. Maximum flower retention percentage of 10 was observed in the accession VTLC-186 and 0% flower retention was recorded in nine cocoa accessions viz., VTLC-162, VTLC-187, VTLC-159, VTLC-193, VTLC-179, VTLC-170, VTLC-174, VTLC-160 and VTLC-189. Cocoa accession VTLC-167 exhibited flower retention percentage of 7.69. Therefore, all the 11 accessions studied in the present investigation exhibited self incompatibility reaction.

Technology evaluation trial

Technology evaluation trials of D x D hybrids have been established in farmers' garden in Karnataka and Andhra Pradesh. Technology evaluation of newly released hybrids Kalpa Samrudhi and Kalpa Sreshta were taken up in farmer's gardens in Karnataka, Kerala, Andhra Pradesh and Tamil Nadu. Further, planting of 14 varieties, including selections and hybrids were taken up in a farmers garden in Tamil Nadu.

DUS centre for coconut

Generation of DUS test data was continued in 11 released/extant coconut varieties *viz.*, Chowghat Orange Dwarf, West Coast Tall, Kalpa Pratibha, Kalpa Dhenu, Kalpa Mitra, Chandra Kalpa, Kera Chandra, Kalparaksha, Chandra Sankara, Chandra Laksha and Kera Sankara. The varieties were planted in 2013 in two different spacings (4 m x 4 m and 6m x 6m). Flower initiation was observed in almost all the varieties, except West Coast Tall and Kalpa Dhenu. Early flowering (25 months after planting) was recorded in Chowghat Orange Dwarf and Chandra Sankara, while time taken for flower initiation in other varieties (Kalpa Pratibha, Kalpa Mitra, Chandra Kalpa, Kera Chandra, Kalpa Raksha, Chandra Laksha and Kera Sankara) varied from 36-39 months after planting. Significant variation for juvenile growth characters was observed among the varieties. The plant height, girth, annual leaf production, length of the leaf and breadth of leaflet, recorded significant variation between the palms in the two spacings adopted. The leaf length and plant height were higher in closer spacing of 4 m x 4 m, while leaf breadth, annual leaf production and leaflet breadth were higher in the 6 m x 6 m spacing.

Planting material production

Planting material in mandate crops was produced to the tune of 796, 580 units during the current year (Table 8) resulting in revenue generation to the tune of Rs. 216 lakhs (Table 9). The Centre-wise production activities are detailed below:

Kasaragod: Nearly 24481 hybrid coconut seed nuts were produced and sown in the nursery from the flowers pollinated last year (Fig. 20). During the year, 159463 female flowers from 443 WCT, 72 COD and 23 LCT palms were pollinated. Pollen germination was observed daily to determine the viability of pollen used for pollination. Breeding behaviour of selected palms in terms of male and female phase, days to female flower receptivity, were observed. The database developed for monitoring and planning artificial pollination program in coconut has been used during the year. About 13450 seed nuts of coconut varieties were produced and sown in the nursery for seedling production.

Observations were recorded on the seedling characters for developing soil less media for coconut planting material production. Coir pith is recommended as soil less media for preparing producing coconut seedlings in poly bags.

Mother palms planted for developing seed gardens in a participatory mode in farmer's field at Mooladkam in Kasaragod district of Kerala, were monitored. Seedlings of released dwarfs were planted in farmers field for establishing a seed garden in Karkala, Karnataka. Further, to facilitate large scale production and supply of quality planting material to farmers in Kerala, the institute in collaboration with the Agriculture Development and Farmers Welfare Department, Government of Kerala has initiated decentralized farmer participatory planting material production of dwarf and hybrid varieties of coconut, with funding support under 'Coconut Development Scheme 2017-18' of Government of Kerala. Two projects have been sanctioned and are being implemented in all districts of Kerala, except Idukki and Wayanad, with farmer participation. Dwarf and tall mother palms available in farmer's garden will be used for production of seed nuts which will be sown in nurseries in farmers' field. Quality seedlings will be distributed among farmers. A planning workshop to formulate action plan for decentralized farmer participatory planting material production was held at ICAR-CPCRI on 26th February 2018. Selected

coconut farmers, scientists from ICAR-CPCRI, Deputy Directors from Department of Agriculture and project staff attended the meeting.

Kidu: In coconut, 18210 hybrid seed nuts were produced and sown in the nursery from the flowers pollinated last year. This year 104480 female flowers from 500 WCT were pollinated and assisted pollination was carried out in 3924 bunches in 654 COD palms. A total of 8742 seed nuts of different coconut varieties were produced. Further, about 437835 seed nuts and 29122 seedlings of arecanut and 10 seed pods and 1682 seedlings of cocoa were produced for meeting the planting material requirement of different stakeholders.

Vittal: About 86678 seed lings and 5975 seed nuts of arecanut varieties were produced. In addition, 566 seed pods and 82,215 seedlings/ grafts of cocoa varieties were produced and sold. Compact plots of high yielding ICAR-CPCRI cocoa varieties were established in 5 ha in MGMG villages. Nine bi-clonal orchards, one polyclonal orchard, two scion banks were established at YSR Hort. University, AP with elite clones/ varieties of ICAR-CPCRI for quality planting material production.

Kayamkulam: About 5340 coconut seed nuts were produced in participatory mode and sown in the nursery at Kayamkulam centre. Approximately 300 vials of pollen collected from healthy and high yielding palms of WCT located in 'hotspots' of root (wilt) disease are being cryo-preserved. The pollen germination was regularly checked and studies revealed that pollen germination percentage was not affected even after eight months of storage.

A five day training programme on 'Hybridization techniques and palm health management in coconut' was conducted during 09-17 November, 2017 and 05-09 February 2018. The beneficiaries were two batches of skilled pollinators nominated by Non-Governmental Organizations, Coconut Producer Societies, Agro Service Centers, Registered Coconut Nurseries and ICAR-KVK's. A total of 110 personnel, nominated from 23 agencies, attended the five day training programme during the past two years.

Mohitnagar: About 600 seed nuts of coconut, 62250 arecanut seednuts and 20000 arecanut seedlings were produced for distribution to farmers. In addition, 15000 black pepper cuttings and 1200 acid lime cuttings were produced and distributed.

Kahikuchi: About 9,000 black pepper cuttings of Panniyur and Karimunda varieties were raised and distributed.

Table 8. Seed production in coconut, arecanut and cocoa

Centre	Coconut			Arecanut			Cocoa			Total
	Varieties	Hybrids	Total	Seednuts	Seedlings	Total	Pods	Seedlings	Total	
Kasaragod	13450	24481	37931	-	-	-	-	-	-	37931
Vittal	-	-	-	5975	86678	92653	-	82215	82215	174868
Kayankulam	5340	-	5340	-	-	-	-	-	-	5340
Kidu	8742	18210	26952	437835	29122	466957	10	1672	1682	495591
Mohitnagar	600	-	600	62250	20000	82250	-	-	-	82850
Total	28132	42691	70823	506060	135800	641860	10	83887	83897	796580

Table 9. Revenue from planting material production (Rs. in lakhs)

Centre	Coconut	Arecanut	Cocoa	Total
Kasaragod	72.10	-	-	72.10
Vittal	-	27.50	8.68	36.18
Kayankulam	32.36	-	-	32.36
Kidu	26.04	37.66	0.18	63.88
Mohitnagar				11.49
Total	130.50	65.16	8.86	216.01

Fig. 20. Planting material production in coconut at Kasaragod

Coconut tissue culture

Effect of auxins on embryonic shoot meristem cultures

In order to understand the effect of varied concentrations of auxins *viz.*, 2, 4-D, picloram and dicamba on callus initiation, shoot meristem from mature zygotic embryos of West Coast Tall cultivar was inoculated on to Y3 medium with or without activated charcoal. Shoot meristem was inoculated in medium devoid of activated charcoal and supplemented with 0.1, 0.2, 0.3, 0.4 and 0.5 mg l^{-1} of 2,4-D or picloram or dicamba. In another experiment shoot meristem explants were inoculated on to Y3 medium supplemented with 0.25 g l^{-1} of activated charcoal and supplemented with 1, 2, 3, 4 and 5 mg l^{-1} of 2,4-D, picloram and dicamba as source of auxin. In experiments, in which medium was devoid of activated charcoal, the position of the explants was changed at frequent intervals (10 days) to prevent browning. Cultures were transferred to medium with half the concentration of the auxins after 4 weeks of incubation. Initial response indicated the formation of calli; however the callus growth was arrested in media devoid of charcoal (Fig. 21).

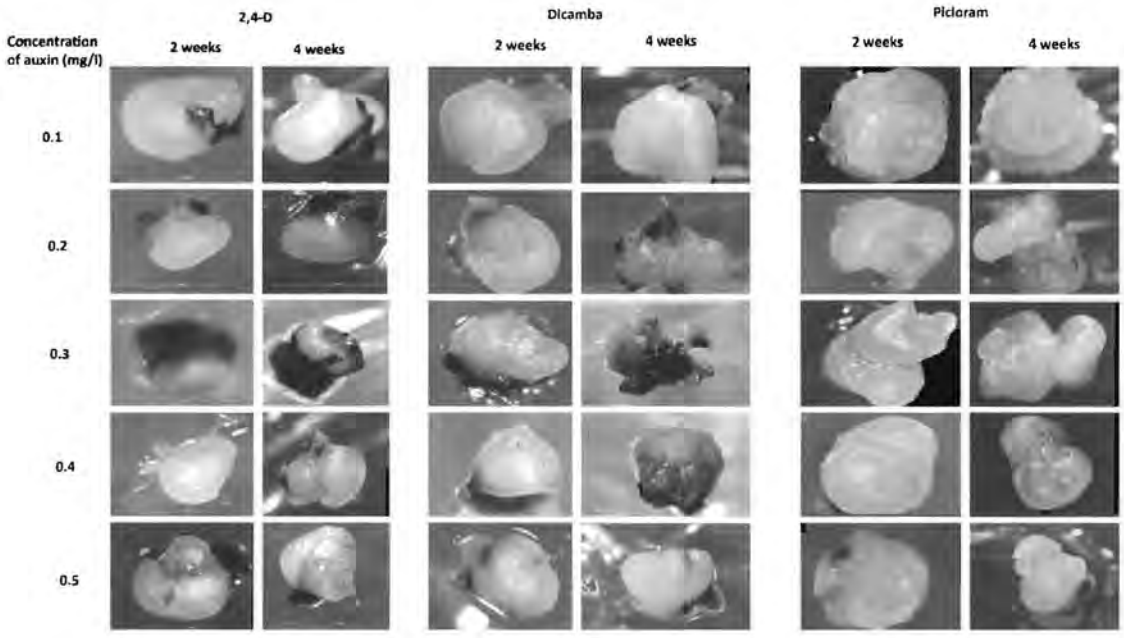


Fig. 21. Effect of different concentrations of various auxins on callus initiation from embryonic shoot meristem explants in the absence of activated charcoal

On the other hand, callus initiation was better in medium supplemented with 0.25 g l^{-1} of activated charcoal and 2,4-D concentration of 5 mg l^{-1} and picloram at 4 mg l^{-1}. Callus obtained from this experiment was chopped and transferred to medium with lower concentration of auxins to enhance embryogenic potential (Fig. 22).

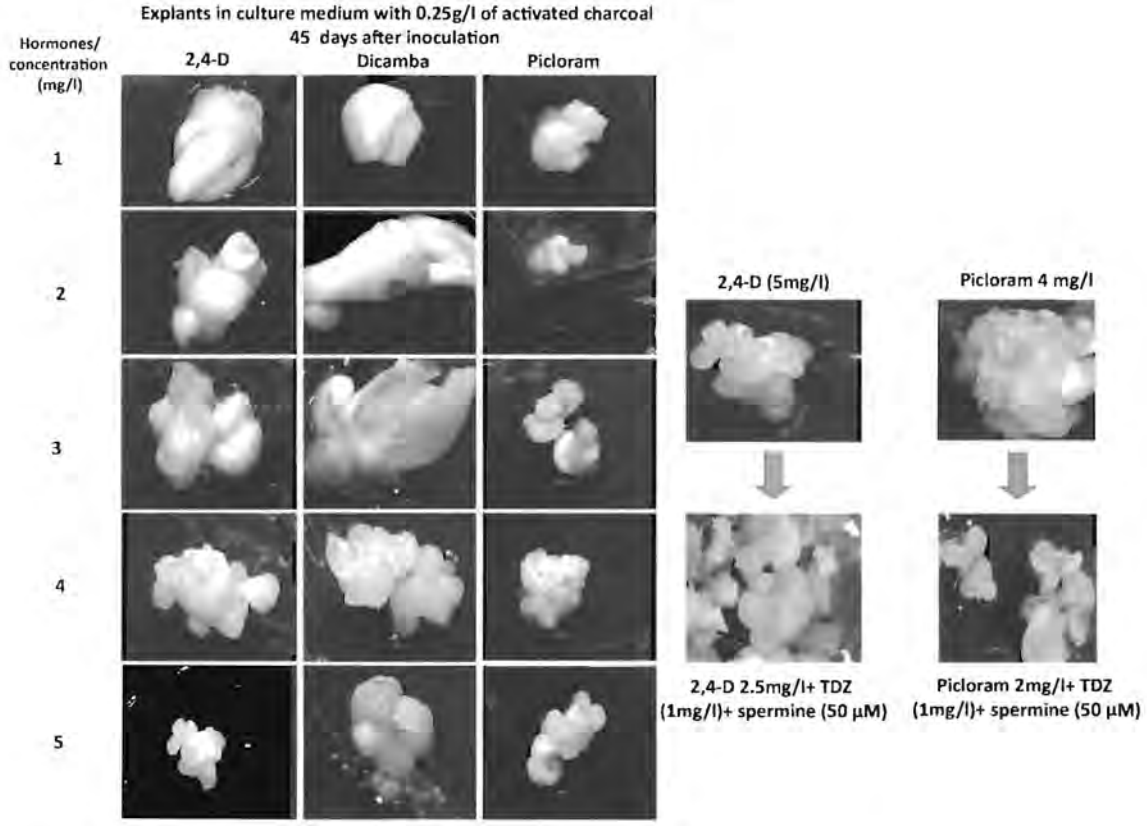


Fig. 22. Effect of different concentrations of various auxins on callus initiation in embryonic shoot meristem explants in the presence of 0. 25g l^{-1} of activated charcoal.

Effect of coconut water and haustorium

Impact of haustorium and coconut water mixture on callus initiation in embryonic shoot meristem explant was studied. For this, 100 g haustorium of the coconut cultivar West Coast Tall was mixed with 100 ml coconut water and ground well to a milky consistency and centrifuged to obtain the haustoria extract liquid fraction/ supernatant. Media was prepared using the supernatant (50 ml l^{-1}), haustoria extract colloid fraction with milky consistency (50 ml l^{-1}), and haustoria extract solid sediment fraction (50 g l^{-1}) and Y3 stock with picloram 100 µM as auxin. Embryogenic callus was obtained from media containing Y3 supplemented with picloram 100 µM and haustoria extract liquid fraction/ supernatant (50 ml l^{-1}), Y3 supplemented with picloram 100 µM and uncentrifuged mixture of coconut water and haustoria extract colloid fraction with milky consistency (50ml l^{-1}). However callus initiation was not observed in medium supplemented with haustoria extract solid sediment fraction.

Effect of new chemicals in callus induction

Effect of three new chemicals, fluridon, atrazine and metatopolin on induction of embryogenic callus in embryonic shoot meristem explants of coconut was investigated. Different concentrations of these chemicals (1 µM, 10 µM, 50 µM, 100 µM and 500 µM) alone and in combination with 100 µM of picloram in Y3 medium were used. Embryogenic callus initiation was faster in media with combination of 10 µM metatopolin and 100 µM picloram.

Electric stimulus

Embryogenic calli obtained from shoot meristem portions of zygotic embryo of coconut was subjected to electric induction. The explants placed on a Y3 media with 10 mg l^{-1} 2,4-D, 30 g l^{-1} sucrose and 1g l^{-1} charcoal in a specialized containers (phytajars) were subjected to 1, 2 and 3 µA of electric current throughout the day and also for one hour /day for one month. The maximum weight of a callus was found in the treatment of 2 µA current throughout the day (Fig. 23).

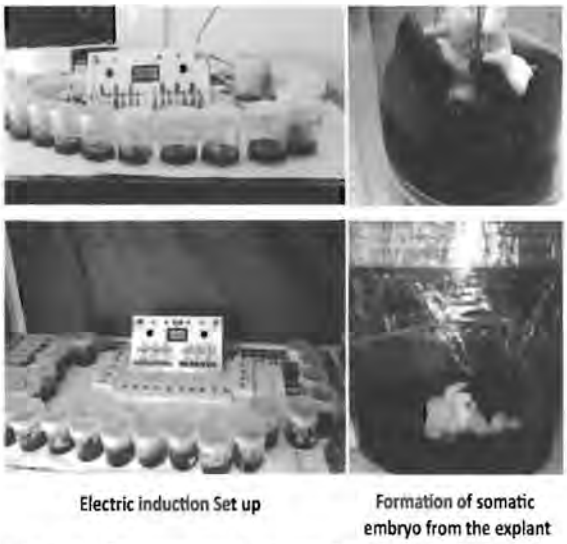


Fig. 23. Experimental set up for electric induction. Formation of somatic embryos in embryonic shoot meristem explants induced with electric current.

Light stimulus

Effect of light on coconut embryo culture

An experiment was devised to find the effect of light in embryo cultured plants. Different lights white, red, yellow, blue and combination of red and blue were used (Fig. 24). Highest shoot length and root length for the embryo cultured plants were obtained in blue light (Fig. 25).

Effect of light on coconut embryogenic callus

Effect of white, red, yellow, blue lights separately and different combinations of red-yellow and red-blue were investigated. The highest number of embryogenic callus was obtained in red light.

Induction of salt stress

An experiment was conducted to induce salt stress in embryonic shoot meristem to induce callus. Sodium chloride @ 100, 200 and 400 mg/l were applied. But the plumule germinated without producing callus.

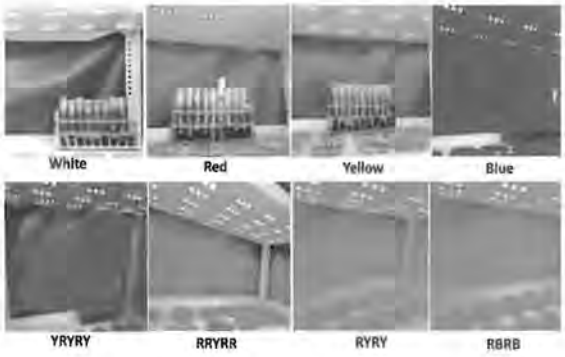


Fig. 24. Experimental setup exposing the cultures to different coloured LED lights such as white, red, yellow and blue and their combinations.

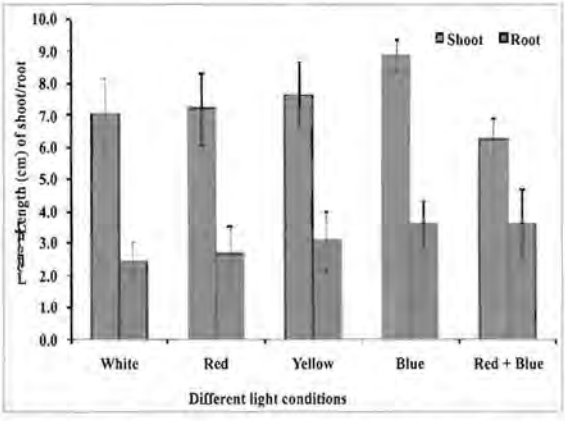


Fig. 25. Influence of different lights on growth and development of embryo cultured plantlets in coconut.

Response of other explants for callus induction and somatic embryogenesis

Immature inflorescence culture

Rachille bits from immature inflorescences of different sizes (2.5, 4, 8, 12 and 16 cm) from Chowghat Green Dwarf (CGD) palm were inoculated onto Y3 medium with 2,4-D (1 mg l^{-1}). Subculturing was done at 45 days interval in the same media and maintained under complete dark condition. A total of 60 plantlets with well developed shoots were transferred to rooting media containing different combination of auxins and cytokinins. Covering the bottom part of test tube with aluminium foil and making a small injury at basal portion of the plantlets, led to initiation of root induction in 70 % of the plantlets. Ten plantlets with well developed roots and more than four leaves were transferred to pots for hardening (Fig. 26).

CGD inflorescence

Rachille bits

First subculture

Second subculture

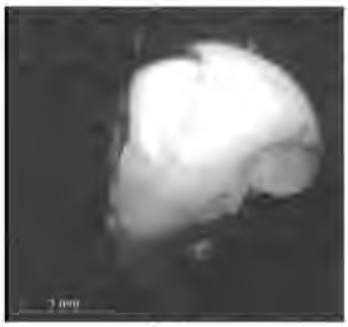
Plantlets obtained from WCT through immature inflorescence culture

Fig. 26. Immature inflorescence culture in CGD and plantlet regeneration from WCT inflorescence

In another experiment cultures have been initiated from immature inflorescence explants (size 4-12 cm) collected from WCT palms in Y3 medium supplemented with various concentrations of 2,4-D (1 mg ml^{-1}), picloram (5, 25, 50, 100 µM) and novel chemicals such as meta topoline for callus induction.

Anther and ovary culture (WCT cultivar)

Anther and ovary explants of inflorescence (-3) from WCT cultivar was inoculated on to four different media combinations ;a) M72 with 40g/l of sucrose, 2,4-D (100 µM) and TDZ (9 µM); b) Y3 with 40 g l^{-1} of sucrose, 2,4-D (100 µM) and TDZ (9 µM); c) M72 with 90g/l of sucrose, 2,4-D (100 µM) and NAA (100 µM); d) Y3 with 90g/l of sucrose, 2,4-D (100 µM) and NAA (100 µM). Media was supplemented with 1g/l of activated charcoal and 2.5 g l^{-1} of gellan gum. Incubation of sterilized spikelets at 37 °C and 4°C were performed to apply the heat and cold pretreatments, respectively. Heat pretreatment was given for four days while cold pre-treatment was continued for two weeks. Anthers were inoculated on to medium after above said pre-treatments. No growth was observed in ovary explants, which turned browned before the next subculture. Anthers in control and pre-treated experiment were sub-cultured after four weeks in the same media supplemented with half the concentration of hormones. Predominant cultures were browned during subsequent sub culturing (Fig. 27).



Ovary

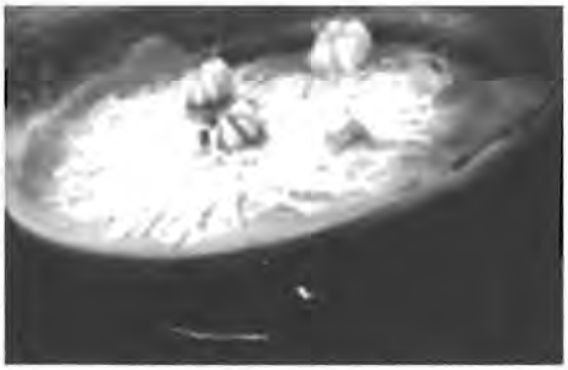
Athers

Athers in M72 medium

Fig. 27. Anther and ovary explants from WCT cultivar cultured in M72 and Y3 medium with different growth regulators.

Use of plant preservative mixture

In an effort to reduce contamination of the culture media, a new chemical plant preservative mixture (PPM) was used. Plant preservative mixture @0.25 ml l^{-1} of media was found to reduce the contamination by 50% (Fig. 8).



Contamination in *in vitro* cultures

Cultures growing in presence of Plant Protection Medium (PPM)

Fig. 28. Efficiency of plant preservative mixture in regulating the contaminations in plumule *in vitro* cultures of coconut.

Establishment and maintenance of cell suspension cultures

Cell suspension initiation and viability studies

Experiments were conducted to initiate cell suspension cultures from plumular explant of coconut. Loose type callus obtained from plumular explants were inoculated into Y3 media with 100 µM picloram. The media used was Y3 with 1-5 mg l^{-1} 2,4-D, 1-5 mg l^{-1} Picloram, with or without malt extract (100 mg, 200 mg, 300 mg, 400 mg, 500 mg, 1 g, 3 g and 5 g l^{-1}) and 100 mg, 200 mg, 300 mg, 400 mg and 500 mg myo-inositol. Suspension was initiated in Y3 medium supplemented with 2,4-D 2.5 mg l^{-1}, myo-inositol and malt extract 300 mg l^{-1}. To provide more visibility of the suspension cultures and to ease the quantification of suspension, a new technique of adding charcoal to the medium was devised. This was done by producing calcium alginate charcoal beads. These beads absorbed phenols and were autoclavable, hence can be directly added to medium and autoclaved (Fig. 29).

Fig. 29. Use of encapsulated activated charcoal beads in suspension culture medium.

Use of temporary immersion systems

Meristemoids obtained from plumular explants were placed in Rita® temporary immersion to study the conversion ratio of meristemoids to plantlets. Media (Y3 + NAA 1 mg l^{-1} + BAP 2 mg l^{-1} + sucrose 30 g l^{-1}) along with charcoal beads were placed in temporary immersion and duration of flushing was set to one minute at six hour intervals. The conversion ratio of meristemoids to plantlets was 30% (Fig. 30).

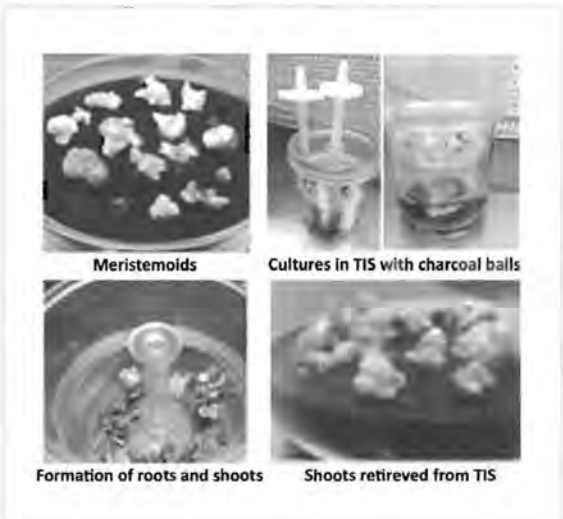


Fig. 30. Temporary immersion system and its efficient use in converting meristemoids formed in coconut embryonic shoot meristem cultures in to plantlets.

Molecular studies to understand/overcome *in vitro* recalcitrance

Standardization of kanamycin concentration on growth of coconut plumule under the influence of activated charcoal

An experiment was designed to establish the optimal concentration of kanamycin in presence of activated charcoal on growth of embryonic shoot meristem

tissue of coconut to use in the transformation experiment. The embryonic shoot meristem from sterilized mature zygotic embryos of WCT cultivar was inoculated on to Y3 medium supplemented with 0, 20, 40, 60, 80 and 100 mg/l of kanamycin a selective antibiotic with varied concentration of activated charcoal *viz.*, 0, 0.25, 0.5, 0.75, 1.0 g l^{-1}. Results indicate that embryonic shoot meristem could survive a concentration of 20 mg l^{-1} of kanamycin, while a concentration of 40 mg l^{-1} was found to be lethal with 0.25 g l^{-1} of activated charcoal. Thus the optimal concentration of kanamycin to be used in transformation experiment of embryonic shoot meristem with minimum quantity of activated charcoal was standardized (Fig. 31).

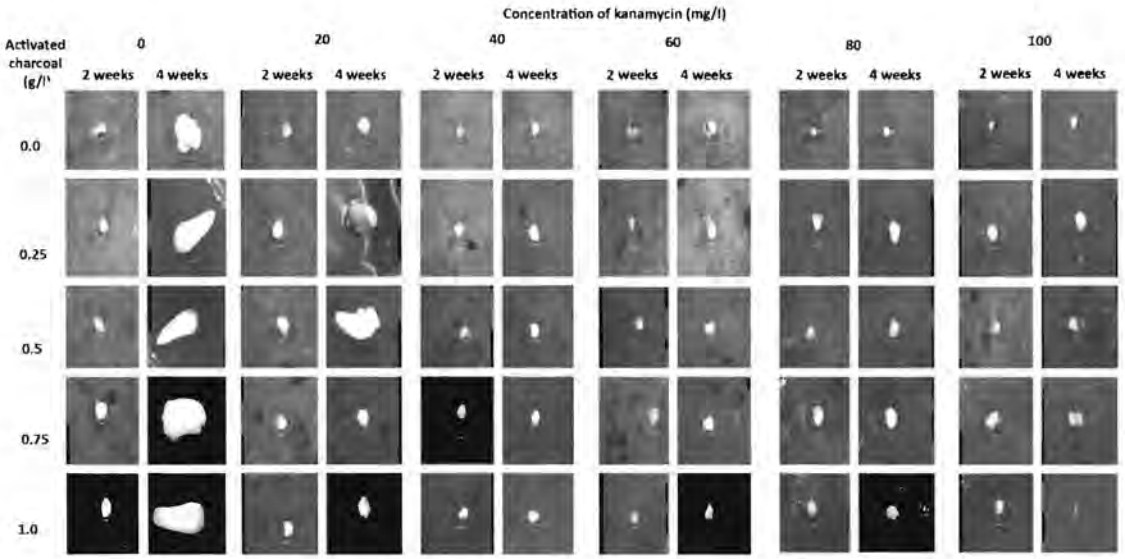


Fig. 31. Influence of different concentrations of kanamycin on embryonic shoot meristem explants in coconut cultured onto Y3 medium supplemented with different concentrations of activated charcoal.

Transformation experiments with embryonic shoot meristem and endosperm calli

Transformation of embryonic shoot meristem explants aimed to enhance the process of somatic embryogenesis was initiated. Three different *Agrobacterium* strains *viz.*, EHA105, PGWB2 and PGWB5 were used. PGWB2 and PGWB5 strains of *Agrobacterium* had *Arabidopsis Wuschel,* a key gene responsible for somatic embryogenesis. PGWB2 has *GUS* gene and PGWB5 uses green fluorescent protein (*GFP*) as the reporter genes. Embryonic shoot meristem and endosperm callus of coconut were co-cultured with the *Agrobacterium* strains and transferred to selective medium after washing with cefatoxime solution (500 mg l^{-1}). Selective media for embryonic shoot meristem explant was Y3 with picloram (4 mg l^{-1}), kanamycin (40 mg l^{-1}), cefatoxime (500 mg l^{-1}) and activated charcoal (0.25 g l^{-1}) whereas it was Y3 with 2,4-D (0.5 mg l^{-1}), kanamycin (40mg l^{-1}), cefatoxime (500 mg l^{-1}) and activated charcoal (0.25 g l^{-1}) for the endosperm calli. About 20% of the embryonic shoot meristem survived in the selective medium and showed initial response in the form of bulging. Endosperm calli and embryonic

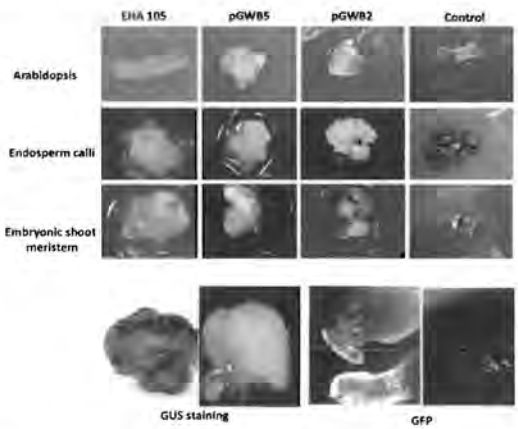


Fig. 32. *Agrobacterium* mediated transformation in endosperm calli and embryonic shoot meristem of coconut.

shoot meristem explants with no co-culture (control) turned completely brown in the selective medium. Embryonic shoot meristem and ensosperm calli were subcultured on to medium with half the concentration of auxin after one month and the cultures are under further investigation for callus initiation in embryonic shoot meristem and multiplication in endosperm calli (Fig. 32).

Genome wide comparison of miRNAs and their target transcripts in embryogenic and non-embryogenic calli of coconut

Small RNA sequencing of embryogenic calli (EC) and non-embryogenic calli (NEC) of coconut was carried out in Illumina HiSeq 2000 platform. A total of 88 conserved miRNAs from 26 miRNA families, with perfect match to the known mature miRNAs, were identified in both types of calli. These miRNAs varied in length from 18 -22 nt and most abundant miRNAs were 21 nt long. In addition to conserved miRNAs, a total of 131 novel miRNAs, of which 25 were specific to EC, 45 were specific to NEC and 34 were common in both the libraries. miRNA targets were predicted using plant small RNA target analysis online server (psRNATarget) and coconut embryogenic transcriptome data generated earlier. Identified targets were observed play a major role in somatic embryogenesis according to previous reports in other plant species.

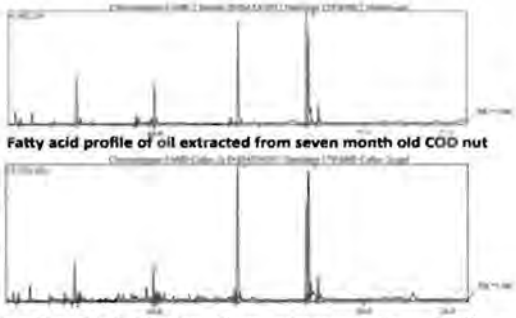
Biochemical analysis of endosperm calli

Calli obtained from endosperm cultures of coconut were tested for the presence of fatty acids through gas chromatography. Extraction of oil from calli was carried out by vigorous shaking with petroleum ether solvent and leaving it for overnight. Upon evaporation of solvent, the obtained fat was esterified and dissolved in HPLC grade hexane and tested in GC. The profile was comparable to that of endosperm from mature nuts (Fig. 33).

Embryo rescue and cryopreservation studies in coconut and arecanut

Embryo rescue in areca inter-specific hybrid

Three plantlets of *Areca* inter-specific hybrid (*A. triandra* x *A. catechu* cv. Mangala) were retrieved via embryo rescue. The growth of the plantlets was very slow and the plantlets are slender in nature (Fig. 34). To improve its growth, medium was supplemented with IAA, BAP and NAA (2 mg/l each).



Fatty acid profile of oil extracted from seven month old COD nut

Fatty acid profile of oil extracted from endosperm calli generated from seven month old COD nut

Fatty acid profile of oil extracted from mature endosperm of COD nut

Specifications/ major fatty acids (%)	Lauric acid	Myristic acid	Palmitic acid	Oleic acid	Linoleic acid
Endosperm from 7 month old COD nut	8	7	23	25	27
Endosperm from 12 month old COD nut	33	21	14	11	
Endosperm callus	7	6	27	11	20

Fig. 33. Fatty acid profile of oil extracted from fresh endosperm (Immature and mature) and callus obtained from endosperm in COD cultivar.

Fig. 34. a. Immature nuts of interspecific hybrid generated by crossing between *Areca triandra* and *Areca catechu* (cv. Mangala) b. Rescued embryo culturing on to medium and subsequent plantlet regeneration

Refinement of droplet vitrification method with encapsulation for coconut embryonic shoot meristem cryopreservation

Modification of pre-growth media and initial retrieval media for droplet vitrification method of cryopreservation

The cryoplates embedded with shoot meristem were desiccated either using PVS 3 solution (V-cryoplate) or silica gel (D-cryoplates) for different time period (2, 4 and 4.5 hrs) and stored in liquid nitrogen for a minimum period of 24 hrs. The results indicate that 2 hrs of desiccation in silica gel or in PVS3 was found to be suitable for plantlet recovery after cryopreservation (Fig. 35).

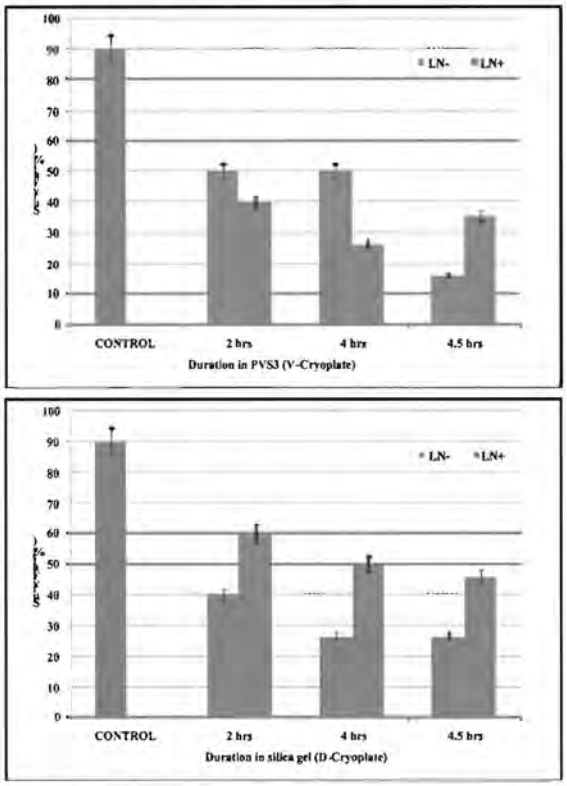


Fig. 35. Survival percentage of embryonic shoot meristem cryostored using D (Desiccation in silica gel) and V cryoplate (PVS3) method

Validation of coconut embryo cryopreservation protocol with wider range of cultivars and cryostore at National Cryogene bank as base collection.

One hundred and fifty embryos from six coconut accessions CGD (IND 029), Kalpa Haritha (IND 045), Tiptur tall (TPT: IND 125), WCT, LCT and LMT were stored in liquid nitrogen tanks for transportation to NBPGR to serve as base collection.

Long term conservation of coconut pollen and its viability and fecundity studies: Efficacy of pollen collection and cryopreservation during monsoon period

Spikelets from five palms each of West Coast Tall (WCT) and Chowghat Orange Dwarf (COD) were processed using five different drying protocols. Results indicate that it is feasible to collect coconut pollen during monsoon season by initial slow drying in room temperature and subsequently at 35°C followed by 40°C. The viability of pollen was retained after desiccation as well as cryopreservation.

Arecanut tissue culture

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

Ten *in vitro* raised plantlets from dwarf and hybrids were successfully hardened in the lab conditions and transferred to bigger grow bags for *ex vitro* hardening. About 50 plantlets are in different stages of *in vitro* development which included Hirehalli Dwarf and dwarf hybrids (Fig. 36-37). The embryogenic cultures from dwarfs and dwarf hybrids are multiplied and maintained in low auxin medium.

Fresh cultures were initiated from inflorescence and plumule explants of Hirehalli Dwarf, dwarf hybrids and apparently healthy palms of YLD hotspot area. Apparently healthy arecanut palms were identified from YLD hotspot area of Sringeri, Karnataka and three inflorescences were collected from these palms were inoculated in callus induction medium. An MoU has been signed with SPIC agro biotech, Coimbatore and cultures initiated from ten inflorescences of dwarf hybrids were handed over for technology refinement and scale up. Another set of six intact inflorescences collected from apparently healthy arecanut palms from YLD hotspot area of Sringeri, Karnataka were also handed over for culture initiation. The officials of SPIC agro Biotech were trained for inflorescence collection, sterilization and culturing.

Fig. 36. Plantlet regeneration from immature inflorescence culture of arecanut dwarf and dwarf hybrids.

Fig. 37. Acclimatization of *in vitro* derived plantlet

Long term maintenance of arecanut embryogenic calli

The maximum survival and somatic embryo formation in cryopreserved embryogenic calli was noticed in cultures pre-grown at 0.3M sucrose and dehydration for 30 minutes in PVS3 solution. Plantlet recovery was achieved from these cryopreserved embryogenic calli (Fig. 38).

Fig. 38. Plantlet recovery from cryopreserved embryogenic calli of arecanut

Molecular characterization of accessions

Assembly and annotation of whole genome sequence of coconut

Assembly and annotation of Chowghat Green Dwarf palm has been completed. Deep sequencing data obtained using hybrid sequencing strategy, with short reads from Illumina and long reads from Pacific Biosciences sequencing, resulted in more than 95% of the raw data with a quality Phred Score >20. A total of 59,328 scaffolds could be generated with a N50 of 86 Kb and G+C % of 31.79. As a result of this hybrid assembly approach, the final draft genome representing CGD genome had a total size of 1.83 Gb with 51953 predicted genes. A total of 47,746 genes (91.9%) could be annotated.

Development of SCAR markers for detection of interspecific hybrids in arecanut

Areca catechu and its wild relatives *viz.*, *Areca concinna and Areca triandra* were characterized using Start Codon Targeted polymorphism (SCoT). Markers unique to *A. catechu* and *A. triandra* were identified. Based on these sequences, SCAR markers specific to *A. catechu* and also to *A. triandra* were designed. Authentic inter-specific hybrids between *Areca catechu* and *Areca triandra* could be identified utilizing these SCAR markers (Fig. 39).

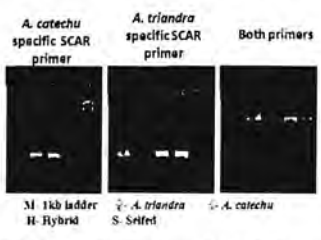


Fig. 39. SCAR markers developed for detection of inter-specific hybrids in arecanut.

3 CROPPING SYSTEMS AND BIORESOURCE MANAGEMENT

Cropping and farming systems

Coconut based integrated farming systems

In the coconut farming, sole cropping appears to be a non profitable and non sustainable venture due to its price instability, competition from other annual oilseed crops; and poor natural resource utilization potential. Hence it is suggested to adopt cropping/farming system approach to improve the sustainability and profitability of coconut farming. To develop a sustainable coconut based integrated farming system, a farming model of one hectare comprising coconut (cv. West Coast Tall and Laccadive Ordinary Tall, 46 years), pepper (trailed on each coconut trunk), banana (in the border row space of the plots), fodder grass-Hybrid Bajra Napier cv. Co5 (in the interspaces of coconut), dairy unit (seven cows of Holstein Friesian and one Jersey cross breed), poultry (100 broiler birds per batch, two batches), goattery (20 does and two bucks) and aquaculture (1000 fingerlings), was studied over 8 years. One hectare of coconut garden integrated with different components as above produced 23100 coconuts (Rs. 2,71,425/-), 17771litres of cow's milk (Rs.5,40,518/-), 250 kg live weight of goat (Rs. 62,525/-), 393 kg of live weight of broiler birds (Rs. 29,720/-), 2340 kg of banana (Rs. 58,500/-), 649 kg of pepper (Rs. 4,41,320/-) and 185 kg of fish (Rs. 18,500/-). The coconut palms in coconut based integrated farming systems, receiving integrated nutrient management practices i.e. organic recycling and 50% of the recommended chemical fertilizers (250:160:600 g N, P_2O_5 and K_2O $palm^{-1}$), increased the yield (132 nuts $palm^{-1}$) by 10 percent compared to monocropping (118nuts $palm^{-1}$). Adoption of coconut based integrated farming system resulted in net income of Rs. 6,72,275/- with a benefit cost ratio of 1.8 as compared to monocrop of coconut (Rs. 1,52,350/-) (Fig. 40).

Fig. 40. Coconut based integrated farming system at Kasaragod

Arecanut based integrated farming system

Arecanut based integrated farming system model (one ha) comprising of arecanut, fodder (grass cv. Co3) as intercrop and sole crop in 0.28 ha area, dairy of 5-7 milching cows (comprising of 6 Holstein Friesian and 1 Gir) and fish (600 fingerlings) was assessed for its sustainability and income generation. The system was highly profitable in terms of net monetory returns which was recorded as Rs. 11,49,648/- with its realized components yields of 3083 kg kernel per ha area (Rs. 1,92,706/-), 27,304 l milk (Rs. 8,87,380/-), 42.8 kg fish (Rs. 3,424/-) and about 75.0 t cow dung (Rs. 54,000/-). The areca leaf sheath, when used as cattle feed replacing 10% of the concentrates, saved Rs. 44/- per day per cattle. The use of hard laterite soil for livestock enterprises like dairy, fishery and fodder cultivation can make use of the land which is not suitable for cultivation of arecanut; hence land resource use can be increased.

Coconut based high density multi species cropping system

High Density Multi Species Cropping System (HDMSCS), which involves growing of more than one crop along with coconut simultaneously improved resource use efficiency and enhance per unit productivity. At ICAR-CPCRI, Kasaragod, a high density model comprising of coconut (at spacing of 8 x 8 m), pepper (trailed on each coconut

trunk), banana cv. Kadali, Robusta (inter row space of palms in single/double rows @ 155 plants ha cinnamon (inter row space of palm@ 116 plants ha^{-1}) and nutmeg (between 4 coconut palms @ 58 plants ha^{-1}) initiated in 2007 is being evaluated for its response to organic (vermicompost, biofertilizers, vermiwash and green manure) and integrated (organic+ inorganic) nutrient management. Yield of intercrops such as black pepper (4.5-5.1 kg $vine^{-1}$), cinnamon (220-256 kg ha^{-1}), banana cv. Kadali (8-10 kg $bunch^{-1}$), banana cv. Robusta (12-15 kg $bunch^{-1}$) was recorded. The coconut yield did not differ significantly among the treatments viz., palms with fully organic, palm with 1/3rd recommended chemical fertilizers (NPK @ 167:107:400 g $plant^{-1}$) and recycling of biomass (vermicompost @ 30 kg $palm^{-1}$) + biofertilizer (200 g $plant^{-1}$) + green manuring + vermiwash (10 l $palm^{-1}$) and palm with 2/3rd (NPK @ 333:213:800 g $plant^{-1}$) recommended chemical fertilizer and recycling of biomass (vermicompost @ 30 kg $palm^{-1}$) indicating the feasibility of complete organic farming. The recyclable biomass produced from the system which was used for organic matter recycling ranged from 24 to 30 t ha^{-1}. The net returns from the coconut based HDMSCS was to the tune of Rs. 7,50,814/- ha^{-1} $year^{-1}$ which is five times more than coconut monocrop (Rs. 1,52,350/-) indicating advantage of adoption of HDMSCS in coconut for increasing the income for farmers.

Nutrient and water management in palms

Impact of harvesting tender nut on the sustained productivity of coconut

Harvesting tender nuts is a highly remunerative way to earn higher profitability in coconut farming since the demand for tender nut is increasing over time. But the impact of continuous harvest of tender nut on the palm should be understood for sustained productivity from the garden. The study was conducted to understand the impact of different harvesting intervals and sequence of harvesting on tender nut and mature nut production. Harvesting of tender nut throughout the year with 25 days interval recorded continued higher yield for three years from 2015 to 2017 (167 – 195 tender nuts $palm^{-1}$ $year^{-1}$) which is significantly different from harvesting tender nuts for six months in a year or alternate year or alternate bunches or harvesting of mature nuts. There was no deleterious effect of continuous tender nut harvesting on growth parameters of the palm like height, number of leaves produced and girth of the palm.

Long term effect of coconut cultivation on soil potassium status

Potassium is the nutrient which is taken up by the coconut palms in larger quantities as compared to any other nutrient. In addition, the perennial nature and rooting pattern of coconut leads to heavy removal of potassium from the same soil volume over years. This warrants monitoring soil potassium status over time. Therefore, the changes in the different potassium fractions in soil after 43 years of coconut cultivation were studied in a long term fertilizer cum manurial experiment. Among the different potassium fractions, lattice potassium content (79-85%) was found to be the highest, which was followed by non exchangeable potassium (8-12%), exchangeable potassium (2-9%) and lowest was observed to be water soluble potassium fraction (1-4%). In coconut basin, soil potassium levels of the fertilizer applied treatments showed higher exchangeable, lattice and total potassium status than nil/no manurial treatments. Though the fertilizer application improved the total potassium status of soil compared to the unfertilized soils the non-exchangeable potassium status started reducing comparatively. The reduction in lattice potassium status in nil/no manurial treatments and slight reduction in non-exchangeable potassium in fertilized plots reveals that it is imperative to apply potassium according to the removal, to compensate the loss from soil, in order to reduce potassium mining in the long term and to sustain soil fertility and productivity.

Long term effect of coconut cultivation on soil phosphorus status

Phosphorus is one of the major nutrients for coconut. The information about the fate of phosphorus in soil is essential for better management of the nutrient. Therefore, the changes which have occurred in the different phosphorus fractions in soil after 43 years of coconut cultivation were studied from a long term fertilizer cum manurial experiment. Phosphorus was fractionated into Easily Soluble P (ES-P), Aluminium P (Al-P), Iron P (Fe-P), Calcium P (Ca-P) and Reductant Soluble P (RS-P) at two depths (0-30 cm and 30-60 cm) through sequential extraction. The dominant phosphorus fraction in the coconut basin at 0-30 cm depth was Ca-P and the trend was as

follows: Ca-P>RS-P>Fe-P>Al-P>ES-P. But at 30-60 cm depth, RS-P became the dominant fraction and the trend was RS-P >Ca-P >Fe-P> Al-P>ES-P. In the basin, the Fe-P was the dominating fraction in both the depths followed by Ca-P and RS-P. The difference in P fractions in manured and non-manured plots clearly showed that the manured plots have high content of all the inorganic phosphorus fractions in both the depths. The P fractions decreased at 30-60 cm depth as compared to 0-30 cm depth (Fig. 41).

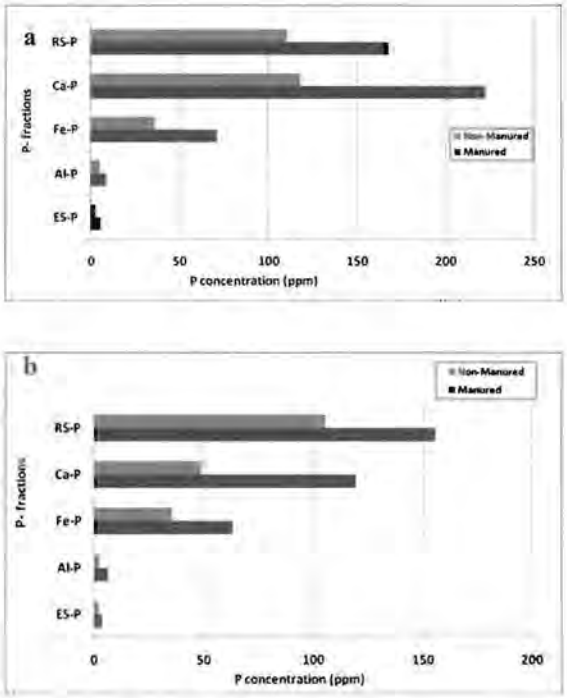


Fig. 41. Phosphorus fractions in coconut basin a) 0-30 cm depth (b) 30-60 cm depth

Nutritional requirement of dwarf varieties of coconut in root (wilt) affected area

A field study was conducted to understand the nutritional requirement of dwarf varieties of coconut [Kalparaksha, Chowghat Orange Dwarf (COD) and Kalpasree]. with different nutrient combinations involving soil test based nutrient application applied in combination with organic and inorganic sources of nutrients. Application of nutrients based on soil test + raising and incorporation of green manure in the basin + vermicompost @ 15 kg palm^{-1} year^{-1} + neem cake @ 5 kg palm^{-1} year^{-1} consistently recorded the highest nut yield irrespective of the varieties for the consecutive three years ie., 64 nuts palm^{-1} (2015), 86 nuts palm^{-1} (2016) and 101 nuts palm^{-1} (2017).

At the end of nine years, the root (wilt) disease incidence was 32.3, 3.1 and 5.2 percentages in Kalparaksha, COD and Kalpasree, respectively. Combined application of nutrients based on soil test and organic sources proved advantageous for better disease tolerance and sustained yield. The disease incidence was 6.9% with application of fertilizers by soil test + organics whereas it was more than 11% in other treatments.

Root studies of an apparently healthy and root (wilt) disease advanced palm of Kalparaksha indicated that the number of primary roots was more in diseased palms, whereas, secondary and tertiary roots were more in the apparently healthy palm. The number of dead roots was more in healthy palms indicating an active root phase.

Improving coconut productivity in Kerala

The multi institutional collaborative project for evaluating the economic viability of coconut based cropping system through site specific management practices was initiated during 2015 in the five Agro Ecological Units of Kerala (Southern Coastal Plain AEU1,Onattukara Sandy Plain AEU-3, South Central Laterite AEU 9, North Central Laterite AEU10 and Northern Laterite AEU11) with the financial assistance for Kerala State Planning Board. The project consisted of field experiments and demonstration of soil and nutrient management in farmers' coconut gardens. The experiment was taken up with five treatment combinations that included application of all the major, secondary and micronutrients along with sodium chloride, lime, dolomite and gypsum and Farmers' practice kept as check.

In the Agro Ecological Unit -9 (South Central Laterite), the content of exchangeable aluminium in the surface soil (0-20 cm), which is responsible for sub soil acidity, was the highest (0.75 milli equivalents 100g^{-1}) indicating the need for application of gypsum for correcting the problem. The exchangeable aluminium content was highest (1.45 milli equivalents 100 g^{-1}) in the case of farmers' practice, where no inputs are being applied. General improvement in soil pH after treatment application was observed in all the experimental sites. In the Agro Ecological Unit - 3 (Onattukara Sandy Plain), the highest percentage increase in yield (21.7 nuts palm^{-1}) was observed in plots where site specific application

of nutrients along with the gypsum, dolomite and lime. Reduction in foliar yellowing and leaf rot was observed in treated palms (Fig. 42).

Fig. 42. General view of the plot in Kalluvathukkal during 2015 and 2017 (after site-specific application of nutrients)

Techno-socio-economic assessment of soil and water conservation and water harvesting structures: Impact of concrete check dam on groundwater augmentation

Impact of concrete check dam (Fig.) on groundwater augmentation was assessed by studying the amount of water percolated from the reservoir. Percolated water was assessed from 20 such concrete check dams constructed mainly to augment the local ground water resources. Groundwater contribution, deep percolation, from irrigated water was negligible since the irrigation was done once in a week using sprinklers or manually by hose irrigation. Hence the percolated water from the reservoir is a major contributor of ground water. Average evaporation rate was measured to be 5mm/day.

Ground water contribution of 24 check dams was found to be 81400 m^3 $year^{-1}$. The average contribution was 3391.7 m^3 check dam^{-1} $year^{-1}$. However, the contribution of two check dams, one in Makkiyad watershed and the other in Munderi watershed (both in Wayanad district of Kerala), was 77895 m^3 $year^{-1}$ which is equivalent to the 95.7% of total contribution of all the checkdams. Barring the top two contributors, the average percolation from a checkdam is 3540.7 m^3 $year^{-1}$. The large surface area of the reservoir of the two checkdams was the major reason for this high ground water recharge. Stream flow characteristics, such as number of days the stream flows per year, also played a role in the water percolation albeit to a much lesser extent. Bed slope of the stream, width and height of the check dam were the major factors affecting the reservoir size. It was observed that the percolation rate did not differ much in the majority of check dams. It could be attributed to the accumulation of silt in the reservoir over a period of time. Width (10 m) and height of these two high contributors in Makkiyad and Munderi watersheds were higher compared to other check dams. However, the reservoir length of these two check dams in Makkiyad and Munderi watersheds are 2150 m and 980 m, respectively (Fig. 43).

Fig. 43. Concrete check-dam for soil water conservation

Microbial studies in YLD affected arecanut plots

The yellow leaf disease (YLD) of arecanut is observed in elevated terrains and low land paddy converted areas. Soil health is one of the important factors for imparting tolerance to any disease. With this background, microbial status of different soils with and without YLD incidence was studied during pre-monsoon and monsoon seasons. No significant difference in bacteria, fungi and actinomycetes population was noticed in the rhizosphere microflora. The root endophytic microflora (27 nos.), root endohytic fungi (2 nos.) and the rhizosphere microflora (40 nos.) associated with healthy and YLD affected palms were isolated and were screened for ACC deaminase and mineral nutrient solubilization. Among them, 20 isolates exhibited potential of the ACC deaminase activity and 27 isolates possessed mineral solubilization potential. The predominantly occurring and rhizospheric root endophytic associated microbes were identified as *Burkholderia* sp. (Fig. 44), *Bacillus* sp. and *Enterobacter* sp. possessing ACC deaminase and mineral solubilization potential. Root endophytically associated fungi viz., *Fusarium* sp. and *Nigrospora* sp. were also identified from the YLD affected arecanut palm.

