वार्षिक प्रतिवेदन
Annual Report
2009-10

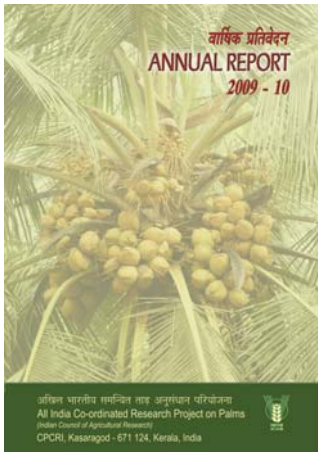
भाकृ अनुप
ICAR

अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना

ALL INDIA CO-ORDINATED RESEARCH PROJECT ON PALMS

(*Indian Council of Agricultural Research*)

CPCRI, Kasaragod 671 124, India



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PREFACE

More than 20 million people in rural areas are engaged in the production, processing and marketing of coconut, oilpalm and palmyrah and their products. To improve the productivity in these crops and thus the income level of the farmers, the All India Coordinated Research Project on Palms was started in 1972. The AICRP Centres located in twelve States representing different agro-climatic regions could identify location specific coconut varieties and hybrids that could be widely cultivated in the respective regions. In addition, region specific coconut based cropping systems evolved through the AICRP on Palms Centres could improve the income from an unit area of coconut garden and also the employment potential. Simultaneously, the integrated nutrient management system as well as integrated pest and disease management systems evolved at different Centres could bring down the cost of production of coconut thus ensuring higher profitability. At present, the All India Coordinated Research Project on Palms, the research network system for palms in the country, comprises of 20 Coordinating Centres based at 12 State Agricultural Universities.

I have immense pleasure to present the Annual Report 2009-10 of All India Coordinated Research Project on Palms. The 36th Annual Report of the AICRP on Palms covers the research results in coconut, oil palm and palmyrah and other related information pertaining to the period from April 2009 to March 2010. However, the data on technical parameters cover the 12 month period of the crop season from July, 2008 to June, 2009. The report includes results obtained from the 12 Centres that conducted experiments on coconut, six oil palm centres and two palmyrah centres. The entire report reflects the collective wisdom and team efforts of the Scientists and staff of the AICRP Centres. I am thankful to all my Project Scientists and Staff in different Centres for their sincere work and sustained enthusiasm in achieving objectives of the project.

My sincere thanks are due to Dr. H.P. Singh, Deputy Director General (Horticulture), ICAR for his sustained keen interest, guidance and encouragement in the progress of the Project. I acknowledge the continued support of Dr. S. Rajan, Assistant Director General (Hort.I) and the staff at ICAR, New Delhi with their valuable help and guidance in the functioning of the Project. The support extended by Dr. George V. Thomas, Director and the Scientists from CPCRI is gratefully acknowledged. I express my sincere thanks to the Vice Chancellors, Director of Research and Heads of Stations of the 20 Centres for their active involvement in ensuring the smooth conduct of the Project.

I acknowledge with thanks the help rendered by Dr. C. Jayabose, Scientist (Economic Botany), Smt. K. Narayani, Personal Assistant and Shri K.S. Ramakrishna, Assistant in Project Coordinator's Cell in bringing out this report. Shri C.H. Amarnath, Technical Officer (Agrl. Statistics) for cover design and Mrs. K. Sreelatha for Hindi translation are also gratefully acknowledged.

Kasaragod
28.07.2010

S. ARULRAJ
Project Coordinator (Palms)

अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना वार्षिक रिपोर्ट 2009-10

कार्य सारांश

भारतीय ग्रामीण आर्थिकता में नारियल, तेल ताड़ और पॉमैरा आदि का स्थान प्रधान है। ग्रामीण क्षेत्रों में 20 करोड़ से अधिक लोग इन तीनों फसलों के तथा उनके उपजों के उत्पादन, प्रक्रमण एवं विपणन में मग्न हैं। इन फसलों की उत्पादन क्षमता बढ़ाने और फलस्वरूप कृषकों का आय स्तर बढ़ाने के लिए 1972 में अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना शुरु किया गया । इस परियोजना का विस्तृत लक्ष्य निम्न हैं :

* विभिन्न सस्य जलवायु क्षेत्रों से नारियल, तेल ताड़, पॉमैरा और उपयोगाधीन ताड़ों में उपयोगी परीक्षण के लिए गुणी जीन स्रोतों की पहचान, संरक्षण तथा उपयोग
* स्थानीय विशेष नारियल आधारित कृषि पद्धति के लिए कृषि प्रबंधन प्रौद्योगिकियों की पहचान।
* तेल ताड़ कृषि के लिए स्थानीय विशेष फसल प्रबंधन प्रौद्योगिकियों की पहचान
* नारियल केलिए स्थानीय विशेष जैव नियंत्रण आधारित समीकृत कीट एवं रोग प्रबंधन विधियों का मानकीकरण

इन परियोजनाएँ वर्तमान में 20 केंद्रों में कार्यान्वित किया गया है। मुख्यालय कासरगोड़ (केरल), अलियार नगर, अडुथुरै, किल्लिकुलम, वेप्पंगुलम (तमिलनाडु); अरसिकरे, गंगावती (कर्नाटक) अम्बाजिपेटा, पांडिरिमामिडी, विजयराय (आंध्रप्रदेश); भुवनेश्वर (उड़ीसा), नवसारी (गुजरात) मधोपुर साबौर (बिहार) पसिघट (अरुनाचलप्रदेश); काहिकुची (असम); मन्डौरी (पश्चिम बंगाल); जगदलपुर (छत्तीसगढ़); रत्नगिरी और मुल्डे (महाराष्ट्र)। इन 20 केंद्रों में से नारियल पर 12 केंद्र, तेल ताड़ पर छह केंद्र, और दो केंद्र पॉमैरा पर अनुसंधान कार्य जारी है। वर्ष 2009-2010 का आय-व्यय 346.00 लाख रुपए था जिसमें 260.00 लाख रुपए भा कृ अन प का भाग है।

सापेक्षिक प्राथमिकताएँ: मुख्य फसलों की सापेक्षिक प्रमुखताओं को विचार करते हुए ग्यारहवीं पंचवर्षीय योजना की अवधि में आय-व्यय का 70.24% नारियल को आबंटित किया गया है और तेल ताड़ के लिए बजट का 19.98% और पॉमैरा केंद्रों के लिए 9.78% आबंटन दिया गया है।

वर्ष 2009-2010 की अवधि में अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना के केंद्रों में अनुसंधान कार्यक्रमों के कार्यान्वयन में महत्वपूर्ण प्रगति प्राप्त की गई है।

उच्च उपज देने वाली नारियल की एक प्रजाति और एक नारियल संकर को उन्नति के लिए उनके वाणिज्यिक खेती स्थिति तक सिफारिश किया जा सकता है। नारियल और तेल ताड़ में मुख्य फसल प्रबंधन प्रौद्योगिकियाँ विभिन्न राज्यों में वाणिज्यिक स्वीकृति स्तर तक उन्नयन किया जा रहा है। तीन मुख्य फसलों की अनुसंधान उपलब्धियों की मुख्य विशेषताएँ इस रिपोर्ट में प्रस्तुत की गई है।

वर्ष 2009-2010 में वाणिज्यिकरण के लिए स्वीकृत सिफारिशें:

नारियल प्रजातियाँ/संकर

कल्पतरु : उच्च गुठली उपज (15750 गुठली/हेक्टर), 15.48 कि ग्रा/ताड़/वर्ष के दर में तेल मात्रा (67.2%) की उत्तम खोपड़ा उपज 2.7 टन/हेक्टर, सूखा सक्षम गुण, जल कमी क्षेत्रों को स्वीकार करने की क्षमता के कारण कनार्टक तमिलनाडु और केरल राज्यों में कृषि के लिए आई. एन. डी 125 एस विमोचन करने का सिफारिश किया गया।

कल्पसमृद्धि

असिंचित परिस्थिति में नारियल संकर आई. एन. डी 376 (आइ. एन. डी 058 एस x आई. एन. डी 069 संकर) की उच्च गुठली उपज 117 गुठली/ताड़, उच्च खोपड़ा उपज 25.72 कि.ग्रा / ताड़/वर्ष और तेल उपज 3.04 टन /हेक्टर आदि उत्तम गुणों को विचार करते हुए अर्ध लंबी, अच्छा डाब पानी गुण (टी. एस एस 6^{o} ब्रिक्स) एवं उपज 346 मि. ली /डाब और सूखा सक्षम प्रकृति आदि उत्तम गुण के यह संकर विमोचन के लिए सिफारिश किया जाता है। कासरगोड़ और काहिकुची केंद्रों में इस संकर का निष्पादन अच्छा पाया गया और इसलिए यह असम और केरल राज्य में कृषि के लिए सिफारिश किया जाता है।

फसल प्रबंधन प्रौद्योगिकियाँ

नारियल बाग में निंबुघास (*सिंबोपोगोन*), सदपहा (*रुटा ग्राविओलेंस*), तुलसी (*ओसिमम सान्क्टम*), कलमेघ (*आन्द्रोग्राफियस पनिकुलाटा*), शिशुमूल (*मरान्टा अरुन्दिनेसिए*) और मकोई (*सोलानम नैग्रम*) आदि औषधीय और सुगंधित पौध के अंतर फसलन से आर्थिक रूप से लाभदायक पाया गया और इसलिए कर्नाटक के मैदानी क्षेत्रों के लिए सिफारिश किया गया।

कर्नाटक के मैदानी क्षेत्रों में नारियल संकर के लिए दो विभाजित मात्रा में 1000 ग्रा नाईट्रोजन : 250 ग्रा फोसफोरस :1000 ग्रा पोटाश प्रति ताड़ प्रति वर्ष का प्रयोग सिफारिश किया जाता है।

नारियल आधारित सस्यन पद्धति के लिए सिफारिश किया गया मॉडल

असम : नारियल + कालीमिर्च + हल्दी

चत्तीसगढ़ : नारियल + कालीमिर्च + लौकी + लोभिया

पश्चिम बंगाल: नारियल + कालीमिर्च + अनानास

तमिलनाडु के तटीय प्रदेश : नारियल + काली मिर्च + केला + कंदफसल + धनिया

उड़ीसा नारियल + केला + रजनी गन्धा (तरुण नारियल के बाग में)

कर्नाटक के मैदानी क्षेत्रों में नारियल के लिए 100% इ $_0$ के दर में ड्रिप सिंचाई सिफारिश किया जाता है। गर्मी के महीनों में (फरवरी - मई) 65 & 75 लीटर प्रति ताड़ प्रति दिन का प्रयोग करना चाहिए। लेकिन हेमन्त एवं मनसून महीनों में 40-45 लीटर / ताड़/दिन पानी की आवश्यकता है।

पश्चिम बंगाल में नारियल के लिए 50% नाइट्रोजन आवश्यकता की पूर्ति कंपोस्ट किया गया कायर गूथा और नाईट्रोजन, फोसफोरस और पोटाश की शेष आवश्यकता की पूर्ति रासायनिक उर्वरक के प्रयोग से की जा सकती है।

फसल संरक्षण प्रौद्योगिकियाँ

तमिलनाडु और आंध्रप्रदेश राज्यों में नारियल काला सिर वाली रोमिल इल्ली (ओपिसिना एरिनोसेल्ला) के अण्डा डालने के पूर्व स्थिति में नारियल बाग के ताड़ में 10% छत्र में छह बार लगातार 5 दिन के अंतराल में 50 मत्कुण /ताड़ अण्डा/लारवा हिंस्र कारडियोस्टेथस का विमोचन कर प्रभावात्मक नियंत्रण किया जा सकता है।

अन्य महत्वपूर्ण उपलब्धियाँ

फसल सुधार

विभिन्न केंद्रों में निम्न नारियल और तेल ताड़ प्रजातियों का निष्पादन अच्छा पाया गया। इन प्रजातियाँ /संकर अतिरिक्त आवश्यक विवरण के संग्रहण और उनके निष्पादन की पुष्टि के बाद इन प्रजातियाँ/ संकर विमोचन के लिए प्रस्ताव किया जा सकता है।

नारियल

अलियार नगर: आई एन डी 042; आई एन डी 018

अम्बाजिपेट : गौतमी गंगा x चन्द्रकल्पा; डबल सेंचुरी x गौतमी गंगा

अरसिकरे :गौतमी गंगा x चन्द्रा कल्पा

वेप्पंगुलम : आई .एन. डी 037

तेल ताड़

मुल्डे :124 डूरा x 266 टेनेरा संकर

विजयराय: 108 डूरा x 98 पिसिफेरा टेनेरा संकर

गंगावती : 108 डूरा x 291 पिसिफेरा टेनेरा संकर

मुख्य सस्य जलवायु क्षेत्रों में नारियल में लंबी x लंबी नए परीक्षणी संकर संयुक्तों के निष्पादन पर मूल्यांकन इस वर्ष प्रारंभ किया गया।

इस कार्यक्रम के अधीन अम्बाजिपेट और वेप्पंकुलम केंद्रों में क्रमशः सात और आठ संकर संयुक्त पूर्व तट क्षेत्र में उनके निष्पादन के लिए मूल्यांकन किया जा रहा है। तथा रत्नगिरी केंद्र आठ संकर सयुक्तों के निष्पादन का मूल्यांकन पश्चिम तट क्षेत्र के लिए उनकी अनुकूलता के लिए किया जा रहा है।

कें रो फ अ सं, प्रादेशिक केंद्र, विट्टल से प्राप्त पाँच नए कोको क्लॉन्स की रोपाई से अम्बाजिपेट, नवसारी और वेप्पंकुलम केंद्रों में नारियल बाग में मिश्रित फसल के रूप में कोको क्लॉन्स के निष्पादन के लिए छानबीन प्रारंभ किया गया। इसी प्रकार नारियल बाग में मिश्रित फसल के रूप में अभी विमोचित काली मिर्च प्रजाति, भारतीय

मसाला फसल अनुसंधान संस्थान से प्राप्त पाँच काली मिर्च प्रजातियाँ जैसे आई. आई. एस. आर तेवम, आई .आई. एस. आर शक्ति, आई. आई. एस. आर मलबार एक्सेल, श्रीकरा और पन्नियूर I की रोपाई के साथ निष्पादन के लिए उनके छानबीन काहिकुची, मन्डौरी और साबैर केंद्रों में प्रारंभ किया गया। ग्यारहवीं पंचवर्षीय योजना कार्यक्रम के भाग के रूप में सुल्फी ताड़ (कारियोटा युरेंस) पर निम्न परीक्षणों के साथ अनुसंधान जगदलपुर (छत्तीसगढ़ राज्य) केंद्र में प्रारंभ किया गया।

सुलफी जननद्रव्य का संग्रहण, संरक्षण और मूल्यांकन सुलफी ताड़ में वृद्धि एवं विकास अध्ययन और छत्तीसगढ के बस्ती क्षेत्रों में सुल्फी ताड़ों में एथ्नो बोटानिकल सूचनाओं के प्रलेखन।

फसल प्रबंधन

निम्न औषधीय और सुगंधी फसलों की रोपाई अंतर फसल के रूप में नारियल बागों में क्रमानुगत क्षेत्रों में कृषि के लिए सिफारिश किया जा सकता है (दो से अधिक वर्ष परिणाम की पुष्टि के बाद)

अलियार नगर	:	सिताराथाई (अलिपिनिया गालंगाल) एवं निम्बुघास (सिम्बोपोगोन फ्लेक्सौस)
अम्बाजिपेट	:	पाचौली और सिट्रोनेल्ला
जगदलपुर	:	आमहल्दी
काहिकुची	:	पाचौली
भुवनेश्वर	:	स्टेविया और अरटेन्सिया
मन्डौरी	:	एकांगी
रत्नगिरी	:	निम्बुघास और शिशुमूल
वेप्पम्कुलम	:	अल्पिनिया गलांगल

अलियार नगर,अम्बाजिपेट, अरसिकरे, जगदलपुर, काहिकुची, मन्डौरी, रत्नगिरी और वेप्पम्कुलम केंद्रों के नारियल बाग में मिश्रित फसल के रूप में वर्ष 2008 में 25 पौध और 25 ऊत संवर्द्धित सामग्रियों (विश्व नोनी अनुसंधान फाऊंडेशन, चेन्नै से प्राप्त) की रोपाई के साथ मोरिन्डा सिट्रि फोलिया के निष्पादन पर निरीक्षण परीक्षण प्रारंभ किया गया। मोरिंडा सिट्रि फोलिया पौध की स्थापना एवं वृद्धि सभी केंद्रों में अच्छी पायी गयी। और सभी केंद्रों में फलन फूलन अंकित किया गया।

ग्यारहवीं पंचवर्षीय योजना कार्यक्रम के रूप में भारत के पूर्वी और पश्चिमी क्षेत्रों में तेल ताड़ के प्रबंधन पर अनुसंधान परियोजना मधोपुर और पसिघट केंद्रों में शुरु किया गया। दोनों केंद्रों में तेल ताड़ फसल वृद्धि प्रशंसनीय है। अरुणाचल प्रदेश राज्य में पसिघट केंद्र में इस वर्ष कुछ तेल ताड़ पौध (वर्ष 2006 में रोपित) फूलने लगे हैं।

किल्लिकुलम और पांडिरिमामिडी केंद्रों में पॉमैरा में कटाई एवं कटाई उपरांत प्रक्रमण और मूल्य वर्द्धन पर निम्न चार अनुसंधान परियोजनाएँ प्रारंभ की गई।

पी एच टी 1, पुष्प रस निस्सारण और फूल नीर आधारित उपज (गुड़, ताड़ चीनी, सितोपल) का मानकीकरण और वाणिज्यिकरण

पी एच टी 2 कंद चूर्ण आधारित उपज जैसे पिज्जा, बेकरी उत्पाद, मिठाई , स्वास्थ्य मिश्रण आदि)

पी एच टी 3 इंधन और रेशा के निस्सारण के लिए पॉमैरा पौध के भागों का उपयोग

पी एच टी 4 पॉमैरा मृदल फल भ्रूणपोष के लिए परिक्षण तकनीकी का मानकीकरण

फसल संरक्षण: वेप्पम्कुलम केंद्र में उनकी प्रचण्डता परीक्षण किए गए गनोडरमा लूसिडम के 17 एकलनों के बीच नारियल पौध में पत्तों की संख्या , पौध की ऊँचाई और पौध की परिधि कम करने में टी टी 1 एकलन अधिक प्रचण्ड पाया गया। तमिलनाडु के विभिन्न जिलों में पाए गए जड़ मुर्झा रोग के सर्वेक्षण से यह देखा गया कि तिरुनलवेली जिला के षेनगोट्आई में रोग लक्षण (5.1%) अधिक है। और कन्याकुमारी जिले के तिरुवट्टूर ब्लॉक में (3.30%) और कोयम्बत्तूर जिले के अनाईमलाई ब्लॉक में (0.11%) पाया गया। जबकि थेनी जिला के बोडी ब्लॉक में संग्रमित पेड़ नहीं पाया गया।

नारियल के कली सड़न रोग के विरुद्ध टी विरिडे और पी फ्लूरोसेंस का विभिन्न संविन्यास के प्रभाव पर अम्बाजिपेट केंद्र में किए गए प्रक्षेत्र परीक्षण से यह देखा गया कि 10 ग्रा दर में स्यूडोमोनस फ्लूरोसेंस का टाल्क संविन्यास, 10 ग्रा दर में त्रैकोडेरमा विरिडे और दोनो जैव एजेंट के 50% और 100% संवर्द्धन पावित के प्रयोग की तुलना में प्रभावी पाया गया।

अम्बाजिपेट केंद्र में नारियल में तनास्त्रवण रोग के विरुद्ध विरोधी के प्रक्षेत्र मूल्यांकन में यह पाया गया कि तना स्त्रवण रोग प्रभावित दरारों पर टी विरिडे लेप लेपन करने से तना स्त्रवण रोग का लक्षण ही नहीं बल्कि रोग फैलाव का भी नियंत्रण किया जाता है।

अलियार नगर केंद्र में नारियल का पत्ता चित्ती रोग (लासियोडिप्लोडिया थियोब्रोमे) प्रबंधन पर पोल्लाची तहसील के तीन गाँवों में कृषकों के क्षेत्रों में तीन स्थानों पर अध्ययन आयोजित किया गया ।आंकडे से यह देखा गया कि नीम केक (5 कि ग्रा /ताड़/वर्ष) के साथ पी. फ्लूरोसेंस (50 ग्रा/ताड़/वर्ष) के मृदा प्रयोग और बाद में अर्धवार्षिक अंतराल में पी फ्लूरोसेंस का 100% संवर्द्धन पावित का मूल वेधन से पत्ता चित्ती रोग प्रबंधन में प्रभावी पाया गया।

नारियल बाग में एरियोफिड कीट का प्रबंधन पर अलियार नगर, अम्बाजिपेट और रत्नगिरी केंद्रों द्वारा आयोजित अध्ययन से एरियोफिड कीट संख्या में गणनीय कमी पायी गयी। और समीकृत कीट प्रबंधन के बिना उपचारित बाग की तुलना में समीकृत कीट प्रबंधन उपचारित बाग में गुठली क्षति अंकित किया जा सकता है। कें रो फ अ सं, कासरगोड़ के कीटविज्ञान प्रयोगशाला के साथ के सहयोग में अलियारनगर केंद्र में अधिसाधारणतया उपयुक्त वनस्पतीय जैसे अज़ाडिराटिन और रसायन डैक्लोरवोस और मोनोक्रोटोफोस के साथ ब्राकोनिंड्स की संगतता पर अध्ययन किया गया। ब्राकोन ब्रेविकोर्निस परजीव्याभ के लिए एल डी 50 अध्ययन के आधार पर यह अनुमित किया जा सकता है कि मोनोक्रोटोफोस अधिक विषालु और मालथियॉन, कारबोसल्फान, फोरेट उससे कम विषालु है।

द्विवार्षिक समूह बैठक

अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना पर उन्नीसवीं द्विवार्षिक बैठक अक्तूबर 12-14, 2009 तक नवसारी कृषि विश्वविद्यालय, नवसारी में आयोजित की गई। अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना केंद्र, राज्य कृषि विश्वविद्यालय, कें. रो. फ. अ .सं, डी .ओ .पी .आर, नारियल विकास बोर्ड, राज्य बागवानी विभाग से कुल 75 प्रतिनिधियों ने द्विवार्षिक बैठक में भाग लिया। डॉ. एच पी. सिंह, उप महानिदेशक, बागवानी, भा .कृ.अनु. प; डॉ. एच.सी. पथक, कुलपति, एन. ए. यु., डॉ एस. राजन, सहायक महा निदेशक, बागवानी, भा. कृ. अनु .प., डॉ .जॉर्ज. वी. थॉमस, निदेशक, कें .रो फ. अ. सं; डॉ. एम. कोच्चु बाबु, निदेशक, डी. ओ.पी.आर., डॉ. एन. एल .पटेले, डीन, बागवानी एवं वानिकी कालेज, एन. ए .यु , डॉ. टी. जयराज, निदेशक, टी. आर. आर. आई., अडुथुरै, डॉ .आर. जे. रबिन्द्रा, निदेशक, एन. बी. ए. आई. आई ने इस बैठक में भाग लिया और कार्यवाईयों पर मार्गदर्शन दिया।

डॉ. एच. पी सिंह, उप महानिदेशक, बागवानी, भा. कृ. अनु. प. ने द्विवार्षिक बैठक का उद्घाटन किया। डॉ एच.सी. पथक, कुलपति, नवसारी कृषि विश्वविद्यालय ने 12 अक्तूबर 2009 को 9.30 बजे आयोजित उद्घाटन समारोह की अध्यक्षता की। डॉ. एस. अरुल राज, परियोजना समन्वयक ताड़ ने वर्ष 2008-2009 अवधि की विशेष उपलब्धियाँ प्रस्तुत की। डॉ. एस. राजन , सहायक महानिदेशक, बागवानी-1 ने विशेष भाषण दिया ।उद्घाटन समारोह के बाद `नारियल अनुसंधान एवं विकास में उभर आती नई समस्याएँ` एक विशेष सत्र डॉ. एच. पी. सिंह, उप महानिदेशक बागवानी, भा .कृ .अनु .प की अध्यक्षता के अधीन आयोजित किया गया। छह तकनीकी सत्रों में द्विवार्षिक समूह बैठक का विचार-विमर्श आयोजित किया गया और अंतिम सत्र में प्रमुख निर्णय/सिफारिशें प्रस्तुत की गई। क्रमानुगत क्षेत्र के प्रतिष्ठित वैज्ञानिकों द्वारा तकनीकी सत्रों की अध्यक्षता की गई। विभिन्न केंद्रों के परियोजनाओं में कार्यरत वैज्ञानिकों को प्रगति रिपोर्ट प्रस्तुत करने का अवसर प्रदान किया गया और उपलब्धियों पर तथा जारी अनुसंधान कार्यक्रम प्रबल करने की कार्रवाई पर विस्तृत चर्चा की गई।

डॉ एस राजन, सहायक महानिदेशक (बागवानी), भा. कृ .अनु. प. ने अंतिम सत्र की अध्यक्षता की। डॉ. एच. सी. पथक, कुलपति, नवसारी कृषि विश्वविद्यालयअंतिम सत्र के गणमान्य अतिथि थे। परियोजना समन्वयक ताड़ ने विभिन्न सत्रों से निकाले गए प्रमुख सिफारिशें तथा वर्ष 2010-2011, और 2011-2012 के लिए तकनीकी कार्यक्रम प्रस्तुत किए। विस्तृत चर्चा के आधार पर वर्ष 2010-2011, और 2011-2012 के तकनीकी कार्यक्रम कुछ आशोधन के बाद अनुमोदित किया गया।

अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना के कार्यान्वयन में हुई प्रगति भारतीय कृषि अनुसंधान परिषद और भा. कृ.अनु.प. के वैज्ञानिक, एस. ए. यु पद्धति के आधार पर है। वर्तमान में मौजूद परियोजनाओं के प्रबलीकरण के साथ अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना लघु पैमाने के करोड़ो के आय स्तर बढ़ाने में मदद करने की प्रतीक्षा रखते है और उनके जीवन स्तर उन्नत करने में साध्य होंगे।

EXECUTIVE SUMMARY

More than 20 million people in rural areas are engaged in the production, processing and marketing of coconut, oil palm and palmyrah and their products. To improve the productivity in these crops and thus the income level of the farmers, the All India Coordinated Research Project on Palms was started in 1972. The broad objectives of the Project are to identify, conserve and utilize elite gene sources for useful traits in coconut, oil palm, palmyrah and underutilized palms from different agro-climatic regions; to evolve crop management technologies for location-specific coconut based farming systems; to evolve location-specific crop management technologies for oil palm cultivation and to standardize location-specific bio-control based integrated pest and disease management schedules for coconut.

At present, the Project is implemented in 20 Centres including its headquarters at Kasaragod (Kerala); Aliyarnagar, Aduthurai, Killikulam, Veppankulam (Tamil Nadu); Arsikere, Gangavathi (Karnataka); Ambajipeta, Pandirimamidi, Vijayarai (Andhra Pradesh); Bhubaneshwar (Orissa); Navsari (Gujarat); Madhopur, Sabour (Bihar); Pasighat (Arunachal Pradesh); Kahikuchi (Assam); Mondouri (West Bengal); Jagadalpur (Chhatisgarh); Ratnagiri and Mulde (Maharashtra). Out of the 20 Centres, 12 Centres are conducting research on coconut, six on oil palm and two on palmyrah. The budget for the year 2009-10 was Rs. 346.66 lakhs of which the ICAR share was Rs. 260.00 lakhs.

Relative priorities

Considering the relative importance of the mandate crops, in the XI Five Year Plan period, 70.24% of budget is allotted to coconut, while oil palm crop received 19.98% of budget and palmyrah Centres are allotted with 9.78%.

During the period 2009-10, significant progress has been made in implementing the research programmes at AICRP on Palms Centres. An high yielding variety in coconut and a coconut hybrid could be recommended for their promotion for commercial cultivation. Important crop management technologies in coconut and oil palm are being scaled up to commercial adoption status in different States. Major highlights of research findings in the three mandate crops are presented here:

Recommendations approved for commercialization during 2009-10

Coconut varieties/hybrids

Kalpatharu : Considering the higher nut yield (15,750 nuts/ha), better copra out turn of 2.7 tonnes/ha @ 15.48 kg/palm/year with oil content (67.2%), drought tolerance attributes and adaptability to water deficit regions, the accession IND 125S was recommended to be released for cultivation in Karnataka, Tamil Nadu and Kerala States.

Kalpa Samrudhi: Considering the superiority of the coconut hybrid IND 376 (a hybrid between IND 058S x IND 069S) for higher nut yield (117 nuts/palm), higher copra out turn (25.72 kg/palm/year) and oil yield of 3.04 tonnes/ha under rainfed conditions, the semi tall habit, good tender nut water quality (TSS 6° brix) and tender nut water yield (346 ml/ tender nut) and drought tolerance nature, the hybrid is recommended for release. As the hybrid is performing well at Kasaragod and Kahikuchi Centres, the hybrid is recommended for cultivation in Assam and Kerala States.

Crop Management Technologies

Intercropping (of medicinal and aromatic plants) in coconut gardens with lemon grass (*Cymbopogon flexuosus*), garden rue (*Ruta graveolens*), thulsi (*Ocimum sanctum*), Kalmegh (*Andrographuis paniculata)*, Arrow root (*Maranta arundinaceae*) and Makoi (*Solanum nigrum*) were found to be economically profitable and hence recommended for maidan tract of Karnataka.

Recommended models of Coconut Based Cropping Systems:

Assam	:	Coconut + black pepper + turmeric
Chattisgarh	:	Coconut + black pepper + bottle gourd+cowpea
West Bengal	:	Coconut + black pepper + pineapple
Coastal Tamil Nadu	:	Coconut + black pepper + banana + elephant foot yam + coriander
Orissa	:	Coconut+banana+tube rose (in young coconut garden)

Drip irrigation @ 100% Eo is recommended for coconut in the *maidan* tract of Karnataka. Water to be applied during summer months (February-May) is 65-75 litres per palm per day, while for winter and rainy months, water requirement is 40-50 litres/palm/day.

In West Bengal State, 50% N requirement for coconut crop could be supplied through composted coir pith and the balance requirement of N, P and K could be applied as chemical fertilizers.

Application of 1000: 250: 1000 g NPK per palm per year in two splits is recommended for coconut hybrids in Maidan tract of Karnataka.

Crop Protection Technologies

Release of egg/larva predator, *Cardiostethus exiguus*, in the crown of 10 % of coconut palms in a garden @ 50 bugs / palm at 5 days interval for six times consecutively at egg-early larval stages of coconut black headed caterpillar (*Opisina arenosella*) gives effective control of the pest in Tamil Nadu and Andhra Pradesh States.

Other significant findings

Crop Improvement

The following coconut and oil palm varieties/hybrids are performing well in different Centres as indicated. These varieties/hybrids could be proposed for release after confirming their performance and collection of required additional details.

Coconut

Aliyarnagar : IND 042; IND 018

Ambajipeta : Gauthami Ganga x Chandra Kalpa; Double Century x Gauthami Ganga

Arsikere : Gauthami Ganga x Chandra Kalpa

Veppankulam : IND 037

Oil palm

Mulde : 124D x 266P Tenera Hybrid

Vijayarai : 104D x 98P Tenera Hybrid

Gangavathi : 108D x 291P Tenera Hybrid

Evaluation on the performance of new experimental cross combinations of Tall x Tall hybrids in coconut in major agro-climatic regions has been initiated during the year. Under this programme, Ambajipeta and Veppankulam Centres are evaluating seven and eight cross combinations respectively for their performance in the East-coast region and Ratnagiri Centre was evaluating the performance of eight cross combinations for their suitability to the West-coast region.

Screening of cocoa clones for their performance as a mixed crop in coconut garden has been initiated at Ambajipeta, Navsari and Veppankulam Centres with the planting of five new cocoa clones received from CPCRI Regional Station, Vittal. Similarly, screening of recently released pepper varieties for their performance as a mixed crop in coconut garden has been initiated at Kahikuchi, Mondouri and Sabour Centres with the planting materials of five pepper varieties viz., IISR Thevam, IISR Shakti, IISR Malabar Excel, Sreekara and Panniyur-1 received from Indian Institute of Spices Research, Calicut.

As a part of XIth Five Year Plan programme, research on sulphi palm (*Caryota urens)* has been initiated at Jagadalpur Centre (Chhattisgarh State) with the following trials: Collection, conservation and evaluation of sulphi (*Caryota urens*) germplasm; Growth and development studies in sulphi palm (*Caryota urens*) and Documentation of ethno-botanical information on sulphi palm (*Caryota urens*) in Bastar region of Chhattisgarh.

Crop management

The following medicinal and aromatic plants could be recommended for cultivation as intercrops in coconut gardens in the respective regions (after confirming the results for two more years).

Aliyarnagar : Sitharathai (*Alipinia galangal*) and Lemon grass (*Cymbopogon flexuosus*)

Ambajipeta : Patchouli and Citronella

Jagadalpur : Amahaldi

Kahikuchi : Patchouli

Bhubaneshwar : *Stevia* and *Artensia*

Mondouri : Ekangi

Ratnagiri : Lemon grass and Arrow root

Veppankulam : *Alpinia galangal*

An observational trial on the performance of *Morinda citrifolia* as a mixed crop in coconut garden has been initiated at Aliyarnagar, Ambajipeta, Arsikere, Jagadalpur, Kahikuchi, Mondouri, Ratanagiri and Veppankulam Centres during 2008 with the planting of 25 seedlings and 25 tissue culture materials (received from World Noni Research Foundation, Chennai) at each Centre as a mixed crop in coconut garden. Establishment

and growth of *Morinda citrifolia* plants has been good in all the Centres with flowering and fruit set being recorded at all the Centres.

