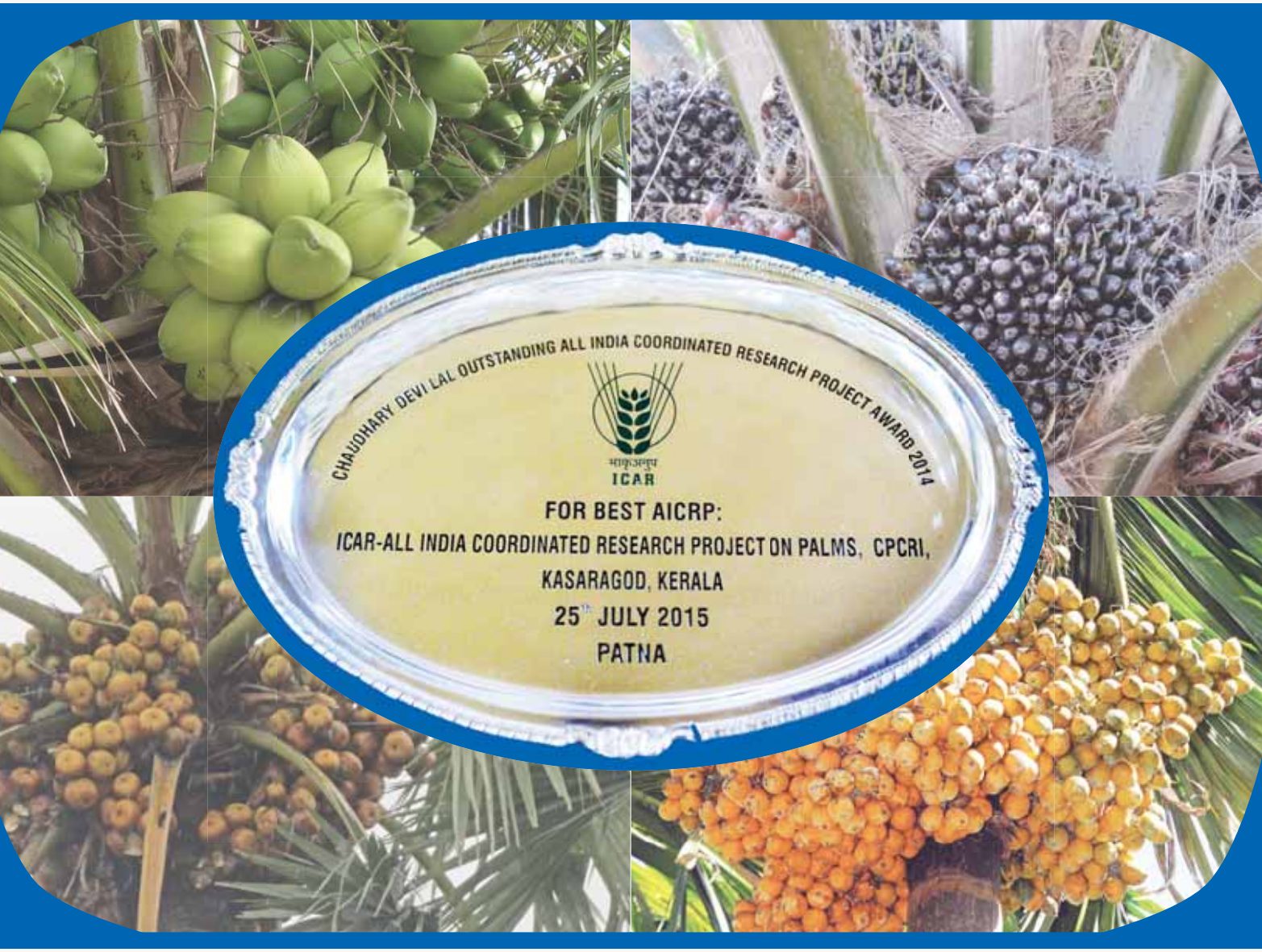
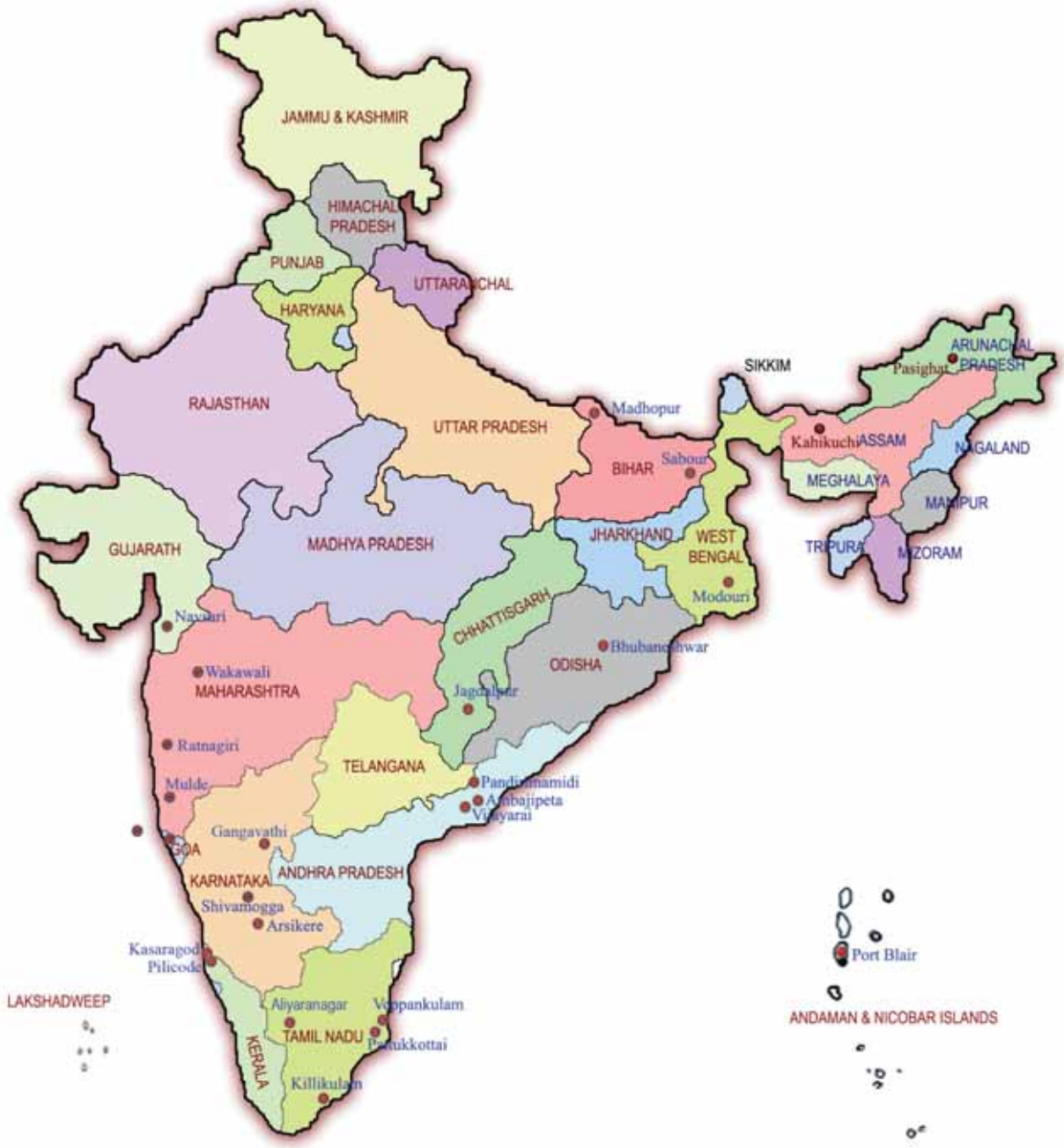
वार्षिक प्रतिवेदन

ANNUAL REPORT 2015-16



भाकृअनुप-अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना
(भारतीय कृषि अनुसंधान परिषद)
भाकृअनुप-के रो फ अ सं, कासरगोड़, 671 124, केरल
ICAR-All India Co-ordinated Research Project on Palms
ICAR-Central Plantation Crops Research Institute
(Indian Council of Agricultural Research)
Kasaragod - 671 124, Kerala, India

MAP SHOWING AICRP ON PALMS CENTRES



ICAR-AICRP on Palms

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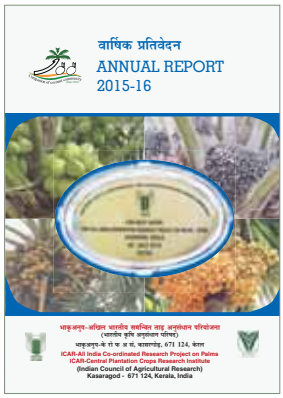

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Contents….

Awards

Chaudhary Devi Lal outstanding AICRP Award

Chaudhary Devi Lal outstanding AICRP Award for 2014 was honourned to the All India Coordinated Research Project on Palms (ICAR-CPCRI, Kasaragod, Kerala) for its contribution in developing many location-specific technologies in crop improvement, production and plant health management of mandate crops *viz*., Coconut, Oil palm and Palmyrah. AICRP Centre, Ambajipeta (Dr. YSRHU, AP) has been judged as the best centre.

The award was received by Dr. H.P. Maheswarappa, Project Coordinator (Palms) on 25th July, 2015 during the 87th ICAR Foundation and ICAR award ceremony held at Patna (Bihar), which was inaugurated by Hon'ble Prime Minster Shri Narendra Modiji. The award was given by Hon'ble Minister of state for Agriculture and farmers welfare Dr. Sanjeev Kumar Balyan and Shri Mohan Bhai Kundariya.

Dr. H.P. Maheswarappa receiving the best AICRP award

Dr. G. Ramanandam receiving the best centre award

I. प्रस्तावना

स्थानीय/क्षेत्रीय विशेष अनुसंधान परिणाम से हुए परावर्तन पर रोपण फसल में अनुसंधान प्रबंधन और नीति निर्माण बहुत अधिक निर्भर रहते हैं। इस मूलभूत सिद्धांत को ध्यान में रखते हुए अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना नारियल, सुपारी, तेल ताड़ और पॉमैरा जैसे ताड़ों पर 20 सुव्यवस्थित केंद्रों और नौ स्वैच्छिक केंद्रों में पिछले चार दशकों से स्थानीय विशेष अनुसंधान किया जा रहा है।

इस वर्ष अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना के वैज्ञानिकों को मुख्य फसलों में स्थानीय विशेष प्रौद्योगिकियों के विकास में उनके योगदान के लिए चौधरी देवी लाल ए आई सी आर पी उत्कृष्ठ पुरस्कार 2014 से पुरस्कृत किया गया।

वर्ष 2015-16 की अवधि में जननद्रव्य संग्रहण के रूप में पाँच भिन्न बौनी पॉमैरा जातियों का संग्रहण किया गया और पश्चिम बंगाल के मिदनापुर जिले से संग्रहित किया गया और दो पॉमैरा केंद्रों में संग्रहित किया गया। एल सी टी x सी सी एन टी, एक उत्कृष्ठ लंबी x लंबी संकर, जिसकी उच्च उपज (161 गुठली प्रति ताड प्रति वर्ष) के आधार पर अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना का वेप्पंगुलम केंद्र में विमोचन के लिए पहचाना गया। पट्टुकोटाई (तमिलनाडु) में वर्ष 2006 को रोपित दस तेल ताड़ संकरों के बीच वृद्धि और उपज के लिए मूल्यांकित संकरों में एन आर सी ओ पी 17 से उच्च ताज़ा फल गुच्छ (163.3 कि.ग्रा/ ताड़ एवं 23.3 टन/हेक्टर) प्राप्त किया गया। अलियार नगर (तमिलनाडु) में फसल उत्पादन में उपयुक्त फूल फसलों जैसे गेंदा, गामफ्रेना, मयूरशिख, सुभगा प्रजाति, हेमपुष्प और अरसिकरे केंद्र के नारियल बाग में अन्तरफसलन के लिए हेमपुष्प, कनकाम्बर, चीन तारक पहचान लिया गया। गंगावती में तेल ताड बाग की बाल अवस्था में भिण्डी, बैगन, और टमाटर फसल के साथ अंतरफसलन से अतिरिक्त आय प्राप्त किया गया आन्ध्रप्रदेश के तटीय जिले में काले सिरवाली रोमिल इल्ली के प्रकोप के लिए 37 लाख परजीव्याभ का वितरण किया गया। आन्ध्रप्रदेश के पूर्व एवं दक्षिण जिले में और कर्नाटक के तुमकुर जिले के स्थानों में स्लग कैटरपिल्लर का प्रकोप पाया गया और प्रकोप जॉचं के लिए लाइट ट्रैप प्रौद्योगिकी का उपयोग किया गया। अम्बाजिपेट केंद्र में प्रक्षेत्र परिस्थिति के अधीन नारियल का तना स्त्रवण रोग के विरुद्ध *ट्राइकोडेरमा हरज़ियानम* (सी पी टी डी 28) का केक रूपांकन प्रभावी पाया गया। आधार तना सड़न रोग जल्दी से पहचान के लिए तूअर और चना सूचक पौध के रूप में पहचान लिया गया है। पॉमैरा के नर और मादा ताड़ों के रस के जैवरासायनिक गुण के संघटन में कुल ठोस और कुल शक्कर के संबंध में लगभग सदृश्य है। यह उल्लेखनीय है कि आदिवासी उप योजना कार्यक्रम अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना के चार केंद्रों द्वारा कार्यान्वित किया गया। इसके अलावा प्रमाणित प्रौद्योगिकियों के प्रचार के लिए सभी केंद्रों में विभिन्न प्रशिक्षण कार्यक्रम और विस्तार गतिविधियाँ कृषक समुदायों और अन्य हितधारकों के लिए आयोजित की जा रही है।

डॉ. टी. महापात्र, सचिव, डेयर और महानिदेशक, भारतीय कृषि अनुसंधान परिषद और डॉ. एस. अय्यप्पन, पूर्व सचिव, डेयर और महानिदेशक, भाकृअनुप, नई दिल्ली द्वारा दिए गए प्रोत्साहन को मैं अपना सौभाग्य मानता हूँ। डॉ. एन.के. कृष्णकुमार, उप महानिदेशक (बागवानी विज्ञान) डॉ. टी. जानकीराम, सहायक महानिदेशक और भारतीय कृषि अनुसंधान परिषद के स्टाफ सदस्यों द्वारा दिए गए समर्थ सहारे और आवश्यक मार्गदर्शन के लिए मैं आभारी हूँ। डॉ. पी. चौड़प्पा, निदेशक और भाकृअनुप-केंद्रीय रोपण फसल अनुसंधान संस्थान के स्टाफ द्वारा दी गई सहायता और मार्गदर्शन के लिए मैं कृतघ्नता ज्ञापन करता हूँ। तकनीकी कार्यक्रमों के रूपांकन और कार्यान्वयन के लिए भाकृअनुप-भारतीय तेल ताड़ अनुसंधान संस्थान, पेडवेगी के निदेशक महोदय डॉ. आर.के. माथुर और अन्य स्टाफ सदस्यों द्वारा दिए गए मार्गदर्शन के लिए आभार प्रकट करता हूँ। इसके अतिरिक्त तकनीकी कार्यक्रमों के प्रभावी कार्यान्वयन के लिए कुलपति, अनुसंधान निदेशक, विभिन्न अनुभागों के प्रमुख, विभिन्न कृषि/बागवानी विश्वविद्यालयों के प्रमुखों द्वारा प्रदान

किए गए तकनीकी एवं प्रशासनिक सहायता के लिए धन्यवाद।

सभी परियोजना अन्वेषकों द्वारा विभिन्न कार्यक्रमों के आयोजन में किए गए प्रयास और दिखाए गए उत्साह के लिए प्रशंसा करता हूँ। विशेषताः डॉ. टी.बी. बसवराजु, डॉ. ए. सुब्रमण्यन, डॉ. एनबीवी चलपति रॉव, डॉ. टी. श्रीनिवासन, डॉ. स्नेहलता रानी, डॉ. संजीव रेड्डी, जी. रेड्डी और अन्य वैज्ञानिकगण को भी धन्यवाद अर्पित करता हूँ जिन्होंने इस रिपोर्ट के संकलन में मदद की है। डॉ. विनायक हेग्डे, डॉ. बी.ए. जेरार्ड, डॉ. पी. सुब्रमणियन, डॉ. एम. सुचित्रा, भा कृ अनु प-कें रो फ अ सं, कासरगोड के प्रति धन्यवाद जिन्होंने विभिन्न गतिविधियों के प्रभावी अनुवीक्षा एवं तकनीकी मार्गदर्शन में सहायोग दिया है। सुश्री एस. सुमिता, वैज्ञानिक, श्रीमती के. नारायणी, निजी सचिव और श्री नारायण नायिक, प्रवर श्रेणी लिपिक, सुश्री ए. गीता और श्री मोहना को भी साधुवाद देता हूँ जिन्होंने इस रिपोर्ट के निष्पादन में मदद और समन्वयन कार्य किया है। हिंदी अनुवाद के लिए डॉ. अल्का गुप्ता और श्रीमती के. श्रीलता को भी धन्यवाद प्रस्तुत करता हूँ।

एच.पी. महेश्वरप्पा

जुलाई, 2016

(डॉ. एच.पी. महेश्वरप्पा)

I. PREFACE

Research management and policy formulations in plantation crops are very much relied on the reflections from location/region specific research outputs. In view of this fundamental principle, All India Coordinated Research Project on Palms (AICRPP) has been conducting location specific research on palms *viz.*, coconut, arecanut, oil palm and palmyrah in 17 regular centres and ten voluntary centres for the last four decades.

The year has been rewarding for the Scientist of AICRP's by receiving Chaudhary Devi Lal outstanding AICRP award-2014 for its contribution in developing many location specific technologies in mandate crops.

During the year 2015-16, five distinct dwarf palmyrah accessions were collected from Midnapur district of West Bengal and conserved at two palmyrah centres. In coconut, LCT x CCNT, a superior Tall x Tall hybrid was identified for release based on its higher yield (161 nuts palm^{-1} yr^{-1}) at AICRP on Palms centre, Veppankulam. Among the ten oil palm hybrids planted during 2006 at Pattukottai (Tamil Nadu), evaluated for growth and yield, the hybrid NRCOP-17 recorded significantly higher FFB yield (163.3 kg/palm & 23.3 t/ha). In crop production, suitable flower crops identified for intercropping under coconut gardens *viz.,* marigold, gomphrena, celosia, zinnia and chrysanthemum at Aliyarnagar centre (Tamil Nadu) and chrysanthemum, crossandra, china aster and marigold at Arsikere centre (Karnataka). During juvenile phase of oil palm garden, intercropping with bendi, brinjal and tomato crops found to provide additional income in Gangavathi. About 37 lakhs parasitoids were supplied to contain outbreak of coconut black headed caterpillar in coastal districts of Andhra Pradesh. There was outbreak of slug caterpillar in pockets of East and West Godavari districts of Andhra Pradesh and Tumkur district of Karnataka, and the light trap technology was effectively used to check the outbreak. Cake formulation of *Trichoderma harzianum* (CPTD 28) employed against stem bleeding disease of coconut was found effective under field conditions in Ambajipeta centre. For early detection of Basal stem rot disease, red gram and bengal gram were identified as indicator plants. Biochemical properties of sap from male and female palms of Pamyrah were almost similar in composition with respect to total solids and total sugar. It is noteworthy that the Tribal Sub-Plan (TSP) program has been implemented by four AICRPP centres. Besides, various training programmes and extension activities have been carried out in all the centres to disseminate the proven technologies to the farming community and other stakeholders.

I consider it a privilege to place on record the encouragement given by Dr. T. Mohapatra, Secretary, DARE and Director General, ICAR; and Dr. S. Ayyappan, former Secretary, DARE and Director General, ICAR. I am also grateful for the strong support and necessary guidance received from Dr. N. K. Krishna Kumar, Deputy Director General (Hort. Science), Dr. T. Janakiram, ADG (Hort. Science) and staff of Horticulture Science Division, ICAR.

I acknowledge the guidance and support provided by Dr. P. Chowdappa, Director and staff of ICAR-CPCRI, Kasaragod, Dr. R. K. Mathur, Director and staff of ICAR-IIOPR, Pedavegi in formulation and implementation of technical programmes. Further the technical and administrative support given by the Vice Chancellors, Directors of Research, Head of Divisions, Head of Stations of various Agricultural/ Horticultural Universities for effective implementation of the technical programmes is greatly acknowledged.

I appreciate the efforts and zeal shown by all the staff of the centres during execution of various programmes and I take this opportunity to express my sincere thanks to scientists of AICRP on Palms especially Dr. T. B. Basavaraju, Dr. A. Subramanian, Dr. N.B.V. Chalapathi Rao, Dr. T. Srinivasan, Dr. Snehalatharani, and Dr. Sanjeevraddi G. Reddi for their help in compilation of this report. I record my sincere thanks to Dr. Vinayaka Hegde, Dr. B. A. Jerard, Dr. P. Subramanian and Dr. M. Sujithra of ICAR-CPCRI, Kasaragod for their effective monitoring and technical guidance for implementation of technical programmes. The support and coordination of Ms. S. Sumitha, Scientist, Smt. K. Narayani, Private Secretary and Mr. Narayana Naik, UDC, Ms. A. Geetha and Mr. A. Mohana of AICRP Cell for bringing out this report and the help rendered by Dr. Alka Gupta and Mrs. K. Sreelatha for Hindi translation are also greatly acknowledged.

July 2016

(H.P. Maheswarappa)

II. कार्य सारांश

अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना केंद्र जिसका मुख्यालय भाकृअनुप-कें रो फ अ सं, कासरगोड एक समन्वयन केंद्र के रूप में 29 केंद्रों (19 नियमित और 10 स्वैच्छिक केंद्र) के साथ नारियल, तेल ताड़, सुपारी और पॉमैरा फसलों की उत्पादन क्षमता बढ़ाने की स्थानीय विशेष प्रौद्योगिकियों के विकासन में सफलतापूर्वक विभिन्न सस्य जलवायु क्षेत्रों का प्रतिनिधित्व कर 13 राज्यों में स्थित है। आनुवंशिक संसाधन, फसल सुधार, फसल उत्पादन, रोग प्रबंधन, कृमि कीट प्रबंधन और कटाई उपरांत प्रौद्योगिकियों के अधीन मुख्य फसलों में वर्ष 2015-16 की अवधि में हुए अनुसंधान कार्य की प्रगति इस रिपोर्ट में प्रस्तुत की गई है।

वर्ष 2015-16 में हुई अनुसंधान उपलब्धियाँ

नारियल

आनुवंशिक संसाधन और फसल सुधार

वेप्पंगुलम केंद्र में लंबी x लंबी संकर के 14 संकर संयुक्तों के मूल्यांकन से एलसीओटी x सीसीएनटी श्रेष्ठ उच्च उपज संकर संयुक्त के रूप में पहचान लिया गया। भाकृअनुप-केंद्रीय तटीय कृषि अनसुंधान संस्थान, गोवा में आयोजित अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना की चौबीसवीं वार्षिक समूह बैठक के अवसर पर यह संकर वेप्पंगुलम संकर संयुक्त1 (वीएचसी1) के रूप में विमोचन के लिए सिफारिश किया गया। स्थिर फलन अवधि में संकर की औसत उपज 161 गुठली/ताड़/वर्ष थी जो इसीटी और वीएचसी1 से क्रमश: 62.6 और 43.8 प्रतिशत अधिक है।

फसल उत्पादन

नारियल आधारित उच्च घनता बहुजातिय फसलन पद्धित

अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना के विभिन्न केंद्रों में विकसित समीकृत पोषण प्रबंधन के अधीन नारियल आधारित फसलन पद्धति से नारियल के इकफसल की अपेक्षा उच्च उत्पादन क्षमता और आय पायी गयी। काहिकुची केंद्र में नारियल अनन्नास + लोभिया असम नींबू + केला + कालीमिर्च के साथ वर्मीकम्पोस्ट का जैविक पुन:चक्रमण के साथ नाईट्रोजन फॉसफोरस पोटाश के शुपार्शित मात्रा के 75 प्रतिशत का फसलन पद्धति का समीकृत पोषण प्रबंधन से 3.17 लाख रुपए प्रति हेक्टर उच्चतम सकल आय और पूर्ण रूप से जैविक उपचार से 2.95 लाख प्रति हेक्टर प्राप्त किया गया। वेप्पंगुलम केंद्र में शुपार्शित नाईट्रोजन फॉसफोरस पोटाश के 50 प्रतिशत मात्रा + वर्मीकंपोस्ट का पुन: चक्रमण + वर्मीवाश प्रयोग + जैव उर्वरक प्रयोग के अधीन नारियल + कालीमिर्च + केला कोको के फसलन पद्धित से उच्च सकल आय (3.52 लाख रुपए /हेक्टर) प्राप्त किया गया और यथावत् हरी खाद प्रयोग के बाद पूर्ण रूप से कार्बनिक पोषण प्रबंधन से 3.16 लाख रुपए /हेक्टर प्राप्त किया गया।

नारियल बाग में फूल फसलों का अन्तरफसलन

नारियल बाग में इकफसल की अपेक्षा फूल फसलों का वर्द्धन उच्च उत्पादक और लाभप्रद है। अलियार नगर में नारियल बाग में उचित फूल फसल के रूप में गेंदा, गामफ्रेना, मयूरशिख, सुभगा प्रजाति, हेमपुष्प, पहचाना गया और अरसिकरे केंद्र में हेमपुष्प, कनकाम्बर, चीन तारक, और गेंदा, काहिकुची केंद्र में अभिसुन्दरा प्रजाति, रजनीगन्धा, कृपाणपर्ण प्रजाति, और गेंदा, मन्डौरी केंद्र में कृपाणपर्ण प्रजाति, रजनीगन्धा, अभिसुन्दरा प्रजाति, रत्नगिरी में नलिनी, हेलिकोनिया, मल्लिका उचित पायी गयी।

नारियल बाग में अन्तरफसल के रूप में कोको

अम्बाजिपेट में अन्तरफसल के रूप में छह कोको क्लोन जैसे वी. टी.एल.सी.सी. 1, वी.टी एल.सी.एच. 1, वी.टी.एल.सी.एच. 2, वी. टी.एल.सी.एच. 3, वी.टी.एल.सी.एच. 4 और वी.टी.एल.सी. 1 के निष्पादन हेतु मूल्यांकन किया गया। उसके बीच वी.टी.एल.सी एच1 से उच्चतम उपज 2.95 कि. ग्रा सूखा बीन प्रति पेड़ प्राप्त किया गया।

कृमि कीट प्रबंधन

काले सिरवाली रोमिल इल्ली

आन्ध्रप्रदेश में सर्वेक्षण की अवधि पर सभी तटीय जिलों में काले सिरवाली रोमिलइल्ली का प्रकोप देखा गया। प्रभावित भागों में 37 लाख परजीव्याभ का वितरण किया गया। तमिलनाडु में तिरुप्पुर, नामक्कल, डिन्डिगुल और कोयम्बत्तूर जिले में कैटरपिल्लर समस्या पायी गयी और नारियल अनुसंधान स्टेशन, अलियार नगर में ब्राकेन ब्रविकोर्निस का परजीव्याभ समूह का पालन पोषण किया गया। 40 हेक्टर क्षेत्रफल में विमोचन के लिए 2,08,100 संख्या परजीव्याभ का वितरण किया गया।

स्लग कैटरपिल्लर

पश्चिम गोदावरी जिले के उप्पलगुटाम, रावुलपालेम, कोथापेटा, रज़ोले, सकेनेटापल्लि और मुमिदिवारम मन्डल से और पूर्व गोदावरी जिले के भिमवारम, पोदुरु और येलमन्चाली मन्डल से स्लग कैटरपिल्लर का तीक्ष्ण लक्षण रिपोर्ट किया गया। लक्षण प्रारंभिक रूप से फरवरी के तीसरे हफ्ते में निरीक्षण किया गया और 160 से 200 हेक्टर क्षेत्रफल कीट से प्रभावित पाया गया। सभी मन्डलों में लाईट ट्राप तकनीकी का उपयोग कर कीट का प्रबंधन सफलतापूर्वक किया गया। बागवानी विभाग के सहयोग के साथ प्रक्षेत्र संदर्शन और

प्रशिक्षण कार्यक्रम आयोजित कर कीट प्रभावित मंडल के कृषकों को प्रबंधन रणनीतियों के प्रचार पर जागरूकता कार्यक्रम आयोजित किया गया।

रोग प्रबंधन

आधार तना सड़न के समीकृत प्रबंधन पर प्रक्षेत्र परीक्षण में कवकानी, जैवएजेंट और समीकृत पोषण प्रबंधन, 5 कि.ग्रा. नीम केक के साथ 125 ग्रा *ट्राइकोडरमा रीसायई/टी एस्पेरेल्लम* 125 ग्रा *स्यूडोमोनस फ्लूरोसेन्स* प्रति ताड़ प्रति वर्ष का मृदा प्रयोग से बागवानी अनुसंधान स्टेशन, अम्बाजिपेट और बागवानी अनुसंधान स्टेशन अरसिकरे में रोग सूचकांक में कमी पायी गयी। जबकि तिमाही अंतराल में 1.25 कि.ग्रा नीम केक के साथ 125 ग्रा *ट्राइकोडरमा रीसायइ/टी एस्पेरेल्लम* 125 ग्रा *स्यूडोमोनस फ्लूरोसेन्स* प्रति ताड़ प्रति वर्ष का मृदा प्रयोग से नारियल अनुसंधान स्टेशन वेप्पंगुलम में रोग सूचकांक कम पाया गया।

कवकानी जैसे 0.15 टेबुकोनज़ोल 25.9 इ सी, 0.10 में टेट्राकोनज़ोल 3.8 इ डब्ल्यु, 0.10 में प्रोपिकोनज़ोल 25 इसी और थिरम 0.28 में कारबोक्सिन 37.5 डब्ल्यु एस आदि कृत्रिम वातावरण में *गेनोडेरमा लूसिडम* की कवक जाल वृद्धि पूर्ण रूप से प्रदर्शित करता है।

कोयम्बत्तूर जिले में पुलियन्कण्डी गॉव में और तमिलनाडु के तिप्तूर जिले में गोमनंगालम्पुदुर गॉव में तिमाही अंतराल में 2 मि.ली. टेबुकोनज़ोल 100 मि.ली. पानी के दर में मूल वेधन से तीक्ष्ण पत्ता चित्ती रोग कम करने में सहायक पाया गया।

तेल ताड़

पाट्टुकोटाई, तमिलनाडु में 2006 में रोपित दस संकर के बीच वृद्धि और उपज निष्पादन मूल्यांकन में वर्ष 2015-16 (रोपाई का नौवाँ वर्ष) एन.आर.सी.ओ.पी 17 संकर महत्वपूर्ण उच्च उपज 163.3 कि ग्रा/ताड़ और 23.3 टन/हेक्टर) रिकार्ड किया गया। विजयराय केंद्र (आंध्रप्रदेश) में 2007 में रोपित विभिन्न संकर संयुक्तों के तुलनात्मक निष्पादन एन.आर.सी.ओ.पी. 4 संकर उच्च उपज 24.9 टन/हेक्टर) और एन.आर.सी.ओ.पी. 5 (19.9 ट न/हेक्टर) से रिकार्ड किया गया।

पॉमैरा

जननद्रव्य संग्रहण : पश्चिम बंगाल के मिदनापुर जिले में अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना, किल्लीकुलम और पान्डिरिमामिडी केंद्र द्वारा जननद्रव्य संग्रहण सर्वेक्षण किया गया। संरक्षण एवं मूल्यांकन के लिए विशेष गुणों की कुल पाँच जातियाँ संग्रहित की गयी।

चौबीसवीं वार्षिक समूह बैठक

अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना की 24 वीं वार्षिक बैठक भा कृ अनु प - केंद्रीय तटीय कृषि अनुसंधान संस्थान, गोवा में 26 से 28 मई 2015 तक आयोजित की गयी। श्री मनोजकुमार साहू, भा प्र से, सचिव (कृषि) गोवा सरकार ने बैठक का उद्घाटन किया। डॉ. एस.के. शर्मा, निदेशक, केंद्रीय शुष्क बागवानी संस्थान, बीकानेर, डॉ. पी.एल. सरोज, निदेशक, काजू अनुसंधान निदेशालय, पुत्तूर, और डॉ. ए.एस. कुमारस्वामी, पूर्व डीन (शिक्षा) कृषि बागवानी विज्ञान विश्वविद्यालय, शिमोगा, की उपस्थिति ने बैठक की गरिमा बढ़ाई। डॉ ए.एस. कुमारस्वामी और डॉ. विरक्तमत ने फसल उत्पादन और कीट प्रबंधन तकनीकी सत्र के विशेषज्ञ सदस्यों के रूप में समूह बैठक में भाग लिया। उद्घाटन सत्र में मुल्डे केंद्र की ओर से अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना, उड़ीसा के नारियल बाग में खुम्भ कृषि की संभावनाएँ, प्रादेशिक नारियल अनुसंधान स्टेशन, भाट्ये अनुसंधान एक झलक (मराठी), तेल ताड़ कृषि (मराठी) प्रकाशनों का विमोचन किया गया। डॉ. एन.के. कृष्णकुमार, उप महानिदेशक (बागवानी विज्ञान), भाकृअनुप, नई दिल्ली की अध्यक्षता में अंतिम सत्र आयोजित किया गया। डॉ. पी. चौड़प्पा, निदेशक, भा कृ अनु प-कें रो फ अ सं, और डॉ. पी. कालिदास, कार्यकारी निदेशक, भाकृअनुप-भारतीय तेल ताड अनुसंधान संस्थान, पेडवेगी इस अवसर पद उपस्थित थे। डॉ. एच.पी. महेश्वरप्पा, परियोजना समन्वयक (ताड़) ने समूह बैठक की सिफारिशों के साथ कार्यक्रमों पर संक्षिप्त विवरण दिया। प्रतिवर्ष अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना के केंद्रों का मूल्यांकन किया जा रहा है और वर्ष 2014-2015 में अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना का मुल्डे केंद्र उत्तम निष्पादन केंद्र के रूप में चुन लिया गया। विभिन्न तकनीकी सत्रों में लिए गए निर्णय अनुमोदन हेतु प्रस्तुत किये गये। अंतिम अभ्युक्ति के रूप में डॉ. एन.के. कृष्णकुमार ने बताया कि प्रजाती विमोचन या किसी प्रौद्योगिकी के विकास के लिए बहुस्थानीय परीक्षण द्वारा अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना प्रबल की जानी चाहिए।

सिफारिशें

अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना केंद्र, वेप्पंगुलम से उच्च उपज प्राप्त एल.सी.ओ.टी x सी.सी.एन.टी, श्रेष्ठ लंबी x लंबी संकर विमोचन के लिए पहचान लिया गया। इससे औसत उपज 161 गुठली /ताड/वर्ष रिकार्ड की गयी जो इ.सी.टी. और वी. एच.सी. से क्रमशः 62.6 और 43.8 प्रतिशत अधिक है।

अलियार नगर केंद्र (तमिलनाडु) में नारियल के अधीन अंतरफसलन के लिए उचित फूल फसल, गेंदा, गामफ्रेना, मयूरशिख, सुभगा प्रजाति, हेमपुष्प और अरसिकरे केंद्र (कर्नाटक), में हेमपुष्प, कनकाम्बर, चीन तारक और गेंदा पाया गया।

नारियल का आधार तना सड़न रोग की पूर्व पहचान के लिए सूचक पादप के रूप में तूअर और चना पहचान लिया गया।

II. EXECUTIVE SUMMARY

The All India Coordinated Research Project on Palms with its headquarters at ICAR- CPCRI, Kasaragod, a coordinating unit with 27 centres (17 regular and 10 voluntary centres) located in 13 states and one union territory representing different agro climatic regions has been successful in developing location specific technologies to improve the productivity of coconut, oil palm, arecanut and palmyrah. Progress of research work in these mandate crops under genetic resources and crop improvement, crop production, disease management, pest management and post harvest technology during the year 2015-16 is presented in this report.