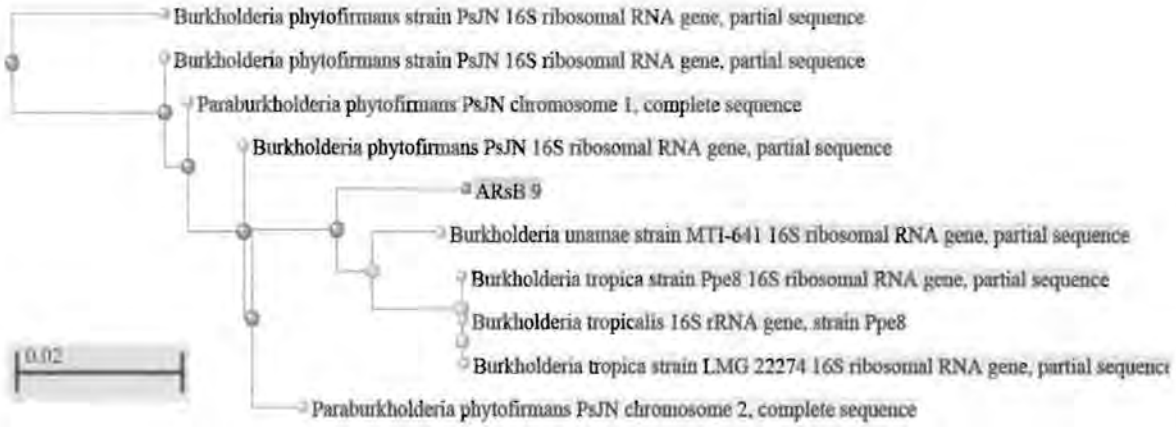


Fig. 44. Phylogenetic tree of ACC deaminase potential arecanut root endophytic and rhizospheric bacteria *Burkholderia unamae* ARsB9.

Bioresources management

Creating wealth from waste

The disposal of husks of tender and matured coconut is an herculean task and they cause health hazards in both rural and urban areas. The composting of all other coconut wastes using earthworms has been standardized. The increased demand for tender coconut in urban areas and commercial use of tender coconut in ice cream industries has increased the accumulation of tender coconut husk. Thus there is an urgent need to develop technology to dispose these husks. Composting of tender coconut and mature coconut husk was carried out using fermented cow-dung along with the addition of organic matter degrading microbial consortium. A consortium of cellulose degrading bacteria isolated from guts of coconut leaf vermicomposting earthworms was added as additional organic matter degrading microbiota. At the end of 4 months, the C:N ratio of the husks was brought down to less than 40 from its initial value of 180 (Fig. 45).

Fig. 45. Coconut husk composting process

Labour friendly technology for harvesting earthworms from vermicomposted substrates

The separation of earthworms from the vermicomposted substrate is tedious process which involves manual separation. A technology was developed at ICAR-CPCRI to naturally separate the earthworms from the vermicomposted substrate using attractant like cow dung. But looking into the scarce availability of cow dung there was a need to refine the technology to reduce the quantity of cow dung usage. A study was conducted to test the feasibility of using sugarcane bagasse with cow dung for quicker harvest of earthworms from the vermicompost heap. This combination was very effective in attracting the earthworms compared to cow dung alone (Fig. 46).

Fig. 46. Technology for harvesting earthworms from vermicomposted substrates

Population dynamics of ammonia and nitrite oxidizers in vermicompost and coir pith compost on storage

The shelf life of the vermicompost and coir pith compost is important for their commercial value. The compost which can be stored for longer time without deterioration of the quality will have better market demand. Thus a study was conducted to understand the changes in the viable population of ammonia and nitrite oxidizers in the coconut leaf vermicompost and coir pith compost after storage. Most Probable Number (MPN) method with ten-fold dilutions was used for enumeration of microbial population (Fig. 47). Quantitative estimates showed decreased numbers of ammonia oxidizers over time in both types of composts. However, decline of population density of nitrite oxidizers was quite rapid in vermicompost as compared to coir pith compost.

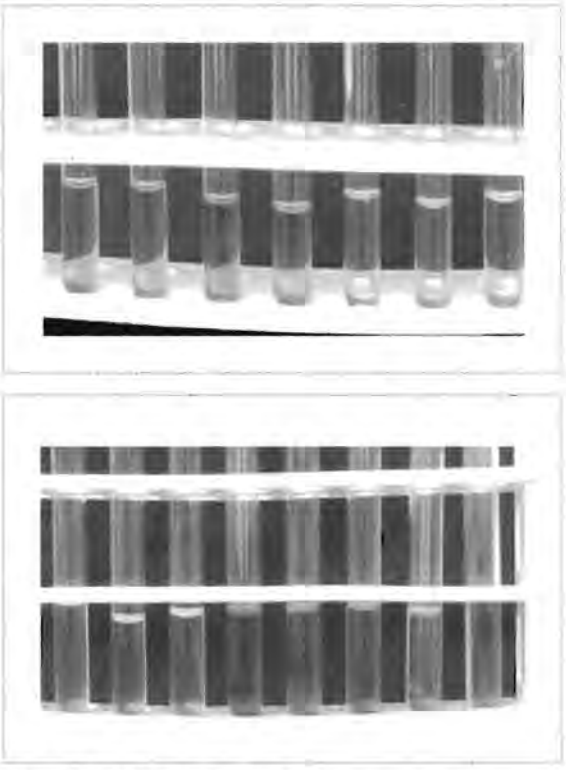


Fig. 47. MPN method of estimating ammonia and nitrite oxidizing bacteria

Arecahusk composting

Towards the development of the microbial consortia for the composting of the recalcitrant lignocellulosic areca husk, the husk from farm *in situ* composting/mulching and retting sites were collected and the associated predominant microorganisms (62 nos.) were isolated and assayed for their lignocelluloytic potential. The genomic DNA of the lignocelluloytic potential isolates was extracted and ITS/16S rDNA was amplified and the potential lignocelluloytic isolates were identified as *Phenorochete* spp. (Fig.48-49), *Aspergillus* sp. *Penicillium* sp. and *Acinetobacter* sp.

Fig. 48. *Phenerochete concrescens* AHF 1 growth in PDA media

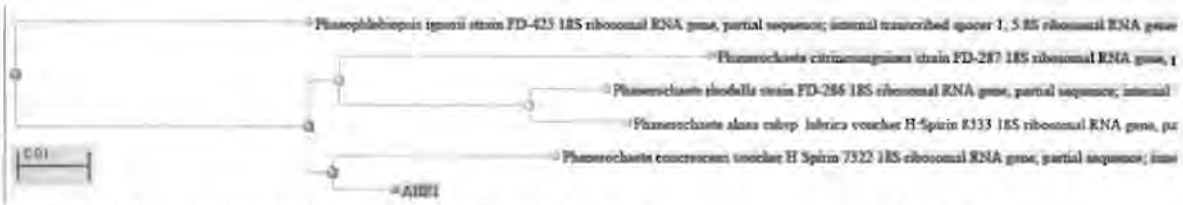


Fig. 49. Phylogenetic tree of ligno-celluloytic potential *Phenerochete concrescens* AHF 1

Characterization and nutrient mineralization/ solubilization studies in Kahikuchi isolates

The soil biota is known to improve the nutrient use efficiency. To understand the microbial activity and efficient microbes for improved nutrient use efficiency, soil samples have been collected from arecanut rhizosphere region which was under organic and INM cultivation. Seventeen putative plant beneficial bacteria were isolated from the samples and were characterized. Four of these exhibited high levels of phosphate solubilizing ability. These were then assessed for silicate and zinc solubilization and were found to be positive. This indicated that a single bacterium with multiple nutrient solubilization capacities were present in the rhizosphere of arecanut palm, particularly, grown with organic inputs (Fig. 50-51)

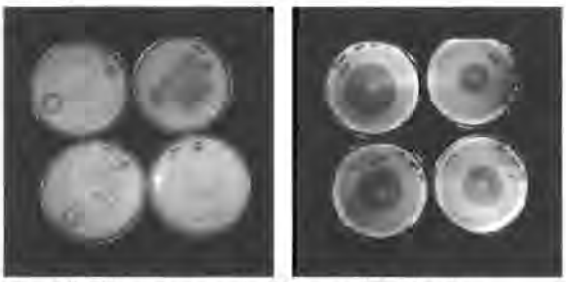


Fig. 50. Phosphate and silicate solubilization

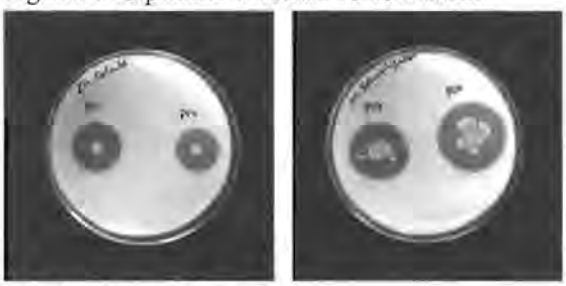


Fig. 51. Zinc solubilization

Naturally occurring giant mushroom from Kasaragod

A giant size mushroom was spotted by a farmer Mr. Jagadish from Vaninagar, Padre, Kasaragod, who brought it to ICAR-CPCRI, Kasaragod (Fig. 52a). The mushroom weighed several kilograms and was found growing in coconut plantation on naturally decomposing mixtures of arecanut wood mulch, grasses, etc. during the month of July (Fig.52b). After its initial spotting by this farmer, at least two other farmer groups from different parts of Kasaragod also reported its occurrence from their fields. Later, this mushroom was found growing near the main gate of CPCRI Hill Block Residential Campus.

The mushroom was stemmed, with its cap centred on the rough stem, which was somewhat wavy along the margin. It was gilled (gills did not appear to be attached to the stalk), with club-shaped stem, slightly convex to flat cap, smooth cap surface, without annular rings and produced spores on gills, off-white colour (Fig.52c). The mushroom was found to be an agaricomycete and was tentatively placed in the family Tricholomataceae with its possible identification as *Macrocybe gigantea*. It appeared to be a wild edible mushroom growing in tropical climate during monsoon season (June - Oct). The mushroom had a thick, leathery trunk of a stem and a massive cap more than a foot across. After its emergence above ground, it lasted for many days in the field before its decay because of frequent rains during that period.

The interiors of stem and cap were full of soft, cottony tissue. This tissue was cloned successfully in the laboratory on artificial medium in petriplates (Fig. 52 d-e). The mycelium was white, linear and clean when grown on potato dextrose agar. Pure culture of this mushroom was obtained to study the feasibility of growing this mushroom artificially using coconut bunch and petiole. Spawn was prepared in sorghum seeds (Fig. 52f) and was used to seed soaked and sterilized pieces of coconut bunch and petiole waste. Mushroom beds could be successfully raised with white cottony growth, which was fast spreading, however, fruiting body initiation could not be observed (Fig. 52g). The methodology followed was essentially that followed for oyster mushrooms, tweaking it a bit may prove helpful. Efforts are on for its artificial cultivation outside its natural habitat. If this extremely large mushroom can be brought into commercial cultivation, it has several advantages. We

can expect much higher yield per unit substrate used. Also, its perishability index is quite low as the soft interiors of cap and stem are protected by tough cap cuticle and stem rind. Since a single mushroom can weigh several kilograms, it holds great promise for our nutritional and food security.

Fig.52a : Farmer, Mr. Jagdish, holding the fully mature giant gilled mushroom

Fig.52b: Site of occurrence of cluster of these mushrooms in coconut plantation

Fig. 52c : Immature stage of giant mushroom from its natural habitat

Fig. 52d : Teasing out cottony tissue from small piece of the cap of this mushroom (notice the size comparison w.r.t. dissecting needles)

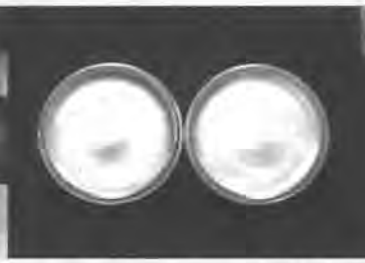


Fig. 52e : Cap tissue of giant mushroom cloned in petriplates

Fig. 52f : Spawn raised on sorghum seeds

Fig. 52g. Cylindrical bed of giant gilled mushroom made using coconut residues

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

Studies on culture dependent microbial analysis conducted in the rhizosphere soils of healthy and diseased coconut palms, located in the hot spot areas of root (wilt) disease in Kottayam and Pathanamthitta districts of Kerala, indicated the dominance of phosphate solubilizers in significant numbers in rhizosphere soils of healthy palms. Soil analysis revealed that the soil reaction was strongly acidic with organic carbon content of 1.2%. Invariably high concentrations of phosphorus (38.9 ppm), calcium (512.38 ppm), iron (57.31 ppm) and manganese (22.6 ppm) were recorded despite the health status of palm. A total of 110 rhizobacterial isolates including eight *Azospirillum* isolates were screened for IAA production and mineral nutrient solubilization. Of these 54 isolates produced IAA in tryptophan supplemented nutrient broth. Dominant among these were silicate solubilisers (57%) and phosphate solubilisers (49%). Seven isolates showed multiple beneficial traits viz., IAA production, P, Zn, Si and K solubilisation (Fig. 53).

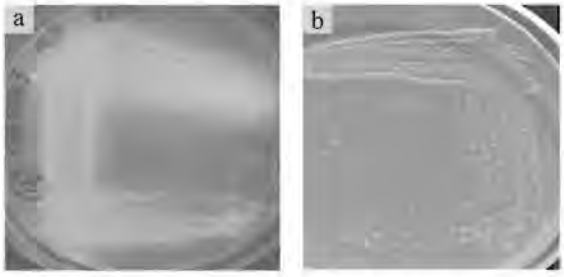


Fig 53. Selected PGPR isolates (a) *Pseudomonas* sp. (b) *Azospirillum* sp.

4 INTEGRATED MANAGEMENT OF DISEASES IN PALMS AND COCOA

Diseases diagnostics and their etiology

Leaf blight and inflorescence dieback of arecanut

Identification of *Colletotrichum* species infecting arecanut

Severe incidence of arecanut leaf blight was noticed during 2016-17 at Jampui Hills of Tripura State and some isolated pockets in arecanut growing areas of Karnataka and Kerala. *Colletotrichum gloeosporioides* has been identified earlier as causal agent of inflorescence dieback in arecanut. However, the taxonomy of *Colletotrichum gloeosporioides* has changed over the years and presently it has been considered as a 'species complex' comprising many different species. During the current year (2017-18) *Colletotrichum* species associated with arecanut were identified based on morphological characters (Table 10) and multilocus sequencing of seven genes *viz., internal transcribed spacer (ITS), actin (ACT), chitin synthase 1(CHS-1), glyceraldehyde-3-phosphate dehydrogenase (GAPDH), β- tubulin (β-Tub), histone spacer (HIS3)* and *ApMat*. Twenty seven *Colletotrichum* isolates comprising 15 from arecanut inflorescence dieback and 12 from arecanut leaf spot/blight diseases were collected from major arecanut growing districts of Karnataka (Shivamogga, Davanagere, Tumkur, Dakshina Kannada, Udupi, and Uttara Kannada), Kasaragod (Kerala) and Jampui hill region of Tripura State. Combined analysis of sequences of seven genes and morphological data confirmed the identity of all the 15 *Colletotrichum* isolates associated with arecanut inflorescence dieback disease as *Colletotrichum aotearoa*. Out of 12 *Colletotrichum* isolates obtained from leaf spot/blight disease, five were identified as *C. fructicola*, one as *C. karstii* and the remaining six identified as *C. siamense* (Fig. 54-57).

Table 10. Morphological features of *Colletotrichum* species causing leaf spot /leaf blight of arecanut

Morphological characters		*Colletotrichum spp.*			
		C. aoteara	***C. fructicola***	***C. karstii***	***C. siamense***
Colony morphology on PDA	Colony colour	White/whitish grey colour	Whitish grey colour	white colour	white/whitish grey colour
	Colony Growth rate (mm/day)	11.0±0.3	10.0±0.2	5.0±0.3	9.0±0.2
Conidial morphology	Shape	Cylindrical straight with both apices end round or one end round and other end pointed	Cylindrical with constriction in middle	Ovoid to cylindrical with both apices round/one end round and other pointed	Cylindrical, straight with both apices round/one end rounded and other pointed
	Size (µm)	19.0×5.0	15.0×4.2	13.5×5.3	17.5×5.2
Appressoria morphology	Shape	Lobed	Unlobed	Weakly lobed	Lobed

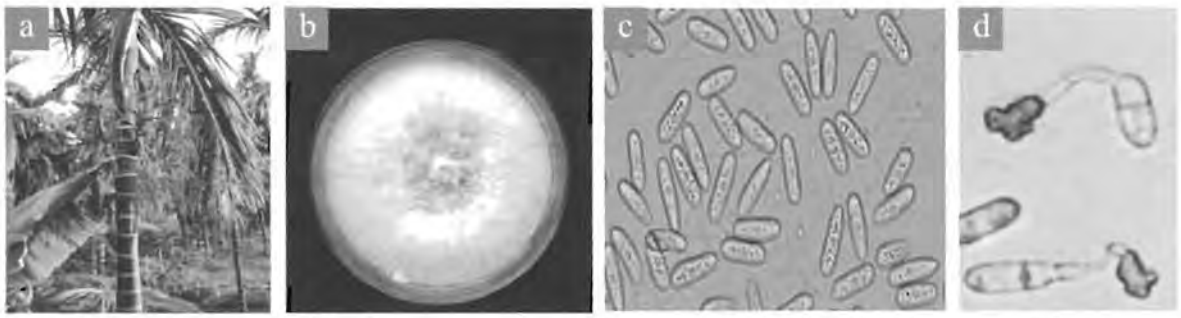


Fig. 54. *Colletotrichum aoteara* causing inflorescence dieback in arecanut (a), colony (b), conidia (c), appressoria (d).

Fig. 55. Symptoms of leaf spot (a) and blight (b) caused by *Colletotrichum* spp

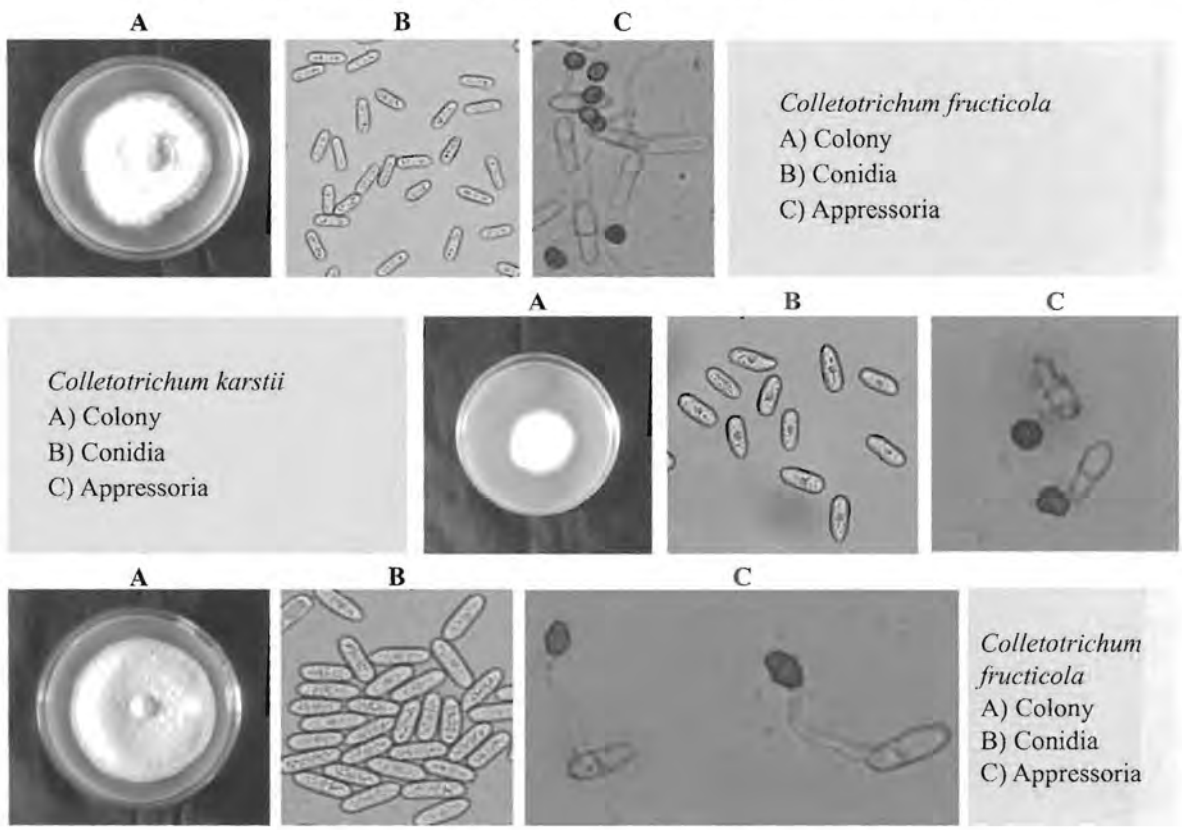


Fig. 56. *Colletotrichum* species causing leaf spot /leaf blight of arecanut

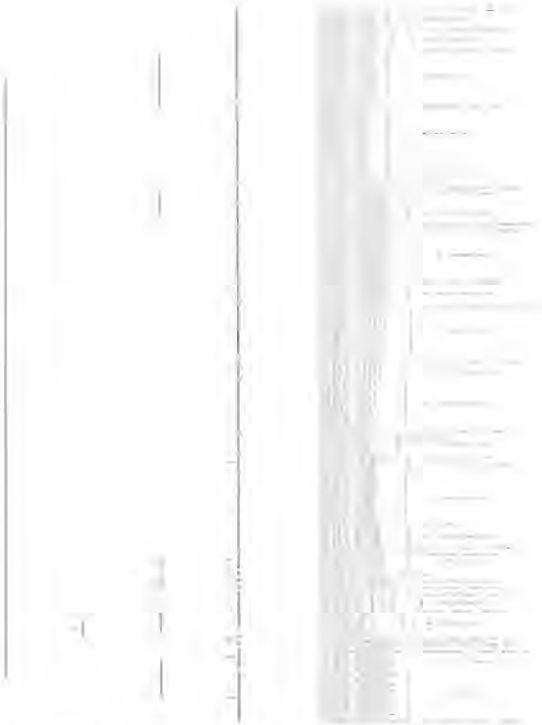


Fig. 57. Phylogenetic tree of *Colletotrichum* spp. infecting arecanut, constructed with concatenated sequences of seven genes *viz.*, *ITS, ACT, CHS-1, GAPDH, βTub, HIS3* and *ApMat.*

Detection of phytoplasma associated with coconut root (wilt) disease

Sero-diagnosis

A total of 60 coconut spear leaf samples were subjected to ELISA using polyclonal antisera against coconut root (wilt) disease (RWD) phytoplasma and 35 samples (58%) were found negative. Based on the sero-diagnosis, about 42% palms were found positive for the disease in the region. The palms which are serologically negative were selected for seed nut collection for the production of healthy disease free seedlings.

Molecular detection

Nucleic acid based diagnostic protocol is found to be the most consistent and reliable detection tool for screening of phytoplasma diseases affecting palms as the titre is relatively low and phytopathogenic mollicutes are unevenly distributed. In order to develop a robust diagnostic technique for the early detection of RWD in coconut palms, DNA was extracted from inflorescence rachillae as well as root tips of RWD affected coconut palms so as to evolve a reliable nucleic acid based (polymerase chain reaction) diagnostic protocol. The isolated DNA from RWD-affected palms when subjected to nested PCR using universal primers of phytoplasma P1/P6-R16F2n/R16R2 showed non-specific as well as inconsistent amplification indicating the need for refinement of the existing detection technique. Repeated attempts using the reported phytoplasma-specific universal primers as well as custom designed primers in PCR reactions indicated that RWD of coconut could not be detected in a consistent and reproducible manner and therefore this technique involving aforesaid primers is not found suitable for early detection of the disease.

Molecular detection and characterization of phytoplasma from auchenorrhynchan fauna and weeds

Cross transmission of phytopathogenic mollicutes among auchenorrhynchan vectors is quite common and weeds serve as a reservoir for phytoplasma diseases. For understanding the cross transmission ability of RWD through different insect vectors, a wide range of putative insect vectors were collected and investigated for the presence of phytoplasma using molecular techniques. *Exitianus indicus* (Distant), *Austroagallia* sp., sesamum leafhopper *Orosius albicinctus* (Distant) and zigzag leafhopper, *Maiestas dorsalis* (Motschulsky) were routinely encountered in light trap catches in coconut ecosystem and the grey planthopper, *Nisia nervosa* was the predominant auchenorrhyncha fauna in coconut plantation in RWD endemic zones.

Sesamum leafhopper, *O. albicinctus* collected from sesamum fields in RWD endemic areas showed positive amplification in nested PCR using phytoplasma-specific universal primers (P1/P6-R16F2n/R16R2) indicating its role in transmission of a phytoplasma disease. The amplicon on sequencing revealed the presence of '*Candidatus* Phytoplasma australasiae"-related strain belonging to subgroup 16SrII which causes phyllody in sesamum. Thus, the role of *O. albicintus* in transmission of sesamum phyllody has been confirmed. Nevertheless, the association of *O. albicinctus* with the transmission of root (wilt) disease of coconut could not be proven due to the detection of divergent phytoplasma group that is not connected with RWD.

In order to ascertain the presence of phytoplasma in the vectors of RWD, DNA was extracted from the planthopper, *Proutista moesta* obtained after different acquisition access periods *viz.*, 16 days and

21 days on RWD affected palms. DNA of these insects when subjected to PCR using phytoplasma-specific universal primers did not yield amplification at desired base pair level. The heteroptern lace bug, *Stephanitis typica* collected from RWD palms and subjected to PCR using universal primers also did not show phytoplasma specific amplicons implying the absence of phytoplasma in these two vectors even after feeding on diseased palms.

Several monocot and dicot weeds in RWD endemic zones were investigated using molecular tools and results indicated that these weeds do not harbor coconut RWD phytoplasma. During 2018, a phyllody symptom was observed in a weed plant, *Spermacoce articularis* (Family: Rubiaceae) in RWD affected plantations in Alappuzha district. The phytoplasma causing phyllody in *S. articularis* was characterised as "*Candidatus* Phytoplasma australasiae"-related strain belonging to subgroup 16SrII indicating that this weed does not serve as the host for RWD phytoplasma

Diseases management

Management of fruit rot disease of arecanut by prophylactic fungicides

Fruit rot disease of arecanut caused by *Phytophthora meadii* is another important disease of arecanut causing severe economic loss. Field trial on management of fruit rot disease of arecanut was conducted for three years (2015-2017 ICAR-CPCRI, Regional Station Vittal and ICAR-CPCRI, Research Centre Kidu in Karnataka using twelve fungicides involving prophylactic spraying during May end and second spray after 45 days. During the year 2017, the fruit rot disease incidence was noticed from first week of August in Kidu and last week of August in Vittal. Among the different fungicides tested for three years, fruit rot disease incidence was nil in the arecanut palms treated with 1% Bordeaux mixture and 0.5 % Mandipropamid 23.3% SC. (Fig. 58).

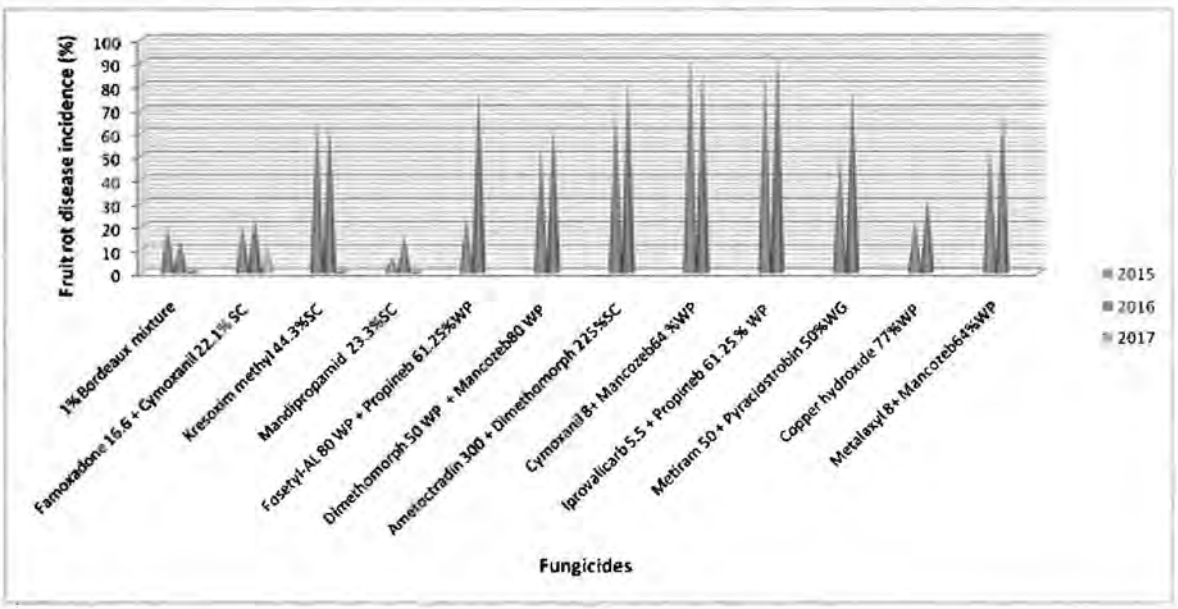


Fig. 58. Evaluation of different fungicides for management of fruit rot disease of arecanut at ICAR-CPCRI research Centre, Kidu.

Management of fruit rot disease of arecanut by prophylactic potassium phosphanate spray

Potassium phosphonate (40%) formulation prepared at ICAR-CPCRI was evaluated against arecanut fruit rot disease as a prophylactic spray @ 0.5% during May end and second spray after 45 days in CPCRI, Regional Station, Vittal. The potassium phosphonate sprayed plots showed 10 % fruit rot disease incidence whereas no disease incidence was recorded from Bordeaux mixture (1 %) treatment.

Management of bud rot disease of coconut

Field trial on management of coconut bud rot disease was conducted in Konnakkad of Balal panchayath for three years using nine treatments which involved the placing of 2 perforated polythene sachets containing

fungicides in the inner most leaf axils of coconut palm. Out of ten treatments bud rot disease incidence was not recorded in five treatments *viz.*, Chlorothalonil 78.12%WP, Iprovalicarb 5.5 + Propineb 61.25 % WP , Dimethomorph 50% WP, Fosetyl-AL 80 WP + Propineb 61.25%WP and Metiram 50 + Pyraclostrobin 50%WG (Fig. 59).

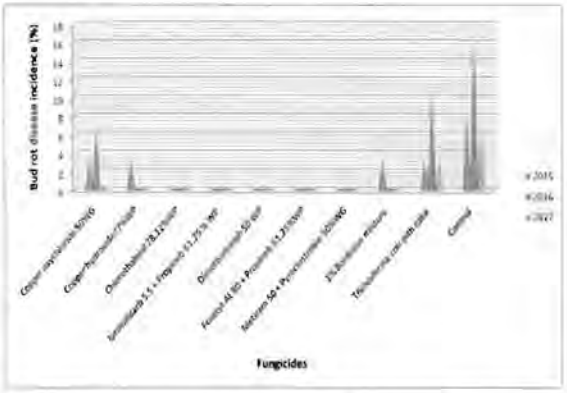
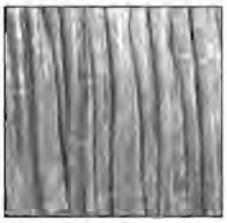


Fig. 59. Evalution of different fungicides for management of bud rot of coconut

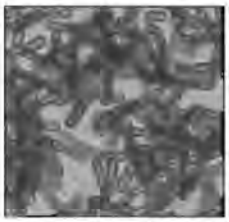
Characterization of sooty mould associated with rugose spiralling whitefly (*Aleurodicus rugioperculatus*) infestation

Presence of black sooty mould on the leaf surface is one of the characteristic symptoms of rugose spiralling whitefly (RSW) infestation on coconut. The sooty mould is saprophytic growth of a fungus on the honeydew secretions from RSW. The black coating of sooty mould on coconut palm leaves hinder photosynthesis and hence is a matter of concern. Sooty mould affected coconut leaf samples (Fig.60) were collected from Udupi region of Karnataka, Kasaragod and Kayamkulam regions of Kerala. The sooty mould fungus was isolated and the pure culture of the fungus was obtained by plating diluted spore suspension in malt extract agar. The dark green-black colonies were slow growing with irregular margins (Fig. 60) Mycelium was brown coloured with a constriction at septa (Fig. 60) The fungus is characterized by elongated conidiomata consisting of aggregated hyphae with bulbous base and at apex an open terminal funnel shaped conidiogenous zone. The culture produced 0-1 septate, ellipsoidal hyaline conidia. Based on the morphological and microscopic characters the sooty mould associated with RSW infestation was identified as *Leptoxyphium* sp. (family Capnodiaceae) by National Fungal Culture Collection of India, Agharkar Research Institue, Pune. The Polymerase chain reaction of the fungal DNA with ITS1 and ITS 4 primer pair produced an amplicon of ~550 bp.(Fig. 60) The sequence comparison of the internal transcribed spacer (ITS) of rDNA also showed 100% identity with *Leptoxyphium* sp. TMS-2011 (HQ631026.1).



Black sooty mould on RSW infested coconut leaves

Colony of sooty mould fungus



Vegetative hyphae constricted at septa

Conidiomata liberating conidia

Conidia

PCR amplification of ITS of rDNA *Leptoxyphium* sp.

Fig. 60. Sooty mould associated with rugose spiralling whitefly infestation on coconut

5 INTEGRATED MANAGEMENT OF PESTS AND NEMATODES IN PALMS AND COCOA

Integrated Pest Management strategies are emerging as intrinsically dynamic and evolving more sustainable in suppression of palm and cocoa pests, aiming at leaving a pest residue for the natural enemies to upkeep biotic balance. Efforts have been fine-tuned to evolve conservatory biological control and bio-scavenging services by beneficial insects to counter pest attack more importantly by the invasive rugose spiralling whitefly. Weather change phenomenon is constantly surfacing in the outbreak of pests for which close monitoring and health management approaches in palms and cocoa are very crucial. Emergency preparedness module of potential invasive pests at the doorsteps had been critically analysed to tackle accidental introduction and counter such incursion at the budding stage. Extensive sensitization campaigns on the bio-suppression of rugose spiralling whitefly and bio-scavenging of sooty mould in different parts of the country showcase how "prevention is better than cure" in pest management programme.

Rhinoceros beetle (*Oryctes rhinoceros* Linn.)

O. rhinoceros is a cosmopolitan pest that invades all stages of palm but relatively more confined on juvenile palms these days in different coconut growing regions of the country causing improper establishment of juvenile palms by entry of adult beetles through the collar region. Extensive impairment of growth and twisting of growing points are recorded in at least 8-10% of juvenile palms (Fig.61). The recent emergence of Guam strain of the beetle adds further setbacks in different countries of South-East Asia as these beetles are not infected by *O. rhinoceros* nudivirus under natural condition. Surveys conducted in different pockets of Kerala, India indicated natural occurrence of 0.7% of *O. rhinoceros* nudivirus infected grubs thereby confirming the absence of Guam strain of beetle. Such natural occurrence of *O. rhinoceros* nudivirus is a clear indication of ecological and environmental safety approaches executed in pest management programmes in palms carried out in our country.

Fig. 61. Rhinoceros beetle damage on juvenile palms

Entangling beetles through nylon netting

Four different fish net materials with variable mesh size (0.8x0.6, 1.2x1.1, 2.5 x 2.0 & 2.6x2.3 cm) were tested as an insect proof cum entangler trapper against rhinoceros beetle during June 2017-Dec 2017. Unopened spear leaf axil along with adjacent leaf base of forty juvenile palms (10 palms per treatment) was covered with nylon fish net as a mat roll in dwarf cultivars. Net cover served as physical barrier by protecting the entry points and thereby preventing the adult beetles to feed and cause further damage. Percent damaged leaves reduced from 61.02 to 7.53 after net protection ($t=17.23$; $p < 0.001$).

Besides this, the nets trapped 69 live adult beetles (on an average of 8.6 beetles per month) by entangling the adult beetles during the period (Table 12; Fig. 62-63).

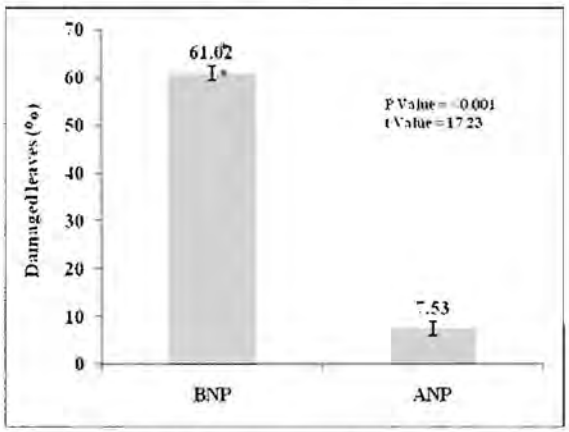


Fig. 62. Comparative advantage of rhinoceros beetle damage after net protection (ANP) and before net protection (BNP)

Fig. 63. Rhinoceros beetles trapped on nylon net

Botanical formulation

In order to shield juvenile palms from the attack by rhinoceros beetle, a spectrum of approaches have been undertaken. Botanical formulation was refined as pellets from the original cake mode for effective field dispensation through leaf axil filling. Feeding zone of the boring black beetle could be effectively encountered by the botanical pellets safeguarding juvenile palms for more than three months period. Studies indicated that placement of two cakes on leaf axil and swiping of paste on the spear leaf and adjoining petiole of juvenile palms significantly reduced leaf damage by 69.2% compared to 62.5% with respect to chlorantraniliprole granules ($t<0.005$).

Ecological engineering and pest regression

A study was conducted to observe the pest incidence in an ecological engineering plot consisting of the root (wilt) disease tolerant Kalpasankara hybrid palms (39 no.) intercropped with nutmeg, rambuttan, banana, curry leaf, jack, marigold, custard apple *etc.* The pest incidence was comparatively low in the ecological engineering plot compared to that of mono-cropped garden, whereas two to three fold increase in pest incidence could be observed. Susceptibility of palms to pests in mono-cropped garden could be due to excessive volatile cues of coconut favouring orientation of pests, which is otherwise diminished in ecological engineering plot due to admixture of volatile cues from coconut as well as from adjacent intercrops and eco-feast crops. A significant attraction of honey bees on coconut and coral vines is indicated in ecological engineering plot. Average yield of Kalpasankara was found to be 161 nuts/palm/year (Fig.64.)

Fig. 64. Crop pluralism and diversity distraction of palm pests

New *Bacillus* spp. infecting rhinoceros beetle

Two distinct spore-forming entomopathogenic bacteria were isolated, purified and tested on second-instar grubs of *O. rhinoceros*. *In vitro* bioassays showed that the isolates 1 and 2 infected second instar *O. rhinoceros* grubs and caused 98% and 90% mortality, respectively ($F=10.03$; $p<0.0001$).

Infected larvae exhibited bacterial septicemia like symptoms and mortality noticed between 2-8 weeks after inoculation. Based on morphology, biochemistry and sequencing of the 16S rRNA gene, the isolate 1 and 2 was identified as *Bacillus cereus* and *Bacillus thuringiensis* (Table11; Fig. 65.)

Table 11. Mortality of grubs of *O.rhinoceros* with bacterial isolates

Sl. No.	Treatment details	Mortality (%)
1	*Bacillus cereus*	98 (86.31[a])
2	*Bacillus thrungiensis*	90 (75.69[b])
3	Control LSD P Value	0 (2.50[c]) 10.03 <0.0001

Fig. 65. *Bacillus* infected rhinoceros 'beetle grub

Synergistic interaction of entomopathogens

Three entomopathogenic nematodes (EPN) species *viz., Steinernema carpocapsae, Steinernema abbasi* and *Heterorhabditis indica* collected from Kerala were studied for their efficacy against *O. rhinoceros* grubs in laboratory conditions. Grub susceptibility varied with the increasing dose of infective juveniles (F = 358.02; df =12; P<0.0001) along with their increasing period of exposure (F = 177.32; df =6; P<0.0001). High mortality could be observed in the grubs infected with *S. carpocapsae* (100%) followed by *S. abbasi* (92%) and *H. indica* (72%) with an increase in incubation period up to 14 days. More infective juveniles produced per cadaver were noticed with *S. carpocapsae* (3223 – 103657 IJs/ cadaver) followed by *S. abbasi* (4722 – 96572 IJs/ cadaver) and *H. indica* (3483 – 85453 IJs/ cadaver) with different dose of IJs tested.

Interactive effect of entomopathogenic fungus (EPF) with varying application times of EPN against *O. rhinoceros* grubs was studied. Grub mortality of 73.3% and 76.6% was observed with EPF and EPN alone, respectively after five weeks of inoculation. Highest mortality of 100% was noticed with prior application of EPF followed by EPN at varying application time interval up to two weeks' intervals, while 86.6% to 93.3% mortality observed with application of EPN after 3- 4 weeks of EPF inoculation (Table 12; Fig. 66-67)

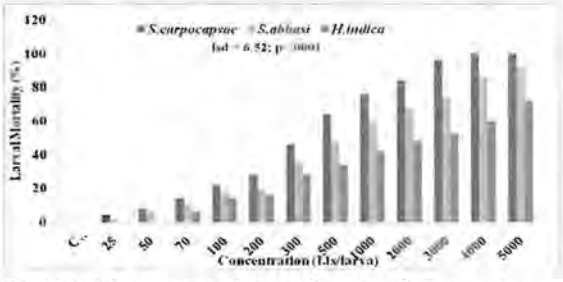


Fig. 66. Per cent mortality of grubs of *O. rhinoceros* exposed to different concentrations of infective juveniles (IJs) of entomopathogenic nematodes (EPNs)

Table 12. Median lethal concentration of entomopathegenic nematodes on grubs of rhinoceros beetle

Incubation period (hrs)	EPN species	LC_{50} (IJs)	Fiducial limit (95%)
48	*S. carpocapsae*	1809[a]	1262-2759
	S. abbasi	3001[a]	2363-4058
	H. indica	15859[b]	8496-55501
72	*S. carpocapsae*	1078[a]	897-1288
	S. abbasi	1663[b]	1347-2083
	H. indica	9780[c]	5671-26502
96	*S. carpocapsae*	854[a]	703-1024
	S. abbasi	1489[b]	1199-1866
	H. indica	5353[c]	3633-9858

Same alphabets on superscript are not statistically significant (P<0.05)

Fig. 67. Progression of EPN infection in rhinoceros beetle grubs

Leaf eating caterpillar (*Opisina arenosella* Wlk.)

O. arenosella emerged in severe proportions at Thokkottu, Karnataka and Anangur, Kerala with complete scorching of palms leaflets at lower whorls and bringing down the nut yield significantly as well. Reduction in the quantum of north-east monsoon showers is found as one of the reasons associated with the sporadic outbreaks of the pest in these regions

Area-wide bio-suppression of *O. arenosella*

A stakeholder's meeting regarding outbreak and bio-suppression of *O. arenosella* at Thokkottu was held at ICAR-CPCRI, Kasaragod on 17th May 2017 in which technical personnel from KVK Mangalore, KVK Udupi, State Horticulture Department Mangalore, Parasite Breeding Station Thumbay and Parasite Breeding Station, Kasaragod participated. A strategic action plan was evolved through sustained release of parasitoids and implemented. A field day was also organized at Thokkottu by ICAR-CPCRI. A farmers meeting was organized on 15.6.2017 at Kallappe, Mangaluru with participation of 120 farmers.

More than nine-lakh stage-specific parasitoids *viz.*, *Goniozus nephantidis* and *Bracon brevicornis* were released at Thokkottu during three months period (April-June 2017) resulting in effective bio-suppression of leaf eating caterpillar by October 2017. From a higher percentage of leaflet damage (96.5%) by *O. arenosella* observed during March 2017, the damage percentage was reduced considerably to 23.4% in October 2017. More so with the emergence of new fronds that are absolutely free from pest attack, the health of palms in those pest-inflicted regions has improved considerably bringing forth an energized image of the affected palms (Fig. 68).

Fig. 68. Pest-infested coconut palms at pre-release of parasitoids and post-release impacts

Furthermore, 4000 parasitoids were supplied to Krishi Bhavan, Thikkodi where an outbreak of leaf eating caterpillar was reported. Sensitization campaigns about the bio-suppression of leaf eating caterpillar were organized at Anangur, Kerala wherein larval parasitoids were released in the pest-infested fields.

Sporadic incidence of *O. arenosella* at Anangur and Vidyanagar, Kasaragod was noticed from 15th standard meteorological week (SMW) to 43rd SMW during 2017 and an attempt was made to correlate weather factors linked to its gradient outbreak. The larval population per ten leaflets ranged from 0.8 to 18.2 during the period. It was observed that the larval population had highest significant positive correlation with maximum temperature and sunshine hours inferring its influence in pest outbreak.

Red palm weevil (*Rhynchophorus ferrugineus* Olivier)

R. ferrugineus is the most devastating pest on palms as it is a fatal enemy causing complete kill of the palm in a span of two-three months if remain undetected and untreated. As part of investigations into new molecules on its efficacy against red palm weevil, it was found that laboratory evaluation of fipronil 5 SC

@ 0.005% induced 90% mortality of red palm weevil grubs in petiole-based bioassay.

Advancing into volatile signature induced-behavior modifying chemicals and field delivery of pheromone system, a gel-based slow release matrix (calcium alginate) of citriodora (5 %) was developed and placement of two gel-matrix sachets on coconut leaf axil @ 5g /palm as well as installation of pheromone trap containing "ferrolure" outside the garden reduced the red palm weevil incidence from 3.4% to 1.7%.

Palm white grub (*Leucopholis* spp.)

Leucopholis burmeisteri, *Leucopholis coneophora* and *Leucopholis lepidophora* (collected from Dakshina Kannada, Karnataka, Kasaragod, Kerala and Chikkamagaluru, Karnataka) exhibited 98, 98 and 89 per cent similarity, respectively with *L. burmeisteri* sulyareca isolate (GenBank Accession No: JN126323.1). All the nucleotide sequences generated have been deposited in NCBI (GenBank Accession No. MG717658 to MG717676). Multiple sequence alignment with MUSCLE, performed to identify potential nucleotide polymorphism indicated the existence of single nucleotide polymorphism (SNP) across the 625 bp fragment of *COI* among the three species of *Leucopholis* (Fig.69).

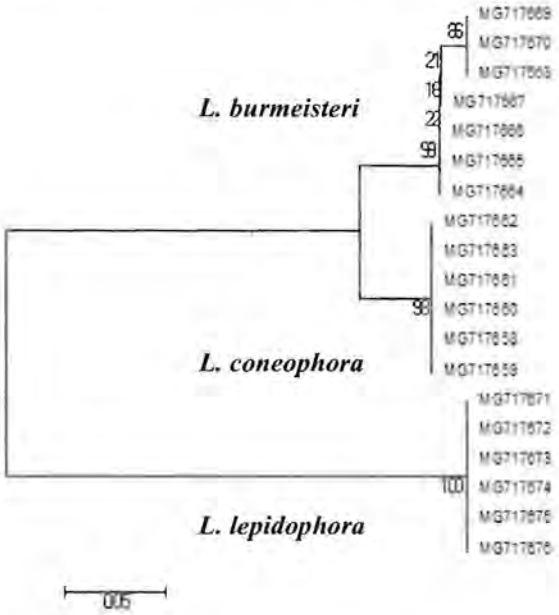


Fig. 69. Phylogenetic analysis of *COI* gene of three *Leucopholis* species based on Neighbour-Joining method

Rugose spiralling whitefly (*Aleurodicus rugioperculatus* Martin)

The exotic rugose spiralling whitefly (RSW), *A. rugioperculatus* has expanded its invasive potential in different coconut growing regions of the country as well as varied host plants gaining as a pest of national importance. Sooty mould encrustation on the upper surface of palm leaflets has attracted several research questions up to the extent of hindering photosynthesis as well as the identity of the fungus associated.

Distribution

RSW expanded its presence in different coconut growing south Indian states *viz*., Kerala, Tamil Nadu, Andhra Pradesh, Karnataka and Goa. Occurrence of RSW on coconut was reported from Tamil Nadu (Tiruppur, Thanjavur, Theni, Marthandam), Andhra Pradesh (East Godavari- Damalacheruvu, Pottilanka; West Godavari-Kalavalapalli, Chikkala and Kakinada), Karnataka (Mulki, Sullia Mangaluru, Dharwad), Kerala (Kasaragod and Kannur, wherein the pest was already reported in central and south Kerala Districts during 2016-17 itself) and Goa (Colva Beach). In several of these new records, the pest incidence exceeded 20 adult whiteflies per palm leaflet (Fig.70).

☆ 2016 ✹2017

Fig.70a Distribution of RSW in various south Indian states

Host range

The new host records of *A. rugioperculatus* included custard apple, sugarcane, oil palm and the ornamental yellow palm (*Dypsis lutescens*). However, Red wax palm (*Cyrtostachys renda*) was found to be tolerant to infestation by *A. rugioperculatus*. Based on the adult RSW population on each palm leaflet among coconut varieties, Chowghat Green Dwarf and King Coconut were found to be more susceptible than West Coast Tall inferring that the Tall cultivars are tolerant than the Dwarf genotypes. The distribution and host range of *A. rugioperculatus* and *Aleurodicus dispersus* are outlined in the phylogenetic tree (Fig.70b).

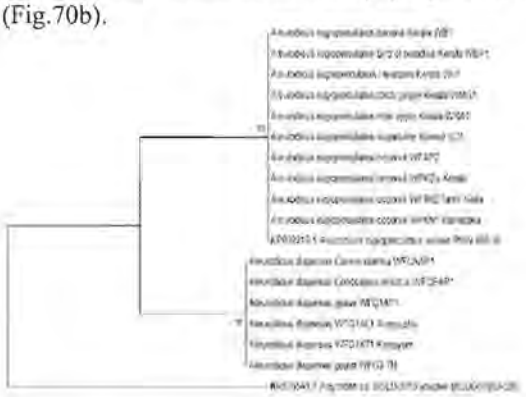


Fig.70b. Phylogenetic tree on distribution and host range of RSW

It was categorically observed that certain host plants such as *Cassia siamea*, *Conocarpus erectus* and *Psidium gujava* had relative preference for *A. dispersus* indicating extreme host affinity. *A. rugioperculatus* was not observed from *C. siamea* and *C. erectus* so far.

Gradient outbreak

Gradient outbreak of *A. rugioperculatus* could be linked with weather factors such as maximum temperature, relative humidity and rainfall *vis-à-vis* the infestation potential. The shift in weather pattern reflected as deficit monsoon could be one of the primary reasons of immediate upsurge of rugose spiraling whitefly in Northern districts of Kerala especially Kannur and Kasaragod. RSW is so sensitive to wet season and heavy rains and the recent deficit in north-east monsoon during 2017, which triggered a drop in relative humidity in Kasaragod, are the immediate reasons for the flare up. Uniform distribution of rainfall in South Kerala in synergy with high humidity subdued the infestation potential and flare-up of RSW in this region. Based on the weather data from Kayamkulam, Kerala a positive correlation with maximum temperature (r=0.950192) could be associated whereas the relative humidity (r=-0.85816) and rainfall (r=-0.73739) were found to be negatively correlated with the live colonies of RSW. Thus, weather plays a critical role in the establishment and infestation potential of RSW in a particular region (Fig.71).

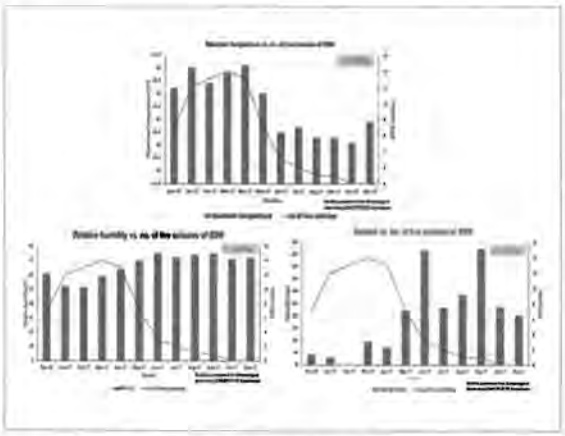


Fig. 71. Influence of weather factors on rugose spiralling whitefly incidence at Kayamkulam, Kerala

Conservatory biological control

Through systematic rearing of *A. rugioperculatus* on coconut seedlings (Chowghat Green Dwarf) in the laboratory, egg to adult period lasted for about 29.2 ± 3.8 days. Adult longevity extended for 7.5 ± 1.3 days and the fecundity of RSW was found to be 32 ± 5.8 eggs/female. Under laboratory/green house condition, egg-laying by RSW was found successful only on coconut seedlings whereas adult RSW could not oviposit on vegetable cowpea, bhendi, as well as on banana.

Predatory green lacewing, *Dichochrysa* sp. nr. *astur* (Banks) was observed during egg laying stages of RSW incursion. Lady beetles, *Jauravia pallidula* (Motschulsky) and *Menochilus sexmaculatus*, were registered during active build-up and final-receding phase of RSW population, respectively. However, the most successful was the parasitism by the aphelinid parasitoid, *Encarsia guadeloupae* which could parasitize >85% RSW in a period of four to six months under field condition exemplifying conservatory biological control. Adult longevity of the aphelinid parasitoid, *E. guadeloupae* was found to be 11 ± 4.8 days with honey supplementation. On an average three adult *E. guadeloupae* emerged from 10 cm coconut leaflet infested by RSW. Furthermore,

emergence of *E. guadeloupae* in 0.5% neem oil-treated coconut leaflet was found to be >85% ensuring safeness of neem oil on the parasitoid.

In this backdrop, 10 cm coconut leaflet containing parasitized RSW pupae was distributed to farmers in the new areas of RSW outbreak. More than 250 coconut leaflets (10 cm) containing parasitized RSW pupae were released in pest prone West Godavari region in Andhra Pradesh during January 2018. (Fig.72 a-b).

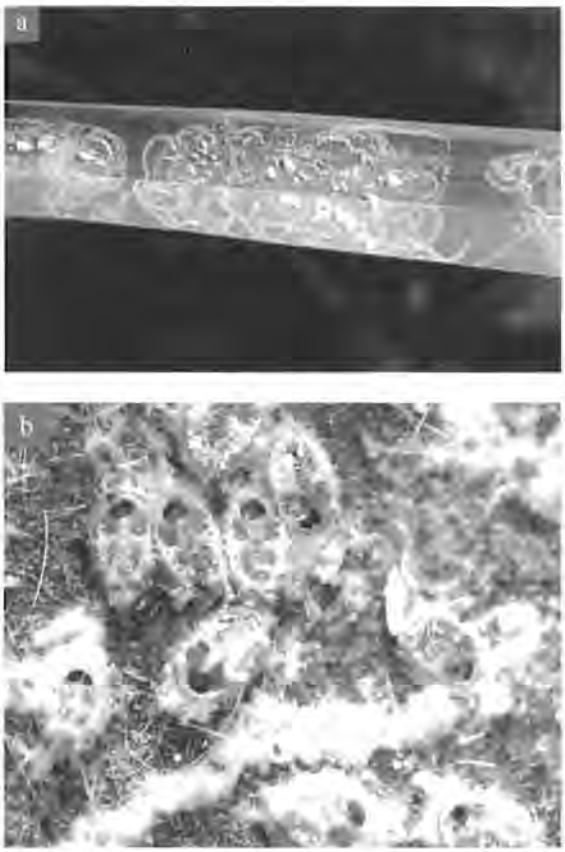


Fig. 72 (a) Coconut leaf bit with parasitized RSW pupae (b) Complete parasitism on a microscopic view

Sooty mould scavenger beetle, *Leiochrinus nilgirianus*

Scavenging action of *Leiochrinus nilgirianus* Kaszab (Coleoptera: Tenebrionidae) on sooty mould deposition on coconut palms due to heavy honeydew production by the invasive rugose spiralling whitefly, *A.rugioperculatus,* was reported for the first time from Kerala, India. Adult beetles, averaging 2.07±0.9 / leaflet, with a maximum of five beetles per leaflet, and immature stages were generally confined to the abaxial of the palm leaves during daytime, but were found feeding on sooty mould on the upper leaf surface during morning hours in damp conditions. This beetle has a body shape and colour pattern resembling lady beetles (Coccinellidae) with swift mobility and limited flying ability.