As a part of the XI Five Year Plan programme, research projects on the management of oil palm gardens in Eastern and North-eastern regions of India have been initiated during the year at Madhopur and Pasighat Centres. Oil palm crop growth was appreciable in both the Centres. A few oil palm plants at Pasighat Centre in Arunachal Pradesh State (planted in the year 2006) have started flowering during the year.

The following four research projects on pre and post harvest processing and value addition in palmyrah have been initiated at Killikulam and Pandirimamidi Centres: Standardization and commercialization of inflorescence sap extraction and inflorescence sap based products (jaggery, palm sugar and candy); Standardization of tuber flour based food products (like pizza, bakery items, confectionery, health mix etc.); Utilization of palmyrah plant parts for the extraction of fibre and fuel and Standardization of preservation technique for palmyrah tender fruit endosperm.

Crop Protection

Among the 17 isolates of *Ganoderma lucidum* tested for their virulence at Veppankulam Centre, TTI - I isolate was found to be more virulent in terms of reducing the number of leaves in coconut seedlings, height of the seedlings and girth of seedlings.

From the survey conducted on the occurrence of root (wilt) disease of coconut in various districts of Tamil Nadu, it was found that the root (wilt) disease incidence was more in Shengottai block of Tirunelveli district (5.1%) followed by Thiruvattar block of Kanyakumari district (3.30%) and Anaimalai block of Coimbatore district (0.11%), while there was no infected trees in Bodi block of Theni district.

Field experiment at Ambajipeta Centre on the effect of various formulations of *T. viride* and *P. fluorescens* against bud rot disease of coconut indicated that application of talc formulation of *Pseudomonas fluorescens* @ 10g was found effective when compared to *Trichoderma viride* @ 10g and application of culture filtrates of 100% and 50% of both the bioagents.

Field evaluation of antagonists against stem bleeding disease in coconut at Ambajipeta Centre revealed that smearing of *T.viride* paste on stem bleeding patches not only controlled the incidence but also prevented the spread of stem bleeding disease.

At Aliyarnagar Centre, studies on management of leaf blight disease (*Lasiodiplodia theobromae*) of coconut were conducted at three locations in farmers' holdings in three villages of Pollachi Taluk and the data indicated that soil application of *P. fluorescens* (50 g/palm/year) along with neem cake (5 kg/palm/year) followed by root feeding of 100% culture filtrate of *P. fluorescens* at half yearly intervals was effective in managing the leaf blight disease.

Studies on the management of eriophyid mite in coconut gardens conducted by Aliyarnagar, Ambajipeta and Ratnagiri Centres indicated that significant reduction in eriophyid mite population and nut damage could be recorded in IPM treated gardens compared to non-IPM gardens.

Studies on the compatibility of Braconids with most commonly used botanicals like Azadirachtin and chemicals Dichlorvos and Monocrotophos was carried out at Aliyarnagar Centre in collaboration with Entomology Laboratory of CPCRI, Kasaragod. Based on LD_{50} studies, it could be inferred that monocrotophos was the most toxic followed by malathion, carbosulfan, phorate and carbaryl for parasitoid *Bracon brevicornis.*

Biennial Group Meeting

The XIX Biennial Group Meeting on All India Coordinated Research Project on Palms was held during October 12-14, 2009 at the Navsari Agricultural University, Navsari. The Biennial Group Meeting was attended by 75 delegates from AICRP on Palms Centres, State Agricultural Universities, CPCRI, DOPR, Coconut Development Board and State Department of Horticulture. Dr. H.P. Singh, Deputy Director General (Hort.), ICAR, Dr. H.C. Pathak, Vice Chancellor, NAU, Dr. S. Rajan, Assistant Director General (Hort I), ICAR, Dr. George V. Thomas, Director, CPCRI, Dr. M. Kochu Babu, Director, DOPR, Dr. N.L. Patel, Dean, College of Hort. & Forestry, NAU, Dr. T. Jayaraj, Director, TRRI, Aduthurai and Dr. R.J. Rabindra, Director, NBAII participated in the Meeting and guided the proceedings.

The Biennial Group Meeting was inaugurated by Dr. H.P. Singh, Deputy Director General (Hort.), ICAR. Dr. H.C. Pathak, Vice Chancellor, Navsari Agricultural University presided over the Inaugural Session held on October 12, 2009 at 09.30 hrs. Dr. S. Arulraj, Project Coordinator (Palms) presented the salient achievements made during the period 2008 and 2009. Dr. S. Rajan, Assistant Director General (Hort.I) delivered the Special

Address. Following the Inaugural Session, a Special Session on "Emerging issues in coconut research and development" was held under the chairmanship of Dr. H.P. Singh, Deputy Director General (Hort.), ICAR.

The deliberations of the Biennial Group Meeting were conducted in six Technical Sessions, chaired by eminent scientists in the respective fields. Scientists working in the Projects at various Centres were given opportunity to present the progress reports. Detailed discussions were held on the findings and actions to be taken for strengthening the on-going research programmes.

The Plenary Session was chaired by Dr. S. Rajan, Asst. Director General (Hort.I), ICAR. Dr. H.C. Pathak, Vice Chancellor, Navsari Agricultural University was the Guest of Honour for the Plenary Session. Project Coordinator (Palms) presented the salient recommendations emerging from different Technical Sessions and also the Technical Programme for 2010-11 and 2011-12. Based on detailed discussions, the Technical Programme for 2010-11 & 2011-12 was approved with certain modifications.

The progress made in the implementation of AICRP on Palms was possible due to the generous guidance and support given by ICAR and Scientists in ICAR and SAU systems. With the strengthening of existing projects, the All India Coordinated Research Project on Palms is expected to help in increasing the income level of millions of small farmers and thus would enable them to raise their standard of living.

3. COCONUT VARIETY RELEASED IN 2009-10

KALPATHARU

1. **Name of the variety:**

   Kalpatharu

2. **Recommended region for cultivation:** Rainfed as well as irrigated situation in Interior Karnataka and Kerala states & irrigated coconut belts in Tamil Nadu.

3. **Salient features:** IND 125 S is a selection from Tiptur Tall, a popular cultivar being grown extensively in the Interior Karnataka. It is a tall palm with circular crown, oval shaped nuts of green colour. The palms take about 6-7 years for flowering. The average yield of nuts per ha is 15925, from 80-120 nuts/ palm. The mean copra content is 172 g/ nut. Approximately, 5600-6800 nuts are required to make one tonne of copra. The oil content in copra is 67.2 %. Oil contains 44.7 per cent of lauric acid.

4. **Contact addresses for further details and planting material requirements**

1. Scientist in-charge
   AICRP on Palms
   Horticultural Research Station (UHS),
   Arsikere 573 103, Hassan Dist. Karnataka
   (Phone : 08174-232465)
   Email : basavarajutb@yahoo.co.in

2. Professor & Head
   Coconut Research Station,
   Aliyarnagar, Coimbatore Dist.,
   Tamil Nadu
   (Phone : 04253-288722),
   Email : arsaliar@tnau.ac.in

COCONUT

4.1 Crop Improvement

Gen.1: Utilization of existing germplasm and description of varieties

(Aliyarnagar, Arsikere, Bhubaneshwar, Sabour, Veppankulam)

Germplasm evaluation trial was continued in five Centres to assess the performance of selections from indigenous and exotic cultivars in different regions of the country. The planting materials were supplied from CPCRI, Kasaragod and AICRP on Palms Centre, Veppankulam.

Aliyarnagar

A total number of 43 genotypes representing different geographic origins were obtained from CPCRI, Kasaragod and are being maintained as three sets. First set consists of 15 accessions planted during 1988. The second set consists of 17 genotypes planted during 1990. The third set comprises of 15 genotypes planted during 1994. Four genotypes are present as duplicates among the three sets. Set I and Set II trials were concluded during 2005 and 2007 as decided in the XVII and XVIII Biennial Group Meetings respectively. In the XIX Biennial workshop held at Navsari Agricultural University during 2009, it has been decided to conclude the ongoing Set III trial in 2012.

In Set III, VPM-3 produced the maximum number of functional leaves (39 nos). Palms in CRP 507 and CRP 505 had reached a height of 780 cm. Nut yield during the

Table 1: Morphological observations recorded in the Set III germplasm (Aliyarnagar, 2009)

Sl. No	Genotype	Rate of leaf production	Nut yield/ palm/year	Weight of the nut (g)	Weight of the dehusked nut (g)	Weight of the kernel (g)	Volume of water (ml)	Copra yield / nut (g)	Copra yield (kg/ palm / year)
1	IND 032	9.0	60.0	1662.50	712.50	350.00	200.00	210	11.61
2	IND 072	10.0	85.0	815.00	510.00	300.00	152.50	190	15.92
3	CRP 509	10.0	83.3	785.00	630.00	350.00	232.00	210	17.91
4	Kera Keralam	10.3	118.0	1132.50	445.00	220.00	158.00	210	24.15
5	Kalpa Dhenu	10.7	48.3	1605.00	1148.50	507.00	250.00	211	18.62
6	CRP 505	11.0	95.0	1600.00	1175.00	515.00	133.20	250	23.18
7	Kera Bastar	11.9	67.2	1045.00	682.50	317.50	121.00	240	15.82
8	CRP 506	10.0	80.0	1182.00	745.00	356.00	193.00	235	19.34
9	IND 007	10.0	42.0	887.50	587.50	270.00	176.00	205	9.02
10	IND 011	9.5	44.0	2287.50	1040.50	577.50	495.00	240	9.60
11	Kera Chandra	9.5	85.0	1157.50	852.50	405.00	190.00	225	18.65
12	IND 001	11.0	48.5	1165.00	667.50	310.00	132.50	195	7.82
13	CRP 507	9.3	62.0	1107.50	627.50	310.00	142.50	190	11.40
14	IND 042	11.0	108.3	900.00	522.50	285.00	140.00	160	16.85
15	VPM-3	10.0	110.0	1165.00	657.50	380.00	162.50	185	20.52
	Mean	9.61	75.77	1233.13	663.10	363.53	191.88	224	16.03

year ranged from 42 nuts/palm/year (IND 007) to 118 nuts/palm/year (Kera Keralam) (Table 1). The cumulative mean nut yield was highest in Kera Keralam and VPM-3 (111.8 nuts) followed by IND 042 (107.6) and CRP 505 (91.6). The volume of water in 10 month old nuts was the highest in IND 011 (495ml). Weight of split nut (907.5g) and kernel weight (577.5g) were also the highest in IND 011. Copra yield (kg per palm per year) varied from 7.82 kg (IND 001) to 24.15 kg (Kera Keralam). CRP 505 could yield the highest copra content of 250g/nut among the Set III genotypes.

Arsikere

The germplasm evaluation trial was initiated to assess the performance of indigenous and exotic cultivars in different regions of the country. The trial consisting of 12 coconut cultivars was laid out at the centre during 1994 in non-replicated design in red sandy loam. Observations on growth parameters, yield of nuts and copra were recorded.

Among the 12 cultivars being tested, the tree height and functional leaves were higher with IND 007, the tree girth was higher with IND 034, while cumulative leaf production was higher with IND 058. The nut yield per palm during 2008-09 was higher with IND 058 followed by IND 048, Kalpatharu, IND 077 and IND 076. The copra yield was higher with Kalpatharu followed by IND 036, IND 058, IND 076 and IND 080. The mean data over last four years showed that the nut yield per palm was higher with IND 048 followed by IND 076, IND 077 and IND 058. The mean copra yield per palm was higher with Kalpatharu followed by IND 076, IND 036, IND 048, IND 077 and IND 058. Considering the nut and copra yield, it could be inferred that the cultivars IND 048, IND 058, IND 076 and IND 077 could be used as parents in hybridization programme in coconut.

Bhubaneshwar

The experiment was planted during December, 2004 at Bhubaneswar with 16 varieties, which include five dwarf varieties, 10 tall varieties and a check variety. The growth parameters of the 16 varieties are given in the Table 3.

Table 2: Growth and yield of different cultivars of coconut (Arsikere 2009)

Sl. No.	Cultivar	Tree height (m)	Tree girth (cm)	Rate of leaf production	Nut yield per palm	Copra yield (kg/palm)	Oil content (%)	Oil yield (kg/ palm)
1	IND 037	6.00	112.90	12.40	50.6	6.17	65.38	4.04
2	IND 034	5.53	119.36	12.27	43.5	6.26	62.84	3.94
3	IND 050	6.32	106.91	12.54	63.6	9.76	55.31	5.40
4	IND 077	6.71	105.60	12.90	80.0	9.22	60.78	5.61
5	IND 080	4.83	101.83	12.33	77.7	9.32	64.53	6.02
6	IND 076	5.57	94.33	12.03	78.4	9.89	62.45	6.18
7	Kalpa Mitra	5.50	107.80	12.30	53.2	8.32	61.93	5.15
8	IND 036	6.07	95.44	12.67	71.1	10.49	66.39	6.96
9	IND 058	5.72	86.00	13.34	90.4	10.40	51.91	5.40
10	IND 048	5.95	89.25	13.75	86.0	10.03	53.98	5.41
11	IND 074	3.58	74.75	11.12	72.6	8.78	62.15	5.46
12	Kalpatharu	4.35	97.25	12.58	81.5	13.04	64.71	8.44

The data revealed that Kera keralam recorded maximum girth of 83.6 cm and IND 025 recorded the maximum height (408 cm). The girth and height of the germplasm types ranged between 31.5 to 83.6 cm and 156.66 to 408.08 cm respectively. Number of leaves on the crown ranged between 12 to 19.33 and number of leaves produced per year ranged between 7.0 to 10.0.

Table 3: Vegetative characters of coconut germplasm (Bhubaneswar 2009)

Sl. No.	Germplasm	Girth (cm)	Height (cm)	Rate of leaf prduction	Leaf length (cm)
1	IND 007	39.6	246	10.0	198
2	Kalpa Raksha	80.4	392	9.2	300
3	IND 058	42.4	242	8.6	191
4	Gauthami Ganga	77.0	384	10.0	286
5	IND 041	35.0	300	8.0	260
6	IND 009	64.2	322	8.0	263
7	IND 025	75.8	408	9.0	280
8	Kera Keralam	83.6	316	9.8	305
9	Kalpatharu	71.6	156	9.3	327
10	IND 053	75.6	386	8.3	343
11	Kalpa Mitra	31.5	217	8.0	185
12	IND 036	62.2	347	8.6	360
13	IND 018	50.8	315	9.0	273
14	IND 037	35.0	252	7.0	230
15	Pratap	38.3	198	7.0	203
16	IND 034	40.0	330	8.0	260

Maximum leaf length (343.33 cm) and petiole length (116.66 cm) were recorded by IND 053 whereas minimum leaf length (185 cm) was in Kalpa Mitra and minimum petiole length (72.0 cm) was found in IND 007.

Sabour

Seedlings of IND 041 were received from Coconut Development Board Farm at Madhopur and planted in the Sabour College Campus Farm. Seed nuts of IND 048, IND 074, IND 007, IND 058 and Gauthami Ganga were received from CPCRI Research Centre, Kidu during December, 2009 and planted in the nursery. Germination percentage of seed nuts was very low.

Veppankulam

Set II germplasm trial was planted in 1994. Morphological and reproductive traits in germplasm entries were recorded and presented in Table 4.

Among the eleven varieties, CRP 509 recorded the highest annual yield of 113.0 nuts/palm followed by VPM-3 and IND 040 (91 nuts/palm). The VPM-3 recorded the highest cumulative yield of 78.9 nuts/palm followed by CRP 509 (78.5 nuts/palm).

Among the 11 coconut genotypes, IND 034 recorded the highest whole nut weight (1575 g), dehusked nut weight (760 g), kernel weight (380 g), shell weight (220 g) and the copra weight (175 g). The kernel thickness was highest (1.3 cm) in IND 034, Kalpatharu and IND 050. The IND 050 recorded the highest nut length (24.8 cm) and IND 034 recorded highest nut breath (17.5 cm).

Gen.1 A: Collection, conservation and evaluation of local germplasm

(Aliyarnagar, Ambajipeta, Bhubaneshwar, Kahikuchi, Jagadalpur, Mondouri, Navsari, Ratnagiri, Sabour, Veppankulam)

Aliyarnagar

A total of 12 collections have been made and planted as an experiment comprising of four replications with

Table 4: Morphological and reproductive traits in germplasm (Veppankulam, 2009)

Sl. No.	Germplasm type	Nut yield / palm	Whole nut weight (g)	Dehusked nut weight (g)	Weight of kernel (g)	Weight of shell (g)	Weight of copra (g)
1.	IND 034	68.9	1575.0	760.0	380.0	220.0	175.0
2.	Chandra Kalpa	52.0	802.5	370.0	192.5	105.0	140.0
3.	Aliyarnagar Tall	71.0	880.0	390.0	215.0	130.0	112.5
4.	Kalpatharu	84.0	740.0	330.0	190.0	102.5	115.0
5.	IND 040	91.0	720.0	440.0	233.3	128.3	120.0
6.	IND 057	59.6	1320.0	652.5	335.0	142.5	147.5
7.	IND 050	70.0	1337.5	704.0	325.0	172.5	167.5
8.	VPM-3	91.0	1090.0	492.5	195.0	155.0	130.0
9.	Kalpa Dhenu	84.8	1165.0	515.0	250.0	137.5	132.5
10.	CRP 777	57.6	600.0	310.0	160.5	110.0	85.0
11.	CRP 509	113.0	1100.0	555.0	272.5	145.0	145.0

four palms representing each genotype per replication. Seedlings of the local collections have been underplanted in the field in two batches during 2007 and 2009. First Set trial of Gen 1A comprising of five ecotypes viz., CRP 735, CRP 736, CRP 737, CRP 743 and CRP 744 was planted in July,2007 (as under-planting). Since the entries were under-planted, the growth and establishment of the seedlings were weak. Growth observations recorded in these seedlings indicated that they had grown upto 150 cm in height with 7 to 8 leaves on an average. Set II of Gen 1A trial comprising of the ecotypes CRP 738, CRP 739, CRP 740, CRP 741, CRP 742, CRP 745 and CRP 746 (each with a minimum of 12 seedlings) were planted on 14.8.2008 and 17.12.2008. Seedlings are getting established in the main field.

Ambajipeta

The seed nuts of local germplasm accessions were collected during August,2005 and the nuts were raised in the nursery. Seedlings of accessions viz., CRP 747 [Pillalakodi green], CRP 748 [Pillalakodi brown], CRP 749 [Jonnalarasi green], CRP 750 [Jonnalarasi brown], CRP 751 [Gangabondam ecotype], CRP 752 [AMB ECT-1], CRP 753 [AMB ECT-2] were planted in the main block @ 12 plants per accession. The survey of local germplasm in East Godavari, Srikakulam and Vizianagaram districts was conducted and the seedlings of three ECT accessions viz., CRP 754 [AMB ECT-3], CRP 755 [AMB ECT-4] and CRP 756 [AMB ECT-5] were planted in nursery.

Bhubaneshwar

The experiment was planted during December,2003 at Bhubaneswar with 11 local germplasm accessions (CRP 790 to CRP 800). The experiment was fitted to RBD with three replications having 4 palms per plot. Data on growth parameters are presented in the Table 5.

CRP 790 showed vigorous growth with respect to height (708.6 cm), girth (142.6 cm), number of leaves on the crown (23.0) and number of leaves produced per year (11.8). The height of the germplasm ranged between 395.6 cm to 708.6 cm in CRP 792 and CRP 790 respectively. The girth of the germplasm types ranged between 69.9 cm to 142.6 cm respectively in CRP 799 and CRP 790. All the germplasm types recorded more than 17 leaves on the crown and produced 9 to11.8 leaves per year. Maximum petiole length (144.6 cm), leaf length (460.2 cm) and leaf breadth (214.1 cm) were recorded by CRP 790.

Jagadalpur

The experiment was initiated in the year 2006-07 to identify and characterize the i*n-situ* cold tolerant coconut palms that will give better performance even when exposed to low temperature of less than 10 ^{o}C for 2-3 months. In this regard, 10 palms were selected so far in

Table 5: Growth characters of local germplasm accessions (Bhubaneshwar, 2009)

Sl. No.	Germplasm type	Girth (cm)	Height (cm)	Leaves / palm	Leaves / year	Petiole length (cm)	Leaf length (cm)	Leaf breadth (cm)	Leaflet breadth (cm)
1	CRP 790 (Local Giant)	142.6	708.6	23.3	11.8	144.6	460.2	214.1	5.6
2	CRP 791 (Tinisira)	117.5	527.5	23.3	11.4	120.0	337.1	188.7	4.3
3	CRP 792 (Goja)	79.0	395.6	20.5	9.7	105.1	332.7	163.7	5.8
4	CRP 793 (Dhila)	81.8	442.2	21.7	10.0	112.8	354.4	186.1	4.7
5	CRP 794 (Bana)	89.2	414.2	22.0	10.4	108.1	358.3	175.3	5.6
6	CRP 795 (Chaka)	83.3	417.3	21.4	10.0	111.3	339.0	176.0	5.1
7	CRP 796 (Goal)	84.8	424.6	21.7	10.1	101.0	314.0	164.4	4.6
8	CRP 797 (Naragi)	108.4	519.2	18.8	10.3	117.5	396.8	177.6	6.0
9	CRP 798 (Suryabana)	80.1	453.9	17.8	9.2	109.4	342.4	184.6	4.3
10	CRP 799 (Jahaji)	69.9	412.2	20.8	10.3	104.1	317.0	175.6	5.7
11	CRP 800 (Dhanei)	75.4	403.6	20.8	10.1	111.3	330.6	166.1	4.9
	CD (0.5)	27.1	92.3	2.6	1.5	18.3	68.6	35.8	0.5

Local germplasm of Bastar zone in Chhattisgarh

Mother palm of Accession No. CRP 726

Mother palm of Accession No. CRP 723

Table 6: Passport data of local germplasm of coconut in Bastar region (Jagadalpur, 2009)

Sl. No.	Accession No.	Details on location of collection	No. of leaves	Spathe prodn	Nut yield/ palm/yr	Weight of kernel (g)	Nut water (ml)	Nut water quality	
								Na ppm	K ppm
1	CRP 723	Geedam Road, Jagdalpur	36	13	293	192	205	116	2147
2	CRP 724	Kondagaon	28	09	240	148	285	154	2078
3	CRP 725	Muchanar Nursery, Barsoor	29	09	160	151	265	166	2809
4	CRP 726	Kirandul Dist. Dantewada	28	11	231	175	343	653	2491
5	CRP 727	Karli, Dantewada	27	11	148	143	310	378	2624
6	CRP 728	Chitrakote Road, Jagdalpur	34	13	286	192	143	241	2536

2006-08 from different parts of Bastar Zone. Observations were continued to be recorded in all the selected palms according to proforma for germplasm collection (Table 6). Seed nuts were collected from the selected palms and seedlings were raised in the nursery.

Kahikuchi

Different accessions of coconut viz., CRP 701 to CRP 710 were collected from different locations of Kamrup, Nalbari, Borpeta and Darrang districts of Assam. Seedlings of these collections were planted in the main field during May, 2005 along with Kamrupa and Kera Keralam as check varieties in RBD with three replications.

As the experiment is in initial stage, observations on vegetative characters were recorded. The data presented in Table 7 shows that the maximum plant height (4.76m) and highest number of leaves (10.90) were recorded in CRP 702, which was collected from Kamrup district. On the other hand, the minimum plant height of 3.5m and lowest number of leaves of 9.1 were recorded in the collection CRP 708.

A new set of coconut germplasm was collected in areas not covered in the previous collection programme. Altogether, five new local germplasm accessions of coconut viz., CRP 711 to CRP 715 were collected from Nowgaon, Marigaon, Mangaldoi and Kamrup districts

Table 7: Growth characters of local germplasm of coconut (Kahikuchi, 2009)

Sl. No.	Germplasm accession	Plant height (m)	Production of leaves
1.	CRP 701	4.15	10.50
2.	CRP 702	4.76	10.90
3.	CRP 703	4.12	10.65
4.	CRP 704	4.55	10.00
5.	CRP 705	3.87	9.58
6.	CRP 706	3.77	10.84
7.	CRP 707	3.98	10.40
8.	CRP 708	3.50	9.10
9.	CRP 709	3.74	10.66
10.	CRP 710	3.58	10.25
11.	Kamrupa	4.10	10.50
12.	Kera Keralam	3.50	10.40
	C.D. at 5%	0.21	0.17

during December, 2007 – January, 2008 and seed nuts of these collections were sown in the nursery during February, 2008. About one year old seedlings of these collections were planted in the main field in the last week of April, 2009 following single row planting with six palms per collection. The experiment is in initial stage and observations on plant height and number of leaves in the seedlings were recorded.

Table 8: Growth characters of local germplasm (Set-II) of coconut (Kahikuchi, 2009)

Sl. No.	Germplasm accession	Plant height (m)	Production of leaves
1.	CRP 711	1.15	6.12
2.	CRP 712	1.02	6.00
3.	CRP 713	1.12	6.66
4.	CRP 714	1.18	5.92
5.	CRP 715	1.08	6.06

Mondouri

Ten local types of germplasm from different districts of West Bengal were collected. Five accessions (CRP 779 to CRP 783) have been planted as Set I in the main field during 2007 in RBD maintaining 7.5x7.5 m spacing. Another 5 types (CRP 784 to CRP 788) have been planted as Set II in main field during 2009.

As the Set I experiment is in initial stage, observations on vegetative characters were recorded (Table 9). Highest plant height (215.45cm) and girth (25.48) were recorded in the collection CRP 779.

Table 9: Growth parameters of local germplasm of coconut (Set I) (Mondouri, 2009)

Accession No.	Details of collections	Height (cm)	No. of leaves/year	Girth (cm)
CRP 779	MHRS-1 (Simurali)	215.45	8.2	25.48
CRP 780	MHRS2 (Chandannagar)	156.75	7.6	17.45
CRP 781	MHRS-3 (Tamluk)	167.24	7.9	18.45
CRP 782	MHRS-4 (Kulpi)	184.32	7.2	21.75
CRP 783	MHRS-5 (Basirhat)	180.22	8.5	22.15

Table 10: Collection and conservation of local germplasm of coconut (Set II) (Mondouri, 2009)

Accession No.	Collection No.	Name of village	Name of district
CRP 784	MHRS-6	Jagulia	Nadia
CRP 785	MHRS-7	Haringhata	Nadia
CRP 786	MHRS-8	Chakdaha	Nadia
CRP 787	MHRS-9	Diara	Hooghly
CRP 788	MHRS-10	Ramnagar	Midnapore (E)

Navsari

Seed nuts of six local germplasm types were collected from different regions of Gujarat (Table 11).

Table 11: Germplasm collections from Gujarat (Navsari, 2009)

Sl. No.	Code Name at present used	Accession number	Year of collection	Location of collection	Remarks
1	Hazarani	CRP 729	2009	Mangarol	Sweet kernel
2	Mahuva Orange	CRP 730	2009	Mahuva	CRS, Mahuva
3	Mahuva Green	CRP 731	2009	Mahuva	CRS, Mahuva
4	Mahuva Orange	CRP 732	2009	Mahuva	Farmer's field
5	Mahuva Green	CRP 733	2009	Mahuva	Farmer's field
6	Gandevi Selection	CRP 734	2009	Gandevi	FRS, Gandevi

Ratnagiri

Salient features of the observations recorded on vegetative growth characters of local germplasm accessions are listed here: In respect of girth, there was no significant difference between the treatments. In respect of height, there was significant difference between the treatments. CRP 759 recorded maximum height of 378.44 cm and was at par with other accessions CRP 757 (337.38 cm).

CRP 758 (363.31 cm) and CRP 761 (354.88 cm) which are statistically superior over CRP 760 and CRP 762. The minimum height was registered by CRP 760

(308.8 cm). In respect of number of leaves and total number of leaves, there was no significant difference between the treatments.

Table 12: Growth characters of local germplasm of coconut (Ratnagiri, 2009)

Sl. No.	Accession No.	Girth (cm)	Height (cm)	No. of leaves	Total no. of leaves
1	CRP 757 (KRBC-1)	49.94	337.38	3.88	18.75
2	CRP 758 (KRBC-2)	51.94	363.31	3.81	19.31
3	CRP 759 (KRBC-3)	56.63	378.44	3.56	18.06
4	CRP 760 (KRBC-4)	45.25	308.88	3.69	18.25
5	CRP 761 (KRBC-5)	48.81	354.88	3.69	18.56
6	CRP 762 (KRBC-6)	47.19	321.44	4.00	18.81
	S.E.	3.66	14.84	0.14	0.92
	C.D.	NS	44.75	NS	NS

Survey was conducted in Ratnagiri district (Ratnagiri and Guhagar) and 28 coconut palms of "Mohacha Naral" – sweet kernel coconut - were selected. From these 28 palms, 490 seed nuts of "Mohacha Naral" were collected and handed over to CPCRI during 2007-08 for further study. From these seed nuts, 10 embryo cultured sweet coconut seedlings were developed at CPCRI for planting at this Research Station and farmers' fields in Guhagar. Further survey was conducted in Guhagar Taluk and 14 palms were marked for further study. Seed nuts were collected for raising the seedlings.

Three seedlings each of fourteen types were planted in the field in July, 2009. Growth observations on height, girth and number of leaves were recorded at the time of planting (Table13).

Data on growth observations presented in Table 13

Table 13: Growth observations of germplasm types collected from Guhagar (Ratnagiri, 2009)

Sl. No.	Accession No.	Height (cm)	Girth (cm)	No. of leaves
1	CRP 763 (NSD-3)	251.67	22.67	8.33
2	CRP 764 (NSD-9)	279.67	21.67	8.33
3	CRP 765 (NSD-10)	281.33	24.33	9.67
4	CRP 766 (NSD-11)	237.33	17.00	9.00
5	CRP 767 (NSD-12)	220.67	17.00	9.00
6	CRP 768 (NSD-13)	199.89	17.00	9.00
7	CRP 769 (NSD-14)	296.67	24.67	9.00
8	CRP 770 (NSD-15)	308.67	24.33	8.00
9	CRP 771 (NSD-17)	281.67	20.33	7.67
10	CRP 772 (NSD-18)	242.33	19.00	9.67
11	CRP 773 (NSD-22)	236.67	17.67	9.00
12	CRP 774 (NSD-23)	163.00	16.67	8.00
13	CRP 775 (NSD-24)	220.67	18.00	9.33
14	CRP 776 (NSD-28)	232.33	26.67	10.00

reveal that CRP 770 recorded maximum height (308.67) followed by CRP 771 (281.67). In respect of girth, CRP 776 recorded maximum (26.67 cm), followed by CRP 769 (24.67cm). However, maximum number of leaves was observed in CRP 776 (10.00) followed by CRP 767 (9.67).

Sabour

Process for the identification of different types of coconut in Bihar State was initiated as per the criteria and discussions.

Veppankulam

During the period under report, data on morphological traits for local germplasm collections were recorded and presented in Table 14.

In Set I local germplasm, CRP 719 recorded the highest number of functional leaves (14.7), CRP 716 recorded longest petiole (1.65 m), longest length of leaves (4.57 m) and length of leaflet (119.0 cm) where as CRP 720 recorded the highest number of leaflets (165.0 cm).

Seed nuts of local germplasm types collected from Marandahalli (CRP 721) and Paramathivelur (CRP 722) in 2009 were planted in the nursery.

Another local germplasm type (CRP 718) with narrow thin trunk and good bearing habit was collected from Pulichankadu, Avanam, Peravurani (Tk.), Thanjavur (Dt.) for strengthening germplasm bank. The collected seed nuts (27) were sown on 02.02.2010 in the nursery in A4 block.

Gen.2: Production and evaluation of new cross combinations

(Ambajipeta, Arsikere, Bhubaneshwar, Jagadalpur, Ratnagiri, Veppankulam)

The hybrid evaluation trial was conducted to assess the performance of indigenous and exotic crosses along with local cultivars. The planting materials for the trial were produced at CPCRI, Kasaragod as well as at AICRP on Palms Centres at Ambajipeta and Veppankulam.

Ambajipeta

The trial was laid out during 1985 with six cross combinations in RBD with three replications. Data on yield attributes, nut yield and nut quality parameters were recorded and presented in Table 15.

It was observed that the highest nut yield per palm per year was recorded in cross combinations Gauthami Ganga x Chandra Kalpa (148.14nuts) and VHC-1 (132.92nuts) as compared to the control Godavari Ganga (114.34 nuts). However, the highest cumulative nut yield during pre-cyclone period was registered in Godavari Ganga (232.32 nuts) followed by Konkan Bhatye Coconut Hybrid-1 (231.24 nuts), whereas the highest cumulative nut yield during the post cyclone period was recorded in cross combinations Gauthami Ganga x Chandra Kalpa (1450.52 nuts) and Gauthami Ganga x Double Century (1440.52 nuts) compared to 1348.33 nuts in the check Godavari Ganga.