Research achievements during 2015-16

Coconut

Genetic resources and crop improvement

The evaluation of 14 cross combination of Tall x Tall hybrids at Veppankulam centre resulted in identification of a superior high yielding cross combination, LCOT x CCNT. This hybrid was recommended for release as VHC - 4 during the 24th Annual Group Meeting of AICRP on Palms held at ICAR - Central Coastal Agricultural Research Institute, Goa. The mean yield of the hybrid during the stabilized bearing period was 161 nuts/palm/year, which is 62.6 and 43.8 per cent higher than ECT and VHC-1, respectively.

Crop production

Coconut based high density multi species cropping system

The coconut based cropping systems under integrated nutrient management developed at different AICRP Centres showed higher productivity and income than monocrop of coconut. At Kahikuchi Centre, the cropping system of coconut + pineapple + cowpea + Assam lemon + banana + black pepper with integrated nutrient management of 75 per cent of recommended NPK coupled with organic recycling with vermicompost recorded higher net income of Rs. 3.17 lakhs/ha followed by fully organic treatment (Rs. 2.95 lakhs/ha). At Veppankulam Centre, the cropping system of coconut + black pepper + banana + cocoa recorded higher net returns (Rs. 3.52 lakhs/ha) under 50 per cent of recommended NPK + organic recycling with vermicompost + vermiwash application + biofertilizer application and *in situ* green manuring followed by fully organic nutrient management (Rs. 3.16 lakhs/ha).

Intercropping of flower crops in coconut garden: Growing of flower crops in coconut garden is highly productive and remunerative than monocropping of coconut. The suitable flower crops identified under coconut are marigold, gamphrena, celosia, zinnia and chrysanthemum at Aliyarnagar Centre; chrysanthemum, crossandra, china aster and marigold at Arsikere Centre; gerbera, tuberose, gladiolus and marigold at Kahikuchi Centre; gladiolus, tuberose and gerbera at Mondouri Centre; lily, heliconia and jasmine at Ratnagiri Centre.

Cocoa as intercrop in coconut garden: Six cocoa clones *viz.,* VTLCC – I, VTLCH – I, VTLCH – 2, VTLCH – 3, VTLCH – 4 and VTLC – 1 were evaluated for their performance as a intercrop in coconut gardens at Ambajipeta centre. Among them, the clone VTLCH –1 gave highest yield of 2.95 kg dry beans per tree.

Pest management

Black headed caterpillar: During the surveys in Andhra Pradesh, outbreak of coconut black headed caterpillar was observed in all the coastal districts and 37 lakh parasitoids were supplied to the affected areas. In Tamil Nadu, the caterpillar problem was noticed in Tiruppur, Namakkal, Dindigul and Coimbatore districts and parasitoids of *Bracon brevicornis* were mass reared at Coconut Research Station, Aliyarnagar and a total of 2,08,100 numbers of parasitoids were supplied for release in an area of about 40 ha.

Slug caterpillar: Severe incidence of slug caterpillar was reported from Uppalagutam, Ravulapalem, Kothapeta, Razole, Sakenetapalli and Mumidivaram mandals of East Godavari and Bhimavaram, Poduru and Yelamanchali mandals of West Godavari district. The incidence was initially observed during third week of February and at around 160 to 200 ha area affected with the pest. In all the mandals, the pest was successfully managed by adopting light trap technology. Awareness programmes on management strategies were disseminated to farmers of affected mandals through field visits and training programmes with the assistance of Department of Horticulture.

Disease management

- In the field trial on integrated management of basal stem rot involving fungicides, bioagents and INM, soil application of 125g of *Trichoderma reesei / T. asperellum* + 125g of *Pseudomonas fluorescens* along with 5 kg neem cake per palm per year reduced the disease index at HRS, Ambajipeta and HRS, Arsikere, whereas, soil application of 125g of *Trichoderma reesei / T. asperellum* + 125g of *Pseudomonas fluorescens* along with 1.25 kg neem cake per palm at quarterly intervals significantly reduced disease index at CRS, Veppankulam.

- Fungicides *viz.*, Tebuconazole 25.9% EC at 0.15%, Tetraconazole 3.8% EW at 0.10%, Tebuconazole + Trifloxystrobin 50% + 25% WG at 0.40 % , Hexaconazole 5% EC at 0.10 %, Propiconazole 25% EC at 0.10 % and Thiram + Carboxin 37.5 + 37.5 WS at 0.28 % were found to completely inhibit the mycelial growth of *Ganoderma lucidum* under *in vitro* conditions.

- Root feeding of Tebuconazole @ 2ml + 100 ml water at quarterly intervals was found to reduce leaf blight disease severity under field conditions at Puliyankandi village in Coimbatore district and Gomangalampudur village in Tirupur district of Tamil Nadu.

Oil palm

Among the ten hybrids planted during 2006 at Pattukottai (Tamil Nadu) and evaluated for growth and yield performance, the hybrid NRCOP-17 recorded significantly higher FFB yield (163.3 kg / palm and 23.3 t/ha) during 2015-16 (at 9th year of planting). Under comparative performance of different hybrid combinations planted during 2007, at Vijayarai centre (A.P), the hybrid NRCOP- 4 recorded significantly higher FFB yield (24.9 t/ha) followed by NRCOP- 5 (19.9 t/ha).

Palmyrah

Germplasm collection: Survey was conducted at Midnapur district of West Bengal by AICRP, Killikulam and Pandirimamidi centres, and a total of five accessions with distinct characters were collected for conservations and evaluation.

XXIV Annual Group Meeting

The Annual Group meeting of All India Coordinated Research Project on Palms was organized from 26th to 28th May, 2015 at ICAR-Central Costal Agricultural Research Institute, Goa. The meeting was inaugurated by Mr. Manoj Kumar Sahoo IAS, Secretary, Agriculture, Government of Goa, and graced by Dr. S.K. Sharma, Director, ICAR-CIAH, Bikaner, Dr. P.L. Saroj, Director, ICAR-DCR, Puttur and Dr. A.S. Kumaraswamy, Former, Dean of Education (UAHS), Shivamogga. Dr. A.S. Kumaraswamy and Dr. C.A. Viraktamath participated in the group meeting as expert members for the technical sessions of Crop Production and Insect Pest Management. Four publications *viz.,* "AICRP on Palms at a Glance", "Prospects of mushroom cultivation in coconut garden in Odisha", RCRS, "Bhatye Research at a glance (Marathi)", "Oil palm cultivation"(Marathi) from Mulde centre were released during the inaugural session. The plenary session was held on 28th May 2015 under the chairmanship of Dr. N.K. Krishna Kumar, DDG (Hort. Sci.), ICAR, New

Delhi and Dr. P. Chowdappa, Director, ICAR-CPCRI and Dr. P. Kalidas, Acting Director, ICAR- IIOPR, Pedavegi were present on the occasions. Dr. H.P. Maheswarappa, Project Coordinator (Palms) briefed about the programmes of group meeting held for two days along with recommendations. The performance of AICRP centres is being evaluated every year and during 2014-15, AICRP centre, Mulde has been judged as the best performing centre. Decisions taken in various technical sessions were presented for the approval. In his concluding remarks, Dr. N.K. Krishna Kumar stated that the programmes of AICRP on Palms should be strengthened through multi location trails for variety release or development of any technology.

Recommendations

- LCOT x CCNT, a superior Tall x Tall hybrid was identified for release based on its higher yield from the AICRP on Palms centre, Veppankulam. It recorded mean yield of 161 nuts/palm/year, which was 62.6 and 43.8 per cent higher than checks ECT and VHC -1, respectively.
- The suitable flower crops identified under coconut are marigold, gomphrena, celosia, zinnia and chrysanthemum at Aliyarnagar Centre (TN), chrysanthemum, crossandra, china aster and marigold at Arsikere Centre (Karnataka).
- Red gram and Bengal gram were identified as indicator plants for early detection of basal stem rot disease of coconut.

III. PROFILE OF AICRP ON PALMS

3.1 Mandate

Among the plantation crops, palms such as coconut (*Cocos nucifera* L.), arecanut (*Areca catechu L.*), oil plam *(Elaeis guineensis* Jacq.) and palmyrah *(Borassus flabellifer* L.) play a significant role in the sustainable livelihoods of millions of small and marginal farmers in the country. The All India Co-ordinated Research Project on Palms came to existence in the year 1972 to carry out the location specific research and the mandates of the project are as follows:

- To identify, conserve and utilize elite genetic resources for useful traits in palms from different agro-climatic regions and to evaluate performance of varieties/hybrids under different locations and to facilitate release of varieties/ hybrids.
- To improve input use efficiency and develop location-specific palm based integrated farming systems to enhance the productivity per unit area, and organic cultivation packages for palms and palm based farming system.
- To evaluate bio-intensive insect - pest and disease management strategies, modeling and forecasting of disease incidence and documentation of insects pest dynamics in changing scenario of palm ecosystem.
- Development of post-harvest technologies in palmyrah and to demonstrate and transfer of technologies to the farmers.

3.2 List of the centres

The project is implemented in 29 centers with its headquarters at Kasaragod and, 15 centers are conducting research on coconut, eight on oil palm, four on arecanut, two on palmyrah and one on sulphi palm. The coordinating centers are located in 13 states and one union territory covering 13 SAU's, one Central Agricultural University and four ICAR institutes.

State	Center/Location	Area of Research	University/ Institutions
Andhra Pradesh	Horticultural Research Station, Ambajipeta, East Godavari, Dt., 533 214 Phone: 08856-244436/243711	Coconut: Crop Improvement, Production & Protection	Dr.Y.S.R Horticultural University, West Godavari Dt., 534 101
	Agricultural Research Station, Vijayarai, West Godavari, Dt., 534 475 Phone : 08812-225431	Oil Palm: Crop Improvement & Production	
	Horticultural Research Station, Pandirimamidi, Ramapachodaram PO 533 288, East Godavari, Dt., Phone : 08864-246577	Palmyrah: Crop Improvement, Production & Post Harvest Technology	
	Indian Institute of Oil Palm Research. Near Jawahar Navodaya Vidyalaya, Pedavegi – 534 450 West Godavari Dt., Phone :08812-259409/259532	Oil Palm: Crop Improvement & Production	Indian Council of Agricultural Research
Andaman and Nicobar	Central Island Agricultural Research Institute, Port Blair- 744 101 Phone : 03192-250436	Coconut and Arecanut: Crop Improvement & Production	Indian Council of Agricultural Research

Arunachal Pradesh	College of Horticulture & Forestry, Pasighat - 791102, Phone : 0368-2224887	Oil Palm: Crop Improvement & Production	Central Agricultural University, P.O.Box 23, Imphal - 795 004, Manipur.
Assam	Horticultural Research Station, Kahikuchi, Guwahati 781 017, Kamrup Dt., Phone : 0361-2840232	Coconut: Crop Improvement & Production	Assam Agricultural University, Jorhat - 785 013
Bihar	Bihar Agricultural College, Sabour - 813 210, Bhagalpur Dt., Phone : 0641-2451001	Coconut:Crop Improvement & Production	Bihar Agricultural University, Sabour, Bhagalpur - 813 210.
	Regional Research Station, P.O. Madhopur - 845 454, Majhaulia Via., West Champaran Dt., Phone : 06252-280542	Oil Palm: Crop Improvement & Production	Rajendra Agricultural University, Pusa, Samastipur - 848 125
Chhattisgarh	Saheed Gundadhoor College of Agriculture & Research Station, Kumharawand Farm, Jagdalpur - 494 005, Phone : 07782-229360	Coconut:Crop Improvement Sulphi palm: Crop Improvement and Disease Management	Indira Gandhi Krishi Vishwavidyalaya, Raipur - 492 012
Gujarat	ASPEE College of Horticulture& Forestry, Navsari Agricultural University, Navsari - 396 450, Phone : 02637-282144	Coconut: Crop Improvement & Production	Navsari Agricultural University, Navsari - 396 450
Goa	Central Coastal Agricultural Research Institute, Ela, Old Goa 403 402 Phone : 0832-2285448	Coconut: Crop Improvement & Production. Arecanut : Crop Improvement and Production	Indian Council of Agricultural Research
Karnataka	Horticultural Research Station, Arsikere - 573 103, Hassan Dt. Phone: 08174-291565/291711	Coconut: Crop Improvement, Production & Protection	University of Horticultural Sciences, Navanagar, Bagalkot - 587 102
	Agricultural Research Station, Gangavathi - 583 227, Koppal Dt. Phone: 08533-271443/271034	Oil Palm: Crop Improvement & Production	
	Arecanut Research Centre, College of Agriculture, Navile, Shivamogga Dt. Phone : 08181-267011	Arecanut : Crop Improvement, Production and Protection	University of Agricultural & Horticultural Sciences, Navile, Shivamooga-577 225
	Agricultural and Horticultural Research Station, Bavikere – 577144, Chikkamagaluru Dt. Phone :08261 255122	Oil Palm: Crop Production	
Kerala	Central Plantation Crops Research Institute, Kasaragod - 671 124 Phone : 04994-232733	Coconut: Crop Production	Indian Council of Agricultural Research
	Regional Agricultural Research Station, Pilicode P.O., Kasaragod - 670 353 Phone:0467-2260450	Coconut: Crop Improvement	Kerala Agricultural University, P.O. KAU, Vellanikkara, Thrissur - 680 656

Maharashtra	Regional Coconut Research Station, Bhatye 421 612, Ratnagiri Dt. Phone : 02352-255077	Coconut: Crop Improvement, Production & Protection	Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli - 415 712, Ratnagiri Dt.
	College of Horticulture, Mulde - 416 520, Kudal Taluk, Sindhudurg Dt. Phone: 02362-244231/244232	Oil Palm: Crop Improvement & Production	
	Central Experimental Station, Asond block, Wakavali, Dalopli Tk. Phone : 02358-282417	Areanut : Crop improvement & Production	
Odisha	Department of Horticulture, (OUAT), Bhubaneshwar - 751 003 Phone : 0674-2397463	Coconut:Crop Improvement & Production	Orissa University of Agriculture & Technology, Bhubaneswar-751003
Tamil Nadu	Coconut Research Station, Aliyarnagar - 642 101, Coimbatore Dt. Phone: 04253-288722/288662	Coconut:Crop Improvement, Production & Protection	Tamil Nadu Agricultural University, Coimbatore - 641 003
	Coconut Research Station, Veppankulam - 614 906, Thanjavur Dt. Phone: 04373-260205/202534	Coconut:Crop Improvement, Production & Protection	
	Agricultural Research Station, Pattukkottai-614 602, Thanjavur Dt.Phone : 04373-235832	Oil Palm: Crop Improvement & Production	
	Agricultural College & Research Institute, Killikulam- 628 252, Vallanad, Tuticorin Dt. Phone : 04630-261226	Palmyrah: Crop Improvement & Post Harvest Technology	
West Bengal	Directorate of Research, P.O. Kalyani - 741 235, Nadia Dt., Phone :033-25827574	Coconut: Crop Improvement & Production	Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia - 741 252,

3.3 Budget

The budget for the year 2015-16 was Rs. 528.00 lakhs (ICAR Share)

(₹ in lakhs)

Sl. No.	Head	Expenditure as on 31.03.2016
1.	Pay and allowances	315.24
2.	T.A.	25.13
3.	RC	180.11
4.	HRD	7.52
	Total	528.00

NEH: 42.5 lakhs, TSP: 25 lakhs

Centre wise budget for 2015-16 (ICAR share)

Centre	Pay	TA	RC	HRD	NRC	Total
Aliyarnagar	35.00	1.60	6.00	0.40	5.41	48.41
Ambajipeta	37.00	1.41	6.50	0.40	10.41	55.72
Arsikere	28.85	1.50	4.50	0.60	3.01	38.46
Jagdalpur	15.54	1.00	8.18	0.75	3.23	28.7
Kahikuchi	23.13	1.10	4.50	0.40	6.00	35.13
Bhubaneshwar	10.50	0.75	8.00	0.75	0.00	20.00
Mondouri	18.60	0.75	3.00	0.30	0.00	22.65
Ratnagiri	40.20	0.90	8.65	0.75	0.00	50.50
Veppankulam	31.60	1.50	5.50	0.40	1.51	40.51
Killikulam	15.50	1.20	3.00	0.10	0.00	19.80
Pandirimamidi	17.50	1.20	3.00	0.10	3.60	25.40
Pattukotai	13.80	0.56	3.50	0.10	0.00	17.96
Gangavathi	3.00	0.40	1.92	0.30	1.01	6.63
Mulde	2.00	0.56	1.50	0.10	0.00	4.16
Vijayarai	2.00	0.56	1.50	0.10	0.38	4.54
Navasari	8.34	0.75	7.50	0.75	0.00	17.34
Sabour	6.38	0.56	2.00	0.10	0.19	9.23
Pasighat	0.00	1.25	4.00	0.32	1.50	7.07
Madhopur	0.00	0.10	0.00	0.00	0.60	0.70
Pilicode	0.00	0.20	1.00	0.00	2.48	3.68
Kasaragod	0.00	0.00	3.50	0.00	0.00	3.50
PC cell	0.00	1.05	3.50	0.00	0.50	5.05
Port Blair	0.00	2.00	8.00	0.20	2.30	12.50
Goa	0.00	1.20	7.00	0.20	0.00	8.40
Shivamogga	6.30	1.50	6.00	0.20	7.15	21.15
Wakawali	0.00	1.13	4.00	0.20	6.04	11.37
Pedavegi	0.00	0.20	1.00	0.00	0.00	1.20
Bavikere	0.00	0.20	2.00	0.00	6.04	8.24
Total	315.24	25.13	118.75	7.52	61.36	528.00

Mode of implementation

The project is implemented through the respective State-Agricultural/Horticultural universities on 75:25 basis of which 75 % is ICAR share and 25 % share is from State Agricultural Universities.

3.4 Staff strength

Category	Present strength
Scientific	35
Technical	20
Supporting	17
Total	72

Staff Position

HEAD QUARTERS

Project Coordinator's Cell, CPCRI, Kasaragod - 671 124, Kerala

Project Coordinator : Dr. H. P. Maheswarappa
Scientist : Ms. S. Sumitha
Private Secretary : Mrs. K. Narayani
UDC : Mr. P.Narayana Naik
Skilled supporting staff : Mr. A. Mohana

ANDHRA PRADESH

Horticultural Research Station, Ambajipeta -533 214, East Godavari Dt., (Phone: 08856 – 243847)

Senior Scientist (Horticulture) : Dr. G. Ramanandam
Scientist (Entomology) : Dr. N. B. V. Chalapathi Rao
Scientist (Horticulture) : Mrs. E. Padma
Scientist (Pathology) : Dr. A. Snehalatha Rani
Technical Assistant : Shri. Ch. Mallikarjuna Rao
Sub Assistant (Tech) : Shri. B. Koteswara Rao
Smt. N. Maheswari

Horticultural Research Station, Vijayayrai – 534 475, West Godavari Dt., (Phone: 08812-225431; Fax: 08812- 225826)

Scientist (Horticulture) : Dr. P. Madhavi latha
Agricultural Extension Officer : M. Tirupathi Raju

Horticultural Research Station, Pandirimamidi, Ramapachodavaram P.O. 533 288, East Godavari Dt., (Phone: 08864 – 243577)

Scientist (Horticulture) : Sri. G. N. Murthy
Scientist (Food Sci. & Tech.) : P. C. Vengaiah
Technical Assistant : A. S. R. Anjaneyulu

ICAR- Indian Institute of Oil palm Research, Near Jawahar Navodaya Vidyalaya, Pedavegi- 534450, West Godavari Dt.

Principal Scientist (Horticulture) : Dr. B. Narasimha Rao
Principal Scientist (Agronomy) : Dr. K. Manorama

ANDAMAN & NICOBAR ISLANDS

Central Island Agricultural Research Institute, Port Blair, P.O.744 101, Andaman & Nicobar Islands (Phone: 03192 250436 (O), Fax: 03192 251068)

Scientist (Horticulture) : Dr. Ajit Arun Waman

ARUNACHAL PRADESH

College of Horticulture and Forestry, Central Agricultural University, Pasighat- 791 102, East Siang Dt., (Phone: 0368- 2224887/ 0368- 2225066(Fax)

Scientist (Horticulture) : Dr. Barun Singh

ASSAM

Horticultural Research Station, Kahikuchi, Guwahati -781 017, Kamrup Dt., (Phone: 0361- 2840232)

Senior Scientist (Horticulture)	:	Dr. J. C. Nath
Scientist (Agronomy)	:	Dr. K. K. Deka
Technical Assistant	:	Shri. P. Bora

BIHAR

Regional Agricultural Station, Madhopur, West Champaran (Phone: 06252-280542)

Scientist (Horticulture)	:	S. C. Narayan

Bihar Agricultural College, Sabour, Bhagalpur- 813210 (Phone: 0641- 2451001)

Scientist (Horticulture)	:	Dr. Ruby Rani

GOA

ICAR – Central Coastal Agricultural Research Institute, Ela, Old Goa, P.O. 403 402.
(Phone: 0832-2284678 / 79, Fax : 0832-2285649)

Principal Scientist (Horticuture)	:	Dr. V. Arunachalam

GUJARAT

Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari 396450 (Phone: 02637-282144)

Scientist (Horticulture)	:	Dr. Pankaj Pandurang Bhalerao

KARNATAKA

Hortcultural Research Station, Arsikere – 573 103, Hassan Dt., (Phone: 08174 - 291565)

Senior Scientist (Agronomy)	:	Dr. T. B. Basavaraju
Scientist (Pathology)	:	Dr. Manjunath Hubballi
Scientist (Entomology)	:	Dr. G. S. Chandrasekhar
Senior Technical Assistant	:	Mrs. Sunita M. Patil (Ms. Shweta from 19-01-2016)
	:	Mr. K.E. Dayananda

Agricultural Research Station, Gangavathi – 584 227, Koppal Dt., (Phone: 08533 – 271034/ 08533 271030)

Scientist (Agronomy)	:	Dr. Sanjeevaraddi G. Reddi
Research Assistant (Technical)	:	Ms. Chandravathi B.

Arecanut Research Station, College of Agriculture, Navile - 577216, Shivamogga Dt., (Phone: 08182267011)

Scientist (Plant Pathology)	:	Dr. B. Gangadhara Naik

Agricultural and Horticultural Research Station, Bavikere – 577 144, Chikkamagaluru Dt. (Phone: 08261 255122)

Scientist (Agronomy)	:	Dr. Basavaraj Naik

KERALA

Central Plantation Crops Research Institute, Kasaragod- 671 124 (Phone: 04994-232893)

Principal Scientist (Agronomy)	:	Dr. P. Subramanian

Regional Agricultural Research Station, Pilicode, Kasaragod Dt., – 670 533 (Ph: 0467-2260450/2282737)

Scientist (Plant Breeding)	:	Dr. Vanaja. T

MAHARASHTRA

Regional Coconut Research Station, Bhatye – 4215612, Ratnagiri Dt., (Phone: 02352- 235077/02352 – 235331

Senior Scientist (Agronomy)	:	Dr. R. G. Khandekar
Scientist (Plant Breeding)	:	Mr. V. S. Sawant
Junior Entomologist	:	-
Junior Agricultural Assistants	:	Mr. P. A. Shinde
	:	Mr. H. B. Yadhav

College of Horticulture, Mulde, Kudal Taluk, Sindhudurg Dt. – 416520
(Phone: 02362 244231 – 244232/02362 – 244231 (Fax)

Scientist	:	Mr. V. P. Damodhar
Senior Technical Assistant	:	Shri N. M. Naik

Central Experimental Station, Asond block, Wakavali, Ratnagiri Dt.

Scientist (Horticulture)	:	Dr.G.D.Shirke

CHHATTISGARH

Saheed Gunadadhoor College of Agriculture & Research Institute, Kumharawand Farm, Jagdalpur- 494 005, Bastar Dt. (Phone: 07782- 229150/07782- 229360 (Fax)

Scientist (Horticulture)	:	Dr. S. Agarwal
Scientist (Agronomy)	:	Shri. P. K. Salam
Technical Asst.	:	Vacant

ODISHA

Department of Horticulture, OUAT, Bhubaneshwar – 751 003 (Phone: 0674 – 2390463)

Scientist (Horticulture)	:	Dr. S. C. Sahoo
Technical Assistant	:	Mr. P.K. Jena

TAMIL NADU

Coconut Research Station, Aliyarnagar – 642 101, Coimbatore Dt., (Phone: 04253- 288722)

Senior scientist (Plant Breeding)	:	Dr. A. Subramanian
Scientist (Entomology)	:	Dr. T. Srinivasan
Scientist (Agronomy)	:	Dr. S. Rani
Scientist (Plant Pathology)	:	Dr. R. Ramjegathesh
Technical Assistant	:	Mr. M. Pachalingam
	:	Mr. Selvaraj

Agricultural Research Station, Pattukottai – 614 602 (Phone: 04373 – 235832)

Scientist (Agronomy)	:	Dr. T. Sumathi
Senior Technical Assistant	:	Th. N. Kanagasabapathy

Coconut Research Station, Veppankulam – 614 906, Thanjavur Dt., (Phone: 04373- 260205)

Senior Scientist (Horticulture)	:	Dr. K. S. Vijai Selvaraj
Scientist (Agronomy)	:	Dr. A. Selvarani
Scientist (Plant Pathology)	:	Dr. S. Thangeswari
Technical Assistant	:	Mr. D.Ravi
	:	Mrs. B.Sundari

Agricultural College & Research Institute, Killikkulam – 628 252, Vallanad, Tuticorin Dt., (Phone: 04630 – 261226/04630 – 261268 (Fax)

Scientist (Horticulture)	:	Dr. T. Prabhu
Scientist (Agrl. Food Proc. Engin.)	:	Er. Thambiduarai
Technical Assistant	:	Mr. M. Ananth

WEST BENGAL

Department of Plantation Crops, Faculty of Horticulture, BCKVV, Mondouri (Kalyani) -741 235, Nadia Dt., (Phone: 033- 25827574)

Senior Scientist (Horticulture)	:	Dr. D.K.Ghosh
Scientist (Plant Breeding)	:	Dr. D. K. Ghosh
Technical Assistant	:	Mr. A. K. Dey

IV. EXPERIMENTAL RESULTS IN COCONUT

4.1 Genetic Resources and Crop Improvement

Gen.1: Conservation and evaluation of coconut genetic resources in different agro- climatic regions

Germplasm conservation occupies a pivotal role in crop breeding as it provides the raw material for future breeding programs. To this end, research efforts were undertaken to conserve and evaluate coconut germplasms; conserve and evaluate local germplasms collections and evaluate elite genotypes from germplasms under multi-location trials.

Expt.1: Evaluation of conserved germplasms

This trial was laid out at Bhubaneshwar, Navsari and Sabour centres for conservation and multi-location testing of coconut germplasm and their evaluation for yield as well as reaction to biotic and abiotic stresses. The experiment was laid out as un-replicated observational trial with 10 and 5 palms per genotype for Sabour; and Bhubaneshwar and Navsari centres, respectively.

List of germplasms under evaluation in Gen 1 Expt.1

Centre	Genotypes evaluated
Bhubaneshwar	COD (IND 007), Sakhigopal (IND 041), MYD (IND 058), St.Vincent (IND 053), SSG (IND 009), Guam type I (IND 025),BSI (IND 036), Andaman Ordinary (IND 018), Zanzibar Tall (IND 037), San Ramon (IND 034), Benaulim, Gangabondam, WCT, MGD, Tiptur Tall and Java Tall
Navsari	COD (IND 007), MYD (IND 058), Gangabondam, CGD, Benaulim, PHOT , Kappadam (IND 001), Seychelles, Borneo (IND 024), FMS (IND 010), LCOT, ADOT (IND 018), San Ramon (IND 034), Guam (IND025/IND026), New guinea Tall (IND 011), WCT and Spicata (IND 040), BRR , BGL , BYL
Sabour	LCOT , PHOT, ADOT (IND 018), Benaulim, Tiptur Tall, Arasampatti Tall, ECT, Gonthembili Tall (IND 051), Zanzibar Tall (IND 037), Hazari Tall , Assam Green Tall and Benaulim.

Bhubaneshwar

Germplasm accessions comprising of four dwarfs and 12 talls were planted during 2004 for evaluation. Among the dwarfs, Gautami Ganga (Gangabondam) performed better by exhibiting the lowest plant height, maximum stem girth, no. of functional leaves, annual leaf production rate and yield (30.6 nuts/ palm). Among the tall palms, the maximum plant height, leaf length and wider leaflets were recorded in IND 036 (BSI). Flowering and yield were observed in all the tall accessions during the year and the highest yield (35.5nuts / palm) was recorded in IND 018 (AO).

Navsari

The trial comprised of four dwarfs and 15 talls, seedlings of which were planted during August, 2014. The trial is in the initial phase of establishment.

Expt.2: Collection, conservation and evaluation of location specific germplasms

This experiment was formulated with a view to collect, conserve and evaluate the local germplasm of coconut for yield and reaction to biotic and abiotic stresses. The trials are in progress in Aliyarnagar, Ambajipeta, Arsikere, Bhubaneshwar, Jagdalpur, Kahikuchi, Mondouri, Navsari, Pilicode, Ratnagiri, Sabour and Veppankulam centres. The evaluation materials comprises of 10-15 local germplasm collection. Among the collections in each centre, some are evaluated in replicated trials and some in observational trials.

Aliyarnagar

A total of 11 germplasms were collected during 2007. Five germplasms were maintained as a replicated trial and the rest were planted as observational trial.

Replicated trial

Since the replicated trial was under-planted, felling of adult palms during 2012 resulted in mortality of some seedlings, and the genotypes CRP735 and CRP736 did not establish well. During the Annual Group Meeting of 2012, it was recommended to include genotypes form Etamozhi region in the replicated trial. Hence, these genotypes were replaced with CRP742 from Nagerkoil district and CRP745 from Theni district during 2013. The mean trunk height of palm was 83.2 cm and the mean girth was 122.2 cm (Table 1). Among the genotypes, CRP 745 was observed to exhibit good overall vigour.

Table 1. Growth characters of local germplasm at Aliyarnagar (Year of planting: 2008)

Germplasms / IC No.	Height (cm)	Girth (cm)	Annual leaf production	Average nut yield /palm
CRP 738 (610371)	289.3	108.9	11.9	66
CRP 739 (610372)	165.0	92.5	8.5	-
CRP 740 (610373)	328.0	138.0	12.0	79
CRP 741 (610374)	362.5	119.8	11.8	46
CRP 742 (610375)	303.5	131.5	12.0	67
CRP 746* (610379)	78.3	117.7	7.3	
Mean	254.4	118.1	11.2	
SD	109.3	18.2	1.5	
CV (%)	42.95	15.4	13.6	

* Genotype mean not considered for calculation of overall mean

Ambajipeta

Thirteen elite local germplasms were collected from traditional coconut growing districts *viz.,* Srikakulam, East and West Godavari of Andhra Pradesh and the seedlings were planted during 2013. Five accessions were planted in replicated trial and eight accessions were planted as an observational trial and seedlings are in establishment stage. It was found that all the genotypes were on par with regard to height and number of leaves, but significant differences was observed for petiole length in replicated trial.

Arsikere

Replicated trial

In Arsikere centre, five local germplasms *viz.,* CRP 811, CRP 817, CRP 818, CRP 820 and CRP 821 collected from Maidan tract of Karnataka were planted in replicated trial for evaluation during July, 2013 and the palms are in establishment phase. Analysis of observations on growth parameters showed significance for all the traits except leaflet breadth and number of leaflets.

Bhubaneshwar

Eleven local germplasm were planted in December, 2003 as observational trial with 10 palms per germplasm. The local germplasm (CRP 790) was observed to be more vigorous compared to the others. All entries have started bearing. The maximum yield (48.7nuts/palm) was recorded in CRP790 (Table 2).

Kahikuchi

In Kahikuchi centre, replicated trial was initiated during 2005 with 10 local accessions of coconut collected from four districts of Assam *viz.,* Kamrup, Darrang, Nalbari and Borpeta, along with two check varieties *viz.,* Kamrupa and WCT (Kera Keralam). Five new coconut germplasm were collected from Nowgaon and Marigaon districts and planted during April, 2009 for evaluation in observational trial.

Replicated trial

The maximum plant height (7.87m), collar girth (176.8 cm), number of functional leaves (27.3) and annual

Table 2. Growth characters of local germplasm in observational trial at Bhubaneshwar (Year of planting: 2003)

Germplasms/ IC. No	Plant height (m)	Plant girth (cm)	No. of leaves produced /palm	No. of nuts/ palm
CRP 790 (612457)	4.41	186.1	12.2	48.7
CRP 791 (612458)	4.37	164.6	12.1	35.2
CRP 792 (612459)	3.33	137.7	12.0	24.8
CRP 793 (612460)	3.48	160.6	11.8	21.8
CRP 794 (612461)	2.93	147.8	12.1	22.5
CRP 795 (612462)	2.9	153.1	11.7	21.4
CRP 796 (612463)	2.91	154.2	11.6	23.7
CRP 797 (612464)	3.3	170.3	12.0	28.5
CRP 798 (612465)	3.13	144.8	12.2	26.1
CRP 799 (612466)	3.19	158.1	11.8	27.8
CRP 800 (612467)	2.71	150.7	12.0	24.3

leaf production (11.9) were recorded in the check variety Kamrupa. Early flowering was recorded in accessions *viz.,* CRP701, CRP703, CRP707 and Kamrupa which was 67 months from planting. No overlapping of male and female phases was observed in all the germplasm studied. With regard to nut characteristics, the genotype CRP702 recorded the highest nut weight (1476.5 g/nut) and tender coconut water content (375.6 ml/nut). Significantly the highest yield of 55.7 nuts/palm was observed in Kamrupa compared to other germplasms (Table 3).

Table 3. Growth and yield characters of local germplasm of coconut in replicated trial at Kahikuchi (Year of planting : 2005)

Germplasm /IC No.	Plant height (m)	Collar girth (cm)	Annual leaf production (no.)	First flowering (months)	Wt. of nut (g)	Nut yield (nuts/palm/year)
CRP 701 (610353)	7.02	149.3	10.5	67	1269.0	40.8
CRP 702 (610354)	7.67	171.9	11.2	68	1476.5	45.7
CRP 703 (610355)	7.66	167.4	11.7	67	1265,5	46.5
CRP 704 (610356)	7.60	166.2	10.6	78	1350.6	43.8
CRP 705 (610357)	7.10	158.7	10.7	70	1240.5	46.9
CRP 706 (610358)	7.15	142.9	11.3	70	1320.7	42.5
CRP 707 (610359)	7.54	137.8	11.6	67	1380.8	44.6
CRP 708 (610360)	6.98	145.2	11.8	70	1300.7	36.0
CRP 709 (610361)	7.07	144.4	10.3	72	1385.6	40.0
CRP710 (610362)	6.82	135.1	11.8	73	1375.4	49.4
Kera Keralam	7.80	170.4	11.3	73	1360.8	40.5
Kamrupa	7.87	176.8	11.9	67	1375.7	55.7
CD (P=0.05)	0.21	10.01	0.39	0.88	43.54	3.42

Mondouri

Ten local germplasms were collected from different districts of West Bengal, five of which were planted in replicated trial during 2007 and the rest in observational trial during 2009.

Replicated trial

The maximum trunk height was recorded in CRP 781 (154.2 cm) while stem girth was maximum in CRP782 (136.9 cm). Significant variation was recorded for all the characters among the genotypes.

Navsari

Four germplasms were planted in Randomised Block Design (RBD) with five replications during 2013 and the seedlings are in establishment phase. Analysis of observations on growth parameters showed wide differences among the genotypes. The maximum plant height (650.2 cm), collar girth (53.2 cm), number of functional leaves on the crown (7.6) and petiole length (34.0 cm) were recorded in CRP 729, whereas, the leaf length (195.8 cm), leaflet length (83.4 cm) and leaflet breadth (4.5 cm) were maximum in CRP 730.