These beetles were only observed on sooty mould covered leaves of coconut and sooty mould laden non-hosts such as custard apple (*Annona squamosa*) and *A. muricata,* indicating their preference to sooty mould, rather than the respective plants. Due to their feeding, the black sooty mould deposits were gradually and eventually completely cleansed and the leaves became bright green, reviving their photosynthetic efficiency. The specially aided adaptive leg features of *L. nilgirianus* with bristle-like hairs on the undersurface of tarsomeres probably aid in proper adhesion on sooty mould laden plant surface and well developed tarsal claws that perhaps assist swift movement on fungus-laden leaflets. On an average one adult beetle could clear 1-2 mm^2 sooty mould laden area in a period of one minute. Consumption of sooty mould deposition on palm leaflets by insects, thereby improving photosynthesis and rejuvenating palm health, is one of the first instances of beneficial scavenging activity reported in any economic crops so far.

The eggs of *L. nilgirianus* are oval, smooth, shiny and bright pinkish to purplishandare laid in clusters on the undersurface of the palm leaflets. Upon eclosion after 2-3 days, a thin white membranous film is found covering the emerging grub, which is shed within 3-5 hrs. The freshly emerged larvae are initially transparent and gradually get melanized and turn dark brown-black. The larvae are onisciform and could roll into a sphere during locomotion and could also be stretched like a cone. The inter-segmental membrane of these grubs is elastic to accomplish this unique pattern of locomotion. The larvae are confined to the undersurface during day time and probably move to the upper surface for feeding on the sooty mould during night hours and early morning before sunrise. Mature, final instar larvae nearing pupation turn paler with the dorso-lateral parts creamy yellow, which is quite prominent during locomotion. Pupation takes place on the undersurface of the palm leaflets and the pupae are exarate and creamy yellow with black patches. Adult beetles are creamy yellow on emergence and gradually turn ferrugineous. Adult beetles are characterized by: strongly convex and

hemispherical body, head fully concealed under pronotum, antenna yellowish brown, composed of 11antennomeres, antennomeres 5-11 often dark brown to black, pronotum anteriorly rounded, legs with penultimate tarsomeres dilated, lobed beneath, and distinctly broader than apical tarsomere. It resembles other known species of *Leiochrinus* from South India and can be conclusively identified only based on the male genitalia (Fig.73 a-n).

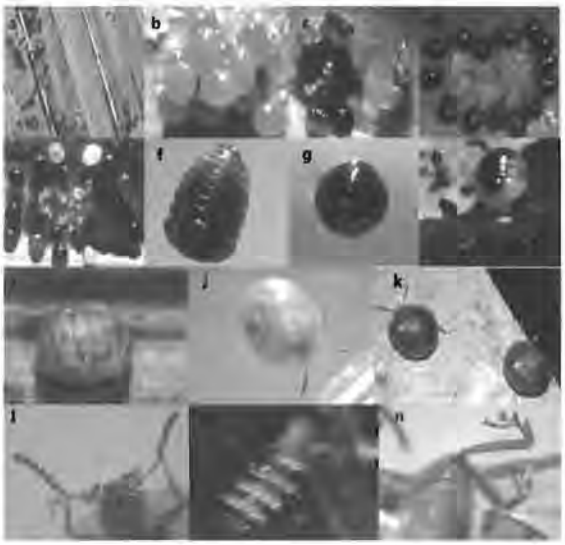


Fig. 73. Life stages and adult features of *L. nilgirianus*:

a. Adult beetles; **b.** Purplish eggs in groups; **c.** Emerging neonates; **d.** First instar larvae; **e.** Second instar larvae; **f.** Larva with extended body; **g.** Larva rolled into a sphere; **h.** Final-instar larva; **i.** Pupa; **j.** Freshly emerged adult; **k.** Ferrugineous adult; **l.** Antennae; **m.** Bristles on tarsomeres; **n**. Tarsal claws.

DNA isolated from grubs and mitochondrial cytochrome c oxidase (*COI*) gene of *L. nilgirianus* was amplified at 710 bp. Nucleotide sequence of *COI* gene of *L. nilgirianus* (GenBank No. MG212503) showed 80 percent identity with *Diaperis boleti* (L.) (Tenebrionidae: Diaperinae) [GenBank acc. No. KJ962024.1]. The aminoacid sequence derived from the *COI* gene sequence of *L.nilgirianus* showed about 99% similarity to *Leiochrinini* sp. 2 ACP-2013 (Tenebrionidae: Diaperinae, Acc. No.AHU86945.1) submitted from the Natural History Museum, London, UK.

In a nutshell, the aphelinid parasitoid, *E. guadeloupae* and the tenebrionid scavenger beetle, *L. nilgirianus* appear to have considerably reduced the pestiferous potential of *A. rugioperculatus* on coconut in Kerala conditions. *In situ* habitat conservation of *L. nilgirianus* would help to reduce the sooty mould at no cost in the most natural and eco-friendly manner avoiding chemical management options and other expensive methods.

Entomopathogenic nematodes

EPN based interventions for sustainable management of root grubs in arecanut

Root grubs (*Leucopholis* sp.) infested arecanut gardens treated with indigenous strains of entomopathogenic nematode (EPN), *Steinernema carpocpasae* (CPCRI – SC1) @ 1.5 billion IJs ha^{-1} (about 10 million IJs $palm^{-1}$) in combination with imidacloprid 25 SL (0.5 ml/2 liter of water), neem cake 2 kg $palm^{-1}$ and providing proper drainage system in gardens resulted in 91% control of white grubs in three years of treatments, significantly higher than that untreated gardens (without IPM practices). The EPN demonstration has exhibited 40% and 100% increase in arecanut yield than untreated gardens in root grub alone and yellow leaf disease (YLD) + root grub infested gardens respectively in Dakshina Kannada and Chikmagalur districts of Karnataka (Fig.74-75)

Fig. 74. EPN demonstration plot at Sullia (Karnataka)

Fig. 75. Infective juveniles (IJs) of EPN

Fig. 76. EPN demonstration plot (a) Before intervention (2014-15), devoid of inflorescence opening/bunches and severe yellowing and (b) After intervention (2017-18), improvement in number of bunch opening and reduction in yellowing

Application of imidacloprid with EPN at lower dosage found synergistic control of root grubs in treated soils. As the grubs in soil become inactive and debilitation, easily succumbs to the attack by the nematodes. Recovery of nematodes (35%-45%) from the nematode treated plots indicates successful establishment of nematodes in soil, perpetuates sustainable management of root grubs. Adoption of improved integrated EPN-based protection measures resulted in better root growth and maximum input utilization leading to enhancement of the arecanut productivity in the region. The increase in the yield of the crop enhanced socio-economic status of the farmers (Fig. 76)

Documentation of EPNs from different agro-climatic zones

A total number of 141 soil samples from different parts of Alappuzha, Kollam, Pathanamthitta, Idukki and Eranakulam districts of Kerala were collected for the documentation and characterization of entomopathogenic nematodes (EPN). Among the total soil samples analysed, 19 were found positive for EPN, which included three Steinernematids and 16 Heterorhabditids. Soil samples collected from ICAR-CPCRI, Regional Station, Kayamkulam yielded 33.3% positive for EPN and its predominance could be one of the reasons for low incidence of white grubs in the farm.

Three Heterorhabditid and two Steinernematid isolates were subjected to molecular characterization by sequencing ITS region of the ribosomal DNA using 18s and 26s primers. All the three Heterorhabditid isolates showed 99% sequence similarity with *H. indica*. One of the Steinernematids (CPCRI 0905) was identified to be *Steinernema hermaphroditum* based on morphological and molecular characters, whereas the other local isolate *Steinernema* sp. (CPCRI 0804) was not similar with any of the described species so far (Fig.77).

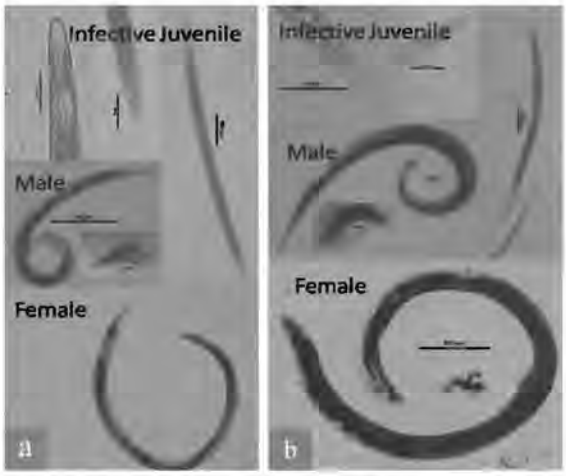


Fig. 77. (a) *Steinernema hermaphroditum* (CPCRI 0905), (b) *Steinernema* sp. (CPCRI 0804)

About 28.5% of soil samples (85) collected from arecanut gardens in Kollur village of Thirthhalli Taluk of Karnataka were found to be Rhabditidae group of free living nematodes which are non pathogenic to insects.

Storage of EPN

The aqua formulation of EPN, *Steinernema carpocapsae* infective juveniles stored at temperature of 15-17°C in 60 micron thickness of low density polyethylene (LDPE) extended the survival of nematodes to four to five months compared to those nematodes stored at room temperature of 25-27°C.

Evaluation of EPN against red palm weevil

Between the two local isolates of EPN [*Steinernema* sp. (CPCRI S0804); *Heterorhabditis indica* (CPCRI H0701)] evaluated in the laboratory, *H. indica* (CPCRI H0701) @ 200 IJs/grub was found to be effective in the suppression of red palm weevil grubs by inducing 100% mortality in 72 h. Preliminary field evaluation of *H. Indica* (CPCRI H0701) (@ 2 million IJ palm^{-1}) combined with the neonicotinoid, imidacloprid (0.1 ml/L) fully recovered the palm infested by red palm weevil with the emergence of new terminal shoot (Fig.77).

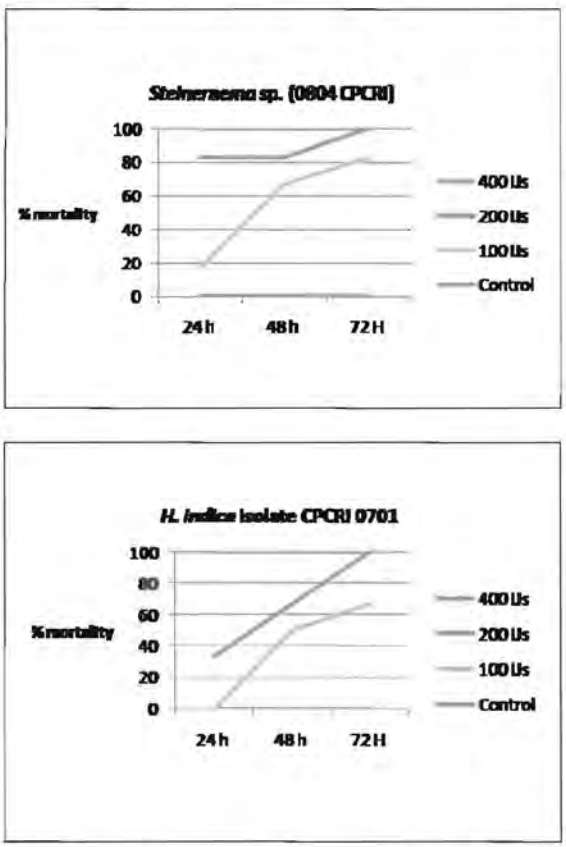


Fig. 77. Laboratory evaluation of EPN isolates against red palm weevil grub

Bio-efficacy of antagonistic bacteria/fungi in root knot nematode management

Sequential planting of moni followed by sorghum and turmeric with 20% marigold (*Tagetes* sp.) and basal application of *Trichoderma harzianum* (10 g/plant) significantly suppressed the root-knot nematode (*Meloidogyne* sp.) population in the interspaces of coconut (gall index 0.6 - 1.0) over the sole turmeric intercrop (gall index 2.5 - 3.) in the nematode affected coconut gardens (Fig.78)

Fig. 78 Turmeric intercropped in coconut garden

Pests of arecanut and cocoa

Two parasitoids *viz.*, *Brachymeria nephantidis* and *Elasmus punctulatus* were recorded for the first time from the pupae of arecanut inflorescence caterpillar, *Tirathaba mundella* (Fig. 79 a-b).

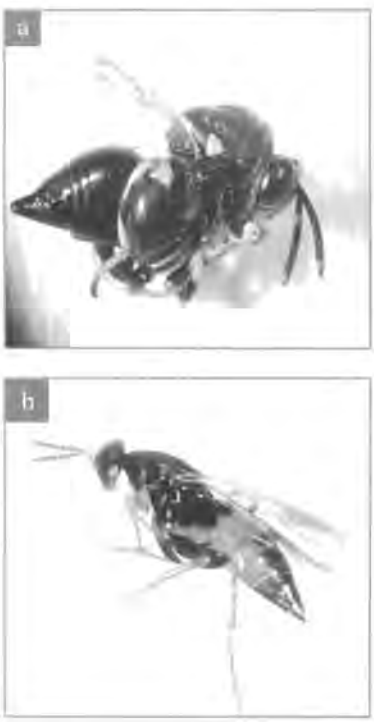


Fig.79 (a) *Brachymeria nephantidis* Gahan
(b) *Elasmus puctulatus* Verma & Hayat

Infestation of *Rhaphipodus subopacus* (Cerambycidae: Coleoptera) was reported for the first time in cocoa. Yellowing and wilting of cocoa plants was the most characterisitc symptom. Grubs feed voracioulsy on internal content of the main stem and made it hollow. Single grub has the potential to kill the plant and the extent of damage was reported as high as 8% (Fig. 80).

Fig. 80. Infestation of *Rhaphipodus subopacus* stems with bore holes (a), wilted cocoa plant (b), boring grub (c) and adult beetle (d).

Infestation of (Cerambycidae : Coleoptera) in cocoa was reported from Vittal, Karnataka. Grubs bore into the main stem and feeds from inside causing wilting. Adult beetle feeds on bark of the branches and results in drying of branches from feeding point. Plantation of less than six years are more susceptible and extent of damage as high as 6% was observed (Fig. 81).

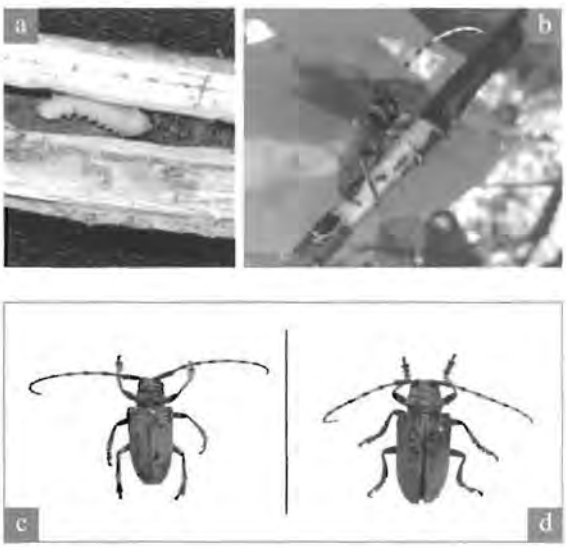


Fig. 81. *Celosterna scabrator* - boring grub inside (a), adult beetle (b), male (c) and female (d) beetles

6 PHYSIOLOGY, BIOCHEMISTRY & VALUE CHAIN MANAGEMENT IN PALMS AND COCOA

Climate resilient adaptation and mitigation

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

Plantation crops, being perennial in nature, have to face the impact of climate change even during a single generation or in a standing plantation. Hence, it is important that the impact of climate change variables such as elevated CO_2 [ECO_2], elevated temperature [ET] and water-deficit stress on plantation crops is understood well to reduce the adverse impacts.

Response to [ECO_2] and high temperature in OTC grown coconut and cocoa seedlings

Exposure of coconut seedlings (variety MYD transplanted during June 2015) to [ECO_2] and [ET] in OTC showed positive plant growth with [ECO_2]. Plant growth recorded almost 1.5 fold increase at 550 ppm and 2 fold increase at 700 ppm CO_2 as compared to chamber control at the end of 2.5 years of treatment exposure. Growth was significantly low with elevated temperature [ET] treatment. Elevated CO_2 to certain extent compensated the growth loss due to [ET]. In cocoa, interactive effects of climate change variables [ECO_2] and [ET] with water deficit stress [50% available soil moisture (ASM)] and high nutrients (150% RDF) on whole plant water use efficiency (WUE) were observed (Fig. 82).

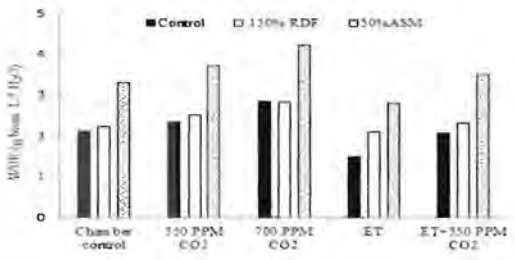


Fig. 82. Interaction effect of climate change variables with water deficit and high nutrients on the WUE of cocoa (CD at 5%- Treat: 0.11; C×T: 0.24).

Seedlings grown under [ECO_2] had higher assimilation rates than seedlings in ambient [CO_2], and this caused an increase in total dry mass of about 10% at 550 ppm and 29% at 700 ppm. Stomatal conductance was lower in [ECO_2]. Seedlings subjected to two CO_2 treatments showed similar transpiration rates despite large differences in total dry mass. Hence, WUE of well-watered and water-stressed seedlings grown under [ECO_2] was 28% and 33% higher, respectively, than WUE of seedlings grown in ambient [CO_2] suggesting additional advantage of [ECO_2] during water deficit stress. The results further indicated that the decreased growth and WUE with increased temperature and water deficit stress could be compensated to certain extent by [ECO_2].

Interaction effect of light and CO_2 on growth of coconut seedlings

Light saturation of photosynthesis in many C3 species like coconut occurs at 50% full sun light (around 800 μEin m^{-2} s^{-1}) (Fig. 83) and hence, beyond that intensity, photo-oxidation occurs and fronds are scorched. However, the leaves of coconut grown under [ECO_2] of 700 ppm, revealed that Pn saturates at 1400 μEin m^{-2} s^{-1}. It thus suggests that coconut under [ECO_2] exhibits better solar radiation

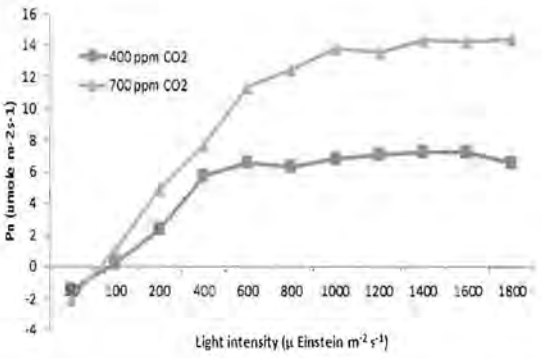


Fig. 83. Interaction effect of photosynthetically active radiation (PAR) and CO_2 on photosynthesis of coconut leaves

interception, conversion efficiency of intercepted solar radiation into chemical energy or photosynthesis, and would result in higher biomass production.

In vitro pollen germination technique to screen cultivars for high temperature

An in vitro pollen germination technique was used to screen 12 coconut genotypes for high temperature tolerance. Coconut genotypes, comprising five talls, five dwarfs and two hybrids exhibited wide variability for cardinal temperatures (T_{min}, T_{opt} and T_{max}) of pollen germination percentage and pollen tube growth when incubated at different temperature levels from 10°C to 50°C (Fig. 84). Mean cardinal temperatures calculated for the 12 genotypes using bilinear model ranged from 23.5°C to 29.5°C, 9.7°C to 16.5°C and 40.1°C to 43.9°C for T_{opt}, T_{min} and T_{max}, respectively. Tall cultivars FMST, WCT, LCT, dwarf cultivar COD and hybrids showed better adaptability to high temperature while dwarf cultivar MYD was the least adaptable. The genotypes that exhibited higher T_{max} for pollen germination and tube growth might be more tolerant to high temperature stress during flowering.

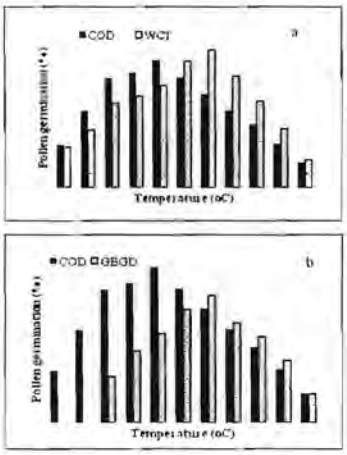


Fig. 84. Pollen germination in contrasting genotypes (a) COD and WCT and (b) COD and GBGD at different temperatures. CD (P=0.05%) between genotypes was 4.3 (a) and 7.6 (b).

Phenotyping drought adaptive traits

Tall varieties, Kalpatharu (KT), a selection from Tiptur Tall, and Kalpa Pratibha (KP), a selection from Cochin China Tall, accumulated higher biomass over the dwarfs Chowghat Green Dwarf (CGD) and Malayan Yellow Dwarf (MYD) when grown with same water input suggesting better WUE in talls over dwarfs (Fig. 85). Both drought avoidance mechanism like high root biomass and drought tolerant mechanism like epicuticular wax deposition, increased SOD and polyphenol oxidase activity were found to be high for talls. Talls under stress partitioned higher biomass towards roots may be to facilitate better extraction of water.

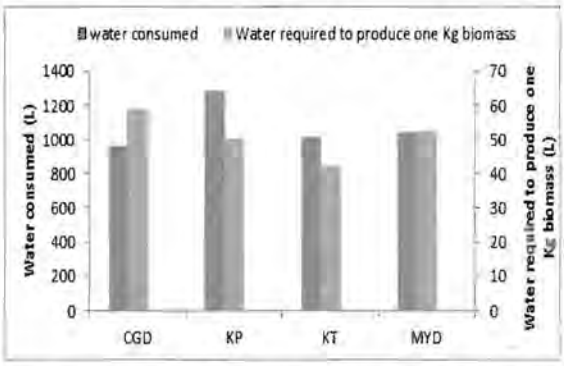


Fig. 85. Water consumption pattern of 1.5 year old coconut seedlings of different cultivars and amount of water required to produce a kg biomass.

Expression profile of water-deficit stress responsive genes

Genes involved in various stress-related molecular and biochemical pathways such as ABA, ethylene dependent hormonal signaling, anti-oxidant machinery and molecular chaperones, were selected to profile their expression under water-deficit stress in coconut. RT-PCR detection showed expression of water-stress responsive genes *viz.*, super-oxide dismutase (*CnSOD*),ethylene response element binding factor (*CnEREB*), ABA response element binding factor (*CnABAER*), dehydrin (*CnDEH*), heat-shock protein (*CnHSP70*), late embryogenesis abundant protein (*cnLEA*), ABA receptor(*CnPHYL*), 9-cis-epoxy-carotenoid dioxygenase(*CnNCED*) except molybdenum co-factor sulfurase (*CnMCS*) in the leaves of coconut that are subjected to moisture-deficit stress. Thus, this experiment corroborated the biochemical findings that water-stress causes modulation of anti-oxidant enzyme systems, increase in hormonal receptors and expressional changes of molecular chaperones in the coconut leaves.

Expression pattern of stress responsive proteins

In order to complement the biochemical and transcriptome based studies, protein expression profiling of coconut cultivars grown under moisture-stress was carried out. Protein expression in the leaves of two coconut genotypes (CGD, MYD)

subjected to moisture stress (for 2 months at 25% ASM) did not show any alteration in expression pattern while profiled in one dimensional SDS-PAGE (Fig. 86).

Fig. 86. Protein expression pattern in the leaves of CGD and MYD seedlings subjected to moisture stress

Nutrient uptake and use efficiency

In order to study the nutrients uptake and use efficiency in coconut, seedlings were grown in an aerated static-solution culture (hydroponics) and in soil. Besides, plant nutrient analysis, expressional changes of nutrient transporter gene families of Malayan Yellow Dwarf and Kalpatharu grown in both soil and hydroponics were investigated. The results show the expression of genes such as zinc transporter(*cnZIP*), metal-nicotianamine transporter YSL9 (*cnYSL9*), cation/calcium exchanger 4-like (*cnCCX4*), calcium-transporting ATPase 4 (endoplasmic reticulum Ca^{2+}-ATPase) (*cnSERCA*), oligopeptide transporter (*cnOPT*). Interestingly, the major plant transporters such as metal tolerance protein (*MTPA2*), natural resistance-associated macrophage protein (*NRAMP*) family transporter (NRAMP3) showed little expression. Real-time PCR (RT-qPCR) based relative quantification of select nutrient transporter genes using the cDNA from leaves of soil grown plants as calibrator and *CnTUB* gene as a normalizer revealed that gene *CnSERCA* is down regulated in both the cultivars whereas, differential regulation of *CnCCX* and *CnOPT* genes were observed (Fig. 87). This investigation thus provides molecular evidence to the differential accumulation of plant nutrients in leaves of seedlings grown in hydroponics and in soil.

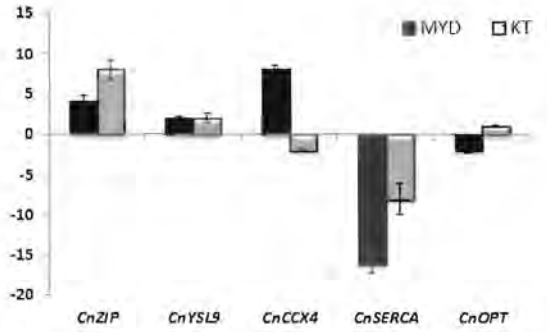


Fig. 87. Relative fold change in expression of nutrient transporter genes of coconut seedlings grown in soil and hydroponics

Nutraceutical properties of coconut products

Anthocyanins in coconut testa

Anthocyanins are water-soluble glycosides of polyhydroxy and polymethoxy derivatives of 2-phenylbenzopyrylium salts. A total of 26 anthocyanin compounds were identified (comprising 9 cyanidin derivatives; 2 peonidin derivatives, 3 delphinidin derivatives, 3 petunidin derivatives, 3 malvidin derivatives and 6 pelargonidin derivatives) from coconut testa, a by-product of coconut processing industries, using UPLC-MS/MS. Four major anthocyanins namely malvidin, delphinidin, cyanidin and pelargonidin were quantified, of which cyanidin was found to be predominant followed by delphinidin (Fig.88-89). A characteristic MS and MS/MS chromatogram of cyanidin is given in (Fig. 90). Most of these anthocyanins identified are reported to possess anti-inflammatory, anti-obese, anti-diabetic, anti-oxidant and radiation -protection properties.

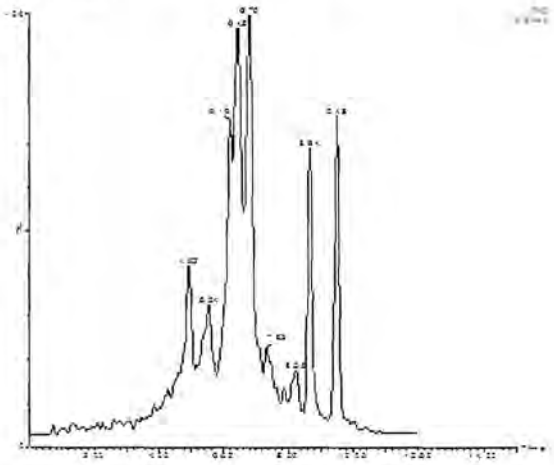


Fig. 88. Total ion chromatogram of anthocyanins identified from acidified methanolic extract of coconut testa.

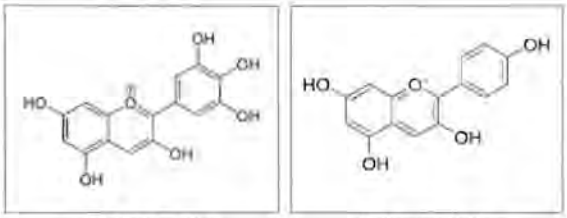


Fig. 89. Anthocyanins characterised from coconut testa.

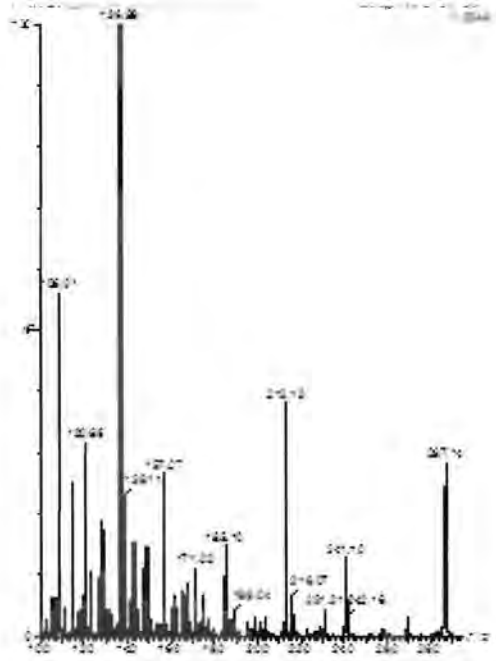


Fig. 90. A typical MS and MS/MS chromatogram of cyanidin

Phytosterols in virgin coconut oil

Phytosterols are plant sterols structurally similar to cholesterol and act in the intestine to lower the cholesterol absorption. VCO prepared following the hot process, fermentation and direct dry expelling contains phytosterol (expressed as mg beta-Sitosterol) in the range of 60.1 mg to 95.4 mg/100 g oil with the mean average of 73.4±8.0 mg/100 g oil.

Functional properties of coconut milk residue and virgin coconut oil cake

Coconut Milk Residue (CMR) has significantly high water absorption index (WAI) compared to virgin coconut oil (VCO) cake in both defatted and non-defatted forms and this could be attributed to the rich dietary fibre content of the CMR (Fig.91). On the other hand, VCO cake has significantly high water solubility index (WSI) compared to CMR and this could be due to the presence of high amount of soluble sugars, proteins and minerals in the VCO cake

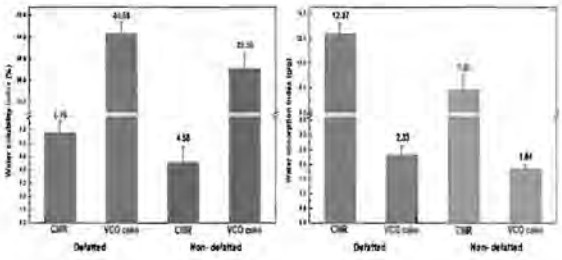


Fig. 91. The water absorption index and water solubility index of both defatted and non-defatted samples of CMR and VCO cake.

Fractionation and in *vitro* protein digestibility of VCO cake protein

Solubility of a protein is one of the critical functional attributes for its use as a food ingredient.The VCO cake contains 20% protein, and hence solubility studies were carried out. Solubility study indicated that VCO cake protein contains about 24.5% albumin, 58.1% globulin and 1.9% prolamine and hence it is highly digestible. Nutritional potential of the protein solely depends on its digestibility and bioavailability. *In vitro* study confirmed that about 51.9 % of the total protein present in the VCO cake could be digested by pepsin(an enzyme secreted by stomach), whereas trypsin (an enzyme secreted by small intestine) digests about 63.2% of the total protein. Thus, it is evident that the protein fraction of the VCO cake could be digested by the digestive enzymes secreted in the stomach and intestine.

Anti-diabetic and hypolipidimic activity of coconut palm sugar

In order to explore the anti-diabetic and hypolipidimic activity of coconut palm sugar, dose fixation study was performed in collaboration with K.S. Hegde Medical Academy, Mangalore, Karnataka. The study revealed that, coconut sugar at the dose of 2g/kg body weight was comparable with the control animals based on change in body weight, hematological parameters and organ weight. This information will be used to study the anti-diabetic and hypolipidimic activity of coconut palm sugar.

Shelf life extension of Kalparasa™ and tender coconut water

Microwave treatment of Kalparasa

Microwave treatment with maximum power level (900 W) and high exposure time (120s) inactivated the spoilage causing microorganisms in Kalparasa, thereby increasing its shelf life to 16 days. Optimal biochemical constituents and organoleptic properties were maintained for up to seven days when Kalparasa was treated at the power level of 600W for 60s and stored at refrigerated temperature of 4°C-6°C. The treatments with 30s exposure time in combination with 600W and 900W recorded no significant improvement from the control. The results of organoleptic evaluation of different microwave treated Kalparasa samples on the 7th day of storage are given in Table 13. The organoleptic evaluation of microwave pasteurized samples revealed that, the treatment with lower power (600W) and optimum exposure time (60s) scored maximum, which was on par with fresh sample. But the treatments with higher power viz., 900W for 90s and 900W for 120s, could not maintain the organoleptic characters like colour, flavour and taste of Kalparasa, detrimentally affecting the overall acceptability.

Table 13. Effect of microwave pasteurization on organoleptic properties of Kalparasa at 7th day of refrigerated storage

Sl. No.	Treatments	Appearance	Colour	Flavour	Taste	OAA
1	600W-60s	7.60 ± 0.70^{a}	7.80 ± 0.63^{a}	7.70 ± 0.48^{a}	8.20 ± 0.63^{a}	8.40 ± 0.51^{a}
2	600W-90s	5.80 ± 1.75^{b}	5.20 ± 1.93^{b}	5.80 ± 1.48^{b}	6.00 ± 1.63^{b}	6.10 ± 1.91^{b}
3	600W-120s	6.20 ± 1.40^{b}	5.60 ± 1.84^{b}	5.90 ± 1.66^{b}	6.60 ± 0.97^{b}	6.40 ± 1.07^{b}
4	900W-60s	6.70 ± 0.82^{ab}	6.50 ± 0.85^{b}	6.10 ± 1.29^{b}	6.20 ± 1.55^{b}	6.30 ± 0.95^{b}
5	900W-90s	6.50 ± 0.97^{ab}	6.20 ± 1.14^{b}	5.50 ± 1.08^{b}	5.80 ± 1.03^{b}	6.00 ± 0.94^{b}
6	900W-120s	6.60 ± 0.97^{ab}	6.50 ± 1.27^{b}	5.50 ± 0.97^{b}	6.40 ± 1.07^{b}	6.50 ± 0.71^{b}
7	Fresh kalparasa	7.60 ± 1.78^{a}	8.20 ± 1.03^{a}	7.80 ± 1.03^{a}	8.00 ± 0.94^{a}	8.40 ± 0.52^{a}
S. Em. ±		0.40	0.42	0.38	0.37	0.33
C.D. at 5%		1.13	1.18	1.07	1.04	0.93
F-value		2.84	6.82	6.92	6.84	10.26

Microwave pasteurization based preservation of tender coconut water(TCW)

The physicochemical characteristics of microwave (900W for 7min) treated TCW were similar to fresh TCW up to 17 days under refrigerated condition and 4 days under ambient condition. Microwave-treated TCW with SMS (0.03% and 0.05%) could be successfully stored for 8 weeks under the refrigerated condition without any discoloration. The microwave-treated TCW with SMS 0.03% and 0.05% can be stored for 17 and 15 days, respectively, under ambient condition. The shelf life of microwave-treated TCW with KMS (0.05%) could be extended up to 38 days under the refrigerated condition and 10 days under ambient condition. Microwave-treated TCW with KMS (0.03%) could be stored for 31 days under the refrigerated condition and 6 days under ambient condition. SMS was found to be more effective in maintaining the quality of TCW during storage. The sensory characteristics of treated samples were similar to fresh tender coconut water (Table 14).

Table 14. Sensory score of microwave-treated tender coconut water (TCW)

Sample	Appearance	Colour	Flavor	Taste	Overall acceptability
T3	8.0	7.5	6.0	7.0	7.0
T4	7.5	7.5	6.0	5.5	6.5
T5	7.5	7.0	5.5	6.0	6.0
T6	7.0	6.5	6.0	6.5	6.5
Fresh TCW	8.0	7.5	8.0	8.0	7.5

*** T3. 600W, 7 min+0.03% SMS: T4. 900 W, 10 min + 0.03% SMS: T5. 600 W, 7 min+0.05% SMS: T6. 900 W, 10 min + 0.05% SMS**

Value addition

Frozen coconut delicacy

It is a unique coconut delicacy made by using coconut milk, coconut sugar, tender coconut water and pulp. It is a vegan product, suitable for those suffering from lactose intolerance, and the fat content of coconut milk has been reduced to 11% (Fig.92). The methodology followed were mixing, pasteurization at 75°C for 15 min, two stage homogenization at 2000 psi and 1000 psi, ageing for an hour at 4°C, freezing using a continuous freezer and hardening at -28°C. Frozen coconut delicacy was prepared using the ingredients in different formulations. The product has an over run of 23.16%. Density, titratable acidity, total solids, crude fat, ash, total phenol and total sugar content were 0.97g/ml, 0.25%, 32.15%, 11.80%, 0.59%, 0.04mg/100g and 11.34mg/100g, respectively, with mean organoleptic acceptability score of 7.1.

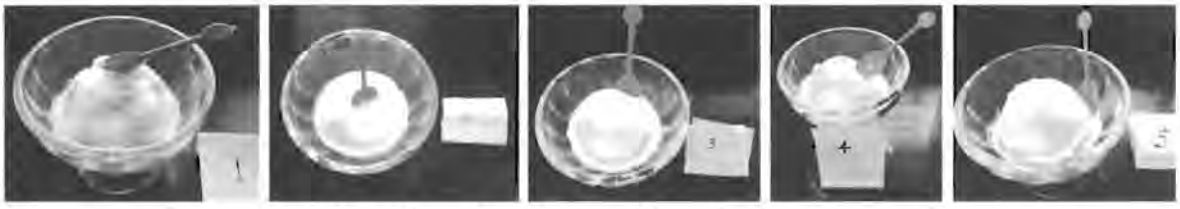


Fig. 92. Different formulations of frozen coconut delicacy

Biscuits from coconut milk residue and jackfruit seed flour

Biscuits prepared with varying combination of CMR and jack fruit seed flour are shown in (Fig. 93). The physical, sensory and biochemical results showed that 50% wheat flour, 20% CMR and 30% jackfruit seed flour was found to be the best combination for biscuits. Biscuits which are baked at 180°C showed excellent colour and appearance than those baked at 200°C. Diameter, thickness and spread ratio of the optimized combination was 5.25 cm, 0.58 cm and 9.13, respectively.

Fig. 93. Biscuits prepared with varying levels of coconut milk residue and jack fruit seed flour

Coconut sugar based homemade dark chocolate

An ideal combination of coconut sugar, cocoa powder and cocoa butter was standardized for preparation of homemade chocolate devoid of dairy products. The moisture content of the mix was fixed to be less than 1.5%. The mould for perfect shaping of the mix and darkchocolate bar after setting is depicted in (Fig. 94). With proper cooling and thawing the chocolate can be made to stay solid under ambient condition.

Fig. 94. Coconut sugar based dark chocolate

Coconut milk powder using foam mat drying

Coconut milk powder is mainly produced by spray drying technique, which requires expensive machineries to produce. Foam mat drying is a simple process of drying liquid - solid foods by mixing with stabilising agent and or foaming agent to produce stable foam, which undergoes air drying temperatures ranging from 50°C-80°C. Egg albumin (4%-10%) and CMC (0.25%-0.75%) are the most effective foaming agent and foam stabilizers. The percentage foam expansion varied from 50.9 to 64.4. The foam dried product is further ground to produce a powdered product.

Considering the number of parameters, the most important ones such as solubility (min), flowability and particle size distribution (mm) were taken into consideration for optimization. The result indicated

that Treatment 8 consisting of coconut milk powder with 10% egg albumin and 0.5% CMC (Fig. 95) was found to be the best (Fig. 96 a-b).

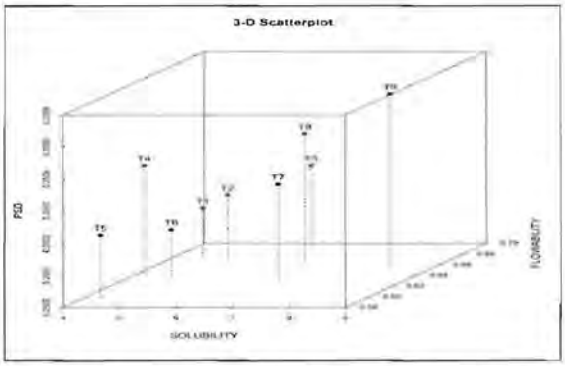


Fig. 95. 3-D scatter optimization diagram on best treatment combination

Fig. 96 (a) Optimized combination of coconut milk powder (b) Coconut milk powder packaged in laminated pouches

Farm mechanization

Prototype of air blast sprayer

A prototype of an air blast sprayer to spray the arecanut palms from ground was fabricated (Fig. 97). This sprayer produces efficient, atomized spray of insecticides/fungicides on the arecanut palm. The main parts of the sprayer are: an air blower to carry the atomized chemical to the crown of the arecanut palm, a chemical injection unit, a tank to store liquid chemical, lance, atomizer and a power transmission unit. The air blower consists of impellers fixed in a circular frame, 20 horizontal fins rotating at a speed of 2200 rpm to 3000 rpm. Technical evaluation of the blower revealed that spray could reach up to 25m height. A centrifugal pump attached to the prototype is the main part of the chemical injection unit. Power to drive both the blower and chemical injection pump is taken from the PTO of the prime mover, a mini tractor. When connected to the prime mover, a powerful air flow created by the blower comes out through the lance. Chemical injection pump gets initialized and the liquid chemical placed in the chemical tank is pumped in to the lance. The liquid chemical comes out through a wire mesh is hit by the fins of the fans rotating at high speed, gets atomized and the spray could reach a height of around 25m.

Fig. 97. A prototype of an air blast sprayer

Arecanut spraying using Unmanned Aerial Vehicle

Arecanut based integrated cropping system involving cocoa, black pepper and banana is common practice by many farmers to augment more income/unit area. The use of tractor mounted air blast sprayer in such cropping system is limited. To overcome the problem, CPCRI has initiated development of a UAV assisted sprayer in collaboration with M/S General Aeronotics Pvt. Ltd., IISC, Bangalore. First prototype of such a machine has already been fabricated. The technical specifications of the UAV are payload capacity -6 L, total weight 15 kg, the droplet size of nozzles 200-300 micron, endurance-15min, maximum flying height 1 km, and it can fly fully autonomous (Fig. 98).

Fig. 98. A prototype of UAV

7 TECHNOLOGY TRANSFER, ECONOMICS AND STATISTICAL METHODS

Keeping pace with changing times, the Institute has evolved newer strategies and approaches to cater its ever increasing clientele base that include farmers, startup entrepreneurs, policy and decision making bodies and overseas agencies. Furthermore, societal outreach by delivering technologies at farmer's doorstep through *Mera Gaon Mera Gaurav* is well attempted. Activities conducted in this regard and implications are summarized in the following:

Technology transfer and co-learning action research approaches

International training programmes

Two short-duration training programmes and two one-day programmes were conducted with a participation of 75 foreign delegates from 14 countries.

Twenty-one executives from seven Asian and African countries (Cambodia, Ghana, Kenya, Liberia, Malawi, Sudan and Uganda) participated in the 'Feed The Future India Triangular Training (FTF ITT) Programme' on Income Generating Enterprises in Plantation Sector conducted during 13-27th February 2018 in collaboration with National Institute of Agricultural Extension Management (MANAGE), Hyderabad (Fig. 99).

Under India-Africa Forum Summit-III (IAFS-III), a training programme on 'Value Addition and Product Diversification of Coconut and Cocoa' was

Fig. 99. Participants and faculty of international training programme (FTF ITT) on 'Income generating enterprises in plantation sector'

Fig. 100. Participants and faculty of international training programme on 'Value Addition and Product Diversification of Coconut and Cocoa'

conducted during 1-15th March 2018 in which 14 foreign delegates from nine African countries (Ghana, Kenya, Malawi, Sudan, Uganda, Tanzania, Nigeria, Ethiopia, Mali and Zambia) participated (Fig.100).

Two batches of officials from Sri Lanka underwent training on Coconut Production Technologies as part of the programme conducted by Indian Institute of Plantation Management, Bengaluru on 21 August (28 trainees) and 13 October 2017 (12 trainees).

Model Training Course

A Model Training Course (MTC) on 'Participatory technology transfer approaches for plantation crops' sanctioned by Directorate of Extension, Ministry of Agriculture and Farmers Welfare, Government of India was conducted during 12-19 December 2017 with participation of 24 extension officers from Tamil Nadu, Kerala, Jammu & Kashmir and Delhi.

Training programmes

Training programme on technologies pertaining to crop improvement, crop production, protection and value addition of mandate crops were conducted for the benefit of farmers and other stakeholders, as listed in Table 15-16. A total of 59 training programmes for farmers (4059 participants) and nine programmes for extension personnel (279 participants) were organized.

Table 15. On-campus training programmes

Sl. No.	Training programme	Date	No. of partici-pants	Collaborating agency (if any)
	Kasaragod			
1	Coconut production technology	16.05.17	46	ATMA, Kozhikode
2	Coconut production technology	20.05.17	40	Karivellur weaver's Co-op. Society, Kannur
3	Coconut production technology	25.05.17	30	
4	Crop management and value addition in coconut	26 to 27.04.17	27	Horticulture Dept., Karnataka
5	Value addition in coconut	19.04.17	32	Horticulture Dept., Karnataka
6	Cocoa cultivation and processing techniques	12 to 14.09.17	50	DCCD, Cochin
7	Coconut cultivation practices	01.03.18	37	ATMA, Malappuram, Kerala
8	Coconut production technology	28.07.17	10	ATMA, Kozhikode, Kerala
9	Coconut production technology	21.09.17	50	ATMA, Theni, Tamil Nadu
10	Coconut production technology	19 to 20.10.17	17	ATMA, Malappuram
11	Crop production in coconut	14.11.17	17	Agriculture Dept., Karnataka
12	Pest and disease management in coconut	15.02.18	83	Govt. of Kerala
13	Effective utilization of technologies for higher productivity in coconut	22.09.17	148	
14	Entrepreneurship Development Programme on ' Value addition in coconut'	19.10.17	68	
15	Integrated crop management and value addition in coconut	08.11.17	17	Horticulture Dept., Karnataka
16	Integrated crop management in coconut	26.03.18	20	ATMA, Kannur
17	Integrated pest management and value addition in coconut	23.11.17	13	
18	RAWE programme	6 to 12.11. 17	10	Kerala Agricultural University
	Regional Station, Kayamkulam			
19	Hybridization techniques and plant health management in coconut	9 to 10.11.17	7	
20	Hybridization techniques and plant health management in coconut	16 to 17.11.17	7	
21	Integrated pest management	12.07.17	45	
22	RAWE Programme Kerala Agricultural University	19 to 22.04.17	14	
23	Seedling management in coconut	24.08.17	20	
24	Advances in arecanut and cocoa production technology	03 to 04.05.17	46	PMKSY, Irikkur, Kerala
25	Advances in cocoa production and processing technology	25 to 27.05.17	32	DCCD, Kochi
26	Cocoa production and processing technology	18 to 22.12.17	49	MIDH-NHM-DCCD
27	Coconut cultivation practices	29 to 30.10.17	15	

28	Integrated crop management in coconut	29.11.17	40	ATMA, Madikeri Block, Karnataka
29	Multi species cropping system in arecanut garden for higher income	16.3.18	90	DASD, Calicut
Research Centre, Kahikuchi				
30	Cocoa cultivation and processing techniques	12 to 14.09.17	50	DCCD, Cochin
31	High density multi species cropping system	24.05.17	48	
32	High density multi species cropping system	18.08.17	34	
33	Nursery management and cropping system in coconut	08.12.17	29	
34	Production and processing technology of black pepper	29.05.17	31	
Research Centre, Mohitnagar				
35	Crop diversification in plantation garden with black pepper	28.07.17	40	
36	Awareness programme on different Govt. schemes for agriculture and allied crops	07.12.17	43	Department of Field Publicity, Government of West Bengal

Table 16. Off-campus training programmes

Sl. No.	Training programme	Date	Location and no. of participants	Collaborating agency (if any)
1	Health management in coconut	05.10.17	Alappuzha (50)	
2	IPM of coconut	24.04.17	Chadayamangalam (39)	PMKSY, Govt. of Kerala
3	Pest and disease management in coconut	13.03.18	Konnakkad, Kasaragod (32)	Govt. of Kerala Project
4	Pest and disease management in coconut	03.03.18	Koliyadukkam, Kasaragod (137)	Govt. of Kerala Project
5	Seedlings management of coconut and distribution of bio-primed coconut seedlings	27.07.17	Cherthala south, Alappuzha (28)	Keragramam project
6	Scientific coconut cultivation	27.07.17	Coochbehar district, West Bengal (43)	
7	Crop diversification in plantation garden with black pepper	04.07.17	Dalsinghpara, West Bengal (54)	
8	INM, IPM and IDM in coconut	30.10.17	Devikulangara (400)	
9	Advances in pest management in coconut	20.10.17	Eramalloor, Alappuzha (110)	
10	Pest and disease management in coconut	26.02.18	Pilicode, Kasaragod (220)	Govt. of Kerala Project
11	Management practices of coconut with special emphasis on improved varieties suitable for root (wilt) disease prevalent tracts	19.06.17	Kadathuruthy, Kottayam (150)	ATMA, Kottayam
12	Advanced production technologies of coconut	17.08.17	Kallara (125)	

13	Pest and disease management in coconut	21.02.18	Kanjirapoyil, Kasaragod (143)	Govt. of Kerala Project
14	Scientific cultivation practices for coconut	31.08.17	Karyampady, Wayanad (77)	
15	Health management in coconut Kera Bhavan, Kochi (50)	25 to 28.09.17		
16	Coconut production technology	06.12.17	Khanapara, Guwahati (32)	
17	Integrated crop management in coconut	28.10.17	Koliyadukkam, Kasaragod (200)	
18	Pest and disease management in coconut	05.03.18	Kavilumpara, Kozhikode (72)	Govt. of Kerala Project
19	Pest and disease management in coconut	16.03.18	Thamarasserry, Kozhikode (42)	Govt. of Kerala Project
20	Pest and disease management in coconut	18.03.18	Marancherry, Malappuram (91)	Govt. of Kerala Project
21	Scientific cultivation practices for coconut	30.08.17	Mathamangalam, Waynad (99)	
22	Identification of pests in coconut and arecanut		Nahira & Bongara	
23	Crop diversification in plantation garden with black pepper	30.08.17	Alipurduar district, West Bengal (56)	
24	Pest and disease management in coconut	15.03.18	Kankol, Kannur (71)	Govt. of Kerala Project
25	Pest and disease management in coconut	28.02.18	Muzhappilangad, Kannur (50)	Govt. of Kerala Project
26	Scientific cultivation of *Dioscorea*	12.07.17	Pathiyoor (19)	
27	Coconut based cropping system	18.12.17	Perumbavoor (63)	Keragramam project
28	Advances in coconut pest management with emphasis on ecological engineering and disease diagnosis and management strategies in coconut	05.09.17	Pollachi, Tamil Nadu (86)	CIPMC, Trichy
29	Integrated nutrient management in coconut ecosystem and role of nutrients in plant protection	26.08.17	Pollachi, Tamil Nadu (78)	CIPMC, Trichy
30	Integrated nutrient management in coconut ecosystem and role of nutrients in plant protection	30.08.17	Pollachi, Tamil Nadu (93)	CIPMC, Trichy
31	Management of Rugose whitefly	27.07.17	Purakkad, Alappuzha (20)	
32	Pest and disease management in coconut	02.03.18	Kundamkuzhy, Kasaragod (73)	Govt. of Kerala Project
33	Pest and disease management in coconut	17.03.18	Vettom, Malappuram (143)	Govt. of Kerala Project

Stakeholder interface programme

Twenty-three interface programme on various aspects of plantation crops were conducted (Table 17). Besides, four interface programme were conducted through video conferencing (Fig. 100).

Fig. 100. Interface programme facilitated through video conferencing in progress

Table 17. Stakeholder interface programmes

Sl. No.	Topic	Date	Location	No. of Partici-pants
1	FFP programme	05 to 07.07.17	Pathiyur	92
2	Performance of hybrid coconut varieties in farmers field	05.08.17	Pallikkara, Kasaragod	33
3	Performance of hybrid coconut varieties in farmers field	14.08.17	Mararikulam, Alappuzha	28
4	Performance of hybrid coconut varieties in farmers field	14.08.17	Mukkannoor, Ernakulam	22
5	Performance of hybrid coconut varieties in farmers field	16.08.17	ICAR-CTCRI, Trivandrum	22
6	Soil health management	17.08.17	KB, Chirakkara, Kollam	100
7	Science, innovations and entrepreneurship	15.09.17	ICAR- CPCRI, Kasaragod	400
8	FFP programme	11.10.17	Pathiyur	101
9	FFP programme	16-17.11.17	Pathiyur	88
10	FFP programme	28-29.12.17	Pathiyur	115
11	Scientist- entrepreneur Interface programme "Dream Big Kalpa"	31.01.2018	ICAR- CPCRI	148
12	High value underutilized fruit crops	05.01.2018	ICAR-CPCRI	118
13	Soil and water conservation	05.01.2018	ICAR-CPCRI	190
14	Workshop on whitefly	06.01.2018	ICAR-CPCRI	49
15	Crop diversity conservation	06.01.2018	ICAR-CPCRI	366
16	Cocoa production & processing	06.01.2018	ICAR-CPCRI	114
17	Fish farming, Dairy and Poultry	06.01.2018	ICAR-CPCRI	156
18	Start-up green - Enabling Agri-preneurship	07.01.2018	ICAR-CPCRI	301
19	Scientist- Farmer Interface Programme	08.01.2018	ICAR-CPCRI	195
20	Bee keeping	09.01.2018	ICAR-CPCRI	240
21	Urjakiran	09.01.2018	ICAR-CPCRI	108
22	Urban & Peri-urban Horticulture	10.01.2018	ICAR-CPCRI	272
23	Value addition in coconut, mango & jack fruit	10.01.2018	ICAR-CPCRI	262
Through video conferencing				
1	Production, protection and processing aspects of coconut	07.11.2017	Pathiyur, Alappuzha	112
2	Coconut production and value addition	10.11.2017	Kaymakulam, Alappuzha	89
3	Coconut based business ventures	14.12.2017	Chakkittappara, Kozhikode	99
4	Feedback session of the training programme	26 .02.2018	MANAGE, Hyderabad	21

e-kalpa: An interactive mobile app

'e-kalpa', the android based mobile digital initiative, is to facilitate hassle free access, at any time convenient to farmers, to the knowledge base and technologies on cultivation and value addition of coconut, arecanut and cocoa along with inter/mixed crops. The application is presently supported in five languages (English, Malayalam, Hindi, Kannada and Tamil). Novel features of e-kalpa include (i) availability of technology snippets even in offline mode; (ii) inter/ mixed crops suitable for coconut/ arecanut based cropping system, wherein the basic details of season/ planting time, spacing, seed rate, integrated nutrient requirement are provided for quick reference; (iii) "Input Calculator" that provides a nutrient management scheme (type, quantity, and

time of application of fertilizers) based on the inputs such as number palms in different age groups. At present, e-kalpa has a knowledge base with 105 technology snippets: coconut (69); arecanut (21) and cocoa (15).

The user base of e-kalpa has exceeded 2000 and everyday, 3 to 5 field problems are being reported online. Rating of this mobile application is 4.6 in scale of 0 to 5, which indicates its practical relevance and user friendly nature.

Fig. 101. Institute showcased its technologies in over 30 exhibitions held across the country

ATIC services

Planting material and technology products were sold to farmers and other stakeholders amounting to Rs.74,52,527/- through ATIC, ICAR-CPCRI Kasaragod. A total of 4233 queries from farmers and other stakeholders on various aspects of crop production, protection and processing of mandate crops were replied through ATIC, including 2679 telephone queries, 238 e-mail queries and 1316 postal queries. Extension literature published include the Hindi publication "Entrepreneur and Farmer Friendly Technologies", Malayalam and Kannada publications on "Coconut", 20 popular articles (nine in English, eight in Malayalam, two in Hindi and one in Kannada). Twenty-nine radio programmes were also conducted.