Regarding nut characters, the highest nut weight and dehusked nut weight was recorded in cross combination Gauthami Ganga x Kera Bastar (1350.20g/nut & 730.22 g/nut) followed by Gauthami Ganga x Double Century

Table 14: Morphological traits of local germplasm (Veppankulam, 2009)

Sl. No.	Accession No.	No. of functional leaves	Length of petiole (m)	Length of leaf (m)	No. of leaflets	Length of leaflet (cm)
1.	CRP 716 (VPM CON 1)	13.6	1.65	4.57	152.00	119.00
2.	CRP 717 (VPM CON 2)	14.3	1.35	4.28	158.00	98.00
3.	CRP 718 (VPM CON 3)	14.0	1.57	4.57	150.00	102.00
4.	CRP 719 (VPM CON 4)	14.7	1.45	4.28	162.66	105.66
5.	CRP 720 (VPM CON 5)	14.0	1.47	4.20	165.00	95.00
6.	Kera Keralam	15.6	1.52	4.50	161.30	105.00
7.	Aliyarnagar Tall	15.0	1.57	4.48	157.30	100.30

Table 15: Nut yield and quality of coconut crosses (Ambajipeta, 2009)

	Treatment	Whole nut weight (g/nut)	Dehusked nut weight (g/nut)	Nut water content (ml/nut)	Mean nut yield	Cumulative nut yield	
						Pre cyclone period (1989-1996)	Post cyclone period (1997-2009)
1	VHC-1	1150.64	700.56	135.00	132.92	141.12	1221.16
2	Godavari Ganga	910.15	660.34	185.00	114.34	232.32	1348.33
3	Konkan Bhatye Coconut Hybrid -1	1350.20	730.22	200.00	112.50	231.24	1007.36
4	Gauthami Ganga x Kera Bastar	1160.34	890.46	224.00	103.02	224.64	1273.25
5	Gauthami Ganga x Double Century	1060.34	710.26	135.00	105.12	152.36	1440.52
6	Gauthami Ganga x Chandra Kalpa	1000.52	620.00	125.00	148.14	165.42	1450.52

(1160.34 g/nut & 890.46 g/ nut) as compared to 1000.52 g/nut & 620.00 g/nut in Godavari Ganga (check).The highest husk weight was recorded in Gauthami Ganga x Kera Bastar (580.44g/nut) followed by VHC-1 (450.32 g/nut). Maximum water content in matured nut was recorded in cross combination Gauthami Ganga x Double Century (224.00 ml/nut) and Gauthami Ganga x Kera Bastar (200.00ml/nut) compared to 125.00 ml/ nut in Godavari Ganga.

Highest copra content was registered in the cross combinations Gauthami Ganga x Double Century (22.03 kg/palm/year) followed by Gauthami Ganga x Chandra Kalpa (21.37 kg/palm/year) as compared to 18.98 kg/ palm/year in the check Godavari Ganga. Maximum oil yield was registered in Gauthami Ganga x Chandra Kalpa (15.67 kg/palm/year) and Gauthami Ganga x Double Century (14.98 kg/palm/year) and Godavari Ganga (14.26 kg/palm/year).

Arsikere

Set I

The hybrid evaluation trial was initiated to assess the performance of indigenous and exotic crosses along with the local cultivar (Kalpatharu). The trial consisting of 9 hybrids and one local cultivar was laid out during 1987 in RBD with three replications. Observations on growth parameters, yield of nuts and copra were recorded.

The palm height and girth did not differ significantly between different cross combinations. The number of functional leaves and cumulative leaf production were significantly higher with Gauthami Ganga x Kerachandra cross compared to other cross combinations. The yield of nuts and copra per palm (Table 16) was significantly higher with Gauthami Ganga x Kera Bastar and on par with Gauthami Ganga x Kerachandra. The mean data over last 4 years showed that the nut yield and copra yield per palm were significantly higher with the cross combination of Gauthami Ganga x Chandra Kalpa followed by Gauthami Ganga x Kera Bastar and Gauthami Ganga x Kera Chandra. Hence these cross combinations could be recommended for cultivation in the *maidan* tract of Karnataka.

Trial on new hybrid combinations in coconut - Set-II

The Set II trial consisting of four hybrids and one local cultivar (Kalpatharu) was laid out during 1992 in RBD with four replications. Observations on growth parameters, yield of nuts and copra were recorded.

Gauthami Ganga x Chandra Kalpa

Table 16: Nut yield and quality of coconut cross combinations(Arsikere, 2009)

Sl. No.	Hybrid	Coconut yield (Nuts/palm/year)						Copra yield (kg/ palm)	Oil yield (kg/ palm)
		2005-06	2006-07	2007-08	2008-09	Mean (2 yrs) 2007-09	Mean (4 yrs) 2005-09		
1	Kapla Prathiba x Chandra Kalpa	26.00	49.23	62.00	62.80	62.40	50.01	6.49	4.31
2	Chandra Kalpa x Kera Chandra	34.36	70.10	78.07	73.77	75.92	64.07	8.31	5.58
3	Chandra Kalpa x Kalpa Prathiba	31.22	78.00	90.23	80.67	85.45	70.03	10.37	6.48
4	Kera Sankara	44.67	76.33	85.27	90.23	87.75	74.13	11.69	7.73
5	Kera Ganga	36.50	70.83	89.17	85.67	87.42	70.54	11.68	7.45
6	Kerasree	42.00	89.80	92.83	79.17	86.00	75.95	11.86	7.75
7	Gauthami Ganga x Kera Bastar	66.97	97.83	121.17	118.83	120.00	101.20	15.65	10.06
8	Gauthami Ganga x Kerachandra	62.11	107.07	114.10	117.15	115.63	100.11	15.64	10.61
9	Gauthami Ganga x Chandra Kalpa	75.78	107.60	123.40	112.73	118.07	104.88	16.91	11.22
10	Kalpatharu	62.60	76.43	96.77	101.25	99.01	84.26	14.19	9.53
	S. Em ±	3.38	6.92	6.44	5.47	5.27	4.17	0.75	0.49
	CD @ 5%	10.04	20.55	19.15	16.26	15.67	12.40	2.22	1.47

Gauthami Ganga x Kerachandra

Gauthami Ganga x Kera Bastar

Table 17: Yield of coconut hybrids - Set - II (Arsikere, 2009)

Sl. No.	Hybrid	Coconut yield (nuts/palm/year)					
		2005-06	2006-07	2007-08	2008-09	Mean (2 yrs) 2007-09	Mean (4 yrs) 2005-09
1	Kera Sankara	21.75	41.35	40.73	59.78	50.25	40.90
2	Chandralaksha	14.58	32.65	55.25	64.88	60.06	41.84
3	IND 058 x Kalpatharu	34.40	65.65	74.20	81.45	77.83	63.93
4	Laksha Ganga	17.38	34.25	61.68	65.18	63.43	44.62
5	Kalpatharu	16.17	23.85	52.20	64.45	58.33	39.17
	S. Em ±	2.92	4.87	3.79	2.75	3.06	1.74
	CD @ 5%	7.58	15.01	11.69	8.46	9.44	5.36

The tree height, number of functional leaves and cumulative leaf production were significantly higher in the hybrid IND 058 x Kalpatharu compared to other hybrids and Kalpatharu. The tree girth was significantly higher with Kalpatharu which was on par with Laksha Ganga, Chandra Laksha and IND 058 x Kalpatharu crosses. The nut yield and copra yield per palm were significantly higher with IND 058 x Kalpatharu followed by Laksha Ganga, Chandra Laksha crosses (Table 17). The mean data over the last four years also showed that the nut yield and copra yield per palm were higher in the hybrid IND 058 x Kalpatharu as compared to other hybrids and Kalpatharu.

Bhubaneshwar

The seed nuts of nine cross combinations were collected from CPCRI, Kasaragod and AICRP on Palms Centre at Veppankulam during 2004 and the field trial was planted during November,2005. The experiment was laid out in RBD with 9 treatments and four replications having 6 palms per plot.

All the entries showed an increase in growth in

Table 18: Mean growth parameters of coconut hybrids (Bhubaneshwar, 2009)

Cross combination	Girth (cm)	Height (cm)	Leaves per year	Leaf length (cm)
Chandralaksha	51.8	343.3	7.7	260.1
VHC -1	71.1	376.3	8.4	269.3
Konkan Bhatye Coconut Hybrid -1	84.6	410.8	7.9	298.4
Gauthami Ganga x Kerachandra	72.6	95.1	8.1	273.6
CRP 509	68.2	375.1	7.8	271.8
VHC -2	79.4	391.3	8.6	278.3
Laksha Ganga	52.5	381.9	7.8	262.5
Kera sree	62.8	374.6	7.8	265.3
Godavari Ganga	71.6	373.9	8.5	269.4
CD (0.5)	NS	NS	NS	NS

respect to vegetative characters. Godavari Ganga recorded maximum height (410.8 cm) and number of leaves on the crown (11.8). Highest leaf length of 298.4 cm was recorded in Konkan Bhatye Coconut Hybrid-1 and highest leaf breadth of 5.1 cm was recorded both in Gauthami Ganga x Kerachandra and VHC-2.

Gen.2A: Evaluation of new coconut hybrids

(Aliyarnagar, Arsikere, Ambajipeta, Bhubaneshwar, Kahikuchi, Mondouri, Ratnagiri, Veppankulam)

The project aims at assessing the performance of location-specific hybrids in coconut. Each Centre is to test five cross combinations and one of the parents in each cross combination shall be the genotype/cultivar performing well at the Centre in Gen.1. trial. Each Centre is to carry out its own crossing programme to produce the hybrid nuts in each cross combination to enable them to take up the field trials as per the experimental design approved in the Biennial Group Meeting.

Aliyarnagar

In this project, a total of five hybrid combinations are under evaluation.

1. Aliyarnagar Tall x IND 058
2. Aliyarnagar Tall x Kalpa Raksha
3. CRP 512 x Aliyarnagar Tall
4. IND 074 x Aliyarnagar Tall
5. IND 007 x Aliyarnagar Tall

Since Aliyarnagar Tall, released from this Centre, was found to be a consistant yielder, the crossing programme was designed to include it as one of the parents. A set of available seedlings (three in 5th cross; 12 seedlings in 1st and 2nd cross) were planted as under - planting in Gen 2 trial area on 1.12.2006. Though the seedlings were two and half years old, their growth was not upto the mark as they were under-planted in a coconut garden. Observations indicated that seedlings have grown upto 145 cm with 7 leaves (IND 007 x Aliyarnagar Tall); 100 cm with 7 leaves in Aliyarnagar Tall x Kalpa Raksha and 180 cm with 8 leaves in Aliyarnagar Tall x IND 058.

For making the trial full fledged one, crosses were continued in all the hybrid combinations. Setting percentage varied from 18 percent (CRP 512 x Aliyarnagar Tall) to 35 percent (IND 074 x Aliyarnagar Tall). In general, dwarf x tall crosses set in a higher proportion compared to the T X D and T X T crosses. Poorest setting percentage was noticed in T X T combination (18 percent). Crossed seednuts are being collected and sowing is taken up.

Ambajipeta

The seedlings of cross combinations viz., CRP 509 x Kalpa Prathiba, Gauthami Ganga x Kalpa Prathiba, CRP 509 x Double Century, Gauthami Ganga x Double Century and Double Century x Gauthami Ganga are in nursery and are to be planted in June, 2010.

Arsikere

The palms for male and female parents have been identified and the crossing programme has been initiated with the following combinations:

Kalpatharu x Kera Chandra

Kalpatharu x Chandra Kalpa

Chandra Kalpa x Kalpa Raksha

Chandra Kalpa x IND 048

Kalpatharu x IND 058

Kalpatharu x IND 048

Bhubaneshwar

Crossing programme was carried out in the following five cross combinations: IND 041 x IND 007; Kalpa Raksha x IND 041; IND 041 x Gauthami Ganga; IND 007 x CRP 794 and Gauthami Ganga x IND 025. The seedlings were planted in the field during February, 2008 by adopting RBD with 4 replications having 6 palms per plot (Table 19).

Kahikuchi

The experiment was undertaken with five cross combinations of coconut i.e., Kamrupa x Kalpa Prathiba, Kamrupa x Double Century, Kamrupa x IND 058, CRP 502 x Kamrupa and CRP 501 x Double Century. For this purpose, better performing palms of female as well as male parents of the selected cross combinations available in the Centre were identified. Hybridization work was initiated from 1st week of March, 2005 following standard procedure as recommended by CPCRI, Kasaragod. Seed nuts of the crosses were sown in the nursery and seedlings were raised. About one year old seedlings were planted in the main field during 2008-09 following randomized block design with six palms per replication.

The experiment is in the initial stage and observations on palm height and number of leaves/palm were recorded (Table 20). Plant height of different crosses

Table 19: Evaluation of new coconut hybrids (Bhubaneshwar, 2009)

Cross combination	Girth (cm)	Height (cm)	No. of leaves/ palm	No. of leaves / year	Leaf length (cm)
IND 041 x IND 007	20.7	116.9	5.6	4.9	102.6
Kalpa Raksha x IND 041	21.6	103.1	5.9	4.3	91.9
IND 041 x Gauthami Ganga	21.8	99.6	6.7	4.8	115.1
IND 007 x CRP 794	17.0	62.3	5.8	3.7	100.7
Gauthami Ganga x IND 025	17.9	84.1	6.8	4.9	91.7
CD(0.05)	NS	NS	0.5	NS	NS

ranged from 1.40 m to 1.70 m and number of leaves/ palm ranged from 6.0 to 7.0 and both the characters were found to be non-significant.

Table 20: Growth characters of different hybrids (Kahikuchi, 2009)

Hybrid	Plant height (m)	Number of leaves
Kamrupa x Kalpa Prathiba	1.45	6.0
Kamrupa x Double Century	1.50	6.3
Kamrupa x IND 058	1.40	6.0
CRP 502 x Kamrupa	1.65	6.6
CRP 501 x Double Century	1.70	7.0
CD at 5%	NS	NS

Mondouri

Crossing programme in the following six cross combinations were carried out in 2004–06 and seedlings of the crossed nuts were raised in the nursery.

i. Kera Chandra X Chandra Kalpa

ii. Chandra Kalpa X Kera Chandra

iii. CRP 509 X Chandra Kalpa

iv. CRP 509 X Kalyani Coconut-1

v. CRP 509 X CRP 502

vi. CRP 509 X Kalpa Mitra

Ratnagiri

Six location–specific cross combinations in coconut are being tested at this Centre in RBD with four replications. The trial was planted in the field in December, 2006. The growth observations recorded are presented in Table 21. In respect of girth, there was no significant difference between various cross combinations. In respect of height, there was significant difference between the treatments. The cross combination CRP 513 x IND 007 has recorded maximum height of 412.46 cm and it is at par with other cross combinations IND 007 x CRP 513 (366.83 cm), IND 007 x CRP 514 (393.00 cm), Pratap x IND 007 (367.96 cm) and CRP 514 x IND 007 (370.21 cm), which are statistically superior over IND 007 x Pratap (276 .12 cm). In respect of number of leaves, there was no significant difference between the various cross combinations.

Table 21: Growth observations on different crosses (Ratnagiri, 2009)

Sl. No.	Name of cross	Girth (cm)	Height (cm)	Total no. of leaves
1	IND 007 x CRP 513	58.46	366.83	21.20
2	IND 007 x Pratap	39.97	276.12	20.81
3	IND 007 x CRP 514	58.88	393.00	21.80
4	CRP 513 x IND 007	66.25	412.46	20.83
5	Pratap x IND 007	53.96	367.96	21.13
6	CRP 514 x IND 007	58.33	370.21	20.54
	SE±	5.32	21.56	0.61
	CD at 5%	NS	64.97	NS

Veppankulam

Five hybrid combinations in coconut are under evaluation. The trial was planted in RBD with four

replications in 2005 in Block C1 in the Veppankulam Farm.

The morphological characteristics for the new hybrids were recorded and presented in Table 22.

along with local tall. The planting materials, except for the local cultivars, were supplied from Central Plantation Crops Research Institute, Kasaragod.

Table 22 : Morphological characters of new crosses (Veppankulam, 2009)

Sl. No	Hybrid	No. of functional leaves	Length of petiole (m)	Length of leaf (m)	No. of leaflets	Length of leaflet (cm)
1.	Kera Keralam x IND 048	16.3	1.6	2.6	148.6	99.7
2.	IND 048 x Kera Keralam	19.6	1.4	2.9	177.3	106.0
3.	Kera KeralamxKalpa Raksha	16.6	1.6	2.7	170.3	102.5
4.	Kera Keralam x IND 074	22.4	1.4	3.1	165.8	109.5
5.	VPM-3 x IND 007	13.3	1.6	2.6	147.3	96.2

Among the five newly crossed hybrids, Kera Keralam x IND 074 recorded the highest number of functional leaves (22), length of leaf (3.1m), length of leaflet (109.5cm) and breadth of leaflet (5.9 cm). Kera Keralam x Kalpa Raksha recorded the highest petiole length (1.6 m). IND 048 x Kera Keralam recorded the highest number of leaflets (177/ leaf).

Among the five crosses, the hybrid IND 048 x Kera Keralam flowered early in 38 to 42 months and Kera Keralam x IND 074 flowered in 39 to 48 months.

In IND 048 x Kera Keralam hybrid, in RI, out of four palms, three flowered in 41 to 42 months, in R2, two out of four flowered in 39 months, in R3, one out of four flowered in 38 months and none of them flowered in R4. Kera Keralam x Kalpa Raksha and VPM-3 x IND 007 flowered during 34 and 37-39 months.

In Kera Keralam x IND 074 hybrid, 3 palms out of four (44 to 48 months) in R1, three in R2 (44 to 48 months), three in R3 (39 to 43 months) and none of them in R4 flowered. In VPM-3 x IND 007 hybrid, out of four palms in R1, three palms flowered in 37-39 months and none of them flowered in R_2, R_3 and R_4. In hybrids Kera Keralam x Kalpa Raksha and IND 048 x Kera Keralam, only one palm each showed flowering during 34th month (RI) and 47th month (RII).

Gen.3: Trial of promising seed materials

(Ambajipeta, Arsikere, Bhubaneshwar, Jagadalpur)

The trial was continued in four Centres to test the performance of released/promising varieties and hybrids

Ambajipeta

The trial was planted in the year 2002 with seven hybrids and two varieties, released in different States, in RBD with three replications. Details of the performance of coconut hybrids/varieties and nut characters are given in the Table 23 & Fig.1.

Highest total number of leaves on crown was recorded in check Godavari Ganga (32.84) followed by Chandralaksha (32.30) and VHC-2 (31.72). The highest rate of leaf production was recorded in Godavari Ganga (13.67) followed by Laksha Ganga (13.44) and Kera Ganga (12.78). Kera Ganga (9.50), VHC-2 (9.34) and Godavari Ganga (9.17) registered higher number of spadices/palm/year. Maximum number of female flowers/ palm/year was registered in Godavari Ganga (277.83) followed by Double Century (272.26) and Chandra kalpa (263.24). Highest mean nut yield/palm was recorded in Godavari Ganga (78.27) and Laksha Ganga (61.13).

Regarding nut characters, the highest nut weight was recorded in Chandra Sankara (1331.67 g/nut) followed by Double Century (1296.67 g/nut) as compared to 1006.67 g/nut in check Godavari Ganga. Maximum husk weight was recorded in Chandra Sankara (680 g/nut). The highest de-husked nut weight was recorded in Chandra Laksha (671.67 g/nut) and Double Century (665.00 g/ nut) as compared to 503.34 g/nut in Godavari Ganga. Nut water content in matured nut ranged from 111 to 167.17 ml/nut in various hybrids. Chandralaksha (310.00 g/nut) and Double Century (308.33 g/nut) registered highest kernel weight as compared to 255.00 g/nut in check Godavari Ganga.

Table 23: Performance of coconut hybrids/varieties (Ambjipeta, 2009)

	Hybrid/variety	No. of leaves on crown	Rate of leaf production	Spadices/ palm/year	Nut yield/ palm	Wt. of whole nut (g/nut)	Husked nut wt. (g/nut)	Water content (ml/nut)
1	Chandra Sankara	29.44	12.84	7.40	56.44	1331.67	651.66	168.17
2	Laksha Ganga	29.90	13.44	8.17	61.13	993.33	505.00	135.50
3	Kera Ganga	30.90	12.78	9.50	60.99	1023.33	498.34	111.00
4	Chandra Laksha	32.30	13.36	8.88	57.38	1251.67	671.67	160.50
5	VHC-1	30.78	12.45	8.64	36.67	910.00	485.00	111.34
6	VHC-2	31.72	13.22	9.34	59.16	1114.17	605.00	163.84
7.	Chandra Kalpa	29.50	12.85	6.34	44.48	1110.00	605.00	138.17
8.	Double Century	31.32	13.42	7.24	44.72	1296.67	665.00	164.34
9.	Godavari Ganga	32.84	13.67	9.17	78.27	1006.67	503.34	154.00

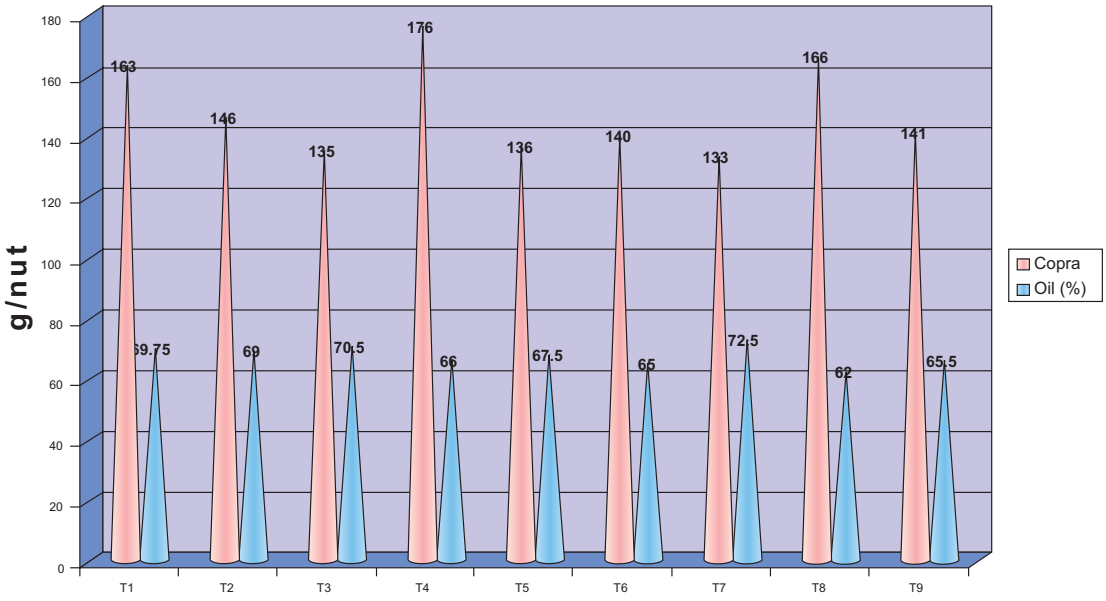

Fig.1: Copra & Oil content (%) in hybrids/varieties (Ambajipeta, 2009)

Highest copra content was registered in hybrid Chandra Laksha (176 g/nut) followed by Double Century (166 g/nut) and Chandra Sankara (163 g/nut) as compared to 141 g/nut in check Godavari Ganga. Maximum oil content was recorded in Chandra Kalpa (72.5%) followed by Kera Ganga (70.5%) and Chandra Sankara (69.75%).

Arsikere

The trial was laid out with 10 varieties/hybrids during 1994 in RBD with three replications to evaluate different varieties and hybrids of coconut. Observations on growth parameters, yield of nuts and copra were recorded.

The tree height and tree girth were significantly higher with VPM-3, while the leaf production was

Table 24: Growth and yield of different varieties and hybrids of coconut (Arsikere, 2009)

Sl. No.	Hybrids/ varieties	Palm height (m)	Functional leaves	Coconut yield (nuts/palm)	Copra yield (kg/palm)	Oil yield (kg/ palm)
1	Kera keralam	6.45	30.50	68.87	10.13	6.88
2	IND 009	5.81	29.39	69.47	11.14	6.74
3	Chandra Kalpa	5.61	29.44	74.07	12.02	8.08
4	IND 030	6.74	30.17	78.30	9.24	5.21
5	Kera Chandra	6.11	30.99	73.07	11.83	7.66
6	VPM-3	7.17	31.11	68.43	11.49	7.50
7	Kera Sankara	5.60	29.75	85.57	13.55	8.72
8	Kera Ganga	5.57	30.38	80.40	13.49	8.67
9	Chandra Sankara	5.71	30.43	93.23	14.83	9.48
10	Kalpatharu	6.52	30.59	85.87	14.73	9.78
	S. Em ±	0.37	0.93	4.12	0.78	0.50
	CD @ 5%	1.09	2.77	12.24	2.31	1.49

significantly higher with Kera Chandra. The nut yield per palm was significantly higher with Chandra Sankara followed by Kalpatharu, Kera Sankara and Kera Ganga. The copra yield was also significantly higher with Chandra Sankara followed by Kalpatharu, Kera Sankara and Kera Ganga. The mean nut yield over the last four years was significantly higher with Chandra Sankara followed by Kera Sankara, IND 030 and Kalpatharu. The mean copra content was significantly higher with VPM-3 followed by Kera Chandra and Kera Ganga. The mean copra yield per palm was significantly higher with Chandra Sankara followed by Kera Sankara, Kalpatharu and Kera Ganga.

Bhubaneshwar

The experiment was laid out with two promising varieties, three hybrids with IND 041 as check in August, 2004. The growth characters are given in Table 25. All the entries showed increase in growth. Maximum height (388.3 cm) and girth (76.0 cm) were observed in Kera Sankara whereas Kera Ganga recorded least girth (53.2 cm). Number of leaves produced per year ranged between 5.6 to 8.1. Maximum petiole length (120.9cm), leaf length (313.1 cm), leaf breadth (158.4 cm) and leaflet breadth (5.1 cm) were recorded by Kera Sankara.

Table 25: Growth characters of promising seed materials (Bhubaneshwar, 2009)

Varieties/hybrids	Girth (cm)	Height (cm)	Leaves/ year	Leaf length (cm)	Leaflet breadth (cm)
Kera Ganga	53.2	279.3	7.1	221.6	4.4
Chandra Sankara	67.1	306.9	7.4	262.0	4.3
Kera Sankara	76.0	388.3	8.1	313.1	5.1
Kera Chandra	62.1	340.8	7.6	266.1	4.4
Chandra Kalpa	65.9	366.3	5.6	299.4	4.4
IND 041	65.0	322.2	7.8	240.0	4.4
CD(0.5)	NS	NS	NS	NS	0.4

Gen.10: Performance of Tall x Tall hybrids in coconut in different agro-climatic regions

(Aliyarnagar, Arsikere, Ambajipeta, Kahikuchi, Navsari, Ratnagiri, Veppankulam)

The crossing programme is in progress at CPCRI, Kasaragod and the seed nuts of the cross combinations viz., Kera Keralam x Kalpatharu, Chandra Kalpa x VPM-3, Pratap x VPM - 3, VPM-3 x CRP 509 and CRP 509 x

Chandra Kalpa are being supplied by CPCRI, Kasaragod for evaluation at seven Centres.

Aliyarnagar

Under this project, a total of five cross combinations are to be tested. Seed nuts for three crosses viz., Chandra Kalpa x VPM-3, Pratap x VPM-3 and CRP 509 x Chandra Kalpa were received from CPCRI and have been sown in the nursery.

Ambajipeta

The crossing programme was initiated at CPCRI, Kasaragod and the seed nuts of three cross combinations viz., Pratap x VPM-3, VPM-3 x CRP 509, CRP 509 x Chandra Kalpa were received from CPCRI, Kasaragod and nursery was raised.

Arsikere

Evaluation of Tall x Tall hybrids of coconut will be initiated immediately after the receipt of hybrid seed nuts from CPCRI.

Navsari

Seed nuts of five hybrids of coconut are yet to be received from CPCRI.

Ratnagiri

This Research Station has received seed nuts of following hybrids from CPCRI, Kasargod, Kerala during this year. The details are given in Table 26.

Table 26: Details of seed nuts received from CPCRI, Kasaragod, Kerala (Ratnagiri, 2009)

Sl. No.	Name of hybrid	Date of receipt	No. of seed nuts received
1.	Kera Keralam x Kalpatharu	16/02/2010	09
		03/04/2010	30
2.	Chandra Kalpa x VPM-3	16/02/2010	30
3.	Pratap x VPM-3	16/02/2010	30
4.	VPM-3 x CRP 509	16/02/2010	30
5.	CRP 509 x Chandra Kalpa	16/02/2010	30

Veppankulam

A total of 139 crossed seed nuts of five Tall x Tall hybrids were received from CPCRI, Kasaragod on 12.02.2010 and were sown in the nursery in A4 block as detailed in Table 27.

Table 27: Hybrids received from CPCRI, Kasaragod (Veppankulam, 2009)

Sl. No.	Details of crosses	No of seed nuts received
1.	Chandra kalpa x VPM-3	30
2.	Kera Keralam x Kalpatharu	30
3.	CRP 509 x Chandra Kalpa	30
4.	VPM–3 x CRP 509	17
5.	Pratap x VPM-3	32
	Total	139

Another set of T x T cross seed nuts were received from CPCRI, Kasaragod and were sown on 09.04.2010.

Gen.10A: Performance of new (experimental) cross combinations of Tall x Tall hybrids in coconut in major agro-climatic regions

(Ambajipeta, Ratnagiri, Veppankulam)

Ambajipeta

The crossing programme was initiated during 2008 with released varieties viz., Double Century, Chandra Kalpa, Kera Bastar, Kalpa Mitra and Kalpa Prathiba. The cross combinations viz., Kalpa Mitra x CRP 509, Double Century x CRP 509, Kera Bastar x CRP 509, Chandra Kalpa x CRP 509, CRP 509 x Kalpa Mitra, Kalpa Prathiba x CRP 509 and CRP 509 x Kera Bastar were started and data are presented in Table 28.

It was observed that the set percentage among the seven cross combinations ranged from 39.78 to 50.00 and the per cent set was highest in Kalpa Prathiba x CRP 509 (50.00) followed by Kera Bastar x CRP 509 (48.95 %). Among the seven crosses, a total of 1821 flowers were crossed, 846 flowers got fertilized and 700 nuts were harvested and were sown in the nursery.

Ratnagiri

The experiment on new experimental cross combinations has been planted in August 2009 with

Table 28: Crossing programme for Tall x Tall hybrid evaluation trial (Ambajipeta, 2009)

	Cross combination	No. of female flowers attempted for crossing	No. of flowers fertilized	% set	No .of nuts harvested
1.	Kalpa Mitra x CRP 509	288	137	47.87	121
2.	Double Century x CRP 509	288	114	39.78	98
3.	Kera Bastar x CRP 509	243	118	48.95	92
4.	Chandrakalpa x CRP 509	259	123	47.80	101
5.	CRP 509 x Kalpa Mitra	250	114	45.87	99
6.	Kalpa Prathiba x CRP 509	243	121	50.00	95
7.	CRP 509 x Kera Bastar	250	119	47.95	94
	Total	1821	846	46.45	700

available seedlings of different cross combinations and details of the same are given in Table 29. Remaining seedlings will be planted in June 2010.

Table 29: Details of seedlings planted (Ratnagiri, 2009)

Sl. No.	Cross combination	No. of seedlings planted
1	Kera Chandra x Pratap	18
2	Pratap x Kera Chandra	18
3	Kera Chandra x CRP 514	8
4	CRP 514 x Kera Chandra	18
5	CRP 513 x Kera Chandra	18
6	Kera Chandra x CRP 513	18
7	Chandra Kalpa x Pratap	-
8	Pratap x Chandra Kalpa	-

Veppankulam

A total of 150 seed nuts of eight T x T cross combinations effected at Veppankulam (Table 30) were collected and sown on 22.08.2009 in the nursery in A4 block. The seedlings are six to seven months old.

Table 30: T x T cross combinations effected (Veppankulam, 2009)

Sl. No.	Details of crosses	No of seed nuts sown
1.	CRP 509 x Kera Chandra	11
2.	CRP 509 x Kalpa Prathiba	11
3.	Kera Keralam x Kalpa Prathiba	30
4.	IND 034 x CRP 509	15
5.	CRP 509 x IND 037	20
6.	CRP 509 x CRP 511	15
7.	IND 034 x IND 037	12
8.	Kera Keralam x Kera Chandra	36
	Total	150

Gen.11: Performance of Dwarf x Dwarf hybrids in coconut in different agro-climatic regions

(Ambajipeta, Mondouri, Ratnagiri, Veppankulam)

The crossing programme was initiated at CPCRI, Kasaragod and the seed nuts of the cross combinations viz., IND 007 x IND 058, IND 007 x Kalpa Raksha, IND 058 x Kalpasree, Gauthami Ganga x IND 048 and Kalpasree x Kalpa Raksha are being supplied by CPCRI, Kasaragod for evaluation at four Centres.

Ambajipeta

The crossing programme was initiated at CPCRI, Kasaragod and the seed nuts of five Dwarf x Dwarf cross combinations are yet to be received from CPCRI.

Mondouri

The planting materials will be collected from CPCRI for planting as per technical programme approved in the Biennial Group Meeting.

Ratnagiri

This Research Station has received seed nuts of five hybrids from CPCRI during this year (Table 31).

Table 31: Details of seed nuts received from CPCRI, Kasaragod, Kerala (Ratnagiri, 2009)

Sl. No.	Name of hybrid	Date of receipt	No. of seed nuts received
1.	IND 007 x IND 058	16/02/2010	35
		03/04/2010	34
2.	IND 007 x Kalpa Raksha	16/02/2010	31
		03/04/2010	31
3.	IND 058 x Kalpasree	16/02/2010	19
4.	Gauthami Ganga x IND 048	16/02/2010	16
		03/04/2010	44
5.	Kalpasree x Kalpa Raksha	16/02/2010	-

Veppankulam

A total of 145 crossed seed nuts of five Dwarf x Dwarf combinations received from CPCRI were sown on 12.02.2010 in the nursery in A4 block as detailed in Table 32.