Pilicode

Three germplasms *viz,* Sannagi Semi Tall, Sannagi Dwarf and Trivandrum are being maintained at RARS, Pilicode as observational trial. To enhance the collection, a state wide collection drive was initiated during 2014-15 and this resulted in identification of good mother palms for 42 local germplasm from five districts *viz.,* Kasaragod, Kannur, Kozhikode, Wayanad and Thrissur. Collection of seed nuts for the mother palms is under progress.

Ratnagiri

A total of six gemplasms collected from Konkan region have been raised in replicated trial and observational trial for evaluation. These were planted in 2007 and 2010, respectively. To evaluate sweet coconut (*Mohacha Naral*) type found in Guhagar Tahasil of Ratnagiri district (Maharashtra), fourteen seedlings and one set of embryo cultured plantlets were planted during 2007.

Replicated trial

Analysis of data recorded in replicated trial showed that the difference among the local germplasm was not significant for the morphological traits. The accession, CRP 761 recorded maximum girth (125.5 cm) and stem height (187.7 cm) while CRP 759 recorded maximum number of leaves (11.5), functional leaves (25.8) and petiole length (162.1 cm).

Veppankulam

Five germplasms were collected and planted during 2005 in RBD as under planting in coconut garden. Subsequently, during 2012, the old palms were removed retaining the newly planted palms. Observations were recorded on nut yield / palm and nut parameters. Analysis of the data revealed that CRP 716 recorded higher annual yield of 51 nuts/ palm. Regarding the fruit quality characters, CRP 717 recorded the maximum whole nut weight, de-husked nut weight and kernel weight (1370 g/nut, 645 g/nut and 320 g/nut, respectively), whereas the ecotype CRP 720 recorded maximum copra content (165 g/nut) (Table 4).

Table 4. Nut yield and nut parameters of local germplasm in replicated trial at Veppankulam (Year of planting : 2005)

Genotype IC numbers	Nut yield / palm	Nut weight (g)	Kernel weight (g)	Copra content (g)
CRP716 (599263)	51	1320	240	110
CRP717(599264)	49	1370	320	130
CRP 718 (599265)	33	1250	280	135
CRP 719 (599266)	48	880	190	80
CRP 720 (599267)	33	1270	310	165
WCT	39	1150	250	120
Arasampatti Tall	37	1090	290	125
SEm±	12.27	93.61	21.56	15.57
CD (P=0.05)	NS	NS	NS	NS

Expt. 3: Evaluation of selection from germplasms

This experiment was formulated to evaluate a few elite exotic coconut genotypes in multi locations in replicated trials for their yield performance and for reaction to biotic and abiotic stresses. *Inter se* crossed seed nuts of different sets of materials were supplied to centers as given below and the experimental layout consisted of six test entries and one local check, planted in RBD with three replications and four palms per genotype per replication.

Participating centres and genotypes under evaluation in Gen. 1 Expt. 3 trial

Name of the centre	Elite genotypes											
	Verik-kobari Tall	St.Vin-cent Tall	Guam-II Tall	Guam-III Tall	Zan-zibar Tall	Straits Settlement Green	Markham Tall	La-guna Tall	Nige-rian green	Pala-wan Tall	Ken-ya Tall	Local check
Ambajipeta	*	*	*	*	*	*					*	*
Aliyarnagar	*			*		*	*		*	*		*
Arsikere	*	*	*			*	*		*			*
Bhubaneshwar	*			*				*	*	*	*	*
Ratnagiri	*	*		*	*	*			*		*	
Veppankulam	*		*			*	*	*	*		*	

In all the centres, seedlings were planted during 2015 and the trial is in the establishment stage. At Aliyarnagar centre, Markham Tall was observed to be more vigorous with better establishment, while in Bhubaneswar, Laguna Tall was observed to have better seedling vigor. At Ratnagiri, Zanzibar Tall was observed to be more vigorous followed by Guam III Tall.

Expt. 4: Performance evaluation of INGR 13065 (*Niu Lekha*) dwarf

This trial was initiated at Aliyarnagar and Ratnagiri centres for evaluation of the dwarf genotype INGR 13065 (*Niu Lekha*). The seedlings supplied by ICAR-CPCRI, Kasaragod were planted in unreplicated trials along with local check during July, 2015 and they are in the establishment phase.

Gen. 2: Evaluation of coconut hybrids in different agro climatic regions

Expt. 1: Production and evaluation of new cross combinations in coconut

This trial is being carried out at Bhubaneshwar, Ambajipeta and Arsikere centres with an objective of evaluating new hybrids for yield, quality and tolerance to biotic and abiotic stresses.

Bhubaneshwar

Eight hybrid combinations were planted along with a check (CRP 509) in a replicated trial during 2005. The data on growth and floral attributes of the palms recorded during the year 2014-15 revealed no significant variation among the cross combinations except for the girth of the palm. Maximum girth (169.5cm) was recorded in the cross GBGD x PHOT hybrid, while the yield was maximum in the combination of ECT x GBGD (35.6 nuts / palm/year).

Ambajipeta

The trial was laid out during 1985 with six cross combinations (ECT x MGD, GBGD x ECT, GBGD x FJT, GBGD x PHOT, GBGD x LCOT and ECT x GBGD along with a Check in RBD. Analysis of data pertaining to yield and yield attributing characters revealed significant differences among the hybrids. The maximum yield (134.0 nuts/palm/year) was recorded in GBGD x LCOT while the highest number of bunches (14.0 per palm), copra content (188.7g / nut), copra output (23.6 kg / palm) and oil yield (16.2 kg / palm) were recorded in GBGD x PHOT cross combination. GBGD x LCOT was on par with GBGD x PHOT regarding copra output (22.1 kg/ palm) and oil yield (15.0 kg/palm) (Table 5).

Table 5. Performance of coconut hybrids at HRS, Ambajipeta (Year of planting : 1985)

Cross combinations	No. of bunches /palm	Nut yield/ palm	Copra content (g/nut)	Oil content (%)	Estimated oil yield (kg/palm)
ECT x MGD	10.7	115.5	141.0	63.5	10.3
GBGD x ECT	9.0	109.1	148.4	63.0	10.1
GBGD x FJT	9.5	110.7	143.5	62.0	9.8
GBGD x PHOT	14.0	125.0	188.7	68.5	16.2
GBGD x LCOT	12.3	134.0	165.0	68.0	15.0
ECT x GBGD	10.5	118.7	155.0	67.0	12.2
SEm±	0.55	4.45	3.14	1.41	0.40
CD (P=0.05)	1.68	13.56	9.56	4.31	1.22

Arsikere

The trial was initiated in 2012 with six cross combinations *viz.*, TPT x PHOT , TPT x LCOT, LCOT x MYD, LCOT x MOD, TPT x MYD and TPT x MOD with TPT as check. The seedlings were planted in the experimental plot in 2012. The growth parameters recorded showed significant difference for all the traits. The maximum values for all the characters were recorded in TPT except for number of leaves as the maximum number was recorded in TPT x MOD, TPT x MYD. Petiole length was maximum in TPT x MOD.

Expt. 2: Evaluation of new coconut hybrids of location specific cross combinations

This trial was laid out to assess the performance of newly developed location specific coconut hybrids at nine centres, in RBD with four replications. The details are furnished below.

Location specific combinations under evaluation in Gen. 2 Expt. 2:

Sl.No.	Centres	Location specific combinations evaluated
1.	Aliyarnagar	Arasampatti Tall x MGD, MGD x Arasampatti Tall, Kenthali x Arasampatti Tall, COD x Arasampatti Tall, COD x WCT
2.	Ambajipeta	CRP 509 x CCNT, GBGD x CCNT, CRP 509 x PHOT, GBGD x PHOT, PHOT x GBGD
3.	Arsikere	Tiptur Tall x PHOT, Tiptur Tall x LCOT, LCOT x MYD, LCOT x MOD, Tiptur Tall x MYD, Tiptur Tall x MOD
4.	Bhubaneshwar	SKL x COD, MGD x SKL, SKL x GBGD, GBGD x IND025, COD x CRP 794
5.	Kahikuchi	ASGT x CCNT, ASGT x IND 058, ASGT x PHOT, CRP502 x ASGT, CRP501 x PHOT
6.	Mondouri	PHOT x LCOT , LCOT x PHOT, CRP509 x JT, CRP509 x JVT, CRP509 x CRP502
7.	Ratnagiri	COD x CRP 513, COD x Benalium, COD x CRP 514, CRP 513 x COD, Benalium x COD, CRP 514 x COD
8.	Veppankulam	WCT x Kenthali, WCT x MOD, MOD x WCT, ADOT x COD, WCT x MGD

Aliyarnagar

The maximum height of 471.6 cm was recorded in the cross KTD x ALR, while the maximum girth was recorded in the hybrid MGD x ALR and it was on par with the cross KTD x ALR. Based on all the parameters, KTD x ALR was observed to be more vigorous as

compared to other crosses. Among the five hybrid combinations, the combination MGD x ALR 1 was observed to be the earliest to start flowering (34 months). For most of the traits studied, the difference between the crosses was non-significant (Table 6).

As part of the trial, apart from the above five hybrids, seedlings of three new hybrids, *viz.,* WCT x KTD, COD x Etamozhi Tall and KTD x Etamozhi Tall were planted during July 2014 in RBD with four replications, with six palms per replication.

Field view at Aliyarnagar

Table 6. Growth characters of location specific hybrids planted in Aliyarnagar (Year of planting : 2012)

Hybrids	Plant height (cm)	Girth (cm)	Annual leaf production	Petiole length (cm)	Months for first spathe emergence
COD x ALR	429.3	130.1	17.7	174.3	37
APT x MGD	417.2	149.3	18.0	185.4	38
MGD x APT	442.1	159.4	20.2	191.6	34
COD x WCT	361.4	119.4	16.4	168.1	37
KTD x ALR	471.6	156.5	20.3	191.4	37
Grand Mean	424.3	142.9	18.5	182.1	-
SEm±	32.6	13.5	1.4	19.5	-
CD (P=0.05)	65.5	27.3	2.9	39.3	-
CV (%)	10.9	13.4	10.9	15.14	-

Ambajipeta

The seedlings of six cross combinations were planted during 2011 in RBD with three replications. However, due to Helen and Philin cyclones during October and November 2013, some of the seedlings were damaged and they subsequently died. Gap filling was done during February 2014. During the year 2014-15, the cross CRP 509 x PHOT recorded the highest plant height (485.0cm) and leaf length (263.7cm) while the total number of leaves (22.5) was maximum in PHOT x GBGD cross combination.

Arsikere

The seedlings were planted during 2012 and the trial is in the establishment stage. Analysis of data on morphological parameters revealed significant difference among the genotypes, wherein Tiptur tall (Local check) recording the maximum values for all the characters.

Bhubaneshwar

The trial was laid out during 2008 in a RBD with four replications. The data on vegetative and floral attributes recorded during the year revealed no significant difference among the palms in different cross combinations except for petiole length. Flowering was observed in all the combinations

Kahikuchi

Among the hybrids under evaluation at Kahikuchi, maximum plant height (585 cm), girth (135cm), leaf production per year (11.9) and number of functional leaves/ palm (24.0) was recorded in the cross CRP501 x PHOT. The cross combination Assam Green Tall x CCNT recorded the highest leaf length (472 cm), petiole length (112.0 cm) and leaflet breadth (5.70 cm). First flowering was observed in all the cross combinations and it ranged from 54 to 60 months after planting except in local check Assam tall (Table 7).

Table 7. Growth characters of location specific hybrids planted at Kahikuchi (Year of planting : 2009)

Hybrids	Plant height (cm)	Collar girth (cm)	Leaf production	No. of leaves	First flowering (months)
Assam Green Tall x CCNT	560	121	10.4	19.0	54
Assam Green Tall x PHOT	554	124	10.6	19.6	58
Assam Green Tall x IND 058	530	117	10.9	21.0	58
CRP502 x Assam tall	548	121	11.5	18.6	60
CRP501 x PHOT	585	135	11.9	24.0	59
Assam tall (Check)	569	120	11.6	19.6	--
CD (P=0.05)	13.45	4.32	NS	1.21	

Mondouri

Analysis of observations recorded showed significant variation among the five different crosses for all the traits studied. Maximum plant height (512.4cm) was recorded by LCOT x PHOT and maximum girth (98.4cm) was recorded in CRP509 x JVT.

Ratnagiri

The trial was planted in December 2006. Analysis of observations on morphological parameters revealed no significant differences among the different cross combinations for all growth characters except stem girth. Significantly maximum girth was recorded in CRP-514 x COD (106.9 cm) which was at par with Benalium x COD (103.9 cm) and CRP- 513 x COD (99.9 cm).

Veppankulam

Among the five hybrids under evaluation at Veppankulam, MOD x WCT recorded higher yield (60 nuts/palm) which was followed by WCT x Kenthali Dwarf (48 nuts/palm). The cross Andaman ordinary tall x Chowghat Orange Dwarf registered maximum whole nut weight and dehusked nut weight (1050 g/nut and 395 g/nut, respectively), whereas, VHC 1(check) recorded higher kernel weight and copra content (190 g/nut and 111 g/nut, respectively).

Expt. 3: Evaluation of released varieties in coconut

This trial was laid out at Ambajipeta and Bhubaneshwar centers to evaluate the promising varieties of coconut arising out of experiments at CPCRI and SAUs. The trial, involving the genotypes mentioned below, was laid out in a randomized block design with three replications.

Ambajipeta

Among the different hybrids and varieties evaluated, no significant difference was recorded for nut yield. Significant differences were observed for palm height, girth, leaf length, husked fruit weight and copra content. Copra content was the highest in VHC II (328 g/nut) and was the lowest in LCOT (215 g/nut) (Table 8).

Table 8. Growth characters and nut features of released varieties and hybrids at Ambajipeta (Year of planting : 2002)

Treatments	Palm Height (m)	Girth (cm)	No. of bunches/ palm	No. of nuts/palm	Nut weight (gm)	De husked nut weight with water (g)	Kernel thickness (cm)	Copra content (g/ nut)
Chandra Sankara (COD x WCT)	6.2	84.6	13.2	155.7	1434.3	527.0	1.2	243.3
Laksha Ganga (LCOT x GBGD)	6.4	100.4	12.3	149.4	1614.5	684.6	1.4	331.0
LCOT	7.4	107.4	12.6	148.3	1303.3	438.5	1.3	215.1
Kera Ganga (WCT x GBGD)	6.7	92.1	13.2	154.6	1402.8	668.8	1.4	294.0

Treatments	Palm Height (m)	Girth (cm)	No. of bunches/ palm	No. of nuts/palm	Nut weight (gm)	De husked nut weight with water (g)	Kernel thickness (cm)	Copra content (g/ nut)
PHOT	7.2	122.6	12.7	137.5	1098.1	643.5	1.2	298.8
VHC-II (ECT x MYD)	7.3	125.3	12.6	138.2	1551.8	714.3	1.3	328.0
VHC-I (ECT x MGD)	7.3	110.9	10.8	113.1	1148.5	491.1	1.1	227.3
Chandra Laksha (LCOT x COD)	7.0	102.2	11.6	149.6	1594.8	687.8	1.3	323.5
Godavari Ganga (ECT x GBGD)	6.2	91.6	12.8	170.3	1483.1	659.5	1.3	304.0
SEm±	0.20	7.34	0.68	14.84	139.87	60.20	0.04	23.57
CD (P=0.05)	0.61	22.21	N.S	N.S	NS	182.05	0.13	71.27

Bhubaneshwar

Analysis of data pertaining to different growth and floral attributes revealed that there was no significant variation among the cultivars except for the girth of the palm. The yield was maximum in the hybrid Kera Sankara (26.3 nuts/palm) followed by Chandra Sankara (23.6 nuts/palm) (Table 9).

Varieties / Hybrids under evaluation in Gen. 2 Experiment 3

Centres	Varieties / Hybrids to be evaluated	Year of planting
Ambajipeta	Hybrids : Chandra Sankara, Chandra Laksha, Kera Ganga, Laksha Ganga, VHC1, VHC 2, Godavari Ganga Varieties : Chandra Kalpa and Double Century (check)	2002
Bhubaneshwar	Hybrids : Kera Sankara, Kera Ganga, Kera Chandra, Chandra Sankara Varieties : Chandra Kalpa and Sakhigopal (check)	2004

Table 9. Growth characters and nut features of released varieties and hybrids at Bhubaneshwar (Year of planting : 2004)

Germplasms	Plant height (m)	Plant girth (cm)	No. of functional leaves /palm	No. of leaves/ palm	No. of inflorescences / palm	No. of nuts/ palm
Kera Ganga (WCT x GBGD)	1.7	116.1	24.1	12.2	6.7	20.7
Chandra Sankara (COD x WCT)	1.7	104.6	23.4	12.0	6.3	23.6
Kera Sankara (WCT x COD)	2.7	135.8	25.2	12.5	9.2	26.3
Kera Chandra (PHOT)	1.6	126.3	24.4	12.1	8.3	12.2
Chandra Kalpa (LCOT)	2.05	136.4	23.1	12.1	8.8	23.0
IND041 (SKL)	1.81	135.5	24.8	12.2	9.1	19.8
CD (P=0.05)	NS	20.69	NS	NS	NS	NS

Expt. 4: Evaluation of Tall x Tall coconut hybrids

The trial was initiated to evaluate five T x T hybrids, *viz.*, LCOT x ADOT, ADOT x ECT, BGR x ADOT, ECT x LCOT, and WCT x TPT at various agro-climatic regions with local check. The hybrids were produced at CPCRI, Kasaragod and supplied to eight centres for evaluation in RBD with three replications and six palms per genotype per replication. Planting was carried out during 2011, 2012 and 2013.

Centre	Year of planting
Aliyarnagar	2011
Ambajipeta	2011
Arsikere	2012
Bhubaneshwar	2013
Kahikuchi	2013
Navsari	2013
Ratnagiri	2011
Veppankulam	2011

Expt. 6: Evaluation of Dwarf x Dwarf coconut hybrids in different agro climatic conditions

This experiment was laid out at Ambajipeta, Mondouri, Ratnagiri, Veppankulam and Pilicode centres to develop short statured hybrids for tender nut, yield and quality and to screen them for pest and disease resistance. The experimental materials comprised of five D x D hybrids *viz.*, COD x MYD, COD x MGD, MYD x CGD, GBGD x MOD, and CGD x MGD supplied by ICAR-CPCRI, Kasaragod and a local check, which were planted in RBD with four replications with six palms per hybrid per replication.

Ambajipeta

The experimental palms were planted in 2011, however, due to Helen and Philin cyclones in 2013, some of the accessions died. Gap filling was done in 2014 and the seedlings are in establishment stage. Analysis of data on morphological parameters revealed significant difference among the hybrids for plant height, total number of leaves, leaf length, petiole length, leaflet length and leaflet breadth. Among the hybrids, COD x MGD recorded the highest plant height (426.5 cm), leaf length (230.3 cm), petiole length (112.4 cm), leaflet length (89.2 cm) and leaflet breadth (4.91 cm). CGD x MGD recorded the highest number of leaves (21.6).

Mondouri

The trial was initiated during 2012 and the palms are three years old. Analysis of data on morphological parameters revealed that the hybrid COD x MYD was the more dwarfer (183.4cm) as compared to the others. Number of leaves produced was maximum in CGD x MGD (8.8) while maximum girth (55.4cm) was recorded in GBGD x MOD.

Ratnagiri

Analysis of observations recorded at fourth year of age of the palms revealed non significant differences for height, functional leaves on the crown and leaf let breadth (cm). CGD x MGD was observed to be the most dwarf hybrid combination recording mean height of 315.8 cm.

Pilicode

The trial was initiated during 2014 with a set of six D x D hybrids *viz.,* COD x MYD, COD x MGD, MYD x CGD, GBGD x MOD, CGD x MGD and GBGD x CGD and all are in the establishment phase.

Veppankulam

The trial was initiated during 2011. The cross CGD x MGD recoded the least palm height and girth (568 cm and 78 cm, respectively). The cross MYD x CGD was the earliest to flower (22 month after planting) and number of female flowers/ buttons was found to be higher in the cross COD x MYD. The volume of tender nut water was maximum in the cross COD x MGD (465 ml/nut).

Gen. 3: Establishment of mother blocks and production of quality planting material in coconut

Activity 1: Demonstration of released coconut varieties in different agro-climatic regions

Demonstration blocks of 10 coconut varieties / hybrids *viz.,* Kalyani Coconut Hybrid - 1, Gautami Ganga, Konkan Bhatye Hybrid, Kera Keralam, Kera Bastar, Kahikuchi Hybrid, Kalpa Prathiba, Kalpa Mitra, Kalpa Raksha and Kalpa Dhenu released by different AICRP centres and CPCRI, Kasaragod were

established in Aliyarnagar, Ambajipeta, Arsikere, Bhubaneshwar, Jagdalpur, Kahikuchi, Mondouri, Navsari, Ratnagiri, Sabour and Veppankulam. The main aim of the demonstration block is to showcase the performance of released cultivars in different agro- climatic conditions. The demonstration block consisted of 10 genotypes and one local check with 10 palms per genotype. The palms in all the centres are three to four years old and have started to flower.

Activity 2: Nucleus seed gardens for released varieties

This activity aims to establish nucleus seed gardens of important varieties for production of quality planting materials. Aliyarnagar, Ambajipeta, Arsikere, Jagdalpur, Kahikuchi, Mondouri, Ratnagiri and Veppankulam centres are participating in the programme.

Varieties for large scale multiplication

Sl.No	AICRP centre	Varieties
1	Aliyarnagar	Kalpa Prathiba, Kera Keralam, COD, Kenthali, MYD and MGD
2	Arsikere	Kalpatharu
3	Ambajipeta	Gautami Ganga, Kalpa Prathiba, Kera Bastar
4	Jagdalpur	Kera Bastar
5	Kahikuchi	MYD
6	Mondouri	Kalyani Coconut 1, Kalpa Mitra, Kera Keralam
7	Ratnagiri	Gautami Ganga, East Coast Tall, Kera Bastar
8	Veppankulam	Kera Keralam, Kalpa Prathiba

Aliyarnagar

Seed nuts from mother palms of Kera Keralam at Coconut Research Station, Aliyarnagar were sown in the nursery periodically and seedlings produced are distributed to farmers. Kalpa Prathiba seed gardens, comprising of 30 seedlings, are in establishment phase. *Inter se* crossing is also in progress to produce true to type seed nuts of Kalpa Prathiba. During 2015-16, 1620 seedlings of WCT, 3359 seedlings of Arasampatti Tall, 1193 seedlings of COD, 834 seedlings of Kenthali dwarf and 2334 seedlings of Chandra Sankara hybrid were distributed to farmers from the mother palms and crossing blocks maintained at CRS, Aliyarnagar. A new mother palm block comprising of 40 MGD and 24 CGD palms were planted during 2015 and the blocks are in establishment phase. Selfing was done in five true to type GBGD palms in a farmers' field at Puliyankandi village and the selfed seed nuts were sown in the nursery. The seedlings from this nursery will be planted during 2016 for establishment of a mother palm garden of GBGD.

Nucleus seed garden in Aliyarnagar

Ambajipeta

Under this project, multiplication of Gautami Ganga, Kera Bastar and Kalpa Prathiba was allotted for Ambajipeta centre. During 2015-16, the *inter se* crossed seedlings of Gauthami Ganga (300 nos.) and Kalpa Prathibha (150 nos.) were planted at Horticultural Research Station, Ambajipeta for production of quality planting material. Further, the mother block (120 nos.) of PHOT is also being maintained, as it is one of the parents in production of new hybrid (GBGD x PHOT).

Kahikuchi

As the female parent for the hybrid MYD x WCT is limited at the centre, a mother block of MYD with 25 palms has been planted in the field. *Inter se* crossed seedlings of Kamrupa (150 nos.) were planted at HRS, Kahikuchi during 2011 for establishment of nucleus seed garden. The growth of the seed garden is satisfactory. A total of 3,500 seedlings of Kamrupa were distributed during 2015.

Mondouri

A total of 50 palms each of three varieties *viz*., Kalyani Coconut –1, Kera Keralam, Kalpa Mitra were planted in 2009 and the mother palm blocks are in establishment phase.

Ratnagiri

For large scale multiplication of newly released coconut hybrids and varieties, mother palms of released varieties are planted on large scale in the orchard. About 175 seedlings each of ECT and GBGD and 290 seedlings of Fiji Tall have been planted for establishment of mother palm gardens. A total of 314 seedlings of Konkan Bhatye Coconut Hybrid – 1, 148 seedlings of Fiji Tall (Kera Bastar), 78 seedlings of GBGD and 43 seedlings of ECT were distributed to farmers during 2015. Apart from seedlings, a total of 1270 seed nuts of Fiji Tall (Kera Bastar) and 289 seed nuts of GBGD were also distributed to farmers during 2015.

Veppankulam

Seed garden of Kera Keralam variety has been established in an area of 2 ha and production of planting materials for Kalpa Prathibha variety is in progress with the available mother palms.

4.2 Crop Production

Agron. 10: Development of coconut based high density multispices cropping system for different agro-climatic regions

(Aliyarnagar, Ambajipeta, Arsikere, Bhubanehwar, Jagdalpur, Kahikuchi, Mondouri, Navsari, Ratnagiri, Sabour, Veppankulam)

The development of location specific cropping system was started during 2008-09 at different centres in an area of 0.40 ha. The crops were planted as per the combinations suggested for different agro – climatic regions. Soil and water conservation practices were adopted by husk burial and mulching. During 2012-13, three treatments were imposed in the cropping system. A control plot of monocrop of coconut with recommended NPK and organic manure was maintained for comparison.

Treatments:

T_1: 75% of Rec. NPK + organic recycling with vermicompost.

T_2: 50% of Rec. NPK + organic recycling with vermicompost + vermiwash application + biofertilizer application and *in situ* green manuring.

T_3: Fully organic: Organic recycling with vermicompost + vermiwash application + biofertilizer application, *in situ* green manuring & green leaf manuring (Glyricidia loppings) + composted coir pith and mulching with coconut leaves.

T_4: Control (Monocrop of coconut with recommended NPK and organic manure).

Aliyarnagar

The coconut based cropping system with cocoa + banana + pineapple was started during 2008. Tissue culture plants of banana (Grand Naine), suckers of pineapple (Kew) and cocoa (4 accessions) were planted in the cropping system. Three treatments of integrated nutrient management were imposed during 2012-13 and compared with the control plot of monocropping of coconut. Black pepper (var. Panniyur-1) was included in the cropping system during December 2015.

The earthworm and microbial population were higher in the cropping system compared to monocrop of coconut. Among the cropping systems, the earthworm population was higher in T_3 (7 to 12) followed by T_2 and T_1. The nut yield of coconut was higher in T_1 followed by T_3, T_2 and T_4. The yield of intercrops was higher in T_1 followed by T_3 and T_2 (Table 10). Among the nutrient management practices, the net return was higher in T_1 (Rs. 3,29,600/ha) followed by T_2 (Rs. 2,98,650/ha) and T_3 (Rs. 2,93,650/ha). The monocrop of coconut (T_4) recorded the lowest net return (Rs. 1,03,725/ha).

Table 10. Yield of coconut and intercrops in the coconut based cropping system (Aliyarnagar)

Treatment	Coconut (nuts/ha)	Cocoa dry beans (kg/ha)	Banana (kg/ha)	Pineapple (kg/ha)	Net income (Rs./ha)
T_1	18478	310	15400	2500	3,29,600
T_2	15195	277	15000	2400	2,98,650
T_3	16820	298	15000	2400	2,93,650
T_4	12900	-	-	-	1,03,725

Selling price: Cocoa @ Rs.200/kg; Banana @ Rs.10/kg; Pineapple @ Rs.10/kg; Coconut @ Rs.10/nut

Ambajipeta

The coconut based multispecies cropping system with cocoa + banana + pineapple + elephant foot yam (Kharif) - Tomato (Rabi) + Heliconia was started during 2008. Three treatments of integrated nutrient management were imposed during 2012-13 and the performance of coconut based cropping system was compared with the control plot of monocropping of coconut. The earthworm and microbial population

were higher in the cropping system compared to monocrop of coconut. The yield was higher in T_1 (176.9 nuts/palm) followed by T_2 (170.4 nuts/palm), T_3 (165.6 nuts/palm) and the least in T_4 (139.8 nuts/palm) (Table 11). The yield of intercrops was also higher in T_1 followed by T_2 and T_3. The net returns were higher in T_1 (Rs. 1,93,183/ha) followed by T_2 (Rs. 1,85,495/ha) and T_3 (Rs. 1,64,600/ha). The monocrop of coconut (T_4) recorded the lowest net return of Rs. 67,920/ha.

Table 11. Yield of coconut and intercrops in coconut based cropping system (Ambajipeta)

Treatment	Coconut (Nuts/ha)	Cocoa dry beans (kg/ha)	Banana (tons/ha)	Pineapple (kg/ha)	Tomato (kg/ha)	Elephant foot yam (kg/ha)	Heliconia (No. of cut flowers/ha)	Net income (Rs./ha)
T_1	26535	585	13.50	1980	531	2985	29160	1,93,183
T_2	25560	562	12.48	1935	516	2884	26730	1,85,495
T_3	24840	551	11.81	1791	500	2682	24300	1,64,600
T_4	20970	-	-	-	-	-	-	67,920

Arsikere

Cocoa, lime and drumstick were planted in the coconut based cropping system during October 2008. Banana was added to the cropping system during October 2012. Three nutrient management treatments were imposed in the cropping system during 2012-13 and compared with the monocrop of coconut.

The nut and copra yield per palm were higher in T_2 and T_3 compared to T_1 and T_4 (Monocrop). The productivity of the cropping system was higher than the monocrop of coconut due to additional yield from the intercrops in T_2 and T_3 compared to T_1. The light interception was higher in the cropping system compared to monocrop of coconut. The net returns were higher in the cropping system under all the three nutrient management practices compared to monocrop of coconut (Table 12). Among the nutrient management practices, the net returns were higher in T_3 (Rs. 2,59,595/ha) followed by T_2 (Rs. 2,42,835/ha) and T_1 (Rs. 2,32,210/ha). The monocrop of coconut recorded the lowest net return (Rs. 75,840/ha).

Table 12. Yield of coconut and intercrops in the coconut based cropping system (Arsikere)

Treatments	Coconut yield (nuts/ha)	Yield of intercrops (kg/ha)				Net Returns (Mean of 3 years) (Rs./ha)
		Cocoa-dry beans yield	Lime-fruit yield	Drumstick-pod yield	Banana-fruit yield	
T_1	9000	236	965	785	8692	2,07,515
T_2	9600	276	986	829	9033	2,15,477
T_3	9430	288	1116	862	9825	2,24,078
T_4	9170	-	-	-	-	74,747

Selling price: 2014-15
Coconut: Rs.12/-nut; Cocoa: Rs. 130/- kg; Lime fruits: Rs. 30/-kg; Drumstick: Rs. 20/- kg; Banana: Rs. 15/- kg

Bhubaneshwar

The crop combination of coconut + guava + banana + pineapple was restructured during 2013 and three nutrient management treatments were imposed in the cropping system. The different treatments under cropping system were compared with the monocrop of coconut. Colocasia was added to the system during 2015. The yield of coconut was similar in all the nutrient management treatments. The yield of banana and guava were higher in T_2, whereas, that of pineapple was higher in T_1. The maximum net return of Rs.1,43,687/ha was recorded in T_1 followed by T_2 (Rs.1,41,399/ha) and T_3 (Rs.1,06,069/ha). The monocrop of coconut recorded the lowest net return of Rs. 4239 per ha.

Jagdalpur

The cropping system of coconut + guava + cinnamon + banana + colocasia + mango ginger + bottle gourd + elephant foot yam + cowpea was initiated during 2008 in coconut garden. The integrated nutrient management treatments were imposed during 2012-13. The yield of coconut and intercrops as well as the net returns in the cropping system were higher in T_2 followed by T_1 and the lowest in T_3.

Kahikuchi

The coconut based cropping system comprising of turmeric, pineapple, Assam lemon, banana, elephant foot yam and black pepper with coconut was started during 2008 and nutrient management treatments were imposed during 2012-13. The population of soil microbes and earth worm was higher in T_3 followed by T_2 and the lowest in T_4. The light interception was higher in the cropping system compared to monocrop of coconut. The yield of coconut and intercrops was higher in T_2 followed by T_1 and T_3. The net return was the highest in T_2 (Rs. 3,74,834/ha) followed by T_1 (Rs. 3,17,715/ha) and T_3 (Rs. 2,95,840/ha). The monocrop of coconut recorded the lowest net returns of Rs. 60,430/ha (Table 13).

CBCS at Kahikuchi Centre

Table 13. Yield of coconut and intercrops in the coconut based cropping system (Kahikuchi)

Treatments	Coconut (nuts/ palm)	Yield of intercrops (kg/ha)					Net return (Rs./ha)
		Black pepper	Pineapple	Banana	Lemon	Cowpea	
T_1	13125	131	17676	12900	4800	4400	3,17,215
T_2	13895	176	20614	16000	5650	4800	3,74,834
T_3	12180	122	17240	12400	4440	4200	2,95,940
T_4	11638		-	-	-	-	60,430

Sale price: Pineapple= Rs.6/kg, Banana= Rs. 6/kg, Assam lemon= Rs. 16/kg, Cowpea= Rs.10/kg, Black pepper = Rs. 250/kg, Coconut= Rs. 10/nut

Mondouri

The cropping system comprising of coconut+ black pepper + banana + lemon + onion + potato was evaluated. The yield of coconut was higher in T_3 followed by T_4 and T_1. The net return was higher in T_1 (Rs. 3,94,341/ha) followed by T_2 (Rs. 3,25,956/ha) and T_3 (Rs. 2,24,650/ha). The monocrop of coconut recorded the lowest net returns of Rs. 89,681/ha

Navsari

The cropping system of coconut + banana + turmeric + elephant foot yam + tannia was initiated during 2014. The nut yield of coconut, fruit yield of banana, tuber yield of elephant foot yam and leaf yield of tannia were higher in T_2. The rhizome yield of turmeric was higher in T_3 followed by T_2 and T_1. The net returns from the cropping system were also higher in T_2 (Rs. 4,85,447/ha) followed by T_3 (Rs. 4,38,381/ha) and T_1 (Rs. 3,90,346/ha). The monocrop of coconut recorded the lowest net income of Rs. 85,636/ha.

HDMSCS in Navsari

Ratnagiri

The cropping system comprising of coconut + black pepper + nutmeg + cinnamon + banana + pineapple was started during 2008 and integrated nutrient management treatments were imposed during 2012-13. The earthworm population was higher in the cropping system compared to monocrop of coconut. The nut yield, copra yield and oil yield per palm were significantly higher in T_2 followed by T_1 and T_3. Maximum earthworm population was recorded in T_3 followed by T_2 and T_1. The net return was higher in T_2 followed by T_1 and T_3 (Table 14).

Sabour

The cropping system of coconut + banana + turmeric + guava + cowpea was initiated during 2014-15. Three treatments of nutrient management were imposed in the cropping system and compared with the monocrop of coconut. The yield of banana, pea and turmeric was higher in T_2 followed by T_3 and T_1.

Veppankulam

The cropping system of coconut + black pepper + banana + cocoa was initiated during July 2009 and nutrient management treatments were imposed during 2012-13. The number of leaves, bunches and buttons per palm were higher in T_2 followed by T_1, T_3 and T_4. The nut yield of coconut was higher in T_2 followed by T_3 and T_1 and was the lowest in T_4. The yield of banana, pepper and cocoa was higher in T_2 followed by T_3 and T_1. The net returns was higher in T_2 followed by T_3 and T_1 and the lowest in T_4 (Table 15).