Front Line Demonstrations

The Institute has conducted 132 Front Line Demonstrations. The farmer participatory demonstrations on best management practices (BMP) for soil health management for enhancing productivity in coconut were conducted in 60 farmers gardens spread over six agro-ecological units in Kerala state. Integrated management of root (wilt) disease is being demonstrated in 64 holdings spread across six districts (Thiruvananthapuram, Kulasekharapuram in Kollam, Cherthala South in Alappuzha, Nedumpuram in Pathanamthitta, Kooroppada in Kottayam, Vellangallur in Thrissur and Parakkadavu in Kozhikode). Farmer participatory demonstration plots on arecanut based multispecies cropping system were initiated in eight plots.

Farmer FIRST Program (FFP)

Identified interventions in the project area

Participatory technology and resource utilization to empower and ensure livelihood security of farmers was demonstrated under Farmer FIRST (Farm, Innovation, Resources, Science and Technology) program in Pathiyoor panchayath covering an area of 1657 ha. The interventions carried out under the project were grouped into six modules *viz.*, (I) coconut based cropping systems; (ii) horticulture crops; (iii) livestock & poultry; (iv) natural resource management; (v) value addition/product diversification and (vi) integrated farming system. Activities carried under the interventions are presented in Table 18.

Implementation and implications

Coconut based cropping systems

The ward-level Coconut Producer Societies were involved in implementation of activities under this module. To begin with, an orientation training program was organized for preparation of farm plans to effectively utilize the resource base and to identify the gaps in the present cultivation practices.

The most discontinued crops recorded in the pre-project survey were paddy and sesamum. Hence revival of local varieties of paddy – 'Navara' and 'Rakthasaali'- along with HYV 'Sreyas' (KAU variety) was attempted and 10 acres were additionally brought under cultivation. Five varieties of sesamum [Kayamkulam-1, Thilak, Thilathara, Thilarani & SVPR 1 (KAU/TNAU varieties)] were introduced in an area of 120 acres. The C 152 cowpea and finger

millet varieties were introduced as intercrops in coconut gardens.

In the model plots of integrated root (wilt) management, majority of the palms are in the apparently healthy and disease early stages (Fig 102) indicating that the palms could be managed for better yield.

Table 18. Activities under the six categories in Farmer FIRST programme

Modules in operation	Number of interventions	Coverage
Coconut based cropping systems	22 intervention components: coconut, sesamum, paddy, cowpea and ragi/finger millet with establishing model plots of integrated root (wilt) disease management technologies	300 coconut plots with 10,000 coconut palms in various age groups - 25 groups of women SGHs in 19 wards
Horticulture crops	Decentralized planting material production of spices, participatory planting material production of tubers	4 groups of 42 farmers (28 women farmers) involved
Livestock & poultry	10 intervention components: fodder, fodder sprout units, azolla, mastitis prevention campaign, promotion of desi cow products, small scale egg incubators and cow mat demonstrations in animal houses	300 animals (110 households), 160 households (fodder cultivation- homesteads and 5 on group basis)
Natural Resource Management (NRM)	Soil sample collection campaign in five wards –5 ha grid based- coconut homestead farmers- facilitated by CPS	19 wards-1000 ha of coconut area
Value addition/ entrepre - neurship	5 intervention components: Virgin Coconut Oil production, primary processing of coconut (three copra dryers), turmeric value addition, coconut based food products	Three individuals and one group of coconut value addition units, turmeric processing unit (group basis)
Integrated Farming System (IFS)	Farm plan based IFS components	200 IFS plots- Selection of households 10-12 in each ward

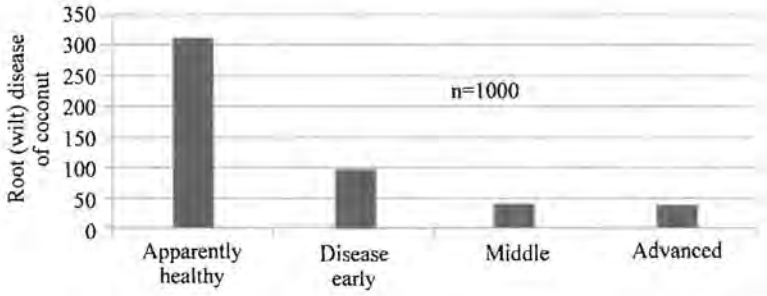


Fig. 102. Classification of coconut palms based on root (wilt) disease progression in the model plots

Area-wide plant protection was organized in one ward (ward number16) with active involvement of Coconut Producers Society (CPS). Most of the plots in the area were observed to be infested with pests/diseases (Table 19). Area-wide community based adoption of plant protection measures in all the plots enhanced the efficacy of technology irrespective of resource base of farmers wherein the individual bias is avoided and cost of adoption got reduced. The participating farmers contributed 75% of the cost of the adoption.

Table. 19. Impact of area wide community adoption of integrated plant protection (N=800 palms)

Pests/Diseases	Percentage incidence	
	Pre-adoption	Post adoption
Rhinoceros beetle	73.36	48.21
Red palm weevil	2.38	0.59
Coreid bug	2.60	1.32
Leaf rot disease	10.77	2.09

The perceivable impact of activities carried out under coconut based cropping systems module are:

(I) Evaluation of paddy varieties: Rakthashali was found to be resistant to pests & diseases with sturdy tillers, Navara was susceptible to blast disease, Coried bug infestation with heavy lodging whereas 'variety Sreyas was observed to be susceptible to leaf roller.

(ii) Drudgery reduction of women farmers through refined seed drill: 60 per cent labour reduced (instead of 6 men labour/acre/day, only 2 women) for sowing operations, 75 per cent time saving for sowing and seed requirement reduced by 50 per cent.

(iii) Cowpea – C152 (to improve adoption of basin management technology of ICAR-CPCRI): Decentralized production of cowpea seeds by women group farmers for reduction in cost of cultivation and ensuring local availability for mutual benefit of coconut farmers and cowpea growers.

Horticulture based module

Community based decentralized planting material production of high yielding varieties of tubers released by ICAR-CTCRI (*Dioscorea* var. Sree Keerthi, *Amorphophallus* var. amorphophallus) and spices varieties released by ICAR-IISR (turmeric var. Prathibha) were taken up as Responsible Extension Approach (REA). Turmeric was cultivated in 5.2 ha contiguous area as intercrop of coconut by 18 groups of women-farmers. These groups are using 50%-70% of the harvested produce for area expansion with an objective to produce sufficient turmeric for a processing unit to be established in the coming years.

The pilot testing of pro tray method of turmeric seedling production was observed to be unsuitable for the sandy loam soil and growth and yield were poor as compared to normal recommended practices.

Livestock based module

Introduced Fodder grass (CO-5) and fodder sorghum (CO FS 31 & 29) and the women farmers group have taken it as a 'Green Enterprise' for income generation. The low cost hydroponics fodder unit with two trays capacity/day indicated positive responses as there was an increase of 0.5 to 0.75 l milk/day/animal. There are 19 such units (households) with a total production capacity of 400 kg/month/unit. In summer season, this intervention was supportive to farmers for covering fodder requirement to a certain extent and suitable for farmers with very low land holding size. Twenty units of production of *Azolla* in readymade containers were established through farmer to farmer exchange. Mastitis prevention campaign was taken up as an important intervention for reducing loss to livestock farmers. Mastitis kits consisting of California reagent (Institute of Veterinary Biologicals, Thiruvananthapuram), povidone iodine, bleaching powder and potassium permanganate were provided to 300 livestock farmers.

Natural resource management

Soil sample collection campaigns were organized in five wards in 5 ha grid based sampling method in coconut homesteads, facilitated by CPS covering 300 ha area. The soil test results indicated: pH (5.5 to 6), available P (25-80 ppm - very high), available K (30-80 ppm - low to medium), calcium (60-130 ppm - very low), Mg (< 120 ppm - very low) and Boron (<1 ppm - low). Sixty-five soil health cards were distributed. Ten schools were involved in the World Soil Day celebrations held on December 05, 2017 and a soil quiz was conducted for school students. Rejuvenation of 100 ponds, and linking with MGNREGS through convergence programme was initiated for water conservation and storage.

Value addition/ entrepreneurship

Value addition of coconut was taken up using ICAR-CPCRI technologies such as VCO production (100 nuts/day), primary processing of coconut (two shell fired copra dryer and one agricultural waste fuel) (Fig. 103) and coconut-based food products' unit. Success story of coconut food products unit was documented in farm magazine, AIR Thiruvananthapuram and Doordarshan (Fig. 104). A mechanized *chakku* (modification to conventional oil

extraction from copra) was also established. Value addition of Rs. 10 per nut could be obtained in VCO production alone. In the coconut-based food product unit, the average monthly production of various products were: Avalos powder (50-70 kg), coconut chutney powder (50-70 kg), ready to use curry mix (10-15 kg), VCO (10-15 l), fried coconut (5-7 kg), and Coconut milk pancake mix (45-60 kg). This unit utilizes 100 to 150 nuts/day and is realizing a value addition of Rs. 20-25/nut.

Integrated Farming System

Coconut based integrated farming systems in homesteads in 200 farmer fields is one of the major interventions for doubling farm income and meeting balanced nutrition requirement. According to resource availability, 50 households were selected for fish culture; agriculture and coconut based intercropping; 50 households for high density multispecies cropping system and in 100 households the existing IFS models were refined.

Outreach programmes in FFP

The total number of extension/outreach programs organized was 54, benefitting 2365 farmers (Table 20). Among the beneficiaries, 57% were women.

Table 20. Outreach programmes conducted under FFP in the year 2017-18

Programs	Number	Participants
Trainings - on and off campus - All in the FFP area	39	1934
Method demonstrations	5	139
Meetings with various farmer groups	6	185
Exposure visits under FFP	4	107
Total	**54**	**2365**

With the objective of building awareness on recent technologies developed by various institutes, the demonstrating technologies for doubling production, as well as orienting to opportunities and scope of agricultural research for farming communities, exposure cum study tour was conducted for 40 practicing farmers to ICAR-Indian Institute of Horticultural Research, ICAR-National Institute of Animal Nutrition and Physiology and ICAR-National Diary Research Institute, Regional Station, Bengaluru.

Mass media utilization

- Twenty-four programme in AIR (Farm & Home) - starting from 20.9.17; State wide relay.
- Feedback from various sections of society - more than 400 responses received in AIR from listeners
- Documenting success stories - farmers (15)

Other supportive programmes

- Field level *Trichoderma* sp. multiplication unit – 500 kg produced
- Nursery for planting material production – Vegetable seedling production, Black pepper multiplication
- Organic waste management - CSIR-NIIST collaborative program on "Bio digester for gas production from cow dung" - 25 litres of bio gas per kilogram of cow dung- collected in an external balloon of 2000 L capacity

Fig. 103. Coconut processing facilities established under the Farmer FIRST programme

Fig. 104. Recording of success stories by AIR, Thiruvananthapuram

Participatory demonstration plots on arecanut based multi species cropping system

Eight beneficiary farmers of Directorate of Arecanut and Spices Development, Kozhikode funded demonstration plots on arecanut-based multi species cropping systems were supplied with cocoa grafts, black pepper grafts and banana suckers for gap filling in demonstration plots. Neem cake and *Trichoderma* sp., copper sulphate, lime and rock phosphate was supplied to beneficiary farmers. Technical guidance on cultivation of arecanut, cocoa, black pepper and banana was provided and also seasonal intercultural operations were done. Thirty-two soil samples were collected from the rhizosphere of arecanut, cocoa, black pepper and banana and analyzed for the quantification of nematode populations. The nematode population ranged from 17-42 nematode/g of soil and free living nematode population ranged from 60-103 nematodes/g soil. The most frequently observed and widely distributed nematode species were root-knot nematodes, *Meloidogyne* sp. (21.5%), followed by spiral nematode, *Helicotylenchus* sp. (13.8%) and burrowing nematode, *Radopholus similis* (4.6%). Training programme and field day on arecanut based cropping system were also organized (Fig. 105-106).

Fig. 105. Training programme on 'Multi Species Cropping System in Arecanut Garden for Higher Income' organized at ICAR-CPCRI, Regional Station, Vittal on 16 March, 2018.

Fig. 106. Field day on 'Arecanut Based Multi Species Cropping System for Higher Income' at Shri Kashmeer D'Souza's garden, Kokkada, Belthangady TK, on 17 March 2018.

Socioeconomic dimensions and value chain dynamics in policy perspective

Experiencing the price rise regime

The price boom regime of the coconut sector was analyzed and the plausible reasons for the current price rise regime have been delineated. The year 2017 has witnessed unprecedented rise in price of raw coconuts as well as coconut oil. It is also noteworthy that the comparative price wedge *vis a vis* the year 2016 is increasing (Fig.107).

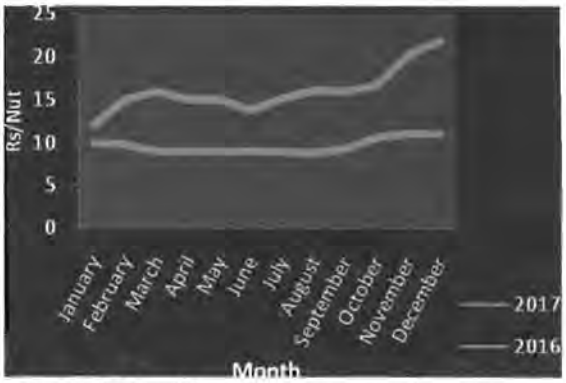


Fig.107. Monthly price movement of coconuts

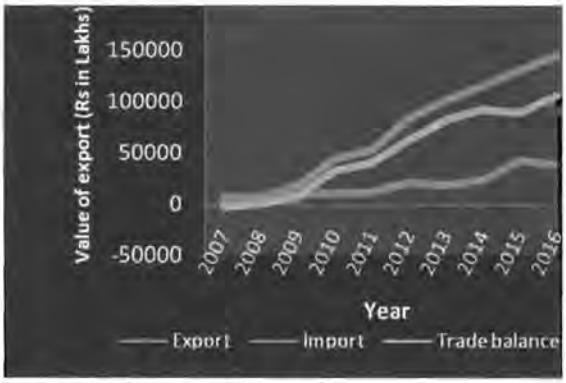


Fig.108. Pattern of trade balance in coconuts

As a matter of fact, the price rise regime has accentuated the perplexity among stakeholders and policy makers. The basic economic rationale of rising price is very well matched on account of 35 per cent reduction in copra arrivals in the year 2017 due to supply shortage, which in turn has resulted from the climate vagaries (long spells of drought) experienced in the previous year. The study also reveals the indications of large scale procurement of copra by the major industrial players on speculation of supply shortage, which has also influenced the overall scarcity of copra.

It is also notable that the exports and the trade balance of the coconut and coconut products has shown

stupendous increase from the year 2009 onwards (Fig. 108) and the positive ambience prevailing in this regard has certainly contributed to the increasing domestic prices of coconuts.

From the academic and policy view point, it is imperative to monitor the value share accrued to the producers in the event of escalating exports. This is particularly important as it is evident from the other developed value chains of plantation crops such as coffee and cocoa, wherein the value share of the producer is meagre. In the case of of coconut value chain, our export orientation is in the nascent stages and there is adequate provision for control and monitoring, and therby ensuring better position of the coconut farmer and small scale entrepreneurs.

While analysing the association of domestic and international prices of coconut oil (Fig.109-110) it was observed that the domestic prices more or less follow a cyclical pattern. Whenever there was a price wedge between domestic and world prices, sooner it gets integrated. As of now, there is an increasing price wedge and the economic rationale suggests an integration to be followed.

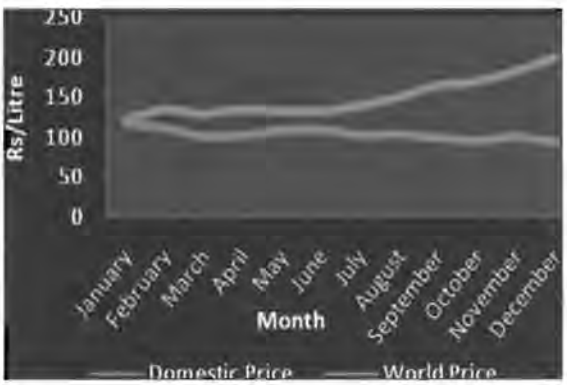


Fig. 109. Price movements of coconut oil (monthly)

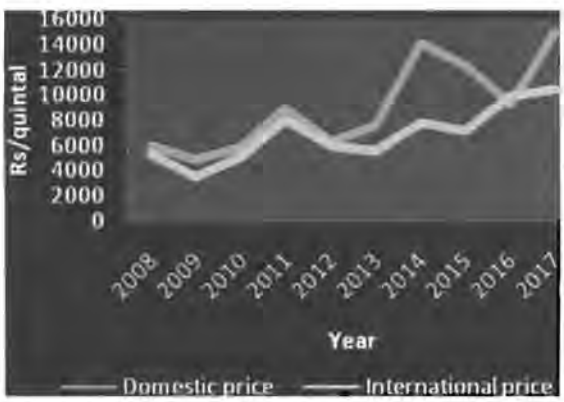


Fig. 110. Temporal price movements of coconut oil

It is also important to note that the price adjust mechanism is possible through substitution of palm oil, in which the prices are at much lower level than that of coconut oil. It is also noteworthy that the blended and adulterated coconut oils are flooded in the domestic market whenever there is a price rise in coconut oils for a longer period.

Policy aspects

The policy research on coconut aspects has manifested as policy write up of the institute on minimum support prices of copra for the CACP. The policy report has reflections from the field level production economics, stakeholders' concerns as well as feedback. In fact the whole exercise can be categorized as the 'inter-institutional mode of policy intervention' as depicted in Fig. 111.

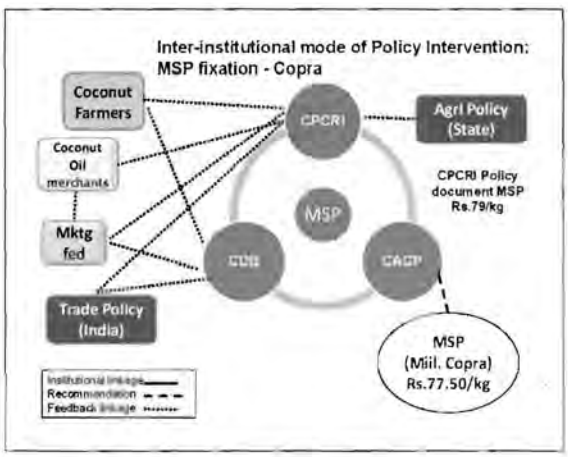


Fig. 111. Inter-institutional mode of policy intervention

Development of statistical and computational techniques for improving research methodology

Field survey to assess incidence of pests and diseases

Field surveys were conducted in Hassan, Tumkur, Chitradurga and Davangere districts of Karnataka to assess the incidence of major pests and diseases of arecanut. The district wise summary of data is presented in Table 21.

Field survey was also conducted in Jalpaiguri and Alipurduar districts of West Bengal. It was observed that the major diseases of arecanut in Jalpaiguri district are tendernut fall (10%), dieback (4%), *Ganoderma* (0.07%) and bud rot (0.03%). In Alipurduar district the percentage incidence of major diseases are viz., tendernut fall (26.54%), dieback (20.46%), *Ganoderma* (0.48%) and bud rot (0.52%).

Table. 21. Pest/disease incidence (% of palms affected) in arecanut in Karnataka

Disease/pest	Hassan	Tumkur	Chitradurga	Davangere
Dieback	0.72	1.22	0.00	1.00
Scale insect	0.00	0.00	0.54	0.08
Leaf spot	0.01	0.00	0.00	0.13
Spindle bug	1.95	5.47	1.73	1.25
Mites	0.01	0.89	3.78	4.18
Cross- band	0.64	3.11	3.03	2.20
Inflorescence caterpillar	0.00	0.00	0.08	0.03
Crown rot	0.05	0.00	0.00	0.08
Nut-splitting	0.00	0.22	0.14	0.13
Tendernut drop	0.50	0.89	0.30	0.13
Anebe *(Ganoderma)*	0.36	0.67	0.00	0.00

Field surveys were was also conducted in Jalpaiguri and Alipurduar districts of West Bengal. It was observed that the major diseases of arecanut in Jalpaiguri district are tendernut fall (10%), dieback (4%), *Ganoderma* (0.07%) and bud rot (0.03%). In Alipurduar district the percentage incidence of major diseases are viz., tendernut fall (26.54%), dieback (20.46%), *Ganoderma* (0.48%) and bud rot (0.52%).

Development of sampling techniques for spatial data analysis

Spatial pattern of major disease and pest incidence in arecanut were studied to find out the best sampling procedure to estimate the pest and disease incidence. Spatial auto correlation (Moran's I) was worked out for the major pests/diseases such as YLD, mites, spindle bug and cross-band. The results show that YLD and mite incidence are auto correlated, which indicates the disease incidence is in cluster form whereas the incidence of spindle bug and cross-band are not significantly auto-correlated. The performance of the simple random sampling, cluster sampling and the spatially balanced stratified random sampling techniques were compared using the field survey data (Table. 22). It can be observed that the spatially balance stratified sampling technique performs better in the case of YLD and mites, where the data is auto-correlated or in cluster form.

Table 22. Efficiency of different sampling methods

Disease/pest	N	n	Mean	Average Mean Square Error		
				Simple	Stratified	Cluster
YLD	183	20	28.43	1.73	0.38	3.58
Mites	136	20	2.55	0.67	0.23	0.78
Cross-band	136	20	2.57	0.43	0.39	0.48
Spindle bug	136	20	2.85	0.56	0.42	0.67

Need based computer programs

Computer programs for spatial auto-correlation (MATLAB), Variogram Analysis (MATLAB) and R code for augmented designs were developed.

Coconut portal

Coconut portal was updated adding updated information on crop production statistics, varieties, crop protection, value addition and machineries. Addition of login credentials for access was also incorporated.

Crop-weather association

Association between weather variables and yield of coconut and arecanut was delineated using ICAR-CPCRI farm level data at Kasaragod and Vittal, respectively over the past thirteen years. Weather variables, *viz.* max. temperature, min. temperature, relative humidity, vapour pressure and rainfall were correlated with the annual per palm productivity. Monthly weather variables which are significantly correlated with annual yield were selected to predict the annual yield.

Coconut

The regression function for coconut is:

$Y = 10.86 X_1 - 5.53 X_2 + 0.07 X_3 (R^2 = 0.83)$

Where Y is the annual yield (number of nuts), X_1: vapour pressure in April, X_2: maximum temperature

during July and X_3: rainfall in November previous year. The estimated and actual yield in coconut is shown in Fig. 112.

Arecanut

The regression function for arecanut is:

$Y=261.97-0.3944X_1+37.6792X_2-11.6254X_3$ ($R^2=0.97$)

Where Y is the annual arecanut yield (number of nuts), X_1: Total rainfall during November (previous year), X_2: maximum temperature during September and X_3: Humidity (FN) March (previous year). The estimated and actual yield in arecaut is shown in Fig. 113.

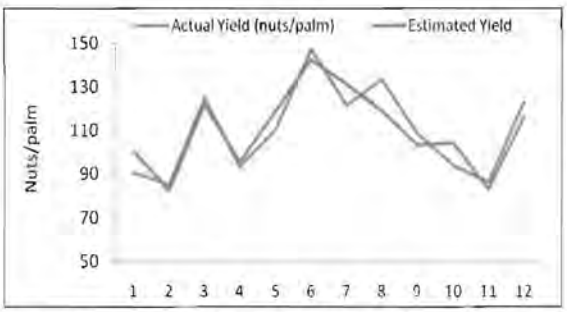


Fig. 112. Estimated and actual yield in coconut

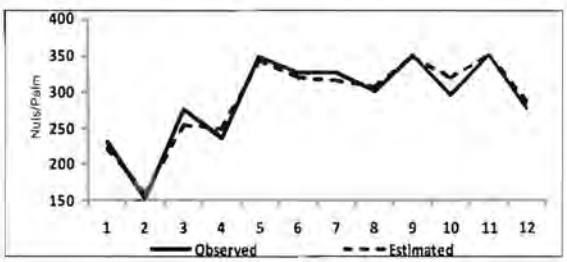


Fig. 113. Estimated and actual yield in arecanut

Weather-based crop insurance in arecanut - Current status

In weather-based crop insurance schemes (WBCIS), climatic factors which can be easily measured, are used as proxy variables for yield loss and compensations are finalized in area approach instead of individual basis. Arecanut crop is insured under WBCIS in Karnataka and Kerala wherein premium and sum assured for a hectare of crop varies among different Reference Unit area (RUA) based on the probability of occurrence of abnormal weather variables as derived from historical data. Different districts in Karnataka and Kerala where arecanut is insured under WBCIS is depicted in the Fig. 114-115 respectively along with the area under arecanut and the insurance actuarial rates.

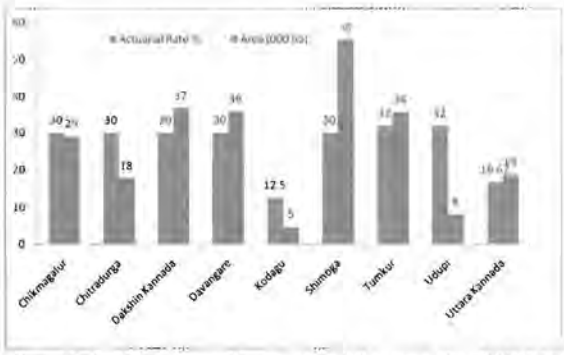


Fig. 114. District wise actuarial rates in WBCIS of arecanut in Karnataka

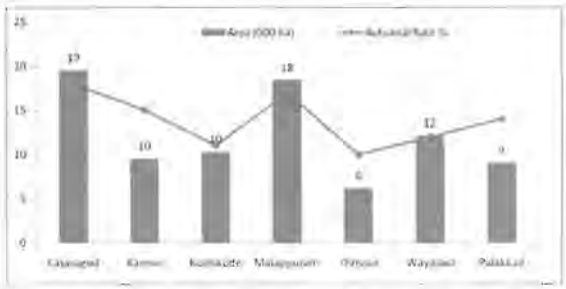


Fig. 115. District wise actuarial rates in WBCIS of arecanut in Kerala

Intellectual property management and transfer/commercialization of agricultural technology scheme

The Institute Intellectual Property and Technology Management Committee met 10 times in the year to take decisions on various issues pertaining to technology transfer. Taking into account the technology generation cost and marketing feasibility, the committee fixed licensing fee for two technologies and also revised fee for nine technologies. The Institute received one national patent for "Coconut chips slicing machine" (Patent No.285418) and three trade mark registrations viz., CPCRI emblem (No. 2574582), Kalpa logo (No. 2320116) and Cocoa Probio (No.2813920) (Fig.116).

A total of 47 technology transfers took place in the year 2017-18: virgin coconut oil (5); coconut chips (7); kalaparasa and palm sugar (13); gadgets and machinery (2); nanomatrix for pheromone delivery (1); carbonated tendernut water (4); coconut deshelling machine (1); design and drawing of VCO cooker (1); dwarf arecanut hybrid VTLAH2 (1); arecanut tissue culture (1), frozen coconut delicacy (2); kalpa soil care (2); kalpa organic gold (1); kera probio (1); coconut vinegar (5) and a revenue of Rs. 16.26 lakh was realized.

The 'Dream Big-Kalpa', Institute-Industry interface programme conducted every year on 31 January, attracted large number of entrepreneurs. During the year 2018, MoUs on ICAR-CPCRI technologies were exchanged with entrepreneurs followed by presentation of ICAR-CPCRI technologies and exhibition of products and services as well as publications (Fig. 117).

केंरो.फ.अ.सं
CPCRI

KALPA

KALPARASA

Cocoa Probio

Fig. 116. Registered trademarks of the Institute

Fig. 117. Exchange of MoA during Institute-Industry interface programme 'Dream Big-Kalpa' on 31 Jan. 2018

Agri-Business Incubation Centre

Three incubatees registered under ICAR-CPCRI agri-business incubation centre: Padhoor Food Product (for VCO); Shri. Haris (for Desiccated Coconut (DC)); and Shri. Nijo Raju Mathew (for activated charcoal). Required licenses and clearance certificate from Pollution Control Board were obtained for starting the commercial operation of the activated carbon unit. An automatic washing system was provided for maintaining better hygiene conditions in the DC unit. A meeting with bank officials was held in connection with credit requirement to operate the DC unit.

Technical support on arecanut tissue culture was provided to M/s SPIC, Coimbatore. A stakeholder meet on arecanut tissue culture was organized on 9 November 2017. Forty delegates including officials from M/s SPIC, representatives of arecanut growers (CAMPCO, MAMCOS, TUMCOS), officials from KVKs, scientists and progressive farmers participated.

Support for technology scaling up of production of 'Kalparasa' was extended to three incubatees: M/s Krishna Plantations Pvt. Ltd., Goa; M/s Palakkad Coconut Producer Company and Shri Ram Mohan, Tiruppur. In the case of technology know-how on frozen coconut delicacy, M/s Hangyo Ice Cream Pvt. Ltd. was provided assistance for large scale production. Shri Sebastian K. Philip, Kalapurackal, Kannur was provided off-campus incubation support for production of Kalpa Gold.

An initiative of graduate engineering students, 'Agroraksha', a mobile application to meet all types of farming inputs and linking them with marketing has registered as incubatee for domain support. Marketing support to the following incubatees is provided: M/s Magicco, Kasaragod; M/s. Dinesh Food, Kannur; M/s Pro-B, Bangalore; and M/s Pilot Smith, Irinjalakkuda.

With an objective to provide technology updation and business insight, three interface programmes with representative of six Coconut Producer Companies were conducted: at Coconut Development Board, Kochi on 16 May, 2017; at ICAR-CPCRI Regional Station, Kayamkulam on 10 November 2017; and at Chakkittappara on 14 December 2017.

In order to create awareness among students and youth on technology innovations and entrepreneur ship, two programmes were conducted at Kasaragod: Interface on science, innovations and entrepreneur ship (15 September 2017) and Start up Green 2018 (7 January 2018). Two technology awareness camps were organized: At KVK, Gopichettipalayam (12-13 October 2017) and at Pathiyur (7 November 2017).

10 ALL INDIA COORDINATED RESEARCH PROJECT (AICRP) ON PALMS

The All India Coordinated Research Project on Palms started functioning from 1972 with the objective of conducting location-specific research in the mandate crops. At present the project has coconut, oil palm, arecanut, palmyrah and cocoa as mandate crops and it is implemented in 30 centres. Its headquarters is at ICAR-CPCRI, Kasaragod and 15 centres are conducting research on coconut, 8 on oil palm, 4 on arecanut, 4 on palmyrah and 7 on cocoa. The coordinating centres are located at 14 states and one union territory covering 13 SAUs/SHUs, two CAUs and four ICAR institutes

Fig. 118. Map showing ICAR-AICRP on palms centres

The budget for the year 2017-18 was Rs. 485 lakhs and the scheme is implemented through the respective state agricultural/horticultural universities on 75:25 basis, with 75% ICAR share and with 100% ICAR funding in the case of CAUs and ICAR Institutes.

Research Achivements

Coconut

Genetic Resources and Crop Improvement

Seven location-specific Tall x Tall coconut hybrids and six Dwarf x Dwarf coconut hybrid combinations are under evaluation at Ambajipeta centre. Observations recorded on 7th year after planting revealed that, the cross LCOT x ECT recorded the highest yield (68 nuts palm^{-1}year^{-1}) followed by PHOT x ECT (65 nuts palm^{-1}year^{-1}). Among the Dwarf x Dwarf hybrid combinations, the highest yield (83 nuts palm^{-1}) was recorded in COD x MGD followed by CGD x MGD (74 nuts palm^{-1}) at the age of 7 years. At Aliyarnagar centre, among the five Tall x Tall cross combinations planted during August 2011, the cross combination ADOT x ECT recorded the highest nut yield of 104.2 nuts/palm/year followed by ECT x LCT (76.7 nuts palm^{-1}year^{-1}).

Fig. 119. Performance of Tall x Tall and Dwarf x Dwarf hybrid combination.

Crop Production

At Ratnagiri centre, integrated nutrient management (INM) under coconut based cropping system is being evaluated for the past five years. Among the four treatments studied, the highest yield of 146.9 nuts/palm/year was recorded in T_1 (75 % recommended NPK + 25% through organic recycling with vermicompost), which was followed by T_2 (139.6 nuts), T_3 (137.0 nuts) and coconut monocropping (134.3 nuts). Copra yield (26.6 kg/palm) and oil yield (17.3 kg /palm) were also high in T_1. The highest yield of pineapple was recorded in T_3 (40 kg), whereas highest yield of banana (125 kg), cinnamon bark (13 kg) and cinnamon leaves (67 kg) were recorded in T_1.

Under INM in coconut based cropping system model at Ambajipeta centre, application of 75% RDF + 25%

through organic recycling with vermicompost followed by 50% RDF + 50% through organic recycling with vermicompost + vermiwash + bio-fertilizer + *in situ* green manuring recorded superior yields of 178.5 and 172.6 nuts/palm/year, respectively when compared with coconut monocropping (142.5 nuts/palm/year). Performance of six cocoa clones *viz.* VTLCC I, VTLCH I, VTLCH 2, VTLCH 3, VTLCH 4 and VTLC 1 are being evaluated as intercrop in coconut gardens, and during the period clone VTLCH 2 gave the highest yield of 2.1 kg dry beans per tree.

Fig. 120. Field view of experimental block at Ratnagiri

Fig. 121. Field view of experimental block at Ambajipeta

Crop Protection

Disease Management

Management of basal stem rot disease in coconut through fungicides

Eight recently introduced fungicides comprising single and combiproducts in commercial formulation were tested against growth of *Ganoderma* sp. *in vitro* at various dosages *viz.*, 100, 250, 500 ppm along with their respective recommended dosages in perennial crops. The results revealed that when applied at recommended concentrations, all the fungicides showed cent percent inhibition excluding Kresoxymethyl. The fungicides *viz.*, Zineb 68%+Hexaconazole 4% WP and Fluxapyroxad 250g/lit+Pyraclostrobin 250g/lit SC at lowest concentration *ie.*, at 100 ppm had cent percent inhibition indicating their effectiveness even at lower concentration against pathogen.

Management of stem bleeding disease in coconut with fungicides

The new fungicide molecules alone or as combiproducts were tested against mycelial growth of *Thielaviopsis paradoxa in vitro*. Each fungicide was tested at four different concentrations namely 100, 250, 500 ppm along with their recommended concentration in perennial crops. At recommended dose of fungicides, except Thifluzamide 24% SC, Kresoxym-methyl 44.3% SC, all fungicides showed varying level of pathogen inhibition. However, the fungicide Carbendazim 25%+Mancozeb 50%WS had cent percent inhibition of pathogen at its recommended concentration. The analysis of inhibitory action at lower concentration of 100 ppm revealed that, the fungicide Carbendazim 25%+ Mancozeb 50%WS had cent percent inhibition of pathogen, indicating its strong action against the test pathogen.

Leaf blight disease of coconut

Molecular characterization of *Lasiodiplodia theobromae* isolates causing leaf blight of coconut was carried out at AICRP centre Aliyarnagar. PCR amplification of ITS region of *L. theobromae* isolates resulted in 550bp amplicons and the sequence information was deposited in GenBank (Accession numbers; MG685854, MG685855 and MG697234).

Fig. 122. Influence of Zineb 68%+Hexaconazole 4%WP on mycelial growth of *Ganoderma* sp. (at AICRP Centre, Arsikere)

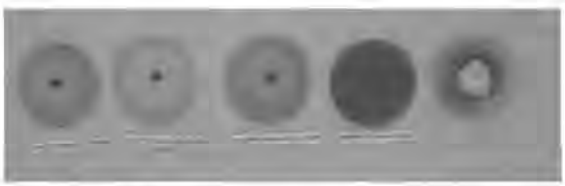
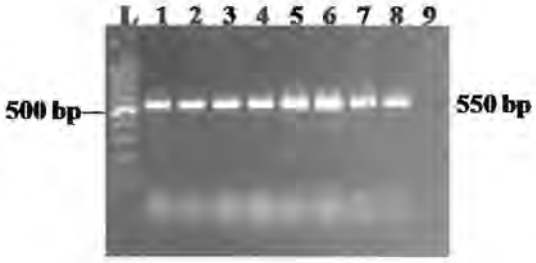


Fig.123. Influence of carbendazim 25%+ Mancozeb 50%WS on mycelial growth of *Thielaviopsis paradoxa* under invitro (at AICRP Centre, Arsikere)



L - 100 bp ladder; Lane 1, 2 - Infected samples from Coimbatore; Lane 3, 4 - Infected samples from Tirupur; Lane 5,6 - Infected samples from Krishnagiri; Lane 7- Positive control (coconut leaf let); 8- Positive control (Cocoa); Lane 9 - Negative control (water)

Fig. 124. PCR amplification of *L. theobromae* by using ITS primers

Pest Management

Incidence of invasive rugose spiraling whitefly, *Aleurodicus rugioperculatus* Martin

At Aliyarnagar centre, studies pertaining to host range, varietal preference and natural enemy fauna of rugose spiraling whitefly (RSW) were carried out and IPM measures were developed to manage the pest. Several host plants were found to harbor different life stages of RSW *viz*., banana, bhendi, sapota, custard apple, citrus, nutmeg, hibiscus and guava. The IPM measures included installation of yellow sticky traps smeared with castor oil @ 10/acre for monitoring the RSW adult population, spraying water forcibly on the under surface of the leaves or spraying with neem based botanicals for inhibiting the growth and development of RSW, release of *Chrysoperla* @ 1000/ha and distribution of coconut leaflets containing parasitized (*Encarsia guadeloupae*) nymphs. Releasing the parasitoids in infested gardens led to drastic decrease in population of RSW from more than 150 adults per leaflet to less than 25 adults per leaflet. Simultaneously the percent of parasitisation by *Encarsia* also increased (over 70% from an initial 10-20%) within a span of six months. The IPM measures were popularized through various awareness meetings and sensitization programmes. A total of 4000 farmers in Coimbatore and Tiruppur districts were provided with *Encarsia* parasitoids. Awareness among the coconut farmers through interactive meetings and awareness-cum-sensitization campaigns to about 1200 farmers led to minimal use of pesticides in the ecosystem while keeping the RSW population under check.

At Ambajipeta centre, RSW was observed in East Godavari, West Godavari and Srikakulam districts of Andhra Pradesh. The parasitoid *E. guadeloupae* was obtained from AICRP on Palms center, Coconut Research Station, Aliyarnagar and released in RSW infested gardens. The parasitoid established successfully in the white fly affected gardens in Kalavalapalli and Chikkala villages of West Godavari district. Leaves containing the parasitized pupae were redistributed to other affected coconut and oil palm gardens. About 40-60 per cent parasitization was observed in the parasitoid released gardens.

At Ratnagiri centre, RSW was observed in RCRS Bhatye and DBSKKV, Dapoli during the month of December 2017. Awareness campaigns against the RSW were organized in Konkan region of Maharashtra and wide publicity was given through newspapers, posters, TV Programme and Radio talk. The State Agriculture Department was also sensitized about the incidence of the new invasive pest. Recorded huge number of coccinellid predators in RSW infested gardens.

At Arsikere centre, surveys revealed the incidence of RSW in Mandya district and Coastal regions of Karnataka (Managalore, Brahmavar and Udupi). The aphelenid parasitoid, *E. guadeloupae*, green lace wings and coccinellids were recorded under RSW infested gardens.

Oil palm

Evaluation of Tenera hybrids

At Pattukkottaii centre, hybrid combinations NRCOP 11 to 20 (planted during 2006), are under evaluation. The fresh fruit bunch (FFB) yield realized during 2017-18 was significantly higher with NRCOP 17 (37.1 t/ha) which was on par with NRCOP 20 (36.0 t/ha).

In another evaluation trial, NRCOP 1 to NRCOP 10 (planted during 2007) were evaluated at different centres. At Mulde centre, hybrid NRCOP-2 recorded significantly higher FFB yield (22.7 t/ha) compared to other hybrids, whereas it was lower in NRCOP-4 (13.7 t/ha). At Vijayarai centre, FFB yield per palm (210.2 kg/palm/year) and FFB yield per hectare (25.9 t/ha) were significantly higher in NRCOP 4, followed by NRCOP 1 and NRCOP 9. At Pattukkottai centre, the hybrid NRCOP 10 recorded significantly higher FFB yield (24.0 t/ha) which was found to be on par with NRCOP 9 (23.5 t/ha).

Fig. 125. Parasitoid distribution by AICRP (Palms) Ambajipeta centre in East Godavari district

Fig. 126. Awareness programme on Rugose spiralling whitefly organised by AICRP (Palms) Aliyarnagar centre at Moongiltholuvu, Tiruppur Dt.

In another evaluation trial, where NRCOP 1 to 10 (planted during 2007) are being evaluated at different centres. At Mulde centre, hybrid NRCOP-2 recorded significantly higher FFB yield (22.7 t/ha) compared to other hybrids, whereas it was lower in NRCOP-4 (13.7 t/ha). At Vijayarai centre, FFB yield per palm (210.2 kg/palm/year) and FFB yield per hectare (25.9 t/ha) were significantly higher in NRCOP 4, followed by NRCOP 1 and NRCOP 9. At Pattukkottai centre, the hybrid NRCOP 10 recorded significantly higher FFB yield (24.0 t/ha) which was found to be on par with NRCOP 9 (23.5 t/ha).

Fig. 127. Bunches of NRCOP 17 (Pattukkottai)

Fig. 128. FFB of NRCOP 4 (Vijayarai)

Meetings held

26th Annual Group meeting of AICRP on Palms

26th Annual Group Meeting of ICAR-AICRP on Palms was held at University of Horticultural Sciences, Bagalkot from 26.07.2017 to 29.07.2017. The programme was inaugurated by Dr. A. K. Singh, DDG (Horticultural Science), Dr. D. L. Maheswar, Vice Chancellor, UHS, Bagalkot presided over the function. Dr. V. Nachegowda, DoR, UHS, Bagalkot welcomed the gathering. Dr. H. P. Maheswarappa, PC (Palms) briefed about the research achievements made during 2016-17 and technologies to be released during the meeting. Dr. P. Chowdappa, Director, ICAR-CPCRI, Kasaragod and Dr. R. K. Mathur, Director, ICAR-IIOPR, Pedavegi graced the occasion. In group meeting about 100 scientists from 13 State Agricultural/ Horticultural Universities, two Central Agricultural Universities and four ICAR

Fig. 129. FFB of NRCOP 2 (Mulde)

institute were participated. During the meeting, 'Palm Jaggery' prepared from fresh inflorescence sap of Palmyrah developed by Pandirimamidi centre was released. A success story on 'Community based approach for biological control of coconut black headed caterpillar outbreak in East Godavari district of Andhra Pradesh' was released along with three

other technical bulletins and fifteen extension folders in local languages from different AICRP centres. Among the 27 AICRP centres, Pattukkottai centre was judged as the best centre based on performance grading. The group meeting deliberated on work done during 2016-17 on different thematic programmes of AICRP and formulated technical programme for 2017-18. The plenary session was held on 28th July 2017 under the chairmanship of Dr. P. Chowdappa, Dr. V. Nachegowda, DoR, Dr. D. R. Patil, ADR and Dr. Vishnuvardhan, ADR, UHS, Bagalkot were present on the occasion. The recommendations made during different sessions were presented by the scientists and Dr. P. Chowdappa presented Best Presentation award to Er. P. C. Vengaiah. Following technologies were recommended for release during the meeting:

1. Improved variety, Kalpa Shatabdi recommended for cultivation in Tamil Nadu for its higher copra content and copra yield.
2. Intercropping of banana, elephant foot yam and pineapple is remunerative during juvenile phase of oil palm cultivation in Konkan region of Maharashtra with additional income of Rs. 80,000/ha/year.
3. Intercropping of cucurbits (ridge gourd, bottle gourd, cucumber and bitter gourd) is remunerative during juvenile phase of oil palm cultivation in West Godavari region of Andhra Pradesh with additional income of Rs. 65,000/ha/year.
4. Soil application of talc based formulation of 125g each of *Trichoderma reesei* and *Pseudomonas fluorescens* + 5 kg of neem cake per palm at yearly interval for the management of basal stem rot disease in coconut.
5. Palmyrah jaggery prepared from inflorescence sap collected by adopting CPCRI method having a shelf life of six months under room temperature recommended for commercial release.

Fig. 130. Address by Dr. A.K. Singh, DDG (H.S.) and release of publication

8 KRISHI VIGYAN KENDRA, KASARAGOD

Major events

Sankalp se Siddhi programme

Sankalp se Siddhi programme and an exhibition was organized on 19th August 2018 at Vorkady with the participation of more than 100 farmers. The oath on New India Manthan was taken by the farmers and dignitaries on the occasion. Lectures by eminent experts, technology demonstrations and an exhibition were conducted. The seven point agenda outlined by the Government of India for doubling farmers income was discussed in detail during the event.

KVK Silver Jubilee celebrations

The KVK Kasaragod celebrated the Silver Jubilee Year of its establishment and the Foundation Day of ICAR-CPCRI by organizing a *Kisan mela*, interface programmes, exhibitions and seminars during 5th to 10th January 2018. Details are provided below.

Paddy Harvest Festival

Frontline demonstration on mechanization in paddy cultivation was carried out in 22 acres of Kottachery and ten acres of Kolavayal padasekharams, employing various farm implements and machineries such as disc plough for tilling the uncultivated paddy fallows, helical blade puddler for churning the soil, and technical advances like mat nursery preparation for raising the paddy seedlings for mechanical transplanting and transplanting using walk behind and riding type transplanters and demonstration of combine harvester for paddy harvesting and straw baler for bundling of straw. Ecological engineering measures for pest management in rice through habitat manipulation by planting nectar providing plants and trap crops were successfully demonstrated. Biological control of paddy leaf folder, *Cnaphalocrocis medulanis* using trichocards was also demonstrated in an area of 22 acres. The use of pink pigmented facultative methylotrophs for management of drought in paddy was also demonstrated in 22 acres in Kottachery padasekharam. Paddy transplanting in Kottachery padasekharam was inaugurated by Adv. Shri. V.S. Sunil Kumar, Hon'ble Minister for Agriculture and Farmers Welfare, Govt. of Kerala on 6th November 2017. The Harvest Festival at Kottachery padasekharam in Kanhangad was inaugurated on 11th March 2018 by Shri Pinarayi Vijayan, Hon'ble Chief Minister of Kerala and was presided over by Shri E. Chandrasekharan, Hon'ble Revenue Minister of Kerala (Fig. 131). The Kolavayal Padasekharam harvest festival was inaugurated by Shri. K. Kunhiraman, Hon'ble MLA of Udma constituency on 29-03-2018.

Fig. 131. Shri Pinarayi Vijayan, Hon'ble Chief Minister of Keralainaugurating the paddy harvest festival at Kottacherry

Field Days

Two Field Days were organized on management of root grubs in arecanut at Udma on 23rd June, 2017 and ecological engineering measures for rice pest management at Vorkady on 21st October, 2017. Around 170 farmers attended the programmes along with civic body functionaries such as panchayat presidents, vice presidents, members and agriculture department officials.

Fig. 132. Demonstration on management of leaf eating black headed caterpillar by release of *Bracon brevicornis* at farmers field in collaboration with Department of Agriculture, Kerala.

Monthly technology advisory meetings

KVK, Kasaragod along with the College of Agriculture, Padannakkad and ATMA provided the farm advisory services regarding various issues related to the pest, disease incidence, nutrient deficiency disorders and other problems faced by farmers during the monthly meetings held at College of Agriculture, Padannakkad.

On farm testing

Six on farm trials were taken up in 24 farmers fields during the year, as listed below.

1. Evaluation of paddy *var.* Shreyas in Kasaragod district
2. Assessment of yard-long bean varieties in Kasaragod district
3. Assessment of coconut water blending with seasonal fruit juices for beverages
4. Assessment of powdery mildew disease management in cucurbitaceous vegetables
5. Eco-friendly management of Rhinoceros beetles in coconut
6. Varietal evaluation of dwarf coconut palm varieties

Frontline demonstrations

Eleven frontline demonstrations(FLDs) including one cluster demonstration under NFSM were undertaken in 88 farmers fields during the year.

1. Ecological engineering measures in rice pest management
2. Demonstration of HYV of Black Pepper variety Thevam
3. Mechanized cultivation of uncultivated fallow paddy lands with heavy machinery
4. Introduction of upland rice variety- Vaisakh
5. Demonstration of micronutrient mixture spray in banana
6. Management of pseudo-stem weevil of banana using cassava bioformulations
7. Introduction of grafted vegetable crops.
8. Demonstration of blast disease management in paddy
9. Ganoderma wilt disease management in coconut
10. Demonstration of scientifically designed cages for backyard poultry
11. Cluster FLD on pulses under NFSM programme

Training

One hundred and nine training programmes were organized during 2017-18 for a total of 3313 participants as detailed below in Table 23.

Table 23. Details of training programmes conducted

Training	No. of programmes	Participants		
		Men	Women	Total
On campus	57	825	858	1683
Off campus	39	753	527	1280
Extension Officials	3	39	78	117
Sponsored	10	96	137	233
Total	**109**	**1713**	**1600**	**3313**

Revolving fund activities

KVK had produced and sold different technology products like 16 kg vegetable seeds, 35,710 nos. of planting materials, 200 kg honey, 110kg mushroom spawn, 2850 rooted pepper cuttings, 4200 nos of earth worms, neem based organic pesticides like NANMA, methyl eugenol traps, cue lure traps and various value added and nutraceutical products during 2017-18 through revolving fund activities.

The total expenditure incurred was Rs.7,73,153/- for various activities generating a revenue of Rs.10,82,524/- during the year. The progressive closing balance of revolving fund as on 31-03-2018 was Rs.15,66,034/-.

Fig. 133. Dr. P. Chowdappa inaugurating the training programme on bee keeping at ICAR-CPCRI, Kasaragod

Externally funded projects

Promotion of Farmer Producer Organization

KVK Kasaragod obtained a funding of 9.06 lakhs from NABARD for the promotion of a farmer producer company. As part of the project, five sensitization programmes were organized at Kasaragod, Parappa, Kuttikol, Choyyamkode and Malakkallu with the participation of around 240 lead farmers. As a producer organization promoting institution (POPI), KVK Kasaragod organized farmers and promoted a farmers producer company " Tulunadu Ecogreen Farmers Producer Company". The company is presently having 70 shareholders with a share capital of 4.5 lakhs. The company has procured 2.5 tonnes of honey from member farmers, processed and marketed it under the brand name " Ecogold Honey" during the year.

Fig. 134. Entrepreneurship development training on food processing for women at KVK, Kasaragod

9 KRISHI VIGYAN KENDRA, ALAPPUZHA

Major events

Sankalp Se Sidhi Programme

Sankalp Se Sidhi -New India Movement 2017-2022' programme was organized on 29.08.2017 to commemorate the 75th anniversary and determination behind Quit India Movement. The programme aimed to propagate the action plan in terms of the seven point programme to double the farmers income by 2022. The pledge on doubling the farmers income by 2022 was also taken by the participants. An overview of the seven point programmes implemented by government of India for the welfare of farmers including *Pradhan Mantri Fasal Bhima Yogana* (PMFBY), *Krishi Sinchayi Yojana,* National Soil Health Card Scheme, e-NAM portal, *Rashrtiya Gokul* Mission, *Paramparya Krishi Vikas Yojana* etc. was presented. The inspirational film was projected for the audience. An agricultural seminar on 'Doubling farmers' income through Integrated Farming Systems' was conducted as part of the programme. An agricultural exhibition on various agricultural technologies was also arranged for the benefit of farmers. About 200 farmers and entrepreneurs actively participated in the programme.

Awareness campaign on Protection of Plant Varieties and Farmers Right's Act

An awareness seminar on 'Protection of Plant Varieties and Farmers' Rights Act' was organized at Kattanam on 21.07.17 for the benefit of the farmers of Onattukara region. The programme was inaugurated by Dr.Jiju.P.Alex, Director of Extension, Kerala Agrl. University in which about 200 farmers of the region attended. Sri.K.Narendran, recipient of the Plant Genome Saviour Award (2013) of the PPV&FR Authority was honored by the chief guest during this programme. An exhibition on different species of medicinal plants was also arranged. Extension booklet and leaflets highlighting the importance of PPV&FR Act and guidelines for registration of farmer varieties were distributed to the participants. The programme was funded by the Protection of Plant Varieties and Farmers' Rights Authority, New Delhi.

Mahila Kisan Diwas

As part of the nationwide celebration of '*Mahila Kisan Divas*', a one day programme was organized on 19.10.2017 with the participation of more than 100 selected woman farmers of the district. The programme was inaugurated by Bharanikkavu Block Panchayath President and Farmer Award winner of Kerala Govt., Smt. Rajani Jayadev Five woman farmers were honored for their significant contributions in the field of crop production, IFS, dairy farming, mushroom cultivation and value addition. *'Payasam'* (*Kheer*) and quiz competitions conducted as part of the celebration drew energetic participation from the farmers and the winners were given prizes. An exhibition of value added products from different entrepreneurs trained and supported by the KVK was arranged on the occasion. Highlight of the one day programme was the enthusiastic and active participation and interaction of all the persons involved.

Fig. 135. Mrs. Rajani Jayadev, Block Panchayath president inaugurating the Mahila Kisan Diwas programme

World Soil Day

The message 'Maintaining the soil and water resources in healthy condition by following good agricultural practices for productivity enhancement and a healthy society' was conveyed to the people in the 'World Soil Day celebrations' organized by the

ICAR-Krishi Vigyan Kendra, Alappuzha in association with Department of Agricultural Development and Farmers' Welfare at Palamel Panchayath Community Hall in Bharanikkavu Block. The Vice President, Palamel Gramapanchayath inaugurated the programme and distributed soil health cards to farmers. Soil health cards were prepared by analyzing representative geo-referenced soil samples from all the six panchayaths of the block in the KVK laboratory. Fertilizer recommendations based on the soil test for the major crops like coconut, banana, tubers, and turmeric were worked out and provided in the soil health cards distributed to 48 farmers of the block (Fig. 136). An awareness talk on 'Good Agriculture practices for healthy soil' was delivered and an 'Interface on Scientific cultivation of Banana and vegetables' was conducted. A total of 135 farmers and officials of Krishi Bhavans of all the panchayaths of Bharanikkavu block attended the programme.

Fig. 136. Distribution of soil health cards on World Soil Day

Live web cast of Prime Minister's address to farmers

Honourable Prime Minister's address to the farmers of the nation on the occasion of Krishi Unnathi Mela and National Conference of KVKs at ICAR-IARI, New Delhi on 17.03.2018 was live web casted for the benefit of about 70 farmers and officials gathered in the KVK. An interface on "Cultivation and value addition of jackfruit" also was arranged on the day.

On Farm Testing

Nine OFTs were taken up during 2017-18 as listed below.

1. Assessment of short duration cassava varieties in coastal plains of Alappuzha district
2. Management of sucking pests in homestead cultivation of solanaceous vegetables
3. Assessing the performance of tomato grafted seedlings against bacterial wilt
4. Assessing the acceptability and keeping quality of *Garcinia cambogia* paste
5. Management of Urolithiasis in goat
6. Assessing the effect of nutrient mix '*Ayar*' in banana cultivation
7. Assessing the performance of short duration cassava varieties in coconut gardens
8. Assessing the effect of border line planting of turmeric in tapioca fields for rodent management
9. Assessing bio-formulations for pseudo stem weevil management in banana

Front Line Demonstrations

Fifteen front line demonstrations were taken up during the year.

1. Demonstration of upland paddy cultivation in coastal sandy soil
2. Demonstration of bush pepper cultivation in homesteads
3. Enhancing productivity of coconut based cropping system through moisture conservation in coastal sandy soils
4. Demonstration of the multi-nutrient mix 'sampoorna' in vegetable cow pea
5. Demonstration on vegetable cultivation in grow bags, with modified growing media and irrigation system for homestead nutritional security
6. Management of stem fly (*Ophiomyi aphaseoli*) in vegetable cowpea
7. Rhizome rot management using PGPR capsule in commercial ginger production
8. Demonstration on Milky mushroom -*Calocyba gambosa*
9. Demonstration of organic manure production from trash fish
10. Demonstration of fish silage feeding in homestead poultry rearing
11. Demonstration of cage culture of pearl spot fish (*Etroplus suratensis*)
12. Demonstration of hydroponics method of fodder production for dairy

Fig. 137. Field day on cluster based integrated pest management practices against mango fruit fly

13. Demonstration of mussel (*Perna viridis)* farming in backwater
14. Demonstration on integrated approach for enhancing profitability of root wilt affected coconut palms
15. Demonstration of cluster based integrated pest management practices against mango fruit fly

Training

One hundred and fourteen training programmes were organized during 2017-18 for a total of 3114 participants as detailed in Table 24.