Table 32: Details of seed nuts received from CPCRI, Kasaragod, Kerala (Veppankulam, 2009)

Sl. No.	Details of crosses	No of seed nuts sown
1.	IND 007 x IND 058	30
2.	IND 007 x Kalpa Raksha	30
3.	IND 058 x Kalpasree	21
4.	Gauthami Ganga x IND 048	30
5.	Kalpasree x Kalpa Raksha	34
	Total	145

Gen.12: Performance of newly released coconut varieties and hybrids in different agro-climatic zones

(Aliyarnagar, Ambajipeta, Arsikere, Bhubaneshwar, Jagadalpur, Kahikuchi, Mondouri, Navsari, Ratnagiri, Sabour, Veppankulam, Goa, Bara Pani, Port Blair)

30 seed nuts per variety are to be supplied to 14 Centres by the Multiplication Centres, for multilocation evaluation/demonstration (Table 33).

Table 33: List of newly released coconut varieties / hybrids and Multiplication Centres

Sl. No.	Name of coconut variety / hybrid	Multiplication Centre
1	Kalyani Coconut -1	Aliyarnagar
2	Gauthami Ganga	Ambajipeta
3	Konkan Coconut Hybrid -1	Ratnagiri
4	Kalpa Dhenu	CPCRI
5	Kera Keralam	Veppankulam
6	Kera Bastar	Ratnagiri
7	Kalpa Prathibha	CPCRI
8	Kalpa Mitra	CPCRI
9	Kalpa Raksha	CPCRI
10	Kahikuchi Coconut Hybrid -1	Ratnagiri

Aliyarnagar

A total of 10 newly released varieties and hybrids are to be tested under this programme. Thirty seed nuts each of Kera Keralam, Kera Bastar and Konkan Bhatiye

Coconut Hybrid-1 were received from Veppankulam and Ratnagiri Centres. The seed nuts were sown in the nursery.

Ambajipeta

Selfing of Gauthami Ganga was initiated during 2009 and about 130 nuts were harvested and dispatched to five testing centres and remaining nuts will be harvested soon and will be supplied to other Centres.

Seed nuts of Kera Bastar, Konkan Bhatye Coconut Hybrid-1 and Kahikuchi Coconut Hybrid-1 were received from Ratnagiri and seed nuts of Kera Keralam were received from Veppankulam @ 30 nuts and were raised in the nursery.

Arsikere

Seed nuts of Kera Keralam from Veppankulam Centre, Konkan Bhatye Coconut Hybrid-1, Kera Bastar and Kahikuchi Coconut Hybrid -1 from Ratnagiri Centre and Gauthani Ganga from Ambajipeta Centre have been received. The nuts were sown in the nursery. The seed nuts of the remaining varieties/hybrids are awaited from CPCRI, Kasaragod.

Jagadalpur

Coconut varieties released in 2007 are to be tested under Bastar conditions. Seed nuts of Kera Keralam were received from Veppankulam Centre and Konkan Bhatye Coconut Hybrid-1 were received from Regional Coconut Research Station, Bhatye, Ratnagiri, Maharashtra.

Mondouri

Seed nuts of Konkan Bhatye Coconut Hybrid-1 were received at the Centre and sown in the nursery.

Navsari

Seed nuts of Konkan Bhatye Coconut Hybrid-1 and Kera Keralam were received and planted in nursery.

Ratnagiri

This Research Station has supplied seed nuts of three varieties/hybrids to different Centres during this year (Table 34)

Table 34: Details of seed nuts supplied to other stations (Ratnagiri, 2009)

Sl. No.	Name of Centre	Date of supply		
		Konkan Bhatye Coconut Hybrid – 1	Kera Bastar	Kahikuchi Coconut Hybrid - 1
1	Aliyarnagar (T.N.)	04/02/2010	14/05/2010	04/02/2010
2	Ambajipeta (A.P)	21/07/2009	23/09/2009	25/03/2010
3	Arsikere (Karnataka)	04/02/2010	04/02/2010	25/03/2010
4	Bhubaneshwar (Orissa)	04/02/2010	04/02/2010	-
5	Goa	21/07/2009	23/09/2009	-
6	Jagadalpur (Chhatisgarh)	21/07/2009	14/05/2010	-
7	Kahikuchi (Assam)	21/07/2009	14/05/2010	-
8	Mondouri (W.B.)	21/07/2009	14/05/2010	-
9	Kasaragod (Kerala)	04/02/2010	04/02/2010	-
10	Bara Pani (Meghalaya)	21/07/2009	04/02/2010	04/02/2010
11	Navsari (Gujarat)	21/07/2009	14/05/2010	-
12	Port Blair (Andaman & Nicobar Islands)	04/02/2010	04/02/2010	04/02/2010
13	Sabour (Bihar)	21/07/2009	25/03/2010	25/03/2010
14	Veppankulam (T.N.)	04/02/2010	04/02/2010	25/03/2010

Sabour

Seed nuts of two coconut hybrids i.e., Konkan Bhatye Coconut Hybrid–1 and Kahikuchi Coconut Hybrid-1 as well as a coconut variety ie, Kera Bastar have been received from RCRS, Bhatye, Ratnagiri (Maharashtra) and have been planted in the nursery.

Veppankulam

30 seed nuts of Kera Keralam were dispatched to all the fourteen testing centres.

Seed nuts of Konkan Bhatye Coconut Hybrid-1(29), Kera Bastar(30) and Kahikuchi Coconut Hybrid- 1(29) were received from Ratnagiri and were sown at the Centre.

Gen.13: Screening of cocoa clones for their performance as a mixed crop in coconut gardens

(Ambajipeta, Navsari, Veppankulam)

Ambajipeta

Six cocoa clones *viz.*,VTLCC–1, VTLCH–1, VTLCH–2, VTLCH–3, VTLCH–4, VTLC–1 (Control) were planted in November, 2008, in RBD with four replications and the clones have established in the field. Data on plant height was recorded (Table 35).

Table 35: Plant height of cocoa clones (Ambajipeta, 2009)

	Treatment	Plant height (cm)
T_1	VTLCC – 1	80
T_2	VTLCH – 1	86
T_3	VTLCH – 2	69
T_4	VTLCH – 3	75
T_5	VTLCH – 4	71
T_6	VTLC – 1 [Control]	82

Navsari

Five cocoa clones were planted in a coconut garden (at bearing stage) in RBD with four replications.

Veppankulam

Cocoa grafts of five hybrids and one cultivar were received from CPCRI Regional Station, Vittal, Karnataka on 06.08.2008 and were planted on 14.08.2008. Establishment of crop is good. The water shoots in the scion were removed periodically. The trial was laid out as per the following details:

Design	:	RBD
No. of cocoa clones to be tested	:	6
Replications	:	4
No. of palms per replication	:	6

Gen.14: Screening of pepper varieties for their performance as a mixed crop in coconut gardens

(Kahikuchi, Mondouri, Sabour)

Kahikuchi

Five pepper varieties *viz.*, IISR Thevam, IISR Shakti, IISR Malabar Excel, Sreekara and Panniyur-1 were selected for the trial. The planting materials of the first three varieties i.e., IISR Thevam, IISR Shakti and IISR Malabar Excel were brought from Indian Institute of Spices Research, Calicut, the variety Sreekara was collected from CPCRI Research Centre, Kahikuchi and Panniyur-1 was taken from HRS, Kahikuchi. The planting materials were multiplied and established in the nursery. The saplings of the above varieties were planted in the main field (coconut garden) on 10th September, 2008 following randomized block design replicated into four times. Six numbers of palms were taken for each variety in each replication.

Pre-experimental yield data of the base crop i.e. coconut for the last five years were recorded which ranged from 51 to 57 nuts/palm/year. The initial nutrient status of soil of the experimental plots were estimated and presented in the Table 37. Growth characters with regard to vine length and number of branches/vine of the pepper varieties were also recorded (Table 36). There is no significant difference among the varieties in vine length and number of branches/vine. However, the highest vine length of 2.40 m and number of branches (6.2) were recorded in IISR Shakthi and Sreekara, respectively.

Table 36: Growth characters of different pepper varieties (Kahikuchi, 2009)

Pepper varieties	Vine length (m)	No. of branches
IISR Thevam	2.30	5.5
IISR Shakthi	2.40	6.0
IISR Malabar Excel	2.04	5.0
Sreekara	2.25	6.2
Panniyur-1	2.35	5.0
CD(p=0.05)	NS	NS

Table 37: Pre-experimental yield of coconut and initial nutrient status of soil under different pepper varieties (Kahikuchi, 2009)

Pepper varieties	Pre-experimental yield of coconut (nuts/palm/yr)	Initial nutrient status of soil			
		pH	N(kg/ha)	P_2O_5(kg/ha)	K_2O(kg/ha)
IISR Thevam	52	5.0	265.0	20.5	127.0
IISR Shakthi	55	4.9	261.0	21.7	125.0
IISR Malabar Excel	51	4.8	264.0	20.0	126.5
Sreekara	54	5.0	266.5	21.6	127.0
Panniyur-1	57	4.8	263.0	19.5	125.8

Mondouri

Pepper varieties to be tested:

i. IISR Thevam

ii. IISR Shakthi

iii. IISR Malabar Excel

iv. Sreekara

v. Panniyur–1

Planting material of the pepper varieties were collected from IISR for further multiplication by quick multiplication technique. The pepper varieties will be planted in the experimental plot during the monsoon season of 2010 as per technical programme.

Sabour

Due to high mortality of planting materials of five pepper varieties received from IISR, Calicut, efforts are being taken to collect additional quantities of planting materials for initiating the trial.

Gen.15: Large scale multiplication of newly released coconut varieties and hybrids in different agro-climatic regions

(Aliyarnagar, Ambajipeta, Jagadalpur, Kahikuchi, Mondouri, Ratnagiri, Veppankulam)

Aliyarnagar

Production of planting materials and establishment of Nucleus Seed Gardens were taken up for Kalpa Dhenu, Kera Keralam and Kalpa Prathiba varieties.

Ambajipeta

Nucleus Seed Garden of Gauthami Ganga has been established.

Jagadalpur

Kera Bastar, released for Chhattisgarh, is being multiplied for production of planting material among farmers of Chhattisgarh. Four seed gardens of Kera Bastar variety with a total number of 252 seedlings have been established.

Kahikuchi

Nucleus Seed Garden of Kamrupa variety has been established.

Mondouri

Laying out of Nucleus Seed Gardens for large scale multiplication of Kalyani Coconut –1, Kera Keralam and Kalpa Mitra has been taken up.

Ratnagiri

For large scale multiplication of newly released coconut hybrid, Kokan Bhatye Coconut Hybrid-1, mother orchards with 50 seedlings each of Gauthami Ganga and CRP 509 have been planted.

Veppankulam

Three newly released coconut varieties viz., Kera Keralam, Kera Bastar and Kalpa Prathiba were taken up for large-scale multiplication at CRS, Veppankulam. Production of planting materials of the three varieties is in progress.

COCONUT

4.2 Crop Production

Agr.3B: Performance of medicinal and aromatic plants as intercrops in coconut gardens

(Aliyarnagar, Ambajipeta, Arsikere, Bhubaneshwar, Jagadalpur, Kahikuchi, Mondouri, Ratnagiri, Veppankulam)

Aliyarnagar

Based on the earlier performance during the evaluation of 15 medicinal and aromatic plants, the following five (three medicinal and two aromatic) plants were selected and planted on 25.04.2007 in 18 year old coconut garden.

Treatments:

Medicinal plants		Scientific name
T1.	Karisalanganni	*Eclipta prostrata*
T2.	Siriyanangai	*Andrographis paniculata*
T3.	Sitharathai	*Alpinia galanga*
Aromatic plants		
T4.	Patchouli	*Pogostemon patchouli*
T5.	Lemon grass	*Cymbopogon flexuosus*

Design: RBD

Replications: 4

The yield and the economic returns of the medicinal and aromatic plants during the year 2008-09 are presented in Table 38.

Among the three medicinal plants and two aromatic plants raised in 18 year old coconut garden, the aromatic plant Lemon grass (*Cymbopogon flexuosus*) recorded the leaf yield of 7170 kg/ha with a net income of Rs.23270/ ha and B:C ratio of 2.17 during the crop period 2008-09. The medicinal plant Sitharathai (*Alpinia galanga*) recorded 6020 kg/ha of rhizomes with a net income of Rs.29650/- and B:C ratio of 2.43.

The pre treatment nut yield and the nut yield over two years (2007-09) revealed that there was a gradual increase in yield of coconut due to intercropping of medicinal and aromatic plants in the 18 year old coconut garden.

The essential oil content was analysed one week before harvest of the plants. Lemon grass (*Cymbopogon flexuosus*) and Sitharathai (*Alipinia galanga*) recorded the maximum oil content of 0.8% and 0.7% respectively when compared to other three crops.

The results obtained in the trial so far indicated that the medicinal plant Sitharathai (*Alipinia galanga*) and

Table 38: Crop yield and economics of medicinal and aromatic plants (Aliyarnagar, 2009)

Treatment	Economic part	Yield (kg/ha)	Oil content (%)	Net income (Rs/ha)	B:C ratio
Siriyanangai (*Andrographis paniculata*)	Leaves	1910	0.5	3170	1.16
Sitharathai (*Alpinia galanga*)	Rhizomes	6020	0.7	29650	2.43
Karisalankanni (*Eclipta prostrata*)	Leaves	1780	0.6	12790	1.66
Patchouli (*Pogostemon patchouli*)	Leaves	1730	0.4	11890	1.61
Lemon grass (*Cymbopogon flexuosus*)	Leaves	7170	0.8	23270	2.17

Table 39: Coconut yield (/palm/yr) in different treatments (Aliyarnagar, 2009)

Plants	2006-07 (Pre – treatment)	2007-08	2008-09
Siriyanangai (*Andrographis paniculata*)	115	124	133
Sitharathai (*Alipinia galanga*)	141	148	154
Karisalankanni (*Eclipta prostrata*)	120	128	135
Patchouli (*Pogostemon patchouli*)	133	138	142
Lemongrass (*Cymbopogon flexuosus*)	121	125	129

the aromatic plant Lemon grass (*Cymbopogon flexuosus*) performed well in 18 year old coconut garden.

Ambajipeta

The experiment was laid out in January 2007 with five medicinal and aromatic plants as intercrop in coconut garden in randomized block design with four replications. The yield data of coconut (main crop) before experimentation and average of two years yield data are presented in Table 40. The yield data of intercrops and economics of the cropping systems presented in Tables 41.

There was a significant increase in the nut yield of the main crop after experimentation. The highest nut yield during the year 2008-09 was recorded in crop combination of patchouli with coconut (102.48 nuts/palm/year) followed by crop combination of coconut + citronella (94.52 nuts/palm/year) as against 60.48 nuts/palm/year in crop combination of coconut + mango ginger.

Among the five medicinal and aromatic crops, lemon grass recorded the highest fresh herbage yield (45.27 t/ha) followed by Citronella (34.32 t/ha) while mango ginger recorded the lowest corm yield (22.05 t/ha). The highest oil yield (kg/t) was registered in lemon grass (3.50 kg/t) followed by patchouli (3.45 kg/t).

The economic analysis of medicinal and aromatic plants as intercrops in coconut revealed that the highest net returns of Rs.52,334/ha was recorded with a crop combination of coconut + patchouli with a benefit cost ratio of 2.13 followed by coconut + citronella (Rs.46,988) with a benefit cost ratio of 2.04. Minimum net returns were recorded in crop combination of coconut + mango ginger (Rs.18,828) with a benefit cost ratio of 1.31. Considering the performance of medicinal and aromatic plants and their economics, two crops *viz.*, patchouli and citronella were found promising for coastal eco system of Andhra Pradesh.

Table 40: Yield data of coconut before & after experimentation (Ambajipeta, 2009)

Crop combination		Nut yield/palm/year			
		2005-06	2006-07	2007-08	2008-09
1.	Coconut + Citronella	72.54	58.82	70.58	94.52
2.	Coconut + Lemon grass	64.58	70.61	88.57	88.67
3.	Coconut + Palmarosa	69.66	81.04	98.56	90.45
4.	Coconut + Patchouli	70.45	71.56	108.81	102.48
5.	Coconut + Mango ginger	56.68	70.59	96.66	60.48
	Mean	66.78	70.52	92.63	87.32

Arsikere

This experiment was designed to identify suitable medicinal and aromatic plants for intercropping in coconut gardens. The experiment was initiated during 2006-07 and concluded during 2008-09 after three years of experimentation. The experiment was laid out in RBD with three replications in a 40 year old coconut garden spaced at 10 x 10 m. Fourteen medicinal and aromatic plants were evaluated in the trial. The crops were harvested depending on the stage and plant part required for the purpose.

The mean yield of all the medicinal and aromatic crops grown as intercrop in coconut garden were reduced

Table 41: Economics of medicinal & aromatic crops as intercrops in coconut garden(Ambajipeta, 2009)

Crop combination	Inter crop yield/ha/year (t/ha)	Oil content (kg/t)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B:C Ratio
T_1: Coconut + Citronella	34.32	3.20	92,167	46,988	2.04
T_2: Coconut + Lemon grass	45.27	3.50	90,747	34,731	1.62
T_3: Coconut + Patchouli	28.41	3.45	98,647	52,334	2.13
T_4: Coconut + Palmarosa	32.54	3.00	88,618	40,456	1.84
T_5: Coconut + Mango ginger	22.05	—	79,564	18,828	1.31

compared to their sole crop yields (Table 42). The reduction in yield was less in kalmegh, makoi, garden rue, tulsi, arrow root, citronella, lemon grass and khus grass grown under coconut indicating better performance of these crops over other medicinal and aromatic crops. The coconut yield was improved with the intercropping of medicinal and aromatic crops (Table 43).

The forskohlin content in coleus, protein and starch content in arrow root, anthocyanin in roselle calyces and oil content in ambrette were improved with intercropping in coconut gardens. On the other hand, the andrographolide content in kalmegh, rutin alkaloids in garden rue, oil content in lepidium and ascorbic acid content in roselle calyces were reduced with intercropping. However, the alkaloid content in makoi, L-DOPA content in cowhage and oil content in tulsi, citronella, lemon grass and khus grass were unaffected by intercropping with coconut.

Economic analysis of growing medicinal and aromatic plants in coconut garden (Table 44) indicated that lemon grass recorded the highest net returns and B:C ratio followed by garden rue, tulsi, kalmegh, arrow root and makoi. Similarly, the intercropping system of growing lemon grass under coconut recorded highest net returns and B:C ratio followed by growing garden rue, tulsi, kalmegh, arrow root and makoi. Hence intercropping of medicinal and aromatic crops like lemon grass, garden rue, tulsi, kalmegh, arrow root and makoi with coconut could be recommended for *maidan* tract of Karnataka.

Table 42: Mean yield and quality of medicinal and aromatic plants as sole crop and as intercrop in coconut garden (Mean of 3 years: 2006-07 to 2008-09) (Arsikere, 2009)

Sl. No.	Intercrop	Economic plant part	Yield (kg/ha)		Quality parameter	Sole crop	Intercrop
			Intercrop	Sole crop			
1.	Kalmegh	Dry herbage (3 harvests/yr)	3396	4572	Andrographolide content (%)	4.40	3.20
2.	Makoi	Dry herbage	2926	4124	Total alkaloids (%)	0.51	0.52
3.	Coleus	Dry Tuberous roots	418	965	Forskohlin content (%)	0.43	0.61
4.	Garden rue	Dry herbage (3 harvests/yr)	3596	5172	Rutin alkaloids (%)	1.68	1.40
5.	Lepidium	Seeds	492	843	Oil content (%)	19.60	17.23
6.	Tulsi	Dry herbage (3 harvests/yr)	4127	5397	Oil content (%)	0.98	1.01
7.	Arrow root	Fresh Rhizome	5341	7020	Protein (%) Starch (%)	3.06 19.10	3.36 20.90
8.	Kacholam	Fresh Rhizome	1079	1295	Oleoresin (%) Oil content (%)	2.34 0.90	2.16 0.92
9.	Cowhage	Seeds	2779	5128	L-DOPA content (%)	3.15	3.13
10.	Roselle	Dry Calyces Seeds	440434	690679	Anthocyanin (mg/100g) Ascorbic acid (mg/100g)	64.56 196.87	69.97 179.73
11.	Ambrette	Seeds	368	661	Oil content (%)	0.24	0.29
12.	Citronella	Green leaves (2-4 harvests/yr)	24937	35725	Oil content (%)	0.95	0.98
13.	Lemon grass	Green leaves (2-4 harvests/yr)	45788	48895	Oil content (%)	0.51	0.53
14.	Khus grass	Dry roots	2176	2906	Oil content (%)	0.83	0.87

Recommendation

Lemon grass, garden rue, tulsi, kalmegh, arrow root and makoi are the promising medicinal and aromatic plants for intercropping in coconut gardens in *maidan* tract of Karnataka.

Table 43: Growth, yield and leaf nutrient status of coconut in intercropping system with medicinal and aromatic plants during 2006-07 to 2008-09(Arsikere, 2009)

Sl. No.	Parameter	Initial	Experimental period			
			2006-07	2007-08	2008-09	Mean
	A. Growth and yield parameters					
1.	No. of functional leaves	29.33	32.50	32.50	33.67	32.89
2.	Nut yield/palm/year	71.00	84.68	96.71	109.64	97.01
	B. Leaf nutrient status					
1.	N (%)	1.89	1.97	2.02	2.02	2.00
2.	P (%)	0.15	0.18	0.19	0.22	0.20
3.	K (%)	1.08	1.21	1.28	1.31	1.27

Kalmegh

Garden rue

Makoi

Tulsi

Arrow root

Lemon grass

Table 44: Economics of intercropping system of medicinal and aromatic plants in coconut garden (Mean of 3 years: 2006-07 to 2008-09) (Arsikere, 2009)

Sl.No.	Intercrop	Economics of intercropping system				
		Gross income (Rs/ha)	Cost of production (Rs./ha)	Net income (Rs./ha)	B:C ratio	LER
1.	Kalmegh	123226	48063	75163	2.56	1.74
2.	Makoi	107019	39961	67058	2.68	1.71
3.	Coleus	69421	41931	27490	1.66	1.43
4.	Garden rue	127618	45753	81865	2.79	1.70
5.	Lepidium	73117	38109	35008	1.92	1.58
6.	Tulsi	122785	45312	77472	2.71	1.76
7.	Arrow root	128624	56413	72211	2.28	1.76
8.	Kacholam	70093	55153	14940	1.27	1.83
9.	Cowhage	104091	43191	60899	2.41	1.54
10.	Roselle	72571	40083	32488	1.81	1.64
11.	Ambrette	66929	42250	24679	1.58	1.56
12.	Citronella	98379	50074	48305	1.96	1.70
13.	Lemon grass	140080	48520	91561	2.89	1.94
14.	Khus grass	102909	45683	57226	2.25	1.75
15.	Coconut alone (9701 nuts/ha)	48505	18890	29615	2.57	1.00

Jagadalpur

Experiment Details

Design	RBD
Replication	04
No. of palms/treatment	06
No. of treatments	05

Treatments

T1- Coconut + Steivia
T2- Coconut + Amahaldi
T3- Coconut + Sarpagandha
T4- Coconut + Tikhur
T5- Coconut + Patchouli

The experiment was initiated during 2006.

Mean nut yield / palm was slightly increased in all the treatments (Table 45). Higher nut yield recorded in Steivia and Patchouli plots (52 & 51) could be due regular watering of both crops through out the year as compared to other seasonal medicinal crops.

Highest gross income (Rs.116650/ha) was recorded in coconut + Tikhur, but highest net income and benefit cost ratio (Rs. 75272/ha and 2.32) was found in coconut + Amahaldi and lowest benefit cost ratio was recorded in coconut + Sarpagandha.

Table 45: Yield and economics of coconut based cropping system with medicinal and aromatic plants as inter crops (Jagadalpur, 2009)

Model	Main crop yield (nuts / palm/year)	Intercrop yield (kg/ha)	Cost of cultivation (Rs./ha)	Gross income (Rs./ha)	Net income (Rs./ha)	B:C ratio
Coconut sole	46	-	17778	40625	19065	1.07
Coconut +Steivia	52	605	48085	67195	19110	0.39
Coconut+ Amahaldi	44	1250	32418	107690	75272	2.32
Coconut+ Sarpagandha	43	514	46178	61815	15637	0.33
Coconut+ Tikhur	43	3250	63578	116650	53072	0.83
Coconut+ Patchouli	51	1740	44278	78015	33737	0.76

Tikhur

Mango Ginger

Kahikuchi

Survey on the cultivation of medicinal and aromatic plants in the potential areas of the region was done. Based on the survey, fifteen important medicinal and aromatic plants having market potential have been identified and those were selected for an observational trial under coconut garden. After completion of one year of observational trial, five promising types of medicinal and aromatic plants were selected for conducting full-fledged trial under coconut garden taking three palms per treatment in a randomized block design replicated into four times. The species selected for the trial are: Citronella (*Cymbopogon winterianus*), Pipali (*Piper longum*), Vedailota (*Paederia foetida*), Patchouli (*Pogostemon cablin*) and Sarpagandha (*Rauvolfia serpentine*).

The yield data (economic parts) of the intercrops and the main crop for four years (2006-07 to 2009-2010) have been pooled and the average values of these were taken for working out the economics of the cropping system (Table 46). The crop combination of patchouli in coconut (T_2) recorded the highest total coconut equivalent yield of 33023 and net return of Rs. 97,117/ha with a benefit cost ratio of 2.43, while treatment T_5 i.e. Sarpagandha in coconut has given the second highest net return (Rs. 65,316/ha) and benefit cost ratio of 2.00.

Table 46: Economics of medicinal and aromatic plants as intercrops in coconut garden (Average of 4 years) (Kahikuchi, 2009)

Treatment	Coconut yield/ha	Intercrop yield/ha	Total Coconut Equivalent yield (nuts)	Gross return (Rs./ha)	Net return (Rs./ha)	B:C
T_1: Coconut (nos) + Pipali (kg dry fruit)	10,839	601.11	19,856	99,280	44,280	1.81
T_2: Coconut (nos) + Patchouli (kg dry leaf)	10,218	3800.78	33,023	1,65,117	97,117	2.43
T_3: Coconut (nos) + Citronella (kg oil)	10,428	157.31	19,866	99,334	46,334	1.87
T_4: Coconut (nos) + Vedailota (kg fresh leaf)	8,884	3702.38	13,327	66,638	16,638	1.33
T_5: Coconut (nos.) + Sarpagandha (kg dry root)	10,228	1979.38 (in 2 yrs.)	26,063	1,30,316	65,316	2.00

Mondouri

The objective of the experiment is to develop an appropriate cropping system with medicinal and aromatic plants as intercrops compatible with coconut. A survey on the cultivation of medicinal and aromatic plants with their market potential in different districts of West Bengal was conducted. Based on the survey, fifteen important species of medicinal and aromatic plants having economic potential were selected. The best performing six species were grown as intercrops in coconut garden under replicated trial and the results are presented in Table 47.

Ratnagiri

The experiment was laid out in June 2006 with five medicinal and aromatic intercrops with coconut as main crop in RBD with 4 replications. The plot size is 6 coconut palms.

The coconut yield data revealed that the percent increase in nut yield over pre treatment yield was maximum in Coconut + Lemon grass model (20%) followed by Coconut + Adulasa (18%), Coconut + Arrow root (15%) and Coconut + Shatavari (14%) and Coconut + Citronella (12%).

Table 47: Performance of medicinal and aromatic plants in coconut garden (Mondouri,2009)

Crops	Height (cm)	No. of leaves	No.of branches	Yield(kg/ha)	Net returns from intercrop (Rs./ha)
Sarpagandha	80.4	108	8	825	35000
Aswagandha	82.6	113	12	750	24500
Arrow root	108.4	91	12	45000	36250
Kalmegh	62.6	2095	25	2800	7000
Vringaraj	52.1*	51	15	3775	32000
Ekangi	15.8	8	3	8000	48750

*** (length)**

Table 48: Economics of coconut based intercropping system with medicinal & aromatic plants (Ratnagiri, 2009)

Sl.No.	Treatment (Model)	Yield		Net return (Rs/ha)	Net return from intercrops (Rs/ha)	B:C Ratio
		Coconut (nuts/ha)	Intercrop (kg/ha)			
1.	Coconut + Shatavari	18550	700	71300	18000	1.99
2.	Coconut + Adulsa	15050	2000	58300	26000	1.80
3.	Coconut + Arrow root	17325	15000	75950	30000	2.04
4.	Coconut + Lemon grass	16450	30000	82700	42000	2.09
5.	Coconut + Citronella	16100	20000	51600	13000	1.69
6.	Coconut	14875	-	31250	-	1.54

The data presented in Table 48 regarding economics of coconut based intercropping system revealed that the highest net return per ha. was recorded under Coconut + Lemon grass model (Rs.82700/ha), followed by coconut + Arrow root (Rs.75950/ha) and coconut + Shatavari (Rs.71300/ha).

The B.C. ratio was maximum from the model Coconut + Lemon grass (2.09), followed by coconut + Arrow root (2.04) and coconut + Shatavari (1.99).

Veppankulam

Based on the earlier observational trial conducted at Coconut Research Station, Veppankulam on "screening of medicinal and aromatic plants suited for growing as intercrop in coconut", a field trial with three medicinal and two aromatic plants was laid out in 36 years old CRP 509 coconut garden in A3 block of Coconut Research Station, Veppankulam. The plot size for each crop was 15 x 4m in between four palms leaving 2m from the palms.

Alpinia galangal

Aloe vera

Ocimum sanctum

Cymbopogan flexuosus

Pogestemon patchouli

The herbal plants were raised as per the treatments. The design of the experiment was RBD and replicated thrice. Regular intercultural operations were carried out as per the package of practices and crops were harvested at maturity stage and the crops were raised organically. The yield of economic parts were recorded replication-wise after processing and finally the economics of raising individual medicinal and aromatic plants as intercrops in coconut were worked out and presented in Table 49.

The medicinal and aromatic plants performed better and recorded better yield as intercrop in adult coconut garden. The *Alpinia galangal* recorded an yield of 3,340 kg of dry tuber ha $^{-1}$ while *Aloe vera* recorded 13,100 kg fresh leaf weight. Tulsi recorded 15,000 kg of fresh leaf ha $^{-1}$. In case of Lemon grass, the yield was 8,432 kg of dried leaf ha $^{-1}$ and for patchouli, it was 1,530 kg of dried leaves ha $^{-1}$.

Agr.5A: Studies on fertilizer application through micro-irrigation in coconut

(Aliyarnagar, Ambajipeta, Arsikere, Bhubaneshwar, Kahikuchi, Kasaragod, Mondouri, Ratnagiri, Veppankulam)

The project was initiated in 2006 to study the effect of fertigation on the productivity of coconut and to work out the economic viability of fertigation over soil application. The experiment was laid out in adult coconut gardens with the following treatments.

T_1 Control (No fertilizer)

T_2 25 % of the recommended dose of fertilizers (RDF) through drip system

T_3 50 % of the RDF through drip system

T_4 75 % of the RDF through drip system

T_5 100 % of the RDF through drip system

T_6 100 % of the RDF through soil application

Design: RBD

Replications: 4

Number of palms/treatment: 6

Quantity of water to be used: Equal to 66 % of open pan evaporation with mulching (using available resources within the farm)

Sources of nutrients:

Urea for nitrogen

Diammonium phosphate for nitrogen and phosphorus

Table 49: Economics of raising medicinal and aromatic plants as intercrops in coconut garden (Veppankulam, 2009)

Sl. No	Particulars	Yield (kg./ha)	Gross return (Rs./ha)	Cost of cultivation (Rs./ha)	Net return (Rs./ha)	B:C ratio
1.	*Alpinia galangal*	3,340	1,33,600	40,802	93,098	3.3
2.	*Aloe vera*	13,100	65,800	22,145	43,355	2.9
3.	*Ocimum sanctum*	15,000	60,000	20,720	39,280	2.8
4.	*Cymbopogan flexuosus*	8,432	33,728	13,915	19,813	2.4
5.	*Pogestemon patchouli*	1,530	42,840	16,740	26,100	2.5

Different medicinal and aromatic plants recorded maximum net return and B:C ratio as intercrops in coconut garden. *Alpinia galangal* recorded a net return of Rs. 93,098/- ha ^{1} with B: C ratio of 3.3 followed by *Aloe Vera* with a net return of Rs. 43,355/- ha^{-1} and B: C ratio of 2.9.

Muriate of potash for potassium

50 kg organic manure is being applied for all the plots

T_2- T_5 : The fertilizers are being applied through drip fertigation in 10 splits from December to September

Aliyarnagar

The trial was initiated in 2007 and treatments were imposed as per technical programme. Data on growth and yield parameters were recorded during the year. The number of functional leaves and annual leaf production were optimum in all the treatments and there was no significant difference among the treatments.

The nut yield did not vary among the treatments statistically during the year 2007-08. However, during the year 2008-09, significant response in nut yield was observed at 50% of RDF through fertigation and after that there was no significant response for increased levels of fertigation dose and they were on par and comparable with 100% basal (soil) application of the fertilizer.

Ambajipeta

The trial was initiated during November, 2007 in a 25 years old garden of CRP 509 variety. The yield attributes and nut yield for the year 2008-09 are presented in Table 51.