Table 14. Yield of component crops in the coconut based cropping system (Ratnagiri)

Treatments	Coconut (nuts/ha)	Yield of component crops (kg/ha)				Net return (Rs./ha)
		Pineapple	Banana	Cinnamon bark	Cinnamon leaves	
T_1	25711	444	3200	71	355	8,15,880
T_2	31194	533	3733	151	533	11,12,629
T_3	21945	622	4267	75	373	7,48,328
T_4	15304	-	-	-	-	1,32,000

Table 15. Yield of coconut and intercrops in the cropping system (Veppankulam)

Treatments	Yield of coconut		Yield of intercrops (kg/ha)			Net return (Rs/ha)
	Nut/palm	Nut/ha	Cocoa	Banana	Pepper	
T_1	108	18967	222	23100	45	286798
T_2	118	20650	262	24125	47	352180
T_3	113	19842	256	22750	40	316853
T_4	105	18294	-	-	-	145342

Selling price: cocoa @ Rs.210/kg, banana @ Rs.10/kg; black pepper @ Rs.900/kg, coconut @ Rs.10/nut.

Agron. 10 A: Development of coconut based farming system

Treatments	Arsikere	Aliyarnagar	Veppankulam
T_1	Coconut + Fodder crops – Cows Fodder grass: Hybrid Napier (Co-3) in the interspace of coconut Fodder legumes: *Stylosanthes hamata* in intraspace of coconut Fodder trees: Drumstick and Agase (*S. grandiflora*) Cows – 5 Nos	Coconut + Fodder trees + Pasture crops – Goat Pasture crops: *Cenchrus ciliaris* + *Stylosanthes hamata* (3:1) Fodder trees: *Sesbania grandiflora* + *Leucaena leucocephala* + *Glyricidia*	Coconut + Fodder trees + Pasture crops – Goat Pasture crops: Cumbu Napier- CO (BN5) + *Desmanthus* sp. Fodder trees: *Sesbania grandiflora* + *Leucaena leucocephala* + *Glyricidia*
	Coconut + Pasture crops – Sheep Fodder crops: Pasture crops: Buffel grass (*Cenchrus ciliaris*) + *Stylosanthes hamata* (3:1) Sheep: 20	Goat : Telicherry breed (6 + 1)	
T_2	Monocrop of coconut		
Area	0.40 ha		

Arsikere

The experiment was initiated during September 2013. The rooted slips of Napier grass (Co-3) were planted in the interspace of coconut at a spacing of 90 cm x 60 cm on 14.09.2013. The fodder legume- *Stylosanthes hamata* was sown in the intraspace of coconut on 16.09.2013. The fodder trees- drum stick and *Sesbania grandiflora* were planted in the border of the plot. The output from coconut and dairy have been quantified and economics of the system has been worked out. During the second year, the farming system of coconut + fodder grass + cows (5) in 0.40 ha recorded a net income of Rs. 1,25,828 as compared to Rs. 60,304 in the monocrop of coconut (Table 16).

The experiment (CBFS with sheep) was laid out during May 2014. The pasture crops such as Buffel grass (*Cenchrus ciliaris*) and stylo (*Stylosanthes hamata*) were sown in the interspace of coconut on 30.05.2014. The establishment and growth of pasture is satisfactory. The sheeps were allowed to graze the pasture from 20.11.2014. The productions of pasture, sheep and sheep manure have been quantified.

Table 16. Output and economics from the coconut based farming system with cows (Arsikere)

Output (0.40 ha)	2013-14	2014-15	Net returns (Rs.) (2014-15)
IFS			
Coconut (Nos.)	7126	6629	
Green fodder (kg)	7900	38100	
Milk (l)	5417	6040	**1,25,828**
Cow dung (kg)	24090	31025	
Urine (l)	5500	5750	
Monocrop			
Coconut (Nos.)	6811	6867	**60,304**

Note: Area- 0.40 ha; Coconut palms: 70; No. of cows: 5.
Coconut: Rs. 12/nut (2014-15); Milk: Rs. 27/litre

Table 17. Output from the coconut based farming system with sheep (Arsikere)

Sl.No.	Output (0.40 ha)	2014-15	Remarks
	IFS		
1	Coconut (Nos.)	3428	Sold at Rs. 12/ nut
2	Pasture production (kg)	4050	Grazed by sheep
3	Sheep manure (kg)	4620	Used for coconut and pasture
4	Lamb production (Nos.)	11	Weight 183 kg
	Monocrop		
1	Coconut (Nos.)	3264	Sold at Rs. 12/ nut

Note: Area- 0.40 ha; Coconut palms: 40; No. of sheep: 20 (18 + 2).

Expt. 3: Integration of goat in coconut based farming system

Aliyarnagar

The experiment was initiated during September 2015

Pasture crops: *Cenchrus ciliaris* + *Stylosanthes hamata* (3:1) were sown in the interspaces of coconut. Fodder trees: *Sesbania grandiflora* + *Leucaena leucocephala* + *Glyricidia* were planted on bunds. Recommended package of practices for coconut and fodder crops are being followed. Tellicherry goats (6 Female +1 Male) were procured on 03.03.2016 and included in the coconut based farming system.

Veppankulam

Tellicherry goats (6 Female +1 Male) were procured and included in the farming system. Soil samples were drawn for analysis of initial nutrient status.

Agron. 11: Coconut based cropping systems for different agro-climatic regions

Expt. 1. Performance of flower crops in coconut garden

(Aliyarnagar, Arsikere, Jagdalpur, Kahikuchi, Mondouri, Ratnagiri)

Aliyarnagar

Five flower crops *viz.*, Chrysanthemum (*Dendranthema grandiflora*), Celosia (*Celosia* sp.), Marigold (*Tagetes erecta*), Zinnia (*Zinnia* sp.) and Gomphrena (*Gomphrena globosa*) were planted in a coconut garden of 24 year old hybrid palms (VHC-2) planted at a spacing of 7.5 m x 7.5 m. Coconut monocrop was maintained as control. The economics worked out based on mean data of three years indicated that the cropping system of Coconut + marigold recorded higher net income (Rs. 2,54,983/ ha) followed by Coconut + gomphrena (Rs. 2,40,458/ ha), Coconut + chrysanthemum (Rs. 2,11,108/ha) and Coconut + celosia (Rs. 2,02,175/ha).

Arsikere

The experiment was laid out during 2012-13 in a 40 year old coconut garden of Tiptur Tall variety planted with a spacing of 10 m x 10 m. Five flower crops *viz.*, Jasmine, Chrysanthemum, Crossandra, China aster and marigold were grown in the inter-row spaces of coconut. A plot of sole crop of coconut was maintained as control. The yield of flowers was 1194 kg/ha in Jasmine, 4414 kg/ha in chrysanthemum,

Chrysanthemum- Arsikere

924 kg/ha in crossandra 2198 kg/ha in China aster and 4382 kg/ha in marigold during 2014-15. The mean data of three years showed that the cropping system of Coconut + chrysanthemum recorded significantly higher net income (Rs. 2,00,558/ha) followed by Coconut + crossandra (Rs. 1,79,483/ha), Coconut + jasmine (Rs. 1,66,767/ha), Coconut + China aster (Rs. 1,21,692/ha) and Coconut + marigold (Rs. 96,350/ha). The monocrop of coconut recorded significantly the lowest net income of Rs. 54,250 per ha. 2013-14) & Rs. 12/- per nut (2014-15).

Jagdalpur

The experiment on intercropping of flower crops in coconut garden was started during 2012-13 and laid out in RBD with four replications. The treatments are: T_1: Coconut + tuberose, T_2: Coconut + gerbera, T_3: Coconut + gaillardia (Kharif) - antirrhinum (Rabi), T_4: Coconut + zinnia (Kharif) - gladiolus (Rabi), T_5: Coconut + marigold (Kharif) - China aster (Rabi). The net income was higher with gerbera (Rs. 1,80,075/ha) followed by tuberose (Rs. 82,800/ha), Gaillardia-antirrhinum (Rs. 77,600/ha), Zinnia - gladiolus (Rs. 75,070/ha) and Marigold - China aster (Rs. 53,602/ha).

Kahikuchi

Five flower crops *viz*., tuberose, gerbera, bird of paradise, gladiolus and marigold were planted in coconut garden. The net returns were higher with Coconut + gerbera (Rs. 7,72,710/ha) followed by Coconut + tuberose (Rs. 5,32,160/ha) and Coconut + gladiolus (Rs. 4,76,930/ha). The monocrop of coconut recorded the lowest net return of Rs. 1,03,750/ha (Table 18).

Table 18. Yield of coconut and flower crops in the cropping system- Mean of 4 years (Kahikuchi)

Treatment	Yield of coconut		Yield of flowers/ ha	Coconut equivalent yield of flowers (nuts/ha)	Total CEY of cropping system (nuts/ ha)	Net returns (Rs./ha)
	Nuts/palm	Nuts/ha				
1. Coconut +Tuberose	68.3	11696	314987 spikes	31498	43194	5,32,160
2. Coconut + Gerbera	65.0	10998	743200 spikes	49546	60544	7,72,710
3. Coconut + Bird of paradise	64.0	11008	32175 spikes	16087	27095	3,09,165
4. Coconut + Gladiolus	65.4	11249	61987 spikes	30993	42242	4,76,930
5. Coconut + Marigold	62.6	10664	20810 kg	20810	31474	3,79,520
6. Coconut Monocrop	60.6	10700	-	-	10700	1,03,750
S.Em ±	0.48	84			3367	
CD (P=0.05)	1.59	278			10516	

CEY: Coconut equivalent yield
Selling price:
1. Tuberose spike/dozen = Rs 12.00
2. Gerbera stalk/dozen = Rs.8.00
3. Gladiolus stick/dozen = Rs. 60.00
4. Marigold per kg = Rs.10.00
5. Bird of Paradise = Rs. 60/dozen
6. Coconut = Rs.15.00/nut

Mondouri

The experiment was laid out in RBD with four replications in a 30 years old coconut garden planted at a spacing of 7.5 x 7.5 m. Five flower crops *viz.*, marigold, tuberose, gerbera, and gladiolus were planted under coconut. Among the cropping system with flower crops, coconut + gladiolus recorded higher net return (Rs. 2,92,717/ha) followed by coconut + tuberose (Rs. 2,46,842/ha), coconut + gerbera (Rs. 222817/ha) and coconut + marigold (Rs. 192487/ha). The monocrop of coconut recorded the lowest net returns (Rs.76,462/ha).

Ratnagiri

The performance of five flower crops *viz.*, *Jasminum sambac, Jasminum multiflorum, Lily* spp., *Heliconia* spp., and *Michelia champaka* was evaluated in the 29 year old COD x WCT coconut garden in RBD with four replications. The yield of coconut was significantly higher in Coconut + Lily followed by Coconut + *Jasminum multiflorum* and Coconut + *M. champaka*. The coconut equivalent yield of flowers was higher in Lily followed by *Jasminum multiflorum* and J. *Sambac*. The net returns were higher with Coconut + Lily (Rs. 4,79,975/ ha) followed by Coconut + *J. multiflorum* (Rs. 3,37,501/ ha) and Coconut + Heliconia (Rs. 2,18,905/ha). The monocrop of coconut recorded the lowest net return of Rs. 1,30,705 per ha.

Expt. 2: Performance of cocoa varieties as intercrop in coconut gardens

(Ambajipeta, Kasaragod, Navsari, Veppankulam)

Ambajipeta

Six cocoa clones *viz.,* VTLCC-1, VTLCH-1, VTLCH-2, VTLCH-3, VTLCH-4 and VTLC-1 were planted during November, 2008 in RBD with four replications. The plant height, girth, canopy spread, single pod weight and number of beans per pod did not differ significantly among the cocoa clones. The dry bean yield was significantly higher in VTLCH-1 (2.9 kg/tree) followed by VTLCH-3 (2.52 kg/tree) and VTLCH-2 (2.50 kg/tree) (Table 19).

Kasaragod

Thirteen cocoa clones were planted during 2008. The yield ranged from 19.8 to 40.3 pods/tree in the plants raised from grafts and from 18.4 to 30.8 pods/ tree in the plants raised from seedlings. The dry bean yield ranged between 0.51 to 0.72 kg/tree among the plants from grafts and 0.31 to 0.64 kg/tree among the plants from seedlings. The highest dry bean yield of 0.72 kg/tree was recorded in VTLCH-1 among plants raised from grafts (Table 19).

Navsari

Five cocoa clones *viz.,* VTLCC-1, VTLCH-1, VTLCH-2, VTLCH-3 and VTLCH-4 were planted during 2009-10 in RBD with four replications. Canopy spread was significantly higher in VTLCH-3 which was at par with VTLCH-1. Significantly higher number of pods/tree (45.25), weight of single dry bean (1.15 g) and dry bean yield/tree (1.59 kg) were recorded in VTLCC-1 which was at par with VTLCC-4(1.42 kg). The pod weight was significantly higher with VTLCH-3 which was at par with VTLCH-4 and VTLCH-1. The number of beans per pod was significantly higher in VTLCH-4 and was at par with VTLCC-1 and VTLCH-1 (Table 19).

Veppankulam

Cocoa grafts of five clones were planted under coconut on 14.08.2008. The experiment was laid out in RBD with four réplications. The growth performance of VTLCH-1 was better compared to other clones. The dry bean yield was significantly higher in VTLCH-1 (2.80 kg/ tree) followed by VTLCC- 1 (2.52 kg/ tree) and VTLCH- 2 (2.00 kg/tree) (Table 19).

Cocoa in coconut garden at Veppankulam (Agron.11-Expt. 2)

Table 19. Yield of cocoa clones as intercrop in coconut garden in different centers

Treatments	Dry bean yield (kg/tree)			
	Ambajipeta	Kasaragod	Navsari	Veppankulam
VTLCC – 1	2.00	0.56	1.59	2.52
VTLCH – 1	2.90	0.72	1.21	2.80
VTLCH – 2	2.50	0.70	1.25	2.00
VTLCH – 3	2.52	0.53	1.31	1.95
VTLCH – 4	1.50	0.62	1.42	1.55
VTLC - 1	1.85	--	--	1.20

Expt. 4: Screening of pepper varieties for their performance as mixed crop in coconut gardens

(Kahikuchi, Mondouri)

Kahikuchi

Five pepper varieties *viz.*, IISR Thevam, IISR Shakthi, IISR Malabar Excel, Sreekara and Panniyur-1 were planted in coconut garden (Assam Green Tall aged 40 years) during September, 2009. The experiment was laid out in RBD with four replications. The number of branches per vine was the highest in Sreekara (24.8). Among the varieties/hybrids, Panniyur-1 recorded significantly higher number of spikes (96.4 in one meter column height), spike length (14.2 cm), number of berries per spike (55.6) and yield (0.82 kg/vine dry pepper) (Table 20).

Table 20. Yield of black pepper varieties under coconut gardens

Pepper variety	Dry pepper yield (kg/plant)	
	Kahikuchi	**Mondouri**
1. IISR Thevam	0.62	0.25
2. IISR Shakti	0.58	0.23
3. IISR Malabar Excel	0.75	0.26
4. Sreekara	0.65	0.31
5. Panniyur-1	0.82	0.60
CD (P=0.05)	0.06	0.021

Mondouri

The rooted cuttings of five pepper varieties were planted during 2010-11 under coconut of 36 years old. Panniyur-1 recorded higher vine length, basal girth and yield of pepper (0.60 kg/vine dry pepper) compared to the other varieties.

Expt. 6: Performance of different tuber crops and spices in coconut based cropping system

Mondouri

The experiment was laid out during 2015-16 in RBD with four replications in a COD x WCT coconut garden of 36 years age. The cropping system of coconut + black pepper + turmeric + elephant foot yam recorded higher net return of Rs. 3,90,300/ha followed by coconut + black pepper + ginger + colocasia (Rs. 2,84,379/ha) and coconut + black pepper + chilli + sweet potato (Rs. 1,75,480/ha). The net return was the lowest in the monocrop of coconut (Rs. 78,050/ha).

Agron. 14: Soil and nutrient management in coconut

Expt. 1: Integrated nutrient management technologies to enhance the productivity and quality of tender nut in dwarf coconut

Aliyarnagar

The experiment was started during 2014-15 in a 25 year old coconut garden of Chowghat Orange Dwarf variety at Avalchinnampalayam village with three treatments *viz.*, T_1: Recommended package of practice, T_2: Biomanures and biofertilizers and T_3: Biomanures and biofertilizers + soil test based NPK and micronutrient application. The experiment was laid out in RBD with seven replications. Growth and tender nut yield of dwarf coconut were not significantly influenced by nutrient management treatments.

Table 21. Growth parameters and yield of tender nuts in dwarf coconut (Aliyarnagar)

Treatments	Tender nut yield (nuts/palm)
T_1- Recommended practice (500:320:1200 g NPK/palm + FYM- 50 kg/palm + TNAU Micronutrient Mixture -1 kg/palm + Neem cake -5 kg/palm)	188
T_2- Biomanures and Biofertilizers (Green leaf manuring-10 kg with Glyricidia loppings + organic recycling of coconut waste through Vermicompost -10 kg + coconut frond mulching + Azospirillum 100 g + Phosphobacteria 100 g + VAM 100 g) + Green manuring with sunhemp twice a year	200
T_3- T_2 + Soil test based NPK and micronutrient application	214
S.Ed ±	6.18
CD (P=0.05)	NS

Expt. 2: Nutrient management through organics in coconut plantation under Island conditions

Port Blair

Experimental details:

Coconut varieties- 3: Andaman Green dwarf, Andaman yellow dwarf and Andaman orange dwarf

Nutrient management- 5

1. Control (Recommended practice - 20 kg FYM + 500:320:1500 g NPK/palm/year)
2. Biofertilizer (Kera Probio 50 g, twice per year) + *In situ* green manure (Cowpea) + Recycling of biomass (Vermicompost (VC)- 2 kg through external application)
3. Biofertilizer (Kera Probio 50 g, twice per year) + *In situ* green manure (Cowpea) + Recycling of biomass (VC, 2 kg through external application) + FYM (15 kg)
4. Biofertilizer (Kera Probio 50 g, twice per year) + *In situ* green manure (Cowpea) + Recycling of biomass (VC, 2 kg through external application) + Poultry manure (8 kg)
5. Biofertilizer (Kera Probio 50 g, twice per year) + *In situ* green manure (Cowpea)+ Recycling of biomass (VC, 2 kg through external application) + FYM (8 kg) + Poultry manure (4 kg)

Treatment combinations: 15; Design: Factorial RBD; Replications: 5; Year of start: 2015-16

An experiment was initiated during 2015 in juvenile palms of dwarf varieties of coconut aged 3 years old *viz*. Andaman Green Dwarf (AGD), Andaman Yellow Dwarf (AYD) and Andaman Orange Dwarf (AOD) to evaluate the effect of organic nutrient management on soil health and yield of coconut. Soil samples were collected from the experimental plots and analyzed for different parameters. Further, pre-experimental growth observations and microbial count were recorded for various parameters.

Expt. 3: Network project on "Organic farming in coconut based cropping system"

(Aliyarnagar, Ambajipeta, Arsikere)

Cropping system to be followed at different Centres:

Aliyarnagar: Coconut + cocoa

Ambajipeta: Coconut + cocoa + banana

Arsikere: Coconut + cocoa + lime + drumstick

Organic nutrient treatments

T_1 - *In situ* organic matter recycling + PGPR consortia (100 g/plant) + In situ green manuring + Husk burial

T_2 - *In situ* organic matter recycling + PGPR consortia (100 g/plant) + In situ green manuring + Husk burial + 25 kg cow dung

T_3 - T_1 + 50% recommended K_2O through the application of sulphate of potash

T_4 - T_2 + 50% recommended K_2O through the application of sulphate of potash

T_5 - Conventional method (Chemical fertilizer application)

T_6 - Application of shredded coconut waste

Aliyarnagar

Number of palms per treatment – 6, Replications - 5

Trenches of 15 m length and 1.3 m width were opened between the coconut palms (T_1 – T_4). Cocoa

was planted on either side of the trenches (6 plants per trench). PGPR consortia and organic manures were applied as per the treatments. Pre - treatment yield and growth as well as yield of coconut during first year of expérimentation were recorded.

Ambajipeta

The trial was initiated during 2015 in a 30 years old East Coast Tall coconut field in four replications. Cocoa (CCRP series) and banana (Tella chakkerakeli) were planted as intercrops and their growth is satisfactory. The initial soil samples were collected for analysis of soil physico-chemical properties and for microbial population. Pre- treatment growth and yield parameters of coconut were recorded and treatments were imposed.

Arsikere

Soil samples and coconut leaf samples have been collected in the experimental plot for determining initial soil and plant nutrient status. Pre-treatmental data on yield of coconut has been recorded. Trenches were opened for *in situ* organic matter recycling. The treatments were imposed and planting of intercrops completed. The observation on the number of bunches and buttons and the nut and copra yield are being recorded in coconut.

Expt. 4: Management of Root (wilt) disease in coconut (Farmer's garden)

Aliyarnagar

Year of start: 2015-16

Package of practices proposed based on the soil test results:

- Addition of organic manure @ 25 kg per palm.
- Application of *Trichoderma viride* @ 50 g/ palm.
- Sowing dhaincha seeds in coconut basin @ 100 g/ palm and incorporation before flowering.
- Application of recommended dose of fertilizers (NPK: 1000:250:1000 g/palm/year).
- Addition of 50 g Zinc sulphate per palm

Management practices as per the package of treatments were initiated in root (wilt) affected garden at three locations (Manakkadavu village of Coimbatore district, Kanakkapillaivalasai village of Tirunelveli district and Melagudalur village of Theni district) based on soil nutrient status. The pH of samples from all sites is in the alkaline range. The organic carbon content is extremely low and Zn was found to be low in all the three locations. Based on the soil nutrient status, the above mentioned packages of practices were followed and treatments were imposed during the year. Disease assessment was done based on the disease grades assigned to flaccidity, yellowing and necrosis symptom in the second or third spiral.

The root (wilt) disease intensity in the garden at Manakkadavu village (Coimbatore district) ranged from 4 to 44 in the pre-treatment, the average root (wilt) disease intensity was 16.25% and average nut yield was 80 per palm (Table 22). The root (wilt) disease intensity in Kanakkapillaivalasai village (Tirunelvelli district) ranged from 0 to 42 in the pre-treatment, the average root (wilt) disease intensity was 14.64% and average yield was 92 nuts per palm. The root (wilt) disease intensity at Melagudalur village (Theni district) ranged from 8 to 60 and the average root (wilt) disease intensity was 28.45% and the average yield was 90 per palm. Depending on the improvement in soil quality at three locations, the treatments will be changed in the coming years.

Table 22. Incidence of root (wilt) disease in demonstration plots

Stages	Manakkadavu	Kanakkapillaivalasai	Melagudalur
	No. of palms		
No symptoms	0	3	3
Disease infection - early stage (less than 20 % DI)	54	48	48
Disease infection - middle stage (25-50 % DI)	19	29	29
Disease infection - severe stage (more than 50 % DI)	0	0	0
Total number of palms	73	80	80

4.3 Disease Management

Path.1: Survey and surveillance of coconut diseases

Aliyarnagar

Roving survey:

Roving survey was conducted in different villages of Coimbatore, Tirunelveli, Tirupur, Kanyakumari and Theni districts for recording the occurrence of coconut diseases (bud rot, basal stem rot, stem bleeding, leaf spot and leaf blight). Among the districts surveyed, maximum incidences of bud rot disease was observed in Tirupur (0.17 %) and Tirunelveli districts (0.17 %); basal stem rot (1.4 %) and stem bleeding (4.94 %) in Tirupur district; leaf spot (1.27 %) in Coimbatore district and leaf blight (10.25 %) in Tirupur district.

Fixed plot survey

To record the incidence of different coconut diseases in Puliyankandi and Karainchettiplayam villages of Anaimalai block in Coimbatore district, fixed plot survey was carried out at quarterly intervals from June 2015 to March 2016 in farmer's field locations.

Observations on the incidence of major coconut diseases *viz.*, leaf blight and *Pestolotia* leaf spot were recorded in respective coconut gardens and maximum incidence of leaf blight and leaf spot were observed in Puliyankandi village (22.32 % and 3.34 %, respectively).

Ambajipeta

Roving survey

Surveys were conducted in different mandals of East Godavari, West Godavari, Srikakulam, Vijayanagaram and Visakhapatnam districts of Andhra Pradesh during 2015-16. Major diseases observed in coconut gardens were basal stem rot, bud rot and stem bleeding along with minor incidence of grey leaf spot. Mean per cent incidence of basal stem rot, stem bleeding and bud rot diseases were 9.96, 1.13 and 0.92 respectively in the surveyed villages. The highest basal stem rot disease incidence (22.6 %) was in Srikakulam district, stem bleeding (5.0 %) in Vijayanagaram district and bud rot (1.13 %) in East Godavari district.

Fixed plot survey

For stem bleeding and bud rot diseases, fixed plot survey was taken up at Horticultural Research Station, Ambajipeta. For basal stem rot disease, fixed plot survey was taken up in farmer's field at P. Gannavaram village in East Godavari District. Per cent disease incidence of basal stem rot during April 2015 was 30 and it increased to 34% by July 2015. Per cent incidence of stem bleeding disease varied between 2.06 to 2.65 during the year. Bud rot disease incidence was observed from September 2015 to December 2015. 3.33% of bud rot was observed during September and 1.63% was recorded during October, November and December months of the year.

Arsikere

Roving Survey

Survey on the occurrence of coconut diseases *viz.*, basal stem rot, stem bleeding, leaf blight and bud rot was conducted in major coconut growing districts *viz.,* Chikkamangaluru, Shivamogga and Tumkur. Basal stem root was predominant in all the districts and the disease incidence ranged from 1 to 2.5 per cent. The maximum incidence of 4.6 per cent was recorded in Shivamogga taluk.The incidence of stem bleeding varied across the areas surveyed, and disease incidence ranged from 0.5 to 3.15 per cent. Maximum incidence of stem bleeding was recorded at Badhravathi taluk of Shivamogga district.

With respect to bud rot disease incidence, it was concentrated more in high rainfall areas than dry belt. The incidence ranged from 1 to 4.85 per cent, and with maximum incidence (4.85 per cent) noticed in Shivamogga taluk. Incidence of leaf spot and leaf blight (12.64 and 26.14 per cent) were recorded at Badhravathi and Koppa taluk, respectively.

Fixed plot survey

Fixed plot survey was taken at Haranahalli, Arsikere taluk, on basal stem rot, stem bleeding, leaf blight and leaf spot at quarterly intervals. The initial incidences (recorded during April 2015) of 28.69 per cent BSR, 18.66 per cent stem bleeding, 38.60 per cent leaf blight was noticed. At the end of the year (March 2016), the incidences of BSR and stem bleeding diseases increased to 37.85 and 22.39 per cent, respectively. However, the incidence of leaf blight disease decreased to 21.35 per cent .

Veppankulam

Roving survey

Survey was conducted in four districts of Tamil Nadu *viz.*, Thanjavur, Thiruvarur, Nagapattinam and Pudukkottai during 2015-16. Major diseases observed in coconut gardens were basal stem rot and bud rot. No incidence of stem bleeding disease was noticed in any of the places where survey was undertaken. Mean per cent incidence of basal stem rot and bud rot diseases were 3.8 and 0.1, respectively in the surveyed villages.

Fixed plot survey

Fixed plot survey for basal stem rot was initiated at Mangadu village in Alangudy taluk of Pudukottai district during December, 2012. The initial per cent incidence of 28.00 during December 2012 was increased to 52.94 during January, 2016.

Path. 2: Basal stem rot disease

Expt. 1: Characterization and management of basal stem rot disease of coconut

Activity I: Collection of *Ganoderma* isolates from various locations to analyse diversity

Arsikere

Fifteen isolates of *Ganoderma* spp. representing varied geographical locations were collected and their variations with respect to morphological and cultural characters were documented. The radial growth of isolates was around 90 mm in 9 days in almost all the isolates and statistically there was no difference among the isolates with respect to growth. Further, the growth of isolates in liquid broth also was almost the same in all and there was no significant difference among them. The colony characters of all isolates were white in colour and most of them were leathery and a few produced cottony growth. In addition, a few isolates also had foldings in their growth (Plate 1).

Plate 1. Morphological and cultural variations of *Ganoderma* at HRS Arsikere

Variations among the *Ganoderma* isolates based on cultural characteristics and pathogenic virulence to Bengal gram

The cultural and morphological variations among the 35 *Ganoderma* isolates were studied. The colony diameter of the isolates on fourth day after inoculation significantly varied and ranged between 30.0 mm to 70.2 mm. The colony diameter of isolates of Andhra Pradesh ranged between 30.0 mm to 70.2 mm, whereas, that of Tamil Nadu ranged between 35.0 mm to 50.0 mm. The colony diameter of isolates of Karnataka ranged from 55.0 mm to 65.0 mm. The average colony diameter of the *Ganoderma* isolates from Andhra Pradesh, Karnataka and Tamil Nadu was 54.0 mm, 61.2 mm and 42.5 mm, respectively. The colony diameter of *Ganoderma boninense* from oil palm showed 45.0 mm and that of type cultures of *Ganoderma lucidum* obtained from Directorate of Mushroom Research, Solan showed the colony diameter of 30.0 mm.

The cultural variations among the isolates were compared with the pathogenic virulence studies on indicator plant Bengal gram. The isolates that

showed a PDI of more than 90.0 were grouped as more virulent isolates. The isolates that showed a PDI of 50.0 to 90.0 were grouped as moderately virulent and the isolates that showed a PDI below 50.0 after one month were grouped as less virulent isolates. The *Ganoderma* isolates of Andhra Pradesh and Tamil Nadu showed a PDI of 10.0 to 100.0 on Bengal gram plants under artificial conditions, whereas, the *Ganoderma* isolates from Karnataka showed a PDI that ranged between 61.9 and 100.0. Per cent disease incidence of type cultures of *Ganoderma lucidum* from DMR, Solan was above 90.0. Isolates of Karnataka were found more virulent when compared to the other states. Five out of six Karnataka isolates showed more virulence nature and one isolate (GI_5) showed moderate virulence nature. Isolates from Andhra Pradesh belonged to all the three categories such as more virulent, moderately virulent and less virulent groups. Six out of eight *Ganoderma* isolates from Tamil Nadu showed less virulence nature and the other two isolates (PVI_2 and CRS 5) showed more virulent nature.

Veppankulam

Two *Ganoderma* sporophores were collected from Avanam and Veppankulam villages and isolated the organism during 2015-16. Totally six isolates of *Ganoderma* were isolated during 2014 -2015.

Identification of pathogenic virulence of *Ganoderma* isolates to coconut using sterilized soil

Arsikere

The virulence of ten *Ganoderma* isolates was studied under sterile soil conditions. All the isolates were able to infect seedlings indicating pathogenic nature of the same. The isolates took varied time scale for infection right from one month (G7 isolate) to 10 months (G1 to G10 isolates).

Activity II: Molecular characterization and conservation of *Ganoderma* spp.

Assessment of genetic similarity among the *Ganoderma* isolates using somatic compatibility testing

A study on somatic compatibility among the *Ganoderma* isolates was carried out to assess the genetic similarity. Somatic compatibility was tested by pairing the isolates in all the combinations and self pairing as control. Mycelia plugs (8 mm) were transferred on to standard 9 cm PDA plate and placed 2 cm apart. The plates were incubated for 10 to 15 days at ambient temperatures, assessed and rated as either compatible or incompatible. Isolates merged into single colony were named as compatible whereas isolates that formed inhibition zone or barrage were described as incompatible.

Possible combinations with the available 35 *Ganoderma* isolates are being carried out and the results are presented in Table 10. Majority of the isolates that belonged to Group 1 in RAPD profile showed compatible reaction among themselves (GA, GA2, GL, GL2, GL3, GL4, A2) and with the isolates that belonged to Group 2A (MKW, KLC, NSP, DGM) except a few (GA1, GW2, GL5 and GL6). Further, the isolates of Group 1 and Group 2A showed incompatibility with KGP isolate of Group 2B except GW2 and GL6. Similarly, isolates of Group 2B showed compatible reaction among themselves and with isolates that showed no grouping in RAPD profile and incompatible reaction with the isolates of Group 1 and Group 2A.

Diversity analysis among the isolates based on ITS 1 and ITS 2 gene amplification

Ten isolates *viz.*, GA, GL, GL4, GL6, DMR 44, KLC, NSP, GP, PVI2 and CRS4 were selected for amplification using ITS 1 and ITS 2 primers. The isolates belonged to all the three regions, Andhra Pradesh, Tamil Nadu and Karnataka and represented all the groups: Group 1, Group 2A, Group 2B and No grouping in the earlier RAPD analysis of 35 *Ganoderma* isolates of coconut. Genomic DNA was isolated from the ten isolates and PCR amplification using ITS 1 and ITS 2 primers was carried out. The amplified product was eluted and sent for sequencing.

Activity III: Epidemiology and disease forecasting

Ambajipeta

Impact of other palms and intercrops in coconut on occurrence and spread of disease

The study was initiated in November 2010 to understand the impact of other palms and intercrops

in coconut on occurrence and spread of basal stem rot disease. Fifty palms in the field with sole coconut and field with coconut + banana were selected in Gannavaram village of East Godavari District. Horizontal and vertical spread of the disease in sole coconut as well as coconut intercropped with banana during the time period is being recorded.

During the year, a new plot was selected for taking observations for coconut intercropped with banana as the banana crop was removed in the earlier plot. Plot for taking observations from sole coconut remained the same. In sole coconut plot, the PDI of 30% during April 2015 was increased to 34% by the end of March 2016 (Table 23). Mean vertical spread in sole coconut crop was recorded as 105.0 cm in April 2015 and as 101.3cm in March 2016. Over a period of six years, the per cent disease incidence of two (Nov, 2010) in sole coconut was increased to 34 (March 2016).

In the new plot selected for coconut and banana, the 16% PDI during April 2015 was increased to 22% by the end of March 2016. Mean vertical spread of the disease in coconut + banana plot was recorded as 123.8 cm in April 2015 and as 120.5 cm in March 2016.

Table 23. Impact of intercropping on BSR disease in coconut

S. No	Month	Intercrop/sole	**Disease index	**VS (cm)	Disease incidence (%)	*HS
1	Oct.,15	Sole crop	50.63	188	11.01	25 (227)
		Coconut+Cocoa	39.70	134	13.40	13 (97)
		Coconut+Banana	46.10	240	17.01	114 (670)
		Coconut+Arecanut	61.42	276	30.00	24(80)
2	Nov., 15	Sole crop	53.83	202	11.01	25 (227)
		Coconut+Cocoa	41.28	139	13.40	14 (97)
		Coconut+Banana	50.23	188	17.01	114 (670)
		Coconut+Arecanut	61.50	274	30.00	24(80)
3	Dec., 15	Sole crop	56.88	206	11.01	25(227)
		Coconut+Cocoa	42.03	146	14.43	14 (97)
		Coconut+Banana	50.87	193	17.01	114 (670)
		Coconut+Arecanut	63.00	302	30.00	24(80)
4	Jan., 16	Sole crop	57.94	230	11.01	25 (227)
		Coconut+Cocoa	43.82	156	14.43	14 (97)
		Coconut+Banana	52.39	201	17.01	114 (670)
		Coconut+Arecanut	63.00	338	30.00	24(80)
5	Feb., 16	Sole crop	56.80	235	11.45	26 (227)
		Coconut+Cocoa	43.54	154	14.43	14 (97)
		Coconut+Banana	52.40	203	17.01	114 (670)
		Coconut+Arecanut	61.00	338	30.00	24(80)
6	Mar., 16	Sole crop	57.80	235	11.45	26 (227)
		Coconut+Cocoa	43.58	154	14.43	14 (97)
		Coconut+Banana	52.50	203	17.01	114 (670)
		Coconut+Arecanut	62.00	338	30.00	24(80)

*Figure in parenthesis indicate total number of palms and figure outside indicates infected palms

** Mean of ten palms

VS- Vertical spread in cm HS- Horizontal spread in number of palms infected

Arsikere

A plot having 227 palms was selected to record the disease incidence at monthly intervals. The weather parameters such as relative humidity, atmospheric temperature, soil temperature, rainfall, and rainy days were recorded to correlate the vertical and horizontal spread of disease. The vertical spread of the disease ranged from 178 to 235 cm and horizontal spread from 21 to 26 palms. During February, 2016 (Max. and Min. RH - 71 and 45 %; Max. and Min. Temp - 31.91 and 13.22 °C; Rainfall - Nil) and March, 2016 (Max. and Min. RH - 70 and 34 %; Max. and Min. Temp - 35.51 and 17.17 °C; Rainfall - Nil) the disease incidence (both vertical - 235 cm and horizontal - 26 palms) of BSR was the highest and during June, 2015 (Max. and Min. RH - 81and 62 %; Max. and Min. Temp - 29.38 and 19.69°C; Rainfall - 123.8mm) the disease incidence (both vertical - 178 cm and horizontal - 21 palms) of BSR was minimum.