Entrepreneurship development unit on 'Seedling production of spice crops'

A seedling production unit was established in partnership with Sneham Cultural and Charitable Society, Elippakulam to produce quality planting materials of ginger, turmeric, pepper, vegetables etc for the benefit of shareholders of Onattukara Spices Farmer Producer Company Limited (OSFPCL) promoted by the KVK. The unit was inaugurated by Shri. R Rajesh, MLA on 19.06.2017 in a farmers' meeting at Bharanikkavu Panchayath Community hall (Fig. 138). The meeting was followed by a training programme on scientific spice cultivation. About 100 farmers attended the programme.

Fig. 138. Inauguration of seedling production of spice crops by Shri R. Rajesh, MLA

External funded projects

Onattukkara Spices Farmer Producer Company

The Onattukara Spices Farmer Producer Company Limited (OSFPCL), promoted by the KVK and funded by NABARD, was inaugurated by Sri. G Sudhakaran, Minister of Public works and Registration, Govt. of Kerala in an auspicious function conducted at Kattanam on 21.07.2017. The Minister also released the products of the company viz. turmeric powder and whole pepper, on the occasion. Prof. Vasudevan, President, Bharanikkavu Grama Panchayath, Sri. C. Sundar, CGM, NABARD and many dignitaries attended the function.

A booklet on 'Cultivation and processing of ginger and turmeric' was released on the occasion. About 200 persons, including majority of the shareholder farmers, actively participated in the programme.

The OSFPCL is one among the 105 FPOs in Kerala, incorporated under the Companies Act as part of the Govt. of India's initiative to promote and support farmer's organizations. The company aims to facilitate the farmers of Alappuzha district to increase the profitability of cultivation of major spice crops in the district viz., turmeric, ginger, pepper and Garcinia. With initial focus on six panchayaths of Bharanikkavu block, the company plans to spread its activities to the entire district in due course. About 235 farmers have become share holders of the company with a share capital of Rs. 2.61 lakhs as on date.

National Innovations on Climate Resilient Agriculture (NICRA) (Phase-II)

The project is funded by ICAR and coordinated by ICAR-CRIDA, Hyderabad through ICAR-ATARI, Bengaluru. Technology Demonstration Component of the project is implemented at Thalavady village, Champakulam block, Kuttanad taluk in Alappuzha District by the KVK. The following technology demonstrations are in progress during the year.

Table 24. Details of training programmes organised

Training	No. of programmes	Participants		
		Men	Women	Total
On campus	39	397	526	923
Off campus	72	884	1159	2043
Extension Officials	2	56	12	68
Vocational	2	19	61	80
Total	**114**	**1356**	**1758**	**3114**

Natural resource management

- Large scale composting of aquatic weeds using EM solution and use for vegetable cultivation in grow bags.
- Soil health card for better nutrient management.

Crop production

- Resource conserving and eco friendly management practices in paddy cultivation.
- Tissue culture banana growing in grow bags in early stage of growth to avoid crop loss by water logging and subsequent field planting for better establishment
- Climate resilient integrated crop management practices in coconut
- Improving nutritional security and income through mushroom cultivation

Livestock & Fisheries

- Climate resilient practices in dairy farming
- Housing of poultry in slatted floor, feeding and disease control measure programme
- Year round fodder production
- Demonstration of fish silage feed supplement for backyard poultry rearing during flooded situations
- Demonstration of low cost fodder sprouts production
- Fabrication of goat shed with raised platform

Enhancing economic viability of coconut based land use systems for land use planning in Kerala state

KVK implements the demonstration component of this Kerala State Planning Board funded project at Chettikulangara, representing the Onattukara Sandy soils (AEU-3) and Mayyanad panchayath representing Southern Coastal Plains (AEU-1). Started in April, 2015, the project aims at increasing the returns from coconut based land use system through increasing productivity of coconut palms by improving the soil health through organic residue recycling and soil test based nutrient management. Management practices including soil test based fertilizer application in two splits, prophylactic plant protection measures, and recording of yield and related observations are being taken up.

Revolving fund activities of KVK

Different inputs were made available to the farmers of the district (as resource centre) through revolving fund activities *viz.*, methyl euginol and cue lure traps, seeds and seedlings, layer chicks, mushroom spawn, micronutrient fertilizers, azolla, bio-agents, EM solution, grow bags etc. The progressive closing balance of revolving fund as on 31.03.18 is Rs.25,88,222/-

VII PUBLICATIONS

Research Articles

Ambili, K., George V. Thomas, Murali Gopal and Alka Gupta. 2017. Influence of crop combinations and soil factors on diversity and association of arbuscular mycorrhizal fungi in arecanut based cropping systems. *Journal of Plantation Crops,* **45**(1): 20-32.

Anithakumari, P. and Chandrika Mohan. 2017. Impact of Farmer Field Schools (FFS) in coconut crop in Kerala State: Gender Based Knowledge Analysis. *Indian Research Journal of Extension Education*, **17**(4): 1-7.

Anithakumari, P., Muralidharan, K. and Chandran, K.P. 2017. Red palm weevil incidence: Spatial pattern and implication in technology adoption. *Journal of Plantation Crops*, **45**(2): 101-109.

Arivalagan, M., Manikantan, M.R., Yasmeen, A.M., Sreejith, S., Balasubramanian, D., Hebbar, K.B. and Kanade, S.R. 2018. Physiochemical and nutritional characterization of coconut (*Cocos nucifera* L.) haustorium based extrudates. *LWT - Food Science and Technology,* **89**: 171-178.

Arivalagan, M., Roy, T.K., Yasmeen, A.M., Pavithra, K.C., Jwala, P.N., Shivasankara, K.S., Manikantan, M.R., Hebbar, K.B. and Kanade, S.R. 2018. Extraction of phenolic compounds with antioxidant potential from coconut (*Cocos nucifera* L.) testa and identification of phenolic acids and flavonoids using UPLC coupled with TQD-MS/MS. *LWT - Food Science and Technology,* **92**: 116126

Bhagya, H.P., Maheswarappa, H.P., Surekha and Bhat, R. 2017. Carbon sequestration potential in coconut based cropping systems. *Indian Journal of Horticulture,* **74**(1): 1-5.

Borgia, M.N., Josephrajkumar, A. and Miranda, M.T.P. 2017. Bio control potential of *Heterorhabditis indica* against the maggot of *Bactrocera cucurbitae* (Diptera: Tephritidae). *Entomon*, **42**(1): 69-74.

Chaturvedi, V.K., Hebbar, K.B., Chandran, K.P., Thomas, R.J, Shareefa, M., Nampoothiri, C.K. and Jinu, S. 2017. Influence of temperature, germination duration and cultivar on *in vitro* pollen germination and pollen tube growth in coconut (*Cocos nucifera* L.). *International Journal of Advanced Research,* **5(5)**: 544-551.

Chowdappa, P., Muralidharan, K. and Rajesh, M.K. 2017. Rejuvenating coconut sector for improving livelihood security. *Current Science,* **112**(12): 2359-2360.

Devakumar, K., Neema, M., Aparna, V., Krishna Prakash, Gangaraj, K.P. and Anitha Karun. 2017. An improved device for coconut embryo extraction. *Journal of Plantation Crops,* **45(3)**: 197-199.

Devakumar, K., Arumuganathan, T., Thomas, R.J., Niral, V., Anitha Karun and Chowdappa, P. 2018. A cost-effective ground pollination system for hybridization in tall coconut palms. *Current Science*, **114 (5)**: 964-970.

Elain Apshara, S. 2017. Comparative study on clonal and seedling progenies of selected cocoa genotypes. *Indian Journal of Horticulture*, **74(2):**168-172.

Govindasamy, V., George, P., Aher, L., Ramesh, S.V., Thangasamy, A., Anandan, S., Raina, S.K., Kumar, M., Rane, J., Annapurna, K. and Minhas, P.S. 2017. Comparative conventional and phonemics approaches to assess symbiotic effectiveness of Bradyrhizobia strains in soybean (*Glycine max* L. Merrill) to drought. *Nature-Scientific Reports*. DOI:10.1038/s41598-017-06441-3.

Harisha, C.B., Diwakar, Y., Aishwath, O.P., Singh, R. and Asangi, H. 2017. Soil fertility and micronutrient uptake by fennel (*Foeniculum vulgare* Mill.) as influenced by micronutrients fertilization. *Environment and Ecology*, **35**(1B): 514-518.

Hebbar, K.B., Pandiselvam, R., Manikantan, M.R., Arivalagan, M., Shameena Beegum and Chowdappa, P. 2018. Palm sap-quality profiles, fermentation chemistry, and preservation methods. *Sugar Tech*, DOI: 10.1007/s12355-018-0597-z.

Jeena Mathew, Krishnakumar, V., Merin Babu, Josephrajkumar, A., Anithakumari, P. and Namboothiri, C.G.N. 2017. Soil characteristics and plant nutrient status in the root (wilt) affected areas of humid tropics. *Ecology, Environment& Conservation*, **23**: 1181-1188.

Jeena Mathew., Krishnakumar V., Nampoothiri, C.K., Kumar, V. and Namboothiri, C.G.N. 2017. Dynamics and nutrient release pattern of silica sources in a typical entisol of tropical humid region of kerala. *Communications in Soil Science and Plant Analysis*, **48**: 2256-2267.

Jerard, B.A., Rajesh, M.K., Thomas, R.J., Niral, V. and Samsudeen, K. 2017. Island ecosystems host rich diversity in coconut (*Cocos nucifera*): Evidences from Minicoy Island, India. *Agricultural Research (Springer)*, **6**(3): 214-226. DOI 10.1007/s40003-017-0264-8.

Jha, U.C., Jha, R., Singh, N.P., Shil, S. and Kole, P.C. 2018. Heat tolerance indices and their role in selection of heat stress tolerant chickpea (*Cicer arietinum*) genotypes. *Indian Journal of Agricultural Sciences*, **88(2)**: 260-267.

Josephrajkumar, A., Chandrika Mohan, Poorani, J., Merin Babu, Daliyamol, Krishnakumar, V., Vinayaka Hegde and Chowdappa, P. 2018. Discovery of a sooty mould scavenging beetle, *Leiochrinus nilgirianus* Kaszab (Coleoptera: Tenebrionidae) on coconut palms infested by the invasive rugose spiralling whitefly, *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae). *Phytoparasitica*, DOI: 10.1007/s12600-017-0635-5.

Karun, A., Sajini, K.K., Muralikrishna, K.S., Rajesh, M.K. and Engelmann, F. 2017. Cryopreservation of arecanut (*Areca catechu* L.) pollen. *CryoLetters*, **38(6)**: 463-470.

Karun, A., Sajini, K.K., Rajesh, M.K., Muralikrishna, K.S., Samsudeen, K., Ajith Kumar, P. and Nagwekar, D.D. 2017. *In vitro* retrieval via embryo rescue of 'Mohachao Narel', a sweet endosperm coconut from Maharashtra. *International Journal of Innovative Horticulture*, **6:** 147-150.

Kumar Arvind, Rahul, C.U., Merin Babu, Tony Grace and Rajesh, M.K. 2017. Comparative secretome prediction and analysis of two *Phytophthora* spp. *Research Journal of Biotechnology*, **12**: 10-16.

Mahesh, V., Swathi Lakshmi, P.S., Dilip Ananda Pawar, Daliyamol, Alok Kumar and Prakash, P. 2017. Matrix ranking: An important PRA tool to assess farmer's preferences and priorities. *Agricultural Science Digest*, **37**(2):100-105.

Moyo, L., Ramesh, S.V., Kappagantu, M., Mitter, N., Sathuvalli, S. and Pappu, H.R. 2017. The effects of potato virus Y-derived virus small interfering RNAs of three biologically distinct strains on potato transcriptome. *Virology Journal*, **14**: 129 https://doi.org/10.1186/s12985-017-0803-8.

Murali Gopal, Shrikant S. Bhute, Alka Gupta, Prabhu, S. R.,George V. Thomas, Whitman, W. B. and Jangid, K. 2017. Changes in structure and function of bacterial communities during coconut leaf vermicomposting. *Antonie van Leeuwenhoek*, **110**: 1339-1355.

Muralikrishna, K.S., Rajesh, M.K., Sajini, K.K., Nagaraja, N.R., Ananda, K.S. and Karun, A. 2017. Immature embryo culture in wild *Areca* spp. *International Journal of Innovative Horticulture*, **6**: 79-83.

Neenu, S., Ramesh, K., Ramana, S. and Somasundaram, J. 2017. Effect of cultivars and sowing dates on nutrient uptake and yield of chickpea under aberrant climatic conditions in black coils of Central India. *Advances in Research*, **12**(4): 1-11.

Nihad, K., Krishnakumar, V. and Haris, A.A. 2017. Marigold-globe amaranth sequential cropping in coconut plantations of coastal humid tropics. *Journal of Plantation Crops*, **45**:121-128.

Nihad, K., Krishnakumar, V. and Sheela, V.L. 2018. Relationship between stress and flowering in heliconia (*Heliconia stricta*). *International Journal of Agriculture Sciences*, **10**: 5137-5139.

Pandiselvam, R., Chandrasekar, V. and Thirupathi, V. 2017. Numerical simulation of ozone concentration profile and flow characteristics in paddy bulks. *Pest Management Science,* **73**: 16981702.

Pandiselvam, R., Kothakota, A., Thirupathi, V., Anandakumar, S. and Krishnakumar, P. 2017. Numerical simulation and validation of ozone concentration profile in green gram (*Vigna radiata*) bulks. *Ozone: Science & Engineering*, **39**(1): 54-60.

Pandiselvam, R., Sunoj, S., Manikantan, M.R., Anjineyulu Kothakota and Hebbar, K.B. 2017. Application and kinetics of ozone in food preservation. *Ozone: Science and Engineering*, **39**(2): 115-126.

Pandiselvam, R., Thirupathi, V., Chandrasekar, V., Kothakota, A. and Anandakumar, S. 2017. Numerical simulation and validation of mass transfer process of ozone gas in rice grain bulks. *Ozone: Science & Engineering*, **40**: 191-197.

Patil, J., Rajkumar and Subhaharan, K. 2016. Survival of earthworms exposed to the entomopathogenic nematodes *Steinernema carpocapsae* and *Heterorhabditis indica. Indian Journal of Nematology, 46: 33-39.*

Prathibha, P.S., Subaharan, K. and Kumar, A.R.V. 2017. Toxicity and dissipation of soil insecticides applied in the management of arecanut white grub, *Leucopholis burmeisteri* Brenk. (Coleoptera: Scarabaeidae). *Phytoparasitica,* **45**: 155-163.

Prathibha, V.H., Hegde, V., Sharadraj, K.M. and Chowdappa, P. 2017. First report of *Lasiodiplodia theobromae* causing apple and immature nut rots on cashew in India. *Journal of Plant Pathology,* **9**: 287-304.

Rajesh, M.K., Rachana, K.E., Kulkarni, K., Sahu, B.B., Thomas R.J. and Karun A. 2017. Comparative transcriptome profiling of healthy and diseased Chowghat Green Dwarf coconut palms from root (wilt) disease hot spots. *European Journal of Plant Pathology, **151**: 173-193.*

Ramesh, S.V., Chouhan, B.S., Gaurav, K., Praveen, S. and Chand, S. 2017. Expression dynamics of *Glycine max* (L.) Merrill derived microRNAs (miRNAs) and their targets during mung bean yellow mosaic India virus (MYMIV) infection. *Physiological and Molecular Plant Pathology*, **100**: 13-22.

Ramesh, S.V., Chouhan, B.S., Gupta, G.K., Husain, S.M. and Chand, S. 2017. Genomic sequence characterization of begomovirus infecting soybean and molecular evolutionary genomics of legume yellow mosaic viruses (LYMVs). *Plant Omics Journal*, **10**: 88-96.

Ramesh, S.V., Sahu, P.P., Prasad, M., Praveen, S. and Pappu, H.R. 2017. Geminiviruses and plant hosts: A closer examination of the molecular arms race. *Viruses*, **9**: 256. DOI 10.3390/v9090256

Ramesh, S.V., Williams, S., Kappagantu, M., Mitter N. and Pappu, H.R. 2017. Transcriptome-wide identification of host genes targeted by tomato spotted wilt virus-derived small interfering RNAs. *Virus Research*, **238**: 1323.

Sabana, A.A., Ginny Antony, Rahul, C.U. and Rajesh M.K. 2018. *In silico* identification of miRNAs and their targets associated with coconut embryogenic calli. *Agri Gene,* 7**:** 59-65.

Samsudeen, K., Rajesh, M.K., Sreejisha, P., Nirmala, A., Ranjith, L.M.R. and Deepa, K. 2017. Coconut artificial pollination management system. *Current Science*, **112**: 1325-1326.

Shameena Beegum, Monika Sharma, Manikantan, M.R. and Gupta, R.K. 2017. Effect of virgin coconut oil cake on physical, textural, microbial and sensory attributes of muffins. *International Journal of Food Science and Technology*, **52**: 540-549.

Shameer, K.S., Nassaer, M., Chandrika Mohan and Ian C.W. Hardy. 2017. Direct and indirect influence of intercrops on the coconut defoliator *Opisina arenosella. Journal of Pest Science*, **91**: 259-275.

Shivaji Hausrao Thube, R., Pandian, T.P., Bhavishya, Saneera, E.K., Mohan, C. and Nagaraja, N.R. 2017. Major storage insect pests of Arecanut *Areca catechu* L. - A Survey. *Journal of Entomology and Zoology studies*, **5**: 1471-1475.

Sivakumar, T., Josephrajkumar, A. and Anitha, N. 2017. First report of tomato pinworm, *Tuta absoluta* (Meyrick) on egg plant *Solanam melongena* L. from Kerala, India. *Entomon,* **42**: 335-338.

Srinivasan, T., Saravanan, P.A., Josephrajkumar, A., Rajamanickam, K., Sridharan, S., David, P.M.M., Natarajan, N and Shoba, N. 2016. Invasion of the rugose spiraling whitefly, *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae) in Pollachi tract of Tamil Nadu, India. *Madras Agricultural Journal*, **103**: 349-353.

Sujatha, S. Bhat, R. and Chowdappa, P. 2017. Status of arecanut production systems in India. *International Journal of Innovative Horticulture*, **6**: 7-24.

Books

Chowdappa, P., Manojkumar, T.S., Leena, S. and John George 2017. 25 years of ICAR Krishi Vigyan Kendra Kasaragod A Journey with the Farmers. ICAR-CPCRI, Kasaragod. 164p.

Maheswarappa, H.P. and Jilu, V.S. 2017. Proceedings of the *XXVI Annual Group Meeting and Technical Programme for 2017-18 of ICAR-All India Coordinated Research Project on Palms*. ICAR-AICRP on Palms, ICAR-CPCRI, Kasaragod. 84p.

Book Chapters

Alka Gupta and Murali Gopal. 2017. Root growth promoting rhizobacteria for biotic stress management. *In*: Training Manual on Breeding for Resistance to Pest and Diseases in Plantation Crops (*Eds*. Thomas, R.J., Josephrajkumar, A., Shareefa, M. and Rajesh, M.K.). ICAR-CPCRI, Kayamkulam, Kerala. pp. 245-250.

Anandha, K.S. 2017. Genetic resources and improvement of arecanut with special emphasis on resistance breeding. *In*: Training Manual on Breeding for Resistance to Pest and Diseases in Plantation Crops (*Eds*. Thomas, R.J., Josephrajkumar, A., Shareefa, M. and Rajesh, M.K.). ICAR-CPCRI, Kayamkulam, Kerala. pp. 113-119.

Ananda, K.S., Anitha Karun and Parthasarathy, V.A. 2017. Arecanut. *In:* Breeding of Horticultural Crops Vol I- Part B: Spices and Plantation Crops (*Eds*. Parthasarathy, V.A., Aswath, C., Nirmal Babu, K. and Senthil Kumar, R.). Today & Tomorrow's Printers and Publishers, New Delhi-110 002, India. pp. 569-589.

Anitha Karun, Rajesh, M.K., Muralikrishna, K.S. and Sajini, K.K. 2017. Tissue culture techniques for production of disease-free planting materials in plantation crops *In*: Training Manual on Breeding for Resistance to Pest and Diseases in Plantation Crops (*Eds*. Thomas, R.J., Josephrajkumar, A., Shareefa, M. and Rajesh, M.K.). ICAR-CPCRI, Kayamkulam, Kerala. pp. 19-46.

Arunachalam, V.A. and Rajesh, M.K. 2017. Coconut genetic diversity, conservation and utilization. *In:* Biodiversity and Conservation of Woody Plants (*Eds*. Ahuja, M. R., Jain, S. M.). Springer International Publishing. pp. 3-36.

Berwal, M.K., Kumar. M., Prakash. K., Rai, G.K. and Hebbar, K.B. 2017. Antioxidant defense system in plants against abiotic stress. *In*: Abiotic Stress Tolerance Mechanism in Plants (*Eds*. Rai, G.K., Kumar, R.R. and Bagati, S.). Narendra Publishing House, New Delhi, India. pp. 75-202.

Chandrika Mohan, Josephrajkumar, A. and Anes, K.M. 2017. Integrated pest management with emphasis on biological control. *In*: Training Manual on Breeding for Resistance to Pest and Diseases in Plantation Crops (*Eds*. Thomas, R.J., Josephrajkumar, A., Shareefa, M. and Rajesh, M.K.). ICAR-CPCRI, Kayamkulam, Kerala. pp. 55-67.

Chowdappa, P. 2017. Genome sequencing and its applications in plantation crops. *In*: Training Manual on Breeding for Resistance to Pest and Diseases in Plantation Crops (*Eds*. Thomas, R.J., Josephrajkumar, A., Shareefa, M. and Rajesh, M.K.). ICAR-CPCRI, Regional Station, Kayamkulam.). ICAR-CPCRI, Kayamkulam, Kerala. pp. 9-15.

Chowdappa, P., Hegde, V., Chaithra, M. and Prathibha, P.S. 2017. Cocoa. *In*: Diseases, Pests and Disorders of Plantation Crops (*Ed*. Chowdappa, P.). Today and Tomorrow Publishers, New Delhi. pp. 113-134.

Chowdappa, P., Hegde, V., KrishnaKumar, V., Josephrajkumar, A., Chandrika Mohan., Prathibha, P.S., Prathibha, V.H., Merin Babu. and Rajkumar. 2017. Coconut. *In*: Diseases, Pests and Disorders of Plantation Crops (*Ed*. Chowdappa,

P.). Today and Tomorrow Publishers, New Delhi. pp. 1-17.

Chowdappa, P., Hegde, V., Prathibha, V.H., Prathibha, P.S., Sujatha, S. and Bhat, R. 2017. Arecanut. *In*: Diseases, Pests and Disorders of Plantation Crops (*Ed.* Chowdappa, P.). Today and Tomorrow Publishers, New Delhi. pp.73-111.

Elain Apshara, S. 2017. Genetic resources and improvement of cocoa. *In*: Training Manual on Breeding for Resistance to Pest and Diseases in Plantation Crops (*Eds*. Thomas, R.J., Josephrajkumar, A., Shareefa, M. and Rajesh, M.K.). ICAR-CPCRI, Kayamkulam, Kerala. pp. 180-193.

Elain Apshara, S. 2018. Cocoa genetic resources management and improvement. *In*: Training Manual on Cocoa Production Technology (*Eds*. Chowdappa, P., Apshara, S.E., Nagaraja, N.R. and Ananda, K.S.). ICAR-CPCRI, Kasaragod. pp. 18-31.

Elain Apshara, S., Balasimha, D. and Parthasarathy, V.A. 2017. Cocoa. *In:* Breeding of Horticultural Crops Vol I- Part B: Spices and Plantation Crops. (*Eds*. Parthasarathy, V.A., Aswath, C., Nirmal Babu, K. and Senthil Kumar, R.). Today & Tomorrow's Printers and Publishers, New Delhi-110 002, India. pp. 591-631.

Hebbar, K.B. and Ramesh, S.V. 2017. Physiological basis of resistance to biotic stress. *In*: Training Manual on Breeding for Resistance to Pest and Diseases in Plantation Crops. (*Eds*. Thomas, R.J., Josephrajkumar, A., Shareefa, M. and Rajesh, M.K.). ICAR-CPCRI, Regional Station, Kayamkulam. pp. 105-112.

Hegde, V. and Prathibha, V.H. 2017. *In*: Diseases of Commercial Crops in India (*Eds*. Gautam, H.R and Gupta, S.K.). Y.S. Parmar University of Horticulture, Nauni Solan, Himachal Pradesh, India, pp 407-432.

Jaganathan, D., Nagaraja, N.R., Jose, C.T., Rajkumar and Thamban, C. 2017. Participatory technology transfer-success story of arecanut based cropping system. *In*: Training Manual on Participatory Technology Transfer Approaches for Plantation Crops (*Eds*. Thamban, C. and Chandran, K.P.). ICAR-CPCRI, Kasaragod, Kerala. pp. ***139-155.***

Josephrajkumar, A. Chandrika Mohan and Anes, K.M. 2017. Innovative approaches in pest management in plantation crops. *In*: Training Manual on Breeding for Resistance to Pest and Diseases in Plantation Crops (*Eds*. Thomas, R.J., Josephrajkumar, A., Shareefa, M. and Rajesh, M.K.). ICAR-CPCRI, Kayamkulam, Kerala. pp. 232-244.

Krishnakumar, V. 2017. Role of nutrition in management of biotic stress in plantation crops. *In*: Training Manual on Breeding for Resistance to Pest and Diseases in Plantation Crops (*Eds*. Thomas, R.J., Josephrajkumar, A., Shareefa, M. and Rajesh, M.K.). ICAR-CPCRI, Kayamkulam, Kerala. pp. 194-201.

Krishnakumar, V. 2017. "Sastreeya krishippanimurakal (Malayalam)." *In*: Thengu enna kalpa vriksham (*Ed*. Elizbeth George). Farm Information Bureau, Thiruvananthapuram. pp. 9-28.

Krishnakumar, V. 2017. "Thengu enna kalpaviksham (Malayalam)". *In*: Thengu enna kalpaviksham (*Ed*. Elizbeth George). Farm Information Bureau, Thiruvananthapuram. pp. 6-10.

Manikantan, M.R., Shameena Beegum, Pandiselvam, R. and Hebbar, K.B. 2018. Entrepreneurship oriented processing and value addition technologies of coconut. *In*: Entrepreneurship and Skill Development in Horticultural Processing (*Eds*. Sudheer, K.P. and Indira, V.), New India Publishing Agency, New Delhi. pp. 237-268.

Manikantan, M.R., Shameena Beegum, Pandiselvam, R. and Hebbar, K.B. 2018. Scope of entrepreneurship development in non-edible value added products of coconut. *In:* Entrepreneurship and Skill Development in Horticultural Processing (*Eds*. Sudheer, K.P. and Indira, V.), New India Publishing Agency, New Delhi. pp. 269-293.

Merin Babu, Rajeev, G. and Vinayaka Hegde (2017) Screening techniques for evaluation of disease resistance. *In*: Training Manual on Breeding for Resistance to Pest and Diseases in Plantation Crops (*Eds*. Thomas, R.J., Josephrajkumar, A.,

Shareefa, M. and Rajesh, M.K.). ICAR-CPCRI, Kayamkulam, Kerala. pp. 140-144.

Meena, B.P., Ramesh, K., Neenu, S., Jha, P. and Rashmi, I. 2017. Controlled release fertilizers for enhancing nitrogen use efficiency. *In:* Enhancing Nutrient Use Efficiency: Concepts, Methods and Management Interventions (*Eds. Ramesh, K., Biswas, A.K., Lakaria, B.L., Srivastava, S. and Patra, A.K.).* New India Publishing Agency, New Delhi. pp. 59-79.

Murali Gopal and Alka Gupta. 2017. Application of metagenomics in crop health management. *In*: Training Manual on Breeding for Resistance to Pest and Diseases in Plantation Crops (*Eds.* Thomas, R.J., Josephrajkumar, A., Shareefa, M. and Rajesh, M.K.). ICAR-CPCRI, Kayamkulam, Kerala. pp. 176-179.

Naduthodi, N. 2018. Cocoa production technology. *In*: Training Manual on Cocoa Production Technology (*Eds.* Chowdappa, P., Apshara, S.E., Nagaraja, N.R. and Ananda, K.S.). ICAR-CPCRI, Kasaragod. pp. 43-48.

Naduthodi, N., Suchithra, M. and Elain Apshara, S. 2018. Processing methods and products of cocoa. *In*: Training Manual on Cocoa Production Technology (*Eds.* Chowdappa, P., Apshara, S.E., Nagaraja, N.R. and Ananda, K.S.). ICAR-CPCRI, Kasaragod. pp. 49-58.

Nagaraja, N.R. and Ananda, K.S. 2018. Six decades of service of ICAR-CPCRI, Vittal. *In*: Training Manual on Cocoa Production Technology (*Eds.* Chowdappa, P., Apshara, S.E., Nagaraja, N.R. and Ananda, K.S.). ICAR-CPCRI, Kasaragod, Kerala. pp. 1-9.

Nagaraja, N.R. and Jose, C.T. 2018. Cocoa development strategies. *In*: Training Manual on Cocoa Production Technology (*Eds.* Chowdappa, P., Apshara, S.E., Nagaraja, N.R. and Ananda, K.S.). ICAR-CPCRI, Kasaragod, Kerala. pp. 93-100.

Nair, R.V. and Thomas, R.J. 2017. Host plant resistance: Concepts and definitions. *In*: Training Manual on Breeding for Resistance to Pest and Diseases in Plantation Crops (*Eds.* Thomas, R.J., Josephrajkumar, A., Shareefa, M. and Rajesh, M.K.). ICAR-CPCRI, Regional Station, Kayamkulam.). ICAR-CPCRI, Kayamkulam, Kerala. pp. 16-18.

Niral, V. 2017. Mapping strategies for improvement of plantation crops. *In*: Training Manual on Breeding for Resistance to Pest and Diseases in Plantation Crops (*Eds.* (*Eds.* Thomas, R.J., Josephrajkumar, A., Shareefa, M. and Rajesh, M.K.). ICAR-CPCRI, Regional Station, Kayamkulam. pp. 202-211.

Niral, V., Rajesh, M.K. and Parthasarathy, V.A. 2017. Coconut. *In:* Breeding of Horticultural Crops Vol I- Part B: Spices and Plantation Crops. (*Eds.* Parthasarathy, V.A., Aswath, C., Nirmal Babu, K. and Senthil Kumar, R.). Today & Tomorrow's Printers and Publishers, New Delhi- 110 002, India. pp. 445- 506.

Praveen, S., Ramesh, S.V. and Mangrauthia, S.K. 2017. Transgenic approaches to combat plant viruses occurring in India. *In*: A Century of Plant Virology in India (*Eds.* Bikash Mandal *et al.*). Springer Nature Singapore Pvt. Ltd. pp 783-805.

Rajesh, M.K. Ramesh, S.V. and Anitha Karun. 2017. Transcriptome analysis to decipher mechanisms underlying resistance to diseases in plantation crops. *In*: Training Manual on Breeding for Resistance to Pest and Diseases in Plantation Crops (*Eds.* Thomas, R.J., Josephrajkumar, A., Shareefa, M. and Rajesh, M.K.). ICAR-CPCRI, Kayamkulam, Kerala. pp. 145-151.

Rashmi, I., Biswas, A.K., Neenu, S., Meena, B.P. and Shinogi, K.C. 2017. Improving Phosphorus Use Efficiency. *In:* Enhancing Nutrient Use Efficiency: Concepts, Methods and Management Interventions (Eds. Ramesh, K., Biswas, A.K., Lakaria, B.L., Srivastava, S. and Patra, A.K.). New India Publishing Agency, New Delhi. pp. 123-140.

Samsudeen, K. 2017. Genetic resources and improvement of coconut. *In*: Training Manual on Breeding for Resistance to Pest and Diseases in Plantation Crops (*Eds.* Thomas, R.J., Josephrajkumar, A., Shareefa, M. and Rajesh, M.K.). ICAR-CPCRI, Regional Station, Kayamkulam.). ICAR-CPCRI, Kayamkulam, Kerala. pp. 75-83.

Suchithra, M. 2018. Planting material production in cocoa. *In*: Training Manual on Cocoa Production Technology (*Eds.* Chowdappa, P., Apshara, S.E., Nagaraja, N.R. and Ananda, K.S.). ICAR-CPCRI, Kasaragod. pp. 32-42.

Thomas, R.J. and Shareeefa, M. 2017. Breeding for resistance to diseases and pests in coconut. *In*: Training Manual on Breeding for Resistance to Pest and Diseases in Plantation Crops (*Eds*. Thomas, R.J., Josephrajkumar, A., Shareefa, M. and Rajesh, M.K.). ICAR-CPCRI, Kayamkulam, Kerala. pp.164-175.

Vinayaka Hegde, Prathibha, V.H., and Merin Babu. 2017. Disease management in plantation crops. *In*: Training Manual on Breeding for Resistance to Pest and Diseases in Plantation Crops (*Eds*. Thomas, R.J., Josephrajkumar, A., Shareefa, M. and Rajesh, M.K.). ICAR-CPCRI, Kayamkulam, Kerala. pp. 212-231.

Technical Bulletins

Alka Gupta and Sreelatha, K. 2017. Invasive rugose spiralling whitefly on coconut (in Hindi). (*Eds*. Chandrika Mohan., Josephrajkumar, A., Merin Babu., Prathibha, P.S., Krishnakumar, V., Hegde, V. and Chowdappa, P.) Technical Bulletin No. 123, Centenary Series 60. ICAR-CPCRI, Kasaragod. 16p.

Alpana Das. 2018. Chocolate Khetir Mahili Panji (Cocoa Calendar in Assamese).

Alpana Das. 2018. Tamul Khetir Mahili Panji (Arecanut Calendar in Assamese).

Bhanuprakash, K. and Chowdappa, P. 2017. Invasive rugose spiralling whitefly on coconut (in Telugu). (*Eds*. Chandrika Mohan, Josephrajkumar, A., Merin Babu, Prathibha, P.S., Krishnakumar, V., Hegde, V. and Chowdappa, P.). Technical Bulletin No. 120, Centenary Series 60. ICAR-CPCRI, Kasaragod. 16p.

Bhavishya and Nagaraja, N.R. and Ananda, K.S. 2017. Adike Krushi Paddathigalu (in Kannada). Technical Bulletin No. 118 (Centenary Series No. 61). ICAR-CPCRI, Kasaragod, Kerala. 34p.

Chandrika Mohan, Josephrajkumar, A., Merin Babu, Prathibha, P.S., Krishnakumar, V., Hegde, V. and Chowdappa, P. 2017. Invasive rugose spiralling whitefly on coconut. Technical Bulletin No. 117, Centenary Series 60. ICAR-CPCRI, Kasaragod. 16p.

Chowdappa, P., Muralikrishna, H. and Mathew, A.C. 2018. Entrepreneur and farmer friendly technologies (in Hindi). Technical Bulletin No. 119. ICAR-CPCRI, Kasaragod. 40p.

Hegde, V., Shivakumar Magada. and Muralikrishna, H. 2017. Invasive rugose spiralling whitefly on coconut (in Kannada). (*Eds*. Chandrika Mohan, Josephrajkumar, A., Merin Babu., Prathibha, P.S., Krishnakumar, V., Hegde, V. and Chowdappa, P.). Technical Bulletin No. 125, Centenary Series 60. ICAR-CPCRI, Kasaragod. 16p.

Josephrajkumar,A., Prathibha, P.S., Merin Babu., Chandrika Mohan., Hegde, V., Krishnakumar, V. and Chowdappa, P. 2017. Red palm weevil in coconut: Knack to crack Trajectory. ICAR-CPCRI, Regional Station, Kayamkulam. 28p.

Prathibha, P.S., Chandrika Mohan, Jilu V. Sajan and Merin Babu. 2017. Invasive rugose spiralling whitefly on coconut (in Malayalam).. (*Eds*. Chandrika Mohan., Josephrajkumar, A., Merin Babu, Prathibha, P.S., Krishnakumar,V., Hegde, V. and Chowdappa, P.). Technical Bulletin No. 124, Centenary Series 60. ICAR-CPCRI, Kasaragod. 16p.

Ravi Bhat. and Surekha, R. 2017. Tengu (in Kannada). (*Eds*. Subramanian, P. and Thamban, C.). Technical Bulletin No. 116. ICAR-CPCRI, Kasaragod. 42p.

Sujithra, M. 2017. Invasive rugose spiralling whitefly on coconut (in Tamil). (*Eds*. Chandrika Mohan., Josephrajkumar, A., Merin Babu., Prathibha, P.S., Krishnakumar, V., Hegde, V. and Chowdappa, P.). Technical Bulletin No. 121, Centenary series 60. ICAR-CPCRI, Kasaragod. 16p.

Thamban, C., Mathew, A.C. and Chandran, K.P. 2017. Tengu Krishi Reethikal. Technical Bulletin No. 119. ICAR-CPCRI, Kasaragod. p42. (In Malayalam).

Papers presented in Seminars/ Symposia/ Conferences/ Workshops

Anes, K.M., Josephrajkumar, A., Merin Babu, Nihad, K., Indhuja, S., Jeena Mathew, Shareefa, M. and Krishnakumar, V. 2018. *Mastering farming through Marvelous Microbes. In*: Proceedings of one-day workshop on "Harnessing Bio-agents for Sustainable Soil and Palm Health". ICAR-CPCRI, Regional Station, Kayamkulam. p48.

Jeena Mathew, Krishnakumar, V. and Abdul Haris, A. 2017. Impact of silicates on the growth of coconut seedlings. *In*: Proceedings of the "7th International

Conference on Silicon in Agriculture". 24-28 October, 2017, Bengaluru, Karnataka. p133.

Jilu, V.S., Sharma, K., Subramanian, S. and Prathibha, P.S. 2017. Attractancy potential of symbiotic bacteria isolated from laboratory reared and wild population of melon fruit fly (Diptera: Tephritidae). *In*: *"27th Swadeshi Science Congress"*. 7-9 November, 2017, Amrita School of Engineering, Kollam, Kerala. p102.

Jissy George and Muralidharan, P. 2017. Thermal processing of tender and unripe ready to cook jackfruit for shelf life enhancement. *In:* Abstracts of the "International Seminar on Production, Value Addition and Marketing of Jack Fruit". 9-12 August, 2017, RARS, Ambalavayal, Waynad, Kerala. pp10-11.

Josephrajkumar, A., Merin Babu, Anes, K.M. and Krishnakumar, V. 2017. Connecting coconut to citizens. *In*: Proceedings of one-day workshop on "Coconut for Nurturing Ecology and Nourishing Society". ICAR-CPCRI, Regional Station, Kayamkulam, Kerala. p32.

Nagaraja, N.R., Elain Apshara, S. and Vinaya Rao. 2017. Study of compatibility mechanism in cocoa (*Theobroma cacao* L.) trees. *In:* Abstracts of "International Symposium on Horticulture: Priorities and Emerging Trends". 5-8 September, 2017, Bengaluru, Karnataka. pp309-310.

Prathibha, P.S., Jilu, V.S. and Hegde, V. 2017. Compatibility of soil insecticides to *Trichoderma harzianum* under in vitro condition. *In*: "27th Swadeshi Science Congress". 7-9 November, 2017, Amrita School of Engineering, Kollam, Kerala. p103.

Prathibha, P.S., Subaharan, K. and Ravindran, P. 2017. Exploration of potential essential oil repellents against red palm weevil *Rhynchophorus ferrugineus* Olivier (Curculionidae: Coleoptera). *In:* National conference on "Biological Control". Bengaluru, Karnataka. 9-11 February 2017.

Rajkumar., Pratibha, V.H., Subramanian, P., Surekha, R. and Hegde, V. 2017. Application of *Trichoderma* enriched neem seed kernel powder for the management of root knot nematode/ fungal wilt in coconut - black pepper cropping system. *In:* National symposium on "Climate Smart Agriculture for Nematode Management". 1113 January, 2017, Goa. p133.

Sivakumar, T., Josephrajkumar, A. and Jiji, T. 2018. Arising pest threats on banana in Kerala. *In:* Book of Abstracts, "National Banana Festival". 17-21 February, 2018, Thiruvananthapuram, Kerala. p76.

Thomas, R.J. and Shareefa, M. 2017. Ecotechnological perspectives in plant breeding. *In*: Proceedings of National Seminar on "Ecotechnological Perspectives for Sustainable Development", 28-29 July 2017, School of Biosciences, Mahatma Gandhi University, Kottayam, Kerala.

Thomas, R.J., Shareefa, M., Merin Babu, Rajeev, G., Josephrajkumar, A. and Chandrika Mohan. 2017. Initial assessment of green dwarf varieties of coconut for the root (wilt) disease prevalent tract. *In:* "27th Swadeshi Science Congress". 10-12 November, 2017, Amrita College of Engineering, Amritapuri, Kollam. p.132.

Popular Articles

Anithakumari, P. 2017. Coconut a health food. *Kerala karshakan* e-journal, 5(4): 10-17.

Anithakumari, P. 2017. Kudumba samrambhamayi kerolpannangal. *Kerala Karshakan*, **63**(4): 28-29.

Chandrika Mohan, Josephrajkumar, A. and Anes, K.M. 2017. Protecting coconut from enemies. *Kerala karshakan e*-journal, **5**(4): 22-27.

Elain Apshara, S. 2017. Cocoa Improvement Programmes of ICAR- CPCRI - A Glance. *The Cashew and Cocoa Journal*, **6**(2): 9-19.

Indhuja, S., Daliyamol and Merin Babu. 2017. Interlinking coconut with microbes. *Kerala karshakan e*-journal, **5**(4): 28-32.

Jeena Mathew, Indhuja, S. and Kalavathy, S. 2018. Care and nourishment to soil for sustained productivity in coconut. *Agriculture World*, **4**(1): 44-49.

Jilu, V.S., Maheswarappa, H.P. and Saju, S.S. 2017. Coconut research in all India basis. *Indian Nalikera Journal*, **8**(5): 19-22.

Jissy George. and Muralidharan, P. 2017. Jack products for health care. *Krishiyankanam*, **25**(5): 36-41.

Jissy George. 2017. Cocoa chocolates to conquer market. *Karshakasree* **23**(11): 90.

Jissy George. 2017. Coconut based enterprises. *Kerala Karshakan*, **63**(4): 23-27.

Jissy George. 2017. Curcumin capsule and ginger paste. *Karshakasree*, **23**(4): 90.

Jissy George. 2017. Food and industrial products from tuber crops. *Karshakasree*, **23**(12): 90-91.

Jissy George. 2017. From frozen coconut scrapings to curry mix. *Karshakasree*, **23**(10): 98.

Jissy George. 2017. Mango-pickle to pulp. *Karshakasree*, **23**(6): 97-98.

Jissy George. 2017. Passion fruit cultivation becomes a fashion. *Karshakasree*, **23**(9): 105-106.

Jissy George. 2017. Products from papaya. *Karshakasree*, **23**(8): 97-98.

Jissy George. 2017. Small millets are not small. *Karshakasree*, **23**(7): 96-97.

Jissy George. 2018. Dry fruits - a sweety unit. *Kerala Karshakan*, **63**(6): 22-23.

Jissy George. 2018. Formalities to initiate a food processing unit. *Karshakasree*, **24**(1): 97-98.

Jissy George. 2018. It's time for soft drinks. *Karshakasree*, **24**(3): 95-97.

Jissy George. 2018. Machineries for food processing. *Kerala Karshakan*, **63**(6):14-15.

Jissy George. 2018. Pickle making- an ideal enterprise. *Karshakasree*, **24**(2): 93.

Jissy George. 2017. Food and industrial products from tuber crops. *Karshakasree*, **23**(12): 90-91.

Josephrajkumar, A., Chandrika Mohan., Poorani, J., Merin Babu. and Krishnakumar, V. 2018. Bio-cleansing of coconut palms infested by rugose spiralling whitefly. *Indian Coconut Journal*: 1-13.

Kalavathi, S., Merin Babu, Jeena Mathew. and Jacob Kurien. 2018. Effective utilization of beneficial microbes. *Kerala Karshakan*, **63**(9): 60-61.

Krishnakumar, V. 2017. Coconut and ecosystem service. *Kerala Karshakan* e-journal, **5**(4): 4-9.

Krishnakumar, V. 2017. Thengine labha vilayakkam (Malayalam). *Kerala Karshakan*, **63**(4): 10-15.

Lekha, G. and Muralidharan, P. 2017. Mushroom production from banana pseudostem waste. *Karshakasree*, **23**(6): 97-98.

Lekha, G. and Muralidharan, P. 2018. Eco friendly management of amaranthus leaf spot disease. *Karshakasree*, **24**(3): 58.

Lekha, G. and Muralidharan, P. 2017. Mushroom production from banana psudostem waste, *Karshakasree*, **23**(6): 97-98.

Maheswarappa, H.P. and Jilu, V.S. 2017. Collaborative network on coconut R&D under ICAR-AICRP on Palms. *Indian Coconut Journal*, **59(12)**: 12-17.

Nagaraja, N.R., Jaganathan, D., Jose, C.T., Rajkumar., Surekha, R., Ananda, K.S. and Thamban, C. 2017. Adikeyalli bahu bele krushi paddathi. *Krishi Bimba Patrike*, **16**(7): 12-19.

Nagaraja, N.R., Rajkumar., Jaganathan, D. Surekha, R. and Shivaji Thube. 2017. Adikeyalli beru hulu nirvahanege entomopathogenic nematode. *Krishi Bimba Patrike*, **16**(10): 21-24.

Nihad, K., Krishnakumar, V and Haris, A.A. 2017. Marigold-globe amaranth sequential cropping fetches more. *Indian Horticulture*, **62**(5): 38-42.

Niral, V. and Ranjini, T.N. 2018. Tender coconut varieties for the benefit of coconut growers. *Indian Coconut Journal*, **10**(9): 5-7.

Prathibha, P.S., Chandrika Mohan., Josephrajkumar, A. and Ravindran, P. 2018. *Thengukalile velleecha badha: Karshakar aashank appedendathilla. Indian Nalikera Journal*, **9**(1): 4-6. Rajeev, M.S. and Muralidharan, P. 2018. We can cultivate black gram and green gram. *Karshakasree*, **24**(3): 36-37.

Rajesh, M.K., Sajini, K.K., Muralikrishna, K.S. and Karun, A. 2017. Coconut biotechnology: New vistas. *Indian Coconut Journal*, **8**: 17-19.

Ravi, S. and Muralidharan, P. 2017. Low cost hydroponics. *Kerala Karshakan*, **63**(3): 68-69.

Ravi, S. and Muralidharan, P. 2017. TMR feed. *Karshakasree*, **23**(10): 88-91.

Ravindran, P. and Prathibha, P.S. 2017. Krishikar karuthi irikkuka - Thengolappuzhu veendum. *Mathrubhumi daily dated March 22nd Kannur Edition.*

Shareefa, M. and Thomas, R.J. 2017. Know closely about dwarf varieties of coconut. *Kerala Karshakan*, **63**(4): 16-19.

Shareefa, M., Thomas, R.J. and Kalavathy, S. 2017. Coconut varieties suitable for tender nut purpose. *Krishiyanganam*, **23**(4): 41-43.

Sivakumar, T. 2017. Availability of quality coconut seedlings. *Kerala Karashakan*, **62**(9): 52-53.

Sivakumar, T. 2018. Eco friendly management of stunted growth and crinkling in green chilly. *Kerala Karshakan*, **62**(9): 52-53.

Sivakumar, T. 2017. Kumil rogam vannalum venda krishi mudangum. *Karshakan*, **25**(12): 34-35.

Subramanian, P., Surekha, R., Selvamani, V. and Bhat, R. 2017. Cowpea: A potential nutrient source in coconut garden. *Indian Coconut Journal*, **60**(3): 23-25.

Thamban, C. 2017. Karshika samrudhi veendedukkan. Mathrubhumi daily 10th June 2017, Kannur edition Supplement. p4.

Thamban, C. 2017. Keralathile thengukrishi-oravalokanam. *Karshakanadam*, **5**(60): 20-23.

Thamban, C. 2017. Kerasamrudhikkayi. *Kerala Karshakan*, **63**(4):32-34.

Thamban, C. 2017. Arogyakaravum sampalsamrudhavumaya jeevitham nalikerathinoppam.. *Indian Nalikera Journal*, **8** (9): 21-2.

Thamban, C. 2018. Kerasamrudhi veendedukkan-Marenda sameepanangalum puthiya padhathikalum. *Kalpadhenu*, **38**(1): 5-12.

Thamban, C. and Jayasekhar, S. 2018. Thaddesha swayambharana sthapanangal vazhi nalikera mekhalayude saktheekaranam-Sadhyathakalum kazhchappadukalum. *Indian Nalikera Journal*, **9**(2):4-10.

Thamban, C., Jaganathan, D. and Muralidharan, K. 2017. Scientist-Farmer interface on effective use of technologies for productivity improvement. *Indian Coconut Journal*, **60**(3): 26-33.

Thamban, C., Nair, K.M. and Subramanian, P. 2017. Nalikera utpadanakshamatha uyarthi varumanam vardhippikkan manninte arogya samrakshana pravarthanam anivaryam. *Indian Nalikera Journal*, **8**(11): 5-9.

Thamban, C., Nair, K.M. and LijoThomas. 2017. Enhancing productivity and income from coconut farming in Kerala-Need for interventions on soil health management. *Indian Coconut Journal*, **60**(5):17-21.

Thamban, C., Rajesh, M.K. and Jesmi Vijayan. 2017. Mixed cropping of pepper in coconut gardens: Successful experiences of a farmer. *Indian Coconut Journal*, **60**(6):12-16.

Thamban, C., Rajesh, M.K. and Jesmi Vijayan. 2017. Thengakku vila kuranjalum Kunhambu kulungilla. *Indian Nalikera Journal*, **8**(12):4-8.

Thomas, R. J. and Shareefa, M. 2017. Diversity in coconut. *Kerala Karshakan (E-Journal)*, **5(4)**: 18-21.

Thomas, R.J., Haris, A.A. and Shareefa, M. 2018. Scientific management of young coconut palms. *Agriculture World*, **4(1)**: 50-23.

Thomas, R.J., Shareefa, M. and Josephrajkumar, A. 2017. Sankarayinagalude paricheranam engane. *Karshakasree*, pp32-34.

Review Papers

Karun, A., Rajesh, M.K., Sajini, K.K., Muralikrishna, K.S., Neema, M., Shareefa, M. and Thomas, R.J. 2017. Coconut tissue culture: The Indian initiatives, experiences and achievements. *CORD* **33**(2): 14-24.

Malhotra, S.K. and Elain Apshara, S. 2017. Genetic resources of cocoa and their utilization: An Appraisal. *Indian Journal of Genetics*, **77**(2): 199-213.

Extension Pamphlets

Alka Gupta, Sreelatha, K. and Murali Gopal. 2017. *Nariyal avshisht par khadhya mushroom krishi* (in Hindi). Extension Folder No. 240 (Centenary Series no. 31), ICAR-CPCRI, Kasaragod.

Anes, K.M., Josephrajkumar, A., Merin Babu., Jinu, S. and Krishnakumar, V. 2018. Entomopathogenic nematodes: Bio-wriggler to Bio-suppress Insects. Bilingual mini poster.

Chandran, K.P., Neema, M., Murali Gopal and Alka Gupta. 2017. *Thengola mannira compost:*

Uthpadana saankethika vidyayum savisheshathakalum (in Malayalam). Extension Folder No. 257 (Centenary Series no. 62), August 2017, ICAR-CPCRI, Kasaragod.

Chandran, K.P., Neema, M., Murali Gopal and Alka Gupta. 2017. *Urea rahitha chakirichoru compost thayyarakkunnathinulla saankethika vidhya* (in Malayalam). Extension Folder No. 258 (Centenary Series no. 63), August 2017, ICAR-CPCRI, Kasaragod.

Chandrika Mohan., Sunny Thomas, Shanavas, M. and Josephrajkumar, A. 2018. Red palm weevil (in Malayalam), Extension folder, No 5. ICAR-CPCRI, Kasaragod (Reprint February 2018).

Jissy George. and Muralidharan, P. 2018. Homestead fruit processing. ICAR-KVK Alappuzha, CPCRI, RS, Kayamkulam. 32p.

Josephrajkumar, A., Anes, K.M., Merin Babu and Krishnakumar, V. 2017. *Mera Gaon Mera Gaurav* Accomplishments (2016-2017) at Kayamkulam, ICAR-CPCRI, Kasaragod.

Kalavathi, S., Jeena Mathew and Jacob Kurien. 2017. Different types of composts from coconut bio-wastes (in Malayalam).

Kalavathi, S., Jeena Mathew, Merin Babu, Indhuja, S. and Jacob Kurien. 2017. Efficient use of natural resources (in Malayalam).

Kalavathi, S., Merin Babu, Jeena Mathew and Jacob Kurien. 2017. Good quality fortified organic manures for sustainable organic farming.

Lekha, G. and Jissy George. 2018. Milky mushroom cultivation and value addition. ICARKVK Alappuzha, CPCRI, RS, Kayamkulam.

Murali Gopal, Alka Gupta and Palaniswami, C. 2017. *Urea rahit coir pith composting prodhyogiki* (in Hindi). Extension Folder No. 238 (Centenary Series no. 29), ICAR-CPCRI, Kasaragod.

Murali Gopal, Alka Gupta, Sreelatha, K. and Subramanian, P. 2017. *Nariyal patta vermicompost utpaadan ka tarikaa evom visheshtayen* (in Hindi). Extension Folder No. 239 (Centenary Series no. 30), ICAR-CPCRI, Kasaragod.

Neema, M., Chandran, K.P., Murali Gopal. and Alka Gupta. 2017. *Thengin jaivavashishttangalil ninnu koon Krishi* (in Malayalam). Extension Folder No. 259 (Centenary Series no. 64), August 2017, ICAR-CPCRI, Kasaragod.

Niral, V., Ranjini, T.N. and Chowdappa, P. 2017. *ICAR-CPCRI ya tengina sudharita taligalu* (in Kannada). Extension Folder No. 260, ICAR-Central Plantation Crops Research Institute, Kasaragod.

Rajeev, M.S., Lekha, G., Sivakumar, T., Sajnanath, K. and Jissy George. 2018. Ginger and Turmeric-Cultivation and processing. ICARKVK Alappuzha, CPCRI, RS, Kayamkulam.

Rajkumar, Jaganathan, D., Shivaji H. Thube, Chandrika Mohan and Hegde, V. 2017. Bearuhulagalabadhaegae EPN (Janthuhulu) jaivika nirvana (in Kannada). Extension handout, ICAR-Central Plantation Crops Research Institute, Kasaragod.

Rajkumar, Jaganthan, D., Chandrika Mohan, Leena, S.,Joseph Rajkumar, A., Hegde, V. and Radhakrishanan, V. 2017. *Mitra nimavirakalilude kavungile verutheeni puzhukkale niyanthrikkam (in Malyalam).* Extension handout, ICAR-Central Plantation Crops Research Institute, Kasaragod.

Rajkumar., Jaganathan, D., Shivaji H. Thube, Chandrika Mohan., Josephrajkumar, A. and Hegde, V. 2018. Entomopathogenic nematode (EPN) for the management of root grub in arecanut. Extension folder No. 256, ICAR-Central Plantation Crops Research Institute, Kasaragod.

Training Manuals

Anes, K.M., Josephrajkumar, A., Merin Babu, Nihad, K., Indhuja, S., Shareefa M., Jeena Mathew and Krishnakumar, V. 2018. Mastering farming through marvelous microbes: Proceedings of one-day workshop on harnessing bio-agents for sustainable soil and palm health. ICAR-CPCRI, Regional Station, Kayamkulam. 40p.