Table 50: Treatment-wise yield performance (Aliyarnagar, 2009)

Treatments		No. of bunches	No. of female flowers	Mean pre-treatment yield (2005-06 and 2006-07)	Nuts/palm/year	
					2007-08	2008-09
T_1	Control (No fertilizer)	8.2	161	105	104	89
T_2	25 % of the recommended dose of (NPK) fertilizers (RDF) through drip system	9.4	208	110	108	104
T_3	50 % of the RDF through drip system	11.2	290	119	115	146
T_4	75 % of the RDF through drip system	11.1	288	115	118	144
T_5	100 % of the RDF through drip system	11.9	294	116	118	146
T_6	100 % of the RDF through basin application	11.9	287	112	116	143
	CD	1.78	76.7	NS	NS	38.3

Table 51: Yield and yield attributes of palms one year after imposition of treatments (Ambajipeta, 2009)

	Treatments	Total no. of leaves on crown	No. of spadices / palm	No. of female flowers / palm	Nut yield before imposition of treatments		Nut yield after imposition of treatments	
					2005-06	2006-07	2007-08	2008-09
1.	Control	31.58	10.31	163.00	52.34	45.98	50.64	56.84
2.	25 % RDF through drip system	30.67	11.67	192.55	52.05	51.88	61.94	64.75
3.	50 % RDF through drip system	31.56	10.70	167.34	53.87	74.06	66.94	72.00
4.	75 % RDF through \drip system	31.41	10.44	153.26	65.82	55.45	73.56	76.28
5.	100 % RDF through drip system	31.87	10.67	159.51	61.12	68.49	67.94	80.11
6.	100 % RDF as soil application	30.09	10.54	173.92	53.08	58.47	66.84	70.45
	Mean				56.38	59.05	64.64	70.07

It was observed that the highest number of leaves on the crown was recorded in T5 (100 % RDF of N,P,K) (31.87) followed by T1 (control) (31.58) and T3 (50 % RDF of N,P,K) (31.56). Maximum number of spadices / palm/year was produced in T2 (25 % RDF of N,P,K) (11.67) followed by T3 (50 % RDF of N,P,K) (10.70) and T5 (100 % RDF of N,P,K) (10.67). The highest number of female flowers was recorded in 25% RDF of N,P,K treatment (192.55) followed by 100% RDF of N,P,K as soil application (173.92) and 50 % RDF of N,P,K (167.34) as against 153.26 female flowers/palm/year in 75% RDF of N,P,K.

There was no significant difference among the treatments before imposition of treatments. Higher nut yields were recorded after one year of imposition of treatments (2008-09) in 100% RDF of N,P,K through drip system (80.11) followed by 75 % RDF of N,P,K through drip system (76.28) compared to the lowest in control (56.84).

Arsikere

The experiment was initiated during July 2007 in RBD with four replications. The yield of nuts during pre-experimental period (2005-07) and during 2007-08 and 2008-09 has been recorded. Soil and leaf samples were drawn at the beginning of the experiment and after two years and analysed for NPK content. The fertilizers are being applied through drip in 10 equal splits in fertigation treatments (at monthly interval excluding May and October), while the fertilizers were applied to soil in 2 splits as per recommended schedule in the treatment T_6.

Table 53: Leaf nutrient status in coconut as influenced by fertigation treatments-after 2 years (Arsikere, 2009)

Treatments	Leaf nutrient status (%)		
	N	P	K
Initial	1.78	0.135	1.02
T_1 : Control (No fertilizer)	1.65	0.128	0.90
T_2 : 25% of Rec. NPK through drip system	1.81	0.138	0.97
T_3 : 50% of Rec. NPK through drip system	1.84	0.143	1.02
T_4 : 75% of Rec. NPK through drip system	2.02	0.156	1.05
T_5 : 100% of Rec. NPK through drip system	2.02	0.176	1.05
T_6 : 100% of Rec. NPK (Soil)	1.87	0.148	0.95
S. Em ±	0.04	0.006	0.02
CD @ 5%	0.11	0.017	0.05

Pre-experimental yield data of coconut during 2005-06 and 2006-07 showed that there were no significant differences between different fertigation treatments (Table 52). During 2008-09, application of 100% NPK through drip irrigation recorded significantly higher yield of nuts and was on par with the application of 75% NPK through drip irrigation and soil application of 100% NPK as per recommended schedule. The mean data of last two years also followed the same trend.

Table 52: Yield of coconut as influenced by fertigation treatments (Arsikere, 2009)

Treatments	Pre-experimental yield data (Nuts/palm/yr)			Experimental period (Nuts/palm/yr)		
	2005-06	2006-07	Mean	2007-08	2008-09	Mean
T_1 : Control (No fertilizer)	55.33	62.03	58.68	57.30	59.89	58.60
T_2 : 25% of Rec. NPK through drip system	54.85	61.50	58.18	58.90	62.22	60.56
T_3 : 50% of Rec. NPK through drip system	58.00	58.35	58.18	64.83	66.44	65.63
T_4 : 75% of Rec. NPK through drip system	58.78	59.73	59.25	62.55	72.84	67.69
T_5 : 100% of Rec. NPK through drip system	59.63	60.85	60.24	70.53	82.16	76.34
T_6 : 100% of Rec. NPK (Soil)	59.60	62.93	61.26	64.20	70.64	67.42
S. Em ±	3.65	4.62	3.70	3.77	4.71	3.63
CD @ 5%	NS	NS	NS	NS	14.00	10.80

Number of functional leaves, bunches and buttons per palm as well as nut setting per cent were not significantly influenced by the fertigation treatments. However, numerically higher values were observed in number of buttons and nut setting per cent with the application of 100% NPK through drip system.

The leaf nutrient status (NPK) of coconut as well as the soil nutrient status after two years of experimentation was higher with the application of 100% NPK through drip system compared to other fertigation treatments. The control plot (no fertilizers) recorded significantly lowest soil and leaf nutrient status (Tables 53&54).

Table 54: Soil nutrient status (kg/ha) as influenced by fertigation treatments in coconut -after 2 years (Arsikere, 2009)

Treatments	Nitrogen			Phosphorous			Potassium		
	0-25 cm	25-50 cm	50-100 cm	0-25 cm	25-50 cm	50-100 cm	0-25 cm	25-50 cm	50-100 cm
Initial	241.48	221.29	202.46	21.32	18.00	17.62	211.20	186.00	172.80
T_1 : Control (No fertilizer)	180.01	171.23	149.28	19.32	17.43	16.17	184.80	177.60	136.80
T_2 : 25% of Rec. NPK through drip system	197.57	188.79	162.45	20.58	18.90	17.43	192.00	184.80	151.20
T_3 : 50% of Rec. NPK through drip system	201.96	197.57	180.01	21.63	20.16	17.22	201.60	196.80	163.20
T_4 : 75% of Rec. NPK through drip system	210.85	201.96	193.18	22.89	21.42	19.95	208.80	201.60	170.40
T_5 : 100% of Rec. NPK through drip system	237.09	219.53	201.96	23.73	22.05	18.69	211.20	204.00	189.60
T_6 : 100% of Rec. NPK (Soil)	201.96	197.46	193.18	20.79	19.95	18.69	192.00	187.10	170.40
S. Em ±	1.75	1.99	2.82	0.46	0.26	0.38	1.09	2.18	0.68
CD @ 5%	5.20	5.90	8.38	1.36	0.77	1.14	3.24	6.48	2.01

Bhubaneshwar

Trial is yet to be initiated.

Kahikuchi

Installation of drip system was completed during August, 2009. The pre-experimental yield data of coconut under different treatments has been recorded (Table 55). Initial (pre-experimental) soil analysis indicated that the soil type is clay-loam having medium level of available N, P and K status. The pH is acidic (4.5-5.2) and EC is normal. The fertilizers were applied through drip from October to March in 10 equal splits in fertigation treatments, while the fertilizers were applied to soil in 2 splits as per recommended schedule in the treatment $T_{6.}$ Observations on number leaves produced/palm, number inflorescences and number of female flowers/ inflorescence were recorded.

Table 55: Pre-experimental yield of coconut (average of 5 years) & initial nutrient status of soil (Kahikuchi, 2009)

Treatment	Pre-experimental yield (nuts/palm/year)	Initial nutrient status of soil		
		N (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)
T_1: Control (No fertilizer)	44.0	231.0	21.8	124.0
T_2: 25 % of the recommended dose of (NPK) fertilizers (RDF) through drip system	47.8	237.3	23.0	128.0
T_3: 50 % of the RDF through drip system	45.0	230.8	22.4	129.0
T_4: 75 % of the RDF through drip system	49.6	245.0	23.5	130.4
T_5: 100 % of the RDF through drip system	50.2	241.0	23.5	132.0
T_6: 100 % of the RDF through basin application	42.0	238.6	22.8	130.6

Mondouri

The fertigation trial was initiated in 2009 and treatments were imposed as per technical programme. Pre-experimental soil and leaf nutrient status was analysed and summarized in Table 56.

Ratnagiri

The experiment was laid out in Kera Keralam variety of coconut garden in sandy soil of Konkan region of Maharashtra during 2006. The pre treatment and post treatment yield data are presented in Table 57. In the period 2002-06 and 2006-09, no significant variation in nut yield of coconut was recorded among the different treatments. It was further observed that nut yield of 2008 - 09 when compared with pre treatment yield, percent increase was maximum in Treatment T_5 i.e. 100 % RDF of NPK through drip irrigation (35%), followed by T_6 i.e 100 % RDF of NPK as soil application (18%) and T_4 & T_3 (16% & 14%), respectively.

Veppankulam

The field experiment was laid out in 27 years old CRP 509 variety palms. Pre experimental nutrient status of soil as well as plant was assessed. Drip irrigation and fertigation are being given as per the technical programme from January, 2008.

Table 56: Pre-experimental soil & leaf nutrient status under different fertigation treatments (Mondouri, 2009)

Treatment	Soil nutrient status			Leaf nutrient status		
	Nitrogen (%)	Phosphorus (ppm)	Potassium (ppm)	Nitrogen	Phosphorus	Potassium
T_1: Control (No fertilizer)	0.085	55.6	121.6	2.10	0.19	1.86
T_2: 25 % of the recommended dose of (NPK) fertilizers (RDF) through drip system	0.086	61.2	117.2	1.94	0.21	1.82
T_3: 50 % of the RDF through drip system	0.078	58.3	114.5	1.96	0.20	1.75
T_4: 75 % of the RDF through drip system	0.088	58.2	118.3	1.88	0.19	1.78
T_5: 100 % of the RDF through drip system	0.091	57.4	113.5	1.86	0.18	1.94
T_6: 100 % of the RDF through basin application	0.082	58.3	115.9	1.92	0.22	1.89

Table 57: Effect of fertilizer application through micro-irrigation technique on yield of coconut (Ratnagiri, 2009)

Tr. No.	Treatment	Pre treatment yield (/palm/year) (2002-06)	Post treatment yield (/palm/year) (2008-09)	Percent increase over pre treatment yield
T_1	Control (No fertilizer)	99	95	-4
T_2	25 % of RDF of NPK through drip	81	89	10
T_3	50% of RDF of NPK through drip	85	97	14
T_4	75% of RDF of NPK through drip	88	102	16
T_5	100 % of RDF of NPK through drip	84	113	35
T_6	100 % of RDF of NPK as soil application	93	110	18
	SE ±	7.54	6.73	-
	C.D. 5%	N.S.	N.S.	-

Results of soil analysis revealed that nitrogen in T_6 (100 % recommended dosage as soil application) recorded significantly higher value of 261.75 kg/ha when compared to T_1 (Control). But it was on par with T_5 (100% recommended dose of NPK through drip irrigation). Regarding phosphorus, T_6 (100% recommended dosage as soil application) was significantly higher (8.0 kg/ha) when compared to T_1 (control). But it was on par with T_5 and T_3 (100% of recommended dose through drip & 50% of recommended dose through drip). In case of potassium, T_6 (100% of recommended dose as soil application) was highly significant (137.5 kg/ha) than T_1 (Control). But it was on par with T_5 and T_4 (100% of recommended dose through drip, 75% of recommended dose through drip) respectively.

Leaf nutrient analysis (Table 58) revealed that regarding nitrogen, T_5 (100% of recommended dose through drip system) recorded significantly higher percentage of 1.77 when compared to T_1 control. But it was on par with T_4 and T_6 (75% of recommended dose through drip system, 100% of dose as soil application). Regarding phosphorus, T_4 (75% of recommended dose through drip system) was significantly higher percentage of 0.085 than T_1 control. However, it was on par with T_5 (100% of recommended dose through drip). In potassium, T_4 (75% of recommended dose through drip system) was significantly higher than T_1 control. However, it was on par with T_5 and T_6 (100% of recommended dose through drip system and 100% of dose as soil application).

Table 58: Leaf nutrient content in different fertigation treatments (Veppankulam, 2009)

Treatment	Leaf nutrient content (%)		
	N	P	K
T_1 Control (No fertilizer)	1.26	0.020	3.075
T_2 25 % of the recommended dose of (NPK) fertilizers (RDF) through drip system	1.60	0.055	4.175
T_3 50 % of the RDF through drip system	1.68	0.062	4.225
T_4 75 % of the RDF through drip system	1.76	0.085	4.755
T_5 100 % of the RDF through drip system	1.77	0.075	4.525
T_6 100 % of the RDF through basin application	1.73	0.072	4.500
SED	0.020	0.005	0.096
CD	0.043	0.011	0.204

Agr. 10. Development of coconut based integrated cropping system models for different agro-climatic regions

(Aliyarnagar, Ambajipeta, Arsikere, Bhubaneshwar, Jagadalpur, Kahikuchi, Mondouri, Navsari, Ratnagiri, Sabour, Veppankulam)

Objectives

- To develop location specific coconut based integrated cropping system models for different agro-climatic regions
- To assess the effect of the cropping system model on the productivity of coconut
- To elucidate the effect of soil moisture conservation practices on the growth of coconut and intercrops.
- To assess the impact of integrated nutrient management technology (with major emphasis on organic wastes recycling process) on soil fertility status and plant nutrient content in coconut.
- To workout the economics of the model

Technical programme

Plot size : 0.40 ha

Replication : Non-replicated

Crop combination : Most profitable model of coconut based cropping system as identified at the respective Centre in the previous trials.

Aliyarnagar

Field preparation like husk burial for soil and water conservation before planting perennial crops like black pepper and cocoa was done and the planting of these crops was taken up on 25.7.2008. Elephant foot yam was planted during third week of August 2009. Four pits for vermicomposting were taken up as per the specifications

and provision for collecting vermiwash had been provided. For irrigating the field, microsprinkler system was laid out. The coconut palms are of 20 years old.

Initial soil analysis of the experimental field was done at 0-15, 15-30 and 30-45 cm depths.

Ambajipeta

Planting of intercrops *viz.*, cocoa and banana were completed during November, 2008. Pineapple, elephant foot yam and heliconia were planted during June 2009 and the experiment was maintained. Harvesting of elephant foot yam was completed.

Cropping system model :
Coconut+Cocoa+Banana+Elephant Foot Yam+Pineapple+Heliconia

Arsikere

The experiment has been initiated during October 2008 in an area of 0.40 ha to develop location specific coconut based integrated cropping system models. Pits were opened, filled with coconut husk, compost and soil and pepper, cocoa, lime and drumstick were planted in the coconut garden on 10.10.2008. Initial soil and leaf samples have been drawn and analysed. Vermicomposting is being done using the wastes of coconut. Green manure crops were raised and incorporated in the basins of coconut. The pre-experimental yield data (2006-08) of coconut and yield data of the component crops during 2008-09 have been recorded.

Jagadalpur

Crop combination: -

Summer season - Coconut + Drumstick + Bottle gourd + Cowpea

Rainy season - Coconut + Drumstick + Colocasia + Elephant foot yam + Amahaldi

Experiment was started during the year 2008. Initial nutrient status and soil moisture levels were recorded. Soil moisture content was estimated at monthly intervals at different depths of soil before irrigation of component crops and the data are presented in Table 59.

Table 59: Soil moisture status (%) of cropping system model experimental plot (Jagadalpur, 2009)

Depth of soil(cm)	February	March	April	May	June
0-30	14.75	14.46	16.70	12.24	11.45
30-60	23.20	22.50	22.40	15.36	15.26
60-90	26.23	25.32	25.13	16.17	18.54

Similarly, status of earthworm population as well as beneficial micro-organisms were estimated and presented in Tables 60 and 61.

Table 60: Earth worm population in cropping system model experimental plot (Jagadalpur, 2009)

Sl.No.	Stages of Earthworm	Depth		
		10 cm depth	20 cm depth	30 cm depth
01	Earthworm	3	2	-
02	Cocoon	1	-	-

Table 61: Beneficial micro-organisms count in cropping system model experimental plot (Jagadalpur, 2009)

Organism	Bacteria (cfu / gm of soil)	Actino-mycetes (cfu / gm of soil)	PSB (cfu/gm of soil)	Tricho-derma (cfu / gm of soil)
Count	6.02×10^5	7.65×10^5	2.19×10^4	9.25×10^3

Kahikuchi

The model comprised of five component crops viz., coconut, turmeric (var. Prova), pineapple (var.Kew), Assam lemon and banana (Chenichampa) and black pepper (var Panniyur-1). A compact coconut block in an area of 0.4 ha was taken for the model. Planting of the component crops under coconut has been done step by step as per the layout of the model. Turmeric and pineapple were planted in the interspaces surrounded by the coconut palms. Banana was planted along the row of the coconut palms keeping two banana plants in between two palms.

In the middle of four coconut palms, there was an Assam lemon plant and for black pepper, coconut palms were taken as standard. Biomass produced out of the intercrops are being recycled by converting into established vermicompost so as to reduce the inorganic nutrient requirement of the coconut palms. For this purpose, low cost vermicompost units have been in the experimental field itself. Soil samples from four different sites of the experimental block were collected and analyzed for their initial nutrient (NPK) content. Pre-experimental yield of coconut (average of 3 years) has been recorded and found to be 55 nuts/palm/year. The experiment is in initial stage. Harvesting of turmeric was completed and an average yield of 8500 kg was recorded from an area of 325.5 sq m.

Mondouri

I. Coconut based cropping system Model : Coconut + pepper + lime + pineapple + heliconia/banana + turmeric

II. Intregated nutrient management: The biomass was recycled back into the system after making vermicompost. From third year onwards, 20% of the recommended dose of fertilizers only is to be applied for both coconut and other component crops and the balance quantity of nutrient requirements is to be met through appropriate farm waste utilization programme (through recycling process). Green manure crop was sown in the coconut basins.

III. Irrigation : Sprinkler irrigation

IV. Soil & water conservation measures: Moisture conservation measures (husk burial and coir pith application) were undertaken.

Ratnagiri

The trial was initiated in 2008 and all the component crops (nutmeg + cinnamon + banana+pineapple) were planted as per technical programme. The biomass was recycled back into the system after making vermicompost.

Veppankulam

Coconut based multi species cropping system i.e., coconut + black pepper + banana + elephant foot yam along with cocoa was initiated in field No. B4 with 37 years CRP 509 tall variety in 0.5 ha. Five vermicompost pits were established around the trial plot and the vermicomposting is in progress. Installation of micro sprinkler system is in progress.

Agr. 11. Observational trial on the performance of *Morinda citrifolia* as a mixed crop in coconut garden

(Aliyarnagar, Ambajipeta, Arsikere, Jagadalpur, Kahikuchi, Mondouri, Ratnagiri, Veppankulam)

Objectives

- To study the performance of *Morinda citrifolia* as a mixed crop in coconut gardens
- To study the impact of mixed cropping of *Morinda citrifolia* with coconut on the productivity of coconut palms and soil fertility status.

Treatment details: *Morinda citrifolia* mixed cropping in single hedge system (one row of *Morinda* – with 3.75 metres plant to plant spacing at the centre of two rows of coconut palms).

Design: Non-replicated

No. of *Morinda citrifolia* plants

Seedlings : 25

Tissue culture materials : 25

Aliyarnagar

Morinda citrifolia plants 25 each in tissue culture and seedlings were planted on 31.07.2008 as intercrop in between the two rows of coconut palms in pits of 45 x 45 x 45 cm dimension in 20 years old coconut garden having 3.75m spacing between the plants. The plants were applied with vermicompost @ 5 kg per plant in 30 cm basin and no inorganic fertilizers were applied. The main crop coconut is of 20 years age. The soil type is sandy loam having low N and medium in P and K status. Soil pH is normal and non-saline.

Table 62: Growth characters of *Morinda citrifolia* (one year after planting) (Aliyarnagar, 2009)

Planting material	One year after planting				
	Height (cm)	Stem girth (cm)	Branches/ plant	Leaves/ plant	Flowered plants (%)
Tissue culture	63.2	3.6	3.0	16.9	20
Seedlings	103.4	5.2	7.7	41.3	40

At one year after planting, the seedlings were found to grow to an height of 103.4 cm compared to tissue culture (TC) plants which recorded 63.2 cm. Growth characters like stem girth, branches and leaf production per plant were found to be better in the seedlings *viz*., 5.2

cm, 7.7 no/plant and 41.3 no/plant respectively. The TC plants recorded lower stem girth (3.6 cm), branches (3.0 nos) and leaves (16.9 no) per plant at one year after planting in the 20 years old coconut garden. Seedlings were found to flower earlier with 40 per cent of the plants compared to 20 per cent with tissue culture plants at fifth month after planting.

Nut yield: Data on the pre treatment base yield for the year 2007-08 and the nut yield during 2008-09 indicated an increase in coconut yield due to intercropping.

Ambajipeta

Observation trial on the performance of *Morinda citrifolia* was planted during August, 2008 with 25 Noni grafts and 25 tissue culture plants in the inter spaces of coconut. Preliminary growth parameters of Noni plants were recorded and presented in Table 63.

Table: 63 Growth parameters of Noni plants (Ambajipeta, 2009)

Planting material type	Plant height (cm)	No. of branches
Seedlings	207	30.84
Tissue culture material	144	12.43

Establishment of Noni seedlings

The plants were established and the survival percentage was good in seedlings than tissue culture plants. The seedling plants recorded more number of branches (30.84) and plant height (207 cm) than tissue culture plants with 12.43 branches/plant and 144 cm plant hight. The seedlings putforth flowers within seven months after transplanting.

Arsikere

The experiment was laid out in August 2008. Seedlings/ tissue culture materials of Indian Noni (*Morinda citrifolia)* were planted on 30.08.2008. Establishment of *Morinda citrifolia* is satisfactory. Flowering and fruit set have been observed. Observations on growth parameters have been recorded (Table 64).

Plant height of *Morinda citrifolia* was higher with seedlings compared to tissue culture materials. However, the annual increment was higher with tissue culture materials. Number of branches and number of leaves were higher with tissue culture materials compared to seedlings. Over all growth performance was better with tissue culture material.

Tissue culture materials

Seedlings

Table 64: Growth performance of *Morinda citrifolia* as a mixed crop in coconut gardens (Arsikere, 2009)

Planting material	At planting			First year after planting		
	Plant height (cm)	No. of branches	No. of leaves	Plant height (cm)	No. of branches	No. of leaves
Seedlings	98.8	-	4.4	135.1	3.8	28.8
Tissue culture materials	50.8	-	5.2	92.0	8.0	57.1

Jagadalpur

Experiment was started in 2008. During the current year, observations on height of plants, no. of lateral branches, incidence of pests and diseases and no. of days taken for flowering were recorded (Table 65). Data indicated that plant height and stem girth were higher in seedling plants but number of branches was more in tissue cultured plants.

Table 65: Growth observations on *Morinda citrifolia* (Jagadalpur, 2009)

Planting material type	Plant height (cm)	Stem girth (cm)	No. of branches
Seedling plants	122	4.1	6
Tissue cultured plant	68	2.9	8

Kahikuchi

Planting materials of *Morinda citrifolia* (25 nos normal seedlings and 25 nos. tissue culture materials) were received from World Noni Research Foundation, Chennai on 25th July, 2008. The seedlings were cured and then planted under coconut on 1st August, 2008 as per the layout of the trial.

Data on growth characters (Table 66) revealed that seedling plants attained higher plant height and more number of branches/plant as compared to the plants raised from tissue culture materials. Seedling plants also took less duration for first flowering (305 days) than the tissue cultured plants (310 days).

Table 66: Growth characters of *Morinda citrifolia* (Kahikuchi,2009)

Type of plant	Plant height (cm)	No. of branches/ plant	No. of leaves/ plant	Days taken to first flowering
Normal seedlings	150	9.0	48.6	305
Tissue culture materials	85	8.5	38.0	310

Mondouri

Morinda citrifolia plants have been collected and planted according to the lay out of the experiment. Inter-cultural operations were undertaken in this plot.

Table 67: Morphological parameters of Noni (Mondouri, 2009)

Growth parameter	Seedling plants	Tissue culture plants
Height(cm)	175.2	108.4
No of branches	10.1	12.3
Disease/pest	nil	nil

Ratnagiri

Planting materials of *Morinda citrifolia* were received in July, 2008 and were planted in a coconut garden as per technical programme. Survival percentage was maximum in seedlings (80%), while it was 60% in tissue culture plants. Data regarding growth observations are presented in Table 68.

Table 68: Growth observations on *Morinda citrifolia* (Ratnagiri, 2009)

Planting material type	Growth observations							
	At the time of planting				After one year of planting			
	Height (cm)		No. of branches		Height (cm)		No. of branches	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Seedling plants	113-155	130	1-5	2	123-178	160	2-11	5
Tissue culture plants	23-83	55	1	1	45-125	86	1-4	2

It was observed that the seedling height ranged from 113 - 155 cm with an average of 130 cm whereas it ranged from 23 - 83 cm with an average of 55 cm in the tissue culture plants. However, it ranged from 123 - 178 cm with an average of 160 cm in the seedlings whereas it ranged from 45 - 125 cm with an average of 86 cm in the tissue culture plants after one year of planting. Further, it was observed that the number of branches ranged from 1 - 5 with an average of 2 in the seedling plants, whereas, it ranged from 0 - 1 with an average of 1 in the tissue culture plants at the time of planting. However, number of branches ranged from 2 -11 with an average of 5 in the seedlings, whereas, it ranged from 1 – 4 with an average of 2 in the tissue culture plants, after one year of planting.

Veppankulam

25 numbers of tissue culture materials and 25 numbers of normal seedlings were planted on 23.07.2008 in non replicated design with a spacing of 3m between 2 coconut rows in Field No. B4 of Coconut Research Station, Veppankulam.

The crop is in early growth stage. The newly emerged flowers were removed frequently, to allow flowering only after 2 years for better canopy of the crop. Frequent infestation of leaf feeder, *Macronia indica* was noticed and it was controlled by recommended pest management practices. Biometric observations viz., plant height, girth of plant, number of branches, number of leaves / plant in tissue culture plants as well as normal seedlings were recorded and reported in Table 69.

Regarding the plant height, the normal seedlings recorded higher plant height (156.32 cm) when compared to tissue culture plants (139.40 cm). Girth of the tissue culture plants was higher (8.01 cm) as against normal seedlings (7.12 cm). Number of branches/plant was higher in tissue culture plants (10.04) than in normal seedlings (6.20). The tissue culture plants recorded higher number of leaves / plant (115.63) when compared to normal seedlings (77.28).

Table 69: Biometric observations on tissue culture plants and normal seedlings of Noni (Veppankulam, 2009)

Sl. No.		Plant height (cm)	Girth (cm)	No. of branches	No. of leaves
1.	Tissue culture plants	139.40	8.01	10.04	115.63
2.	Normal seedlings	156.32	7.12	6.20	77.28

COCONUT

4.3 Disease Management

Path.3: Etiology and epidemiology of *Ganoderma* wilt disease of coconut

(Ambajipeta, Arsikere, Veppankulam)

Ambajipeta

Studies on genetic variability and grouping of *Ganoderma* isolates by using RAPD & RAMS – PCR analysis

Genetic diversity and grouping of Ganoderma isolates was studied by RAPD & RAMS, among the 12 isolates of *Ganoderma* spp isolated (by the respective Centre Scientists) from infected roots of coconut palms of endemic areas of Andhra Pradesh (Gannavaram, Nallagerla, Ambajipeta), Tamil Nadu (Veppankulam) and Arsikere (Karnataka). A total of 52 amplified fragments were produced by four primers in all the isolates with 100% of polymorphism. All the ten primers produced 100% polymorphic bands. All the primers produced specific bands to various isolates. The genetic similarity among the 12 isolates of *Ganoderma* varied from 0 to 72%. The isolate pairs Gl-Gwilt1, Gl-G12 and Ga1-Njl showed 100% genetic diversity between them whereas the genetic similarity (72%) was observed between the isolates Ga2 and Gwilt1 (Fig.2).

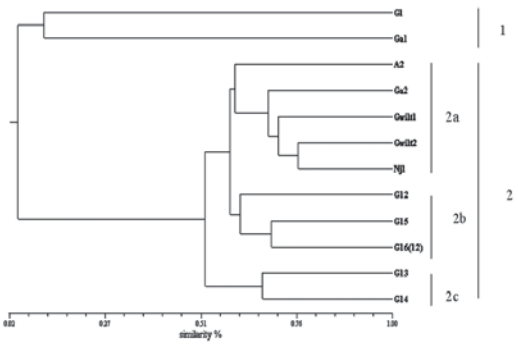

Fig.2. Dendrogram showing the relationship among the *Ganoderma* isolates based on RAPD pattern (Ambajipeta, 2009)

In case of RAMS analysis, a total of 81 amplified fragments were produced by seven primers in all the 12 isolates of which all were polymorphic with 100% polymorphism. The primer GFP3 produced a minimum of 7 bands whereas the primers GFP2 and GFP10 produced maximum bands. The genetic similarity among the *Ganoderma* isolates varied from 0 to 75%. The pairs Gwilt1, Gwilt2 and Njl showed maximum genetic similarity

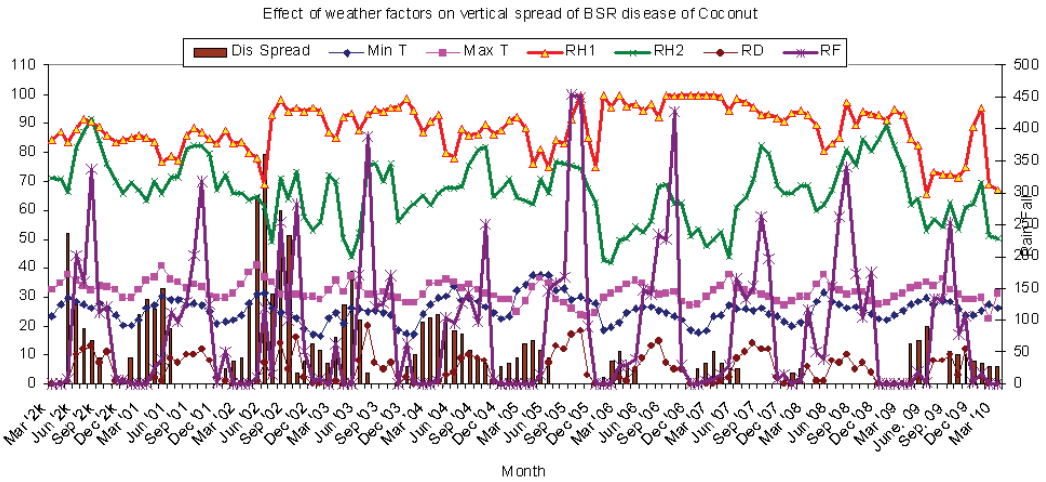

Fig.3: Effect of weather factors on vertical spread of BSR disease of coconut (Ambajipeta, 2009)

between them, whereas the isolates Gl and G13 showed 100% genetic diversity. The minimum genetic similarity of 1% was observed between the isolates Gl and G14.

On UPGMA clustering analysis, the 12 isolates of *Ganoderma* were divided into two main clusters. Polymorphic amplification products were produced by all *Ganoderma* isolates, when the microsatellite primers were used, which indicate that microsatellite motifs exist abundantly in the genome of *Ganoderma* isolates. The isolates Gl and Ga1 were formed into separate cluster from other 10 isolates and showed maximum genetic diversity with other isolates.

Epidemiology and disease forecasting

Correlation studies between weather factors and spread of basal stem rot disease for the period from January, 2000 to February 2010 indicated that number of rainy days, rainfall and evening relative humidity were found to have significantly negative relationship with vertical spread of basal stem rot disease in coconut (Fig.3).

Arsikere

As the Pathologist was on long leave (on medical grounds), all the Pathology projects were kept in abeyance at Arsikere Centre during 2009-10.

Veppankulam

The cultures of 17 isolates of *Ganoderma lucidum viz.*, CRS 1, CRS 3, CRS 4, CRS 5, CRS 6, CRS 7, MSL 1, KKD 1, VK 1, TKT 1, PV 1, PV 2, VRM 1, VPM 1, VKD 1, PKK 1& TTI 1 collected from different places were used to identify the pathogenic virulence of *Ganoderma* isolates to coconut. The pots which were filled with sterilized sand + 300 g of sorghum grain based inoculum of each of the 17 isolates were planted with ECT seedlings @ 1 seedling per isolate on 28.05.2008. For control, two pots filled with sterilized sand alone were planted with ECT seedlings @ 1 seedling / pot.

TTI - 1 isolate was found to be more virulent in terms of reducing the number of leaves, height of the seedling and girth of seedling.

Path.4: Management of basal stem rot disease of coconut

(Ambajipeta, Arsikere, Veppankulam)

Ambajipeta

Isolation of *Trichoderma* spp: Soil samples were collected from rhizosphere region of coconut palms from different villages of East Godavari district viz., Komaragiri patnam, Razole, Sakhinetipalli, Ponnamanda and Gannavaram and isolated *Trichoderma* spp by using *Trichoderma* specific medium.

Table 70: Efficacy of botanicals against *Ganoderma* spp (Ambajipeta, 2009)

Sl. No.	Fresh extract	Mean mycelium growth on PDA (mm)			
		G. applanatum		*G. lucidum*	
		Mycelial growth (mm)	% inhibition	Mycelial growth (mm)	% inhibition
1.	Garlic (Bulb)	28.5	68.3	19.0	78.8
2.	Ginger (Rhizome)	25.0	72.2	26.0	71.1
3.	Onion (Bulb)	37.0	58.8	38.2	57.5
4.	Chilli (Fruit)	36.2	59.0	28.7	68.0
5.	*Aloe vera* (leaf)	42.5	52.0	54.5	39.0
6.	Amla (Berry)	45.0	50.0	55.0	38.0
7.	Noni(leaf)	36.5	59.4	47.0	47.7
8.	Betelvine (leaf)	50.0	44.4	50.0	44.4
9.	Eucalyptus (leaf)	35.0	61.1	35.0	61.5
10.	Sapota (leaf)	40.0	55.5	50.0	44.4

New strain of *Pseudomonas fluorescens* from cocoa pod rot sample from Palivela village of East Godavari district was isolated by using King's B media.