Impact of intercropping on BSR disease in coconut

The disease incidence in different coconut gardens having cocoa, banana and arecanut as intercrops was recorded to assess the impact of intercrops on basal stem rot disease. The disease index was less in gardens with cocoa as inter crop when compared to gardens with other intercrops.

Expt. 3: Management of basal stem rot disease in coconut

Activity I: Biological management – Collection, conservation and characterization of bioagents from different locations

Veppankulam

The antagonistic effect of four isolates of *Trichoderma viride* was tested against basal stem rot causing pathogen *Ganoderma lucidum* by dual culture technique and the isolates TV1, TV4, TV3 and TV2 showed 100, 75, 72 and 65 per cent inhibition over control, respectively.

Activity II: Integrated management of BSR – involving fungicides, bioagents and INM

Ambajipeta

The experiment on field management of basal stem rot was taken up with new treatments in the earlier selected garden at P. Gannavaram village of East Godavari District of Andhra Pradesh during September 2014 for standardization of dosage frequency and method of application of *Trichoderma reesei*, *Pseudomonas fluorescens* along with neem cake (5kg/palm/year), root feeding with Hexaconazole @3ml/100ml of water/palm/quarter and micronutrient application @1kg/palm/year. Pre and post treatment data are being recorded from the treated palms at regular intervals.

All the treatments except T_6 (soil application of talc based formulation of 125g of *Pseudomonas fluorescens* + 5 kg of neem cake/ palm/year) showed decreased disease index by the end of March 2016 (Table 24). Treatment T_4 showed the lowest disease index up to June 2015 and is on par with treatments T_9, T_3, T_{11} and T_1. However, by the end of March 2016, the treatment T_9 (soil application of talc based formulation of 125g of *Trichoderma viride* and *Pseudomonas fluorescens* + 5 kg of neem cake/ palm/year) and T_3 (soil application of talc based formulation of 125g of *Trichoderma viride* + 5 kg of neem cake/ palm/year) showed the lowest disease index of 6.2 and are on par with other treatments T_4, T_{11}, T_1, T_2, T_{10} and T_8 .

Arsikere

The new experiment for standardization of dosage frequency and method of application of *Trichoderma reesei*, *Pseudomonas fluorescens* along with neem cake @5kg/palm/year, root feeding with Hexaconazole @3ml/100ml of water/palm/quarter and micronutrient application @1kg/palm/year was initiated during the second fortnight of June, 2014 in a farmer's field. Observations for the incidence of BSR were recorded before imposition of treatments and post application observations were recorded at different months after treatment imposition. Among the different treatments under study, soil application of talc based formulation of 125g each of

Table 24. Standardization of dosage frequency and method of application of bioagents

S. No	Treatment	Disease index				
		Mar 2015	June 2015	Sep 2015	Dec 2015	Mar 2016
T_1	SA of Talc based formulation of 125g of *Trichoderma reesei* + 1.25 kg of Neem cake/ palm at quarterly interval	14.76	13.80	13.80	14.16	12.60
T_2	SA of Talc based formulation of 125g of *Trichoderma reesei* + 2.5 kg of Neem cake/ palm at six monthly interval	15.98	15.92	14.12	14.24	14.12
T_3	SA of Talc based formulation of 125g of *Trichoderma reesei* + 5 kg of Neem cake/ palm/year	8.48	7.4	6.3	6.72	6.2
T_4	SA of Talc based formulation of 125g of *Pseudomonas fluorescens* + 1.25 kg of Neem cake/ palm at quarterly interval	6.84	5.9	5.6	5.4	6.36
T_5	SA of Talc based formulation of 125g of *Pseudomonas fluorescens* + 2.5 kg of Neem cake/ palm at six monthly interval	26.72	27.32	25.52	24.68	24.20
T_6	SA of Talc based formulation of 125g of *Pseudomonas fluorescens* + 5 kg of Neem cake/ palm/year	29.72	31.04	29.00	26.40	31.88
T_7	SA of Talc based formulation of 125g of *Trichoderma reesei* and *Pseudomonas fluorescens* +1.25 kg of Neem cake/ palm at quarterly interval	26.88	28.20	25.80	24.60	26.08
T_8	SA of Talc based formulation of 125g of *Trichoderma reesei* and *Pseudomonas fluorescens* +2.5 kg of Neem cake/ palm at six monthly interval	16.16	15.56	14.48	14.24	16.40
T_9	SA of Talc based formulation of 125g of *Trichoderma reesei* and *Pseudomonas fluorescens* + 5 kg of Neem cake/ palm/year	7.28	6.08	5.12	5.24	6.2
T_{10}	Root feeding of 1 ml of Hexaconazole in 100 ml water thrice in a year	25.56	28.68	26.52	27.92	15.76
T_{11}	SA of Talc based formulation of 125g of *Trichoderma reesei* and *Pseudomonas fluorescens* + 5 kg of Neem cake/ palm/year+ Root feeding with 1 ml Hexaconazole/100ml thrice in a year + Micronutrient application @1kg/palm/yr	14.16	13.80	12.84	12.84	11.92
T_{12}	Control	32.28	33.00	33.00	33.96	35.28
	SEm±	5.81	6.17	6.14	5.98	6.46
	CD (P=0.05)	16.63	17.66	17.57	17.03	18.49

Trichoderma reesei and *Pseudomonas fluorescens*+ 5 kg of neem cake/ palm at yearly interval recorded lesser incidence of disease .

Veppankulam

In the field trial on the integrated management of basal stem rot disease in coconut at Sanakarai village of Peravurani taluk of Thanjavur district, all the IDM practices were imposed as per the treatment schedule. Soil application of talc based formulation of 125g each of *Trichoderma viride* and *Pseudomonas fluorescens* + 1.25 kg of neem cake/ palm at quarterly intervals was found to be effective in suppressing the basal stem rot disease of coconut .

Activity III. Screening of new fungicides

Screening of ten systemic fungicides *viz.,* Azoxystrobin 23% EC (0.10%), Kresoxim methyl 44.3% SC (0.10%), Tebuconazole 25.9% EC (0.15%), Tetraconazole 3.8% EW (0.10%), Tebuconazole +

Trifloxystrobin 50% +25% WG (0.40%), Difenconazole 25% EC (0.10%), Hexaconazole 5% EC (0.10%), Propiconazole 25% EC (0.10%), Thiram + Carboxin 37.5 + 37.5 WS (0.28%) and Thiophanate methyl 70%WP (0.30%) was carried out with pure culture of *Ganoderma* under *in vitro* conditions. Three replications per each chemical were maintained along with control.

Ambajipeta

Of the chemicals tested, fungicides *viz.,* Tebuconazole, Tetraconazole, Tebuconazole + Trifloxystrobin, Difenconazole, Hexaconazole, Propiconazole and Thiram + Carboxin inhibited 100 per cent growth (Plate 2).

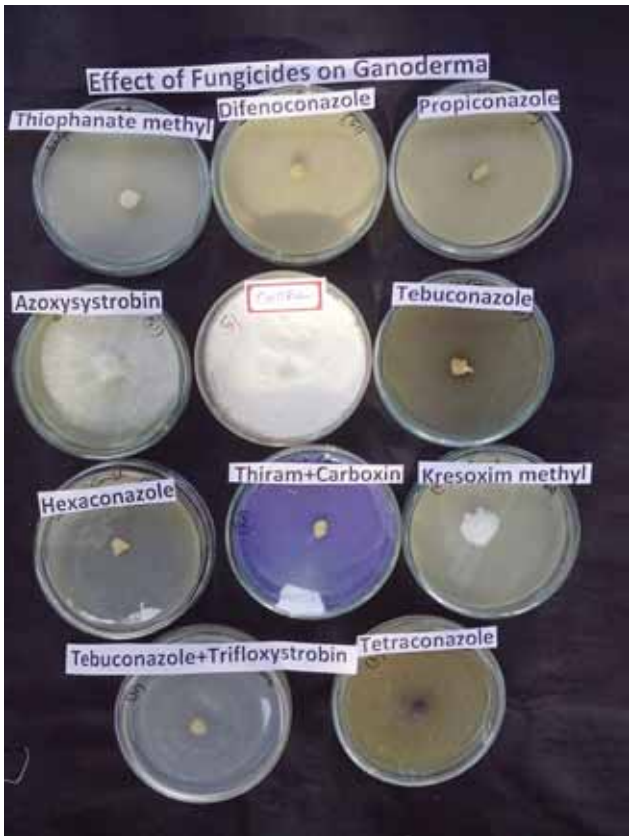

Plate 2. *In vitro* screening of fungicies against *Ganoderma lucidum* at HRS Ambajipeta

Arsikere

Among the different fungicides tested, fungicides *viz.,* Tebuconazole, Teraconazole, Tebuconazole +Trifloxystrobin, Hexaconazole, Propiconazole, Thiram + Carboxin, and Thiophanate methyl inhibited 100 per cent growth (Plate 3).

Plate 3. *In vitro* screening of fungicies against Ganoderma lucidum at HRS Arsikere

Veppankulam

The inhibitory effect of ten systemic fungicides at different concentrations under *in vitro* on the growth of *Ganoderma lucidum* causing basal stem rot disease on coconut was evaluated by poisoned food technique. Each chemical was replicated three times with proper control. Among the ten fungicides tested, Tebuconazole 25.9% EC, Tetraconazole 3.8% EW, Tebuconazole + Trifloxystrobin 50% + 25% WG, Difenoconazole 25% EC, Hexaconazole 5% EC, Propiconazole 25% EC, Thiram + Carboxin 37.5 + 37.5 WS has recorded 100 per cent inhibition of *Ganoderma lucidum* and showed superior over other tested fungicides.

Expt. 4: Early detection of basal stem rot disease in coconut

Ambajipeta

A pot experiment was initiated for identification of indicator plants for basal stem rot disease of coconut. Fungal culture of *Ganoderma lucidum* was mixed with sterile soil before sowing germinated sprouts of red gram, Bengal gram and bhendi (okra). Forty germinated seeds were transferred to the sterile soil inoculated with *Ganoderma lucidum*. Bengal gram plants showed infection with *Ganoderma* within one month. Infected seedlings showed withering, yellowing, browning of the lower set of leaves followed by upper leaves and drying of the plants. When the infected seedlings were uprooted, whitish fungal growth was observed on the cotyledons. In later stages, complete rotting of the basal stem

Table 25. Percent disease incidence on indicator plants

S. No	Indicator plant	Symptom	Percent Disease Incidence			
			15 DAI	30 DAI	45 DAI	60 DAI
1	Bengal gram	Wilting (Withering, yellowing, browning of the lower set of leaves followed by upper leaves)	2.50	10.00	17.50	45.00
2	Red gram	Wilting	0.00	0.00	2.50	5.00
3	Bhendi (Okra)	No symptom	0.00	0.00	0.00	0.00
4	Control	No symptom	0.00	0.00	0.00	0.00

DAI: Days after inoculation

region and death of the plants were observed. Pure culture of *Ganoderma* was re-isolated from the basal stem regions of infected bengal gram plant. Red gram plants showed wilting symptom after 45 days (Table 25). However, bhendi plants did not show any symptom of infection after two months of inoculation.

Expt. 5: Identification of coconut types resistant to *Ganoderma* wilt disease

Ambajipeta

Forty four coconut varieties/ hybrids were screened for identification of resistance against basal stem rot disease from 1984 at the Horticultural Research Station, Ambajipeta. However, none of the germplasm showed resistance to the pathogen. The varieties or hybrids screened under the programme were San Ramon OP, San Ramon SP, San Ramon IC, B.S .Islands OP, B.S. Islands SP, B.S. Islands IC, Java OP, Java SP, Java IC, S.S.Green OP, S.S.Green SP, S.S.Green IC, Guam OP, Guam SP, Guam IC, St. Vincent OP, St. Vincent SP, St. Vincent IC, L.O.OP, L.O. SP, L.O. IC, TxD (WCT x COD), DxT (COD x WCT), TxD (ECT x GB), West Coast Tall, East Coast Tall, GB x PO, GB x Fiji, GB x LO, Gangabondam, Andaman Ordinary, Chowghat Orange Dwarf, Malayan Yellow Dwarf, Philippines Ordinary, Cochin China, VHC–1, VHC–2, Java, Kera Ganga, Laksha Ganga, Chandra Laksha, Godavari Ganga and Chandra Shankara.

Veppankulam

The On Farm Trials for the evaluation of resistance of coconut germplasm against basal stem rot disease in coconut are being conducted at Pulichankadu, Thennakudy and Veppankulam villages. Twenty six coconut varieties/ hybrids were screened for identification of resistance against basal stem rot disease from 1984 at the Coconut Research Station, Veppankulam. The varieties or hybrids screened under the programme were LO, PHO, AO, CC, ECT, WCT, RB, COD, MYD, MOD, MGD, Thailand, Fiji, GB , RB 41, BSR tolerant ECT (s), WCT (s), ECT x RB, COD x ECT, AO x ECT, ECT x LO, MYD x CGD, LO x AO, COD x MYD, CGD x MGD and BEN x AO. However, none of the coconut germplasm showed resistance to the basal stem rot disease. ECT x RB, WCT, AO, CC, Fiji and RB are the coconut accessions under study at Pulichankadu village from 2009 onwards. All these accessions showed more than 70 % disease incidence within seven years period.

Path. 3: Stem bleeding and bud rot diseases

Expt. 1: Management of stem bleeding disease in coconut

Activity I: Evaluation of Bioagents

Ambajipeta

Evaluation of different formulations of bio agent, *Trichoderma* was tested against stem bleeding disease of coconut at two locations, Horticultural Research Station, Ambajipeta and farmer's field at Mukkamala village. Effect of *Trichoderma harzianum* cake formulation as well as *Trichoderma reesei* paste formulation along with positive control (paste application of copper oxy chloride) was tested against stem bleeding disease of coconut. In case of cake application, the treatment was given only once during the study period. In case of paste application, it was carried out every month and the treated palms were observed for the disease symptom and the per cent recovery of the treated palms was observed.

Application of *Trichoderma harzianum* cake formulation caused complete recovery of the stem bleeding disease affected palms when compared to the paste application of *Trichoderma viride* and copper oxychloride. Disease index of 2.85 and 0.71 at HRS Ambajipeta and Mukkamala was brought down to nil within 50 days of cake application. Disease index of 0.90 and 3.55 was reduced to 0.37 and 0.46 in case of paste application of copper oxychloride at the two locations, HRS Ambajipeta and Mukkamala, respectively (Table 26). However, the treatments did not differ significantly.

Table 26. Field evaluation of cake and paste formulations of Trichoderma species against stem bleeding disease of coconut

S. No	Treatment	At HRS Ambajipeta		At Mukkamala	
		DI (BT)	DI (50 DAT)	DI (BT)	DI (50 DAT)
1	*Trichoderma harzianum* cake application	2.85	0.00	0.71	0.00
2	*T. reesei* paste application (as swabbing)	0.92	0.48	0.43	0.23
3	Copper oxychloride paste application	0.90	0.37	3.55	0.46
4	Control	3.53	3.53	4.63	4.63
	SEm±	1.23	1.08	2.16	2.08
	CD (P=0.05)	N.S	N.S	N.S	N.S

*Mean of seven replications DAT – Days after treatment
DI: Disease Index BT: Before Treatment

Activity II: Chemical management through fungicides

Ambajipeta

For chemical management of stem bleeding disease, the systemic fungicides, Tebuconazole 25.9% EC (0.15%), Tetraconazole 3.8% EW (0.1%), Difenconazole 25% EC (0.1%), Hexaconazole 5% EC (0.1%), Propiconazole 25% EC (0.1%), Thiram + Carboxin 37.5 + 37.5% WS (0.28%) and Pencycuron 22.9% SC (0.1%) were screened under *in vitro* conditions at recommended concentrations. Chemicals Tebuconazole, Difenconazole, Hexaconazole showed complete inhibition of the mycelial growth at six days after inoculation. However, all the fungicides except Pencycuron showed complete inhibition of the mycelial growth at three days after inoculation.

Arsikere

Ten fungicides were tested against *Thielaviopsis paradoxa* under *in vitro*. The result revealed that the fungicides Tebuconazole 25.9% EC (0.15%), Hexaconazole 5% EC (0.1%), Propiconazole 25% EC (0.1%) and Thiram + Carboxin 37.5 + 37.5% WS (0.28%) inhibited 100 per cent of growth of test pathogen. However, based on the cost, propiconazole was selected for field evaluation.

Expt. 2: Management of Bud rot disease in coconut

Activity II: Screening of latest fungicides against bud rot disease

Ambajipeta

Screening of the latest fungicides *viz.,* Azoxystrobin 23% EC, Kresoxim methyl 44.3% SC, Pyroclostrobin + Metiram 60% WG, Bordeaux mixture 1%, Copper oxychloride 50% WP, Copper hydroxide 77% WP, Chlorothalanil 75% WP and Famexadone + Cymaxanil (Equation Pro) 60%WG was done under *in vitro* conditions. All the tested fungicides showed complete inhibition of the mycelia growth of the pathogen under *in vitro* conditions.

Path. 4: Leaf blight disease of coconut

Expt. 1: Characterization and epidemiology of leaf blight disease in coconut

Activity III: Epidemiology and disease prediction

Aliyarnagar

Monthly weather data including maximum and minimum temperature, relative humidity and rainfall and the leaf blight disease incidence were recorded regularly at weekly intervals. The leaf blight disease intensity increased with increase in temperature and

the maximum disease intensity was observed during April. Disease intensity was found to be low during December (19.88) and higher during April and May (25.6 and 25.9, respectively).

Expt. 2: Studies on the management of leaf blight disease in coconut

Activity I: Screening of available systemic fungicides against leaf blight pathogen

Arsikere

In vitro evaluation of fungicides against *Pestolotia* spp.

Nine fungicides were tested under *in vitro* against *Pestolotia* spp. Almost all fungicides inhibited the growth of pathogen. Tebuconazole 25.9% EC (0.15%), Difenoconazole 25% EC (0.1%) , Thiophanate methyl 70% WP (0.3 %), Azoxystrobin 23% SC (0.1%), and Carbendazim 50%WP (0.1 %) reported 100 per cent inhibition.

Activity I: Evaluation of systemic fungicides (Tebuconazole and Propiconazole) against leaf blight disease

Aliyarnagar

Two management field trials each at Puliyankandi village of Anaimalai block in Coimbatore district and Gomangalampudur village of Udumalaipet block in Tirupur district were laid out and the treatments are imposed at appropriate time. Pre- treatment and post observation (15 months after application) were recorded in both the trial plots and presented in Table 27. Maximum reduction in disease severity at 12.01 and 13.26 per cent was observed in root feeding of Tebuconazole @ 2ml + 100 ml water at quarterly interval treated palms in Puliyankandi and Gomangalam pudur village trials, respectively.

Table 27. Effect of systemic fungicides against leaf blight disease of coconut during 2015-2016 (Puliyankandi, Coimbatore district)

Treatments		Pre-treatment observation	Post-treatment observation*	Reduction in disease severity
		PDI		
T_1	Root feeding of Tebuconazole @ 2ml + 100 ml water at quarterly interval	25.52	13.51	12.01 (20.28)[a]
T_2	Root feeding of Tebuconazole @ 2ml + 100 ml water at half yearly interval	29.84	22.40	7.44 (15.83)[e]
T_3	Root feeding of Tebuconazole @ 2ml + 100 ml water once in a year	26.56	20.89	5.67 (13.78)[f]
T_4	Root feeding of Propiconazole @ 2ml + 100 ml water at quarterly interval	25.4	14.47	10.93 (19.31)[c]
T_5	Root feeding of Propiconazole @ 2ml + 100 ml water at half yearly interval	36.6	28.53	8.07 (16.50)[d]
T_6	Root feeding of Propiconazole @ 2ml + 100 ml water once in a year	20.6	15.82	4.78 (12.63)[g]
T_7	Root feeding of 2 g of Carbandazim in 100 ml water thrice at 3 months interval	29.92	18.58	11.34 (19.68)[b]
T_8	Control	32.4	30.58	1.82 (7.75)[h]
	SEd			0.06
	CD (P=0.05)			0.12

PDI= per cent disease index

* Post treatment observation taken at 15 months after application of treatments

Values in the parentheses are Arcsine transformed values. The alphabet represents the treatment significance based on DMRT.

Path. 5: Root (wilt) disease of coconut

Expt. 1: Assessing the incidence of root (wilt) disease in Tamil Nadu

Aliyarnagar

Roving survey on the occurrence of root (wilt) disease was conducted in different villages of Coimbatore, Dindigul, Tirupur and Theni districts. Among the villages surveyed, maximum incidence of root (wilt) disease was observed in Maelagudalur village (68.0 per cent) of Cumbum block in Theni district followed by Vadakarai village (67.7 per cent) of Thenkasi block in Tirunelveli district.

Among the villages surveyed in Coimbatore district, severe incidence of root (wilt) disease was recorded in Ambarampalayam village (58.0 per cent) of Pollachi South block followed by Aathupollachi village (47.0 per cent) Polachi North block. Among the blocks in Coimbatore district, maximum incidence of root (wilt) disease was observed in Pollachi South block (13.7 per cent) followed by PN Palayam block (8.9 per cent) and minimum in Anaimalai block (3.3 per cent).

Among the blocks surveyed in Kanyakumari district, maximum disease incidence was recorded in Thiruvattaru block (9.1 per cent) and minimum in Agastheeswaram block (0.16 per cent). In Tirunelveli district, severe incidence of root (wilt) disease was recorded in Vadakarai village (67.7 per cent) of Thenkasi block followed by Maelakadayanallur village (46.9 per cent) of Kadayanallur block. Roving survey was carried in Theni district, more incidence was recorded in Maelagudalur village (68.0 per cent) followed by Maninagar village (61.6 per cent) of Cumbum block.

On an average, Theni district showed 59.1 per cent of root (wilt) disease incidence in Cumbum block only followed by Tirunelveli district recorded 16.9 per cent in all the surveyed blocks and an average of 9.2 per cent incidence was observed in Coimbatore district and no incidence was recorded in Tirupur district (Table 28).

Table 28. Roving survey on Root (wilt) incidence of coconut in Tamil Nadu

S. No.	District	Root (wilt) incidence (%)
1	Coimbatore	9.2
2	Kanyakumari	4.8
3	Theni	59.1
4	Tirunelveli	16.9
5	Tirupur	-
Mean		18.0

Awareness programme

In order to create awareness about the root (wilt) disease and its diagnosis to prevent further spread from already infected areas, several awareness programmes were organized and eradication of severely affected trees was emphasized.

4.4 Pest Management

Ent.3: Survey and monitoring of pest problems in coconut (eriophyid mite, rhinoceros beetle, red palm weevil, black headed caterpillar and other Pests)

Aliyarnagar

Roving Survey

Roving survey was carried out in five districts of Tamil Nadu *viz.,* Coimbatore, Tiruppur, Tirunelveli, Kanyakumari and Krishnagiri and the extent of damage in terms of per cent incidence and intensity were recorded for major pests of coconut during these surveys.

The incidence of rhinoceros beetles was noticed in young plantations in the age group of 3 years to 15 years. The mean incidence of rhinoceros beetle was 48.1%, 37.2%, 28.3%, 40.0% and 35.0 % in Coimbatore, Tiruppur, Tirunelveli, Kanyakumari and Krishnagiri districts, respectively and the leaf damage ranged between 9.7 % and 17.2 % in these districts. The mean incidence of red palm weevil was the highest in Tiruppur district (5.5%). The incidence of red palm weevil was noticed in three years old palms (Pongalur block, Tiruppur district) to 25 year old palms. The mean nut damage due to eriophyid mite (88.9%) along with Mean Grade Index (1.60) was the highest in Krishnagiri district

Among the five districts surveyed for black headed caterpillar infestation, Tirunelveli and Kanyakumari districts had no incidence of this pest. A mean incidence of 36.5% damage by black headed caterpillar was noticed in Krishnagiri district with high damage in Kaveripattinam block (48.6% damage) in this district. Palmyrah palms (*Borassus flabellifer*) adjacent to coconut palms also housed the larval stages of coconut black-headed caterpillar.

Black-headed caterpillar infested garden at Kaveripattinam block, Krishnagiri Dt.

Damage by coconut black headed caterpillar on coconut leaves

Black Headed Caterpillar attacking Palmyrah palms, *Borassus flabellifer*

Minor pests

Incidence of slug caterpillar, *Contheyla rotunda* was noticed in Kottamangalam (Tiruppur district) to an extent of 28.9% and in Velliyampalayam village of Tiruppur district (50.7%). Incidence of termite, *Odontotermes obesus* was noticed to an extent of 34.1% in Coimbatore district. Further, incidence of spiralling whitefly, *Aleuroducus disperses* was noticed to an extent of 26.0 to 40.0% in Anaimalai

block, Coimbatore district in age group of 3 – 5 year old palms and was accompanied by sooty mould formation.

Slug caterpillar damage at Velliyampalayam

Slug, *Contheyla rotunda*

Spiraling whitefly, *Aleurodicus disperses*

Fixed Plot Survey

Fixed plot surveys were conducted in three locations *viz.,* Avalchinnampalayam and Kottur (Coimbatore district) and Avinashipalayam (Tiruppur district). Rhinoceros beetle incidence was noticed only in Avalchinnampalayam garden, and the leaf damage by beetles ranged between 3.4 to 7.7% from June 2015 to March 2016. Red palm weevil incidence was noticed in Avinashipalayam village only and an incidence of 10.3% was recorded during September 2015 and gradually reduced upon following the recommended control measures. With regard to eriophyid mite the Avalchinnampalayam garden recorded very low nut damage (5.4 to 8.7%) while, Avinashipalayam and Kottur fields registered nut damage to an extent up to 68.4% and 66.0%, respectively. However, the mean grade index did not exceed beyond 1.11 and is in the Moderate intensity as per the CPCRI scale.

Ambajipeta

Roving survey

Roving survey was carried out in East Godavari, West Godavari, Vishakapatnam, Vizianagaram and Srikakulam districts. Rhinoceros beetle, black headed caterpillar and eriophyid mite are the major pests infesting coconut in these regions. The incidence of Rhinoceros beetle was 15% and 13% in the Srikakulam and Vishakapatnam districts and ranged around 10 in East Godavari, West Godavari and Vizianagaram districts. The leaf damage by the beetle was 10.8, 13.7, 11.7, 16.5 and 21.8 and spindle damage was 6.3, 8.8, 8.3, 9.7 and 13.0% in East Godavari, West Godavari, Vishakapatnam, Vizianagaram and Srikakulam districts, respectively. No incidence of red palm weevil was observed during the survey. A high infestation of black headed caterpillar was observed in all the coastal districts surveyed except Vizianagaram. The incidence was 62.9, 50.9, 42.8 and 47.1 % in East Godavari, West Godavari, Vishakapatnam and Srikakulam districts, respectively.

A severe out break of black headed caterpillar was recorded in Allavaram mandal of East Godavari in 675 ha and was successfully managed by inundative release of larval parasitiods *viz., Bracon hebetor* and *Goniozus nephantidis*. The infestation of eriophyid mite was recorded from all the plantations observed in the surveyed districts and was in the range of 80.6 to 92.6. The intensity of mite was moderate to high in all the districts surveyed.

Opisina arenosella galleries on the nuts at Bendamurulanka village

Black headed caterpillar damage in Challapalli Village , East Godavari district

High incidence of Slug caterpillar in Sakinetipalli village

However, severe incidence of sporadic pest slug caterpillar *Macroplectra nararia* was recorded (approximately in 500 ha) in the villages of Kothapeta, Ravulapalem from February 2016 and in Uppalagutam, Mummadivaram, I.Polavaram, Sakinetipalli and Thallarevu mandals of East Godavari district and Bhimavaram, Poduru and Yelamanchali mandals of West Godavari Andhra Pradesh from March 2016 and the pest incidence is increasing .

Fixed plot survey

Fixed plot survey was undertaken in Palivela village in Kothapeta mandal and Korlapativaripalem in Ambajipeta mandal of East Godavari district. Low intensity of rhinoceros beetle leaf damage was noticed in both the gardens and it ranged from 17.2 to 18.1 % at Korlapativaripalem and 4.4 to 12.8 % at Palivela village. No spindle damage was observed in the fixed plot gardens. With respect to eriophyid mite, 80 to 90 % incidence was observed in both the fixed plot survey villages. High mite intensity was observed in Korlapativaripalem and moderate intensity of mite was noticed in Palivela village. No incidence of red palm weevil and coconut black headed caterpillar was observed in fixed plot survey gardens. Slug caterpillar was observed during February 2016 in Palivela village and adoption of management practices has led to reduction of caterpillar incidence in this garden.

Arsikere

Roving Survey

The roving survey was carried out in Hassan, Tumkur, Mysuru and Mandya districts and the extent of damage in terms of per cent incidence and intensity were recorded for major pests of coconut. The infestation of rhinoceros beetle was noticed mostly in all newly planted gardens in all the age groups of 4 to 42 years. The highest incidence 53.6 % was noticed in Hassan district followed by 38.7 % in Mysuru district. The incidence of red palm weevil was maximum (up to 12.50%) in Tumkur district followed by 4.8 % infestation in Mysuru district. The incidence of red palm weevil was also noticed in Mandya (1.88%) and Hassan (0.50%) districts.

The infestation by coconut black headed caterpillar was noticed in all the four major coconut growing districts of Karnataka. An incidence of 20.8% was noticed in Tumkur district followed by Hassan (12.4%), Mysuru (12.3%) and Mandya (4.6 %) districts. The infestation of eriophyid mite was also noticed in all major districts of Karnataka and in most cases, the incidence was as high as 100 % in the harvested nut samples. The highest incidence of mite incidence was recorded in Tumkur district (62.9%) followed by Hassan (46.7%), Mysuru (39.8%) and Mandya (33.9%) districts.

Fixed Plot Survey

To record the incidence and intensity of infestation of different pests of coconut, fixed plot survey

was carried out at quarterly intervals from March 2015 to February 2016 in farmer's fields located at Haronahally and Habbanghatta villages of Hassan district. The palms were in the age group of 15 to 27 years. The infestation by major pests was recorded four times in a year. In Habbanghatta, the highest incidence of rhinoceros beetle (44.52 %), eriophyid mite incidence (37.38 %) and nut damage (55.80 %) was observed while high leaf damage (48.85 %), and spindle damage (15.10 %) due to rhinoceros beetle was observed at Haronahally village.

Ratnagiri

Roving Survey

Roving survey work was carried out in major coconut growing districts of Konkan region of Maharashtra *viz.,* Raigad and Palghar districts. The infestation of rhinoceros beetle was more or less similar in all the districts, and ranged from 13.9 to 14.4 % in all the districts. The maximum incidence was observed in Palghar while minimum incidence was observed in Raigad district. The maximum spindle damage of 3.3 % was observed in Raigad district whereas, maximum leaf damage was observed in Palghar district (11.32 %). The incidence of red palm weevil was similar in both Raigad (6.7 %) and Palghar districts (6.6%). The infestation of black headed caterpillar was noticed in both the districts. The maximum incidence was observed in Palghar district (4.1%) followed by Raigad district (3.5%). The infestation of eriophyid mite was recorded from coconut orchards surveyed in all the districts. The incidence of this pest was more or less similar in both the districts with Raighad district registering a nut damage of 45.4% (MDGI = 0.70) and Palghar district registering a nut damage of 47.3% (MDGI = 0.85).

Fixed Plot Survey

To record the incidence and intensity of infestation of various pests of coconut, fixed plot survey was carried out at quarterly intervals from April 2015 to March 2016 at farmer's field in Ratnagiri taluk of Maharashtra. The infestation of rhinoceros beetle was in the range of 19.6 to 27.7% and the maximum infestation (27.7%) was observed during April 2015 which declined to 22.8 % during March, 2016. The infestation of red palm weevil which was in the range of 7.8 % during April 2015 went up to 10.6% during March, 2016. The maximum incidence of black headed caterpillar was noticed during April 2015 and was 9.51 %. During rainy season, the incidence decreased to 6.5 % during August 2015 and again slowly increased up to 9.6 % during March 2016. The infestation of eriophyid mite was in the range of 28.94 to 36.1% and the maximum infestation (36.1%) was during August 2015. The intensity of eriophyid mite was from low to moderate.

Ent. 5: Management of eriophyid mite in coconut gardens

Aliyarnagar

The trial is being continued in the farmers field at Kottur Malayandipattinam, Anaimalai block, Coimbatore (District). Before imposing the treatments *i.e.,* T 1 : INM package (in 2 or 3 splits) with root feeding of azadirachtin (root feeding thrice a year @1% (10 ml + 10 ml water) T 2 : INM package (in 2 or 3 splits) without root feeding of azadirachtin and farmers practice the per cent nut damage ranged from 58.7 to 66.0 in different treatments. After imposing the treatments, the nut damage slightly showed a decreasing trend in INM, IPM with root feeding treatment recording a nut damage of 50.1 % while INM, IPM without root feeding registered a nut damage of 56.6 and the control exhibiting 64.0 % damage. After 7th month, the nut damage was minimum (48.5%) in INM, IPM with root feeding as against 61.2 % nut damage in control plots while after 10 months the per cent nut damage was on par in both INM, IPM with root feeding (46.5) and INM, IPM without root feeding (49.2) treatments as against 64.4% in control . With regard to Mean Grade Index, the initial grade index stood in the range of 0.91 to 1.11 in different treatments. At the end of 7th month, the INM, IPM with and without root feeding treatments were on par with each other (0.73 and 0.82 respectively) as against 1.04 in control plot.

Ambajipeta

The trial was conducted in farmer's field at Korlapativaripalem village of East Godavari district. The pre treatment observation revealed that the

eriophyid mite infestation was 97.02, 97.74 and 98.87 %, respectively in the various treatments. After four months interval, the mite infestation decreased in INM, IPM garden with root feeding *i.e.,* from 97.0% to 87.1 as against 92.1% in control plots. After 8 months too, the nut infestation got reduced in all the treatments. However, after 12th month, increase in per cent mite infested nuts was recorded in all the treatments from 65.0 to 90.8 in treatment T_1 and from 88.0 to 94.2 in treatment T_2. Regarding eriophyid mite intensity, the initial MDGI was in the range 1.15 to 1.70 with scale being moderate. After 12 month interval, the grade index in all the plots gradually increased. The mite intensity in 2015-16 was moderate in all the treated and control plots(Fig. 1) .