Anes, K.M., Josephrajkumar, A., Merin Babu, Nihad, K., Indhuja, S., Shareefa M., Jeena Mathew and Krishnakumar, V. 2018. Advances in pest management and harnessing scientific temperament. ICAR-CPCRI, Regional Station, Kayamkulam. 50p.

Chowdappa, P., Elain Apshara, S., Nagaraja, N.R. and Ananda, K.S. 2018. Cocoa production technology. ICAR-CPCRI, Regional Station, Vittal. 106p.

Shareefa, M., Merin Babu., Josephrajkumar, A. and Thomas, R.J. 2017. Practical manual on 'Breeding for resistance to pest and diseases in plantation crops. ICAR-CPCRI, Regional Station, Kayamkulam, Kerala. 43p.

Thomas, R.J., Josephrajkumar, A., Shareefa, M. and Rajesh, M.K. 2017. Breeding for resistance to pest and diseases in plantation crops. ICAR-CPCRI, Kasaragod, Kerala. 261p.

Thomas, R.J. and Shareefa, M. 2018. Quality planting material production of coconut for the root (wilt) disease prevalent tract (In Malayalam). ICAR-CPCRI, Regional Station, Kayamkulam. 27p.

DVD

Hegde, V., Bhat, R., Prathibha, V.H. and Surekha, R. 2017. IDM technologies in Coconut. Documentary film on ICAR-CPCRI technologies on production and processing of coconut.

VIII TECHNOLOGY ASSESSED AND TRANSFERRED

Nutrient mixtures for coconut: 'Kalpa Poshak' and 'Kalpa Vardhini'

Two nutrient mixtures *viz.*, 'Kalpa Poshak', comprising potassium, sulphur, zinc, copper and boron for seedlings and juvenile coconut palms and 'Kalpa Vardhini', comprising potassium, magnesium, sulphur, zinc and chlorine for adult bearing palms, were released. Application of Kalpa Poshak @ 25 g per palm in four split doses enhanced the growth parameters such as height and number of leaves of Kalpa Sankara hybrid at ICAR-CPCRI, Regional Station, Kayamkulam. The palms supplied with Kalpa Vardhini @ 125 g each in four split doses, along with recommended dose of fertilizers, recorded early flowering. The recommended dose of Kalpa Poshak is 40 g palm^{-1} year^{-1} in the first year after planting and 100 g palm^{-1} year^{-1} from 2nd year onwards and that of Kalpa Vardhini is 500 g palm^{-1} year^{-1}.

Kalpa Poshak, a nutrient mixture for adult palms

Kalpa Vardhini, a nutrient mixture for seedlings & juvenile palms

Coconut variety IND010S

A high yielding coconut variety, suitable for tender nut, copra and inflorescence sap production was developed. The variety is a selection from IND 010, a population of Federated Malay States Tall, introduced from Malaysia during the year 1940. The variety is tall in habit and suitable for cultivation in coconut growing tracts of Kerala, Tamil Nadu. The annual average nut yield is 133 nuts palm^{-1} year^{-1}, with copra out turn of 24.47 kg palm^{-1} year^{-1}, with 31.68% more nut and 54.68% more copra yield over WCT (control). The variety recorded 33.33% higher inflorescence sap yield (32 l inflorescence^{-1}) than WCT, along with good quality and quantity (450 ml) of tender nut water.

Coconut variety IND010S

Kalpa Vermiwash

Kalpa Vermiwash (vermin-wash) is a clear brown coloured liquid produced from vermicomposting coconut leaves and is collected after the passage of water through actively vermicomposting substrate with earthworms. It is a combination of the washings of the earthworms' body surface along with the leachate of the vermicomposting substrate. It harbours a large number of microbiota that helps in improving the soil health and plant growth. The vermiwash is alkaline and contains major and minor nutrients in appreciable quantities along with the plant growth promoting hormones. 'Kalpa Vermiwash' should be diluted 5 to 10 times with water and applied to crops. This product is suitable for improving the yield of crops like vegetables, flowers and also export oriented crops like pepper, nutmeg, clove and vanilla. It's application has enhanced the population of numbers of microorganisms particularly the beneficial and controlled the population of the nematode *Meloidogyne incognita* and gall formation in bhendi.

Kalpa Vermiwash production is a spin off technology from vermicomposting using *Eudrilus eugeniae* (ICAR-CPCRI strain) that helps in increasing the farm income through reduction of input cost.

Bio-suppression of arecanut white grub with entomopathogenic nematodes (EPN)

An effective strategy for management of arecanut white grub was developed. Soil application of aqua formulation of EPN, *S. carpocapsae* @ 1.5 billion IJs ha^{-1} with imidacloprid 0.0045% and neem cake 2 kg $palm^{-1}$ showed about 91.8% reduction in root grub (*Leucopholis* spp.) population, with significant increase in yield (62%), over a period of three years in arecanut plantations in Karnataka.

Aqua formulation of
entomopathogenic nematodes (EPN)

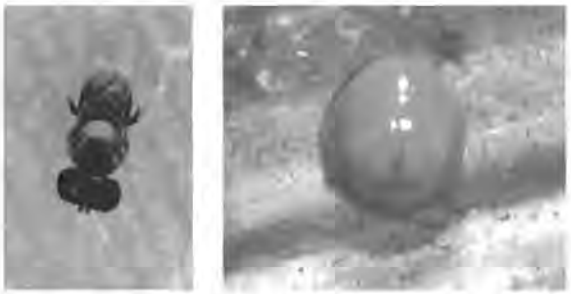
Coconut Leaf
Vermiwash

Coconut leaf vermiwash
produced in
plastic barrel or mud pot

Bio-suppression of rugose spiralling whitefly and bio-scavenging of sooty mould

Effective strategy for management of invasive rugose spiralling whitefly was developed and is detailed below:

- Conservatory biocontrol of aphelinid parasitoids (*Encarsia guadeloupae*) and re-introduce parasitized pupae in emerging zones of whitefly outbreak
- *In situ* habitat conservation of the sooty mould scavenger beetle, *Leiochrinus nilgirianus for cleansing the sooty mould deposits on palm leaflets*



Aphelinid parasitoids (*Encarsia guadeloupae*) and sooty mould scavenger beetle, *Leiochrinus nilgirianus'*

Coconut milk residue (CMR) and jack fruit seed powder enriched biscuits

Technology for preparation of biscuits with combination of coconut milk residue and jack fruit seed flour, along with wheat flour (20:30:50) was standardized.

Biscuits prepared with varying levels of coconut milk residue and jack fruit seed flour

Air blast arecanut sprayer

Fruit rot, caused by *Phytophthora meadii*, is a serious problem in arecanut, causing yield loss of up to 90% if timely fungicide spray is not undertaken. Spraying of arecanut bunches is a challenging task, constrained by lack of skilled work force required to climb and spray the trees and occurrence of incessant rainfall during the spraying season. To address these challenges, prototype of an air blast sprayer mounted on a mini garden tractor, capable of delivering fungicide solution to a height of 30 m, was developed in collaboration with ASPEE, Mumbai. The sprayer has a tank capacity of 40 litres with discharge rate of 1-2 L min^{-1}. This machine has been found suitable for spraying operations in arecanut mono-cropping system.

Air blast arecanut sprayer

Unmanned Aerial Vehicle (UAV) assisted arecanut sprayer

Considering the need for mechanization of spraying operations in arecanut plantations and the limitation of using tractor mounted air blast sprayer in arecanut based integrated cropping system, involving cocoa, black pepper and banana, Unmanned Aerial Vehicle (UAV) assisted sprayer was developed in collaboration with M/S General Aeronautics Pvt. Ltd., IISC, Bangalore. The first prototype of this machine, with flight endurance of 15 minutes, maximum height of 1 km, payload capacity of 6 litre and spray droplet nozzle size of 200-300 micron, has already been fabricated and its utility was demonstrated.

Unmanned Aerial Vehicle (UAV)

e-kalpa app

To facilitate the availability of knowledge at finger tip to farming community for effective adoption and doubling their income, an android based multi-lingual (English, Malayalam, Hindi, Kannada) mobile application was developed as part of the Digital India initiative. e-kalpa is available to farmers/general public, in both offline and online mode and provides real time access to the knowledge base and technologies on cultivation and value addition of coconut, arecanut and cocoa along with inter/mixed crops.

Novel features of e-kalpa include (i) availability of technology snippets in offline mode (ii) information regarding inter/ mixed crops suitable for coconut/ arecanut based cropping system including the details of season/ planting time, spacing, seed rate, integrated nutrient requirement are provided for quick reference; (iii) "input calculator" that provides a nutrient management scheme (type, quantity, and time of application of fertilizers) based on the information such as number palms in different age groups.

e-kalpa android app

IX

AWARDS & RECOGNITION

ICAR Award

ICAR-KVK Alappuzha was awarded the Pandit Deendayal Upadhyay Rashtriya *Krishi Vigyan Protsahan Puraskar* 2016-17 for Zone XI. The award consisting of a certificate and prize money of Rs. 2.25 lakhs was received from Shri Radha Mohan Singh, the Hon'ble Union Minister for Agriculture and Farmer's Welfare, by Dr. P. Chowdappa, Director, ICAR-CPCRI and Dr. P. Muralidharan, Principal Scientist & Head, ICAR-KVK-Alappuzha, at the 89th ICAR Foundation day and Award Ceremony, held at National Agricultural Science Complex, New Delhi on 16th July, 2017. The ICAR-KVK Alappuzha has been functioning since 2004 as the knowledge and resource centre in the field of farm sciences and allied enterprises, fostering inclusive farming in the district.

Shri Radha Mohan Singh, Hon'ble Minister for Agriculture and Farmers' Welfare handing over the Best KVK Award to Dr. P. Chowdappa, Director, ICAR-CPCRI and Dr. P. Muralidharan, Head, KVK Alappuzha

Other awards

The Institute exhibition stall, displaying novel technologies in palms and cocoa, received first prize for the best stall in the category of government organizations in the National Horticultural Fair organized at ICAR-Indian Institute of Horticultural Research, Bengaluru during March 15-17, 2018.

Dr. Jayasekhar S., Scientist (Sr. Scale) was awarded the certificate of appreciation by the Ministry of Commerce, Consumer, Trade, Innovation and Labour, Government of the Kingdom of Tonga for the meritorious work done and the development of the National Strategy for Coconut Sector for the Kingdom, during his deputation from 28th February to 6th October, 2017.

Dr. Jayasekhar S. receiving the award from Hon'ble Minister, MCCTIL, Government of the Kingdom of Tonga

The paper entitled "Compatibility of soil insecticides to *Trichoderma harzianum* under *in vitro* condition" by Dr. Prathibha P. S., Mrs. Jilu, V. S. and Dr. Vinayaka Hegde was conferred with best oral presentation award in the 27th Swadeshi Science Congress held at Amrita School of Engineering, Kollam, Kerala during November 7-9, 2017.

Dr. Sivakumar T., Dr. Joseph Rajkumar A. and Dr. Jiji T. were conferred with best poster award for their paper entitled "Arising pest threats on banana in Kerala" presented at the National Banana Festival 2018 held at Kalliyoor, Thiruvananthapuram, Kerala during February 17-21, 2018.

X

TRAINING AND CAPACITY BUILDING

During the period, 31 scientists, 20 technical, 40 administrative and 17 skilled supporting staff have undergone training within the country. Further, one scientist attended a workshop outside the country. Three staff acquired higher educational qualifications and have been awarded Ph.D degree.

Workshop attended abroad

Dr. Jayasekhar. S, Scientist Sr. Scale attended the Pacific Coconut Sector Value Chain Workshop at Nadi, Fiji during 11th to 13th July, 2017.

Trainings organized for staff at the institute

Training for scientific staff

A training workshop on "Writing and Publishing Skills for Scientists" was organized during 7-9th March 2018 at ICAR-CPCRI Kasaragod. Dr. Yateendra Joshi, Associate Fellow, Communication Research Institute, Canberra handled the technical sessions. A total of 34 scientists, from four ICAR institutes, three each from DCR, Puthur, IISR, Kozhikode and CIFT, Kochi and the remaining from CPCRI, attended the programme. The training comprised of different sessions, covering effective internet search and literature reviews, writing effective emails, letters, and memos, accurate presentation of tables, figures pie-charts in reports and articles etc, good report writing, and producing well-designed documents and posters. Dr. V. Niral, Principal Scientist, was the Course Director and Dr. Neenu., Scientist, was the Course coordinator.

Training for technical staff

A training programme on "Basics in computer Applications" for the technical staff was conducted at during 27 to 28 March, 2018. Dr. Chandran K P, Principal Scientist, ICAR-CPCRI Kasaragod and Mr. Sebastian George, ACTO, ICAR-CPCRI Kasaragod served as Course coordinators. Six technical personnel (50% first time trainees) of ICAR-CPCRI, Kasaragod participated in the programme. The course content of the programme included familiarisation of computer hardware parts, Introduction to commonly used computer software, Introduction to MS-Word and MS-Excel and FMS-MIS operations. In addition, hands on practical sessions were also included in the programme.

In addition, a one day field oriented refresher course cum training programme on Pest and Disease - Diagnosis, Surveillance and Management was conducted on 18th May- 2017 under the guidance of Dr. Vinayaka Hegde, Head Division of Crop Protection, for members of the surveillance squad and nine technical personnel attended the training.

Training for administrative staff

Considering the job requirements, two training programmes were conducted at ICAR-CPCRI

Certificate distribution of training programme at Vittal on "Basics in Computer Applications"

Kasaragod on current topics: E-procurement and GeM on 15th June 2017 and GST, GeM and E-Procurement on 7th August 2017. A total of 35 staff from the institute, including Administration and Accounts Section staff from headquarters, ICAR-CPCRI Regional Station Vittal, Regional Station Kayangulam, Research Centre Kahikuchi, Research Centre Kidu and ICAR-KVK Alleppey, attended the training.

Training for skilled supporting staff

A training programme on "Basics in computer Applications" for the skilled supporting staff was conducted at ICAR-CPCRI Regional station, Vittal during 13 to 15 March, 2018, with Dr. C T Jose, Pr. Scientist, ICAR-CPCRI Regional Station Vittal, Dr. Chandran K P, Pr. Scientist, ICAR-CPCRI Kasaragod and Mr. Sebastian George, ACTO, ICAR-CPCRI Kasaragod as Course coordinators. A total of six participants, including five from ICAR-CPCRI Regional Station Vittal and one from ICAR-CPCRI Research Centre Kidu, participated in the programme. The course content included familiarization of computer hardware parts, basic computer operations, introduction to commonly used computer software and FMS-MIS operations. In addition, hands on practical sessions were also included.

Another training programme on "Nursery Techniques and Farm Management Practices in Plantation Crops" was conducted at ICAR-CPCRI Research Centre, Kidu during 14 to 16 March, 2018, with Dr. Subramanian, Pr. Scientist, ICAR-CPCRI Kasaragod as Course Director and Mr. Diwakar, Y., Scientist, ICAR-CPCRI Research Centre Kidu as Course coordinator. Under this programme 11 skilled supporting staff members (90% first time trainees) were trained on the theoretical ad practical aspects of nursery and farm management. The training programme was found to be highly effective in terms of knowledge upgradation among majority of the trainees to the extent up to 40 per cent. Considering the present day needs in the digital era, a session on introduction to basic information technology was also included for the benefit of the trainees.

Human Resources Development - Physical targets and achievements

Category	Total no. of employees	No. of trainings planned during the year	Total no. of employees undergone training	% realization of trainings planned
Scientist	81	13	29	223.08
Technical	101	18	19	105.56
Administrative & Finance	57	32	39	121.88
Skilled Supporting Staff	125	15	17	113.33
Total	**364**	**78**	**104**	**133.33**

HRD Financial targets and achievements

RE 2017-18 for HRD (Rs in lakhs)	Actual Expenditure up to 31 March, 2018 for HRD (Rs in lakhs)	% Utilization of allotted budget
8.9	7.02	78.88

Training prorgamme on Nursery Management Practices in Plantation Crops at Research Centre, Kidu

Category-wise trainings attended by employees during 2017-18
Category: Scientific staff

S. No.	Name of employee	Designation	Discipline/ Section	Name of training programme attended
1	Ms. Ranjini T.N.	Scientist	Spices Plantation Medicinal & Aromatic Crops	Biodosimetry, 4-6 May, 2017 at K.S. Hegde Medical College Academy, Mangalore Writing and publishing skills for scientists during 7-9 March, 2018 at ICAR-CPCRI, Kasaragod
2	Dr. M. Arivalagan	Scientist	Biochemistry	Biodosimetry, 4-6 May, 2017 at K.S. Hegde Medical College Academy, Mangalore Metabolite profiling as a selection tool for abiotic and biotic stress tolerance in horticultural crops during 27th November to 6th December, 2017 at ICAR-IIHR, Bangaluru
3	Dr. R. Pandiselvam	Scientist	Agricultural Process Engineering	Biodosimetry, 4-6 May, 2017 at K.S. Hegde Medical College Academy, Mangalore Design and Manufacturing of Agro Processsing Machines, 01-21 August, 2017, CIAE, Bhopal
4	Mr. Najeeb Naduthodi	Scientist	Spices Plantation Medicinal and Aromatic Crops	Short Course on Breeding for resistance to pest and diseases in plantation crops during 21-30 November 2017 at ICAR-CPCRI, RS, Kayamkulam Writing and publishing skills for scientists during 7-9 March, 2018 at ICAR-CPCRI, Kasaragod
5	Ms. M. Suchithra	Scientist	Spices Plantation Medicinal and Aromatic Crops	Metabolite profiling as a selection tool for abiotic and biotic stress tolerance in horticultural crops during 27th November to 6th December, 2017 at ICAR-IIHR, Bangaluru Writing and publishing skills for scientists during 7-9 March, 2018 at ICAR-CPCRI, Kasaragod
6	Dr. Indhuja	Scientist	Agricultural Microbiology	Microbial identification and preservation during 8-13 January 2018 at NCPNR, Pune Microbial Genomics during 15-19 January 2018 at NCPNR, Pune Training cum workshop on Methodological Framework for implementation of FFP, during 10-13 October 2017, Tamil Nadu Veterinary and Animal Sciences University (TANUVAS), Chennai Writing and publishing skills for scientists during 7-9 March, 2018 at ICAR-CPCRI, Kasaragod
7	Dr. R. Sudha	Scientist	Fruit Science	Application on OMICS tools and techniques for Agricultural germplasm improvement during 9th Feb-1st March, 2018 at ICAR-IASRI, New Delhi Writing and publishing skills for scientists during 7-9 March, 2018 at ICAR-CPCRI, Kasaragod
8	Dr. Neenu S	Scientist	Soil Science	Writing and publishing skills for scientists during 7-9 March, 2018 at ICAR-CPCRI, Kasaragod
9	Dr. Neema M.	Scientist	Spices Plantation Medicinal and Aromatic Crops	Writing and publishing skills for scientists during 7-9 March, 2018 at ICAR-CPCRI, Kasaragod

10	Dr. Prathibha P.S.	Scientist	Agrl. Entomology	Writing and publishing skills for scientists during 7-9 March, 2018 at ICAR-CPCRI, Kasaragod
11	Dr. Sujithra M.	Scientist	Agrl. Entomology	Writing and publishing skills for scientists during 7-9 March, 2018 at ICAR-CPCRI, Kasaragod
12	Dr. Selvamani V.	Scientist	Soil Science	Writing and publishing skills for scientists during 7-9 March, 2018 at ICAR-CPCRI, Kasaragod
13	Mr. S. Jayasekhar	Scientist	Agrl. Economics	Writing and publishing skills for scientists during 7-9 March, 2018 at ICAR-CPCRI, Kasaragod
14	Dr. Rajkumar	Scientist	Nematology	Writing and publishing skills for scientists during 7-9 March, 2018 at ICAR-CPCRI, Kasaragod
15	Dr. Vinayaka Hegde	Pr. Scientist & Head Division of Crop Protection	Plant Pathology	Writing and publishing skills for scientists during 7-9 March, 2018 at ICAR-CPCRI, Kasaragod
16	Dr. S. Paulraj	Scientist	Agrl. Micro-biology	Writing and publishing skills for scientists during 7-9 March, 2018 at ICAR-CPCRI, Kasaragod
17	Dr. Joseph Rajkumar	Pr. Scientist	Agrl. Ento-mology	Writing and publishing skills for scientists during 7-9 March, 2018 at ICAR-CPCRI, Kasaragod
18	Dr. Merin Babu	Scientist	Plant Pathology	Writing and publishing skills for scientists during 7-9 March, 2018 at ICAR-CPCRI, Kasaragod
19	Dr. Jeena Mathew	Scientist	Soil Science	Writing and publishing skills for scientists during 7-9 March, 2018 at ICAR-CPCRI, Kasaragod
20	Dr. K. Nihad	Scientist	Floriculture	Writing and publishing skills for scientists during 7-9 March, 2018 at ICAR-CPCRI, Kasaragod
21	Dr. Anes K.M.	Scientist	Nematology	Writing and publishing skills for scientists during 7-9 March, 2018 at ICAR-CPCRI, Kasaragod Training cum workshop on Methodological Framework for implementation of FFP, during 10-13 October 2017, Tamil Nadu Veterinary and Animal Sciences University (TANUVAS), Chennai
22	Mr. Khadke Ganesh Navanath	Scientist	Spices Plantation Medicinal and Aromatic Crops	Writing and publishing skills for scientists during 7-9 March, 2018 at ICAR-CPCRI, Kasaragod
23	Dr. R. Thava Prakasa Pandian	Scientist	Plant Pathology	Writing and publishing skills for scientists during 7-9 March, 2018 at ICAR-CPCRI, Kasaragod
24	Mr. Diwakar Y.	Scientist	Spices Plantation Medicinal and Aromatic Crops	Writing and publishing skills for scientists during 7-9 March, 2018 at ICAR-CPCRI, Kasaragod
25	Mrs. Jilu V. Sajan	Scientist	Agrl. Ento-mology	Writing and publishing skills for scientists during 7-9 March, 2018 at ICAR-CPCRI, Kasaragod
26	Dr. M. Senthil Amudan	Scientist	Plant Biochemistry	Writing and publishing skills for scientists during 7-9 March, 2018 at ICAR-CPCRI, Kasaragod
27	Dr. N.R. Nagaraja	Scientist	Genetics and Plant Breeding	Writing and publishing skills for scientists during 7-9 March, 2018 at ICAR-CPCRI, Kasaragod

28	Dr. Alka Gupta	Pr. Scientist	Microbiology	Writing and publishing skills for scientists during 7-9 March, 2018 at ICAR-CPCRI, Kasaragod
29	Dr. L.S. Singh	Scientist	Spices Plantation Medicinal and Aromatic Crops	Short Course on Breeding for resistance to pest and diseases in plantation crops during 21-30 November 2017 at ICAR-CPCRI, RS, Kayamkulam
30	Dr. M.R. Manikantan	Pr. Scientist	Agricultural Process Engineering	Storage stability of sugarcane juice in high-density polyethylene based nano composite packaging films, during 18th 21st September, 2017 at ICAR-SBI, Coimbatore
31	Dr. P. Anitha kumari	Pr. Scientist	Agricultural Extension	Training cum workshop on Methodological Framework for implementation of FFP, during 10-13 October 2017, Tamil Nadu Veterinary and Animal Sciences University (TANUVAS), Chennai

Category: Technical staff

S. No.	Name of employee	Designation	Discipline/ Section	Name of training programme attended
1	Shri M.V. Sreedharan	Sr. Technical Asst.	Farm	Selection, adjustment, operation & maintenance of agricultural implements for field &horticultural crops held at CIAE, Bhopal from 01-10 August, 2017 Cocoa Production and Processing Technology during 18-22 December, 2017 at ICAR-CPCRI, RS, Vittal Pest and Disease- Diagnosis, Surveillance and Management during 18-05-2017 at CPCRI, Kasaragod
2	Shri Mana Mohan M.	Technical Officer	Maintena-nce	Selection, adjustment, operation & maintenance of agricultural implements for field & horticultural crops held at CIAE, Bhopal from 01-10 August, 2017
3	Shri Narayana Naik	Sr. Tech. Asst.	Farm	Cocoa Production and Processing Technology during 18-22 December, 2017 at ICAR-CPCRI, RS, Vittal
4	Dr. C. Kesavan Nampoothiri	CTO	Statistics	Agro meteorological data collection analysis and management during 11-23 December, at ICAR-CRIDA, Hyderabad
5	Shri V. Balakrishna	Technical Officer	Farm	Basics in computer Applications during 27-28 March, 2018 at ICAR-CPCRI, Kasaragod Pest and Disease- Diagnosis, Surveillance and Management during 18-05-2017 at CPCRI, Kasaragod
6	Shri A. Divakaran	Senior Technician	Farm	Basics in computer Applications during 27-28 March, 2018 at ICAR-CPCRI, Kasaragod
7	Shri K. Balakrishna	Technical Officer	Farm	Basics in computer Applications during 27-28 March, 2018 at ICAR-CPCRI, Kasaragod
8	Shri P.K. Krishnankutty	Technical Assistant	Farm	Basics in computer Applications during 27-28 March, 2018 at ICAR-CPCRI, Kasaragod

9	Shri Rajendran Nair M.P.	Technical Officer	Farm	Basics in computer Applications during 27-28 March, 2018 at ICAR-CPCRI, Kasaragod
10	Shri Radhakrishnan Nambiar	Sr. Tech. Assistant	Farm	Basics in computer Applications during 27-28 March, 2018 at ICAR-CPCRI, Kasaragod
11	Shri Ananda Gowda B.	Technical Assistant	(Field/ Farm)	Cocoa Production and Processing Technology during 18-22 December, 2017 at ICAR-CPCRI, RS, Vittal
12	Shri Padmanabha Naik A.R.	Sr. Technician	(Field/ Farm)	Cocoa Production and Processing Technology during 18-22 December, 2017 at ICAR-CPCRI, RS, Vittal
13	Shri Ravindran Patali	Asst. Chief Technical Officer	Lab	Pest and Disease- Diagnosis, Surveillance and Management during 18-05-2017 at CPCRI, Kasaragod
14	Mrs. Sugatha Padmananabhan	Asst. Chief Technical Officer	Lab	Pest and Disease- Diagnosis, Surveillance and Management during 18-05-2017 at CPCRI, Kasaragod
15	Shri Ramakrishnan	Senior Technical Officer	(Field/ Farm)	Pest and Disease- Diagnosis, Surveillance and Management during 18-05-2017 at CPCRI, Kasaragod
16	Shri M.V. Madhavan	Senior Technical Assistant	Technology	Pest and Disease- Diagnosis, Surveillance and Management during 18-05-2017 at CPCRI, Kasaragod
17	Dr. K.S. Muralikrishna	Technical Assistant	Lab	Pest and Disease- Diagnosis, Surveillance and Management during 18-05-2017 at CPCRI, Kasaragod
18	Shri A. Sanjeeva	Technical Assistant	(Field/ Farm)	Pest and Disease- Diagnosis, Surveillance and Management during 18-05-2017 at CPCRI, Kasaragod
19	Mrs. Vimala M.	Sr. Technician	Lab	Pest and Disease- Diagnosis, Surveillance and Management during 18-05-2017 at CPCRI, Kasaragod
20	Dr. T. Sivakumar	SMS	KVK Alleppey	Short Course on Breeding for resistance to pest and diseases in plantation crops during 21-30 November, 2017 at ICAR-CPCRI, RS, Kayamkulam
21	Smt. K. Sreelatha	Asst. Chief Tech. Off.	Hindi Cell	E-procurement & GeM on 15/6/2017 held at CPCRI, Kasaragod

Category: Administrative staff

S. No.	Name of employee	Designation	Discipline/ Section	Name of training programme attended
1	Shri S.K.C. Bose	SFAO	Accounts	Establishment and financial matters for Under Secretaries and F &AOs of ICAR during 17-23August, 2017 at NAARM, Hyderabad
2	Smt. Girija Chandran	Private Secretary	PB&PHT Division	Emotional Intelligence, 2-4 August, 2017 ISTM, New Delhi GST, GeM and E-Procurement on 7/8/2017 held at CPCRI, Kasaragod

3	Shri K.K. Sasi	A.F.&A.O	Accounts	Refresher course for AAO's and AFAO's from 23-29 June 2017 held at NAARM, Hyderabad GST, GeM and E-Procurement on 7/8/2017 held at CPCRI, Kasaragod
4	Shri Pradeep Kumar Vasu	Asst. Administrative Officer	Admini-stration	Refresher course for AAO's and AFAO's from 23-29 June 2017 held at NAARM, Hyderabad E-procurement & GeM on 15/6/2017 held at CPCRI, Kasaragod GST, GeM and E-Procurement on 7/8/2017 held at CPCRI, Kasaragod
5	Shri T.E. Janardhanan	Asst. Administrative Officer	Admini-stration	General Financial Rules 2017; E-procurement & GeM, 22-23/8/2017 at ISTM, New Delhi E-procurement & GeM on 15/6/2017 held at CPCRI, Kasaragod GST, GeM and E-Procurement on 7/8/2017 held at CPCRI, Kasaragod
6	Shri K.R. Nithianandan	Asst. Administrative Officer	Admini-stration	E-procurement & GeM on 15/6/2017 held at CPCRI, Kasaragod
7	Smt. Lucy D'Souza	Asst. Administrative Officer	Admini-stration	E-procurement & GeM on 15/6/2017 held at CPCRI, Kasaragod Workshop on GST during 5-8 November, 2017 at ISTM, New Delhi
8	Shri K.G. Bhageerath	Asst. Administrative Officer	Admini-stration	E-procurement & GeM on 15/6/2017 held at CPCRI, Kasaragod
9	Shri T.N. Vidyadharan	Assistant		E-procurement & GeM on 15/6/2017 held at CPCRI, Kasaragod
10	Smt. M. Reetha	AAO	Accounts	E-procurement & GeM on 15/6/2017 held at CPCRI, Kasaragod
11	Smt. Sheeja P.P.	JAO	Accounts	E-procurement & GeM on 15/6/2017 held at CPCRI, Kasaragod
12	Smt. Sheena Kumari K.T.K.	Assistant	Accounts	E-procurement & GeM on 15/6/2017 held at CPCRI, Kasaragod
13	Smt. Rupa Manikandan	UDC	Accounts	E-procurement & GeM on 15/6/2017 held at CPCRI, Kasaragod
14	Smt. Mary A.J.	LDC	Accounts	E-procurement & GeM on 15/6/2017 held at CPCRI, Kasaragod
15	Shri Jayarajan V.V.	LDC	Accounts	E-procurement & GeM on 15/6/2017 held at CPCRI, Kasaragod
16	Shri S.B. Baburaj	AF&AO	Admini-stration	E-procurement & GeM on 15/6/2017 held at CPCRI, Kasaragod
17	Shri K. Haridasan	Assistant	Admini-stration	E-procurement & GeM on 15/6/2017 held at CPCRI, Kasaragod
18	Smt. V. Madhavi Kutty	UDC	Admini-stration	E-procurement & GeM on 15/6/2017 held at CPCRI, Kasaragod
19	Smt. K.S. Vishalakshi	Assistant	Admini-stration	E-procurement & GeM on 15/6/2017 held at CPCRI, Kasaragod
20	Shri Paulson Sam George	UDC	Admini-stration	E-procurement & GeM on 15/6/2017 held at CPCRI, Kasaragod

21	Smt. Preethi K.	UDC	Administration	E-procurement & GeM on 15/6/2017 held at CPCRI, Kasaragod
22	Shri Udayakumar	UDC	Administration	E-procurement & GeM on 15/6/2017 held at CPCRI, Kasaragod
23	Shri P.K. Pramodkumar	LDC	Administration	E-procurement & GeM on 15/6/2017 held at CPCRI, Kasaragod
24	Shri Dinesh	LDC	Administration	E-procurement & GeM on 15/6/2017 held at CPCRI, Kasaragod
25	Shri Umesh Kumar	LDC	Administration	E-procurement & GeM on 15/6/2017 held at CPCRI, Kasaragod
26	Shri Ratan Singh	LDC	Administration	E-procurement & GeM on 15/6/2017 held at CPCRI, Kasaragod
27	Shri Krishna Naik	Asst. Administrative Officer	Administration	E-procurement & GeM on 15/6/2017 held at CPCRI, Kasaragod GST, GeM and E-Procurement on 7/8/2017 held at CPCRI, Kasaragod
28	Shri Ramesh Babu	Personal Assistant	Administration	GST, GeM and E-Procurement on 7/8/2017 held at CPCRI, Kasaragod Enhancing efficiency and behavioural skills for Stenographers / PAs/PSs, PPSs of ICAR during 25-31 October, 2017 at NAARM, Hyderabad
29	Shri Raveendran M.	Asst. Administrative Officer	Administration	GST, GeM and E-Procurement on 7/8/2017 held at CPCRI, Kasaragod
30	Shri Mohammed Haneefa	LDC	Administration	GST, GeM and E-Procurement on 7/8/2017 held at CPCRI, Kasaragod
31	Shri Aswin Raghunath	LDC	Administration	GST, GeM and E-Procurement on 7/8/2017 held at CPCRI, Kasaragod
32	Shri Arun N.K.	LDC	Administration	GST, GeM and E-Procurement on 7/8/2017 held at CPCRI, Kasaragod
33	Smt. Remya T.R.	LDC	Admin-stration	GST, GeM and E-Procurement on 7/8/2017 held at CPCRI, Kasaragod
34	Shri T.K. Gangadharan	Cashier	Administration	GST, GeM and E-Procurement on 7/8/2017 held at CPCRI, Kasaragod
35	Shri Thomas P.M	Assistant	Administration	GST, GeM and E-Procurement on 7/8/2017 held at CPCRI, Kasaragod
36	Shri K.T.Unni	PA	Administration	GST, GeM and E-Procurement on 7/8/2017 held at CPCRI, Kasaragod
37	Shri Subhash Paul	Assistant	Administration	Refresher course on Administration and Finance management during 18-23 January, 2018 at NAARM, Hyderabad
38	Shri Deepak Meena	LDC	Administration	E-procurement & GeM on 15/6/2017 held at CPCRI, Kasaragod
39	Smt. K.R. Rejitha	Stenographer	Administration, KVK Alleppey	E-procurement & GeM on 15/6/2017 held at CPCRI, Kasaragod

Category: Skilled Support Staff

S. No.	Name of employee	Discipline/ Section	Name of training programme attended
1	Shri Chandu Naik	Farm	Basics in Computers during 13-15 March, 2018 at ICAR-CPCRI, RS, Vittal
2	Shri Choma B.	Farm	Basics in Computers during 13-15 March, 2018 at ICAR-CPCRI, RS, Vittal
3	Shri Dharmapala B.	Farm	Basics in Computers during 13-15 March, 2018 at ICAR-CPCRI, RS, Vittal
4	Shri M. Ananda	Farm	Basics in Computers during 13-15 March, 2018 at ICAR-CPCRI, RS, Vittal Nursery Techniques and Farm Management Practices in Plantation crops during 14-16 March, 2018 at ICAR-CPCRI, RS, Vittal
5	Shri Jathappa V	Farm	Basics in Computers during 13-15 March, 2018 at ICAR-CPCRI, RS, Vittal
6	Shri Isubu D.	Farm	Basics in Computers during 13-15 March, 2018 at ICAR-CPCRI, RS, Vittal
7	Shri Durgesha M.	Farm	Nursery Techniques and Farm Management Practices in Plantation crops during 14-16 March, 2018 at ICAR-CPCRI, RS, Vittal
8	Shri S. Venkatramana	Farm	Nursery Techniques and Farm Management Practices in Plantation crops during 14-16 March, 2018 at ICAR-CPCRI, RS, Vittal
9	Mrs. N. Bhavani	Farm	Nursery Techniques and Farm Management Practices in Plantation crops during 14-16 March, 2018 at ICAR-CPCRI, RS, Vittal
10	Mrs. Chandravathi	Farm	Nursery Techniques and Farm Management Practices in Plantation crops during 14-16 March, 2018 at ICAR-CPCRI, RS, Vittal
11	Mrs. Komalangi	Farm	Nursery Techniques and Farm Management Practices in Plantation crops during 14-16 March, 2018 at ICAR-CPCRI, RS, Vittal
12	Shri Regappa Gowda S.	Farm	Nursery Techniques and Farm Management Practices in Plantation crops during 14-16 March, 2018 at ICAR-CPCRI, RS, Vittal
13	Shri Neelappa Gowda	Farm	Nursery Techniques and Farm Management Practices in Plantation crops during 14-16 March, 2018 at ICAR-CPCRI, RS, Vittal
14	Mrs. S. Susheela	Farm	Nursery Techniques and Farm Management Practices in Plantation crops during 14-16 March, 2018 at ICAR-CPCRI, RS, Vittal
15	Shri S. Padmayya Gowda	Farm	Nursery Techniques and Farm Management Practices in Plantation crops during 14-16 March, 2018 at ICAR-CPCRI, RS, Vittal
16	Mrs. Rukmini S	Farm	Nursery Techniques and Farm Management Practices in Plantation crops during 14-16 March, 2018 at ICAR-CPCRI, RS, Vittal
17	Shri V.S. Pakeera	Field/Farm	Pest and Disease- Diagnosis, Surveillance and Management on 18-05-2017 at CPCRI, Kasaragod

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

Category	No. of Train -ings	Participants (No.)			Institutes/office representation (No.)			States/UT repr. (No.)	Trainees attending training programme for first time after joining service (No.)
		ICAR	Non-ICAR	Total	ICAR	Non-ICAR	Total		
Scientist	2	38	16	54	6	8	14	5	0
Technical	2	15	0	15	1	0	1	1	3
Administrative & Finance	2	39	0	39	2	0	2	3	0
Skilled Support	2	17	0	17	1	0	1	1	14
Total	**8**	**109**	**16**	**125**	**10**	**8**	**18**	**10**	**17**

PG Studies

Shri Saran Kumar Rizal, Chief Technical Officer, ICAR-CPCRI RC, Kahikuchi was awarded Ph.D degree in Agricultural Extension by Visva-Bharati University, Shantiniketan, West Bengal, for his doctoral thesis "Impact Assessment of Records and Extension Activities of Government Agencies: A study in Jalpaiguri District of West Bengal" under the guidance of Prof. Sarthak Choudhuri, Department of Agricultural Extension, Visva-Bharati University.

Shri M. Arivalagan, Scientist (Biochemistry) has been awarded Ph.D degree from the Department of Biochemistry and Molecular Biology, School of Biological Sciences, Central University of Kerala, Kasaragod for his doctoral thesis "Biochemical and nutritional evaluation of coconut (*Cocos nucifera* L.) haustorium and its co-products" under the guidance of Dr. Santosh R. Kanade, Asst. Professor, Department of Biochemistry and Molecular Biology, Central University of Kerala.

Shri T. Sivakumar, SMS (Agrl. Entomology) was awarded doctoral degree from Kerala Agricultural University, Thrissur for his research work on 'Management of banana pseudo stem weevil using safer chemicals and bio rational methods' under the guidance of Dr. Jiji T., Professor of Entomology, College of Agriculture, Vellayani, Thiruvananthapuram.

Students' project works

To facilitate the students' research, MOU have been executed with St. Aloysius College (Autonomous), Mangalore, National Centre for Aquatic Animal Health, CUSAT, Cochin, Alva's College, Moodbidri, Karnataka and Kannur University, Kannur University of Agricultural Sciences, Raichur. Based on the MOU, 15 M.Sc. students have successfully completed their M.Sc. project works of three months duration.

XI

WORKSHOPS, SEMINARS SUMMER INSTITTUES FARMERS DAYS ORGANIZED

Union Minister of State for Agriculture & Farmers Welfare visited Muttar village

The Union Minister of State for Agriculture and Farmers Welfare, Mr. Sudarshan Bhagat visited Muttar on 4th May, 2017, where the project on 'National Innovations in Climate Resilient Agriculture' (NICRA) is being implemented and interacted with the farmers. Dr. Sreenath Dixit, Director, ICAR-ATARI, Bengaluru, briefed about the technology demonstrations carried out by ICAR-KVK Alappuzha and the Hon'ble Minister was apprised with the developments in the agriculture scenario of the village over the last five years consequent to the implementation of the NICRA project. The Minister explained about the farmer friendly development programmes implemented by the Govt. of India in various parts of the country, such as Prime Minister's *Fasal Bhima Yojana*, *Krishi Sinchayi Yojana*, Soil Health Card programme etc. for doubling the farmers' income by 2022. Shri Kummanam Rajasekharan, State President BJP, peoples' representatives and officials of Agricultural Departments were present during the function. About 150 farmers attended the programme and shared their experiences with the Hon'ble Minister.

Stakeholders meeting on coconut leaf eating caterpillar outbreak

A stakeholders meeting on management of leaf eating caterpillar (*Opisna arenosella* Walker) was organized by ICAR-CPCRI at Thokkottu, Mangaluru, on 17th May 2017. Personnel from KVK Mangalore, KVK Udupi, State Horticulture Department Mangalore, Parasite Breeding Station Thumbay, and Parasite Breeding Station Kasaragod participated in the meeting. After thorough discussions, field release of parasitoids (*Goniozus nephantidis*) during evening hours was suggested for successful establishment of parasitoids.

Mr. Sudarshan Bhagat, Minister of State for Agriculture and Farmers Welfare, addressing the farmers at Muttar

Dr. P. Chowdappa, Director, ICAR-CPCRI addressing the gathering during World Coconut Day

Dr. P. Chowdappa, Director, ICAR-CPCRI giving away the prizes to student winner

World Coconut Day celebrations

Various programmes were organized at ICAR-CPCRI, Kasaragod in connection with the World Coconut Day celebrations. Competitions were held for the students on essay writing, painting and elocution. A total of 124 students, representing eight schools participated in the programme. Quiz competition for farmers was held with the focal theme on 'Coconut for Prosperity', involving farmers from four localities of Kasaragod district wherein *'Keragramam'* scheme is being implemented. A competition on preparation of coconut recipes was held for women. Training programme on 'Effective utilization of technologies for higher productivity in coconut' was conducted as part of the celebrations. Valedictory function of World Coconut Day celebrations was held on 22nd September, 2017 in which Shri Bimal Ghosh, Deputy Director of Agriculture, Kasaragod was the guest of honour. Dr. P. Chowdappa, Director, ICAR-CPCRI presided over the function.

Interface on Science, Innovations and Entrepreneurship

An Interface programme on Science, Innovations and Entrepreneurship was organized at ICAR-CPCRI, Kasaragod on 15th September, 2017, as a curtain raiser to the 3rd India International Science Festival (IISF) to be held at 2017 at Chennai during 13-16 October, 2017. Shri N. A. Nellikunnu, Hon'ble MLA Kasaragod, while inaugurating the interface programme, urged the participating students to carry forward the dream of the nation to become a world leader by 2030. He encouraged them to engage themselves with rigorous scientific experiments and keen observations. While remembering former President of the Nation Late A.P.J. Abdul Kalam, he also called upon the students to develop passion for life. He pointed out that many budding scientists from

Innovators addressing students at ICAR-CPCRI, Kasaragod during the interface programme on Science, Innovations and Entrepreneurship

the soil of Kasaragod possess the caliber to emulate Sir C.V. Raman and Dr. A.P.J. Abdul Kalam. Dr. Ravi Bhat, Principal Scientist & Head Division of Crop Production, ICAR-CPCRI presided over the function and mentioned about the relevance of this programme, to instill scientific temper among students and public, as envisaged by IISF-2017. The IISF series has relevance to India's long term vision for developing and widening the spectrum of scientific temper in the continent, being organized by Vijnana Bharathi in collaboration with the Ministry of Earth Sciences, New Delhi. The Festival focuses on showcasing India's contribution in the field of Science and Technology over the years. Dr. K.A. Navas, Head, Government College of Engineering, Kannur delivered the keynote address and motivated the students to become innovators and entrepreneurs. Shri B. Shivakrishna Bhat, IMC Member, ICAR-CPCRI and Dr. Anitha Karun, Principal Scientist and Head Division of Crop Improvement offered felicitations. Well known innovators interacted with the students during the programme. More than 400 students from different schools of Kasaragod district actively participated in the interface programme.

Students interacting with scientists on field experiments at ICAR-CPCRI, Kasaragod

Shri N.A. Nellikkunnu, MLA distributing soil health card to farmers at ICAR-CPCRI, Kasaragod

World Soil Day celebration and distribution of soil health card

World Soil Day was celebrated on 5th December 2017 at ICAR- CPCRI, Kasaragod with the aim to promote and spread the messages on the importance of soil quality for food security, healthy ecosystems and human well-being.

Shri N.A. Nellikkunnu, Hon'ble MLA, Kasaragod, inaugurated the World Soil Day celebration and distributed soil health cards to farmers from the district. In his inaugural address, Shri Nellikkunnu highlighted the importance of soil testing and distribution of soil health cards to the farming community for optimizing nutrient management in crops cultivated, reducing cost of cultivation and enhancing productivity. Dr. Ravi Bhat, Director-in-charge presided over the inaugural function. Soil health cards were distributed to about 127 farmers from various villages of Kasaragod district on the occasion. A Scientist-Farmer interface programme was also organized. Permanent hoardings on Soil Health Card scheme have been installed at ICAR-CPCRI and KVK, Kasaragod.

World Soil Day celebrations with the theme 'Caring for the Planet Starts from the Ground' was convened

Adv. Prathibha Hari, MLA distributing prizes to the winners of quiz competition at Pathiyoor

Main Gate of ICAR-CPCRI

Gate in front of KVK Kasaragod

Southern Gate of ICAR-CPCRI

Permanent hoardings on Soil Health Card scheme installed at ICAR-CPCRI and KVK, Kasaragod

by hosting soil quiz competition for students at ICAR-CPCRI, Regional Station, Kayamkulam and Farmer-Scientist interface programme at Pathiyoor Grama Panchayath. The programme was inaugurated by Shri V. Prabhakaran, President, Pathiyoor Grama Panchayath and Shri K. Sukumaran, Standing Committee (Development) Chairman presided over the function. Dr. V. Krishnakumar, Head, ICAR-CPCRI, Regional Station, Kayamkulam delivered the key note address on the importance of soil on human civilization and sustenance. An extension pamphlet on 'Soil health management for sustained coconut productivity' was released on the occasion. Soil health cards were distributed to 60 farmers in the Panchayat. NRPMHSS, Kayamkulam and Panchayath HS, Pathiyoor emerged victorious in the Soil quiz contest and prizes were distributed by Hon'ble MLA Adv. (Mrs.) Prathibha Hari during the valedictory function. Adv. (Mrs.) Prathibha Hari highlighted that soil is the soul of infinite life and urged students to love farming to reach greater heights.

Training on 'Soil Health Management' in connection with 'World Soil Day' was organized at ICAR-

Inauguration of training on Soil Health Management at Vittal

CPCRI, Regional Station, Vittal. Interaction was held among scientists and participants. Dr. Nagaraja N. R., Scientist, ICAR-CPCRI, Regional Station, Vittal, coordinated the programme.

ICAR-KVK, Alappuzha, in association with Department of Agricultural Development and Farmers' Welfare, organized World Soil Day celebrations at Palamel Panchayath Community Hall in Bharanikavu Block. During the programme, 48 soil health cards prepared by analyzing representative geo-referenced soil samples in the KVK laboratory were distributed. About 135 farmers and officials of Krishi Bhavans of all the panchayaths of Bharanikavu block attended the programme.

World Soil Day was also celebrated on 5th December, 2017 at Pradhanpara, Belakoba, Jalpaiguri. A total of 40 farmers of the region attended the programme. Training was imparted on the importance of soil and its health for the benefit of the crops, importance of soil testing and method of collection of soil samples for testing.

Stakeholder's Meet on Arecanut Tissue Culture

A stakeholder's meet on arecanut tissue culture was held on 9th November 2017 under the chairmanship of Dr. P. Chowdappa, Director, ICAR-CPCRI, to address farmers requirement of dwarf arecanut hybrids for replanting of senile arecanut plantations. Over 40 delegates including Dr. S. Narayanan, Director and company representatives SPIC, Coimbatore; Dr. M.K. Naik, Director of Research, UAHS, Shivamogga; Dr. Srinath Dixit, Director, ICAR-ATARI, Bangalore; Office bearers from CAMPCO, Mangalore; MAMCOS, Sirsi; TUMCOS, Davangere and Raichur; Heads of KVK Mangalore, Sirsi, Uttara Kannada, Udupi, Shivamogga, and Davangere; Dr. Narayana Swamy, Professor UAHS,

Shivamogga, progressive farmers and scientists from ICAR-CPCRI participated. Dr. S. Narayanan, Director, SPIC assured the commitment made by SPIC to ICAR-CPCRI on taking up commercial production of arecanut dwarf hybrids by tissue culture technology. He also suggested that a Regional Hardening Facility could be set up, at an appropriate time, when plantlets become ready.

Kisan Conference and Agri-business Expo-2018

A mega Kisan Conference and Agri-business Expo-2018 was organized at ICAR-CPCRI, Kasaragod in connection with the foundation day celebrations of the Institute, which is in its 101st year of establishment, and the 25th year of establishment of ICAR-KVK, Kasaragod.

The Agri-business Expo was inaugurated by Shri E. Chandrasekharan, Hon'ble Minister for Revenue, Govt. of Kerala on 5th January, 2018. During the inaugural address, the Minister urged the research institutes to introspect on whether their findings and acquired knowledge are trickling down to the farmers. He highlighted the importance of organic agriculture to overcome the major problems caused by indiscriminate use of chemical fertilizers and pesticides in the past.

Shri E. Chandrasekharan, Hon'ble Minister for Revenue, Govt. of Kerala inaugurating the Agri-business Expo

The mega Kisan Conference held on 8th January 2018 was inaugurated by the chief guest Shri D.V. Sadananda Gowda, Hon'ble Union Minister for Statistics and Programme Implementation, Govt. of India. The *Kisan* Conference was attended by nearly 3000 farmers. On the occasion, the minister also inaugurated the new building of Kendriya Vidyalaya No. 1. Kasaragod.

Dr. P. Chowdappa, Director, ICAR-CPCRI addressing the stakeholder's meet on arecanut tissue culture

Shri D.V. Sadananda Gowda, Hon'ble Union Minister for Statistics and Programme Implementation, Govt. of India inaugurating the new building of Kendriya Vidyalaya No. 1, Kasaragod

Hon'ble Union Minister, in his inaugural address highlighted the importance of the agriculture in the national economy and stated that the agriculture sector contributed to 17% of GDP, and provides employment to 54% of the population. The total allocation for the rural, agriculture, and allied sectors in 2017-18 was Rs. 1,87,223 crores, which was 24% higher than the previous year. He also emphasized that the government has implemented various schemes such as *'Krishi Sinchayi Yojana'*, *'Paramparagat Krishi Vikas Yojana'*, etc. to double the farmer's income by 2022. He mentioned that so far 9.91 crore soil health cards have been distributed by the government. He appreciated the efforts of ICAR-CPCRI in enhancing the productivity and income of the plantation growers in the country.

The Hon'ble Minister released a commemorative postal stamp to mark 100 years of ICAR-CPCRI in the presence of Col. S.F.H. Rizvi, Post Master General, Northern Region, Kozhikode. The Hon'ble Minister felicitated three of the best farmers of the region: Shri Sibi Joseph of Balal, Kasaragod (coconut), Shri Rama Kishore of Bantwal, Karnataka (arecanut), and Shri Vishwanath Rao of Sullia (cocoa), during the function. MoUs on licensing of

Shri D.V. Sadananda Gowda, Hon'ble Union Minister for Statistics and Programme Implementation, Govt. of India inaugurating the Kisan Mela

technologies developed by the Institute were also exchanged before the Hon'ble Minister: arecanut tissue culture, coir pith composting and coconut leaf composting with Southern Petrochemical Industries Corporation (SPIC), Coimbatore and virgin coconut oil (VCO), coconut chips, frozen coconut delicacies and Kalparasa with Madhura Agro, Coimbatore.

Micronutrient formulations for coconut *viz.*, 'Kalpa Vardhini' and 'Kalpa Poshak' and selected publications *viz.*, "25 years of ICAR-Krishi Vigyan Kendra Kasaragod", "Entrepreneur and Farmer Friendly Technologies" in Hindi and "Coconut" in Malayalam and Kannada were released by the Union Minister on the occasion.

Dr. P. Chowdappa, Director, ICAR-CPCRI handing over MOU on arecanut tissue culture to Shri Narayanan of SPIC, Coimbatore in the presence of Shri D.V. Sadananda Gowda, Hon'ble Minister for Statistics and Programme Implementation, Govt. of India

Release of commemorative postal stamps

Postal stamp on ICAR-CPCRI Kasaragod

Shri P. Karunakaran Hon'ble Member of Parliament, Kasaragod presided over the function. Shri N. A. Nellikunnu Hon'ble MLA, Kasaragod felicitated ICAR-CPCRI and the KVK for organizing such programmes to bring the farmers and general public

together and achieve higher prospects. Shri A.G.C. Basheer, President, Kasaragod District Panchayath, Shri A.A. Jaleel, President, Mogral Puthur Panchayath, offered felicitations. Smt. T.R. Ushadevi, Principal Agriculture Officer, Kasaragod was also present. Dr. A.K. Singh, DDG (Hort. Sci.) ICAR, mentioned the landmark achievement of ICAR-CPCRI in enhancing productivity of coconut from 5000 nuts per hectare to 13000 per hectare over the years.

Concurrent with the six day Agri-business Expo, the following farmer interface programmes were also organized:

- Seminar on 'Soil and water conservation technologies and integrated soil health management' (5-1-2018; 10:30 AM)
- Seminar on 'High value under-utilized fruits' (5-1-2018; 11:30 AM)
- Training on 'Arecanut based multispecies cropping system and management of root grub using entomopathogenic nematodes' (6-1-2018; 10:30 AM)
- Seminar on 'Production and processing of cocoa' (6-1-2018; 11:30 AM)
- Seminar on 'Dairying, goat farming, poultry rearing & fisheries for doubling farmers' income' (6-1-2018; 2:30 PM)
- Workshop on 'Bio-suppression of rugose spiraling whitefly of coconut' (6-1-2018; 9:30 AM)
- Seminar on 'Crop diversity' (6-1-2018; 11:30 AM)
- Start-up Green 2018 - Enabling Agripreneurship' (7-1-2018; 10:30 AM)
- KVK-ATMA: Farmer-Scientist Interface meeting' (8-1-2018; 2:00 PM)
- Interface meeting on 'Beekeeping' (9-1-2018; 10:30 AM)
- Awareness programme on 'Energy conservation and LED bulb assembly' (9-1-2018; 11:30 AM)
- Seminar on 'Urban and peri-urban horticulture' (10-1-2018; 11:00 AM)
- Interface on 'Value addition to coconut, mango and jackfruits' (10-1-2018; 2:00 PM).

A total of 3000 farmers and other stakeholders actively participated in these interface programmes. The workshop on "Bio-suppression of rugose spiraling whitefly" of coconut, which was organized on 6th January 2018, was inaugurated by Dr. N.K. Krishna Kumar, Regional Representative, South and Central Asia, Bioversity International. Dr. P. K. Chakrabarty, ADG (Plant Protection), ICAR was also present as guest of honour. Strategies for management of the invasive rugose spiraling whitefly, were worked out, along with release of technical bulletin and posters in English, Hindi, Malayalam, Kannada, Tamil and Telugu for distribution to different stakeholders in various coconut growing states.

The Agri-business Expo-2018 attracted participation from exhibitors; products of diverse nature were exhibited in about 150 stalls. The exhibitors included representatives of ICAR Institutes, corporate sector agri-business houses and small and medium scale enterprises involved in production of agri-based value added food materials, farm implements and equipments for irrigation, urban and peri-urban horticulture etc. On an average, around 10,000 visitors, comprising of farmers, entrepreneurs and school students, visited the exhibition daily.

The Valedictory Function of the Kisan Conference and Agri-Business Expo- 2018 was held on 10th January, 2018 under the chairmanship of Dr. P. Chowdappa, Director, ICAR-CPCRI.