Effect of botanicals against *Ganoderma applanatum* and *G.lucidum* under *in vitro* conditions: Ten extracts from botanicals at 10 per cent concentration were screened against *Ganoderma* spp under *in vitro* conditions by poisoned food technique. All were extracted from economic part of the botanicals. Fresh extracts from ginger and garlic inhibited the mycelial growth of *Ganoderma applanatum* by 72.2% and 68.3% respectively and *G.lucidum* by 71.1% and 78.8% respectively under *in vitro* conditions (Table 70).

Effect of *leaf extract of Glyricidia* on the growth *Ganoderma spp*

Glyricidia leaf extract of four different concentrations viz., 25% (T_1), 50% (T_2), 75% (T_3) and 100% (T4) were used for this study. The flask containing only Potato Dextrose Broth served as control. These flasks were kept at 28±1°C for twenty days and the observations were recorded. Glyricidia leaf extract at 75% & 100% concentrations (T_3 and T_4) were found effective in inhibiting the mycelial growth of both the species of *Ganoderma*.

Four treatments i.e. root feeding of culture filtrates of *Trichoderma viride* to *Ganoderma wilt* diseased coconut palms at different intervals were given. *Ganoderma* wilt affected coconut palms, which received six times of root feeding of 100% *Trichoderma viride* culture filtrates at bimonthly interval were found effective, i.e., the spread of *Ganoderma wilt* disease was arrested in diseased palms.

Studies on secondary metabolites of *T.viride* on *Ganoderma spp*

Potato Dextrose broth (2%) was prepared and inoculated with 5mm discs of *Trichoderma viride* culture aseptically and incubated at room temperature for about 20 days. Cell free extract (Culture filtrate) was obtained by centrifugation at 500rpm for 10 minutes. Supernatant liquid was taken and mixed with PDB at different combinations (v/v) to get 50% - 100% secondary metabolite medium. Flasks were inoculated with *Ganoderma applanatum* and *G.lucidum* and flasks were incubated at room temperature for observation. Flasks containing only PDB served as control. The experiment was replicated twice. Ten days after inoculation, observations were recorded. The results revealed that *Ganodrma applanatum* and *G.lucidum* were inhibited completely at all the concentrations ranging from 50% - 100%.

Rhizosphere engineering

Population dynamics of rhizosphere microflora of basal stem rot disease affected palms, apparently healthy and healthy coconut palms were studied to find out their influence on basal stem rot. Soil samples were collected from diseased and healthy palms from four villages. Serial dilution technique was adopted to study the microbial population in diseased and healthy palm rhizospheres. Results revealed that *Aspergillus flavus, A. niger* and *Penicillum spp* were the most common fungi present in all the samples. In case of healthy palms, there were no infection propagules (*Ganoderma*), where as in case of disease affected and apparently healthy soil samples, *Ganoderma* propagules were found in equal number i.e., CFU ($2x10^{-2}$–10^{-4}cfugm^{-1}) in all the samples but *Trichoderma* spp colonies were more in case of apparently healthy palm soil ranging from $3x10^3$–10^5 when compared to samples of affected palms (0-10^{-2}cfugm^{-1}).

Veppankulam

Management of basal stem rot disease of coconut through biocontrol agents and neem cake

Observations were recorded in the field trial with 16 treatments on the management of BSR disease of coconut using *Trichoderma viride* and *Pseudomonas fluorescens* and neem cake at Mahizhankottai in a farmer's field. The trial was initiated on 05.02.2008.

Treatments

T_1 = Root feeding of 100% culture filtrate of *Trichoderma viride* (25 ml) at quarterly interval

T_2 = Root feeding of 100% culture filtrate of *T. viride* (25 ml) at 6 months interval

T_3 = Root feeding of 100% culture filtrate of *T. viride* (25 ml) / year

T_4 = Basal application of *T. viride* (50 g) + neem cake (5 kg) / year

$T_5 = T_1 + T_4$

$T_6 = T_2 + T_4$

$T_7 = T_3 + T_4$

T_8 = Root feeding of 100% culture filtrate of *Pseudomonas fluorescens* (25 ml) at quarterly interval.

T_9 = Root feeding of 100% culture filtrate of *P. fluorescens* (25 ml) at 6 months interval.

Table 71: Disease index, nut yield and population of biocontrol agents in the BSR management trial (Veppankulam, 2009)

Treatment	Disease index (mean)		Nut yield (palm/year)		Population of biocontrol agents			
	Initial	After two years	Initial	After two years	*T. viride* (cfu x 10^3 / g / dry soil)		*P. fluorescens* (cfu x 10^5 / g / dry soil)	
					Initial	After 3 months	Initial	After 3 months
T_1	1.16	1.45	90	105	2.0	3.0	1.0	1.5
T_2	1.34	1.52	105	124	2.0	2.0	0.7	1.0
T_3	1.25	1.70	92	103	2.0	2.5	0.5	1.0
T_4	1.13	1.32	100	119	1.5	4.0	0.5	1.5
T_5	1.05	1.27	110	133	2.0	4.0	0.7	1.0
T_6	0.92	1.27	112	135	1.5	4.0	0.5	1.0
T_7	1.16	1.40	108	123	1.5	5.0	0.7	1.5
T_8	1.53	1.80	101	120	1.0	2.0	1.0	1.0
T_9	1.25	1.55	90	104	1.0	2.0	0.7	1.0
T_{10}	1.37	1.70	91	110	1.0	3.0	1.0	1.5
T_{11}	1.32	1.67	102	128	1.0	3.0	0.5	3.5
T_{12}	1.09	1.42	113	136	1.0	2.0	0.5	3.0
T_{13}	1.12	1.45	110	126	1.0	2.0	0.7	3.0
T_{14}	2.02	2.55	103	122	1.0	2.0	1.0	2.5
T_{15}	2.33	2.77	85	96	1.5	1.5	0.5	1.0
T_{16}	1.35	2.70	88	78	1.5	1.5	1.0	1.0
CD (P=0.05)	NS	NS	5.6	19.1	0.5	1.2	NS	0.7

T_{10} = Root feeding of 100% culture filtrate of *P. fluorescens* (25 ml) / year

T_{11} = Basal application of *P. fluorescens* (50 g) + neem cake (5 kg) / year

$T_{12} = T_8 + T_{11}$

$T_{13} = T_9 + T_{11}$

$T_{14} = T_{10} + T_{11}$

T_{15} = Neem cake @ 5 kg / palm / year

T_{16} = Control

Replications : 2

Plot size: 2 palms / replication

Design : CRD

In this trial, the initial disease index ranged from 0.92 to 2.33 (Table 71)while the disease index recorded after two years ranged from 1.27 to 2.77 indicating that there was no further spread of the disease after the imposition of treatments. The initial nut yield ranged from 85 to 113. After two years, the nut yield ranged from 96 to 136. The initial population of *Trichoderma viride* ranged from 1.0 to 2.0 x 10^3 cfu / g dry soil whereas after 3 months of treatment in the second year, it ranged from 1.5 to 5.0 x 10^3 cfu / g dry soil. The initial population of *Pseudomonas fluorescens* ranged from 0.5 to 1.0 x 10^5 cfu / g dry soil whereas after 3 months of treatment in the second year, it ranged from 1.0 to 3.5 x 10^5 cfu / g dry soil.

Path.5: Preventing spread of root (wilt) disease in Tamil Nadu and Karnataka States

(Aliyarnagar, Arsikere)

Aliyarnagar

Survey on the occurrence of root (wilt) disease of coconut was conducted in Tamil Nadu-Kerala border areas of Theni, Kanyakumari, Thirunelveli and Coimbatore districts and the infection levels were recorded.

From the survey conducted on the occurrence of root (wilt) disease of coconut in various districts of Tamil Nadu, it was found that the incidence was more in Shengottai block of Thirunelveli district (5.1%) followed by the Thiruvattar block of Kanyakumari district (3.30%) and Anaimalai block of Coimbatore district (0.11%) while there was no infected palms in Bodi block of Theni district.

Among the several villages of the identified blocks, Kulasekaram village of Thiruvattar block showed highest incidence of root (wilt) disease (15.7%) with some advanced symptoms. All the remaining villages showed an incidence from 3.0 to 9.3 per cent except Kattalai and Ponmanai which were free from the root (wilt) disease incidence.

In Thirunelveli district, severe root (wilt) disease incidence was noticed in Lalagudi (14.3%) and Sivaramapettai (10.00%). Rest of all villages showed an incidence ranging from 0.3 to 8.6 per cent. None of the villages were found free of root (wilt) disease incidence. Regarding Coimbatore district, the disease incidence was recorded only in Manakkadavu village (3.30%) of Anaimalai block.

Path.7: Biocontrol of bud rot and stem bleeding diseases of coconut

(Ambajipeta)

Field evaluation of antagonists against bud rot disease in coconut: Field experiment on evaluation of various formulations of *T.viride* and *P. fluorescens* against bud rot disease of coconut was carried out. Formulations (treatments) were applied in crown region of coconut seedlings. Data on incidence of bud rot disease on seedlings in each treatment were recorded. Application of talc formulation of *Pseudomonas fluorescens* @ 10g was found effective when compared to *Trichoderma viride* @ 10g and application of culture filtrates of 100% and 50% of both the bioagents.

Field evaluation of antagonists against stem bleeding disease in coconut: Field experiment on evaluation of various formulations of *T.viride* against stem bleeding disease of coconut was carried out. Out of the total number of 2462 coconut palms in Ambajipeta campus, 123 palms, i.e., 5.0 % of the palms, were affected with stem bleeding disease during the month of November 2008. All the diseased patches were treated with *T.viride* paste at monthly interval and it was observed that incidence was reduced to 1.58 % (39 palms) during August 2009. Again during the month of October, disease incidence was increased to 4.18 % due to favourable weather conditions for the spread of the pathogen but percentage of infected palms were less than half when compared to previous year when treatment was not started. The results revealed that smearing of *T.viride* paste on stem bleeding patches not only controlled the incidence but also the spread of the disease.

Biocontrol of stem bleeding disease of coconut: Spraying of culture filtrates of *T.viride* and *P.fluorescens* at two different concentrations i.e 100% and 50% at two different intervals viz., 15 days and 30 days at all possible combinations with one check were imposed on stem bleeding patches of coconut. All treatments were replicated thrice. Out of eight treatment combinations imposed, T_1 i.e., spraying of culture filtrate of *T. viride* (100% conc) twice at 15 days interval was found effective against stem bleeding disease, indicating its suitability as a prophylactic spray.

Path.8: Survey and surveillance on diseases of coconut

(Aliyarnagar, Ambajipeta, Arsikere, Veppankulam)

Aliyarnagar

The survey on the incidence of stem bleeding, basal stem rot, leaf blight and bud rot disease was conducted in different villages of Coimbatore and Thirunelveli district. Leaf blight disease was found to be the major problem to the tune of 11.70 per cent and 6.99 per cent in Coimbatore and Thirunelveli districts, respectively. Both basal stem rot and stem bleeding disease incidences were found in Pethanaickanur, Kaliapuram and Thathur villages of Coimbatore district and Thenpothai village of Thirunelveli district. Rest of the villages showed either of the diseases. While the Ambarampalayam village in Coimbatore and Mekarai village in Thirunelveli district were found free of stem bleeding and basal stem rot diseases, bud rot incidence was very less in Coimbatore district. Only Pethanaickanur village showed some

Table 72: Management of leaf blight disease (Location – Karianchettipalayam) (Aliyarnagar, 2009)

Treatment	Pre-treatment PDI	Post-treatment PDI	Reduction in disease severity (PDI)	Mean nut yield/ palm/ year
T_1 – Root feeding (RF) of 100% culture filtrate of Pf1 (25 ml) at quarterly interval	22.4	13.3	9.1	96
T_2 – RF - 100% culture filtrate of Pf1 (25 ml) at 6 months interval	23.6	15.4	8.2	88
T_3 – RF - 100% culture filtrate of Pf1 (25 ml/year) once in a year	24.1	18.9	5.2	90
T_4 – Soil application of *Pseudomonas fluorescens* @ 50 g + neem cake (5 kg) /palm/year	23.1	13.7	9.4	102
T_5 – T1+T4	22.8	7.2	15.2	112
T_6 – T2+T4	22.4	7.2	15.6	115
T_7 – T3+T4	22.8	9.4	13.4	106
T_8 – Soil application of neem cake (5 kg/palm/year)	23.1	18.5	4.6	86
T_9 – Control	24.2	33.4	-	78
CD (P=0.05)			3.1	5.2

incidence (0.19%). In Thirunelveli district, except Panpozhi and Ilangi, all the other villages showed 0.25 to 0.46 per cent bud rot incidence.

Ambajipeta

Survey conducted during the year 2009-10 in various coconut gardens in different villages of East Godavari and West Godavari districts indicated that basal stem rot disease, bud rot and stem bleeding disease commonly occurred in all the surveyed gardens. Survey indicated that mean per cent incidence of basal stem rot, bud rot and stem bleeding diseases on coconut recorded up to 5.4, 1.9 and 2.8 percent respectively in Andhra Pradesh. However, no tatipaka disease incidence was noted in the surveyed areas.

Veppankulam

Survey was conducted in Thanjavur and Thiruvarur districts to assess the incidence of basal stem rot, stem bleeding and bud rot diseases in coconut.

Stem bleeding disease incidence was not noticed in any of the places where survey was undertaken. Bud rot disease incidence was noticed in 5 places out of 43 places surveyed. Altogether, 17,441 palms were covered in the survey and among them 167 palms were affected by basal stem rot disease showing 0.95% infection. Among the 17,441 palms surveyed, only 23 palms were affected by bud rot disease showing 0.13 % infection.

Path 9: Studies on management of leaf blight (*Lasiodiplodia theobromae*) of coconut

(Aliyarnagar)

In vitro studies revealed that *Pseudomonas fluorescens* was highly effective in inhibiting the *Lasiodiplodia theobromae* compared to other bioagents. Hence, on-farm field experiment was laid out at Karianchettipalayam village of Pollachi Taluk to study the effect of both the talc-based powder formulation as well as the culture filtrate of *P. fluorescens* against leaf blight disease.

Pre treatment and post treatment observations on leaf blight disease were made and the difference between the two gives the reduction in disease severity. The annual yield of coconut in different treatments was also recorded.

The results of the on-farm field experiment conducted at Karianchettipalayam village revealed that the combined application of talc-based powder formulation of *P. fluorescens* to soil (50 g/palm/year) along with neem cake (5 kg/palm/year) followed by root feeding of 100% culture filtrate of *P. fluorescens* at half yearly intervals was effective in managing the disease (15.6% disease reduction) (Table 72). In the control, maximum disease intensity of 33.4% was observed. In addition to disease reduction, the nut yield per palm was also found to be the highest (115 nos) in combined application of *P. fluorescens* to soil along with neem cake followed by root feeding at half yearly intervals as against the lowest (78) in the control.

Further, three trials have been laid out at three different locations *viz.*, Kambalapatti, Karianchetti-palayam and Samathur villages of Pollachi taluk to evaluate the efficacy of the individual as well as combined application of *P. fluorescens* culture filtrate and powder formulation with or without the application of neem cake.

The data indicated that soil application of *P. fluorescens* (50 g/palm/year) along with neem cake (5 kg/palm/year) followed by root feeding of 100% culture filtrate of *P. fluorescens* at half yearly intervals was effective in managing the leaf blight disease.

Path.10: Early detection of basal stem rot (*Ganoderma* wilt) disease of coconut

(Ambajipeta, Arsikere, Veppankulam)

Ambajipeta

Development of Diagnostic Kit for basal stem rot disease: Simple serological tests like ELISA, Slide agglutination test and Glass capillary tube tests were found effective and efficient in early detection of *Ganoderma applanatum and G.lucidum.*

Identification of indicator plants for basal stem rot disease: Red gram was resown again in sick soil to study the consistency of the symptoms of bark splitting at the base. Results indicated that bark splitting of red gram at the base was consistent in all the plants that are grown in *Ganoderma* sick soil. Other indicator plants like chick pea and black gram are also being tested.

Veppankulam

In order to find out the reaction of some crop plants to act as indicator plants for the early detection of basal stem rot disease, seeds of red gram, bengal gram, brinjal, tomato, bhendi, cowpea, green gram, black gram, chillies and cluster beans were sown in pots filled with sterilized sand and inoculated with G*anoderma lucidum* (multiplied on sorghum grains) on 04.01.2010 for testing the suitability of these crops as an indicator host for the early detection of BSR. Observations were recorded on 24.03.2010.

The plants were observed for bark splitting and *Ganoderma* sporophore formation and none of the plant species exhibited these symptoms.

Path.14: Etiology and epidemiology of leaf blight disease of coconut

Aliyarnagar

Leaf blight disease infected samples were collected from seven different locations *viz*., Aliyarnagar, Angalakurichi, Karianchetipalayam, Kambalapatti and Subbeagoundanpudur and Samathur villages of Pollachi Taluk of Coimbatore district and Veppankulam village of Thanjavur district in Tamil Nadu. The associated fungal pathogen, *Lasiodiplodia theobromae* was isolated using potato dextrose agar medium to study about the genetic variability. The leaf blight disease incidence was recorded at monthly interval. Weather parameters *viz*., maximum temperature, minimum temperature, relative humidity and rainfall were also recorded. The disease incidence is correlated with weather parameters. Leaf blight disease intensity increased with increase in temperature and the maximum disease intensity was observed during March-April. Disease intensity was reduced after the receipt of rainfall. Disease intensity was found to be the lowest during November-December.

Path.15. Early detection of bud rot disease of coconut

Ambajipeta

Development of diagnostic kit for bud rot disease: Polyclonal antiserum against *Phytophthora palmivora* was raised using New Zealand White rabbits. *Phytophthora palmivora* was detected by using the antiserum produced by employing simple serological tests viz., cavity slide test and glass capillary tube test. Various forms of ELISA were also standardized for detecting the *P. palmivora.*

Path.16: Evaluation of coconut types with resistance to basal stem rot disease of coconut

(Ambajipeta, Arsikere, Veppankulam)

Ambajipeta

New planting materials are being procured from Gen1, Gen2 and Gen3 trials for screening and the trial would be planted in sick soil during the month of June 2010.

Veppankulam

Seed nuts collected from the basal stem rot resistant palms from hot spot area of Thambikkottai were planted in the nursery for screening purpose. The seedlings obtained from these seednuts were used for laying out of an On-Farm Trial in a farmer's holding at Pulichankadu village, Peravurani taluk, Thanjavur district. In this trial, the following no. of seedlings were used to test verify them for basal stem rot resistance. The seedlings were planted in a CRBD on 01.12.09. The trial is in progress

I.	CRP 509 x CRP 802	15
II.	Kera Keralam	10
III.	VPM-3	10
IV.	Kalpa Prathiba	15
V.	Kera Bastar	10
VI.	CRP 802	10

In addition, five seedlings of selfed CRP 802 and six seedlings of CRP 509 x CRP 802 were planted in the BSR disease sick plot at CRS, Veppankulam on 13. 11.2009 for further evaluation.

Path.17: Studies on post harvest diseases of coconut

(Aliyarnagar, Ambajipeta, Arsikere, Veppankulam)

Aliyarnagar

Based on the previous studies, the fungus *Aspergillus flavus* was found to be the predominant mycoflora on copra as well as unhusked nuts. The antagonist *T. viride* was found to be effective in inhibiting *A. flavus in vitro*. In order to find out a good chemical preservative, various compounds were screened against *A. flavus*. Among them, the potassium metabisulphite and benzoic acid were found to be effective and showed 73.0 and 68.5 per cent mycelial growth inhibition compared to the control (Table 73).

Table 73: Effect of chemical preservatives on the mycelial growth of *A. flavus* (Aliyarnagar, 2009)

Sl. No.	Treatment (500 ppm)	Mycelial growth of *A. flavus* (cm)	Inhibition over control (%)
1.	Potassium metabisulphite	2.4	73.0
2.	Benzoic acid	2.8	68.5
3.	Sodium benzoate	3.6	59.6
4.	L-ascorbic acid	3.4	61.8
5.	Propionic acid	5.2	41.6
6.	Acetic acid glacial	7.1	20.2
7.	Control	8.9	-
	CD (P=0.05)	2.8	-

Ambajipeta

As none of the chemical preservatives have shown complete inhibition of all the four test pathogens, combination of menadione at 400 ppm and benzoic acid at 750 ppm was tested and total inhibition of *Aspergillus flavus, A.niger, Rhizopus spp* and *Penicillium spp* was observed.

Methyleugenol (a natural food preservative) was tested for its efficacy against the common pathogens isolated from the rotted coconut / copra samples by poisoned food technique at seven different concentrations i.e. 0.1% to 0.7% and on two different media like Potato Dextrose Agar (PDA) and Coconut Dextrose Agar (CDA) which is a good substratum for *Aspergillus* spp growth. All the four common pathogens viz., *Aspergillus niger, A.flavus, Rhizopus oryzae* and *Penicillium spp* were tested against each concentration on two media and plates containing PDA and CDA without methyleugenol served as controls. Each treatment was replicated thrice. Inoculation plates were incubated for 7 days at 29 ± 1^0c. One week after inoculation, radial growth of each test pathogen was recorded in all the plates. Data revealed that methyleugenol was effective against all the three mycoflora viz., *Aspergillus niger, A.flavus, and Penicillium spp* with inhibition ranging from 66.6-100% and showed little effect on Rhizopus spp (10-16.6%) on CDA over control at 0.6% (T5) and 0.7% (T6) concentrations of Methyleugenol.

Methyleugenol was tested on fresh copra meat at

different concentrations ranging from 0.1%(T1), 0.2% (T2), 0.3% (T3), 0.4% (T4) and 0.5% (T5). Samples were sprayed with treatment solutions after draining out the water from the broken nuts. Fresh copra samples without any spray of methyleugenol served as control. After spraying, broken nuts were kept under sunlight and dried for one week. After completion of drying, observations were recorded. Observations showed that samples treated with 0.3%, 0.4% and 0.5% solutions were completely free of any fungal contamination.

Isolation of rhizosphere antagonistic mycoflora: Soil dilution plate count method was used for isolation of antagonistic mycoflora from the rhizosphere of coconut palms and hyphal tip method was adopted for pure culturing of these organisms.

Dual culture technique was employed to test the efficiency of fungal bioagents of *Trichoderma spp* on *A.flavus, A.niger, Rhizopus spp and Penicillium spp* under in vitro conditions. All the *Trichoderma spp* viz., *T.viride, T.harzianum, T.hamatum and T.longibrachiatum* were found to inhibit the mycelial growth of *A.flavus, A.niger, Penicillium spp* with percent inhibition ranging from 31% to 100%. Among the four species of *Trichoderma* tested, maximum inhibition of pathogen was recorded with *T. longibrachiatum* with percent inhibition of 100%, against *Penicillium spp*, 72% against *A.flavus.* This was followed by *T.hamatum* and *T. harzianum* and *T.viride* with percent inhibition of 67%, 61%, and 34% respectively. While none of the fungal bioagents of *Trichoderma spp* inhibited the growth of *Rhizopus spp*., all the *Trichoderma spp* were found to be effective against *Penicillium spp* with maximum percent inhibition of 100%.

Effect of age of the nuts at the time of harvest on storage rots: Age of the nuts at the time of harvest plays a major role in shelf life of the produce. Samples of different ages viz., nine months, ten months, eleven months and twelve months were collected from farmers' gardens. From each sample, half were kept with full husk and remaining half were partially dehusked for each sample. Fifteen nuts were kept for observation and observations were recorded at monthly interval by using destructive sampling method. At the end of each month, five nuts were broken and number of healthy and spoiled nuts were recorded. Data revealed that the lowest rotting percentage was recorded in twelve months and eleven months old nuts. In case of twelve months old nuts, there was no rotting up to first two months of storage in both whole nuts and partially dehusked nuts and after three months rotting was upto 13.33% in whole nuts and 6.7% in partially dehusked nuts. In case of eleven months old nuts, rotting was not seen in one month of storage in both whole nuts and partially dehusked nuts. Rotting was upto 26.7% in whole nuts and 13.33% in partially dehusked nuts after three months of storage. In case of nine and ten months old nuts, damage started from second month onwards. The studies revealed that eleven and twelve months old nuts in partially dehusked condition could be stored for longer duration when compared to whole nuts.

Veppankulam

Effect of three chemical preservatives on the *in vitro* growth of *Aspergillus flavus, A. niger, Rhizopus* sp. and *Penicillium* sp. were assessed and the results are presented in Table74.

Citric acid reduced the growth of *Penicillium* sp. to the extent of 46 per cent, while acetic acid and sodium chloride were less effective. Acetic acid was the most effective against the growth of *Aspergillus niger* where 33 per cent reduction was observed. Growth of *A. flavus* was arrested up to 22 per cent by sodium chloride. Growth of Rhizopus sp. was inhibited to the maximum of 33 per cent by citric acid.

Table74: Effect of chemical preservatives on the growth of pathogens isolated from copra (Veppankulam, 2009)

Organism isolated from copra	Mycelial growth (mm)				% reduction over control		
	Citric acid	Acetic acid	Sodium chloride	Control	Citric acid	Acetic acid	Sodium chloride
Aspergillus niger	51	60	73	90	43	33	18
A. flavus	53	66	70	90	41	26	22
Penicillium sp.	48	70	78	90	46	22	13
Rhizopus sp.	60	64	80	90	33	28	11

COCONUT

4.4 Pest Management

Ent.3: Survey and monitoring of pest problems in coconut

(Aliyarnagar, Ambajipeta, Ratnagiri)

Aliyarnagar

An extensive rowing survey on the incidence and intensity of four major coconut pests *viz.*, rhinoceros beetle, black headed caterpillar, red palm weevil and eriophyid mite, was carried out in selected coconut gardens in Salem, Erode, Coimbatore and Thirupur Districts. The data were recorded in five randomly selected taluks of each district comprising five revenue villages in each block.

- Survey revealed that a few coconut gardens in Dharmapuri district (94.5%) followed by Erode district (87%) recorded the highest incidence of black headed caterpillar.
- The incidence of coconut rhinoceros beetle in Chennimalai, Perundurai and Sathyamanagalam blocks ranged from 10 to 24 per cent, while it was 2.7 to 9.4 per cent in Coimbatore district.
- The percent infestation of eriophyid mite in Coimbatore district ranged from 55.00 to 85.00. Significant reduction was observed in eriophyid mite population and nut damage in IPM treated gardens compared to non-IPM gardens.

Ambajipeta

Periodical survey for monitoring of five pests viz., black headed caterpillar, red palm weevil, rhinoceros beetle, eriophyid mite and slug caterpillar were conducted by following 'Rowing' and 'Fixed Plot' survey.

Fixed Plot Survey: Two villages were selected for Fixed Plot survey in East Godavari district i.e., Sakinetipalli and Ponnamanda. Mild to medium intensity of rhinoceros beetle was noticed in both the villages surveyed. Minor pests like bag worm was also observed. The gardens have recovered from the out break of coconut slug caterpillar in the year 2009. Presently, inflorescence emergence was observed in these affected palms.

Rowing Survey: Rowing survey was conducted in 54 villages of East Godavari district, 31 villages in West Godavari, 2 villages in Visakhapatnam and one village each in Guntur and Nellore districts.

Severe infestation of coconut black headed caterpillar in East Godavari (11 villages), West Godavari (13 villages), Visakhapatnam (2 villages) and slug caterpillar in East Godavari (18 villages) and West Godavari (14 villages) districts was recorded during the rowing survey. Medium infestation of red palm weevil in 20 villages in East Godavarai district was noticed. Medium incidence of rhinoceros beetle was noticed in East Godavari, West Godavari and Visakhapatnam districts. Mild to medium intensity of coconut eriophyid mite was recorded in all the districts surveyed.

Leaf chaffer beetles [black and brown] damage was found predominant on cocoa crop and bag worm infestation was noticed on cocoa, coconut and oil palm crops.

Ratnagiri

To record the intensity of infestation of various pests of coconut, a rowing survey was carried out in Thane, Ratnagiri and Sindhudurg districts of Konkan region of Maharashtra from April 2009 to March 2010. Minimum two gardens in each village and two villages in each taluka were selected for recording the infestation. Observations on the incidence and intensity of rhinoceros beetle, red palm weevil, black headed caterpillar and eriophyid mite were recorded. The observations recorded during the survey are summarized in Table 75.

In case of eriophyid mite, grade wise intensity on fruits was also recorded. For this purpose, twenty palms were randomly selected and observations were recorded.

Rhinoceros beetle: The infestation of rhinoceros beetle was in the range of 11 to 19 %. Maximum infestation (19.13 %) was in the month of July 2009.

Red palm weevil : The infestation of red palm weevil was in the range of 1 to 3 %. Maximum infestation (2.96 %) was in the month of July 2009.

Eriophyid mite: The infestation of eriophyid mite was in the range of 53 to 57 %. Maximum infestation (56.73 %) was in the month of April 2009.

Table 75: District wise coconut pests situation in Konkan region (Ratnagiri, 2009)

Sl. No.	District	No. of palms inspected	Per cent infestation			
			Rhinoceros beetle	Red palm weevil	Eriophyid mite	Black headed caterpillar
1	Thane	3917	15.83	1.04	64.16	7.60
2	Ratnagiri	3824	15.29	3.79	57.00	-
3	Sindhudurg	4618	15.76	8.16	65.40	-

Black headed caterpillar: The incidence of black headed caterpillar was not noticed during fixed plot survey.

Fixed plot survey was carried out at three months interval from April 2009 in Ratnagiri district in two places, viz; one at RCRS, Bhatye Farm and another in farmer's field. Observations on the incidence and intensity of all the pests were recorded. The observations recorded during the survey are summarized in Table 76.

Table 76: Fixed plot survey of coconut pests (per cent infestation) from April 2009 to April 2010 (Ratnagiri, 2009)

Sl. No.	Month	No. of palms observed	Rhinoceros beetle	Red palm weevil	Eriophyid mite	Black headed caterpillar
1	April 09	30	11.59	1.04	56.73	0.00
2	July 09	30	19.13	2.96	56.62	0.00
3	Oct 09	30	17.13	2.35	53.27	0.00
4	Jan 10	30	15.24	1.70	54.63	0.00
5	April 10	30	12.69	1.62	53.63	0.00

Ent.5: Management of eriophyid mite in coconut gardens

(Aliyarnagar, Ambajipeta, Ratnagiri)

Integrated management trial on eriophyid mite in coconut garden was carried out in farmers holdings near Aliyarnagar, Ambajipeta and Ratnagiri Centres. The following mentioned IPM inputs were applied to the experimental plot containing 100 experimental palms.

i. Phytosanitary measures

ii. Root feeding of azadirachtin 10,000 ppm @ 10 ml + 10 ml water. The treatments are given three times in a year i.e., December - February, April - June and September - October.

iii. Recycling of organic wastes

iv. Raising of green manure crops in the basin

v. Application of recommended dose of fertilizers

vi. Recommended level of irrigation

vii. Husk burial in basin

viii. Soil moisture conversation measures

Aliyarnagar

Pre-treatment observations on the population level of eriophyid mite and its natural enemies were recorded. The population level of eriophyid mite in two month old buttons of treated palms was reduced after imposing the IPM package. The percent reduction of eriophyid mite over the untreated palms was also worked out. Results indicated that significant reduction in eriophyid mite population and nut damage could be recorded in IPM treated gardens as compared to non-IPM gardens.

Ambajipeta

The experiment was conducted in a plot having 100 palms in Munganda village. IPM package for the

management eriophyid mite was implemented in the plot.

Data was recorded on intensity of eriophyid mite from 3rd bunch in the selected plot at quarterly intervals. Mild intensity of mite i.e., 2.35 grade index was observed in the IPM implemented gardens whereas 2.65 grade index (Medium) intensity was recorded in control plot.

Ratnagiri

The trial was conducted at farmers' fields in Waingani village of Ratnagiri district. One block was treated with IPM package and another block was kept as a control plot. The pre treatment observations were recorded before applying the treatments. Post treatment observations were also recorded at three, six and nine months. Simultaneous observations were also made in control plot. Data was recorded on pre-treatment and post -treatment intensity of eriophyid mite from 3rd bunch in the selected plot.

It was observed that the eriophyid mite infestation was in the range of 90 to 92 % in both the plots before application of various treatments. The eriophyid mite infestation was reduced from 92.21 % to 34.38 % after applying integrated package. On the other side, percentage of healthy fruits was increased from 7.78 % to 65.63 %. The eriophyid mite population remained the same in control plot.

Ent.10: Compatibility of natural enemies with the most commonly used botanical/chemical pesticides (*Brachymeria sp.*)

(Aliyarnagar, Ambajipeta)

Aliyarnagar

Mass culturing of Braconid parasitoid viz., *Bracon brevicornis* and Bethylid parasitoid was continued on the alternative host of rice grain moth larvae *Corcyra cephalonica* in the bicontrol laboratory for conducting bioassay studies.

Studies on the compatibility of Braconids with most commonly used botanicals like azadirachtin and chemicals dichlorvos and monocrotophos was carried out in the Entomology Laboratory of CPCRI, Kasaragod, Kerala. The Relative Toxicity of dichlorvos, monocrotophos, carbaryl, phorate and malathion on Braconid parasitoids was also worked out. (Table 77).