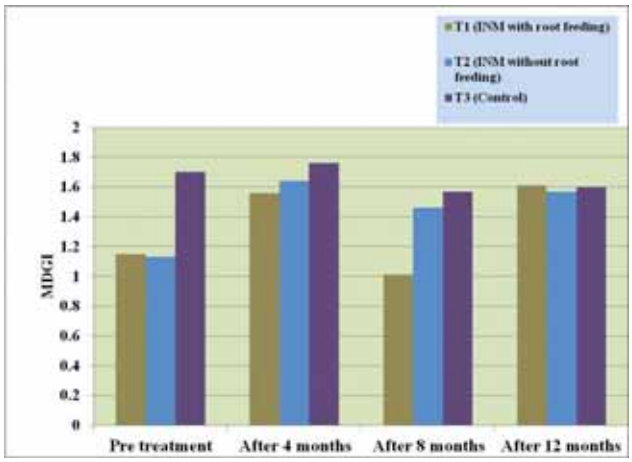

Fig.1. Mean Damage Grade Index(MDGI)due to eriophyid mite in experimental plots Korlapativaripalem village of East Godavari district , Andhra Pradesh (2015-2016)

Arsikere

The trial was conducted at Horticulture Research Station, Arsikere in a 17 year old garden.

The per cent nut damage ranged between 78.6 and 79.9 before imposing treatments. Upon imposing the treatments, the per cent nut damage gradually reduced and by fourth month, the per cent nut damage recorded was in the range of 66.4 to 73.5 in the treatments (T_1 & T_2) as against 84.3 in control. By eighth month, the IPM and INM treatments with and without root feeding were effective in reducing mite infestation with 59.4 and 67.1% nut damage as against 87.8 % nut damage in control plot. Similarly after 12 months of imposing the treatments, the per cent nut damage gradually reduced to 52.1 to 61.8 in the treatments (T_1 and T_2) as against 90.4 in control.

A similar trend was also noticed in the Mean Grade Index due to eriophyid mite infestation. After twelve months of imposing treatments, the INM (with root feeding) treatment imposed gardens exhibited the least MGI (1.46) and was on par with INM (without root feeding) gardens with a MGI of 2.12 and were significantly superior to the control plot (MGI = 3.88).

Ratnagiri

The trial was conducted at farmer's field in Karla village of Ratnagiri district. The pre treatment and post treatment observations were recorded at four months interval up to twelve months from 3rd bunch in the selected plots. Before application of treatments it was observed that the eriophyid mite infestation was 49.1, 49.7 and 52.7 % in different blocks. After four months interval, the mite infestation gradually decreased from 49.1 % to 46.7 % in treatment T_1 and from 49.7 per cent to 48.8 % in treatment T_2. Similar trend in mite infestation was observed even after eight and twelve month's interval. In treatment T_1, mite infestation decreased to 31.6 % while in treatment T_2 it decreased to 43.6 %. The treatment T_1 (INM with root feeding) was significantly superior over rest of the treatments followed by T_2.

The eriophyid mite intensity initially was in the range 2.05 to 3.02 with mean damage grade index being high to severe. After four, eight and twelve month's interval, intensity in treated plots gradually declined to mild (T1) and moderate (T2).

Ent.11: Evaluation of improved strains of parasitoids (Braconid) (*Goniozus nephantidis* – larval parasitoids) and predators (*Cardiostethus exiguus*) in the field against *O. arenosella*

Arsikere

The field trail was conducted in a farmer's field at Kaidalu, Tiptur Tq. Tumkur Dist. (Karnataka) having outbreak of coconut black headed caterpillar incidence. There was a high initial larval population ranging from 20.52 to 21.05 per ten leaflets during October 2015 and gradually decreased to 15.1, 5.0 and 1.2 per ten leaflets in treatment T_1 (conditioned)

and 17.6, 8.0 and 4.9 per ten leaflets in treatment T_2(unconditioned). In untreated control, the larval population of 20.84 per ten leaflets was recorded prior to release of parasitoids and showed an increase to 22.47 and 24.84 per ten leaflets in first and second months and later decreased to 18.24 in third month (Table 29). The conditioning of parasitoids had more impact on reducing black headed caterpillar population when compared to un-conditioned parasitoids.

Table 29. Evaluation of pre-conditioned parasitoid *Goniozus nephantidis* against *Opisina arenosella* in Karnataka (2015-16)

Treatment	Average no. of larvae/ ten leaflets (Pre release count) October 2015	*O. arenosella* larval population/ ten leaflets (Post release count)		
		After one Month (November-2015)	After second month (December- 2015)	After third month (January- 2016)
T_1(Conditioned)	20.5 (26.93)	15.1 (22.87)	5.0 (12.97)	1.2 (6.39)
T_2(Unconditioned)	21.1 (27.31)	17.6 (24.83)	8.0 (16.39)	4.9 (12.72)
T_3 (Control)	20.8 (27.16)	22.5 (28.29)	24.8 (29.89)	18.2 (25.28)
Sig.	NS	Sig	Sig	Sig
SEm±	0.15	1.70	5.20	5.40
CD (P=0.05)	0.38	4.20	13.10	13.50
CV (%)	5.80	7.80	8.20	7.50

Figures in parenthesis are square root transformed values

Ent.12: Studies on field efficacy of commercially available pheromones against coconut insect pests *viz*., rhinoceros beetle, red palm weevil and black headed caterpillar

Aliyarnagar

Studies on the rhinoceros beetle trap catches are being continued in the farmer's field at Avalchinnampalayam, Anaimalai block, Coimbatore district. During the period from April 2015 to March 2016, the CPCRI-NPM lure recorded the maximum trap catch of 217 beetles with a mean catch of 54.3/ trap. The PCI lure on the other hand registered a trap catch of 121 beetles (30.3/ trap). Further, saw dust placed inside the PVC pipes registered about 58 eggs and 70 first instar grubs indicating that, virgin females also were attracted to the traps. The sex ratio in both the CPCRI as well as PCI lures were female biased (1.89 and 1.88, respectively). The CPCRI lures were not changed during the study period while the PCI lures were changed twice indicating the longevity of CPCRI lures (Table 30) .

Table 30. Comparative efficacy of different lures against rhinoceros beetle in Tamil Nadu (2015-16)

Month	Total no. of beetles trapped in 4 traps		
	T_1 – NPM CPCRI lure	T_2 – PCI lure	T_3 – Blank trap
April, 2015 To March 2016	217	121	0
Mean nos./ trap	54.3 ± 5.4	30.3 ± 3.4	0
Sex ratio (Female: male)	1.89 : 1	1.88 : 1	-
Lure installation date	27.07.2015	29.04.2015	-
Lure replacement	Nil	27.08.2015 30.12.2015	-

Values represent Mean ± Standard Error
Chi square = 10.2; df 2; Kruskall-Wallis test (Sig <0.05)

Studies on the red palm weevil pheromone catches were conducted at Avinashipalayam, Tiruppur disrict. The red palm weevil incidence at the time of initiating the experiment was 10.3 %. During the period from October 2015 to March 2016, the CPCRI lure registered a trap catch of 88 (22.0/ trap) as against 49 (12.3/ trap) in PCI lures and 5 (1.3/ trap) in control. Here also, the trap catch was female biased with a sex ratio of 1.66 for CPCRI lures and 1.72 for PCI lures. The PCI lures were changed once, while the CPCRI lures were not changed during the study period indicating the longevity of the CPCRI lures.

Studies on the black headed caterpillar pheromone catches have been initiated in a six acre garden (var: Local tall) at Gomangalampudur village (Tiruppur district) during Feb-March, 2016. The leaf damage at the time of initiating the experiment was 27.5% (category: Low). Five sticky traps with PCI lures and without lures were installed in the garden at coconut canopy level. Lure catches were recorded at 15 days interval and the data at the end of one month revealed a total of 196 moths / 4 traps in the sticky traps (with pheromone lures) as against a total of 127 moths/ 4 traps in sticky traps without lures.

PCI Lures of coconut black headed caterpillar at trial plot, Gomangalampudur

Trap catches at Gomangalampudur

Ambajipeta

Studies were conducted with NPM CPCRI lure and PCI lure arranged in two different gardens against rhinoceros beetle. CPCRI lure has trapped 185 beetles/4 traps with an average of 46.25/trap and in PCI lure, 72 beetles/4 traps with an average of 18.0 beetles/trap during the experimental period. No catch was recorded in the control trap.

Studies were repeated with NPM CPCRI lure and PCI lure arranged in two different gardens in Mosallapalli and Vakalagauvu village against red palm weevil during October 2015. The highest number of weevils were trapped in CPCRI lures (325 weevils/4 traps) with an average of 81.25 weevils/trap. The PCI lures recorded a trap catch of 171 weevils/4 traps (42.75 weevils/trap) during the experimental period. One female weevil was noticed in control trap.

Studies were also conducted with PCI lure against black headed caterpillar in two different gardens in Bendamurlanka and Challapalli village in 3 ha area during February 2016 and the traps were installed in the garden at lower whorl of the palm. The adult moths collected and other pests trapped were recorded for every 15 days interval and data collected for two months revealed that the mean moths trapped in sticky traps with pheromone lures in Bendamurlanka and Challapalli villages were 16.67/ trap and 7.53/ trap. Simultaneously, the sticky traps (without pheromone lures) registered a trap catch of 6.0/trap and 7.6/trap in Bendamurlanka and Challapalli villages, respectively (Table 31).

BHC traps laid out at Ambajipeta

Table 31. Evaluation of PCI lures against black headed caterpillar in Andhra Pradesh (2015-16)

Month	Bendamurlanka (15 traps/ha)		Challapalli (10 traps/ha)	
	T_1 – PCI lure with sticky trap	T_2 – Sticky trap alone	T_1 – PCI lure with sticky trap	T_2 – Sticky trap alone
Total no. of moths trapped (Feb-March 2016)	100	36	45.2	45.6
Mean no. of moths/ trap	16.66 ± 7.95	6.00 ± 0.96	7.53 ± 1.15	7.6 ± 1.15
Lure installation date	12-2-2016	12-2-2016	29-2-2016	29-2-2016
Lure replacement	Nil	Nil	Nil	Nil

Values represent Mean ± Standard Error

Arsikere

An experiment was carried out at Habbhanghatta village in 30 acres farmers' field. As regards to rhinoceros beetle, NPM CPCRI lure trapped significantly higher number of rhinoceros beetles (53.2 beetles / trap) as compared to PCI lures (20.5 beetles / trap). No catch was recorded in the control trap (Table 32).

Studies on red palm weevil pheromone lures are being carried out with three lures *i.e.,* Central Plantation Crops Research Institute (NPM CPCRI-T_1), Pest Control India (PCI-T_2) and Blank trap at Bidarmmanagudi kaval (18 km away from HRES, Arsikere) in 30 acres farmers' field. As regards to red palm weevil, NPM CPCRI lure trapped significantly higher number of red palm weevils (43.3 beetles / trap) as compared to PCI lures (20.8 beetles / trap). No catch was recorded in the control trap. It was observed that NPM CPCRI lure registered higher trap catches than the PCI lure .

Studies on the black headed caterpillar pheromone catches have been initiated in a two acre garden (var: Tiptur tall) at Hulukatte village (Tumkur district) during March, 2015. The frond damage at the time of survey was 16.9 % (category: Low). Five traps each of sticky traps with PCI lures and without lures were installed in the garden. Lure catches were recorded at 15 days interval and the data at the end of one month revealed that 43 moths were trapped in the sticky traps (with pheromone lures) as against 18 in traps without lures (Table 32 and 33).

Table 32. Comparative efficacy of different lures against rhinoceros beetles in Karnataka (2015-16)

Month	Total no. of beetles trapped in 4 traps		
	T_1 – NPM CPCRI lure	T_2 – PCI lure	T_3 – Blank trap
April 15 To March 16	213	82	0
Mean nos./ trap	53.25 ± 2.12	20.50 ± 1.28	0.0 ± 0.0
Sex ratio (Female : Male)	1.53 : 1	1.81 : 1	-

Values represent Mean ± Standard Error
Chi square = 10.2; df 2; Kruskall-Wallis test (Sig <0.05)

Table 33. Evaluation of PCI lures against black headed caterpillar in Karnataka (2015-16)

Month	Total no. of moths trapped in 5 traps	
	T_1 – PCI lure with sticky trap	T_2 – Sticky trap alone
March –April 2015	43	18
Mean nos./ trap	8.60 ± 0.61	3.61 ± 1.22
Lure installation date	02.03.2016	02.03.2016
Lure replacement	Nil	Nil

Values represent Mean ± Standard Error

Ratnagiri

With regard to rhinoceros beetle, the NPM CPCRI lure trapped significantly higher number of rhinoceros beetles (98.8 beetles / trap) as compared PCI lures (63.0 beetles / trap). No catch was recorded in the control trap. It was observed that NPM CPCRI lure had more number of beetles trapped followed by PCI lure.

Ent. 14: Validation of integrated pest management technology for *Oryctes rhinoceros* in different regions

Arsikere

The IPM package including use of pheromones, *baculovirus*, naphthalene balls and *Metarhizium anisopliae* have applied on a large contiguous area of 10.00 ha. This trial was conducted in farmers' field at Doddenahally village of Arsikere Taluk, Hassan district in 9-10 years old coconut garden. Initial observations regarding incidence of rhinoceros beetle, leaf damage and spindle damage were recorded. The garden had 76.9 % incidence, 42.8 % leaf damage and 29.1 % spindle damage before the initiation of the experiment. The observations recorded after four months indicated that, incidence was reduced to 35.2 %, the leaf damage came down from 42.8 to 24.8 while the spindle damage reduced from 29.1 to 15.8 %. Another observation recorded after eight months indicated that the incidence was reduced up to 18.0 %, the leaf damage came down to 9.4 while the spindle damage reduced to 7.5 % (Table 34).

Table 34. Pre and post treatment infestation levels of rhinoceros beetles in the experimental garden in Karnataka (2015-16)

Total no. of palms	Pre- treatment (%) July-2015			Post-treatment (%) November-2015			Post-treatment (%) March-2016		
	Incidence (%)	Leaf damage (%)	Spindle damage (%)	Incidence (%)	Leaf damage (%)	Spindle damage (%)	Incidence (%)	Leaf damage (%)	Spindle damage (%)
1522	76.9	42.8	29.1	35.2	24.8	15.8	18.0	9.4	7.5
SEm±	2.94	1.86	3.17	3.38	3.69	1.58	1.31	2.23	0.77

Values represent Mean ± Standard Error

Ent. 16: Multi-location field evaluation of talc formulation of *Hirsutella thompsonii* (CPCRI isolate) against coconut eriophyid mite at AICRP palm centres

Aliyarnagar

Treatments:

T1: Spraying talc formulation of *H.thompsonii* @20g/ palm – 3 sprays during October/November, January/February and April/May

T2: Spraying *H.thompsonii*@20g/palm during October/November and January/February, followed by Botanical formulation (2% Neem oil – garlic – soap emulsion) during April/May

T3: Spraying Palm oil – sulphur emulsion – 3 sprays / year during October / November, January/ February and April/May

T4: Control

The population of eriophyid mite varied between 12.3 and 16.3/4 mm^2 before the treatment imposition. After imposing the treatments, the population of mites reduced from 15.3/ 4mm^2 to 12.7/ 4mm^2 after 3 months and recorded a population of 13.7/4 mm^2 after 7 months while the population was 19.7/4 mm^2 in control. No significant difference was observed in the mite population between different treatments. With regard to the nut damage by eriophyid mites, the pre-treatment nut damage ranged from 56.3 to 85.9 % prior to imposing the treatments. At four months after treatment (MAT), T1 recorded a nut damage of 54.2 % as against 80.7 % in the control. At 7 MAT also, the reduction was less pronounced with T1 recording 54.0 % nut damage as against 76.2 % in the control. With respect to the mean grade index, MGI of 0.89 was recorded in T1 before imposing the treatments as against 1.54 in

the control. There was a significant reduction in all the treatments at four MAT with T1 registering MGI of 0.64, followed by T2 (0.93) and T3 (0.97) which were on par with each other as against MGI of 1.35 in the control. Similar trend was noticed at 7 MAT also, with T1 registering MGI of 0.62 as against MGI of 1.23 in control (Table 35).

Table 35. Grade index of harvested nuts, mite intensity and mite population per 4 mm^2 in experimental garden (2015-16)

Tr. No.	Pre treatment observation (Aug 2015)			Post treatment observation (4 months after spraying) (Dec 2015)			Post treatment observation (7 months after spraying) (Mar 2016)		
	Damaged nuts (%)#	MGI **	mite / 4mm^2 **	Damaged nuts (%)#	MGI **	mite / 4mm^2 **	Damaged nuts (%)#	MGI **	mite / 4mm^2 **
T1	56.3^a (48.6)	0.89^a (1.18)	15.3 (3.98)	54.2^a (47.4)	0.64^a (1.07)	12.7 (3.63)	54.0^a (47.3)	0.62^a (1.06)	13.7 (3.76)
T2	74.0^b (59.3)	1.03^a (1.24)	16.3 (4.10)	69.4^b (56.4)	0.93^b (1.20)	14.3 (3.85)	65.4^b (54.0)	0.91^b (1.19)	14.7 (3.89)
T3	76.0^b (60.6)	1.06^a (1.25)	12.3 (3.58)	70.9^b (57.3)	0.97^b (1.21)	14.3 (3.85)	69.9^b (56.7)	1.06^c (1.25)	13.3 (3.72)
T4	85.9^b (67.9)	1.54^b (1.43)	16.0 (4.06)	80.7^c (64.0)	1.35^c (1.36)	18.7 (4.38)	76.2^c (60.8)	1.23^d (1.32)	19.7 (4.49)
Significance	**	**	NS	**	**	NS	**	**	NS
SEd	3.76	0.06		0.93	0.04		1.22	0.02	
CD (P=0.05)	9.20	0.15		2.27	0.11		2.99	0.04	
CV (%)	7.77	6.91		2.02	5.42		2.73	2.01	

Figures in parenthesis are arcsine transformed values
** Figures in parenthesis are square root transformed values
Values followed by a common letter are not significantly different by LSD (P=0.05)

Ambajipeta

The experiment was initiated during February 2012 with four treatments with 20 palms in each treatment (total 80 palms for the experiment) at HRS, Ambajipeta farm. In the nuts harvested during February 2015, the grade index was moderate in T1 and T2 treatments and high in T3 and control palms. In the entire nuts harvested during 2015-16, the mite intensity was high in all the treatments along with control palms (Table 31). The pre-treatment mite population ranged from 1.22 to 3.92/1mm^2 in February 2015 and decreased in all the treatments by May 2015 which ranged from 0.53 to 1.14/1mm^2 and then increased in all the treatments by November 2015 (2.77 to 5.58 /1mm^2). An increase in the predator count per nut was observed from February 2015 to November 2015 (Table 36).

Arsikere

The pre-treatment observations were recorded before imposing the treatments. Post treatment observations were recorded at three and six month's intervals. Simultaneous observations were also made in the control plot. Before application of treatments, it was observed that the population of eriophyid mite ranged between 17.57 to 18.34 / 4mm^2. After three months of spraying, all the treatments showed significant reduction in mite population (14.37 to 15.11 / 4mm^2) when compared to control (19.87 / 4 mm^2). The extent of nut damage in different treatments ranged from 69.31 to 70.92 % with a mean grade index of 1.65 to 1.88 before the initiation of the experiment. After three months of spraying, the treatment T_1 registered the least damaged nuts (65.43 %) and mean grade index (1.24). Subsequently, after six months also,

Table 36. Grade index of harvested nuts and mite incidence at HRS, Ambajipeta

Tr. No.	Pre-treatment harvested nut scale for Feb 2015 harvested nuts	Grade index for May 2015 harvested nuts	Percent incidence of mite during 1st spray (May 2015)	Grade index for Oct 2015 harvested nuts	Percent incidence of mite during 2nd spray (October 2015)	Grade index for March 2016 harvested nuts	Percent incidence of mite during 3rd spray (March 2016)
T1	1.36 (1.53)* (moderate)	2.39 (1.84)* (High)	95.31 (82.23)**	2.64 (1.89) (High)	86.16 (74.00)**	2.44 (1.64) (High)	94.17 (79.87)**
T2	1.89 (1.70) (moderate)	2.29 (1.81) (High)	94.99 (81.18)	2.28 (1.79) (High)	98.57 (88.08)	2.48 (1.65) (High)	99.51 (88.21)
T3	2.60 (1.89) (High)	2.12 (1.75) (High)	92.86 (77.72)	2.79 (1.94) (High)	98.61 (87.38)	2.41 (1.64) (High)	95.18 (81.16)
T4	2.48 (1.85) (High)	2.43 (1.84) (High)	97.61 (85.25)	2.81 (1.94) (High)	98.60 (87.78)	2.12 (1.63) (High)	99.58 (88.64)
SEm±	0.07	0.04	2.14	0.05	2.12	0.01	1.70
CD (P=0.05)	0.22	NS	NS	NS	5.89	NS	4.73

*Figures in parenthesis are square root transformed values
** Figures in parenthesis are arcsin transformed values

the treatment T_1 recorded the least damaged nuts (58.94 %) and mean grade index (0.73).

Ratnagiri

The experiment was initiated during 2012 with four treatments with 20 palms in each treatment. During 2015-16, the treatment T_3 recorded significantly the lowest mite infestation of 41.32 % after 12 months period from the initial level of 54.70 % (Table 37). There was reduction in Mean Damage Grade Index also in treatments T_2 and T_3. Both the treatments recorded Mild MDGI and was followed by treatment T_1 which recorded Moderate MDGI, whereas, in control a high MDGI was recorded .

The pre- treatment mite population which ranged from 2.39 to 2.54 /1mm^2 in February 2013 decreased to 1.19 to 1.22 /1mm^2 in March 2016 except in the control, where an increase in population was noticed. However, no predator population was observed in December 2015 as compared to the other months .

Table 37. Per cent mite infestation in the harvested nuts from Feb 2015 to March 2016 (Ratnagiri)

Treatment	% nut damage (Feb 2015)	% nut damage (4MAT)	% nut damage (8MAT)	% nut damage (12MAT)
T1	55.64 (48.25)	50.76 (45.43)	49.01 (44.43)	47.88 (43.79)
T2	50.89 (45.51)	47.14 (43.36)	46.87 (43.20)	45.67 (42.51)
T3	54.70 (47.71)	46.51 (43.00)	43.94 (41.52)	41.32 (40.00)
T4	56.89 (48.97)	58.90 (50.13)	58.09 (49.66)	58.02 (49.62)
SEm±	0.97	0.51	0.34	0.30
CD(P=0.05)	N.S.	1.52	1.03	0.91

MAT – Months after treatment
Values in parenthesis are arcsine transformed values

Ent. 17: Evaluation of newer insecticides against red palm weevil, *Rhynchophorus ferrugineus*

Aliyarnagar

The treatments were imposed in different locations *viz.,* Pongaliyur, Aliyarnagar and Avinashipalayam. Imidacloprid treatment was imposed in a garden with Chowghat Orange Dwarf at Pongaliyur and a recovery of 75% was noticed. At Coconut Research Station, Aliyarnagar, four palms (var: Arasampatti Tall) were noticed with crown damage and two recovered upon treating with Indoxacarb. The two palms which failed to recover were in the advanced stage of damage by red palm weevil. Trunk application (through the affected bore hole) with chlorantraniliprole registered a recovery of 100.0%, while trunk application of carbosulfan exhibited a recovery of 60.0%. The trunks that were hollowed out by red palm weevil grubs to an extent of more that 50 per cent failed to recover even after repeated treatments. Further, in all the affected gardens, insecticide control measures alone were not incorporated. Insecticides were used only as one of the components while field sanitation, placement of lures (for a period of two months), treating the collar region with insecticides, etc. were also followed for overcoming the red palm weevil incidence.

Ambajipeta

Experiment was initiated during August 2015 in one ha area of coconut garden intercropped with banana in Vyagreswaram village. Total number of palms in the garden were 210 and the red palm weevil infested palms were five initially. The treatments were imposed on these palms infested palms at monthly intervals based on necessity. Among the treatments, chlorantrailiprole and carbosulfan treatmented palms were having comparatively severe incidence. The imidaclorpid and indoxacarb treated palms recovered within three months (in November 2015), whereas, chlorantrailiprole and carbosulfan treated palms are under recovery, whereas, the control palm has died within six months after observation. Five more infested palms were observed in the same garden and the infestation was observed in the crown region. All treatments were again imposed on the freshly infested palms.

One more replicated trial was initiated in red palm weevil infested garden on fish ponds in Thummalapalli village during January 2016. The total palms in the garden were 50. The infested palms were 15. All the palms recovered from red palm weevil damage except carbosulfan treated palms and control palms.

Arsikere

An experiment was carried out at Bidarammanagudi kaval (25 km away from HRES, Arsikere) in farmers' field. Treatments were Imidacloprid 17.8 SL : (0.5 ml + 500 ml of water), Indoxacarb 14.5 SC (2.0 ml + 500 ml of water), Chlorantraniliprole 18.5 SC (2.0 ml + 500 ml of water), Carbosulfan 25 EC (2.5 ml + 500 ml of water) and an untreated control. The insecticidal treatments were imposed on the affected palms once in a month through crown region as well as through the bored hole (made by the weevil on trunk portion). Post- treatment observations were recorded at three and six month's intervals. Simultaneous observations were also made in control plot.

The garden had 44 palms with infestation by red palm weevil. Upon imposing the different treatments, the palms have recovered up to 91.67% by the application of chlorantraniliprole followed by the application of indoxacarb (81.25%), imidacloprid (57.14%) and carbosulfan (44.44%) .

Ratnagiri

An experiment was carried out at three different locations *viz.,* Basani, Nirul and Bhatye in farmers' field. It was observed that all the treatments except carbosulfan trunk application resulted in 100 % recovery of the affected palms while carbosulfan registered 50 % recovery .

V. EXPERIMENTAL RESULTS IN OIL PALM

5.1 Crop Improvement

Gen. 8: Studies on the comparative performance of different hybrid combinations of Oil Palm

Pattukkottai

Ten hybrids were planted during 2006 at Peraiyur, Mannargudi taluk, Thiruvarur District. The soil of the experimental field is red sandy loam. Randomized Block Design was adopted with three replications and six palms per treatment.

Ten hybrid combinations:

1	NRCOP 11 (49 D x 66 D)
2	NRCOP 12 (25 D x 214 D)
3	NRCOP 13 (25 D x 66 D)
4	NRCOP 14 (68 D x 36 D)
5	NRCOP 15 (21 D x 214 D)
6	NRCOP 16 (131 D x 66 D)
7	NRCOP 17 (350 D x 66 D)
8	NRCOP 18 (107 D x 214 D)
9	NRCOP 19 (61 D x 66 D)
10	NRCOP 20 (28 D x 68 D)

Among the hybrids evaluated for growth and yield parameters, the hybrid NRCOP 16 recorded the lowest palm height of (3.63 m). NRCOP 15 registered the highest palm girth (2.72 m) and NRCOP 17 recorded significantly more number of female inflorescence (13.80). The highest FFB yield (163.3 kg/palm and 23.4 t/ha) was registered in the hybrid NRCOP 17 during the period from April 2015 to March 2016.

Gen. 8B: Development and evaluation of D x D & D x P crosses by utilising drought tolerant African dura types

Centres: Gangavathi and Mulde

Gen. 8B [I]: Development of Dura x Dura crosses

Gangavathi

Based on ten years data on evaluation of oil palm genotypes for drought tolerance five genotypes *viz.*, ZS-3-R-3-3, ZS-1-R-3-2, ZS-6-R-2-2, ZS-3-R-2-6 and TS-5-R-3-3 were selected as mother palms

Table 39. Growth performance of oil palm hybrids (2015-16)

Hybrids	Palm height (m)	Palm girth (m)	Annual leaf production	Sex ratio	FFB yield (kg/ palm)	FFB yield (t/ha)
NRCOP 11	3.5	2.5	25.3	66.8	124.4	17.7
NRCOP 12	3.8	2.5	23.0	69.5	96.9	13.8
NRCOP 13	4.3	2.4	25.8	64.1	94.3	13.5
NRCOP 14	4.5	2.7	26.0	68.9	128.1	18.3
NRCOP 15	3.6	2.7	25.3	65.5	99.8	14.3
NRCOP 16	3.6	2.3	23.8	67.6	104.4	14.9
NRCOP 17	3.9	2.5	24.7	72.6	163.3	23.4
NRCOP 18	3.8	2.5	23.9	64.7	126.6	18.1
NRCOP 19	3.8	2.6	23.6	68.3	101.1	14.5
NRCOP 20	4.3	2.7	24.6	67.1	159.8	22.4
SEm±	0.08	0.09	0.50	-	2.12	-
CD (P=0.05)	0.21	0.21	1.22	-	4.36	-

for crossing programme in order to develop and evaluation of new crosses.

The pollen grains collected from above mentioned genotypes was stored by reducing its moisture to 4% in desiccators at an ambient temperature. A total of 12 D x D crosses were made and seeds separated from the bunch and sent to ICAR-IIOPR, Pedavegi for further process.

Mulde

The genotypes *viz.*, 1. (ZS-2-R-3-3) V5, 2.(ZS-8-R-2-5) V11, 3. (TS-2-R-2-2) V10, 4. (TS-11-R-2-3)V18, 5. (TS-11-R-2-6) V18 were selected as mother palms for crossing programme for further development and evaluation of new crosses. A total of five D x D crosses were made and seeds separated from the bunch, submitted to ICAR-IIOPR, Pedavegi for further process.

Gen. 8B [II]: Development of Dura x Pisifera crosses

Gangavathi

The pollen grains were collected from ICAR-IIOPR, Pedavegi and stored by reducing its moisture to 4% in desiccators at an ambient temperature. A total of 10, D x P crosses were made and seeds separated from the bunch and sent to ICAR-IIOPR, Pedavegi for further process.

Mulde

The pollen grains were collected from ICAR-IIOPR, Pedavegi. A total of nine D x P crosses were made and seeds separated from the bunch and sent to ICAR-IIOPR, Pedavegi for further process.

Gen. 8C: Evaluation of new cross combinations in oil palm

Gangavathi, Madhopur, mulde, Pasighat, Pattukkottai and Vijayarai

Gangavathi

Ten new oil palm hybrids developed from ICAR-IIOPR, Regional Station, Palode were planted during 2007 by adopting RBD with three replications and six palms per treatment. Soil of the experimental field is black clay.

During 2015-16, the palm height was significantly lower with the hybrids NRCOP-10 (2.1 m) compared to NRCOP-1 (2.9 m), NRCOP-4 (2.7 m) and it was on par with other hybrid combinations (Table 40). The palm girth was significantly higher with the hybrid NRCOP-2 (2.3 m) and the lowest palm girth was recorded with NRCOP-1, 8 and 9 (2.3 m). The significantly higher annual rate of leaf production was recorded with NRCOP-4 (18.4) compared to NRCOP-6 (17.0) and NRCOP-10 (17.1) and it was on par with other hybrid combinations. Significantly higher number of female inflorescence was recorded with the hybrid NRCOP-1 (10.1) over NRCOP-3 (7.4) and NRCOP-7 (7.6). The other hybrids were on par with NRCOP-1. The sex ratio was higher with the hybrid NRCOP-1 (69.1), whereas the lowest sex ratio was recorded with NRCOP-6 (53.1).

The highest number of bunches per palm was recorded with hybrid NRCOP-4 (7.0) and it was significantly superior over all other hybrids. The hybrid NRCOP-1 (19.9 kg) recorded significantly higher mean bunch weight over NRCOP-9 (13.8 kg) and NRCOP-3 (14.8 kg) but it was on par with the remaining hybrids. The hybrid NRCOP-4 (112.3 kg) recorded significantly superior FFB yield over all other hybrid combinations except NRCOP-6 (102.7 kg) and NRCOP-8 (101.4 kg). The hybrid NRCOP- 4 (16.1 t/ha) recorded the significantly higher FFB yield over all other hybrids except NRCOP-6 (14.7 t/ha), NRCOP-8 (14.5 t/ha) and NRCOP-10 (14.1 t/ha).

Hybrid cross combinations:

1	NRCOP-1 (78D x 435P)
2	NRCOP-2 (90D x 577P)
3	NRCOP-3 (158D x 116D)
4	NRCOP-4 (131D x 435P)
5	NRCOP-5 (5D x 577P)
6	NRCOP-6 (173D x 435P)
7	NRCOP-7 (183D x 577P)
8	NRCOP-8 (70 D x 577P)
9	NRCOP-9 (28D x 435P)
10	NRCOP-10 (345D x 577P)

Table 40. Vegetative growth parameters, FFB yield and yield attributes of different oil palm hybrids (Gangavathi, 2015-16)

Hybrids	Palm height (m)	Palm girth (m)	Annual leaf production	No.of female Inflorescences	Sex ratio	Number of bunches	Mean bunch weight (kg)	FFB yield (t/ha)
NRCOP-1	2.9	2.3	17.9	10.1	69.1	4.6	19.9	11.8
NRCOP-2	2.3	2.7	18.1	9.7	63.0	4.5	19.7	11.9
NRCOP-3	2.2	2.4	17.8	7.4	58.2	5.4	14.8	11.6
NRCOP-4	2.7	2.4	18.4	9.9	64.4	7.0	18.5	16.1
NRCOP-5	2.4	2.7	18.0	8.7	66.4	5.4	16.5	13.1
NRCOP-6	2.1	2.3	17.0	8.4	53.1	5.8	18.8	14.7
NRCOP-7	2.2	2.4	17.5	7.6	59.6	4.6	18.4	9.6
NRCOP-8	2.5	2.3	17.0	8.6	68.3	6.4	17.6	14.5
NRCOP-9	2.3	2.3	17.5	9.3	69.0	6.4	13.8	13.6
NRCOP-10	2.1	2.5	17.1	8.5	61.9	6.1	16.2	14.1
SEm±	0.188	0.088	0.42	0.71	3.07	0.43	1.13	0.8
CD(P=0.05)	0.566	0.26	1.25	2.1	9.05	1.28	3.34	2.37
CV%	13.74	6.33	4.17	14.07	8.54	13.44	11.3	10.64

Mulde

Oil palm seedlings were planted during September 2007 in RBD design with three replications and nine plants per treatment.

The ten cross combinations of oil palm did not show significant variation for palm height and palm girth, however, the average annual leaf production was significant and production of average number of leaves was in the range of 23.7 to 28.1. The highest number of leaves (28.1) was recorded in NRCOP-7. Various cross combinations of oil palm did not show significant variation for production of female, male, total inflorescences and sex ratio. The maximum female flowers (8.0) and the least male flowers (5.1) were recorded in NRCOP-2, whereas, NRCOP-7 recorded the least (5.2) number of female flowers. Sex ratio was the highest (61.1%) in genotype NRCOP-2 due to more female flowers and lowering maleness, whereas, the sex ratio was the lowest (40.7%) in NRCOP-10. The different hybrids did not show significant variation for yield attributing characters (Table 41).

Bunch yield of NRCOP-2 (Mulde)

Bunch yield of NRCOP-4 (Gangavathi)

Bunch yield of NRCOP-6 (Gangavathi)

Table 41. Vegetative growth parameters and FFB yield & Yield attributes of different oil palm hybrids (Mulde, 2015-16)

Hybrids	Palm height (m)	Palm girth (m)	Annual leaf production	Female Inflorescence	Sex ratio	Number of bunches	Mean bunch weight (kg)	FFB yield (kg/palm)	FFB yield (t/ha)
NRCOP-1	2.8	2.8	27.0	5.4	42.1	5.1	13.1	67.5	9.7
NRCOP-2	3.0	2.7	25.5	8.0	61.1	6.5	13.8	89.7	12.8
NRCOP-3	2.7	2.6	27.0	5.7	44.6	4.8	10.7	51.5	7.4
NRCOP-4	2.4	2.4	24.2	5.8	46.4	5.3	11.9	62.4	8.9
NRCOP-5	2.4	2.7	25.2	6.2	52.0	5.3	11.4	61.7	8.8
NRCOP-6	2.7	2.6	26.7	6.3	48.9	5.6	11.4	63.9	9.1
NRCOP-7	2.6	2.7	28.1	5.2	43.7	4.7	12.3	58.3	8.3
NRCOP-8	2.8	2.4	23.7	5.6	45.9	5.2	13.0	67.4	9.6
NRCOP-9	3.1	2.8	25.5	5.9	45.9	5.4	12.4	66.3	9.5
NRCOP-10	2.5	2.5	23.9	5.5	40.7	5.4	11.6	59.4	8.5
SEm±	0.3	0.15	0.8	0.7	0.9	0.7	10.1	1.5	0.9
CD (P=0.05)	N.S.	N.S.	2.5	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Pasighat

The growth of the plants with respect to palm girth, number of male flowers, and number of leaves produced per palm among the cross combinations did not differ significantly (Table 42). The number of female flowers per palm recorded was maximum in NRCOP-22 (10.7) which was statically at par with NRCOP-23, NRCOP-21, NRCOP-26, NRCOP-24 and NRCOP-25. The average maximum bunch weight recorded was (8.6 kg) in NRCOP-21. The maximum yield was recorded in NRCOP-23 (74.4/ palm and 10.6 t/ha) and the minimum yield was observed in NRCOP-30 (34.2 kg/palm and 4.9 t/ha).