Crop Diversity Fair

A seminar and exhibition on crop diversity was held on 6th of January at ICAR- CPCRI, Kasaragod, with funding support from Bioversity International and the Kerala Gramin Bank, under the chairmanship of Dr. P. Chowdappa, Director, ICAR-CPCRI. The objective of this programme was to create awareness and promote agrodiversity conservation, document and showcase the plant genetic diversity in the region, and facilitate community seed chains.

The seminar was inaugurated by Dr. N Krishna Kumar, Bioversity International Regional Representative for South and Central Asia and former DDG, Horticultural Sciences, ICAR. In his inaugural address, Dr N Krishna Kumar emphasized that diversity drives evolution and called upon the participants to plant and nurture at least one plant and to help prevent the loss of food diversity and extinction of native breeds/landraces. Dr. Sooryaprakash Shenoy, Principal Scientist and Head at Dr. Shivarama Karanatha Pilikula Nisargadhama, Pilikula, Mangalore talked about

'Plant diversity in Western Ghats'. Mr. Jayakumar from Thanal, Thiruvanatha puram, Kerala spoke about, "Role of NGO's in conservation". Mrs. Manorama Joshi, Secretary, Vanastree, Sirsi, Karnataka shared her experiences on "Conservation in homestead-community seed production and livelihood opportunities". Dr. Chandrashekar Chowta, progressive farmer from Miyapadavu, Kasaragod spoke on 'Food diversity- status and challenges'. Mr. Jayaprakash, Secretary, Pulari organization, Kasaragod, Mr. Parameshwara Bhat, traditional rice grower from Belthangadi, Karnataka and Mr. Suresh, a farmer from Wayanad, shared their experiences in the field of conservation. Farmers and farmer's organization from different parts of the Karnataka and Kerala, exhibited their collection of traditional varieties and landraces of different agricultural crops. About 300 participants, including farmers and students from different schools and colleges in and around Kasaragod and Mangalore attended the seminar.

A crop diversity fair, showcasing the diversity in local land races and germplasm of paddy, minor millets, vegetables, tuber crops, fruits, medicinal plants, spices, cashew, cocoa, coconut and arecanut, was also inaugurated on this occasion. The exhibition was visited by thousands of people and well appreciated by the general public as well as the exhibitors. In addition to creation of awareness on plant diversity, farmer conservers of crop diversity, and nongovernmental organizations involved in conservation, the seminar and exhibition also facilitated exchange as well as sale of seed of local landraces.

Dr. N. K. Krishna Kumar, Bioversity International Regional Representative for South and Central Asia, delivering the inaugural address and visiting the crop diversity fair

Workshop on Bio-suppression of Rugose Spiraling Whitefly

The workshop on 'Bio-suppression of Rugose Spiraling Whitefly' of coconut was conducted at ICAR-CPCRI Kasargod on 6th January 2018 under the chairmanship of Dr P. Chowdappa, Director. Dr. N.K. Krishna Kumar, Regional Representative, South and Central Asia, Bioversity International, inaugurated the workshop. Dr. P. K. Chakrabarty, ADG (Plant Protection), ICAR was the guest of honour. The workshop was attended by scientists from ICAR institutes, AICRP on Palms, SAUs and officials from the State Agriculture/Horticulture Departments. Strategies for management of the invasive rugose spiraling whitefly, were chalked out, along with release of technical bulletin and posters on this pest in English, Hindi, Malayalam, Kannada, Tamil and Telugu for distribution to different stakeholders in various coconut growing states.

Posters on 'Invasive rugose spiraling whitefly of coconut' in six languages

Dream Big – Kalpa 2018

An interface programme of scientists and entrepreneurs named 'Dream Big – Kalpa 2018' was held on 31st January, 2018 at ICAR-CPCRI, Kasaragod. Dr. P. Chowdappa, Director, stressed on the importance of value addition and invited participants to take-up technologies from ICAR-CPCRI. He also highlighted the technology worthiness and pointed out that so far with 16 potential technologies, 185 technology transfers have been made in just three years. He also called for forming clusters of farmers called 'Kisan Sampadas' to take forward the entrepreneurial industries, overcoming the major hindrances of land fragmentation, increasing input costs, climatic vagaries and market competition.

Mr. Pravas K. Naik, Krishna Plantations, Goa receiving a copy of the MoU from Dr. P. Chowdappa, Director, ICAR-CPCRI, Kasaragod

Mr. Abdul Rasheed, General Manager, District Industries Centre, Kasaragod and the Chief Guest of the function spoke on the support offered by the Kerala State Government to promote entrepreneurship, viz. trainings, micro-credits, marketing, trade fairs, certifications, and various promotive strategies and stressed that by utilizing these the sky is the limit for a young entrepreneur. He invited the participants to break the comfort zones and emerge as leaders in the arena and make use of the opportunities available in Kasaragod. Mr. Sawad Nullippady, Coordinator, Start-up Mission, Kerala spoke on the various opportunities and the support programmes for starting business enterprises. He invited the participants to make use of the various Central and State Government subsidies and schemes.

During the programme, MoUs on technologies of ICAR-CPCRI were exchanged with entrepreneurs, followed by presentation of institute technologies and exhibition of products and services as well as publications. A special lecture on the various programmes of Coconut Development Board under Coconut Mission were highlighted by Shri K.S. Sebastian, Asst. Director (Mktg.), CDB, Kochi.

Planning Workshop for Decentralized Farmer Participatory Planting Material Production in Coconut

A workshop to formulate action plan to produce coconut seedlings in all districts of Kerala, except Idukki and Wayanad, under 'Coconut Development Scheme 2017-18', was held at ICAR-CPCRI on 26th February 2018, in collaboration with Agriculture Development and Farmers Welfare Department, Government of Kerala. The prime objective of this workshop was to create awareness and enable production of coconut planting material in a farmer participatory mode, to ensure availability of good quality seedlings locally to the growers and at reasonable cost. Dr. P. Chowdappa, Director ICAR-CPCRI presided over the inaugural session and in the presidential address emphasized on the importance of quality planting material in improving production and doubling farmer's income. Ms. Ushadevi J.R., Principal Agriculture Officer, Kasaragod was the Chief Guest and succinctly explained the scenario of coconut cultivation in Kerala and the urgent need for improving availability of quality seedlings. Dr. D. C. Chowta, President, Green Valley Coconut Producers Federation offered felicitations. Selected coconut farmers, scientists from ICAR-CPCRI, Deputy Directors from Department of Agriculture attended the meeting.

XII

PARTICIPATION OF SCIENTISTS IN CONFERENCES MEETINGS, WORKSHOPS AND SYMPOSIA

Deputation Abroad

Dr. P. Chowdappa, Director, ICAR-CPCRI participated in a Seminar Series of Coconut, Rubber and Tea at CRT Trade Fair 2017 and presented a paper on 'Value addition in coconut' at Colombo during 11th – 13th August, 2017.

Dr. P. Chowdappa, Director, ICAR-CPCRI attended Asian Conference on Plant Pathology at Jeju, South Korea during 13th – 16th September, 2017 and presented a country report on 'Plant Pathology Education and Research in India: Present Scenario and Future Challenges'.

Dr. P. Chowdappa, Director, ICAR-CPCRI, Kasaragod visited Nadi, Fiji during 31st October, 2017 to 4th November, 2017 to attend the 18th COGENT Steering Committee Meeting. He made a presentation on 'Current status of International Coconut Genebank for the South Asia and Middle East Countries (ICG-SAME)'.

Shri Jayasekhar S., Scienist (Sr. Scale) was deputed as Coconut Development Expert (under the Indian Technical and Economic Cooperation) under the Ministry of External Affairs, Government of India for a period of seven months (28th February to 6th October, 2017) to develop a coconut revitalization strategy for the Kingdom of Tonga. He also attended the Pacific Coconut Sector Value Chain Workshop at Nadi, Fiji during July 11 – 13, 2017.

Dr. P. Chowdappa, Director, ICAR-CPCRI Kasaragod ICAR-CPCRI Kasaragod addressing delegates at Jeju, South Korea

Dr. P. Chowdappa, Director, ICAR-CPCRI Kasaragod ICAR-CPCRI Kasaragod addressing delegates at Colombo, Sri Lanka

Dr. P. Chowdappa, Director, ICAR-CPCRI, Kasaragod presenting 'Current status of ICG-SAME' at Nadi, Fiji

Dr. K. B. Hebbar, Principal Scientist and Head, Division of PB & PHT, and Dr. S. Elain Apshara, Principal Scientist (Hort.) visited University of Reading, UK,during 6-8 June 2017 to attend a meeting on development of 'Collaborative Framework for Cacao Evaluation (CFCE) focusing on drought/heat/CO_2 and multi-site evaluation trials' organized by Bioversity International, Italy.

Within India

Name and designation	Title	Place and date
Dr. P. Chowdappa, Director	Interactive meet on 'Prospects and Potential for Cocoa in Karnataka'	UAHS, Navile, Shivamogga; 6th May 2017
Dr. P. Chowdappa, Director	Seminar on 'Entrepreneurs Development and Industrial Opportunities in Areca'	SDMIT, Ujire; 9th May 2017
Dr. P. Chowdappa Director	35th Group Meeting of AICRP on Vegetable Crops	ICAR-IIHR, Bengaluru; 25th June 2017
Dr. P. Chowdappa Director	Workshop on 'Emerging Applications of Space Technology in Agriculture and Allied Sectors'	SAC, Ahmedabad; 28th and 29th June 2017
Dr.P. Chowdappa, Director, Dr. K.S. Ananda and Dr. V. Krishnakumar, Heads of the Station, Dr. Anitha Karun, Dr. Ravi Bhat, Dr. Vinayaka Hegde, Dr. K. B. Hebbar, Dr. C. Thamban, Heads of Division; Dr. V. Niral, Dr. P. Subramanian, Dr. Chandrika Mohan, Dr. A. Joseph Rajkumar, Principal Scientists; Dr. Rajkumar, Mrs. Jilu V. Sajan, ScientistsDr. P. Chowdappa, Director , Dr. Vinayaka Hegde, Head, Division of Crop Protection, Dr. V. Selvamani and Dr. R. Sudha, Scientists	Annual General Meeting of AICRP on Palms	UHS, Bagalkot; 26th to 29th July 2017
Dr. P. Chowdappa, Director , Dr. Vinayaka Hegde, Head, Division of Crop Protection, Dr. V. Selvamani and Dr. R. Sudha, Scientists	CII Coconut Festival -2018 – 'Farm to Fridge and Beyond'	CODISSIA Complex, Coimbatore; 27th -28th January 2018
Dr. P. Chowdappa, Director	National Symposium on 'Plant Health Management – Eco-Sustainable Paradigm'	AAU, Jorhat; 16th February 2018
	Kisan Mela on 'Doubling Farmers Income From Arecanut Based Cropping System'	ICAR-CPCRI, Research Centre Kahikuchi; 18th to 20th February, 2018

	ICAR-Directors Conference	NASC Complex, New Delhi; 8th to 9th March, 2018
	National Conference on Climate Change and its Impact on Livelihoods'	19th March, 2018
Dr. C. Thamban, AHD Social Science	Workshop on 'Watershed based Development'	Taliparamba, Kannur; 29th June 2017
Dr. Anitha Karun, Dr. Vinayaka Hegde, Heads of Division and Dr. V. Niral, Principal Scientist	Workshop on 'Applications of New Tools in Crop Improvement and Disease Management in Plantation Crops'	Alva's College, Moodbidri; 27th September 2017
Dr. Chandrika Mohan, Principal Scientist	Seminar on 'Nurturing Naturalistic Intelligence to Craft a Green World'	College of Technical Education, Kayamkulam; 9th June 2017
Dr. Murali Gopal, Principal Scientist	Circular Economy Seminar-2017	FICCI, New Delhi; 25th -26th April 2017
Dr. Murali Gopal, Principal Scientist	Workshop on 'Microbe Based Technologies for Soil Health and Plant Nutrition'	NASC Complex, New Delhi; 25th August 2017
Dr. S. Kalavathi, Principal Scientist, Dr. M. Shareefa and Mrs. Jilu V. S., Scientists	27th Swadeshi Science Congress	Amrita School of Engineering, Kollam; 7th -9th November 2017
Dr. P. Anithakumari, Principal Scientist and Dr. Merin Babu, Scientist	FNational Workshop on 'Farmer's Feedback on Doubling Farm Income by 2022'	ICAR-NAARM, Hyderabad; 22nd -23rd December 2017
Dr. P. Anithakumari, Principal Scientist and Dr Neema, Scientist	'Woman Scientist & Entrepreneurs Conclave' as a part of India International Science Festival -2017	Anna University, Chennai; 15th-16th October 2017
Dr. V. Niral and Dr. Elain Apshara, Principal Scientists	12th Review Meeting of DUS test centres	ICAR-IISR, Lucknow; 15th- 17th January 2018
Dr. Regi J. Thomas, Principal Scientist	Collaborative National Seminar on 'Eco-Technological Perspectives for Sustainable Development'	Collaborative National Seminar on 'Eco-Technological Perspectives for Sustainable Development'
Dr. (Mrs) Alpana Das, Senior Scientist, ICAR-CPCRI, Research Station, Kahikuchi	State Level Workshop on 'Prospects of Coconut Production and Value'	CDB, Guwhati; 11th December 2017
Dr. Alpana Das, Principal Scientist & SIC, RC, Kahikuchi	National Seminar on 'Smart Farming for Exchange Input Use Efficiency, Income and Environment Security'	ICAR Research Complex for NEH Region, Umiam; 19th -21st September 2017

Dr. Merin Babu, Mr. Diwakar Y and Dr. Shameena Beegum, Scientists	'Sensitizing Youth to Flagship Programmes of Government'- Young Scientists Conclave as a part of India International Science Festival -2017	Anna University, Chennai; 14th-16th October 2017
Dr. Jeena Mathew, Scientist	7th International Conference on 'Silicon in Agriculture'	UAS, Bengaluru; 24th-28th October 2017
Dr. Nagaraja, N. R, Scientist-Sr. Scale (Plant Breeding)	International Symposium on 'Horticulture: Priorities and Emerging Trends'	J. N. Tata Auditorium, National Science Seminar Campus, Indian Institute of Science, Bengaluru; 4th -8th September 2017
Smt. Jissy George, SMS (Home Science)	International Seminar on 'Production, Value Addition and Marketing of Jack Fruit'	RARS, Ambalavayal; 9th-12th August 2017

XIII LINKAGE AND COLLABORATIONS

International

Asia Pacific Coconut Community, Jakarta, Indonesia	Co-operation between coconut growing countries in the Asia - Pacific region on research priorities in coconut sector
Bioversity International, Malaysia	Exchange of genetic resources, International Coconut Gene Bank for South Asia and socio-economic collaboration
Coconut Research Institute, Sri Lanka	Resistance breeding programme against coconut Weligama leaf wilt disease in Sri Lanka

National

ICAR Institutes

ICAR-CIARI, Port Blair	Conservation of coconut genetic resources and breeding strategies
ICAR-CIAE, Bhopal	Development of labour saving machineries and gadgets
ICAR-CIFT, Kochi	Value addition of coconut based products
ICAR-CRIDA, Hyderabad	Climate change network programme through NICRA
ICAR-CTCRI, Thiruvananthapuram	Cassava and coconut based value added products, intercropping of tubercrops in coconut gardens
ICAR-IIHR, Bengaluru	Varietal screening, cropping systems, agricultural tools and machinery and horticultural IP related activities
ICAR-IISR, Kozhikode	Cropping system studies, *Phytophthora* diseases in plantation crops
ICAR-NBAIR, Bengaluru	Biological pest control programme of palms and cocoa
ICAR-NBAIM, Mau	Microbial research network
ICAR-NBPGR, New Delhi	Germplasm registration and exchange of PGR
ICAR-IIOPR, Pedavegi	Cropping systems, tissue culture and biotechnological investigations
ICAR-NRC for Orchids, Pakyong	Technology Mission for the development of North Eastern states

Others

Coconut Development Board, Kochi	Research and development in coconut
Directorate of Arecanut and Spices Development, Kozhikode	Research and development in arecanut
DBT, New Delhi	Advancements in Biotechnology and Bioinformatics
Directorate of Cashew and Cocoa Development, Kochi	Research and development in cocoa
Govt. of Kerala/ Planning Board/ Rashtriya Krishi Vikas Yojana (RKVY)	Technology support programmes on coconut
DIT, New Delhi	Bioinformatics programmes
DST, New Delhi	Molecular biology research and women empowerment programmes
NABARD, Mumbai	Developing/ demonstrating model coconut clusters in root (wilt) affected areas
PPV & FRA, New Delhi	Plant variety registration, DUS Centre on coconut and arecanut, Development of cocoa DUS guidelines
KSCSTE, Thiruvananthapuram	Research in biotechnology and bioinformatics and funding science programmes
CAMPCO, Mangalore	Arecanut/ cocoa research and development

XIV RESEARCH PROJECTS

At present, 38 research projects, including 19 projects funded by external agencies, are being undertaken at the institute, as detailed below.

Projects/ Divisions	Crop Improvement	Crop Production	Crop Protection	Physiology, Biochemistry and PHT	Social Sciences	Total
Institute Project	5	3	3	4	4	**19**
NAIP/ Network	1	-	1	-	2	**4**
DBT	1	-	-	-	-	**1**
CDB	-	-	-	-	-	-
Others	5	1	2	3	3	**14**
Total	**12**	**4**	**6**	**7**	**9**	**38**

Institute Funded Projects

Project No.	Project Title	Project Leader	Associate (s)
1000761028	Genetic resources management of coconut, arecanut and cocoa	V. Niral	K.S. Ananda, S. Elain Apshara, K. Samsudeen, A. K. Sit, L.S. Singh, Alpana Das, N. R. Nagaraja, T.N. Ranjini, M. Suchithra, Y. Diwakar, M. Sujithra, R.Sudha, N. Najeeb, Regi Jacob Thomas, M.K. Rajesh, Anitha Karun, K.B. Hebbar, Thava Prakasa Pandian, E.K.Saneera, Shameena Begum, Shivaji H. Thube, C. Thamban, Ravi Bhat, Murali Gopal and Scientist from ICAR-CIARI, Andamans
1000761029	Genetic investigations and breeding in coconut, arecanut and cocoa	Regi Jacob Thomas	K. Samsudeen, V. Niral, K.S. Ananda, S. Elain Apshara, M. Shareefa, A.K. Sit, N.R. Nagaraja, Merin Babu, A. Joseph Rajkumar, L.S. Singh, Y. Diwakar, R. Sudha, T. N. Ranjini, M. Suchithra, N. Najeeb, Alpana Das, Scientist from ICAR-CIARI-Andaman and S. Sendur Kumaran (KVK, Kundrakudi)
1000761031	Development of tissue culture techniques in coconut	Anitha Karun	M. K. Rajesh, K. Devakumar, M.Neema, V. Aparna, Regi Jacob Thomas, and M. Shareefa
1000761030	Biotechnological applications in palms and cocoa	M.K. Rajesh	Anitha Karun, K.S. Ananda, P. Chowdappa, M. Neema, V. Aparna, Murali Gopal
1000761032	Development of double-stranded RNA	M.K. Rajesh	A. Joseph Rajkumar and S.V. Ramesh

	based food bait for the suppression of red palm weevil		
1000763057	Cropping/ farming approaches for improving soil health and system productivity in coconut, arecanut and cocoa	P. Subramanian	Ravi Bhat, H. P. Maheshwarappa, V. Krishnakumar, Surekha, V. Selvamani, Alka Gupta, Bhavishya, A. Abdul Haris, K. Nihad, Arun Kumar Sit, S. Neenu, K.S. Karthika, Alpana Das, L. S. Singh, V. H. Prathibha, P. S. Prathibha, and B. Narasimha Swamy
1000763058	Enhancing nutrient and water use efficiency for sustained productivity in coconut, arecanut and cocoa	Ravi Bhat	P. Subramanian, V. Krishnakumar, K. Nihad, V. Selvamani, S. Neenu, A. Abdul Haris, Jeena Mathew, Surekha, K.S. Karthika Alka Gupta, Murali Gopal, S. Indhuja, Arun Kumar Sit, S. Paulraj, Merin Babu, P. Anitha Kumari, Bhavishya and B. Narasimha Swamy
1000763055	Bioresources management in coconut, arecanut and cocoa	Alka Gupta	Murali Gopal, Ravi Bhat, P. Subramanian, H.P Maheswarappa, Vinayaka Hegde, V. Krishnakumar,A. Abdul Haris, S. Indhuja, V. Selvamani, K. Nihad, S. Neenu, K.S. Karthika, S. Paulraj, Jeena Mathew, Regi Jacob Thomas, Merin Babu, V.H. Prathibha, Surekha, M. Sujithra and B. Narasimha Swamy
1000765039	Integrated approaches for management of fungal diseases of palms and cocoa	Vinayaka Hegde	V.H. Prathibha, Thava Prakash Pandian, Daliyamol
1000765040	Diagnostics and management of root (wilt) disease (RWD) in coconut and yellow leaf disease (YLD) in arecanut	Vinayaka Hegde	K.B. Hebbar, A. Joseph Rajkumar, V.K. Chaturvedi, Murali Gopal, Merin Babu, U. Keerthana, Thava Prakash Pandian, S. Indhuja and Daliyamol
1000765041	Integrated management of pests and nematodes in palms and cocoa	Chandrika Mohan	A. Joseph Rajkumar, P.S. Prathibha, Rajkumar, M. Sujithra, Sivaji H. Thube, E.K Saneera, Jilu V. Sajan, Merin Babu, K.M. Anes, R.Thava Prakasa Pandian, Daliyamol, A.K. Sit, V.H. Prathibha
1000766014	Phenotyping for climate resilient adaptation and mitigation strategies	K.B. Hebbar	S.V. Ramesh, M. Arivalagan, S. Elain Apshara, S. Neenu, Surekha, V.K. Chaturvedi, A.K. Sit, B. Sravanthi
1000767018	Mechanization, processing, product diversification and nutraceutical properties	M.R. Manikantan	K.B. Hebbar, M. Arivalagan, A.C. Mathew, Shameena Beegum, R. Pandiselvam, Murali Gopal, S. Paulraj and Sucheta Kumari from KSHEMA, Mangalore
1000767019	Development of coconut milk powder using low investment	M.R. Manikantan	M. Arivalagan, A.C. Mathew, Shameena Beegum, R. Pandiselvam and S. Paulraj

	foam mat drying and ready to cook *kheer* mix		
1000769020	Technology transfer and co-learning action research approaches	C. Thamban	S. Kalavathy, P. Anithakumari, D. Jaganathan, C.T. Jose, K. Muralidharan, K.P. Chandran, S. Jayasekhar, Abdul Haris, Sandip Shil, Alpana Das in collaboration with other scientists of the Institute
1000769013	Socio-economic dimensions and value chain dynamics in policy perspective	S. Jayasekhar	K.P.Chandran, C.Thamban, K. Muralidharan, C.T. Jose and Sandip Shil
1000769019	Development of statistical and computational techniques for improving research methodology	C.T. Jose	K. Muralidharan, K.P Chandran, Sandip Shil, Shivaji H. Thube, Thavaprakash Pandian, D. Jaganathan
1000769022	Crop - weather modelling and methodological evaluation of crop insurance in plantation crops	K.P. Chandran	C.T. Jose, K. Muralidharan, Sandip Shil, S. Jayasekhar, K.B. Hebbar, S. Kalavathi

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	K.S. Ananda	-
1050761115	Development of DUS testing criteria and establishment of genebank for cocoa	S. Elain Apshara	-
1050761107	Large-scale production of elite and hybrid seedlings of coconut for the root (wilt) disease prevalent tract	Regi Jacob Thomas	M. Shareefa, Merin Babu and S. Kalavathi
2010760004	Seed production in coconut, arecanut, cocoa (Under ICAR Project on seed production in agricultural crops)	K. Samsudeen	K. S. Ananda, V Niral, S.Elain Apshara Regi Jacob Thomas, M. Shareefa, Devakumar, Surekha, K. M. Anes, Murali Gopal and Y. Diwakar

1050231012	Development of a database for plantation crops for biologists	M.K. Rajesh	P. Chowdappa, Anitha Karun
1050761098	Enhancing economic viability of coconut based land use system for land use planning in Kerala	V. Krishnakumar	Jeena Mathew, Ravi Bhat, V. Selvamani, C. Thamban, A. Abdul Haris, K.P. Chandran S. Indhuja, S. Neenu, P. Subramanian
1050761109	Mass production of plant growth promoting microbes and bio-control agents for sustainability of coconut based farming system	Vinayaka Hegde	V.H. Prathibha, Alka Gupta, Murali Gopal, C. Thamban, and P. Chowdappa
1050761105	Demonstration of EPN in arecanut for the management of root grub	Rajkumar	D. Jaganathan and Shivaji H. Thube
1050761119	Development of ready to eat extruded snacks from co-products of coconut processing	M.R. Manikantan	Shameena Beegum and R. Pandiselvam
1050761112	Techno-socio-economic assessment of soil & water conservation and water harvesting structures	A.C. Mathew	C. Thamban, P. Muralidharan and S. Jayashekhar
1050761113	Design and development of an air blast sprayer for arecanut	A.C. Mathew	R. Pandiselvam and D. Dhalin from KAU, Vellayani
1000767021	Development of tender coconut trimming machine and preservation protocol for trimmed tender coconut	R. Pandiselvam	A.C. Mathew, M.R. Manikantan and Shameena Beegum
1050761108	Consortium Research Platform (CRP) on farm mechanization and precision farming	L.S. Singh	-
1050761117	Participatory technology integration to empower and ensure livelihood security of farmers in Alappuzha district	P. Chowdappa, P. Anithakumari	A. Joseph Rajkumar, K. Nihad, M. Shareefa, Jeena Mathew, S. Indhuja, Merin Babu, D. Jaganathan, Anu George, KVASU

1050761118	Participatory demonstration plots on arecanut based multispecies cropping system	N. R. Nagaraja	C. T. Jose, S. Elain Apshara, Bhavishya, Rajkumar
2010760007	Intellectual property management and transfer/ commercialization of agricultural technology scheme	P. Chowdappa	K. Muralidharan, A.C. Mathew, M.R. Manikantan
1050761110	Establishment of Agri-Business Incubation (ABI) Centre at ICAR-CPCRI, Kasaragod	K. Muralidharan	A.C. Mathew, M.R. Manikantan, R. Pandiselvam, D. Jaganathan

XV

RESEARCH AND ORGANIZATIONAL MANAGEMENT

Research Advisory Committee Meeting

The XX Research Advisory Committee Meeting of the institute was held at ICAR-Central Plantation Crops Research Institute, Kasaragod during 5th and 6th March, 2018, under the chairmanship of Dr. H.P. Singh, former Deputy Director General (Hort. Science), ICAR. Dr. P. Das, Dr. N. Kumar, Dr. P. Chowdappa, Director, ICAR-CPCRI, Dr. W.S. Dhillon, ADG (Hort. Science-II), ICAR, New Delhi, Shri. Suresh Kumar Shettty, Shri. Shivakrishna Bhat, Members and Dr. K.B. Hebbar, HD (PB & PHT) Member Secretary, along with the scientists of ICAR-CPCRI, KVK-Kasaragod, KVK-Alappuzha participated in the meeting. Dr. P. Chowdappa, Director, ICAR-CPCRI extended A warm welcome to the Chairman and members of the committee. In his presentation, he highlighted the achievements of ICAR-CPCRI and the progress made during the year.

Dr. H.P. Singh, former DDG (Hort. Science), ICAR and Chairman RAC, addressing the scientists

Following were the recommendations made by the RAC:

- Strengthen efforts to generate mapping populations in coconut using segregating populations already available within the Institute and AICRPP centres.
- Efforts may be made to sequence the whole genome of a tall variety of coconut to identify genes controlling plant habit by comparing with the genome of the dwarf cultivar already available.
- Generate genome sequence of arecanut, to decipher genes responsible for arecoline content to aid development of varieties with low arecoline content.
- Reinforce work on climate-smart management of palms and cocoa, to combat anticipated effects of climate change and develop suitable varieties to meet future challenges.
- Strengthen production of quality planting materials through Public-Private-Partnership mode.
- Scale up initiatives in value addition in coconut and arecanut.
- Scale up multiplication and area-wide release of parasitoids/ biocontrol agents to suppress rugose spiralling whitefly in collaboration with AICRPs.
- Assess impact of technologies developed by the Institute auguring social and economic transformation.

Institute Research Committee Meeting

The 45th Annual Institute Research Committee Meeting of the ICAR-Central Plantation Crops Research Institute was held at Kasaragod from 3rd to 7th April 2017, under the chairmanship of Dr. P. Chowdappa, Director. The meeting was conducted in nine sessions, including an introductory and a plenary session, for reviewing 38 research projects, including 28 externally funded projects. Progress of work and achievements made under the ongoing research projects were discussed in detail and the technical programme for the year 2017-18 was formulated. The plenary session was held on 07th April, 2017, with Dr. P. Chowdappa, Director, ICAR-CPCRI, Kasaragod as the chairman and Dr. K. Nirmal Babu, Director, ICAR-IISR, Kozhikode as the co-chair. Shri Jeevan Saldanha, Karnataka Chamber of Commerce, Dr. P.R. Suresh, Associate Director of Research, RARS (KAU), Pilicode and Shri Babulal Meena, Directorate of Arecanut and Spices Development, Kozhikode were

the special dignitaries. Shri H.M. Shiva Prasad, Shri B.K. Ramesh and Shri K.H. Krishna Prasad, farmer representatives, presented the farmers requirements, for refinement of the research programmes of the Institute. Dr. P. Chowdappa, Chairman, highlighted the salient research accomplishments of the Institute and projected the viable technologies for the industrial and farming sector, augmenting economic and social sustainability. He expressed commitment and full support of ICAR-CPCRI to double farmers' income. Dr. Nirmal Babu, Co-Chair, stressed on the need for popularizing technologies in a better way and frequent interactions with business experts for marketing of the technologies.

Dr. K. Nirmal Babu, Director ICAR-IISR, Kozhikode addressing the 45th IRC Meeting

The 46th annual Institute Research Committee Meeting of the institute was held at ICAR-CPCRI Kasaragod during 20th to 24th March, 2018. During the IRC meeting, all the ongoing research projects (including externally funded projects), grouped under seven research programmes, were discussed in detail and the technical programme for the year 2018-19 was fine-tuned based on RAC and QRT recommendations and farmer's need and finalized. The plenary session was held on 24th March, 2018 under the chairmanship of Dr. P. Chowdappa, Director. The session was co-chaired by Dr. Homey Cheriyan, Director, Directorate of Arecanut and Spices Development, Kozhikode, Kerala. The progress of research and achievements under the ongoing projects under crop improvement, biotechnology, crop production, disease management, pest management, physiology & biochemistry, pre and post-harvest technology, value addition and social sciences, including transfer of technologies were presented by the respective Principal Investigators. Dr. Shishir N.Y. Kolathaya delivered a special lecture on artificial intelligence and its relevance/probable applications in agriculture during the plenary session

Institute Management Committee meeting

The IMC meeting was held on 3rd March, 2018 at ICAR-CPCRI, Kasaragod under the chairmanship of Dr. P. Chowdappa, Director. Major activities of the institute were presented before the IMC members, the critical issues were deliberated and recommendations were evolved. The reconstituted Institute Grievance Committee was approved during the meeting.

Dr. P. Chowdappa, Director, ICAR-CPCRI interacting with IMC members

XIV INTELLECTUAL PROPERTY AND TECHNOLOGY MANAGEMENT

Patents granted

The Institute has acquired the following patent and trademarks during this period:

Sl. No.	Name of the Patent	Patent No.	Inventors
1	Coconut chips slicing machine	285418 dated 19-07-2017	Dr. Mathew A.C. and Dr. Madhavan K.

Trademarks Registered

Sl. No.	Trademark type	TM Class	Registration No.
1	CPCRI (Emblem)	99	2574582 dated 27-12-2016
2	Kalpa (Collective mark)	99	2320116 dated 19-09-2016
3	Kalparasa (Collective mark)	32	2813919 dated 02-10-2017
4	Cocoa Probio	1	2813920 dated 04-10-2017

Consultancy services

Consultancy services were taken up as part of the professional service functions of the Institute during 2017-18 as detailed below:

Sl. No.	Consultancy service	Client	Amount (Rs.)
1	Nutrient analysis of neem cake	Mr. Shukoor K.N.Kanaje, Kasaragod	1250.00
2	Balance 40 % of the sampling cost for collecting 150 nos. soil samples @ Rs. 22/-	The Assistant Soil Chemist, Office of the Assistant Soil Chemist Soil Testing Laboratory, Kasaragod	1320.00
3	Nutrient analysis of plant	Ms. Rajina M., Taliparamba	6000.00
4	Nutrient analysis of neem cake and organic manure	Agricultural Officer, Krishi Bhavan Enmakaje, Kasaragod	2500.00
5	Nutrient analysis of organic manure	Panchayat Development Officer Grama Panchayath, Belthangadi	1250.00
6	Nutrient analysis of organic compost	Jeeva Organic, Hassan	2500.00
		Total	**14820.00**

The scientific expertise of the Institute has been utilized in completion of various contract research/consultancy projects during 2017-18. The details are as below:

Sl. No.	Particulars	Client	Amount (Rs.)
1	Contract Research Project on "Evaluation of Mangala Kolenashak against fruit rot disease of arecanut"	Dr. Adarsha T.S., Mangalore Chemicals & Fertilizers Limited, Hassan	128495.00
2	Contract Research Project on "Evaluating the field efficacy and agronomic suitability of the product 'Mangala Kalpavruksha' on arecanut	Dr. Adarsha T.S., Mangalore Chemicals & Fertilizers Limited, Hassan	121680.00
3	Consultancy project entitled "Impact of climatic change on coconut, areca nut, cocoa and adaptation strategies"	Ministry of Environment, Forest and Climate Change, Government of India, New Delhi	982000.00
	Total		**1232175.00**

Technology commercialization

During the period, 17 technologies were commercialized through non-exclusive licensing with memorandum of agreement as per the details given below, an amount of Rs. 17,26,000/- have been collected as technology transfer fees.

Sl. No.	Name of technology commercialized	Date of signing MOU	Value (in Rs.)	Licensee
1	Collection of fresh and hygienic Kalparasa and production of natural coconut sugar	18-04-2017	15,000	Mr. Ganapati S. Naik, AVP Uttara Kannada Coconut Farmers Producer Company Ltd., Karnataka
		01-06-2017	15,000	Mr. V. Gnanasambandam, Ramanuja Nagar, Coimbatore
		16-06-2017	15,000	Mr. T.H. Siva Prasad, Chitlapakkam, Chennai
		19-06-2017	15,000	Mr. Dilip Kumar Raju Indukuri, Vadlavanipalem, West Godavari District
		22-06-2017	15,000	Mr. Vishnu Charan, Singanallur, Coimbatore
		25-09-2017	15,000	Mr. K.S. Somashekhar Reddy, Vedhavathi Coconut Producers Federation, Challakere, Chitradurga
		15-09-2017	15,000	ICAR- Taralabalu Krishi Vigyan Kendra, Davanagere
		26-10-2017	15,000	Kalpatharu Coconut Producer Co. Ltd., Turuvekere, Tumkur
		27-10-2017	15,000	Maharaja Coconut Producer Company, Chapuradoddy, Mandya
		06-12-2017	50,000	Madhura Agro Process Pvt. Ltd., Coimbatore
		19-12-2017	50,000	Gurushri Farmer Producer Co. Ltd., Beeraganahally, Tumkur
		19-12-2017	50,000	Malenadu Nuts & Spices Producers Co. Ltd., Bhadravathi

		19-12-2017	50,000	Nunke Male Siddeshwara Producer Co. Ltd., Chitradurga
2	Technical know-how of production of virgin coconut oil (VCO)	22-05-2017	40,000	Mr. Shridhar Mallaiah, Vidyashankar Nagar, Mysore
		19-07-2017	40,000	C. Nandihally Coconut Producer's Federation, Gubbi Taluk, Tumkur
		19-07-2017	40,000	Kalpatheertha Coconut Producer Company Ltd, Tumkur
		06-12-2017	40,000	Madhura Agro Process Pvt. Ltd., Coimbatore
		16-01-2018	40,000	Krishna Plantations Pvt. Ltd., Margao
3	Design and drawing of VCO cooker	21-06-2017	20,000	Mr. M. Nachimuthu, N.M. Engineering Industries, Coimbatore
4	Technical know-how of production of coconut chips	18-05-2017	15,000	Crisco, Nammalwarpet, Chennai
		22-05-2017	15,000	Mr. Abdul Rasheed P.K., Kakkadampuram, Malappuram, Kerala
		16-06-2017	15,000	Mrs. Lisha M. M., Kuttiadi, Kozhikode
		14-09-2017	15,000	Mr. Haridasan Potty, Thiruvalla
		16-10-2017	15,000	Ms. Nithy Cesil, Chennai
		06-12-2017	15,000	Madhura Agro Process Pvt Ltd, Coimbatore
		01-03-2018	15,000	Mr. D.A. Mohammed Arif, Kasaragod
5	Matured coconut based value added products	03-04-2017	15,000	Mr. Nijo Raju Mathew, Kumbazha
		25-04-2017	15,000	Perambra Coconut Producer Company, Perambra, Kozhikode
		22-05-2017	15,000	Mr. Shridhar Mallaiah, Mysore
		22-05-2017	15,000	Mr. Abdul Rasheed P.K., Malappuram
		18-05-2017	15,000	Crisco, Nammalwarpet, Chennai, Tamil Nadu
6	Preservation of carbonated tender coconut water	25-05-2017	25,000	Mr. S. Chidambaranathan, Coimbatore
		26-09-2017	25,000	Mr. Sachin U., Kasaragod
		22-08-2017	25,000	Mr. Sreevidya Shaju, Thrissur
7	Coconut de-shelling machine	20-09-2017	1,000	Deepika Agro Products, Salem
8	Frozen coconut delicacy	08-09-2017	60,000	Hangyo Ice Cream Private Limited, Brahmavar
9	Nanomatrix for delivery of pheromone for the management of red palm weevil and rhinoceros beetle (Jointly developed technology of ICAR-CPCRI & JMCASR)	10-07-2017	3,00,000	Agro PheroSolutionz, Hyderabad
10	Process of carbonated tender coconut water	08-11-2017	25,000	Mr. A. Rajagopalan, Thrissur

11	Technical know-how of Kalpa Organic Gold (coconut leaf vermicompost)	27-11-2017	20,000	M/s SPIC Agro Biotech Centre, Coimbatore
12	Technical know-how of Kalpa Soil Care (urea free coir pith composting)	27-11-2017	25,000	M/s SPIC Agro Biotech Centre, Coimbatore
13	Technical know-how of frozen coconut delicacy	06-12-2017	60,000	Madhura Agro Process Pvt. Ltd., Coimbatore
14	Protocol for arecanut tissue culture	13-12-2017	2,50,000	M/s SPIC Agro Biotech Centre, Coimbatore
15	Arecanut tissue culture protocol for mass production of Dwarf Arecanut Hybrid VTLAH2	08-01-2018	1,00,000	M/s SPIC Agro Biotech Centre, Coimbatore
16	Technical know-how of Kera Probio talc formulation	31-01-2018	50,000	Farmer First Programme, Pathiyoor Grama Panchayath, Alappuzha
17	Technical know-how of Kalpa Soil Care	26-02-2018	25,000	Mr. Sebastian K. Philip, Kannur
	Total		**17,26,000**	

Dr. P. Chowdappa, Director, ICAR-CPCRI handing over Kalparasa technology to President of Coconut Producers Federation at Kasaragod in the presence of Shri H. Ekantaiah, Former Minister, Govt. of India, Karnataka

Sale of technology products

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

Sl. No.	Item	Qty. / Nos.	Total Amount
1	Book	1017	77642
2	CD	2	600
3	Earthworms	2150	1699
4	Vermicompost	7174	98217
5	Coconut	325174	4092381
6	Mushroom spawn	10	880
7	Coir pith Compost	57	627
8	KeraProbio	114	3135
9	Vermiwash	1	110
10	*Trichoderma*	13.52	1487
11	Immature nuts	123	1076
12	Entomopathogenic nematodes	2	220
13	Coconut seedlings (Hybrid)	26715	7128500
14	Coconut seedlings (Dwarf)	8113	1510614
15	Coconut seedlings (Tall)	8106	778281
16	Poly bag coconut seedlings (Hybrid)	408	116688
17	Poly bag coconut seedlings (Tall)	1197	152712
18	Poly bag coconut seedlings (Dwarf)	743	192408
19	Tall seednuts	159	8745
20	Dwarf seednuts	2425	13865
21	Polybag *inter se* coconut seedlings	13	1859
22	Arecanut seednuts	550025	4151200
23	Arecanut seedlings	55582	971640
24	Black pepper cuttings	15000	225000
25	Acid lime	1200	18000
26	Cocoa seedlings	1905	19050
	Total		**1,97,96,191**

XVII PERSONNEL

Scientific Staff

Kasaragod

Sl. No.	NAME	DESIGNATION
1.	Dr. Chowdappa P.	Director
2.	Dr. Maheswarappa H.P.	Project Coordinator (Palms)
3.	Dr. Ravi Bhat	HD (Crop Production)
4.	Dr. Hebbar K.B.	Acting HD (PB & PHT)
5.	Dr. Vinayaka Hegde	HD (Crop Protection)
6.	Dr. (Mrs.). Anitha Karun	HD (Crop Improvement)
7.	Dr.Thamban C.	Acting HD (Social Sciences) up to 31.12.2017
8.	Dr. Muralidharan K.	Acting HD (Social Sciences)w.e.f. 1.1.2018
9.	Dr. Murali Gopal	Principal Scientist (Agril. Microbiology)
10.	Dr. (Mrs.) Alka Gupta	Principal Scientist (Agril. Microbiology)
11.	Dr. (Mrs.) Niral V.	Principal Scientist (Genetics)
12.	Dr. Subramanian P.	Principal Scientist (Agronomy)
13.	Dr. Mathew A.C.	Principal Scientist (Soil&Water Conservation Engg.)
14.	Dr. Samsudeen K.	Principal Scientist (Economic Botany)
15.	Dr. Rajesh M.K.	Principal Scientist (Agril. Biotechnology)
16.	Dr. Bhanuprakash	Principal Scientist (Plant Physiology) w.e.f. 10.7.2017
17.	Dr. Chandran K.P.	Senior Scientist (Agril. Statistics)
18.	Dr. Manikantan M.R.	Senior Scientist (Agril Process Engg.)
19.	Dr. Devakumar K.	Senior Scientist (Agril. Biotechnology) up to 20.6.2017
20.	Sri Jayasekhar S.	Scientist Sr. Scale (Agril. Economics)
21.	Dr. Jaganathan D.	Scientist (Agril. Extension) up to 31.5.2017
22.	Dr. Selvamani V.	Scientist (Soil Science)
23.	Sri Arivalagan M.	Scientist (Biochemistry)
24.	Dr. (Mrs.) Prathibha P.S.	Scientist (Agril. Entomology)
25.	Dr. Rajkumar	Scientist (Nematology)
26.	Dr. (Mrs.)Prathibha V.H.	Scientist (Plant Pathology)
27.	Smt. Surekha	Scientist (Agronomy)
28.	Dr. Sujithra M.	Scientist (Agril. Entomology)
29.	Dr. (Mrs.) Neenu S.	Scientist (Soil Science)
30.	Dr. (Mrs.) Neema M.	Scientist (SPM&AP)
31.	Smt. Sumitha S.	Scientist (SPM&AP)
32.	Sri Krishna Prakash	Scientist (SPM&AP) (on Study Leave)
33.	Smt. Aparna Veluru	Scientist (SPM&AP)
34.	Dr. Shameena Beegum	Scientist (SPM&AP)
35.	Smt. G. Panjavarnam	Scientist (Fruit Science) (on Study Leave)
36.	Dr. Paulraj S.	Scientist (Microbiology)
37.	Smt. Jilu V. Sajan	Scientist (Agril. Entomology)
38.	Sri Pandiselvam R.	Scientist (Agril. Process Engg.)

39.	Kum. Ranjini T.N.	Scientist (SP&M&AP)
40.	Smt. Keerthana Umapathy	Scientist (Plant Pathology)
41.	Dr. Ramesh S.V.	Scientist (Biotechnology)
42.	Dr. Sudha R.	Scientist (Fruit Science)
43.	Sri Bhukya Narasimha Swamy	Scientist
44.	Smt. Bandela Sravanthi	Scientist

KVK, CPCRI, Kasaragod

Sl. No.	NAME	DESIGNATION
45.	Dr. Manojkumar T. S.	Principal Scientist & Head, KVK

Kayamkulam

Sl. No.	NAME	DESIGNATION
46.	Dr. Krishnakumar V.	Head
47.	Dr. Chandrika Mohan	Principal Scientist (Ag. Entomology)
48.	Dr. (Mrs.) Anitha Kumari P.	Principal Scientist (Ag. Extension)
49.	Dr. (Mrs.)Kalavathy S.	Principal Scientist (Ag. Extension)
50.	Dr. Chaturvedi V.K.	Senior Scientist (Biochemistry) up to 30.9.2017
51.	Dr. Regi Jacob Thomas	Principal Scientist (Hort.)
52.	Dr. Joseph Rajkumar	Principal Scientist (Ag. Entomology)
53.	Dr. (Mrs.) Nihad	Scientist (Hort.)
54.	Dr. Jeena Mathew	Scientist (Soil Science)
55.	Dr. (Mrs.) Shareefa M	Scientist (Hort)
56.	Dr. (Mrs.) Merin Babu	Scientist (Plant Pathology)
57.	Dr. Abdul Haris	Principal Scientist (Agronomy)
58.	Dr. (Mrs.) Indhuja S.	Scientist (Microbiology)
59.	Smt. Daliyamol	Scientist (Plant Pathology)
60.	Dr. Anes K.M.	Scientist (Nematology)

KVK, CPCRI, RS, Kayamkulam

Sl. No.	NAME	DESIGNATION
61.	Dr. Muralidharan P.	Pr. Scientist & Head, KVK

Vittal

Sl. No.	NAME	DESIGNATION
62.	Dr. Ananda K.S.	Head
63.	Dr. Jose C.T.	Principal Scientist (Agril. Stati.)
64.	Dr. Elain Apshara S.	Principal Scientist (Horticulture)
65.	Dr. Senthil Amudhan M.	Senior Scientist (Biochemistry)
66.	Sri Nagaraj N.R.	Scientist (Plant Breeding)
67.	Kum. Chaithra M	Scientist (Plant Pathology)
68.	Smt. Priya U.K.	Scientist (Soil Science)
69.	Smt. Karthika K.S.	Scientist (Soil Science)
70.	Sri Bhavishya	Scientist (SPM&AP)
71.	Sri Shivaji Hausrao Thube	Scientist (Agril. Entomology)
72.	Smt. Saneera E.K.	Scientist (Agril. Entomology)
73.	Kum. Suchithra M.	Scientist (SP&M&AP)
74.	Dr. Thava Prakash Pandian R.	Scientist (Plant Pathology)
75.	Sri Najeeb Naduthodi	Scientist (Fruit Science)

Kidu

Sl. No.	NAME	DESIGNATION
76.	Sri Khadke Ganesh Navanath	Scientist (SPM&AP)
77.	Sri Diwakar Y.	Scientist (SPM&AP) (w.e.f. 02.05.16)

Mohitnagar

Sl. No.	NAME	DESIGNATION
78.	Dr. Arunkumar Sit	Principal Scientist (Hort.)
79.	Dr. Sandip Shil	Scientist (Agril. Statistics)

Kahikuchi

Sl. No.	NAME	DESIGNATION
80.	Dr. (Mrs.) Alpana Das	Senior Scientist (Agril. Biotechnology)
81.	Sri Anok Uchoi	Scientist (SPM&AP)
82.	Dr. Leichombam Singhajit Singh	Scientist (SPM&AP)

Technical Staff

Kasaragod

Sl. No.	NAME	DESIGNATION
83.	Sri Muralikrishna H .	Chief Technical Officer (Technical Information)
84.	Dr. Sajini K.K.	Chief Technical Officer (Lab.)
85.	Sri John George	Chief Technical Officer (Lab.)
86.	Sri Sebastian A. George	Chief Technical Officer (Lab)
87.	Sri Mohammed Basheer B.M.	Chief Technical Officer (Lab) up to 30.11.2017
88.	Smt. Shobha K.	Chief Technical Officer (Library)
89.	Sri Ravindran P.	Asst. CTO (F/F)
90.	Sri Bikash Chowdhury	Asst. CTO (Field/Farm)
91.	Sri Devadas K.	Asst. CTO (F/F)
92.	Smt. Sugatha Padmanabhan	Sr. Tech. Officer (Lab.)
93.	Sri Ramakrishnan N	Asst. CTO (F/F)
94.	Smt. Sreelatha K.	Asst .Chief Tech. Officer (OL)
95.	Sri Shyama Prasad K.	Asst. CTO (Programme Assistant (Audio Visual)
96.	Sri Krishnan M.	Tech. Officer (Field/Farm)
97.	Sri Sadanandan A.	Tech. Officer (Mech. Engg.)
98.	Sri Rajendran Nair M.P	Tech. Officer (Mech. Engg.)
99.	Sri Hareesh G.S.	Tech. Officer (Instrumentation Engg.)
100.	Sri Balakrishnan K.	Tech. Officer (Field/Farm)
101.	Sri Ajith Kumar K.	Tech. Officer (Civil Engg.)
102.	Sri Gopalakrishnan V.K.	Tech. Officer (Civil Engg.)
103.	Sri Balakrishnan V.	Tech. Officer (Field/Farm)
104.	Sri Manohara S.	Tech. Officer (Vehicles)
105.	Sri Pankajakshan K.N.	Sr. Tech. Assistant (Vehicles)
106.	Sri Radhakrishnan Nambiar K.N.	Sr. Tech. Assistant (Field/Farm)
107.	Sri Suresh Kumar V.	Sr. Tech. Assistant (Field/Farm)
108.	Sri Krishnan Nair K.	Sr. Tech. Assistant (Field/Farm)
109.	Sri Devaraj K.	Sr. Tech. Assistant (Jr. Engineer)
110.	Sri Raghavan K.	Tech. Assistant (Field/Farm)
111.	Sri Madhavan M.V.	Tech. Assistant (Field/Farm)
112.	Sri Sanjeeva A.	Tech. Assistant (Field/Farm)
113.	Dr. Muralikrishna K.S.	Tech. Assistant (Field/Farm)

114.	Smt. Nivedhitha M..S	Tech. Assistant (Field/Farm)
115.	Smt. Jesmi Vijayan	Tech. Assistant (Field/Farm)
116.	Sri Satheesh Kumar A.V.	Sr. Technician (Vehicles)
117.	Sri Panduranga	Sr. Technician (Field/Farm)
118.	Sri Krishnankutty P.K.	Jr. Technical Assistant (Field/Farm)
119.	Sri Bhavani Sankar Naik	Sr. Technician (Field/Farm)
120.	Sri Divakaran A.	Sr. Technician (Field/Farm)
121.	Sri SebastianK. J.	Sr. Technician (Field/Farm)
123.	Sri Radhakrishnan V.	Sr. Technician (Field/Farm)
124.	Sri Dinesh Kumar N.	Sr. Technician (Field/Farm)
125.	Sri Varghese A.O.	Sr. Technician (Field/Farm)
126.	Sri Sunil S.	Sr. Technician (Eleectrical Engineering)
127.	Smt. Vimala M.	Sr. Technician (Field/Farm)

KVK (Kasaragod)

Sl. No.	NAME	DESIGNATION
128.	Dr. Leena S.	Chief Technical Officer (SMS)(Entomology)
129.	Sri Sanal Kumar R.	Chief Technical Officer (SMS)(Plant Pathology)
130.	Dr. Saritha Hegde	Chief Technical Officer (SMS)(Home Science)
131.	Dr. Neelofar Illiaskutty	CTO (Programme Assistant)(Home Science)
132.	Smt. Jayashree M.P.	Asst. CTO (SMS) (Agrl. Extn.)
133.	Sri Manikandan K.	Sr. Tech. Officer (Programme Assistant (Hort.)
134.	Sri Ramadas A.K.	Tech. Asst. (Vehicles)

Kayamkulam

Sl. No.	NAME	DESIGNATION
135.	Dr. Keshavan Nampoothiri C.	CTO (Statistics)
136.	Dr. Shanavas M.	CTO (Lab.)
137.	Sri Thajuddin S.	Asst. CTO (Library)
138.	Dr. Rajeev G.	Asst. CTO (Lab.)
139.	Sri Jacob Kurian	Asst. CTO (Field/Farm)
140.	Dr. Narayanan Namboothiri C.G.	Asst. Chief Tech. Officer (Field/Farm)
141.	Sri Sudhanandan K.K.	Senior Tech. Officer (Field/Farm)
142.	Sri Anilkumar B.	Tech. Officer (Field/Farm)
143.	Sri Rajendran K.	Tech. Officer (Field/Farm)
144.	Sri Asokan E.R.	Tech. Officer (Photography)
145.	Sri Udayabhanu K.P.	Tech. Officer (Field/Farm)
146.	Sri Sunny Thomas	Senior Tech. Assistant (Field/Farm)
147.	Sri Sunil Kumar P.K.	Tech. Assistant (Field/Farm)
148.	Sri Jinu Sivadasan	Tech. Assistant (Field/Farm)
149.	Sri Joy V.P.	Tech. Assistant (Field/Farm)

KVK, Kayamkulam

Sl. No.	NAME	DESIGNATION
150.	Sri Rajeev M.S.	Asst. CTO (Subject Matter Specialist)(Agronomy)
151.	Dr. Ravi S.	Asst. CTO (Subject Matter Specialist)(Animal husbandry)
152.	Dr. Sivakumar T.	Asst. CTO (Subject Matter Specialist)(Agrl. Entomology)
153.	Smt. Lekha G.	Asst. CTO (Subject Matter Specialist)(Plant Pathology)
154.	Smt. Jissy George	Asst. CTO (Subject Matter Specialist)(Home Science)

155.	Dr. Sajnanath	Asst. CTO (Subject Matter Specialist)(Soil Science)
156.	Sri Ansary K.M.	Technical Assistant(Computer)
157.	Smt. Bijila P.V.	Technical Assistant (Hort.)
158.	Sri Dayanandan Unnithan T	Sr. Technical Assistant (Vehicles)

Vittal

Sl. No.	NAME	DESIGNATION
159.	Dr. Moosa H.	Chief Technical Officer (Field/Farm)
160.	Smt. Meenakshy Patil	Sr. Technical Officer (Library)
161.	Sri Purandhara C.	Technical Officer (Field/Farm)
162.	Sri Adolpheno Francis Mascaranchas	Sr. Technical Assistant (Electrical Engineering)
163.	Sri Sreenivasa Bhat Y.	Sr. Technical Assistant (Field/Farm)
164.	Sri Abdul Aziz	Sr. Technical Assistant (Field/Farm)
165.	Sri Ananda Gowda B.	Technical Assistant (Field/Farm)
166.	Sri Chandrasekhara Shetty V.	Technical Assistant (Vehicles)
167.	Sri Ramanna Gowda	Technical Assistant (Vehicles)
168.	Sri Tharanatha Naik. K	Sr. Technician (Vehicles)
169.	Sri Santhosh Kumar P.	Technical Assistant (Field/Farm)
170.	Sri Sreedharan M.V.	Sr. Tech. Assistant (Field/Farm)
171.	Sri Padmanabha Naik A.R.	Sr. Technician (Field/Farm)

Kidu

Sl. No.	NAME	DESIGNATION
172.	Sri Nagesha N.	Technical Officer (Field/Farm)
173.	Sri Chandra Nairy	Technical Officer (Field/Farm)
174.	Sri Manamohana M.	Technical Officer (Mechanical Engineering)
175.	Sri Narayana Naik	Sr. Technical Assistant (Field/Farm)
176.	Sri Gopalakrishna A.S.	Sr. Technical Assistant (Field/Farm)

Mohitnagar

Sl. No.	NAME	DESIGNATION
177.	Dr. Saran Kumar Rizal	Chief Technical Officer (Field/Farm) w.e.f. 21.02.2018
178.	Sri Avrajyothi Ghosh	Asst. Chief Technical Officer (Field/Farm)
179.	Sri Jagadish Roy Burman	Sr. Technical Assistant (Field/Farm)
180.	Sri Jagadish Roy	Sr. Technical Assistant (Vehicles)
181.	Sri Pratap Kumar Sarkar	Technical Assistant (Field/Farm)

Kahikuchi

Sl. No.	NAME	DESIGNATION
182.	Dr. Saran Kumar Raizal	Chief Technical Officer (Field/Farm) up to 20.02.2018
183.	Sri Das N .C.	Technical Officer (Field/Farm)
184.	Sri Gopinath Malekar	Technical Assistant (Vehicles)
185.	Sri Prakash Burman	Sr. Technician (Field/Farm)

Administrative Staff

Kasaragod

Sl. No.	NAME	DESIGNATION
186.	Sri Sureshkumar	Chief Administrative Officer up to 08.11.2017
187.	Sri T.D.S. Prakash	F&AO up to 25.4.2017
188.	Sri Bose S.K.C.	Sr. Finance & Accounts Officer 21.4.2017 to 31.7.2017
189.	Sri Ram Avathar Parashar	Sr. Finance & Accounts Officer w.e.f. 26.12.2017
190.	Smt. Narayani K.	Private Secretary
191.	Smt. Girija Chandran	Private Secretary
192.	Smt. Sulochana Nair	Private Secretary
193.	Sri Kunhiraman Nair K.	Private Secretary (PS to Director)
194.	Sri K.M. Jayaram Naik	Administrative Officer up to 29.04.2017
195.	Sri JanardhananT.E.	Administrative Officer w.e.f. 23.12.2017
196.	Smt. Prabhavathy K.	Assistant Administrative Officer up to 31.5.2017
197.	Sri Nithianandan K.R.	Assistant Administrative Officer
198.	Sri Bhageerath K.G.	Assistant Administrative Officer
199.	Smt. Reetha M.	Assistant Administrative Officer
200.	Sri Vidhyadharan T.N.	Assistant
201.	Smt. Luizy D'Souza	Assistant Administrative Officer w.e.f. 01.06.2017
202.	Smt. Vishalakshi K.S.	Assistant
203.	Sri Thomas P.M.	Assistant
204.	Sri Ramadasan K.	Assistant
205.	Smt. Sheenakumari K.T.K.	Assistant
206.	Sri Narayana Naik P.	Assistant
207.	Sri Unni K.T.	Personal Assistant
208.	Smt. Sheeja P.P.	Junior Accounts Officer up to 14.11.2017
209.	Smt. Arathi A.R.	Stenographer Gr.III
210.	Smt. Rupa Manikandan	Upper Division Clerk
211.	Smt. Preethi K.	Upper Division Clerk
212	Sri Paulson Sam George	Upper Division Clerk
213.	Smt. Remya T.R.	Lower Division Clerk
214.	Sri Gangadharan T.K.	Lower Division Clerk
215.	Smt. Mary A.J.	Lower Division Clerk
216.	Sri Udayakumar N.	Lower Division Clerk
217.	Sri Pramodkumar P.K.	Lower Division Clerk
218.	Sri Jayarajan Valiyaveetil	Lower Division Clerk
219.	Sri Umesh Kumar	Lower Division Clerk
220.	Sri Dinesh	Lower Division Clerk
221.	Sri Ratan Singh	Lower Division Clerk

Kayamkulam

Sl. No.	NAME	DESIGNATION
222.	Sri Pradeep Kumar Vasu	Assistant Administrative Officer
223.	Sri Baburaj S.B.	Asst. Finance & Accounts Officer
224.	Sri Haridas K.	Assistant
225.	Sri Venugopal K.	Assistant
226.	Smt. Sreelatha K.	Assistant
227.	Sri Ramesh Babu C.	Personal Assistant
228.	Sri Prasanna Sarangan	Personal Assistant

229.	Smt. Madhavikutty V.	Assistant w.e.f. 16.3.2018
230.	Smt. Annamma N. Topino	Assistant w.e.f. 16.3.2018
231.	Smt. Rejitha K.R.	Stenographer Gr. III

Vittal

Sl. No.	NAME	DESIGNATION
232.	Sri Krishna Naik P.	Asst. Admn. Officer
233.	Sri Sasi K.K.	Asst. Finance & Accounts Officer
234.	SriMohammed Haneefa P.K.	LDC
235.	Smt. Jayashree K.	UDC
236.	Sri Aswin Reghunath	UDC

Kidu

Sl. No.	NAME	DESIGNATION
237.	Sri RavindranM.	Assistant Administrative Officer
238.	Smt. Lakshmi Narayana	Lower Division Clerk
239.	Sri Arun N.K. Raj	Lower Division Clerk

Mohitnagar

Sl. No.	NAME	DESIGNATION
240.	Sri Sushanta Roy	Assistant up to 31.12.2017
241.	Sri Subash Paul	Assistant
242.	Sri Sathyabratha Moharana	Lower Division Clerk

Kahikuchi

Sl. No.	NAME	DESIGNATION
243.	Sri Saji T.J.	Upper Division Clerk
244.	Sri Deepak Meena	Lower Division Clerk

Skilled Support Staff

Kasaragod

Sl. No.	NAME
245.	Sri M.Shankara
246.	Sri Bhaskara Velichapad
247.	Sri Srihari Ballaya up to 31.10.2017
248.	Sri Haridas Poojary up to 31.05.2017
249.	Sri Madhavan Nair P. up to 30.06.2017
250.	Sri Narayanan Nair K. up to 30.4.2017
251.	Sri Narayanan Nair P.
252.	Smt. Baby K.
253.	Sri Kunhikannan K.
254.	Sri Mohana A.
255.	Sri Keshava K.
256.	Smt.Banu K.
257.	Sri Sukumaran K.
258.	Sri Krishnan K.V.
259.	Sri Chaniya Naik P.A.
260.	Sri Kumaran P.
261.	Sri Pakeeran V.S.
262.	Smt. Thambai V.