Table 77: Median Lethal Dose of insectcides to *Bracon brevicornis* (Aliyarnagar, 2009)

Chemical	LD_{50} Value ng / cm^2
Malathion	23.02
Phorate	41.60
Carbosulfan	37.67
Monocrotophos	18.91
Carbaryl	49.80

Based on LD_{50} studies, it could be inferred that monocrotophos was the most toxic followed by malathion, carbosulfan, phorate and carbaryl for parasitoid *Bracon brevicornis.*

Ambajipeta

The culture of the test organism *i.e.*, pupal parasitoid, (*Brachymeria* sp.) of *Opisina arenosella* was multiplied in the laboratory for conducting bio-assay studies. Culture so obtained was taken to CPCRI, Kasaragod to conduct studies on behavioural activity of the parasitoid. Three parasitoids viz., *Brachymeria* spp, *Bracon hebetor* and *Goniozus nephantidis* were exposed to four chemicals, viz., carbaryl, chlorpyriphos, phorate and endosulphan at the concentrations of 10.00 to 0.15 ppm. Insects of same physiological stage were released with honey fed and allowed for 24 hours for observation. The mortality data was subjected to statistical analysis using SPSS version-10.

In the case of carbaryl, the per cent mortality of *Brachymeria* spp adults increased with the increase in doses of the pesticide. The highest mortality (100 percent) was recorded with the higher doses i.e., 10 and 5 ppm. However, at the lower doses i.e., 1.25 and 0.62 ppm, it was lowest of 25 and 10 per cent. The dose of carbaryl required to kill 50 per cent population of *Brachymeria* spp adults proved to be 2.546 ppm, which is much lower than the recommended dose against the coconut pests (3 g./lt).

Amongst the various pesticides evaluated for their toxicity against *Bracon hebetor* (Table 78), carbaryl was the safest with LD50 value being 2.412 ppm, followed by phorate (1.717 ppm) and endosulfan (0.225 ppm) respectively. However, chlorpyriphos even at the lowest concentration of 0.15 ppm gave 100 per cent mortality of the adults of *Bracon hebetor*. Therefore, carbaryl proved to be 1.404 and 10.720 times less toxic than phorate and endosulfan against the adults of *Bracon hebetor.*

Table 78: LD_{50} evaluation of various pesticides against *Bracon* adults (Ambajipeta, 2009)

Sl. No.	Pesticide	Heterogenity X^2	LD_{50} (ppm)	Fiducial limits	Relative toxicity
1.	Chlorpyriphos	The lowest concentration (0.15 ppm) gave 100% mortality			
2.	Phorate df = 6	83.276	1.717	—	1.404
3.	Carbaryl df = 2	1.252	2.412	2.028-3.020	1.000
4.	Endosulfan df = 2	0.289	0.225	—	10.720

Brachymeria parasitoids were mass multiplied for further studies like range fixing and to find out lowest concentration to the extent possible and parasitoids were tested against monocrotophos, malathion and endosulphan at five concentrations i.e., 10 ppm, 5 ppm, 2.5 ppm, 1.25 ppm and 0.6 ppm. Mortality data was recorded after 24 hours of exposure (Table 79).

Table 79: Mortality percent of *Brachymeria* sp. after 24 hours of exposure to insecticides (Ambajipeta,2009)

Treatment	10 ppm	5 ppm	2.5 ppm	1.25 ppm	0.6 ppm
Monocrotophos	100	100	73.33	93.33	60
Malathion	100	100	100	53.33	33.3
Endosulfan	100	86.7	93.33	—	—
Control	0.13	0.13	—	0.2	0.2

Ratnagiri

Culture of *Goniozus nephantidis* was collected from Thane district. Mass culturing *Goniozus nephantidis* was continued on the alternate host of rice grain moth larvae *Corcyra cephalonica* in the laboratory for conducting bioassay studies.

Ent.11: Evaluation of improved strains of parasitoids (Braconid) and predators (*Cardiastethus exiguus*) in the field against *O. arenosella*

(Aliyarnagar, Ambajipeta, Ratnagiri)

Aliyarnagar

A field experiment on the evaluation of predator *Cardiostethus exiguus* on *O. arenosella* was initiated at Ekatampalayam village of Chennimalai Taluk of Erode district with the following treatments.

Location : Chennimalai, Erode

No. of seasons : Two

Period : 2008-09 & 2009-10

No. of nymphs / adults released / tree : 50

No. of palms / replication : 10

No. of releases made : 4

Time interval : 15 days

Results indicated that *Caridiostethus exiguus* was an efficient egg/larval predator of *O. arenosella* and could effectively suppress the caterpillar population, when released alone @ 50 nos./ palm at 15 days interval for six times consecutively.

Ambajipeta

The larval parasitoid *Goniozus nephantidis* was mass multiplied in the laboratory for conducting experiment with pre-conditioning of parasitoids to improve the potency of parasitization under field conditions. The experiment was initiated in pest infested coconut garden in Gundipudi village in East Godavari district on fish pond bunds with three treatments of 100 palms each and pre-release data was recorded.

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

(Aliyarnagar, Ambajipeta, Ratnagiri)

Aliyarnagar

Studies on field efficacy of commercially available pheromones viz., Chemtica Ferrolure, CPCRI-Lure, Brookland and PCI against red palm weevil *Rhhynchophorus ferrugineus* was continued in three locations namely Pethanaickanur, Nallur and Kanniyur.

In Pethanaickanur, among the four types of aggregation pheromone traps tried, Chemtica – Ferrolure trap was found to trap significantly the highest 442 (295 females & 147 males) numbers of adult red palm weevils followed by Brookland Pheromone lures trap upto 303 (196 females & 107 males), PCI lures trap upto 246 (160 females & 86 males) and CPCRI lures trap upto 193 weevils (125 females & 68 males).

Studies on the field efficacy of commercially available pheromones against coconut rhinoceros beetle were also carried out. The rhinolure pheromones of Chem Tica lure (T1) and Pest Control India Ltd. lure (T2) were evaluated in rhinoceros infested garden during the period 2009–10. Data on the number of trapped adult rhinoceros beetles was recorded. Sexing of the beetles was also done. It is observed that Chem Tica lure (T1) was found to be significantly superior in attracting more number of adult rhinoceros beetles per trap per month followed by Pest Control India Ltd.lure (T2). More number of beetles were trapped after the onset of monsoon rain.

Ambajipeta

Studies on red palm weevil : Studies on red palm weevil pheromone lures were conducted during the year with three available lures i.e., CPCRI lure (T_1), Chem Tica (T_2) and Pest Control India (T_3). Pheromone catches during the period indicated that highest number of weevils were trapped in Chem Tica lure (26.0 weevils/trap/month) followed by PCI lure catching 7.9 weevil/trap/month. Maximum number of weevils were trapped in the months of April, May, June and July 2009. It was also found that the infestation levels as well as dead palms percentage have decreased in the gardens where pheromone traps were placed whereas dead palms percentage has increased in the control plots. Longest working period of the lure was recorded in the lure supplied from CPCRI [> 2 years] followed by Chemtica that worked for 5 months 17 days.

Studies on rhinoceros beetle : Similar studies were conducted with rhinoceros beetle lures (rhino lures) with available two commercial formulations i.e., Chem Tica (T_1) and Pest Control India Ltd. (T_2) arranged in two different gardens. From the data, it was found that highest number of beetles were trapped in Chem Tica lure (5.86 beetles/trap/month) while PCI lure could catch 1.43 beetles/trap/month during the experimental period. More number of beetles were trapped during the months of February, April, May and July 2009. Leaf damage has come down by 40.8 and spindle damage by 48.1 per cent decrease over pre treatment damage in the garden where Chem Tica lure was kept. Longest working period was recorded in the lure supplied by Chemtica i.e., 5 months and 2 days.

Ratnagiri

From the experiments conducted, it was observed that the total number of rhinoceros beetles trapped in Chem tica lure was 94 and PCI lure was 96 indicating that Chem tica and PCI lures were equally effective for attracting beetles.

Similarly, it was observed that total number of red palm weevils trapped in Ferro lure + was 81, PCI lure was 109 and CPCRI lure was 65 indicating that PCI lure was more effective for attracting weevils.

Ent.13: Screening of coconut germplasm for tolerance/ resistance to *O.arenosella* (Ambajipeta, Aliyarnagar)

Aliyarnagar

Relative resistance of coconut varieties including DxT, TxD hybrid combinations and local germplasm types are being observed in black headed caterpillar hot spot areas of Tamil Nadu state especially Coimbatore, Erode, Thirupur, Salem and Dharmapuri districts.

Ambajipeta

Studies were conducted to screen coconut germplasm through artificial diet prepared from coconut varieties to coconut black headed caterpillar. Two sets of experiments were done depending on the population available with uniform age, one set with artificial diet with leaf powders and second with fresh leaves of respective varieties, as neonate larvae could not feed on artificial diet/leaves in the laboratory. Each experiment was done repeatedly. During the year 2010, the experiment was conducted on leaves of six coconut varieties (CRP 509, Gauthami Ganga, Godavari Ganga, Double Century, Kera Bastar and Kalpa Prathiba) by releasing 7 days old larvae @ 15 larvae/ variety. Shortest

developmental period was recorded in CRP 509, Gauthami Ganga and Double Century i.e., 41.5 days. Maximum population could complete life cycle in the variety CRP 509 (33%).

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

(Aliyarnagar, Ambajipeta)

Aliyarnagar

The IPM package including use of pheromones, *baculovirus*, naphthalene balls and *Metarhizium anisopliae* is to be validated in a contiguous area of 10.00 ha.

A contiguous area of 15 ha has been identified at Odayakulam, Pollachi for laying out large scale demonstration plot on validation of integrated pest management technology for *Oryctes rhinoceros*. There were about 1200 palms with an age of 3 years including DxT, TxD and local tall varieties. As a pre treatment observation, the intensity of coconut rhinoceros beetle damage was recorded (upto 35 to 40% on leaf, spindle and spathe).

Ambajipeta

Survey is being conducted to locate the rhinoceros infested coconut garden [10 ha area]. Rhinoceros grubs are being collected from breeding sites for isolation of natural strain of Baculovirus for further culturing. Metarhizium was obtained from M/s. K.N.Biosciences (India) Pvt. Ltd., Hyderabad. Pheromone lures were also obtained from M/s. Chem Tica Pvt. Ltd., Trichur. The experiment will be initiated soon.

Ent.15. Effect of management practices on the incidence and intensity of coconut pests

(Aliyarnagar, Ambajipeta, Ratnagiri)

Incidence and intensity of coconut pests are to be recorded in different treatments in the following three AICRP experiments:

a) Agr.3B: Performance of medicinal and aromatic plants as intercrops in coconut gardens

b) Agr.5A: Studies on fertilizer application through micro-irrigation technique for coconut

c) Agr.10: Development of coconut based integrated cropping system model for different agro climatic regions.

Aliyarnagar

Initial observations on the incidence and intensity of coconut pests namely coconut rhinoceros beetle, eriophyid mite, red palm weevil, black headed caterpillar and sucking pests (scale and mealy bug) were recorded.

It was found that the rhinoceros beetle incidence was high on coconut palms intercropped with lemon grass and Patchouli and moderate on coconut palms intercropped with Karisalanganni, Sriyanangai and Sitharathai. Similarly, in the case of eriophyid mite incidence, coconut palms intercropped with Sriyananagai was found to have high incidence followed by moderate level of incidence when intercropped with Karisalanganni, Lemon grass and Patchouli. On the other hand, low level of eriophyid mite infestation was noticed on coconut palms intercropped with Sitharathai.

Initial observations on the incidence and intensity of coconut rhinoceros beetle, eriyophyid mite, red palm weevil, black headed caterpillar and sucking pests of scale and mealy bug were recorded in different treatments of fertigation trial.

Rhinoceros beetle damage was to found to be in higher proposition on the coconut palms treated with 50%, 75%, 100% recommended dose of fertilizers through drip irrigation and 100% recommended dose of fertilizers as basin application. There was low level of infestation on 25% recommended dose of fertilizers through drip irrigated palms and control.

Ambajipeta

Data on the incidence and intensity of coconut pests were collected from the three experiments as per technical programme.

OIL PALM

5.1 Crop Improvement

Gen 8: Studies on the comparative performance of different hybrid combinations of oil palm

(Gangavathi, Mulde, Vijayarai, Aduthurai)

Mulde

Objective	:	To evaluate the performance of oil palm hybrids
Treatments	:	Eleven tenera hybrid combinations
Experimental design	:	Randomized Block Design
Replications	:	Three
Plot size	:	8 palms/plot
Year of start	:	August, 1991

The data regarding yield attributes were recorded in eleven hybrid combinations of oil palm during the period July, 2008 to June, 2009 and are presented in Table 80.

The data indicated that there was no significant difference among the hybrid combinations in respect of number of FFB/palm and FFB yield (kg/palm & t/ha). Hybrid combination 109 D x 291P (V_3) produced more (6.11) number of FFB followed by hybrid combination 124 D X 266 P (5.76). Hybrid combination 124 D X 266 P (V_4) recorded higher FFB yield of 154.86 kg /palm (22.16 t/ha) followed by the hybrid combination 109 D X 291 P (113.05 kg/palm & 16.16 t/ha). The bunch weight was significantly higher (27.23 kg/bunch) in hybrid combination 124 D X 266 P (V_4).

As regard the cumulative mean FFB yield during 2002-2009, hybrid combination 124 D X 266 P (V_4) produced higher FFB yield of 129 kg/palm & 18.58 t/ha, followed by hybrid combination 148 D X 98 P (114.30 kg/palm & 16.35 t/ha).

Table 80: Yield performance of different tenera hybrids (Mulde, 2009)

Sl. No.	Cross combination	Number of FFB	Bunch weight (kg/bunch)	Yield of FFB (kg/palm)	Yield of FFB (t/ha)
1.	V1 – 115 D x 291 P	4.30	20.24	89.21	12.75
2.	V2 - 104 D x 98 P	3.80	16.07	61.53	8.80
3.	V3 - 109 D x 291 P	6.11	18.61	113.05	16.16
4.	V4 - 124 D x 266 P	5.76	27.23	154.86	22.16
5.	V5 - 220 D x 98 P	3.11	18.81	61.50	8.79
6.	V6 - 65 D x 111 P	3.63	19.45	74.66	10.67
7.	V7 - 35 D x 291 P	4.11	18.62	75.05	10.73
8.	V8 - 82 D x 226 P	4.00	19.28	78.61	11.24
9.	V9 - 148 D x 98 P	4.55	21.65	95.38	13.63
10.	V10 - 18 D x 32P	3.85	20.74	80.64	11.53
11.	V11 - 128 D x 291P	5.11	17.93	90.24	12.90
	SE ±	0.85	1.77	19.69	2.81
	CD at 5%	N.S.	5.22	N.S.	N.S

Aduthurai

Design : Randomised Block Design

Replications : 3

Plot size : 6 palms/plot

Treatments : 10 hybrid combinations

Date of planting (Main Field) : 11-04-2006

Location : Peraiyur Village, Thiruvarur District.

Soil Type : Red sandy loam

Biometric observations on plant height and number of leaves / palm were recorded during February 2010 (Table 81).

Gen.8A: Evaluation of oil palm genotypes for drought tolerance

(Gangavathi, Mulde)

Gangavathi

System of cultivation : Rainfed

Treatments : Six Zambian (ZS) and three Tanzanian (TS) selections

Design : RBD

Replications : 3

Year of planting : October, 1998

The FFB yield during 2008-09 remained non significant among the various genotypes (Table 82). The genotype ZS-5 recorded numerically higher mean FFB yield of 5.43 t/ha followed by the genotypes TS-5 and ZS-1 with FFB yields of 4.94 and 4.86 t/ha respectively.

The cumulative FFB for a period of 7 years from 2002-03 to 2008-09 revealed that there was no significant difference between genotypes. The cumulative FFB yield was higher in the case of ZS-3 (15.76 t/ha) followed by ZS-5 with FFB yield of 14.15 t/ha.

Table 81: Growth attributes of oil palm hybrids (Aduthurai, 2009)

Name of the hybrid	Palm height (m)			Mean	No. of leaves			Mean
	R_I	R_{II}	R_{III}		R_I	R_{II}	R_{III}	
NRCOP 11	4.59	2.64	2.09	3.11	36.3	33.0	28.5	32.6
NRCOP 12	4.03	1.74	2.03	2.40	39.3	26.7	21.0	29.0
NRCOP 13	3.76	3.43	3.08	3.42	36.8	36.8	34.0	35.9
NRCOP 14	4.79	3.69	3.90	4.13	39.3	37.0	31.3	35.9
NRCOP 15	3.71	3.73	2.15	3.20	38.8	41.8	25.5	35.4
NRCOP 16	2.65	2.54	3.48	2.89	36.3	34.5	35.4	35.4
NRCOP 17	3.36	2.67	2.96	2.19	35.6	33.3	31.4	33.4
NRCOP 18	2.71	3.19	2.76	2.89	31.0	32.3	34.1	32.5
NRCOP 19	2.85	2.36	3.73	2.98	35.9	24.5	38.7	33.0
NRCOP 20	4.32	3.69	3.84	3.95	38.0	39.5	37.3	38.3
S.Ed		0.54				3.65		
CD(0.05)		1.44				7.67		
C.V(%)		20.74				13.01		

There was significant difference in plant height and number of leaves produced (Table 81). Hybrid NRCOP14 exhibited better growth and vigour followed by NRCOP 20 and NRCOP 13. NRCOP 14 recorded maximum plant height(4.13 m) and was on par with NRCOP 20, NRCOP 13 and NRCOP 15. NRCOP 20 registered maximum number of leaves(38.3) and was on par with NRCOP 13 and NRCOP 14(35.9 leaves /palm) and NRCOP15 & NRCOP 16 (35.4 leaves /palm).

No significant difference in the number of bunches per palm was observed for oil palm genotypes. Mean number of bunches were higher in the genotype ZS-1 (4.82) followed by TS-5 (4.10).

Mean bunch weight was higher in the genotype ZS-6 (10.42 kg/bunch) followed by ZS-5 (10.16 kg/bunch). However, there was no significant difference in the mean bunch weight.

It is clear from Table 83 that the eighteen drought tolerant genotypes of oil palm showed significant variation for average height and for average girth. However, significant variation for production of leaves during the year was not noticed. The genotype G.B. 25/314 (V1) recorded significantly maximum height (4.17 m) followed by genotype TS-8 (4.14 m). Genotype ZS- 9 (V9) was found to be dwarfest genotype (2.41m).

Table 82: Yield parameters of different drought tolerant oil palm genotypes (Gangavathi,2009)

Genotype	FFB Yield (t/ha)								No.of bunches (2009)	Mean bunch weight(kg) (2009)
	2003	2004	2005	2006	2007	2008	2009	Cumu-lative		
ZS-1	0.81	0.66	0.81	1.80	0.95	3.19	4.86	13.09	4.82	7.25
ZS-3	1.52	1.04	0.29	1.82	2.55	3.72	4.81	15.76	3.70	9.28
ZS-5	0.91	1.26	0.48	1.28	1.71	3.08	5.43	14.15	3.73	10.16
ZS-8	1.18	0.58	0.48	0.74	1.08	2.46	4.00	10.53	3.55	8.30
ZS-6	1.62	1.29	0.48	1.93	1.69	2.89	3.75	13.64	2.60	10.42
ZS-9	1.03	1.10	0.55	1.30	1.23	3.54	3.94	12.68	3.33	8.66
TS-4	1.03	1.45	0.57	1.41	0.89	1.68	4.08	11.10	3.13	8.90
TS-5	1.37	0.78	0.58	1.25	2.37	2.05	4.94	13.35	4.10	8.44
TS-7	0.84	0.73	1.43	1.71	1.18	2.56	3.75	12.21	3.47	7.55
SEm±	0.28	0.17	0.24	0.19	0.19	0.58	0.89	1.18	0.66	1.25
CD (p=0.05)	NS	0.53	NS	0.57	0.59	NS	NS	NS	NS	NS

Mulde

System of cultivation : Rainfed

Treatments : Eighteen Guinea Bissau (GB), Tanzania (TS) and Zambian selections (ZS)

Experimental design : Randomized Block Design

Spacing : 9 m x 9 m

Replications : Three

Palms per plot : Six

Date of planting : June, 1999

Data regarding height, girth and number of leaves/palm in respect of different accessions were recorded during the period July, 2008 to June, 2009 and presented in Table 83.

Genotype TS-4 recorded significantly maximum girth (2.81m) followed by TS-5 (2.79m). Production of number of leaves per palm was in the range of 18.11 to 22.66.

Production of male inflorescences and total number of inflorescences differed significantly among the different genotypes. Genotype TS-8 (V15) produced significantly lowest number of male inflorescences (5.02), whereas, genotype G.B. 22/311 (V2) recorded significantly highest (11.65) number of male inflorescences. The number of productive inflorescences was non significant but was found more (5.77) in genotype G.B. 21/310 (V3) while it was lowest (2.60) in genotype TS-5 (V13). Genotype G.B. 22/311 (V2) produced significantly maximum (15.75) number of total inflorescences followed by G.B. 21/310 (14.44).

There was no significant difference among the different genotypes for number of FFB/palm. Genotype

Table 83: Growth performance of drought tolerant genotypes (Mulde, 2009)

Genotype		Height (m)	Girth (m)	No. of male inflores-cences	No. of Productive inflores-cences	Total No. of inflores-cences	No. of FFB / palm	Wt. of bunch (kg)	Yield of FFB (kg/ palm)
V1	G.B. 25/314	4.17	2.75	6.77	5.55	12.32	3.95	3.25	10.09
V2	G.B. 22/311	2.97	2.73	11.65	3.94	15.75	5.50	4.04	22.30
V3	G.B. 21/310	2.91	2.53	8.66	5.77	14.44	4.73	3.01	13.80
V4	ZS - 1	2.66	2.62	8.66	4.33	12.99	5.16	7.34	38.88
V5	ZS - 2	2.60	2.51	6.06	4.05	10.12	5.72	8.49	48.44
V6	ZS - 3	2.62	2.77	7.15	3.21	10.35	4.21	8.41	35.96
V7	ZS - 5	2.73	2.71	5.77	4.27	10.05	6.00	9.19	55.00
V8	ZS - 6	2.73	2.56	5.90	3.94	9.48	6.26	7.66	47.74
V9	ZS - 9	2.41	2.60	7.66	3.72	11.38	5.07	6.57	33.54
V10	TS - 2	2.98	2.64	6.55	4.83	11.38	6.55	8.03	53.11
V11	ZS - 8	2.94	2.53	7.81	3.88	11.69	6.39	10.07	64.66
V12	TS - 4	3.26	2.81	6.89	3.16	10.05	5.60	8.63	47.86
V13	TS - 5	3.80	2.79	6.62	2.60	9.22	4.56	5.95	27.16
V14	TS - 7 (Control)	3.41	2.73	6.55	2.94	9.49	4.10	7.98	34.04
V15	TS - 8	4.14	2.62	5.02	3.10	8.13	4.05	6.79	27.41
V16	TS - 9	3.12	2.73	6.89	2.99	9.88	4.11	8.43	34.55
V17	TS - 10	3.12	2.59	8.16	3.83	11.99	5.00	9.38	46.57
V18	TS - 11	2.93	2.61	6.16	2.66	8.33	4.97	8.61	44.42
S. E. ±		0.22	0.53	1.00	0.79	1.03	0.83	0.98	6.99
C.D. at 5 %		0.65	0.15	2.89	N.S.	2.98	N.S.	2.82	20.10

TS-2 (V10) produced more number of FFB/palm (6.55) followed by ZS-8 (6.39). Genotype ZS-8 (V11) recorded significantly higher bunch weight (10.07 kg/bunch) while genotype G.B. 21/310 recorded significantly lower bunch weight (3.01 kg/bunch) followed by genotypes G.B.25/ 314 (3.25 kg/bunch) and G.B. 22/311 (4.04 kg/bunch). Genotype ZS-8 (V11) produced significantly maximum FFB yield (64.66 kg/palm and 9.48 t/ha).

Data on relative water content, electrolyte leaching and lipid peroxidase activity among the different genotypes during 2008-09 were recorded and presented in Table 84.

The Relative Water Content (RWC) recorded for the months of April, May and June 2009 (stress period) did not vary significantly for different genotypes. The mean RWC was higher with TS-10 (95.80 %). It was the lowest in G.B. 25/314 (86.30 %).

The electrolyte leaching was estimated for the period of April, May and June 2009 and expressed as the percentage of final conductivity. There was no significant difference among the different genotypes in respect of electrolyte leaching. However, the genotype ZS-3 recorded lowest electrolyte leaching of 13.29% followed by TS-2 (13.48 %) and ZS-9 (13.50 %).

The lipid peroxidation was estimated in the months of April, May and June 2009. Various genotypes did not

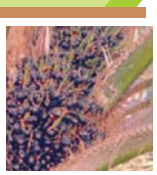

Table 84: Biochemical and physiological parameters of drought tolerant genotypes (Mulde, 2009)

Genotype		RWC	Electrolyte leaching (%)	Lipid Peroxidation (OD value)	No. of dried leaves	No. of dried bunches
V1	G.B. 25/314	86.30	16.44	0.031	5.16	1.10
V2	G.B. 22/311	91.36	16.03	0.051	3.27	0.55
V3	G.B. 21/310	86.92	17.53	0.040	7.11	1.55
V4	ZS - 1	92.14	13.80	0.039	3.39	0.55
V5	ZS - 2	88.88	15.20	0.027	3.61	0.38
V6	ZS - 3	90.55	13.29	0.032	6.27	0.22
V7	ZS - 5	91.48	14.76	0.035	4.11	0.49
V8	ZS - 6	87.09	14.48	0.030	4.05	0.88
V9	ZS - 9	93.59	13.50	0.039	4.49	0.16
V10	TS - 2	93.29	13.48	0.049	5.00	0.55
V11	ZS - 8	92.18	15.79	0.048	3.67	0.16
V12	TS - 4	87.69	15.17	0.042	6.11	0.72
V13	TS - 5	90.03	14.27	0.087	5.33	0.44
V14	TS - 7 (Control)	90.93	16.16	0.045	4.94	1.22
V15	TS - 8	88.74	13.65	0.040	3.16	1.05
V16	TS - 9	90.66	14.53	0.047	3.83	1.05
V17	TS - 10	95.80	13.57	0.046	4.77	0.44
V18	TS - 11	93.52	15.03	0.036	2.55	0.33
S. E. +_		3.20	1.26	0.015	1.23	0.31
C.D. at 5 %		N.S.	N.S.	N.S.	N.S.	N.S.

express significantly for lipid peroxidation. The lowest peroxidase activity (as indicated by lower OD value) was observed in the genotype ZS-2 with an OD value of 0.027 followed by genotype ZS-6 (0.030 OD value).

The number of dried leaves and number of dried bunches did not show significant variation. Average number of dried leaves was lowest in the genotype TS-11 (2.55) and highest in the genotype G.B. 21/310 (7.11).

The mean number of dried bunches/ palm was the lowest (0.16/palm) in the genotypes ZS-8 (V11) and ZS-9 (V9) and highest in the genotype G.B. 21/310 (1.55).

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

(Aduthurai, Gangavathi, Mulde, Vijayarai, Madhopur, Pasighat)

Aduthurai

SET I

The trial was planted in a farmer's field during September, 2007.

Design : Randomised Block Design

Replications : 3

Plot size : 6 palms/plot

Treatments : 10

Soil type : Clay loam soil

Farmer's Name : K.Mujibir Rahman, S/o. L. Kamal Batcha

Location : Manakarambai, Thittai Via, Thanjavur Dt.

Biometric observations, viz., plant height and number of leaves were recorded during June, 2009 and the mean data are furnished in Table 85. The data revealed that among the hybrid combinations, Tenera Hybrid 9 registered significant vigour with a maximum palm height of 153.7 cm with 11.67 leaves/ palm. TH 6 is less vigourous with a palm height of 128.1 cm while TH-1 has produced the least number of leaves (8.66 / palm).

Table 85: Growth attributes of new hybrid combinations (Aduthurai, 2009)

Sl. No.	Hybrid	Palm height (cm)	No.of leaves/ palm
1.	14 x 66 (TH 1)	135.2	8.66
2	15 x 66 (TH 2)	136.2	9.33
3.	25 x116 (TH 3)	143.0	10.70
4.	37x435 (TH 4)	148.8	10.70
5.	38 x 116 (TH 5)	142.7	9.00
6.	39 x 214 (TH 6)	128.1	10.33
7.	58 x 214 (TH 7)	151.6	11.67
8.	66 x 435 (TH 8)	138.7	10.66
9.	88 x 435 (TH 9)	153.7	12.33
10.	351 x 435(TH10)	137.9	11.33
	SE/D	12.85	1.50
	CD(0.05)	26.99	3.15
	CV (%)	11.11	17.7

Set II

The Set II trial was planted in a farmer's holding during August, 2008.

Design : Randomised Block Design

Replications : 3

Plot size : 6 palms/plot

Treatments : 10

Farmer's Name : Mr S.Pandiyan, S/o. Sivagnanam

Location : Peraiyur, Mannargudi Taluk, Thiruvarur Dt.

Soil Type : Red sandy loam

Bio-metric observations on plant height and number of leaves / palm were recorded during February 2010 and the data were analysed for statistical significance and the mean values are presented in Table 86.

Among the ten hybrid combinations, NRCOP 8 has registered maximum palm height of 232.3 cm, followed by NRCOP 4 (228.0 cm). NRCOP 1 was found to be dwarf by recording lesser palm height of 192.1 cm. Among the ten hybrid combinations, NRCOP 3 has recorded maximum number of leaves/palm,(23.1), followed by NRCOP 8 and NRCOP 9 each with 22.1 leaves/ palm. NRCOP 7 has recorded the least number of leaves (17.1/ palm).

Gangavathi

Ten new oil palm hybrids received from the Directorate of Oil Palm Research Regional Station, Palode were planted during 2007 and the details are as follows:

Design : RBD

Replications : 3

Palms/plot : 6

Date of planting : 15-2-2007

Spacing : 9m x 9m x 9m equilateral triangle method

Soil type : Black clay

Data on growth parameters and inflorescence production were recorded and summarized in Table 87.

The observations indicated that there was no significant difference in palm height among different hybrids. Mean palm height was higher with the hybrid NRCOP 6 and NRCOP 3 (4.05 and 3.60 m respectively).

Similarly, palm girth did not differ significantly. Mean palm girth was more in the case of NRCOP 2 (0.79 m) followed by NRCOP 4 (0.78 m).

The annual rate of leaf production remained non significant for various hybrids. The mean number of leaves produced were more with the hybrid NRCOP 1 and NRCOP 9 (20.89 and 20.66 respectively).

Table 86: Growth attributes of new hybrid combinations (Aduthurai, 2009)

Name of the hybrid	Palm height (cm)				No. of leaves			
	R_I	R_{II}	R_{III}	Mean	R_I	R_{II}	R_{III}	Mean
NRCOP 1	191.5	213.8	170.9	192.1	19.5	20.3	15.0	18.3
NRCOP 2	186.0	175.0	228.3	196.4	19.3	13.0	23.0	18.4
NRCOP 3	221.8	224.5	235.2	227.2	21.5	24.3	23.6	23.1
NRCOP 4	214.5	226.3	243.3	228.0	18.0	22.0	22.3	20.8
NRCOP 5	212.5	190.8	189.0	197.4	22.0	19.3	21.0	20.8
NRCOP 6	232.3	215.0	194.7	214.0	22.0	20.5	17.3	19.9
NRCOP 7	187.5	224.2	203.0	204.9	16.0	18.0	17.3	17.1
NRCOP 8	238.8	226.3	231.8	232.3	23.0	22.5	21.0	22.1
NRCOP 9	208.3	226.5	216.3	217.0	20.5	24.5	21.3	22.1
NRCOP 10	226.3	222.5	212.1	220.3	20.5	21.5	17.7	20.6
S.Ed			13.70				2.04	
CD(0.05)			28.79				4.28	
C.V(%)			7.88				12.28	

Table 87: Vegetative growth parameters and inflorescence production in different oil palm hybrids (Ganagavathi, 2009)

Hybrid	Palm height (cm)	Palm girth (cm)	Annual leaf production	Male inflore-scences	Female inflore-scences	Sex ratio
NRCOP 1	334	65	20.89	4.17	5.70	56.30
NRCOP 2	356	79	19.55	3.87	7.13	63.67
NRCOP 3	360	65	19.44	3.53	5.50	57.18
NRCOP 4	357	78	18.83	5.37	6.13	53.81
NRCOP 5	347	75	20.16	3.37	6.40	67.27
NRCOP 6	405	68	15.61	3.77	4.07	51.48
NRCOP 7	314	67	17.50	3.23	5.27	58.25
NRCOP 8	334	67	17.61	4.24	4.77	52.78
NRCOP 9	340	67	20.66	4.17	6.70	60.70
NRCOP 10	294	60	15.72	4.42	5.17	50.42
S. Em ±	030	07	1.55	0.74	0.75	-
CD (p=0.05)	NS	NS	NS	NS	NS	-
CV (%)	15.02	16.54	14.48	32.13	22.82	-

The number of male inflorescences was non significant for various hybrids. However, less number of male inflorescences was recorded in the case of NRCOP 7 and NRCOP 5 (3.23 and 3.37 respectively). NRCOP 10 recorded higher number of male inflorescence (4.42).

The number of female inflorescences was non significant for various hybrids. However, the number of female inflorescences was more in the hybrids NRCOP 2 and NRCOP 9 (7.13 and 6.70 respectively).

The sex ratio was higher in the case of NRCOP 5 (67.27) followed by NRCOP 2 (63.67) and NRCOP 9 (60.70).

Mulde

Objective: Multilocation trials on the performance of the oil palm hybrids

Experimental Details :

Treatments : 10 Hybrid Combinations

Experimental design : Randomized Block Design

Spacing : 9 m x 9 m

Replications : Three

Palms per plot : Nine

Date of planting : September, 2007

The growth observations in respect of new cross combinations of oil palm were recorded and data presented in Table 88.