Table 42. Growth & inflorescence production of Oil palm hybrids (Pasighat, 2015-16)

Hybrids	Palm height (m)	Palm girth (m)	Annual leaf production	Female Inflorescences	Number of bunches	Mean bunch weight (kg)	FFB yield (kg/palm)	FFB yield (t/ha)
NRCOP-21	0.55	2.3	21.0	9.3	6.7	8.6	57.6	8.2
NRCOP-22	0.57	2.2	20.6	10.7	9.1	7.9	72.3	10.3
NRCOP-23	0.56	2.3	20.5	9.7	8.5	8.7	74.4	10.6
NRCOP-24	0.56	2.2	20.7	8.8	7.9	7.8	62.1	8.9
NRCOP-25	0.46	2.2	21.0	8.1	7.1	7.6	53.5	7.7
NRCOP-26	0.59	2.2	20.2	8.9	7.2	8.4	60.4	8.6
NRCOP-27	0.55	2.2	20.4	6.8	7.7	5.7	43.6	6.2
NRCOP-28	0.54	2.3	20.4	7.0	7.6	7.4	54.4	7.9
NRCOP-29	0.53	2.3	20.6	7.0	8.7	6.4	55.6	7.9
NRCOP-30	0.42	2.2	20.7	6.0	6.2	5.5	34.2	4.9
CD (P=0.05)	NS	NS	NS	2.71	0.67	0.86	9.50	1.36
CV (%)	5.68	4.45	1.78	19.13	5.09	6.80	9.74	9.74

Pattukkottai

Ten new oil palm hybrids developed from ICAR - IIOPR, Regional Station, Palode were planted during Sept. 2007 by adopting RBD with three replications and six palms per treatment. Soil of the experimental field is red sandy loam.

During 2015-16, the lowest palm height (2.7 m) was recorded in the hybrid NRCOP 10, whereas, the highest palm girth (2.7 m) was recorded in the hybrid NRCOP 2. The maximum number of leaves produced (25.9) and number of female inflorescence (13.7) was recorded in the hybrid NRCOP 5. The hybrid NRCOP 3 recorded significantly the highest number of male inflorescence (7.2). The highest FFB productivity (90.8 kg/palm) and FFB yield (12.9 t/ha) was recorded in the hybrid NRCOP 9 during the period April 2015 to March 2016 (Table 43).

Table 43. Growth and yield performance of oil palm hybrids (Pattukkottai, 2015-16)

Hybrids	Palm height (m)	Palm girth (m)	Annual leaf production	No. of male inflorescences	No. of female inflorescences	Total no. of inflorescences	Sex ratio	FFB yield (kg/palm)	FFB yield (t/ha)
NRCOP 1	3.2	2.4	24.5	7.0	13.2	20.2	65.4	62.1	8.8
NRCOP 2	3.3	2.7	25.1	6.9	11.3	18.1	62.0	65.2	9.3
NRCOP 3	3.2	2.4	23.2	7.2	12.9	20.1	64.3	52.1	7.4
NRCOP 4	3.4	2.7	25.3	6.8	12.2	19.1	64.0	69.3	9.9
NRCOP 5	3.2	2.5	25.9	6.6	13.7	20.2	67.5	80.7	11.5
NRCOP 6	3.1	2.5	24.0	6.7	12.8	19.8	64.8	55.6	7.9
NRCOP 7	3.0	2.7	25.2	6.7	12.1	18.8	64.4	74.5	10.7
NRCOP 8	3.1	2.4	24.1	6.9	11.6	18.7	62.8	58.7	8.4
NRCOP 9	2.9	2.4	25.2	6.5	13.6	20.2	67.7	90.8	12.9
NRCOP 10	2.7	2.5	24.1	6.7	11.6	18.3	63.4	45.9	6.5
S. Em ±	0.08	0.15	0.52	0.26	0.46	0.65	-	1.98	-
CD(P=0.05)	0.18	0.31	1.10	0.52	0.90	1.39	-	3.12	-

NRCOP 7

NRCOP 9

Vijayarai

Hybrids were planted during Sept. 2007 by adopting RBD with three replications and six palms per treatment. Palm height and annual leaf production per palm and sex ratio were not significantly influenced by various cross combinations. Among the crosses, NRCOP-5 recorded significantly higher palm girth (2.9), which was on par with NRCOP-1, NRCOP-4 and NRCOP-7 (Table 44).

Bunch yield of NRCOP -04 (Vijayarai)

Table 44. Performance of different hybrids of Oil Palm (Vijayarai, 2015-16)

Hybrids	Palm height (m)	Annual leaf production	Palm girth (m)	Sex ratio (%)	No. of bunches/ palm	FFB yield (kg/palm)	Bunch weight (kg/ palm/year)	FFB yield (t/ha)
NRCOP-1	7.8	26.4	2.8	56.3	10.4	105.4	10.1	15.0
NRCOP-2	6.8	24.5	2.6	54.2	9.8	106.9	10.9	15.3
NRCOP-3	7.3	26.9	2.8	54.5	10.7	112.7	10.6	16.1
NRCOP-4	7.8	25.3	2.8	73.8	12.6	174.0	13.9	24.9
NRCOP-5	7.6	26.4	2.9	45.9	11.1	138.9	12.4	19.7
NRCOP-6	7.0	26.2	2.7	54.9	10.9	124.7	11.3	17.8
NRCOP-7	7.7	25.2	2.9	64.6	10.6	121.7	11.5	17.4
NRCOP-8	7.6	26.2	2.8	48.9	10.8	120.6	11.2	17.3
NRCOP-9	7.2	25.9	2.7	59.9	10.9	131.5	12.1	18.8
NRCOP-10	7.1	26.7	2.7	65.7	10.5	110.8	10.6	15.8
SEm±	0.45	0.783	0.10	-	1.005	14.56	0.99	2.08
CD(P=0.05)	NS	NS	NS	-	NS	30.59	NS	4.37
CV (%)	7.48	3.69	4.74	-	11.36	14.30	10.67	14.57

Yield parameters differed significantly among different hybrids except number of bunches per palm. NRCOP-4 recorded significantly higher bunch weight per palm (13.9 kg), which was on par with NRCOP-8 (11.2 kg). The highest FFB yield was recorded in NRCOP-4 (174.0 kg/palm/year), which works out to be 24.9 t/ha followed by NRCOP-5 (19.7 t/ha).

Gen.8D: Progeny evaluation trial in oil palm

Gangavathi, Madhopur, mulde, Pasighat, Pattukkottai and Vijayarai.

Gangavathi

Cross combinations:

Sl. No.	Cross Combination
1	NRCOP-31 (257 CD x14 P)
2	NRCOP-32 (254 CDx17 P)
3	NRCOP-33(198 CDx129 P)
4	NRCOP-34(124 CDx14 P)
5	NRCOP-35(124 CDx17 P)
6	NRCOP-36 (99 CDx14 P)
7	NRCOP-37(66 CDx17 P)
8	NRCOP-38(66 CDx14 P)
9	NRCOP-39(42 CDx14 P)
10	NRCOP-40(92 CDx129 P)

Year of planting: 2012

During 2015-16, the palm height was significantly superior with the hybrid NRCOP-32 (96.3 cm) over all other hybrids except NRCOP-37 and NRCOP-38 (84.8 and 81.3 cm, respectively). Palm girth did not differ significantly among the different hybrids. The hybrid NRCOP-38 (14.6) recorded significantly higher annual leaf production per palm over NRCOP-33 and NRCOP-40, each recording 13.2.

General field view of Gen 8D (Gangavathi)

Mulde

Planting was done in the experimental field during October, 2011 by adopting RBD with three replications and six palms per treatment/plot.

The ten new cross combinations of oil palm did not show significant variation for average height and it ranged between 0.9 to 1.0 m. However, production of number of leaves, female, male and sex ratio significantly differed among the different genotypes. NRCOP-33 produced the highest number of leaves (30.5) per year. Sex ratio was maximum (82.3 %) in genotype NRCOP- 38 due to lowering the production of male inflorescences. NRCOP-31 produced maximum female (7.3) and male inflorescences (3.8) during the year 2015-16.

Pasighat

Layout and planting of this trial was done in August 2012. The growth of the plants with respect to plant height and number of leaves produced in the main field over a period of one year was found to be statistically at par in all the cross combinations. The collar girth recorded was maximum in NRCOP-32 (128.8 cm) which was statistically at par with other cross combinations *viz.,* NRCOP-34, NRCOP-36 and NRCOP-31. The collar girth of NRCOP-32 was significantly higher than NRCOP-40, NRCOP-33, NRCOP-39, NRCOP-37, NRCOP-35 and NRCOP-38. The minimum collar girth (104.2 cm) was recorded in NRCOP-38.

Pattukkottai

Nine hybrids *viz.*, NRCOP 31, 32, 33, 34, 35, 36, 37, 38 and 39 were planted on 26.02.2013 in ARS, Pattukkottai. Among the hybrids received, only five hybrids (NRCOP 31, 32, 33, 38 and 39) have sufficient seedlings for the replicated trial. Other four hybrids *viz.,* NRCOP 34, 35, 36 and 37 were planted as non-replicated trial for observation. The seedlings have established well.

Biometric observations on palm height (cm), palm girth (cm), total number of leaves were recorded in five hybrids. The highest palm height (3.14 m), palm girth (1.54 m) and leaf length (3.10 m) was recorded in the hybrid NRCOP 32.

Field view of Gen 8 D trial (Pattukkottai)

Vijayarai

A perusal of the data revealed that, among various hybrids, significantly the highest palm height of 6.03 m was recorded in NRCOP-32. No significant differences were observed for number of leaves per palm and palm girth.

Growth parameters like palm height, palm girth, and number of leaf production per palm per year did not vary among the crosses. The number of bunches per palm was the highest in NRCOP-37(11.7) followed by NRCOP-32 (11.6). The average bunch weight was significantly the highest in NRCOP-33 (10.2 kg) followed by NRCOP-35, 32 and 40. The fresh fruit bunch yield was the highest in NRCOP-32 (13.3 t/ha) followed by NRCOP-35 (12.7 t/ha) (Table 45).

Gen. 8 D: Set II: Evaluation of new cross combinations in Oil Palm

Vijayarai

Eleven hybrid combinations *viz.*, NRCOP 41 to 52 were planted during 2013 with RCBD. During the year, palm height ranged from 3.18 m to 3.93 m and the annual leaf production from 20.4 to 22.3 among the different hybrids.

Table 45. Performance of different cross combinations on FFB yield and yield attributes of Oil Palm (Vijayarai, 2015-16)

Hybrids	No. of bunches/ palm	Average bunch weight (kg)	FFB yield (kg/ palm)	FFB yield (t/ha)
NRCOP -31	9.26	6.3	56.5	8.1
NRCOP - 32	11.6	8.1	93.2	13.4
NRCOP - 33	5.4	10.2	52.9	7.6
NRCOP - 34	10.5	7.2	78.2	11.2
NRCOP - 35	10.6	8.4	88.8	12.7
NRCOP - 36	9.7	5.9	58.3	8.3
NRCOP - 37	11.7	7.1	83.3	11.9
NRCOP- 38	8.3	6.6	54.9	7.7
NRCOP - 39	8.8	6.4	54.2	7.8
NRCOP - 40	9.3A	7.8	70.8	10.1
SEm±	1.61	0.6	11.8	1.7
CD (P=0.05)	3.39	1.31	24.7	3.53
CV (%)	20.80	10.3	20.83	20.83

5.2 Crop Production

Agron. 13: Demonstration on oil palm production potential in North East Region

Pasighat

The 29 oil palm seedlings planted during 2006 is utilized for the maximization plot and all the recommended crop management practices are being adopted to harvest maximum yield. The average plant height, collar girth and number of leaves recorded during March 2016 were 146.38 cm, 248.97 cm and 21.45 leaves per palm, respectively. Flowering and fruiting in all the palms have been observed. Pollinating weevil brought during January-2013 from IIOPR, Pedavegi was released in the plantation and subsequent to it, the fruit setting was improved. The number of FFB produced per plant was 9.5 with an average bunch weight of 16.8 kg and the yield recorded was 22.8 t/ha.

Agron. 15: Intercropping in young oil palm garden

Gangavathi

Objectives

1. To identify the suitable intercrops in juvenile oil palm garden
2. To supplement farmers income during pre bearing period under TBP area

Treatment details

Inter crops

T_1: Brinjal
T_2: Tomato
T_3: Bhendi /Okra
T_4: Chilli
T_5: Onion
T_6: Cluster bean
T_7: Beans

During 2015-16, growing okra as intercrop recorded significantly higher fruit yield (2.85 t/ha) over all other vegetable treatments as intercrops in juvenile oil palm garden except growing tomato as intercrop. The yield attributes were also significantly higher in the treatment with okra as intercrop when compared to other treatments. The gross returns received from okra as intercrop was Rs. 56,979 per ha when compared to all the other intercrops.

Pooled data of three years (2013-16) indicated that growing okra as intercrop recorded significantly higher fruit yield (3.5 t/ha) over all the other vegetable intercrops in juvenile oil palm garden. The gross and net returns received when okra was grown as inter

Table 46. yield and Economics of the vegetables intercropping with oil palm - pooled data of three years (2013, 2014 & 2015)

Treatments	Fruit yield (t/ha)				Cost of cultivation (Rs./ha)	Gross return (Rs./ha)	Net return (Rs./ha)	Output input ratio
	2013	2014	2015	Pooled mean				
T_1	2.01	1.47	1.53	1.67	16,541.00	33,389.30	16,848.30	2.02
T_2	3	2.41	2.75	2.72	14,216.00	27,233.30	13,017.30	1.92
T_3	2.47	5.18	2.85	3.50	19,561.00	70,026.63	50,465.63	3.58
T_4	2.2	1.85	1.46	1.84	18,281.00	36,759.97	18,478.97	2.01
T_5	0.3	0.22	0.22	0.25	14,651.00	3,745.00	-10,906.00	0.26
T_6	1.4	0.85	0.76	1.00	16,251.00	25,115.83	8,864.83	1.55
T_7	1.3	0.75	0.79	0.95	15,610.00	28,440.40	12,830.40	1.82
SEm±	0.15	0.17	0.158	0.14		2044	432	0.23
CD (P=0.05)	0.45	0.53	0.51	0.48		6116	1326	0.72
CV%	14.9	11.2	11.88	10.96		10.42	4.82	17.12

T_1: Brinjal + Oil Palm, T_2: Tomato + Oil Palm, T_3: Okra + Oil Palm
T_4: Chilli + Oil Palm, T_5: Onion + Oil Palm, T_6: Cluster bean + Oil Palm T_7: French beans + Oil Palm

crop in oil palm was high (Rs. 70,026 and Rs. 50,465 per ha, respectively) when compared to all other intercrops evaluated (Table 46).

Mulde

Agron.15: Intercropping in young oil palm garden

Objective: Demonstration of intercrops in juvenile garden

Under Mulde condition, banana, elephant foot yam and pineapple could provide additional return to the tune of Rs. 81,820/- per ha. of oil palm garden.

General view of Bhendi as intercrop in oil palm (Gangavathi)

General view of the intercropping in oil palm (Mulde)

VI. EXPERIMENTAL RESULTS IN ARECANUT

6.1 Crop Improvement

Gen. 4: Establishment of mother blocks and production of quality planting material in Arecanut

Activity I: Evaluation of released arecanut varieties in different agro-climatic regions

Shivamogga

Six arecanut varieties *viz*. Mangala, Sumangala, Sreemangala, Mohitnagar, Swarnamangala and Madhuramangala were received from CPCRI, Vitla and planted in the month of August 2015. Variety Sreewardhini was received from Maharashtra and planted in the month of November 2015. Six palms of each variety were planted with three replications following RBD at AHRS, Honnavile.

Activity II: Establishment of nucleus seed garden of arecanut

Centres: Goa, Port Blair, Wakawali and Shivamogga

Varieties:

1 **Goa:** Hirehalli Dwarf

2. **Port Blair:** Andaman Dwarf and Samrudhi

3. **Wakawali:** Shriwardhan and Hirehalli Dwarf

4. **Shivamogga:** Hirehalli Dwarf

Goa

Objective of the experiment is to develop a nucleus garden of dwarf arecanut. First batch of eight plants of Hirehalli Dwarf were planted during 1989 along the roadside as avenue plants. Selected palms among this set were multiplied by selfing and open pollinated seedling progenies. Open pollinated (half-sib) progenies were planted as second phase during 2011 in a block as a part of the previous project. Off-type segregants were eliminated from the block and the putative dwarf progenies were retained. Segregation in phenotypic data of 190 half sib progeny seedlings was analysed for the past four years.

A block of dwarf areca with Hirehalli dwarf was established as nucleus seed garden with 42 palms during 2015-16 as phase III. An additional set of 21 dwarf progenies were inter planted in Tall Mangala areca plot of Farm B. Existing dwarf areca phase II is extended by land filling activities to provide space for selected dwarf areca progenies as phase IV planting in rainy season of 2016.

Port Blair

Fifty seednuts each of arecanut variety Samrudhi and Andaman Dwarf type were collected from mother palms maintained at the Sippighat farm of ICAR- Central Island Agricultural Research Institute, Port Blair for establishment of nucleus seed garden. Seednuts were sown in the polybags and the nursery is being maintained at Garacharma farm following recommended nursery practices.

Shivamogga

Twenty five seedlings of arecanut variety Hirehalli dwarf were brought from CPCRI, Vitla and planted in the AICRP research plot at AHRS, Honnavile during August 2015.

6.2 Crop Production

Agron.18: Development of Arecanut based cropping systems for different agro climatic regions

Expt. 1: Evaluation of Arecanut based cropping system models

Port Blair

Trials on cropping system models comprising of arecanut, banana, ginger, black pepper and elephant foot yam were initiated at the Sippighat farm since July 2015. Initial soil analysis of the experimental block revealed following parameters: pH (4.64), EC (0.7 dS/m), available nitrogen (292.2 kg/ha), available potassium (225.5 kg/ha) and soil organic carbon (2.1%). Pre-experimental yield in the plot was 83.2 nuts/palm/year. Cropping system models *viz*. arecanut alone (T_1); arecanut + black pepper + banana (T_2); arecanut + black pepper + ginger (T_3); arecanut + black pepper + elephant foot yam (T_4) have been established for assessing their suitability and profitability under island ecosystems.

Agron. 20: Studies on crown choking disorder in Arecanut (demonstration)

Shivamogga Centre

Objectives:

1. Survey and characterization of crown choking disorders
2. To demonstrate management strategies to overcome the disorders in arecanut

Roving surveys were carried out in Shivamogga and Davanagere districts of Karnataka state, wherein the highest incidence of crown choking disorder was reported. During the survey, the per cent incidence of crown choking disorders varied from place to place. In Davanagere district, out of 78 gardens surveyed, the frequency of occurrence of disorder ranged from 0.0-87.5 % with a mean incidence of 42.56 %. However, with respect to the incidence of disorder, maximum incidence of 11.7% was observed in Channagiri taluk, which was followed by Honnali (10.3 %), Harihara (8.7 %) and Davanagere (8.3 %). In Shivamogga district, the frequency of gardens affected by the disorder ranged between 8.3 to 54.5% with a mean incidence of 30.36%. Among the seven taluks surveyed, maximum incidence of 14.5% was observed in Shivamogga taluk, followed by Bhadravathi (11.9 %), Hosanagara (7.1 %) and Shikaripura (6.4 %), whereas the lowest incidence of 3.54% was recorded in Thirthahalli taluk.

Observations were recorded on initial mean number of healthy and infected leaves per plant and healthy roots per unit area in normal and crown choking disorder affected plants. In healthy palms, 8.03 healthy leaves per palm and 24.8 healthy roots per sq. ft. area were recorded, while the parameters were lower (6.0 and 13.4, respectively) in moderately infected plants. In case of severely infected plants, healthy leaves were absent and mere 6.2 healthy roots were recorded per square feet area.

6.3 Pest Management

Ent. 18: Evaluation of entomopathogenic nematodes (EPN) for the management of areca white grubs.

Experimental details:

Design : RBD Treatments : 5 Replication : 4

Palms/replications : 15 Locations : 2

Arakere (Shivamogga Tq.),

Koluru (Thirtahalli Tq.)

Treatment details :

1. T1- *Heterorhabditis indica* @ 5g/palms –
2. T2- *Steinerema carpocapsae* (CPCRI _SC 1)@ 1.5 billion IJs /ha -
3. T3- *Steinerema carpocapsae* (CPCRI _SC 1)@ 0.75 billion IJs/ha + imidacloprid 17.8 SL
4. T4- Imidacloprid 17.8 SL @0.0045% (0.5ml/2 litter water)
5. T5- Absolute control

Mode of application

T1: One time application during June- July by dissolving *Heterorhabditis indica* @ 5g in 1 litre of water and drenching in root zone.

T2: Two time application during June- July and Sept-Oct through drenching in 5 lit of water (dry soil), if soil moisture is at the field capacity directly inject nematode solution at the depth of 10 – 15 cm in slanting position.

T3: Two time application during June- July and Sept-Oct through drenching insecticide drenching @5 lit of water at root zone followed by directly injecting the nematode to the root zone.

T4: One time application during Sept- Oct.

At 30 DAT, non-significant difference was observed among the treatments. However, at 60 DAT, significantly lower grub population was observed in T3 and T4. At 90 DAT, the trend was continued and

Table 47. Mean grub population/ palm in Koluru (Location 1)

Treatments	Mean number of grubs/palm			
	Before treatment	30DAT	60DAT	90DAT
T1	2.58 (1.75)	1.75 (1.47)	1.25 $(1.32)^{ab}$	0.50 $(0.99)^{bc}$
T2	1.92 (1.55)	1.17 (1.26)	0.67 $(1.04)^{bc}$	1.00 $(1.17)^{ab}$
T3	2.50 (1.73)	1.25 (1.31)	0.50 $(0.99)^{c}$	0.00 $(0.71)^{c}$
T4	2.25 (1.64)	0.83 (1.13)	0.33 $(0.89)^{c}$	0.00 $(0.71)^{c}$
T5	3.42 (1.94)	2.00 (1.57)	1.75 $(1.48)^{a}$	1.25 $(1.31)^{a}$
SEm±	0.07	0.06	0.03	0.04
CV%	15.82	18.74	15.95	21.20
CD (P=0.05)	-	-	0.28	0.31

Replication:3 DAT: Days after treatment In each replication, 3 palms were sampled for root grubs
Number of palms per treatment: 60
Before treatment observation: 20.07.2015 30DAT: 22.08.2015
60DAT: 10.09.2015 90DAT:19.10.2015
Figures in the parenthesis are square root transformed values (x+0.5)

significantly lower grub population was observed in T3 and T4. No grubs were found in these treatments at 90 DAT (Table 47).

On an average, 4-7 cm intermodal length was there just 30 cm below the lower leaf. On an average, 5-9 leaves were there in the tagged palms. Same tagged plants will be observed for the parameters next year to know the influence of treatments (Table 48).

Table 48. Growth characters of palms in the experimental plot at Koluru (Location 1)#

Treatments	Internodal length (cm)*	Number of leaves*
T1	4.41 ±1.44	6.66 ± 1.67
T2	4.66 ± 1.72	6.50 ± 1.56
T3	4.41 ± 1.67	7.00 ± 1.41
T4	4.75 ± 1.35	7.00 ± 1.04
T5	4.41 ± 0.90	7.16 ± 1.52

#Before start of experiment: observation made on 20.07.2015
Next observation will be made before the start of experiment this year (2016)
*Observation of 12 palms per treatment (3 palms in each replication)

VII. EXPERIMENTAL RESULTS IN PALMYRAH

7.1 Genetic Resources

Gen. 9 : Survey, Collection and Evaluation of Palmyrah germplasm

Survey and collection of palmyrah germplasm was done to identify dwarf and superior palmyrah genotypes for high neera and nungu yield. During the year 2015–16 the survey for the collection of Palmyrah was taken up in Midnapur district of West Bengal. A preliminary survey was taken up during the last week of April, 2015. The entire district was explored to identify the potential palmyrah growing areas for collection of fruits after full maturity. The collection of germplasm was taken up during 17th to 22nd August 2015. Five germplasms were collected and planted in the F block area of the orchard of Agricultural college and Research Institute, Killikulam as well as in the farm of Horticultural Research Station, Pandirimamidi centre.

Details of specific traits considered for collection of palmyrah germplasms from Medinipur district of West Bengal during August 2015

S. No.	Accession No.	Date of collection	Village Name	Taluk	Special traits
1	WB-01/15	18.08.15	Sophiabad	Barkola	Early flowering and semi dwarf (6.5 m)
2	WB-02/15	19.08.15	Hosnabad	Horishpur	Semi dwarf type (5.9 m)
3	WB-03/15	19.08.15	Hosnabad	Horishpur	Semi dwarf type (7 m)
4	WB-04/15	20.08.15	Kanchdahri	Guidahri	Early flowering and semi dwarf type (6.2 m)
5	WB-05/15	20.08.15	Mugvasan	Mugvasan	Dwarf type (5 m)

palmyrah germplasms from Medinipur district of West Bengal

Performance of Palmyrah germplasm accessions

The data on biometrical observations as well as flowering and fruiting characters were recorded for all the germpasm accessions assembled in both the centres. In 1991 planted germplasm accessions the highest neera yield was recorded with Acc. No. 11/91(51.37 l.). The highest average number of bunches (5.75) was recorded with Acc. No. 12/91 and the highest average number of fruits (11.3) was recorded with Acc. No. 4/91 (Table 49).

Table 49 . Inflorescence sap yield from 1991 planted germplasm collection

S. No.	Acc. No.	Avg. No. of bunches /tree	Avg. No. of fruits/bunch	Avg. Inflorescence sap yield/tree
1	1/91	5.0	10.7	31.5
2	2/91	4.5	8.2	37.9
3	3/91	4.0	9.5	28.5
4	4/91	4.8	11.3	24.2
5	5/91	5.0	7.2	28.5
6	6/91	3.5	7.8	45.7
7	7/91	5.0	9.3	35.5
8	8/91	4.7	8.2	37.3
9	9/91	3.3	7.8	27.9
10	10/91	5.0	8.6	--
11	11/91	5.0	6.9	51.3
12	12/91	5.7	9.3	34.3
13	13/91	4.5	8.7	23.7

The 1995 planted accessions are showing huge variation in their growth. Among the five accessions of 1995 planted, Acc. 2/95 has recorded the highest neera yield (26.5 l.), the highest number of bunches (5.2) and yet flowering was not observed in Acc. 4/95 and Acc. 5/95.

7.2 Post Harvest Technology

PHT.1: Standardization and commercialization of Inflorescence Sap Extraction and Inflorescence Sap Based Products (Jaggery, Palm Sugar and Candy)

Pandirimamidi :

1. Biochemical analysis of neera of both male and female palms

Palmyrah sap is rich in sugar, minerals and proteins, and is a rich source of ascorbic acid and carbohydrate with sucrose as the major sugar. The biochemical composition of freshly collected sap through CPCRI method is given in Table 50.

Table 50. Biochemical analysis of Palmyrah sap collected through CPCRI Method

100 ml sample*	Sap from male palm		Sap from female palm	
	Range	Average	Range	Average
pH	6.4- 7.0	6.9	6.7-7.0	7.0
Total solids (% brix)	10-14	12.5	9-15	12.0
Total sugar (g)	9.56 -12.80	11.58	10.0- 13.5	11.4
Reducing sugar (g)	0.31-0.42	0.34	0.34-0.43	0.40
Protein (g)	0.12-0.25	0.18	0.16-0.20	0.20
Ash(g)	0.2- 0.45	0.34	0.15-0.4	0.30
Ascorbic acid (mg)	24-32	28	23-34	29
Crude fat (g)	0.0-0.05	Trace	0	0

* Average value of ten samples

Sap from male plam using traditional (left) and CPCRI method (right)

2. Process for development of Palmyrah jaggery powder/Palmyrah sugar

The sugar content of sap ranges from 9 - 13 %, which means it can yield up to 500g sugar per palm per day (with an average yield of sap 4 litre per day). Fresh sap collected through CPCRI method was carefully boiled up to 70, 80 and 90% brix and cooled to room temperature. The syrup so obtained can be used as sweetener or the syrup on drying at low temperature gives palm sugar or jaggery. From the results it was found that the sap concentrated up to 80 and 90% brix and cooled gave fine quality palm sugar or jaggery.

The shelf life studies of palm sugar developed from the above was carried out during 2015-16 and it was found that the sugar stored under room temperature with multilayer pouch gave best quality without any changes up to 6 months.

Fine quality palm sugar or jaggery

PHT.2: Standardization of Tuber Flour Based Food Products (Like Pizza, Bakery items, confectionery, health mix etc.)

Pandirimamidi

Effect of soaking in water and nutritional values.

Fresh palmyrah tuber (apicolon) flour and flour soaked for 8 hours in tap water and dried was analyzed for biochemical analysis. There was slight decrease in fat, ash, fibre, copper content, whereas, protein, iron and zinc content increased (Table 51). From the data, it was found that the bitterness was removed by soaking in water and losses due to soaking is minor.

Table 51. Biochemical analysis of palmyrah tuber (apicolon) flour

	Fresh flour	Soaked and dried flour
MC (w.b %)	5.19	5.32
Fat (%)	0.57	0.43
Ash (%)	2.60	1.80
Protein (%)	3.20	3.40
Fibre (%)	10.17	8.80
Copper (ppm)	0.11	0.05
Zinc (ppm)	0.29	0.41
Iron (ppm)	1.16	2.40
Manganese (ppm)	0.26	0.05

Equilibrium moisture content studies of tuber flour

A sorption isotherm represents the relationship between EMC of a material with the relative humidity (RH) of the surrounding environment at a particular temperature. The procedure from the literature was followed for deriving sorption isotherms at 20, 30, 40 and 50°C. Approximately two g samples of Palmyrah tuber flour in sterilized glass petridishes were placed in six separate desiccators containing saturated salt solutions (LiCl, $MgCl_2$, $Mg(NO_3)_2$, NaCl, KCl and K_2SO_4) for maintaining relative humidity (R.H.) levels from 10 to 95%. The sorption isotherm of Palmyrah tuber powder decreased with increase in temperature at constant relative humidity.

PHT. 3:Utilization of palmyrah plant parts for the extraction of fibre and fuel

Killikulam

(i) The modification of the existing palmyrah fiber extractor is in progress. The first hand information was obtaining from local fibre extraction factory on the conventional / traditional machines which are being used by the palm artisans / entrepreneurs and also to find out difficulties if any, in those fiber extractors. After careful examination, the following few ideas in modification of the existing fiber extractors were generated.

1. The spikes length of the main rotating axle is changed from 3 cm to 5 cm length.
2. A hydraulic compression jack was provided over the main rotating drum to hold palmyrah leaf base firmly. For this, hydraulic circuit is designed and fabrication is in progress.
3. A damper needs to be provided to avoid vibration of the machine.
4. The changeover switch is provided for reverse rotation of main drum for improving the efficiency of fiber extractor.

ii. The ergonomic study of the existing palmyrah fiber extractor was done. A total of three male subjects were selected for this study. All the three subjects were calibereted and Heart Rate, Oxygen Consumption, Energy Cost, Acceptable work limit, Limit of continuous performance, overall discomfort rating and Body part discomfort score were observed during operation of the existing fiber extractor. The recorded data are furnished in the following Table 52.

PHT. 4: Standardization of preservation technique for Palmyrah tender fruit endosperm

Pandirimamidi

Standardization of medium for preservation of *nungu*

Palmyrah tender fruit endosperm contains high moisture and highly sensitive to atmosphere conditions. They are susceptible to moisture loss and

Table 52. Ergonomic parameters of fiber machine

Parameters	Subject 1	Subject 2	Subject 3
Heart rate, Beats/min	159.5	168.0	152.1
VO_2, l/min	1.65	1.76	1.52
Energy Expenditure, kJ/min	34.4	36.8	31.7
Energy grade of work	Very heavy	Very heavy	Very heavy
Acceptable workload (35%VO_2 max)	80.8	86.5	74.6
LCP, 40 beats/min	76.5	88.9	71.7
ODR Score	> More than Moderate discomfort (8.0)	< Very uncomfortable (8.3)	> More than moderate discomfort (7.6)
Body Part Discomfort Score	Severe pain in chest region, knees, leg, foot, mid back and wrist, moderate pain in elbow, lower back. (51)	Severe pain in chest regions and left and right palm, knees, leg, foot, mid back and wrist, moderate pain in elbow, lower back.(55)	Severe pain in chest regions and left and right palm, knees, leg, foot, mid back and wrist, moderate pain in elbow, lower back. (46)

need to be stored at high humidity, low temperature and controlled atmosphere. During storage in freezing condition, chilling injury and hardness is one of the important factor for consideration. Keeping these problems of storage and packaging of endosperm, efforts were made to study the effect of different packaging and storage of tender fruit endosperm on shelf life and quality.

The endosperm of palmyrah tender fruit was extracted and peeled hygienically and immersed in suagr syrup of 40% brix and 50% brix and without syrup as control and packed in three packing materials *i.e* Polypropylene (120 micron), Multilayer pouch (120 micron) and Aluminum foil, and stored under ambient and cold conditions. There was sharp increase in physiological loss in weight of endosperm stored at room temperature, whereas, the increase in PLW was found to be very slow when stored at low temperature. The endosperm with 50% brix showed very low increase in physiological loss in weigh (PLW). This was found to be more effective in high RH and low temperature as compared to room temperature (RT). From the results it was found that the tender fruit endosperm packed in 50% brix sugar syrup with multilayer pouch under refrigerated conditions gives shelf life up to six months.

Nungu packed in multilayer pouch

VIII. MONITORING CENTRES AND MEETINGS

Monitoring

The technical programmes in all the centres were monitored by the Project Coordinator by visiting them and keeping constant touch with all the centres through phone and email. Time to time advice and direction was given for proper implementation of the technical programmes. Monthly progress report and budget utilization information were obtained from centres regularly and the same was reviewed critically. During the visit to centres, discussions were held with Vice Chancellor, Director of Research and Head of the Division of the SAUS's of the concerned centre as well as with the scientist of AICRP on Palms for the smooth functioning of the research programmes. After each visit, suggestions were given for implementing the technical programmes.