263.	Smt. Kamala
264.	Sri Murugan M. up to 31.05.2017
265.	Sri Sureshbabu K.G.
266.	Sri Ninan T.J.
267.	Sri Krishnankutty K.
268.	Smt. Chithralekha Kodoth
269.	Sri Chandrahasa B.
270.	Sri Rameshan V.T.
271.	Sri Krishnankunhi K.
272.	Smt. Shobhana K.
273.	Sri Krishnan M.
274.	Smt. Leela V.A.
275.	Smt. Sarojini U.
276.	Sri Krishnankutty V.
277.	Sri Prabhakaran P.P.
278.	Sri Ramachandran B.
279.	Sri Sanjeeva Patali B.
280.	Smt. Sasikala N.V.
281.	Sri Lakshmana Naik
282.	Smt. Lalitha Bai
283.	Sri Velayudhan M.
284.	Smt. Mohini S. up to 07.7.2017
285.	Sri Bhaskaran N.
286.	Sri Sundara B.
287.	Sri Suresan K.
288.	Sri Madhu A.
289.	Sri Madhavan K.A.
290.	Sri Babu K.
291.	Sri Aneesh E.M.
292.	Smt.Vanamalini K.

Canteen Staff

Sl. No.	NAME
293.	Sri Jayaprakash K.
294.	Sri Balakrishnan B.
295.	Sri Vijayan K.

Kayamkulam

Sl. No.	NAME
296.	Sri Sivan M.E.
297.	Sri Thankachan K.B.
298.	Sri Ravindran R.
299.	Sri Soman K.
300.	Sri Omanakuttan K.
301.	Sri Damodaran K.C.
302.	Sri Unnikrishnan V.T.
303.	Sri Mani T.K.
304.	Sri Ravi K.
305.	Sri Vijayan K.V.

306. Sri Sreedharan K.K.
307. Sri Sukumaran C.
308. Smt. Valsala K.
309. Sri Sundaran C.
310. Sri Sajeev K.N.
311. Sri Ibrahim K.P.
312. Smt. Suma N.
313. Sri Harikuttan A.T.
314. Smt. Saseendra K.
315. Sri Babu C.R.
316. Sri Ajith Mattappadan
317. Sri Rajesh R.
318. Smt. Leena L.
319. Sri Ancil Pereira
320. Sri Rajesh S.
321. Sri Reghu N.

Canteen Staff

Sl. No.	NAME
322.	Sri Justin Jayaraj Das
323.	Sri Parameshwaran S. up to 31.12.2017

Vittal

Sl. No.	NAME
324.	Sri Narayana Paleri up to 30.6.2017
325.	Sri Harischandra
326.	Sri Chandu Naik
327.	Sri Sudhakara
328.	Sri Gopala A.
329.	Sri Isubu D.
330.	Sri Dharmapala B.
331.	Sri Vinod K.
332.	Sri Ibrahim
333.	Sri Chinnappa K.C. up to 30.6.2017
334.	Sri Choma B.
335.	Sri Mohana
336.	Sri Somappa K.
337.	Sri Ananda M.
338.	Sri Mahesan N.B.
339.	Sri Monappa Gowda K.

Canteen Staff

Sl. No.	NAME
340.	Sri Shivarama Poojary A.

Kidu

Sl. No.	NAME
341.	Sri Baliappa Gowda
342.	Sri Medappa Gowda up to 31.5.2017

343.	Sri Balappa Gowda
344.	Sri Venkataramana S.
345.	Sri Chennappa S.
346.	Smt. Bhavani N.
347.	Smt. Susheela S
348.	Smt. Lolakshi
349.	Sri Janardhana S.
350.	Sri Dasappa Gowda
351.	Smt. Susheela T.
352.	Sri Padmayya Gowda
353.	Smt. Bhavani B.
354.	Sri Rukmini S.
355.	Sri Bhojappa S.
356.	Sri Narayana S.
357.	Smt. Komalangi
358.	Sri Chennappa V.
359.	Sri Jathappa Gowda V.
360.	Sri Sheenappa Gowda S.
361.	Sri Neelappa S.
362.	Sri Regappa S.
363.	Smt. Chandravathi S.
364.	Sri Durgesha M.

Mohitnagar

Sl. No.	NAME
365.	Smt. Janaki Devi up to 30.6.2017
366.	Sri Sailen Seal
367.	Sri Krishna Kr. Mandal
368.	Sri Nripendra Chandra Roy
369.	Sri Kartick Chandra Biswas
370.	Sri Sushanta Burman
371.	Sri Mahadev Misra

Kahikuchi

Sl. No.	NAME
372.	Sri Gopal Thapa
373.	Sri Sathish Baishya
374.	Sri Pankaj Das

XVIII

DISTINGUISHED VISITORS

Hon'ble Minister D.V. Sadananda Gowda, Minister for Statistics and Programme Implementation being received by Dr. P. Chowdappa, Director at CPCRI, Kasaragod

Shri E. Chandrasekharan, Hon'ble Revenue Minister, Government of Kerala, along with Shri N.A. Nellikkunnu, MLA, Kasaragod and Local Government officials, visited ICAR-CPCRI, Kasaragod on 26th August, 2017 for discussions.

Shri E. Chandrasekharan, Hon'ble Revenue Minister, Government of Kerala, Shri N.A. Nellikkunnu, MLA, Kasaragod interacting with scientists and Local Government officials at ICAR-CPCRI, Kasaragod

Shri G. Sudhakaran, Hon'ble Minister for Public Works and Registration, Government of Kerala visited the Regional Station, Kayamkulam on 5th August, 2017 and interacted with the Scientists on the research programmes of the Institute.

Shri K.M.M. Alimaligothi, IES, Advisor, Commission for Agriculture Costs & Prices, Ministry of Agriculture & Farmers Welfare, Govt. of India visited the experimental fields of the Regional Station, Kayamkulam and interacted with the scientists on the problems in coconut price sector.

Shri Rishi Raj Singh, IPS, Excise Commissioner, Govt. of Kerala visited ICAR-CPCRI Kasaragod on 17th May, 2017 to inspect the Neera tapping from coconut palms at Kasaragod

Shri Rishi Raj Singh, IPS, Excise Commissioner, Govt. of Kerala interacting with Dr. P. Chowdappa, Director

Dr. P. Chowdappa, Director explaining coconut vermicomposting to Shri Chhabilendra Roul, IAS, Addl. Secretary, DARE & Secretary, ICAR

Shri Chhabilendra Roul, IAS, Addl. Addl.Secretary, DARE & Secretary, ICAR visited ICAR-CPCRI Kasaragod on 30th June, 2017 during his visit to various ICAR establishments in Kasaragod, Madikeri, Mangalore and Puttur.

Shri Raghavendra Suhas (IPS), DIG, Intelligence Bureau, Jaipur, Rajasthan visited ICAR-CPCRI, Research Centre, Kidu on 10th April, 2017, to obtain first hand information on high yielding varieties of coconut along with their special attributes and standard package of practices. He also visited the field gene bank and collected information on the outcomes of coconut research and development at the Institute.

List of VIPs visits to ICAR-CPCRI centres

Sl. No.	Name and designation of the person visited	Date & Place	Occasion
1	Dr. K. Nirmal Babu, Director, ICAR-IISR, Kozhikode	7 April 2017 ICAR- CPCRI, Kasaragod	Annual Institute Research Committee Meeting
2	Shri Sudarshan Bhagat, Union Minister of State for Agriculture and Farmers Welfare, GOI	4 May, 2017 ICAR-CPCRI, RS, Kayamkulam	'National Innovations in Climate Resilient Agriculture' farmer interface
3	Dr. Sreenath Dixit, Director, ICAR-ATARI, Bengaluru	4 May, 2017 ICAR-CPCRI, RS, Kayamkulam	'National Innovations in Climate Resilient Agriculture' farmer interface
4	Shri N. A. Nellikunnu, Hon'ble MLA Kasaragod	15 September, 2017 ICAR-CPCRI, Kasaragod	Interface programme on Science, Innovations and Entrepreneurship
5	Dr Prof. P.K. Michael Tharakan, Chairman, KCHR, Thiruvananthapuram	21-30 November, 2017 ICAR-CPCRI, RS, Kayamkulam	ICAR-sponsored short course on 'Breeding for resistance to pests and diseases in plantation crops'
6	Shri N. A. Nellikunnu, Hon'ble MLA Kasaragod	5 December 2017 ICAR- CPCRI, Kasaragod	World Soil Day celebration
7	Adv. (Mrs.) Prathibha Hari, Hon'ble MLA, Alappuzha	5 December 2017 ICAR- CPCRI, Kasaragod	World Soil Day celebration
8	Dr. N.K. Krishna Kumar, Regional Representative, Bioversity International	6 January 2018 ICAR- CPCRI, Kasaragod	A seminar and exhibition on crop diversity
9	Shri P. Karunakaran, Hon'ble MP, Kasaragod	8 January 2018 ICAR- CPCRI, Kasaragod	Kisan Mela 2016 and Agri-Business Expo
10	Shri N. A. Nellikunnu, Hon'ble MLA Kasaragod	8 January 2018 ICAR- CPCRI, Kasaragod	Kisan Mela 2016 and Agri-Business Expo
11	Dr. A.K. Singh, Deputy Director General (Hort. Sciences), New Delhi	8 January 2018 ICAR- CPCRI, Kasaragod	Kisan Mela 2016 and Agri-Business Expo
12	H.P. Singh, former Deputy Director General (Hort. Science)	5 - 6 March, 2018 ICAR- CPCRI, Kasaragod	Research Advisory Committee Meeting
13	Dr. Prassanna Kumar Patsani, Hon'ble Member of Parliament (Rajya Sabha) and Dr. Sunil Baliram Gaikwad, Hon'ble Member of Parliament (Lok Sabha), Second Sub- committee of Committee of Parliament on Official Language	24 January 2018 Alappuzha	Visit of Parliamentary Delegation on Official Language
14	Dr. Yateendra Joshi, Associate Fellow, Communication Research Institute, Canberra	7-9 March 2018 CPCRI Kasaragod	A training workshop on "Writing and Publishing Skills for Scientists"
15	Dr. Homey Cheriyan, Director, Directorate of Arecanut and Spices Development, Kozhikode	24 March, 2018 ICAR- CPCRI, Kasaragod	Annual Institute Research Committee Meeting
16	Dr. A.K. Tripathi, Director, ICAR-ATARI	14 September, 2017 ICAR-CPCRI, RC, Kahikuchi	Hindi Week

XIX MERA GAON MERA GAURAV

"*Mera Gaon Mera Gaurav*", the village adoption programme, is being implemented by the Ministry of Agriculture and Farmers' Welfare, Govt. of India to promote the direct interface of agricultural scientists with the farmers to hasten the lab to land process. It provides farmers with required information, knowledge and advisories on a regular basis by adopting villages. In this perspective, ICAR-CPCRI, Kasaragod and its regional stations and research centres have implemented the MGMG initiative in collaboration with other stakeholders *viz.*, Department of Agriculture, Krishi Vigyan Kendras, Grama Panchayats, input dealers, progressive farmers, SHGs etc. During 2017-18, a series of training programmes, demonstration on improved practices, farm advisory visits, and mobile advisory services were organized in the selected villages for the benefit of the farming community. A team of 61 scientists adopted a total of 68 villages for their overall development.

Station/ Centre	No. of scientists	No. of teams	No. of villages
Kasaragod	32	8	38
Kayamkulam	14	3	16
Vittal	10	3	10
Kahikuchi	2	1	2
Mohitnagar	2	1	3
Kidu	1	1	1
Total	**61**	**17**	**70**

Summary of activities conducted during 2017-18

Centre/ Station	Visit to village		Interfaces		Demon strations conducted		Trainings conducted		Mobile based advisory		Literature support provided	
	No.	No. of farmers	No.	No. of farmers	No.	No. of farmers	No.	No. of farmers	No.	No. of farmers	No.	No. of farmers
Kasaragod	31	408	9	588	9	260	6	300	40	417	23	2600
Kayamkulam	78	1064	30	2713	43	1065	66	1836	1970	2091	337	2532
Vittal	34	271	2	98	1	5	2	88	11702	11791	80	9517
Kahikuchi	6	78	2	110	1	18	3	48	8	10	2	22
Mohitnagar	17	275	2	145	-	-	4	120	10	160	2	135
Kidu	6	73	-	-	2	14	-	-	80	80	22	25
Total	182	2169	45	3654	56	1362	81	2392	13810	14549	466	14831

Major areas of capacity building programmes

- On farm production of vermicompost from farm wastes
- Nutrient management in coconut and arecanut
- Importance of soil nutrient testing and soil health cards
- Pest and disease management in coconut
- Mother palm selection, seed nut collection, nursery management and seedling selection in coconut
- Sustainable vegetable farming
- Package of practices of coconut and banana Pest and disease management in arecanut and cocoa
- Biopriming of coconut seedlings
- Management of pseudo stem borer disease of banana

- Pest management in vegetable cultivation
- Problems and management of rainy season vegetables
- Harvesting and storage practices for summer vegetables.
- Post harvest processing and value addition
- Moisture conservation techniques

Salient outcome

Mother palm selection: Superior disease-free high yielding coconut palms (87 palms from 28 farmers) were identified in different villages for seed nut collection (565 nuts) and seedling production of about 450 (*Amma thengu* programme) has been successfully launched in farmers' gardens with technical expertise extended by the scientists. Bio-priming of seedlings with *Pseudomonas fluorescens* improved the vigour, enhanced collar girth and early leaf splitting. These seedlings are found to be of best quality and planting these coconut seedlings and adoption of scientific cultivation procedure would double their income in coming years.

Crop geometry: Optimum spacing for all crops especially for coconut (Talls- 7.5 x 7.5 m; Dwarfs- 7.0 x 7.0 m) was greatly stressed in all villages for effective harnessing of solar energy to provide favourable condition for maximizing yield and doubling farmer's income. Adoption of correct geometry reduced coconut volatile cues resulting in effective pest suppression and thereby encouraged optimum growth for timely flowering. This strategy would further enhance nutrient uptake and accommodate compatible intercrops as well.

Crop pluralism: To effectively utilize the concept of *"an inch of land with a bunch of crops"*, crop diversification and intensification for sustained income on daily, weekly, monthly, six-monthly and yearly basis is envisaged fostering systematic and continuous employment, de-risking farmers, crop residue recycling and multiple crop volatiles subduing pests for poverty-free New India. De-risking farmers in all adopted villages has heightened their confidence level and encouraged adoption of scientific farming approach. Coconut system is very eco-friendly to entertain multiple crops for sustained income. Ecological engineering and high-density multi-species cropping developed by ICAR-CPCRI are better options in this strategy to frame farming to fullness.

Soil health management: Regular soil sampling, their analysis and nutrient recommendation based on soil test results coupled with distribution of soil health cards to farmers in the adopted village is being implemented. Deficiency symptoms were diagnosed and remedial measures suggested. Calcium, magnesium, potassium, zinc and boron were mostly limiting nutrients. Application of bio-innoculants (Kera Probio) and a new nutrient formulation developed by ICAR-CPCRI has enhanced nutrient availability and improved palm health. These techniques advanced flowering and ensured constant income for the farmers, with judicious application of nutrients absolutely on need basis. During the period, soil samples were collected from five selected gardens from each village and soil health cards were distributed to 250 farmers on 5th December 2017, on the occasion of World Soil Day celebrations conducted at the Institute.

The incidence of nut splitting in arecanut is a growing concern of the farmers in Dakshina Kannada district with incidence recorded in 5 - 7% palms in 20-25 years old gardens. One time application of borax @50 g/palm during pre-monsoon is suggested to tackle this problem. Farmers are adopting this technology and reported satisfactory results after this intervention.

Nutrient related problems were identified in banana plantations (variety *Kadali*) grown in red lateritic soil at Kasaragod district. Inter-veinal chlorosis of young leaves, reduction in leaf size, narrowing of leaf width, drying and shredding of leaves etc., were observed in 65 to 75 % of the plantains. Multiple micronutrient deficiencies were identified as a cause for these problems. Farmers were advised to take up soil application of banana micronutrient mixture @150 g/ plant, at an interval of two months. Single application of micronutrient mixture improved the health status of the plantains and about 98 % plantains recovered from the deficiency symptoms. Thus, this timely intervention saved the crop from major loss and farmers are convinced and ready to adopt scientific crop production measures. The recovered gardens have convinced many visiting farmers from the nearby villages.

Bio-resource management: Converting waste to wealth by organic biomass recycling in palm cropping system through vermicomposting, husk burial, mulching, sowing cow pea in palm basin and

incorporation during flowering are effective resource utilization strategies for soil sustainability. Farmers could realize benefit by increased soil organic matter and structural improvement for sustained output. Health of crops in the system was improved and farmers could visibly appreciate the change in soil health.

Pest and disease management: Application of *Metarhizium anisopliae* in cow dung pits and leaf axil filling with botanicals, cakes and naphthalene balls reduced rhinoceros beetle damage. Application of new strategies such as botanical paste and pellets in suppression of rhinoceros beetle damage is well projected. Systematic monitoring for early detection, correct geometry and curative treatment with imidacloprid 0.02% and entomopathogenic nematodes, *Hetrorhabditis indica* recovered red palm weevil infested palms.

Raising root (wilt) disease tolerant varieties/hybrid (Kalparaksha, Kalpasree and Kalpa Sankara) in root (wilt) disease endemic zones and leaf rot management using hexaconazole (2 ml/300 ml water) are showcased in the adopted villages for enhancing the visibility of the technology and better adoption by the farmers in the villages.

Deficit monsoon showers, drop in relative humidity and elevation in maximum temperature favoured gradient outbreak of invasive rugose spiraling whitefly, *Aleurodicus rugioperculatus* for which pesticide holiday (no pesticide usage) and conservatory biological control using *Encarsia guadeloupae* is recommended in the adopted villages. Weather induced pest outbreak of sucking insects are well projected and farmers have been empowered on emergency preparedness module to counter such incursion. Potential invasive pests such as coconut leaf beetle, *Brontispa longissima* has been sensitized in all awareness programmes.

Secondary agriculture: Virgin coconut oil production technologies, fish and jackfruit processing technologies were demonstrated in selected villages for enhancing profitability among farmer clusters. Timely orientation on value addition in all crops was imparted to farmers in the village for boosting their income so that youths are attracted to farming and agri- business ventures.

Rural credit and marketing: Availability of rural credit for farming operations with all nationalized banks, NABARD, co-operative societies were highlighted to farmers for availing farm loan at minimum interest level. The need of availing crop insurance schemes with State Department of Agricultural Development and Farmer's Welfare, supply of crop produces especially coconut to producer companies for higher monetary returns was emphasized. Market linkage to all farmers in the villages was opened out for better price realization which reduced the risk involved.

Inauguration of training programme on 'Plant Health Management" at Bedadka in Kasaragod

Scientists from CPCRI, RS, Kayamkulam interacting with farmers

Scientists from CPCRI, RS, Vittal interacting with cocoa farmer

Diagnostic field visit to mixed farming unit

XX

SWACHH BHARATH ABHIYAN

Staff members actively participated in Swachh Bharat Abhiyan at Headquarters, Regional Stations & Research Centres. On every Fridays staff members devoted one hour for cleaning the office premises. Besides, on special occasions, cleaning of public places adjoining the campuses was also undertaken. Special programmes conducted under Swachh Barat Abhiyan are as follows.

SwachhtaPakhwada

'Swachh Bharat Pakhwada was observed during 16th - 31st May 2017. Activities carried out during the fortnight include strengthening of e-office, general maintenance of office bilding, sanitation, cleaning and beautification of office premises, utilization of bio waste for making vermicomposting, awareness creation among public on 'Swachh Bharat' by displaying banners etc.

Swachhta Hi Seva

The campaign 'Swachhta Hi Seva' was conducted during 15th September to 2nd October 2017 as part of Swachh Bharat Mission anniversary. The following activities were carried out during the period of campaign: Launching of 'Swachhta Monitoring System and 'sapth' taking by staff was organized on 16th September 2017. The banner 'Swachhta Hi Seva' was displayed in different public places. 'Seva Diwas' was observed on 17th September 2017 by staff members participating cleaning activities. On 24th September 2017 employees performed 'shramadan' and contributed for making public toilet at Kumbala as part of observance of 'Samagra Swachhta Diwas'. All employees assembled in a public place adjacent to the Institute and cleaned the permiseson 25th September 2017 to observe 'Sarvatra Swachhta'. The celebrations concluded with a valedictory function in which best performing sections on 'cleanliness' were honoured.

Dr. P. Chowdappa, Director, ICAR-CPCRI handing over lock and key of the public toilet to the Panchayat President at Kumbla, Kasaragod

Staff carrying out cleanliness programme in public places near the campus

XXI WOMEN'S CELL ACTIVITIES

The International Women's Day was celebrated at the institute in appreciation of the role of women in society and to sensitize on issues of gender parity. In this connection, a formal programme was organized at ICAR-CPCRI, Kasaragod on 12.3.2018, under the aegis of the Institute Women's Cell. Dr. P. Chowdappa, Director, presided over the function. Dr V Niral, Principal Scientist and Chairperson, Institute Women's Cell, welcomed the gathering. Adv. (Mrs.) Jaya Adoor, a practicing lawyer in the Kasaragod Bar and an accredited Mediator under Dispute Resolution Forum, was the chief guest on the occasion. Mrs. Jaya Adoor spoke on some of the issues faced by the working women/girls in society and the legal provisions available for the welfare of women. Director in his presidential speech stressed on different aspects of women empowerment and the global target of ensuring gender parity in our society. He also stressed the need to highlight the contribution of women in society and honour the women achievers during the Women's Day celebrations. A pick and speak programme on the theme "Men's perspective on women" was organized, with the whole hearted participation of all categories of staff at the institute. In addition, staff members recited poems and songs on women empowerment and status in society. The meeting ended with the vote of thanks by Mrs Sulochana Nair, Member Secretary.

In addition, Institute Women's Cell convened a meeting of Research Associates, SRFs, JRFs and students working at the institute on 1st May, 2017 to understand the problems/issues, if any, being faced by women at the workplace and to create awareness on prevention of sexual harassment, under the chairmanship of Dr. V Niral, Principal Scientist and Chairperson Internal Complaints Committee. Meeting of the regular women staff of the institute was also organized to promote bonding and discuss common issues. A farewell lunch and a get together of all women staff was organized on 2nd August 2017 in honour of Mrs. Mohini, Skilled Supporting Staff, who took voluntary retirement from ICAR service.

Members of Womens' Cell from ICAR-CPCRI, RS Vittal conducted a tour on International Womens' Day to ICAR-IIHR, CHES Chettali and ICAR-IISR Appangala.

International Women's Day celebrations at Kasaragod


Women's Cell meeting in honour of Mrs. Mohini


Visit of Women's Cell members from ICAR-CPCRI, RS, Vittal to Chetalli and Appangala

XXII MAJOR EVENTS & OTHER INFORMATION

World Environment Day

World Environment Day was celebrated at ICAR-CPCRI, Kasaragod on 5th June, 2017. The celebration was inaugurated by the Director, Dr. P. Chowdappa. West Indian Cherry seedlings were planted along the avenue near the Kendriya Vidyalaya in ICAR-CPCRI premises, by the Director and staff of the institute. West Indian Cherry seedlings were also planted at the crèche located in the institute premises. Mahagony and neem tree saplings were planted at the Nursery School in the ICAR-CPCRI residential premises. The programme was attended by institute staff as well as the teachers and students of the Nursery School. The celebration was facilitated by the Institute Aesthetic Committee and Nursery School Management Committee.

Dr. P. Chowdappa, Director, planting a sapling near ICAR-CPCRI Nursery School at Kasaragod

Workshop on Coconut for Nurturing Ecology and Nourishing Society

A workshop on "Coconut for Nurturing Ecology and Nourishing Society" was conducted on 5th June, 2017 at Regional Station, Kayamkulam, towards honing agricultural acumen among higher secondary school students as part of World Environment Day celebrations, with support from the Kerala State Council for Science Technology and Environment, Thiruvananthapuram. Scientists led the technical sessions on Ecology Edging out Economics, Coconut and Ecosystem Service, Coconut as Health Food, Diversity of Coconut and Invertebrates Intertwined with Coconut. Eleven schools participated in the quiz competition entitled "Coconut to Nature and Mankind". Govt. Boys Higher Secondary School, Kayamkulam and MSM School, Kayamkulam emerged victorious. Students were also taken around the experimental plots. Valedictory function was presided over by Dr. V. Krishnakumar, Head of the Station. Smt B. Vijayamma, President, Krishnapuram Grama Panchayat inaugurated the programme by lighting the lamp and urged the students to connect to nature by critical observation. Dr. J. G. Ray, Head, School of Biosciences, M.G. University gave a scintillating talk on "Ecology and Environment" and advised the participants to learn from nature, as nature hardly makes any mistakes. A booklet and e-copy on "Connecting Coconut to Citizens" were released on the occasion.

ICAR-KVK–Alappuzha in collaboration with Eco Club of Govt. Higher Secondary School, Mangalam celebrated the World Environment Day in Arattupuzha Grama Panchayat. An awareness talk on 'Connecting people to nature through agriculture', highlighting the relevance of conserving natural resources through different agricultural practices, followed by an orientation programme for 'Terrace cultivation of organic vegetables' was delivered by Dr. K. Sajnanath (SMS, KVK). Smt. M. Jayasree Headmistress, Shri S. Jayalal Co-coordinator of Eco Club, and Smt. K. Kanakamma spoke on the occasion in which more than 50 students from eco club participated.

International Yoga Day

As per the directions of Deputy Director (GAC), ICAR, New Delhi, the 3rd International Day of Yoga

was celebrated at ICAR-CPCRI, Kasaragod on 21st June, 2017, in a befitting manner. Dr. (Smt.) Sharvari, Yoga Scholar and Ayurvedic physician, delivered a lecture on the relevance of yoga to maintain the health of people, both mental and physical. She also explained various components of yoga practices such as Asanas and Pranayama based on Pathanjali Yoga Sutra, to empower ourselves, to take more responsibility towards our nation with a free mind. An impressive display of Yogaasanas accompanied with a lyric of Gurupadukastrothra, presented by the students of Chaithanya Vidyalaya, Kasaragod was well appreciated and created more interest in practicing yoga to lead a stress-free life.

International Yoga Day was celebrated at Regional Station, Vittal and all the staff members actively participated in the yoga session conducted by Dr. S. Elain Apshara and Shri P. Ashok.

International Yoga Day was celebrated at ICAR-CPCRI, RC, Kidu and yogasanas were performed by all the staff members of the centre under the expert guidance of Shri Vrijesh, Yoga Instructor.

International Yoga day was celebrated at ICAR-CPCRI, RC, Mohitnagar and all the staff members participated in this event. Few of the local youth were also invited to participate in order to make them aware of the importance of Yoga for health and mind.

Independence Day

The Institute celebrated the 71st Independence Day of our nation on 15th August, 2017. Dr. P. Chowdappa, Director hoisted the National Flag and delivered Independence Day address at Kasaragod. Independence Day was also celebrated in the Regional Stations at Kayamkulam, Vittal and the Research Centres at Kahikuchi, Kidu and Mohitnagar

International Yoga Day celebration at ICAR-CPCRI, RS, Kayamkulam

Sadbhavana Diwas

In compliance of the ICAR circular, Sadbhavana Diwas was observed at ICAR-CPCRI, Kasaragod on 18th August, 2017. Dr. P. Chowdappa, Director, ICAR-CPCRI administered the pledge to the staff of the Institute in English, followed by Dr. Alka Gupta, Principal Scientist administering the oath in Hindi. Sadbhavana Diwas was also celebrated at ICAR-CPCRI, Research Centre, Mohitnagar..

Dr. P. Chowdappa, Director, ICAR-CPCRI addressing staff and public on the occasion of Independence Day at Kasaragod

Dr. P. Chowdappa, Director, ICAR-CPCRI administering Sadbhavana Pledge to the staff at ICAR-CPCRI, Kasaragod

Onam celebrations

Onam was celebrated at Kasaragod and Regional Station, Kayamkulam with traditional fervor and gaiety encompassing a galaxy of cultural entertainment programmes by the recreation club members that commenced with flower carpet competition for children and elders, *Onapattu*, tug of war and concluded with *Onasadya*.

World Honeybee Day

World Honeybee Day was celebrated with a "Bee Quiz" and a talk on "Prospects of beekeeping", at MSM College, Kayamkulam on 21st August, 2017. More than 125 students attended the programme.

Mahila Kisan Divas

As part of the nationwide celebration of 'Mahila Kisan Divas', one day programme was organized by ICAR-KVK-Alappuzha on 19th October 2017 with the participation of more than 100 selected woman farmers of the district. The programme was inaugurated by Smt. Rajani Jayadev, President, Bharanikkavu Block Panchayat. Five woman farmers were honoured for their significant contributions in the field of Crop production, Integrated Farming System, Dairy Farming, Mushroom cultivation and Value addition. A competition on *'payasam'* preparation and a quiz contest were also held as part of the celebrations. An exhibition of value added products from different entrepreneurs, trained and supported by the KVK, was also arranged on the occasion.

Institute Biosafety Committee Meeting

Institute Biosafety Committee meeting was held under the chairmanship of Dr. P. Chowdappa, Director at ICAR-CPCRI on 15th December, 2017. Dr. George Thomas, Scientist 'F', RGCB, Thiruvananthapuram, Dr. Rekha Rai, Professor, Dept. of Microbiology, KSHEMA, Mangalore and Dr. Ginny Antony, Asst. Professor, Central University of Kerala, Kasaragod were present. Issues related to the various projects undertaken and the biosafety measures were discussed.

Members of Biosafety Committee taking stock of the programmes undertaken by ICAR-CPCRI

Science Promotion Week

ICAR-CPCRI, Regional Station Kayamkulam organized an Open Day Programme *'Sastrajalakom'* as part of the 'Science Promotion Week - 2017, commemorating the birth of Sir C.V. Raman, Madam Marie Curie and Pandit Jawaharlal Nehru on 14th November 2017. The programme included an orientation session for the students of VHSC for sensitizing them in science with special emphasis to agriculture and eco-friendly farming. Dr. S. Kalavathi, Head (i/c) inaugurated the function and motivated the participants in keeping a scientific temper in routine life, in her address. The technical sessions were handled by Dr. Joseph Rajkumar, Principal Scientist and Mrs. Daliyamol, Scientist.

Science Promotion Week

ICAR-CPCRI, Regional Station Kayamkulam organized an Open Day Programme '*Sastrajalakom*' as part of the 'Science Promotion Week - 2017, commemorating the birth of Sir C.V. Raman, Madam Marie Curie and Pandit Jawaharlal Nehru on 14th November 2017. The programme included an orientation session for the students of VHSC for sensitizing them in science with special emphasis to agriculture and eco-friendly farming. Dr.S. Kalavathi, Head (i/c) inaugurated the function and motivated the participants in keeping a scientific temper in routine life, in her address. The technical sessions were handled by Dr. Joseph Rajkumar, Principal Scientist and Mrs. Daliyamol, Scientist.

Young participants at Science Week organized at ICAR-CPCRI, RS, Kayamkulam

Jai Kisan Jai Vigyan as farmer-scientist interface

ICAR-CPCRI, Regional Station, Kayamkulam convened Jai Kisan Jai Vigyan programme as part of Mera Gaon Mera Gaurav Farmer-Scientist interface on 29th December, 2017. About fifty farmers from 17 villages adopted by the scientists participated in the programme. The theme for the year was "Doubling Farmers Income through Innovative Coconut Farming". Dr. V. Krishnakumar, Head inaugurated the programme. A pamphlet on "An epilogue of salient accomplishments of Mera Gaon Mera Gaurav activities for the period 2016-17" was released on the occasion.

Jai Kisan Jai Vigyan programme held on 29th December 2017 at Kayamkulam

Inauguration

Participating farmers

Release of *Mera Gaon Mera Gaurav* highlights

Award distribution for Best Idea on Doubling Farmers' Income

National Agricultural Education Day

National Agricultural Education Day was observed to commemorate the birth anniversary of Dr. Rajendra Prasad, on 4th December, 2017 at ICAR-Central Plantation Crops Research Institute, Kasaragod. Dr. R. Muralidhara Prasad, formerly Director of Extension, Kerala Agricultural University was the chief guest. While interacting with the students from

Dr. R. Muralidhara Prasad, formerly Director of Extension, KAU, delivering lecture at ICAR-CPCRI, Kasaragod

various schools in the district, he expressed his conviction that "Pursuing agricultural sciences for a career is most rewarding". Importance of agriculture for nation's economy and food security was highlighted by Dr. Ravi Bhat, Director i/c in his presidential address. Over 150 students from different schools participated in the programme. Students were also provided an opportunity to visit experimental fields and laboratories of the Institute.

Vigilance Awareness Week

The Vigilance Awareness Week programme and Integrity Pledge by all employees in Headquarters and Regional Stations was held on 30th October 2017. All employees, contractual staff, contractors and general public who had visited the Institute/Regional Stations were encouraged to take the e-pledge. In an effort to spread the message of vigilance against corruption among the public a total of 10 banners were displayed at vantage locations. Quiz programme on CVC and RTI was conducted in three schools in Kasaragod district. A painting competition was also conducted in one school. An essay writing competition was held at Government College, Kasaragod. A quiz competition and a workshop on 'preventive vigilance' were conducted for the staff. Shri T. A. Shafi, President, Press Club, Kasaragod delivered the valedictory address.

In addition to the oath undertaken by all staff of RS, Kayamkulam, during the Vigilance Awareness Week-2017, Dr. A. Joseph Rajkumar, Pr. Scientist spoke on the theme "My Vision - Corruption-free India to accomplish New India by 2022".

Shri T. A. Shafi, President, Press Club, Kasaragod addressing the staff at ICAR-CPCRI, Kasaragod

National Science Day celebrated at Kayamkulam

A one day workshop on 'Harnessing bio-agents for sustainable soil and palm health' was organized for undergraduate life science students at ICAR-CPCRI, Regional Station, Kayamkulam on 15th February 2018 as part of National Science Day celebration. The programme was sponsored by Kerala State Council for Science Technology and Education, Thiruvananthapuram. The programme included thematic sessions handled by Scientists and elocution and quiz contests for the participating students on the theme "Science and Technology for Sustainable Future". In the valedictory function, Dr Thomas Biju Mathew, Head, Pesticide Residue Research and Analytical Laboratory, KAU, Vellayani was chief guest and a delivered a talk on "Pesticide Residues and Safe Use of Pesticides". An e-manual on "Mastering Farming through Marvelous Microbes" was released on the occasion.

Participants at the National Science Day celebration at Regional Station, Kayamkulam

Dr. P. Chowdappa, Director, ICAR-CPCRI administering the "*Sankalp se Siddhi*" Pledge to the staff at ICAR-CPCRI, Kasaragod

Sankalpa se Siddhi

New India Manthan – *Sankalp se Siddhi* programme was organized by Krishi Vigyan Kendra, ICAR-CPCRI, Kasaragod at Vorkadi, Kasaragod on 19th August, 2017. ICAR-KVK-Alappuzha organized the '*Sankalp se Siddhi*' programme on 29th August, 2017 at the auditorium of ICAR-CPCRI, Regional Station, Kayamkulam, These programmes were aimed to propagate the action plan in terms of the seven point programme to double the farmer's income by 2022. An agricultural exhibition on various agricultural technologies was also arranged for the benefit of farmers. About 300 farmers and entrepreneurs actively participated in the programme.

Institute Joint Staff Council

IJSC of the Institute has been reconstituted for three years from 21st September, 2017 having following members: Director, ICAR-CPCRI, the Chairman of IJSC, Dr. Ravi Bhat, Head, Division of Crop Production, Dr. Vinayaka Hegde, Head, Division of Crop Protection, Dr. K. Samsudeen, Principal Scientist, Chief Administrative Officer, Senior Finance and Accounts Officer,all members and Assistant Administrative Officer (Establishment-I.) is the Member Secretary (Official Side). The staff side members are Shri C. Ramesh Babu, P.A., Shri M.V. Sreedharan, Sr. Tech. Asst., Shri N. Dinesh Kumar, Sr. Technician, Shri B. Chandrahasa, SSS, Smt. K. Saseendra, SSS, Shri Kartick Chandra Biswas, SSS, Shri M. Ravindran, Asst. Admin. Officer.

Live programme on Prime Minister's address at Krishi Unnati Mela 2018

A live telecast of Shri Narendra Modi, Hon'ble Prime Minister's visit to the Krishi Unnati Mela at the ICAR-IARI Mela Ground, Pusa Campus, New Delhi and his address to the gathering, were projected on a big screen for scientists, farmers and public assembled in the Platinum Jubilee Hall, ICAR-CPCRI, Kasaragod on 16th March, 2017.

A view of the live programme arranged for the public at ICAR-CPCRI, Kasaragod on the occassion of Krishi Unnati Mela

Library & Information Service

The ICAR-CPCRI Library and Information Centre, in keeping with its mission to acquire, organize, preserve and disseminate information on the plantation crops, coconut, cocoa and arecanut, holds a rich collection of resources catering to the information requirements of the scientific, technical and administrative staff of the institute, the researchers from universities, under-graduate and post-graduate students, industries in plantation sector and other related organizations.

Documentation Services

Web Agris Project

Under WebAgris Project, a web based system for distributed data input has been developed, based on common standards of data input. The agricultural bibliographic information has been processed and disseminated through the internet or on CD-ROM. Furthermore, the library inputs data from two Indian journals, *Indian Coconut Journal* and *Journal of Plantation Crops* has been collated.

The library web page

The library web page under the institute website gives an overall view of the activities and services provided by the library.

- The Online Public Access Catalogue (OPAC)
- Institute publications
- Institute Digital Repository
- Consortium of e-resources in Agriculture (CeRA)/Krishikosh/Krishiprabha/AgricatLinks to subscribed e-books/online databases
- Online journals/archives
- Databases developed in-house
- Open access resources

ICAR-CPCRI Digital Repository

The institute digital repository, holding a literature collection to the tune of 6523, is very user friendly with eight communities and provides full text access to its resources through the intranet. The access to the digital repository is provided in the institute website under the webpage for library. The digital repository records, on an average, around 325 hits per month.

Research publications of ICAR-CPCRI Staff

- Institute publications
- Mandate Crops-Other than CPCRI
- Deputation reports
- Reprints
- RPP
- Theses
- Dissertations / Project Reports

Online journals / databases / e-books

The institute provided links to access the subscribed e-journals, archives of e-journals, e-databases and e-books in the library page.

Document Delivery Service

As part of the Resource Sharing Programme under CeRA, the library provided online Document Delivery Service to the tune of 300 articles, on demand.

News paper clippings service (Glimpse)

"The glimpse", a newspaper clippings service covering news items related to agriculture and allied sciences, is being brought out every month. News items related to the institute are being made available under the head 'CPCRI in Media' in the institute web site.

Reprography service

Library and Information Centre also provided reprography service such as scanning / photocopying of resources to clientele, as well as to visitors to the library

Exchange of publications

The institute received around 250 publications such as Annual Reports, Research Highlights and Vision documents from other institutes, on reciprocal exchange.

Web notifications

Advance intimations/information brochures of all major events organized by ICAR-CPCRI are uploaded on the institute website for wider dissemination among the stakeholders.

All tender notifications/ quotations in respect of store purchases/civil works/outsourcing manpower /disposal of farm produce etc., and notifications on recruitment of permanent staff/ project staff at the institute are placed in ICAR-CPCRI website for ensuring better transparency and outreach of information.

XXIII

BUDGET & EXPENDITURE

The Budget & Expenditure for the financial year 2017-18 in respect of ICAR-CPCRI, Kasaragod is as given below:

(Figures in Rupees)

Budget Head	Budget	Expenditure
Revenue		
Estt. Charges	295000000	289260156
OTA	10000	0
Pension	287200000	280698738
TA	500000	4989280
Research & Operational expenses	41500000	41500411
Works Repair & Maintenance		
Office Buildings	11000000	11163465
Residential Buildings	8225000	8443047
Minor Work	5400000	5761144
Other Administrative Charges	73515000	72789885
Miscellaneous Expenses (including HRD)	3260000	3259816
Tribal Sub Plan - General	--	--
Capital		
Equipments	210000	728030
Information Technology	223000	221825
Library	387000	386372
Furniture & Fixtures	39000	35466
Livestock	10000	10000
Works		
Minor Work	1631000	1112360
Tribal Sub Plan - Capital	--	--
TOTAL	**732610000**	**720359995**

Other Projects	Opening Balance	Receipts	Expenditure	Refund
Other Plan Schemes	68452	99476780	78801518	17566019
Deposit Schemes (Externally funded)	13746307	63066673	22937980	5418892
KVK, Kasaragod	-563000	14678000	13487000	
KVK, Alappuzha	11078	14784997	14471977	

Revenue receipts

Head	Receipts
Income from sales/ services	27304877
Fee/Subscription	495491
Income from Royalty, Publication etc.	61161
Other Income	28846803
STD Interest	3545276
Recoveries on Loans & Advances	1998392
TOTAL	**62252000**

XXVI WEATHER DATA

ICAR-CPCRI, Kasaragod

Month	Temp.		RH %		Wind velocity (km/h)	Sunshine (h)	Evapo-ration (mm)	Rainfall (mm)	Rainy days
	Max (°C)	Min (°C)	FN	AN					
April 2017	33.8	26.0	76	63	2.5	7.4	4.7	018.8	01
May 2017	34.0	25.2	75	63	2.5	6.6	4.3	080.5	04
June 2017	29.7	23.8	83	84	2.7	1.6	2.1	857.6	28
July 2017	29.2	23.8	85	81	2.1	1.9	2.1	675.0	30
Aug. 2017	29.2	23.7	86	82	1.7	2.7	1.8	724.4	26
Sept. 2017	30.1	23.9	82	82	1.9	5.0	2.6	268.2	13
Oct. 2017	30.7	23.6	80	73	1.6	5.4	2.7	087.6	07
Nov. 2017	32.8	22.4	71	61	1.2	8.0	3.4	009.2	01
Dec. 2017	32.5	21.1	72	55	1.6	8.0	3.4	007.6	02
Jan. 2018	31.7	20.0	76	57	1.7	8.5	3.6	000.0	00
Feb. 2018	32.0	21.0	78	60	2.3	8.8	3.7	009.6	01
Mar. 2018	33.1	22.9	77	60	2.4	7.6	4.4	020.4	01

ICAR-CPCRI, Regional Station, Kayamkulam

Month	Temp.		RH %		Wind velocity (km/h)	Sunshine (h)	Evapo-ration (mm)	Rainfall (mm)	Rainy days
	Max (°C)	Min (°C)	FN	AN					
April 2017	33.1	25.4	92	64	2.5	8.4	3.9	72.9	5
May 2017	32.0	25.3	93	70	2.0	6.6	3.6	223.0	11
June 2017	30.5	24.1	92	75	1.5	4.9	3.3	466.5	21
July 2017	30.6	24.3	92	72	2.1	6.0	3.5	252.5	18
Aug. 2017.	30.3	24.6	93	74	2.3	5.9	3.5	285.0	14
Sept. 2017	30.3	24.0	93	75	2.0	5.8	3.5	474.0	19
Oct. 2017	30.1	23.7	93	71	1.5	7.2	3.6	235.9	14
Nov. 2017	30.9	23.1	93	72	1.3	6.2	3.5	203.4	13
Dec. 2017	32.5	21.3	92	58	1.3	8.1	3.8	70.4	4
Jan. 2018	32.5	19.9	92	53	1.7	8.6	3.9	00.6	0
Feb. 2018	33.3	21.5	92	53	1.8	9.9	4.1	36.8	1
Mar. 2018	33.5	23.8	92	58	1.9	8.4	3.9	37.8	4

ICAR-CPCRI, Regional Station, Vittal

Month	Temp.		RH %		Wind velocity (km/h)	Sunshine (h)	Evapo ration (mm)	Rainfall (mm)	Rainy days
	Max (°C)	Min (°C)	FN	AN					
April 2017	35.6	23.4	91.4	54.7	3.3	3.5	4.9	12.4	1
May 2017	34.4	22.2	92.1	61.4	3.2	4.3	3.8	118.4	8
June 2017	29.6	21.4	97.0	84.7	2.2	1.8	1.5	893.5	30
July 2017	29.2	21.1	97.5	83.3	2.8	1.9	1.6	680.2	29
Aug. 2017.	29.3	21.4	97.4	84.7	2.4	1.6	1.9	770.5	23
Sept. 2017	30.6	21.9	95.9	75.7	2.2	3.6	2.4	293.5	15
Oct. 2017	31.9	21.2	94.6	68.7	1.7	4.2	2.5	83.4	6
Nov. 2017	33.7	19.8	91.6	53.7	1.8	5.2	2.9	53.8	2
Dec. 2017	33.0	17.9	90.1	47.0	2.3	5.9	3.1	0.0	0
Jan. 2018	33.7	16.3	94.5	39.6	1.9	6.0	3.3	0.0	0
Feb. 2018	35.3	17.5	92.8	34.0	2.5	6.7	4.1	0.0	0
Mar. 2018	35.1	20.1	92.8	48.1	2.8	4.8	4.4	79.4	2

ICAR-CPCRI, Research Centre, Kidu

Month	Temp.		RH %		Wind velocity (km/h)	Sunshine (h)	Evapo ration (mm)	Rainfall (mm)	Rainy days
	Max (°C)	Min (°C)	FN	AN					
April 2017	36.9	23.4	93	50	N.A.	7.1	6.3	77.4	5
May 2017	33.5	21.7	95	65	N.A.	5.2	4.3	244.8	18
June 2017	29.3	20.9	96	88	N.A.	2.1	2.6	970.4	28
July 2017	29.1	20.5	97	88	N.A.	1.1	2.5	1163.6	30
Aug. 2017.	29.3	20.9	97	87	N.A.	1.7	2.5	851.2	27
Sept. 2017	31.6	20.9	96	74	N.A.	3.8	3.1	420.9	21
Oct. 2017	33.1	20.9	95	69	N.A.	4.6	3.3	213.4	16
Nov. 2017	34.1	18.9	93	51	N.A.	6.6	3.9	14.0	3
Dec. 2017	34.2	16.9	92	46	N.A.	8.4	4.1	0	0
Jan. 2018	34.7	15.1	93	37	N.A.	8.3	4.5	0	0
Feb. 2018	36.2	18	93	29	N.A.	8.6	5.6	0	0
Mar. 2018	37.4	21.9	94	41	N.A.	7.3	6.1	22.0	0.3

N.A. Not available.

XXV

OFFICIAL LANGUAGE IMPLEMENTATION

Visit of Second Sub-committee of Committee of Parliament on Official Language

Dr. Prassanna Kumar Patsani, Hon'ble Member of Parliament (Rajya Sabha) and Dr. Sunil Baliram Gaikwad, Hon'ble Member of Parliament (Lok Sabha), Second Sub-committee of Committee of Parliament on Official Language visited Alappuzha, Kerala on 24th January 2018 as part of the inspection on use of Hindi in the Department. Hon'ble dignitaries were extremely pleased to see the use of Hindi in all aspects of official work including promotion/branding of coconut value added products at ICAR-CPCRI. The Committee reviewed all aspects of implementation of official language at the Regional Station and the implementation was rated as good. Publications in Hindi on "Value-added products of coconut" (*नारियल के मूल्य वर्द्धित उत्पाद*), "Rugose spiraling whitefly" (*रूक्षपृष्ठी सर्पिल सफेद मक्खी*), and a Mobile App on coconut cultivation, e-Kalpa in Hindi (*नारियल खेती पर एक मोबाइल अप्लिकेशन ई-कल्प*) were released by the Hon'ble Parliamentarians. Dr. P. Chowdappa, Director, ICAR-CPCRI, Dr. V. Krishnakumar, Head, ICAR-CPCRI, Regional Station, Kayamkulam, Dr. Vikramaditya Pandey, Principal Scientist, Shri M.L. Gupta, Assistant Director (OL) and Mr. Manoj Kumar, ACTO, (OL) from ICAR, New Delhi participated in the review programme.

Hon'ble Parliamentarians releasing the publications in Hindi and inspecting the exhibits

Hindi Week celebrations

Inaugural function of *Hindi Chethana Mas* was conducted on 20th September, 2017 under the chairmanship of Dr. P. Chowdappa, Director. He urged the staff members to do maximum official work in Hindi. Dr. P. Supriya, Asst. Professor (Hindi and Comparative Literature), Central University of Kerala, Kasaragod delivered a lecture on the possession and position of Hindi Language.

Valedictory function of *Hindi Chethana Mas* celebration was held on 25th October, 2017 under the chairmanship of Dr. P. Chowdappa, Director, ICAR-CPCRI. Dr. (Smt.) Sudha Balakrishnan, Head (Hindi and Comparative Literature), Central University of Kerala was the chief guest, and she delivered a lecture on the importance of Hindi Language. Prizes were distributed to winners of the different competitions conducted during the *Chethana Mas* celebrations and also awarded cash prizes to the staff members for the maximum usage of Hindi in official work.

ICAR-CPCRI, Regional Station, Kayamkulam celebrated 'Hindi Week' on the occasion of '*Hindi*

Address by Dr. P. Supriya during the inaugural function of *Hindi Chethana Mas*

Dr. Sudha Balakrishnan addressing the gathering during the valedictory function of *Hindi Chethana Mas*

Diwas', from 14th to 20th September, 2017. During the week long celebrations, various competitions like dictation, extempore speech, slogan writing, poem recitation *etc.* were organized among the employees enhanced working linkage through Hindi. The valedictory function, held on 22nd September, 2017, was chaired by Dr. V. Krishnakumar, Head of Station. Shri Achutha Panicker (Retired Professor), the Chief Guest, emphasized on the inclusive usage of Hindi in routine life. Cash prizes were also distributed to the winners of various competitions as well as to those employees who had promoted Hindi in their official work.

Hindi Week was celebrated at Research Centre, Kahikuchi from 14th September, 2017 to 22nd September, 2017. The opening function was chaired by Dr. Alpana Das, Scientist-in-Charge. Competition on various aspects of Hindi usage was conducted and prizes were distributed, Dr. A.K. Tripathi, Director, ICAR-ATARI was the chief guest of the concluding ceremony.

Hindi Week Celebration was held at ICAR-CPCRI, Research Centre, Mohitnagar from 14-20th September, 2017, to promote the use of Hindi in official work. Teachers from Kendriya Vidyalaya, Raninagar, Jalpaiguri delivered lectures in official language on different aspects.

भाकृअनुप
ICAR

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

Agrisearch with a human touch

ISSN 973-5445

9 770097 354454

www.cpcri.gov.in