Centres visited

Centre	Date of visit
Ratnagiri (Maharashtra)	20.04.2015
Wakawali (Maharashtra)	21.04.2015
Mulde (Maharashtra)	22.04.2015
Goa	23.04.2015
Bhubaneshwar (Odisha)	01.07.2015 to 03.07.2015
Shivamogga (Karnataka)	11.08.2015
Bavikere (Karnataka)	12.08.2015
Aliyarnagar (Tamil Nadu)	02.09.2015 to 04.09.2015
Pilicode (Kerala)	16.09.2015
Gangavathi (Karnataka)	04.11.2015
Veppankulam & Pattukkottai (Tamil Nadu)	19.11.2015
Jagdalpur (Chhattisgarh)	03.12.2015 to 05.12.2015
Arsikere (Karnataka)	11.02.2016
Ambajipeta, Vijayarai, Pedavegi, Pandirimamidi (Andhra Pradesh)	21.03.2016 to 23.03.2016

Visit made to centres

Ratnagiri

Mulde

Visit to Aliyanagar

Visit to Bavikere for site selection

Visit to farmer's garden in shivamogga

Visit to Veppankulam

Visit to Navsari

Meetings

XXIV Annual Group Meeting

The Annual Group Meeting of All India Coordinated Research Project on Palms was organized from 26th to 28th May, 2015 at ICAR-Central Costal Agricultural Research Institute, Goa. The Annual Group Meeting was inaugurated by Mr. Manoj Kumar Sahoo, IAS, Secretary, Agriculture, Govt. of Goa. The inaugural function was presided by Dr. S.K. Sharma, Director, CIAH, Bikaner, Dr. P.L. Saroj, Director, ICAR - DCR, Puttur and Dr. A.S. Kumaraswamy, Former, Dean of Education (UAHS), Shivamogga graced the occasion. Head of Divisions of CPCRI, Scientists from different centres of AICRP on Palms and scientists from different ICAR Institutes participated in the programme. Dr. H.P. Maheswarappa, Project Coordinator (Palms) gave a brief report of the AICRP. In his report, he highlighted the achievements made during 2014-15 and progress of different technical programmes. Dr. N.P. Singh welcomed the delegates and enumerated the problems in palms cultivation in Goa which include shortage of manpower, especially for harvesting of nuts and incidence of pests and diseases. Dr. S.K. Sharma highlighted the role of palms in national economy; both in past and in

the present. He also suggested that post harvest technology and value addition are required to be strengthened to meet the growing demands and increase the income of the farmers. Dr. P.L. Saroj emphasized that INM is an important issue and recycling can reduce input requirement and improve the productivity. He suggested that location specific intercropping with high value crops models needs to be strengthened to meet the local demands. Dr. A.S. Kumaraswamy opined that co-operation between SAUs and ICAR institutes is very much essential for the overall development. He suggested that basic research could be undertaken by the student during their higher education and provision of fellowships could be made to facilitate the work. Role of interdisciplinary research needs to be strengthened and research is also required to study the effect of global warming on incidence of pests and diseases and productivity of coconut. He also suggested that drought is a growing concern and minimum water requirement to save the palms needs to be studied. Further, slow release fertilizers and crop specific nutrient mixtures needs to be developed and tested. Mr. Manoj Kumar Sahoo appreciated the concept of AICRP as a platform for sharing ideas for carrying out research for overall development of the sector at ground level. He urged that consolidated efforts are required from all the stakeholders to reduce the problem of farmer's suicide and bring back people in agriculture. He also requested to make agriculture as a profitable venture by development and adoption of improved technologies. Four publications released from the AICRP centres during the inaugural session namely AICRP on Palms at a Glance, Prospects of mushroom cultivation in coconut garden in Odisha, RCRS, Bhatye Research at a glance (Marathi) and Oil palm cultivation (Marathi) from Mulde centre.

The plenary session was held on 28th May 2015 under the chairmanship of Dr. N.K. Krishna Kumar, DDG (Hort. Sci.), ICAR, New Delhi and Dr. P. Chowdappa, Director, ICAR-CPCRI and Dr. P. Kalidas, Actg. Director, ICAR- IIOPR, Pedavegi were present on the occasions. Dr. H.P. Maheswarappa, Project Coordinator (Palms), briefed about the group meeting programme held for two days along with recommendations. The performance of AICRP centres is being evaluated every year and during 2014-15, AICRP centre, Mulde has been judged as the best performing centre. DDG (Horticulture Science) gave away the certificate and memento to Mr. M.S. Gawankar, Scientist In-charge of the centre. Recommendations from the various sessions presented for the approval of the session.In his chairman's remarks, DDG stated that, AICRP work should be strengthened through the Multi location trails (MLT) for variety release or any technology development.

Release of publication by dignitaries

Address by Dr.N.K.Krishna Kumar, DDG (Hort Sci.,)

Best centre Award – AICRP on Palms, Mulde

Core committee to finalise the technical programme for AICRP on Palms, Oil palm centre, Bavikere

The core committee consisting of Dr. H. P. Maheswarappa, Dr. B. N. Rao and Dr. R. K. Mathur met at AHRS, UAHS, Bavikere,Chikkamagalur Dt. on 12th August 2015 and visited the farm; and identified the blocks suitable for the AICRP trials and finalised the Technical programme.

Regional Workshop on oil palm

Regional workshop on 'Technological strategies for enhancing oil palm production in Western Region of India' was held at Biotech Lab, Belgaum, Karnataka (covering Karnataka, Maharashtra, Goa, Gujarath and Kerala States) on 28.1.2015. The workshop was attended by State Government officials, oil palm growers and palm oil industrialist. Dr. D.L. Maheswar, VC, UHS, Bagalkot was the Chief Guest and following technical sessions were held Oil palm development in western states, Oil palm Research – Technologies and Way Forward, Interface among different oil palm stakeholders.

Regional Workshop on oil palm in North Eastern Region

Regional workshop on Technological strategies for enhancing oil palm production for North Eastern Region was held at Aizawal, Mizoram during 2-3rd February, 2016. About 117 officer of state department of Agriculture / Horticulture, staff of oil palm procuring unit, scientist staff of ICAR, SAU's and KVK from Mizoram, Arunachal Pradesh, Nagaland, Meghalaya, Assam and West Bengal attended the workshop.

Regional workshop held at Belgaum

Regional workshop held at N.E. Region

IX. EXTENSION, POPULARIZATION OF TECHNOLOGIES AND TSP

Coconut

Aliyarnagar

- 40 members participated in certificate course on "Coconut production technology" organized by Directorate of Open and Distance Learning, TNAU, at CRS, Aliyarnagar from July 2015. Three numbers of Training on Integrated Pest and Disease management in Coconut and 18 Outreach programmes were conducted in Tiruppur and Coimbatore districts.
- Organized an awareness programme on Coconut Root (wilt) disease on 21.04.15 at Panpoli village, Thenkasi.
- Scientist of the centre delivered three special lectures on crop protection topics at Pongaloor block of Tirupur district.
- Press coverage: 9 Nos.

Best stall award at Farmers day by TNAU, Coimbatore on 30.01.16

Special lecture on Coconut Production technology at Athipalayam village (02.11.15)

Ambajipeta

FOCT Training Programmes

- Scientists of Horticultural Research Station, Ambajipeta conducted six FOCT Training programmes of six days duration for 20 trainees per bacth and imparted training on harvesting of coconuts using climbing machines and management practices for coconut, sponsored by Coconut Development Board.

Training programme on Hybridization in coconut

- Horticultural Research Station, Ambajipeta organized six days vocational training on "Hybridization technique in coconut" from 02.11.2015 to 07.11.2015 for 30 trainees (rural youth) at Krishi Vignana Kendra, Dr.YSRHU, Venkataramannagudem where in the scientists imparted practical training on hybridization technique and various skills involved such as selection of elite mother palms, emasculation, bagging, pollen collection, storage, pollination and identification of matured seednuts for harvesting and production and protection technologies.
- Total seven numbers of All India Radio talks were delivered and total 18 programmes were telecasted in Dooradarshan and other TV networks.
- Scientists have been participated in total ten numbers of trainings, two numbers of Rytu chaitanya yaatra and two numbers of Rytu sadassu.

Diagnostic visits

- A total of 26 field diagnostic visits were carried out to monitor and forecast the pest and disease incidence on coconut and coconut based cropping systems in Andhra Pradesh.
- Scientists of HRS, Ambajipeta organized/

participated 14 Training programmes for the benefit of farming community

Exhibition on improved coconut varieties

FOCT Training organized at HRS, Ambajipeta

Arsikere

Training cum demonstration on Integrated management of basal stem rot disease in coconut

- A training and demonstration on Integrated management of basal stem rot disease in coconut was organized on 10.02.2016 at Bommasamudra village in Arsikere Taluk. The programme was inaugurated by Dr. H. P. Maheswarappa, Project Co-coordinator, AICRP on Palms CPCRI, Kasargod.

Training on Integrated management of BSR

Farmers- Scientists interaction meeting on Coconut cultivation

- Farmers- Scientists interaction meeting was organized at KVK, Tiptur on 11.02.2016 to discuss the problems in coconut cultivation. About 50 farmers participated in the discussion. Dr. H.P. Maheshwarappa, Project Co-coordinator AICRP on Palms, CPCRI, Kasargod inaugurated the programme and addressed the gathering. Dr. Sukanya, Programme Coordinator, KVK, Tiptur presided over the function. The scientists of HRES, Arsikere and KVK, Tiptur participated in the discussion.

Inauguration of the Farmers- Scientists interaction meeting

World coconut day celebration

World coconut day with the theme "Coconut for family nutrition, health and wellness" was celebrated at AICRP on Palms, HRES Arsikere on 2nd September 2015. Around 100 farmers from various villages of Arsikere taluk participated in the programme. A training programme on coconut production technology was organized on 02.09.2015 as part of world coconut day celebration at HRES, Arsikere.

Participation in Krishi Mela/ Horticulture Mela -10 nos

The Scientists working under AICRP on Palms at HRES, Arsikere participated in Krishi Mela/ Horticulture Mela organized by the Agriculture/ Horticulture Universities and other organizations. The specimens of different varieties and value added

products of coconut and information on production and protection technologies of coconut were exhibited in the exhibition stall.

Bhubaneshwar

- Organized four off campus and two-days Farmer's training programme on "Management of coconut palms in Coastal sands" in Puri, Jagatsinghpur and Balasore districts of Odisha on 26.02.2016 and 27.02.2016. A total of 175 participant farmers were benefited by the training programmes.
- Twelve on campus FOCT training programmes and three off campus farmer's training programmes organized by CDB, State centre, Bhubaneswar & four training programmes organized by State department of Horticulture and Agriculture and imparted training to 793 farmers and others on various aspects of coconut cultivation during last year.

Training programme on Livelihood improvement through Integrated Coconut farming

Kahikuchi

Training on "Improved production technology of coconut" was conducted five at different locations of Kamrup district (Chandrapur, Borihat, Hajo, Boko, Chaigaon).

Demonstration: Four demonstrations on nursery raising technique in coconut, integrated nutrients management practices in coconut, low cost drip irrigation, diseases and pests management in coconut & Friend of Coconut Tree (FOCT) were given at Hajo, Rani, Lapatul & at the Centre during the period.

Coconut Block Plantation: Coconut block plantation has been initiated in the farmers' field namely by Sri Umesh Bora of Lapatul having 40 palms and Sri Milon Bora of Rani having 20 palms. Intercropping of turmeric and banana has been taken up in the block plantation by both the farmers.

TV Talk: A TV programme on 'Production technology of Coconut' has been recorded at the centre and telecasted on 11.03.2016 by DD Guwahati.

World Coconut Day was celebrated on 2nd September in the farmers' field, to created awareness and interest on the importance of coconut among the farmers and there by tried to transfer the technologies in the farming community.

World coconut day celebration

Mondouri

- On 2nd september 2015 World coconut day was celebrated at the Horticultural Research Station, Mondouri, BCKV as well as in the farmers' field. Seedlings were distributed to farmers.

World coconut day at Mondouri centre

- Scientists from the mondouri centre were associated as resource person with 25 no of FOTC Training of coconut farmer (approx 25 X40 = 1000 farmers), sponsored by Coconut Development Board, Imparted training on coconut cultivation and management, integrated farming in Coconut and establishment of Coconut nursery and its management, Coconut based multi-tier cropping system.

Training programme to farmers

Navsari

- World Coconut day was organized on 2nd September, 2015 at ASPEE College of Horticulture and Forestry, NAU, Navsari. In this programme, created the awareness on importance of coconut as well as covered the important points like planting systems, improved varieties, organic and in-organic fertilizer management, irrigation management, intercropping, IPDM, marketing channels and information regarding health benefits of value added products of coconut to the farmers. A good number of farmers and youth participated there by tried to transfer the technologies in the farming community.

World coconut day celebration at Navsari

- Nine numbers of training programmes on 'Production Technology of Coconut,' seven numbers of demonstrations of technology in the farmer's field and nine numbers of Field days/ Training programmes were organized at different districts of Gujarat state.

- Participated in three *Krushimela*/Horticulture *Mela*/Exhibitions.

Farmers visit to centre

Port Blair

- A training programme entitled 'Enhancing the productivity of arecanut and coconut plantations through incorporation of suitable intercrops' was organized on 11.1.2016 at Sibapuram village of North and Middle Andaman Islands.
- One day field demonstration on coconut climbing device was organized at Kanyapuram village of South Andaman district on 4.2.2016.
- Distributed planting material of improved varieties of black pepper to farmers from Sibapuram, Middle Andaman and Diglipur, North Andaman.

A view of training programme at Sibapuram, North and Middle Andaman Islands

A view of field demonstration on coconut climbing device at Kanyapuram, South Andaman

Ratnagiri

Farmers rally of coconut growers on coconut cultivation and integrated pest and disease management at Guhagar:

- Organized a farmer's rally on coconut cultivation and integrated pest and disease management for the coconut growers in Ratnagiri district on January 16. About 1808 farmers were participated in this programme.
- Total 44 method demonstration programmes were organized in Ratnagiri and Palghar districts of Maharashtra. Demonstrations includes use of climbing device on coconut, vermicompost preparation, integrated management of Red Palm Weevil and eriophyid mite, effective use of Parasitoids for the control of black headed caterpillar, cinnamon harvesting, spices cultivation in coconut etc. Total 354 male and 217 female farmers participated.

Training on Vermicomposting technology

Radio Programmes :

One radio talk was broadcasted on "Lakhibaug hamkhas utpanna denari sankalpana" - Bhetwarta delivered by Dr. R.G.Khandekar, Agronomist, RCRS Bhatye.

Sabour

- Delivered lecture on coconut cultivation on 7.4.2015 at Purnea district (50 farmers participated).
- Participated and given advisory service in two video conferencing with farmers from BAU Media Centre.

Veppankulam

Extension / Outreach Programmes Conducted: 5 Nos.

- Conducted district level seminar on "Cocoa production technology" on 30.03.2015.
- Celebrated World Coconut Day on 02.09.2015.

- One day training on "High Tech Coconut Cultivation" on 12.02.2016 and one day training on "Marketing & value addition in coconut" on 23.02.2016 were organised
- District level seminar on "Cocoa production technology" on 03.03.2016 at Coconut Research Station, Veppankulam.

District level seminar on cocoa production technology

One day training programme on Marketing and value addition in coconut

Oil palm

Gangavathi

- Four district level training programmes on Oil palm for farmers were organized from November 2015 to February 2015.
- Participated and exhibited stall in Krishimela 2015-16 of UAS, Raichur on 5th December-2015 and 30th Jan -1st February -16, and Totagarike mela on 19th – 21st December-15 by UHS, Bagalkot.
- AIR-Hospet, interviewed and broad-casted on 'Oil palm cultivation'.
- One day training programmes attended – seven as resources person.

Dr. R. K. Mathur, Director, ICAR-IIOPR, inaugurating one day training programme on "Oil Palm – Production Technology"

Pasighat

Participation in exhibition

a. Arunachal Agri Fair, 18-18 January, 2016 at CHF, Pasighat

b. Regional Agri Fair-2016, 3-5 Feb. 2016 at Aizwal, Mizoram

c. Mithun Mela and Farmers Awarness Programme at Takilaloong Village, Pasighat, East Siang District, Arunachal Pradesh.

Delivered lecture on the topics "Scope of oil palm cultivation in NE Region" and "Production technology of oil palm" in different training programmes organized by the department of Agriculture. Govt. Of Arunachal Pradesh and in trainings conducted by College of Horticulture and Forestery Pasighat.

- Conducted State Level Training Programme on "Oil Palm Production Technology" January 20th to 21st 2016 in association with IIOPR, Pedavegi.
- Total three numbers of Farmer's days conducted.

Pattukkottai

- Organized training programme on Oil palm cultivation technologies on 25.02.2016.
- Participated in MSSRF Farmers Exhibition & workshop and imparted Oil palm production technologies to the needy Oil palm farmers during 05.06.15 to 07.06.15 at HC&RI (W), Trichy.

Training cum awareness campaign and exposure visit of farmers

Palmyrah

Killikulam

Training conducted: (Off campus)

Training on Use of Palmyrah fiber extractor machine and palmyrah by products on 15.3.16 at Surandai.

Oil palm field exposure visit at Pattukottai

MSSRF Farmers Exhibition & workshop stall

Krishimela / Exhibitions Participated:

- Participated, exhibited palmyrah materials in krishi unnati mela 2016 (National Agricultural mela) from 19.03.2016 to 21.03.2016 at IARI, Pusa, New Delhi.
- Exhibited palmyarh activity stall in VOC, College ground, Thoothukudi on 02.10.2015 organised by Government of Tamil Nadu.

National Agricultural mela at IARI, Pusa, New Delhi

Pandirimamidi

- For tribal youth, training on Palmyrah climbing using coconut climber and palm climber, Demonstration cum training on Neera collection using CPCRI Technology, Palm jaggery preparation from palmyrha neera and training on bakery and confectionary items using palmyrah tuber (apicolon) flour to establish cottage industries at village level has been conducted at HRS, Pandrimamidi.
- Radio talk - Palmyrah utilisation and value addition programme.

Training on bakery products from palmyrah tuber

Training on palmyrah climbing using machine

Farmers training programme under TSP at Bissam (Cuttack), Rayagada (dist) on 30.09.2015

Coconut seedlings distribution under TSP programme

Tribal sub plan (TSP)

Bhubaneshwar

- Organized four off campus one- day farmer's training programmes, four off campus field day programmes. Coconut seedlings were supplied to tribal families in Keonjhar, Rayagada and Sundargarh districts of Odisha. The AICRP Scientist participated in twelve FOCT training programmes and three off campus farmer's training programmes and conducted one demonstration on 'Integrated management of coconut plantation' in the farmer's field.
- New coconut plantations were developed by the centre in the current year with 3500 coconut seedlings in 37 villages involving 360 tribal farmers particularly in non-traditional areas in three tribal districts (Keonjhar, Rayagada and Sundargarh) under TSP programme.

Navsari

1. **Training programme on "Production Technology of Coconut":-** Various training programmes on "Production Technology of Coconut" were conducted during the year 2015-16 under TSP. There were six numbers of programmes on demonstration of technology in the farmer's field and five numbers of field days/ training programmes were organized by the centre at different villages of Valsad and Dang districts under TSP.

2 Supplied coconut seedlings, conducted extension activities and distribution of inputs through TSP in thirteen villages of Dang and Valsad districts of south Gujarat.

Distribution of inputs to farmers under TSP at Navsari

Training programmes on Coconut cultivation under TSP at Jagdalpur

Jagdalpur

Training programme on coconut cultivation under TSP

During the year 2015-16, fourteen numbers of training programmes were conducted on various aspects of coconut production at different villages under TSP programme. Various training programmes on production technology of coconut were conducted in different villages of Jagdalpur namely Kumharawand, Choker, Tirathgarh, K.V.K., Dantewada and Chichadi.

Different extension activities were carried out such as conducting training programmes on improved coconut and intercrop cultivation practices. Distribution of healthy coconut seedlings, fungicides, bio-fertilizers and biocontrol agents to the tribal farmers.

Ratnagiri

- Two farmers training programmes were organized in Dhanoshi & Kadachimeth village, Jawhar Tahsil, Palghar district of Maharashtra.
- Total 533 Tribal Families & six Public trust from Dhanoshi & Kadachimeth Taluka Jawhar district Palghar have been supplied with 2695 Coconut seedlings and 3234 Cinnamon seedlings planted in the tribal villages.

Distribution of planting material to TSP beneficiaries

X. PUBLICATIONS

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XI. WEATHER DATA OF COORDINATED CENTRES

(APRIL 2015 – MARCH 2016)

Coconut centres

Aliyarnagar

Month	Temp (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Max.	Min.	
April'15	25.1	21.8	92.3	53.6	128.7
May'15	34.6	22.3	88.8	61.3	115.2
June'15	33.1	22.2	83.9	54.8	132.0
July'15	32.4	21.4	83.6	56.1	70.6
Aug'15	33.6	20.1	87.5	67.3	92.3
Sep'15	33.8	20.2	91.3	78.1	44.9
Oct'15	32.2	20.4	89.7	72.7	66.0
Nov'15	30.0	19.5	91.4	73.1	284.6
Dec'15	30.5	17.1	89.5	67.6	127.4
Jan'16	33.0	17.6	86.6	54.9	-
Feb' 16	34.2	14.5	85.6	42.0	-
Mar '16	35.5	28.5	87.5	44.0	18.8

Ambajipeta

Month	Temp (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Max.	Min.	
April'15	38.4	34.3	60.2	58.4	--
May'15	39.3	35.2	62.1	60.3	--
June'15	33.2	32.0	71.0	74.0	361.8
July'15	35.9	34.0	63.0	57.2	143.2
Aug'15	34.8	31.5	74.5	66.1	166.6
Sep'15	34.0	31.5	79.2	71.8	186.8
Oct'15	30.3	29.9	77.2	74.4	79.9
Nov'15	28.8	27.1	81.1	73.8	113.7
Dec'15	30.1	29.1	72.6	64.0	0.9
Jan'16	28.4	28.3	69.4	62.3	--
Feb' 16	32.8	32.0	64.7	53.7	--
Mar '16	39.2	34.1	55.5	42.2	--

Arsikere

Month	Temp (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Max.	Min.	
April'15	33.0	18.3	71.0	42.0	96.4
May'15	32.3	19.6	78.2	50.4	88.6
June'15	29.3	19.6	81.1	62.2	123.8
July'15	29.5	18.9	75.1	60.3	28.2
Aug'15	28.6	18.9	79.7	62.0	185.6
Sep'15	29.0	18.1	80.7	61.9	138.0
Oct'15	30.6	15.9	81.0	54.1	42.6
Nov'15	26.0	17.7	82.2	69.4	256.1
Dec'15	28.0	15.4	80.5	70.4	4.6
Jan'16	28.8	10.0	71.7	55.3	-
Feb' 16	31.9	13.2	71.0	45.0	-
Mar '16	35.5	17.0	70.4	33.9	-

Bhubaneshwar

Month	Temp (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Max.	Min.	
April'15	37.1	24.1	88.4	50.2	115.8
May'15	38.9	27.0	87.8	51.1	-
June'15	36.2	26.1	88.2	62.8	94.8
July'15	32.4	25.0	90.0	71.0	223.5
Aug'15	33.0	25.0	92.3	77.2	297.8
Sep'15	33.0	25.0	91.0	75.0	151.5
Oct'15	33.0	23.4	93.0	66.0	75.5
Nov'15	31.2	20.1	91.0	55.0	8.3
Dec'15	29.2	17.5	86.0	52.0	14.8
Jan'16	30.0	15.7	91.0	39.0	0.6
Feb' 16	34.5	21.2	89.0	42.0	3.0
Mar '16	37.0	23.4	86.0	40.0	1.5

Jagdalpur

Month	Temp (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Max.	Min.	
April'15	33.5	23.2	81.7	42.8	117.5
May'15	37.4	26.3	78.1	37.4	95.0
June'15	30.4	24.4	87.8	61.6	466.1
July'15	30.5	24.8	87.0	67.1	156.3
Aug'15	29.3	24.2	90.5	75.3	347.0
Sep'15	30.4	23.8	94.1	66.3	337.2
Oct'15	31.8	20.7	94.5	43.9	10.6
Nov'15	29.6	16.5	94.6	43.0	-
Dec'15	29.6	14.4	95.7	42.2	10.0
Jan'16	29.0	10.0	93.1	31.0	-
Feb' 16	32.9	15.4	89.9	32.1	5.3
Mar '16	34.9	19.3	88.9	30.6	38.9

Kahikuchi

Month	Temp (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Max.	Min.	
April'15	35.0	18.3	74.0	62.4	179.0
May'15	35.3	20.9	79.0	70.5	330.0
June'15	35.1	22.9	87.0	83.6	244.0
July'15	36.0	24.1	88.0	84.8	237.0
Aug'15	36.4	24.6	87.9	83.8	292.0
Sep'15	35.9	23.1	86.7	82.4	219.0
Oct'15	34.7	19.3	82.3	79.0	9.0
Nov'15	30.7	13.9	81.3	80.1	1.0
Dec'15	27.4	7.9	84.0	82.4	12.0
Jan'16	26.9	9.3	79.9	71.0	2.0
Feb' 16	30.7	10.1	75.2	57.6	12.0
Mar '16	33.4	14.9	66.4	54.5	21.0

Mondouri

Month	Temp (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Max.	Min.	
April'15	32.2	24.0	89.6	56.7	98.7
May'15	37.6	27.2	88.9	59.0	31.1
June'15	34.6	26.9	91.9	71.9	343.9
July'15	32.6	25.9	97.8	86.0	464.3
Aug'15	33.3	26.8	94.7	76.7	193.6
Sep'15	33.9	26.1	96.0	70.9	227.3
Oct'15	33.4	23.7	94.1	62.4	41.6
Nov'15	31.3	18.8	93.3	53.2	-
Dec'15	27.2	15.5	96.1	58.2	6.6
Jan'16	25.8	11.9	93.0	53.0	3.0
Feb' 16	30.7	18.0	93.0	54.0	31.9
Mar '16	34.3	21.8	93.0	48.0	35.8

Navsari

Month	Temp (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Max.	Min.	
April'15	33.3	22.8	87.5	53.3	-
May'15	35.0	26.4	83.1	57.9	-
June'15	32.0	25.7	86.7	74.5	379.5
July'15	30.7	26.2	87.0	78.4	321.0
Aug'15	30.6	25.3	90.3	74.0	65.0
Sep'15	31.0	23.4	91.9	68.7	440.0
Oct'15	32.5	23.1	86.4	45.0	3.0
Nov'15	33.1	20.3	77.7	40.9	-
Dec'15	31.3	13.1	72.2	29.2	-
Jan'16	30.8	15.1	81.0	31.0	-
Feb' 16	30.0	13.8	80.2	33.0	-
Mar '16	35.4	18.6	85.7	29.6	-

Ratnagiri

Month	Temp (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Max.	Min.	
April'15	32.8	23.7	70	66	-
May'15	34.2	26.7	73	68	0.4
June'15	35.4	26.7	98	98	1134.1
July'15	30.6	25.1	83	79	275.7
Aug'15	29.9	23.8	88	84	387.2
Sep'15	31.1	23.3	87	79	439.3
Oct'15	34.2	23.4	81	73	98.8
Nov'15	34.9	22.3	65	65	17.9
Dec'15	34.0	20.0	63	57	-
Jan'16	33.0	17.2	63	51	-
Feb' 16	31.2	18.3	78	63	-
Mar '16	34.4	22.2	65	55	-

Sabour

Month	Temp (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Max.	Min.	
April'15	33.2	20.0	81.0	51.3	70.9
May'15	36.4	24.6	75.5	55.4	35.5
June'15	34.6	25.9	80.8	65.3	161.8
July'15	32.2	25.1	88.2	75.2	298.3
Aug'15	32.1	25.7	90.5	78.8	409.7
Sep'15	32.8	27.3	88.8	73.3	121.7
Oct'15	31.3	20.4	88.6	67.2	11.4
Nov'15	28.5	14.7	91.3	63.6	-
Dec'15	23.1	9.2	95.5	61.3	-
Jan'16	22.6	7.7	94.8	58.8	24.4
Feb' 16	27.9	11.2	87.5	48.5	3.4
Mar '16	32.3	16.1	82.4	43.3	2.1

Veppankulam

Month	Temp (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Max.	Min.	
April'15	35.2	28.0	81.0	66.0	116.0
May'15	32.6	27.7	73.5	64.0	59.4
June'15	33.7	28.9	75.8	62.0	3.0
July'15	36.2	27.9	60.7	58.5	49.0
Aug'15	29.2	30.0	66.2	56.5	62.0
Sep'15	38.1	29.1	73.4	60.5	148.4
Oct'15	36.3	27.1	86.0	68.5	146.0
Nov'15	29.0	25.2	82.2	76.5	261.0
Dec'15	30.1	23.2	75.3	92.0	150.5
Jan'16	30.1	20.4	81.0	83.0	-
Feb' 16	35.1	23.2	88.5	69.5	-
Mar '16	33.6	23.8	85.5	57.0	-

Oil palm centres

Gangavathi

Month	Temp (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Max.	Min.	
April'15	35.6	20.0	60.2	32.6	87.9
May'15	38.0	24.3	50.2	28.0	21.0
June'15	34.0	24.0	56.5	37.7	29.4
July'15	34.1	23.6	55.9	36.8	3.5
Aug'15	32.4	23.0	64.4	48.4	31.9
Sep'15	31.7	22.8	71.1	53.4	196.7
Oct'15	32.4	21.3	60.3	44.0	-
Nov'15	29.2	19.7	69.1	49.2	5.6
Dec'15	31.4	16.5	62.4	34.1	6.6
Jan'16	30.0	15.6	53.8	30.1	-
Feb' 16	33.8	19.4	49.8	24.9	-
Mar '16	37.3	21.9	39.2	19.0	-

Mulde

Month	Temp (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Max.	Min.	
April'15	36.5	23.1	88	63	-
May'15	36.2	25.1	88	64	052.5
June'15	31.3	23.5	93	81	744.7
July'15	30.8	24.1	92	82	563.9
Aug'15	30.1	23.9	92	82	599.7
Sep'15	31.3	23.3	92	76	253.7
Oct'15	34.5	23.2	92	67	120.5
Nov'15	34.7	21.3	90	60	046.5
Dec'15	35.8	21.2	88	64	-
Jan'16	35.2	14.6	88	54	-
Feb' 16	36.0	17.2	88	59	-
Mar' 16	36.7	19.9	87	57	-

Pasighat

Month	Temp (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Max.	Min.	
April'15	27.4	*	77.4	68.7	68.9
May'15	28.8	*	88.0	82	514.6
June'15	30.1	*	88.4	80.4	493.5
July'15	30.1	*	83.6	80.6	312.5
Aug'15	27.6	*	92.1	91.8	100.3
Sep'15	30.2	11.9	83.2	82.3	385.9
Oct'15	30.3	10.2	83.1	82.5	385.9
Nov'15	25.3	10.0	80.0	64.8	21.50
Dec'15	21.7	9.2	78.8	67.9	-
Jan'16	22.5	9.2	70.2	61.6	45.5
Feb' 16	22.5	10.6	75.7	68.7	125.8
Mar '16	23.0	12.4	78	72	107

*Not Available

Pattukottai

Month	Temp (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Max.	Min.	
April'15	35.2	28.0	81.0	66.0	116.0
May'15	32.6	27.7	73.5	64.0	59.4
June'15	33.7	28.9	18.8	62.0	3.0
July'15	36.2	27.9	60.7	58.5	49.00
Aug'15	29.2	30.0	66.2	56.5	62.0
Sep'15	38.1	29.1	73.4	60.5	148.4
Oct'15	36.3	27.1	86.0	68.5	146.0
Nov'15	29.0	25.2	82	76.5	261.0
Dec'15	30.1	23.2	75	92.0	150.5
Jan'16	30.1	20.4	81	83.0	-
Feb' 16	35.1	23.2	88	69.5	-
Mar '16	33.6	23.8	85	57.0	-

Vijayarai

Month	Temp (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Max.	Min.	
April'15	40.	25.7	93.4	44.	--
May'15	40.8	27.4	89.7	35.9	--
June'15	33.7	25.6	93.5	57.6	256.1
July'15	35.7	26.2	89.9	45.3	66.0
Aug'15	33.6	25.3	95.9	58.1	247.8
Sep'15	32.7	24.8	97.0	61.8	143.4
Oct'15	33.6	24.1	95.9	50.8	86.6
Nov'15	31.7	22.2	91.5	45.5	41.4
Dec'15	30.5	20.7	95.2	48.8	--
Jan'16	33.0	18.8	97.5	42.8	--
Feb' 16	33.3	21.7	98.8	52.4	--
Mar '16	39.2	34.1	55.5	42.2	--

Arecanut centres

Goa

Month	Temp (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Max.	Min.	
April'15	35.3	24.2	88.9	53.4	-
May'15	35.3	25.8	88.2	57.1	50.8
June'15	31.4	23.5	94.3	76.5	837.1
July'15	30.5	23.1	95.1	80.6	904.2
Aug'15	30.2	23.4	95.6	80.7	496.4
Sep'15	31.4	23.8	94.5	74.7	256.2
Oct'15	34.4	23.9	92.1	63.1	53.4
Nov'15	35.1	22.7	83.0	46.0	4.2
Dec'15	35.1	22.3	80.9	40.9	-
Jan'16	34.2	18.5	80.6	32.0	-
Feb' 16	34.1	20.4	90.9	46.2	-
Mar '16	35.3	24.2	88.9	53.4	-

Port Blair

Month	Temp (°C)		RH (%)	Rainfall (mm)
	Max.	Min.	Max.	
April'15	32.6	25.1	71.8	163.9
May'15	31.8	25.4	79.6	368.8
June'15	30.5	25.1	86.5	409.5
July'15	30.6	25.3	79.7	305.6
Aug'15	29.1	24.5	86.5	567.5
Sep'15	30.0	24.3	88.1	434.6
Oct'15	30.9	24.8	80.5	233.8
Nov'15	30.9	25.3	79.6	210.4
Dec'15	32.0	24.8	74.6	151.0
Jan'16	30.6	23.7	70.8	62.3
Feb' 16	30.9	24.2	70.0	-
Mar '16	32.5	24.6	69.0	17.0

Shivamogga

Month	Temp (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Max.	Min.	
April'15	34.6	22.1	76.8	51.5	48.6
May'15	33.2	22.7	82.7	74.1	196.0
June'15	28.7	21.5	85.7	76.4	294.8
July'15	28.5	21.1	86.1	78.4	121.0
Aug'15	29.7	22.3	86.0	76.9	83.2
Sep'15	30.1	22.0	85.4	75.4	214.4
Oct'15	31.3	21.9	81.4	72.3	135.0
Nov'15	29.2	19.4	82.8	69.2	79.4
Dec'15	31.8	18.0	84.3	60.4	2.0
Jan'16	31.1	15.2	76.1	50.5	0.6
Feb' 16	34.3	18.2	73.7	48.9	-
Mar '16	37.7	21.1	73.8	35.4	-

Palmyrah centre

Killikulam

Month	Temp (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Max.	Min.	
April'15	35.4	32.2	95	79	51.4
May'15	36.1	32.1	95	83	29.2
June'15	37.6	25.9	89	81	-
July'15	36.8	24.9	92	83	-
Aug'15	36.6	24.8	100	81	12.6
Sep'15	33.6	23.6	100	82	62.6
Oct'15	33.3	22.9	100	85	152.6
Nov'15	30.8	22.2	100	92	380.2
Dec'15	29.6	21.9	100	88	136.2
Jan'16	30.9	20.7	96	74	-
Feb' 16	33.9	22.3	90	81	-
Mar '16	34.7	23.8	91	79	4.0

Pandirimamidi

Month	Temp (°C)		RH (%)		Rainfall (mm)
	Max.	Min.	Max.	Min.	
April'15	34.3	22.1	89	38	58.0
May'15	44.3	21.6	78	36	63.8
June'15	39.4	22.4	94	48	263.5
July'15	38.4	21.7	97	52	108.0
Aug'15	35.3	22.1	98	69	167.0
Sep'15	35.5	21.6	98	73	182.0
Oct'15	37.6	19.9	95	74	136.0
Nov'15	33.0	16.6	96	51	78.6
Dec'15	33.3	12.2	98	43	-
Jan'16	35.3	12.4	98	36	1.2
Feb' 16	37.1	14.8	97	48	12.8
Mar '16	35.9	15.4	95	39	3.6

Participants of XXIV AGM held at ICAR-CCARI, Goa

भाकृअनुप
ICAR

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

Agrisearch with a human touch