It is clear from Table 88 that the ten new cross combinations of oil palm did not show significant variation for palm height, palm girth and number of leaves/palm. Average height of palm of the new cross combinations ranged between 48.33 cm (90 D X 557 P) to 65.33 cm (28 D X 435 P). Average girth of the palm ranged between 36.00 cm (78 D X 435 P) to 51.00 cm (28 D X 435 P). Average number of leaves per palm was in the range of 13.83 (78 D X 435 P) to 18.70 (28 D X 435 P).

Vijayarai

Treatment: Ten cross combinations of Tenera hybrids

Design : Randomized block design

Replications : Three

No. of palms /plot : Six

Spacing : 9×9 m

Date of planting : 09-04-2007

Observations on vegetative growth parameters were recorded and presented in Table 89.

Table 88: Growth performance of oil palm hybrids (Mulde, 2009)

Sl. No.	Cross combination	Number assigned	Palm height(cm)	Palm girth(cm)	No. of leaves/palm
1.	78 D X 435 P	NRCOP 1	51.00	36.00	13.83
2.	90 D X 557 P	NRCOP 2	48.33	50.66	16.70
3.	158 D X 116 P	NRCOP 3	58.66	49.33	16.00
4.	131D X 435 P	NRCOP 4	52.33	36.33	16.50
5.	5 D X 577 P	NRCOP 5	51.66	37.33	15.59
6.	173 D X 435 P	NRCOP 6	54.66	40.00	17.62
7.	183 D X 577 P	NRCOP 7	52.66	37.66	16.03
8.	70 D X 557 P	NRCOP 8	61.00	46.66	15.62
9.	28 D X 435 P	NRCOP 9	65.33	51.00	18.70
10.	345 D X 577 P	NRCOP10	52.66	45.00	18.33
	SE ±	7.91	7.66	1.41	
	CD at 5%	N.S.	N.S.	NS	

Table 89: Vegetative growth parameters recorded in the new cross combinations of oil palm (Vijayarai, 2009)

Entry	Palm height (cm)	Palm girth (cm)	Number of leaves
NRCOP 1	240	80	13.1
NRCOP 2	250	90	16.0
NRCOP 3	270	110	16.2
NRCOP 4	220	80	15.5
NRCOP 5	250	90	15.0
NRCOP 6	260	90	14.8
NRCOP 7	240	90	14.8
NRCOP 8	250	100	15.3
NRCOP 9	290	130	17.2
NRCOP 10	240	90	14.8
CD at 5%	NS	NS	NS

The growth characters i.e., palm height, girth of palm and number of leaves were found non significant. However, the maximum palm height was recorded in NRCOP 9 with 290 cm and the shortest palm height was recorded in NRCOP 4 with 220 cm. The maximum number of leaves was recorded in NRCOP 9 with 17.2 and the lowest number of leaves was recorded in NRCOP 1 with 13.1. The palm girth was recorded maximum in NRCOP 9 with 130 cm. The lowest girth was recorded in NRCOP 1 and NRCOP 4 with 80 cm.

Madhopur

Experimental details

No. of hybrid combinations : 10

Replications : 3

Plot size : 9 palms/plot

Design : RBD

The Centre received primary nursery seedlings (2 months old) with accession numbers NRCOP 21 to NRCOP 30 during June, 2009. The seedlings were transferred to secondary nursery during July, 2009. The nursery was adversely affected by the cold weather (frost) during January, 2010. At present, the plants are recovering fast. Fertilizers were applied to the secondary nursery as per the recommended schedule. Data on morphological parameters of the seedlings collected during March 2010 is presented in Table 90.

Table 90: Morphological parameters of the oil palm seedlings (Madhopur, 2009)

Sl. No.	Accession No.	No of leaves/palm	Leaf length (cm)
1	NRCOP 21	13.5	39.7
2	NRCOP 22	11.8	42.2
3	NRCOP 23	12.5	40.1
4	NRCOP 24	12.5	46.1
5	NRCOP 25	5.0	46.3
6	NRCOP 26	11.6	43.1
7	NRCOP 27	12.4	40.3
8	NRCOP 28	10.8	47.2
9	NRCOP 29	12.4	48.6
10	NRCOP 30	11.0	48.8

Pasighat

Experimental details

No. of hybrid combinations : 10

Replications : 3

Plot size : 9 palms/plot

Design : RBD

The Centre received primary nursery seedlings (3 months old) with accession numbers NRCOP 21 to NRCOP 30 during July, 2009. The seedlings were transferred to secondary nursery during August, 2009. At present, 35 seedlings are being maintained in each combination, of which 27 seedlings in each combination are required for laying out the field trial in July 2010. Fertilizers were applied to the secondary nursery as per the recommended schedule. Data on morphological parameters of the seedlings were collected during March 2010 (Table 91).

Gen.8D: Multi location trial on performance of new (experimental) cross combinations in oil palm

(Aduthurai, Gangavathi, Mulde, Vijayarai, Madhopur, Pasighat)

Objective: Multilocation progeny evaluation trials on the performance of new oil palm hybrids (experimental crosses).

Table 91: Morphological parameters of the seedlings in secondary nursery (Pasighat, 2009)

Sl. No	Accession No.	Palm height (cm)	Palm girth(cm)	Number of leaves/palm	Leaf length (cm)
1	NRCOP 21	77.13	14.17	10.24	53.09
2	NRCOP 22	77.31	14.02	10.92	52.09
3	NRCOP 23	66.29	12.64	10.51	45.13
4	NRCOP 24	55.13	10.74	9.70	36.89
5	NRCOP 25	71.19	12.92	9.75	49.50
6	NRCOP 26	64.14	12.62	10.07	44.51
7	NRCOP 27	69.55	12.73	10.28	48.24
8	NRCOP 28	67.82	12.21	10.33	48.09
9	NRCOP 29	56.38	10.66	9.77	37.16
10	NRCOP 30	72.65	11.67	9.60	46.89

Experimental Details :

Replications : Three

Treatments : 10 Tenera Hybrid Combinations

Design : Randomized Block Design

Plot size : 9 palms/ plot

A total number of 500 sprouts (per Centre) of ten hybrid combinations (50 per combination) with Entry Numbers NPCOP 31 to NRCOP 40 were provided to all the Centres from DOPR, Pedavegi during December, 2009. These sprouts were transferred in polybags for further maintenance in the primary nursery. Growth of the seedlings at all the Centres was satisfactory.

OIL PALM

5.2 Crop Production

Agr. 6A : Studies on the fertilizer application through micro-irrigation technique in oil palm

(Aduthurai, Gangavathi, Mulde, Vijayarai, Madhopur)

Design : Randomized Block Design

Treatments

T_1 300:150:300g NPK through fertigation

T_2 600:300:600g NPK through fertigation

T_3 900:450:900 g NPK through fertigation

T_4 1200:600:1200g NPK through fertigation

T_5 1200:600:1800g NPK through fertigation

T_6 1200:600:2700g NPK through fertigation

T_7 1200:600:2700g NPK through soil application

Replications : Three

Plot size : 6 palms /plot

Fertilizer Source : Urea for nitrogen, Diammonium Phosphate for nitrogen and phosphorus and Muriate of Potash for potassium (Fertigation is to be given in 6 splits).

Aduthurai

The trial was initiated in 2008 and the fertilizers are being applied in alternate months in six equal splits. For treatments, T_1- T_6 fertilizers are being applied thorough fertigation, while, for treatment, T_7, fertilizers are being applied through soil.

Pre-experimental leaf samples were analyzed for nutrient content. In all treatments, available N in leaf is low where as available P is medium and K is high.

During this period, growth attributes viz., number of leaves and stem girth were recorded and statistically analyzed. In addition, yield attributes, viz, number of bunches, bunch weight and FFB yield were also recorded.

Gangavathi

The trial was initiated during July, 2009 and treatments were imposed as per schedule. Data on growth and yield parameters were recorded.

Mulde

Trial was initiated during July 2008 and fertigation treatments were imposed as per schedule. Pre-experimental samples of soil and leaf were collected and analysed.

Vijayarai

The fertigation experiment is yet to be started at this Centre.

Madhopur

The trial was planted during May, 2009 and micro-irrigation system has been installed. Accessories for imposing fertigation treatments are being procured.

Agr. 12: Development of an integrated water and nutrient management model for oil palm cultivation in North –East Region

(Pasighat)

Treatments

T-1 : Irrigation management through drip system

T-2 : T_1+50% NPK as organic manure + 50% NPK as chemical fertilizers

T-3 : T_1+ 100% NPK as chemical fertilizers

T-4 : T_1+ 100% NPK as organic manure

T-5 : Rain fed + 100% NPK as organic manure

Replications : 4

Plot size : 6 palms/plot

Chemical fertlizers were applied in three split doses in T_2 and T_3 treatments in pre- monsoon, post monsoon and summer months. The organic manure treatment in T_2, T_4 and T_5 treatments were applied in two split doses on equivalent nutrient basis.

One hundred and fifty 'Tenera' plants were planted in the month of August, 2008 at the College Farm. These plants are being used as experimental material for conducting this trial.

Table 92: Results of pre- treatment soil analysis (Pasighat, 2009)

Treat-ment	pH	Organic Carbon (%)	Available Nitrogen (kg/ha)	Available P_2O_5 (kg/ha)	Available K_2O(kg/ha)
T_1	5.17	1.13	223.5	14.5	134.5
T_2	5.15	1.13	224.0	14.7	133.8
T_3	5.17	1.14	224.3	14.0	135.2
T_4	5.15	1.13	223.0	14.6	134.7
T_5	5.25	1.14	225.0	14.5	133.5

Pre- treatment leaf nutrient status(Pasighat,2009)

Treatment	N(%)	P(%)	K(%)
T_1	2.48	0.14	0.96
T_2	2.51	0.15	0.96
T_3	2.51	0.15	1.00
T_4	2.46	0.14	0.98
T_5	2.53	0.15	0.96

Pre- treatment soil and leaf samples were collected. Soil and leaf samples have been analyzed and the mean values of the plots are presented in Table 92. The 9th leaf was sampled for recording the leaf nutrient status.

The recommended doses of nutrients were applied as per the treatment details in the month of March, 2010. Urea, Rock phosphate and MOP were used as sources for N, P and K respectively and FYM, Vermicompost and wood ash were used as organic manure.

Morphological parameters such as palm height, palm girth and number of leaves were recorded at the time of imposition of treatments. The mean values of the morphological parameters are presented in Table 93.

Agr.13: Demonstration on oil palm production potential in Eastern and North East Regions of India (Madhopur, Pasighat)

Madhopur

230 oil palm seedlings were planted during May, 2009 for establishing a "Maximisation Plot". All the recommended crop management practices were adopted to ensure better growth of seedlings.

Pasighat

The 29 oil palm seedlings planted in the year 2006 are being taken up as the material for "maximization plot" and all the recommended crop management practices are being adopted to ensure better growth. The average plant height, collar girth and number of leaves per plant recorded in month of February,2010 were 2.40m, 70.30 cm and 19.9 leaves respectively. From October,2009 to March, 2010, flowering has been observed in five palms.

Table 93: Morphological parameters recorded at the time of imposition of treatments (Pasighat, 2009)

Sl. No.	Treatment	Palm height (cm)	Collar girth (cm)	Number of leaves/ palm
1	T_1: Irrigation management through drip system	106.8	27.4	15.9
2	T_2: T_1+50% NPK as organic manure + 50% as chemical fertilizers	108.3	26.5	15.6
3	T_3: T_1+ 100% NPK as chemical fertilizers	111.7	33.6	16.2
4	T_4: T_1+ 100% NPK as organic manure	101.7	23.5	14.7
5	T_5: Rain fed + 100% NPK as organic manure	100.7	25.1	15.1

PALMYRAH

6.1 Genetic Resources & Crop Production

Gen. 9: Survey and collection of palmyrah germplasm and evaluation

(Killikulam, Pandirimamidi)

Killikulam

Collection of dwarf, early and high yielding genotypes are being pursued through intensive surveys conducted both in Tamil Nadu and Andhra Pradesh States since 1995. During the period under report, a germplasm survey was conducted in Andhra Pradesh.

A joint survey was conducted in Srikakulam district of Andhra Pradesh from 17.08.2009 to 20.08.2009 involving the AICRP on Palms scientists in co-ordination with the scientist from NBPGR Regional Station, Hyderabaed. A total of nine accessions were collected, after traveling through a distance of about 992 km. Based on the details provided to NBPGR, New Delhi, these collections were assigned with Accession Number of IC 574554 to IC 574562.

Meanwhile, the germplasm lines that have reached the bearing stage at Pandirimamidi Centre, Andhra Pradesh, (that are not available in Killikulam Gene Bank) were also received from Pandirimamidi Centre. A total of 22 lines comprising of 13 accessions of 1991 batch and 9 accessions of 1994 batch of germplasm have been received in two sets and sown during 2009. Thus the total germplasm collection at Killikulam centre stands as 210. The abstract of germplasm collection at Killikulam centre is given in Table 94.

Table 94: Germplasm status at Killikulam (Killikulam, 2009)

Block in which planted	Year of collection	Number of collections maintained
Block I (E)	1995	35
Block II (NA)	1997	26
Block III (NA)	1999	23
Block IV (EO)	2001	10
Block IVa (EO)	2001	8
Block V (EO)	2002	13
Block Va (EO)	2002	8
Block VI (EO)	2003	2
Block VII (EO)	2004	12
Block VIII (NA)	2005	9
Block VIII (NA)	2006	14
Block IX (NA)	2007	10
Block IX (NA)	2008	9
Accs. transferred from Pandirimamidi	2009	22
Block X (NA)	2009	9
Total		210

Pandirimamidi

During the year 2009, a joint survey and collection of germplasm was taken up in the month of August in Srikakulam district of Andhra Pradesh. Nine accessions which are mostly dwarf in stature have been collected. The passport data on the mother palms were recorded. Collected germplasm stones were sown in field in single rows adopting the spacing of 4 x 4 m, after recording fruit parameters. Basins were pot watered at weekly intervals for the first two months and there after at 15 days intervals based on the prevailing weather conditions.

Emergence of inflorescences was noticed in 1991 accessions in the first week of December. Male palms were early in putting forth the inflorescences (December) followed by the female palms which showed the inflorescences in the second week of January. Tender fruit yield data for 1991 batch germplasm were recorded and presented in Table 95.

In female palms of 1991 block, flowering was initiated in the month of December and extended up to the second week of March. Earliest flowering was observed in accession 1/91. Number of fruit bunches produced/plant varied both across the accessions and within the accessions. Number of bunches produced ranged from 1 to 11. Mean number of fruits per bunch

Table 95: Tender fruit yield in 1991 germplasm (Pandirimamidi, 2009)

Accession	Plant Number	No. of bunches /palm	No. of fruits/ bunch	Fruit weight (kg)	Tender fruit weight per bunch (kg)
Acc-1/91	2	6	9.5	0.698	0.983
	6	8	8.5	0.723	0.862
	9	9	10.7	0.839	1.540
	12	1	12.0	0.540	0.480
Acc-2/91	4	5	8.6	0.550	0.431
Acc-4/91	2	6	8.0	0.735	0.925
	14	6	8.7	0.550	1.135
Acc-6/91	2	2	10.0	0.478	0.375
Acc-7/91	2	1	10.0	1.163	0.950
Acc-8/91	2	5	7.0	0.752	0.549
	3	3	6.7	0.695	0.498
	4	7	8.7	0.650	0.450
Acc-9/91	1	11	12.1	0.489	0.850
	12	2	6.0	0.958	0.550
Acc-10/91	2	5	5.0	0.850	0.430
	13	5	6.0	0.350	0.225
Acc-11/91	6	8	8.0	0.780	0.540
Acc-12/91	1	11	11.5	0.797	1.379
	2	10	9.0	0.850	1.150

also varied among the accessions from 5 to 12.1. Highest number of bunches were produced by accession 9/91 followed by accession 1/91. Mean bunch weight also varied from 2.38 to 12.5 kg. Tender fruit yield was highest with accession 12/91 followed by accessions 1/91 and 4/91.

Among the 10 accessions of 1993, mean palm height was found highest in accession 17/93 (4.22 m). Number of leaves produced ranged from 10.6 to 13.6, highest being found in accession 21/93. Leaf length, breadth and petiole length were found highest with accessions 23/93 and 16/93.

Among the 14 accessions of 1994, palm height was maximum in accession 37/94(5.22m) where as accession-25/94 has produced highest leaf number and 31/94 has shown highest leaf length(1.33m), breadth(1.67m) and petiole length(1.71m).

Among 14 accessions of 1995, palm height was highest with accession 51/95 and maximum stem girth was recorded with accession 50/95(1.684m). Leaf length, breadth and petiole length were found highest with accession 51/95.

Of the 8 accessions of 1998, palm height was highest in accession 56/98 (2.85m). Accession 57/98 has given higher values of leaf length, breadth and petiole length.

Of the 8 accessions of 1999, palm height was highest in accession 65/99 (1.81m). Accession 67/99 has given higher values of leaf length (1.31m), breadth (1.13m) and petiole length (1.25m).

Plant height of accessions of the year 2000 have ranged from 0.35 m to 1.23 m, maximum being observed in accession 69/2000(1.23m). Number of leaves produced ranged from 8.4 to 12. Highest leaf parameters have been recorded with accession 65/2000).

Among the accessions of 2001, mean palm height ranged from 0.21 m to 6.96 m. Number of leaves produced ranged from 5.25 to 14.2 among the accessions. Leaf parameters were found good in accession 161/2001.

Among the 18 accessions collected from Nalgonda district, plant height was highest in accession140/02. Number of leaves produced /palm varied from 6.8 to 10.0. Relative accession 134/02 has given higher leaf parameter values over the other accessions.

Of the 16 accessions collected from Tamil Nadu, palm height ranged from 0.10 m to 0.73 m. Number of leaves produced was higher in accession 157/02 and 149/02.

Of 13 accessions collected locally in 2003, growth rates was highest in accession 174/03 and lowest in accession 167/03.

Number of leaves produced was highest in accession 178/04 among the 2004 accessions. Palm height was highest in accession 179/04. All accessions did not show clear difference for leaf parameters.

Gen.16: Gowth and development studies in palmyrah (Killikulam, Pandirimamidi)

Killikulam

a) Frequency of single, double and triple seeded fruits

A total number of 600 fruits harvested from the adult palms were scored for the frequency of single, double and triple seeded fruits and the following observations were recorded (Table 96).

It is inferred that the sex ratio is maintained as 1:1 considering the belief that single seeded would give rise to female, while double seeded would give male and female in equal proportions and triple seeded would give male and female in 2 : 1 ratio.

Table 96: Frequency of single, double and triple seeded fruits (Killikulam, 2009)

Sl. No.	Single Seeded	Double Seeded	Triple Seeded	Total
Set I	14	22	63	99
Set II	11	25	55	91
Set III	54	110	140	304
Set IV	16	42	48	106
Total	95	199	306	600
	(15.83%)	(38%)	(51%)	(100%)

b) Confirmation of sex ratio with relevance to seed number

A total of 30 seeds in each of single, double and triple seeded fruits have been sown in lines @ 15 seeds per line and as such there are 6 lines to confirm the sex ratio in each seed characteristics of fruits.

c) Growth and development studies in various growth stages

Rate of leaf growth and stalk growth in three growth phases viz; Seedling phase, Juvenile phase and Adult phase (male and female separately) was studied by utilizing the germplasm materials.

Seedling phase: Five fruits were collected from each of three locations and from the total of 15 fruits, a single seed was selected from each fruit and as such a total of 15 seeds were sown in a line during November to record observations on leaf and stalk characters in the seedling phase.

Juvenile phase: The germplasm material collected and planted during 2003 was utilized for observing the growth characters of leaf and stalk at weekly intervals. There are 13 accessions in 2003 collection and out of that one palm in each of 10 accessions were tagged for recording the observations at weekly intervals.

Adult phase: The existing adult trees of nearly 22 years of age was utilized for the study, which included 5 trees in each of male and female. Recording of observations on leaf and stalk growth in the above plants right from initiation was done at weekly intervals and the rate of growth of leaf and stalk were recorded from February to June, 2009.

Among the different phases of growth, the rate of growth of leaf and stalk was comparatively lower in seedling phase than that of juvenile and adult phase. Similarly, among the juvenile and adult phase, rate of growth of leaf and stalk was comparatively more in adult phase. In general, there was a gradual increase in the growth rate as stage of tree advanced (Table 97).

The data showed that it took more days for completion of active growth of leaf and stalk in the juvenile phase than the adult phase. Further, it was also noticed that the growth of leaf ceased as the stalk initiated and subsequent growth was exhibited only in the stalk.

Table 97: No. of days taken for completing the active growth of leaf and stalk (Killikulam, 2009)

Phase	Days taken for completing active growth of leaf	Days taken for completing active growth of stalk
Juvenile	76.9	99.6
Adult-Male	44.8	68.2
Adult-Female	35.0	76.6

Pandirimamidi

The project was initiated in October 2007**.** Seeds were collected from three different agro climatic regions in the district namely, delta areas of Konaseema region, coastal sandy areas and rain fed upland areas. Collected seeds were sown on raised beds. Beds have been pot watered initially for fifteen days. Time taken for emergence of plumule from stone varied from 10 to 15 days among different stones irrespective of the collection origin. Further, it was observed that the rate of germination varied from 45 to 70 percent. Time taken for root formation varied from 32 to 43 days. Time taken for maximum tuber formation varied between 95 to 115 days and time taken for emergence of seedlings ranged from 156 to 181 days. In the juvenile phase, rate of leaf production was once in 31-37 days and leaf retention period was 6-8 months. In the adult palms, rate of leaf production was once in 24-29 days and leaf retention varied from 12-15 months (Table 98).

In early juvenile stage, rate of petiole growth was 6 mm/month and it was found faster in younger leaves (13.2 mm). Lamina growth rates were also faster in younger leaves compared to older leaves. Rate of production of new leaf was once in 60-70 days among the plants evaluated.

Table 98: Early juvenile stage - 3 years age (Pandirimamidi, 2009)

Leaf Number	Rate of petiole growth (mm/month)	Rate of lamina growth (cm/month)	Rate of leaf production
1	6.0	2.60	Once in 60 -70 days
2	8.4	3.92	
3	10.6	9.28	
4	3.2	10.06	

In the palms of 6 years age also, rates of petiole and lamina were found faster in young inner leaves of the crown compared to the older ones.

In the adult phase palms, petiole growth rates were faster in crown leaves. For successive leaf opening, it has taken 25 – 29 days.

Inflorescence growth rate ranged from 9.18 cm/ fortnight in male and 8.10 cm in female palms.

Agr.9: Studies on influence of levels of defoliation on inflorescence sap and tender fruit yield in palmyrah (*Borassus flabellifer* L.)

(Killikulam, Pandirimamidi)

Killikulam

During November, 2009, observations on number of leaves, leaf length, stalk length, number of inflorescences, length of inflorescence produced in female and male palms and number of fruits in female palms were recorded and the data are presented in Tables 99 & 100.

The results showed that the palms that were defoliated to the level of 30 % had the maximum number of inflorescences both in male & female palms. The percent increase in leaf number after defoliation was the highest in the palms which were defoliated to the level of 90 %, both in male and female trees and it was the least in control. Observations on the number of branches per inflorescence and length of inflorescence showed that the trees which were defoliated to the level of 70 % had the maximum length of inflorescence in male, while in female palms, 30 % had the maximum length. The control recorded the least values for both the parameters.

Pandirimamidi

The trial was initiated during the month of October, 2007 with male and female palms available in the farm. Selected palms have been divided into three blocks and were labeled. Each block contained 15 palms and 3 palms were used for each treatment within the block. Defoliation was carried out in the month of October in all the three blocks as per the treatments suggested at Biennial Group Meeting. Emergence of inflorescence began in the month of January and tapping was resorted to and continued upto the end of April 2009.

In male palms, total yield of inflorescence sap (Table 101) was found highest (310.165 litres) with 50% defoliated palms followed by 30% defoliated palms (249.425 litres). Lowest yields have been recorded with

Table 99: Yield of nungu and biometrical observation on leaf and stalk characters of female trees (Killikulam, 2009)

Treatment	Leaf length (cm)	Stalk length (cm)	No. of inflores cences	Length of inflores-cence (cm)	No. of leaves	% increase of leaves over initial	No. of fruits per palm
90 % defoliation	98.75	135.00	7.00	91.0	23.50	68.30	27.5
70 % defoliation	110.25	145.50	8.00	84.3	28.50	30.70	48.5
50 % defoliation	106.25	148.25	6.75	92.5	34.00	12.66	76.0
30 % defoliation	104.00	144.25	9.00	99.3	37.25	4.92	85.5
Control	103.00	143.25	8.25	106.5	47.50	2.36	96.5
S Ed	N.S	NS	NS	19.7924	1.9408	0.8009	5.9889
CD 0.01				43.12 *	5.92 **	2.44**	18.29**

Table 100: Biometrical observations on leaf and stalk characters of male trees (Killikulam, 2009)

Treatment length (cm)	Leaf length (cm)	Stalk inflorescences	No. of inflorescence (cm)	Length of leaves	No. of of leaves over initial	% increase
90 % defoliation	113.50	135.00	6.50	138.8	26.25	77.50
70 % defoliation	111.50	14.75	11.00	145.0	27.25	20.27
50 % defoliation	111.50	158.75	10.75	142.8	33.75	11.09
30 % defoliation	116.50	137.00	11.25	141.5	36.75	6.70
Control	115.25	129.75	9.50	135.8	48.00	2.72
S Ed	NS	NS	0.9197	NS	2.0145	0.6133
CD at 0.1			2.8094**		6.1538**	1.8734**

70% defoliated palms (123.545 litres). Similar trends have been recorded with female palms also where highest yield of 343.470 litres has been recorded with 50% defoliated palms and lowest in 90% defoliated palms (83.990 litres). However, the differences among the treatments are not significant in both kinds of palms. Palms did not show significant differences for length of matured leaf stalk, relative water content of leaves and days to initiation of flowering. Further in male palms, inflorescence sap yields were the highest in February and March months (Table 102) where as the yields were the highest in March and April months in female palms.

Relatively higher temperature during summer months seems to be favourable for higher rates of sap flow compared to winter months in both the groups of palms (Table 102).

It was further observed that minimum temperature between 16.3 to 25.6 degree celesius coupled with maximum temperature of around 38.7 degree celecius favoured enhancement of inflorescence sap yield.

PHT.1: Standardization and commercialization of inflorescence sap extraction and inflorescence sap based products (jaggery, palm sugar and candy)

(Killikulam, Pandirimamidi)

Pandirimamidi

The present systems of tapping of inflorescence sap in different regions was documented. Similarly, existing methods of jaggery preparation also were recorded.

Table 101: Effect of different levels of defoliation on the inflorescence sap yield in palmyra (Pandirimamidi, 2009)

Treatment	Days for initiation of flowering after defoliation	No. of days tapped (Duration)	Mean No. of Inflores-cences tapped	Total inflorescence sap yield (lit)	Relative Water Content%	Length of matured leaf stalk (m)
MALE PALMS						
30% Defoliation	88.25	37.5	3.5	249.425	83.95	1.3
50% Defoliation	64.75	65.5	2.5	310.165	80.02	1.4
70% Defoliation	64.75	34.5	2.5	123.545	82.95	1.4
90% Defoliation	79.75	46.5	3.3	137.540	83.43	1.3
Control	74.00	59.5	3.0	221.085	84.21	1.4
Sem+	8.238	8.246		18.092	1.625	0.072
CD @ 0.05 %	NS	NS		NS	NS	NS
FEMALE PALMS						
30% Defoliation	79.75	58.3	3.8	304.990	82.66	1.0
50% Defoliation	63.00	52.8	3.8	343.470	83.29	1.1
70% Defoliation	75.50	42.5	3.3	231.720	83.99	1.2
90% Defoliation	92.50	37.0	2.0	83.990	79.74	1.3
Control	74.75	55.8	4.0	154.990	83.06	1.1
SEm±	14.897	8.520		27.563	2.104	0.096
CD @ 0.05 %	NS	NS		NS	NS	NS

Table 102: Month wise inflorescence sap yields in male and female palms (Pandirimamidi, 2009)

(In Litres)

Sl.No	Sex of palm	January	February	March	April
1	Male palms	167.255	554.295	306.350	14.275
2	Female palms	91.605	121.820	459.060	446.640

To improve the shelf life, inflorosence sap was treated with heat at the following temperatures and chemical analysis of samples is in progress.

T1 = Control at 0^{O}C for 10 minutes

T2 = Heating at 70^{O}C for 10 minutes

T3 = Heating at 80^{O}C for 10 minutes

T4 = Heating at 90^{O}C for 10 minutes

T5 = Heating at 100^{O}C for 10 minutes

Also trials were initiated by adding chemical preservatives to inflorescence sap to study their impact on shelf life.

PHT.2: Standardization of tuber flour based food products (like pizza, bakery items, confectionery, health mix etc.)

(Killikulam, Pandirimamidi)

Pandirimamidi

Trials were initiated on new methodologies for the preparation of flour and suji.

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

(Killikulam, Pandirimamidi)

Pandirimamidi

Trials on increasing the shelf life of the tender fruit endosperm were initiated.

SULFI PALM

7.1 Genetic Resources & Crop Production

Gen. 18: Growth and development studies in Sulphi palm (C*aryota urens*)

Jagadalpur

The project was initiated in August, 2009 and following salient observations were made on sulphi palm:

- Three types of sulphi viz., early, medium and late are grown.
- It requires 10, 15, 20 and 25 years for first tapping - depending on the plant type.
- It produces sap for 4-6 months continuously and 15-25 lit. of sap could be tapped from a single tree per day and the income from a single tree is around Rs.20000 - 25000/- per annum

Gen. 19: Documentation of ethno-botanical information on Sulphi palm (C*aryota urens*) in Bastar region of Chhattisgarh

Jagadalpur

The project was initiated in August, 2009 and the following salient observations were made on sulphi palm:

- Sulphi juice is used as a soft drink popularly known as "Bastar Beer".
- Trunk is used as a drain pipe in the field and also to drain the roof water and deliver the water in dug well and to field.
- Pitchers are used as common vessel for collection of sap.
- Emerging spathe when swollen and just opened indicate that the inflorescence is ready for tapping.
- If four leaves emerge on the crown and attain equal height means the tree would start producing inflorescence.
- Contract for tapping is a common phenomenon due to very high height of tree and special skill is required for tapping. Share for tapping is 33.33% and 66.66% respectively for contractor and tree owner.

8. BUDGET FOR 2009-10 (ICAR SHARE)

(Rupees in lakhs)

SLNo	Centre	Pay	TA	RC	Works	Equip	Furnit	Total
1	Aliyarnagar	6.59	0.71	5.27	—	3.46	0.20	**16.23**
2	Ambajipeta	8.02	1.90	5.75	0.75	4.41	0.25	**21.08**
3	Arsikere	2.26	0.20	2.00	0.63	2.54	0.10	**7.73**
4	Jagadalpur	1.84	0.55	5.81	1.08	0.05	0.10	**9.43**
5	Kahikuchi	10.45	0.46	2.90	14.75	17.97	0.20	**46.73**
6	Bhubaneshwar	3.80	0.40	2.00	1.88	—	0.10	**8.18**
7	Mondouri	3.17	0.40	2.74	0.25	0.81	0.10	**7.47**
8	Ratnagiri	10.10	0.60	4.45	—	2.01	0.15	**17.31**
9	Veppankulam	8.90	0.60	6.23	0.82	2.69	0.15	**19.39**
10	Navsari	3.20	0.24	2.76	1.00	1.00	0.10	**8.30**
11	Sabour	3.72	0.24	2.32	4.00	1.00	0.10	**11.38**
12	Killikulam	13.58	0.48	2.40	0.50	4.07	0.20	**21.23**
13	Pandirimamidi	2.56	0.35	1.00	1.57	2.38	0.10	**7.96**
14	Aduthurai	2.05	0.45	1.60	2.50	0.67	0.05	**7.32**
15	Gangavathy	3.20	0.20	1.00	1.00	0.88	0.05	**6.33**
16	Mulde	6.62	0.34	1.76	2.75	3.13	0.10	**14.70**
17	Vijayarai	2.01	0.10	0.50	1.00	0.40	0.05	**4.06**
18	Pasighat	—	0.50	13.70	0.50	0.30	0.15	**15.15**
19	Madhopur	—	0.50	8.57	0.50	0.30	0.15	**10.02**
	Total	**92.07**	**9.22**	**72.76**	**35.48**	**48.07**	**2.40**	**260.00**

9. STAFF POSITION

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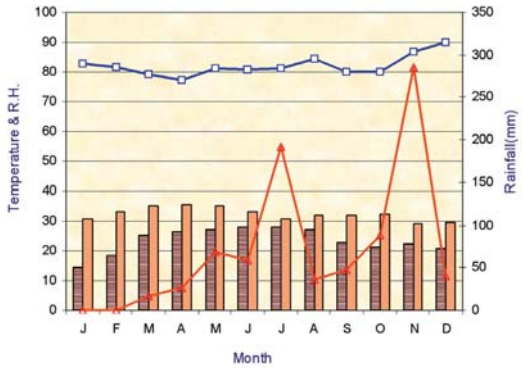
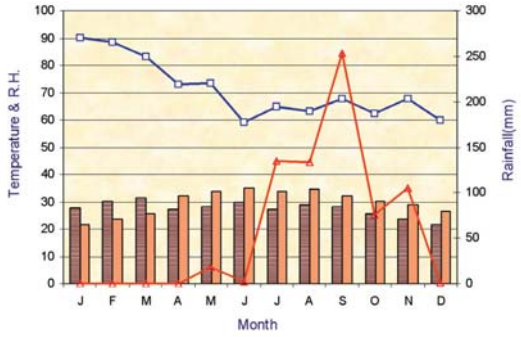
Coconut Centres

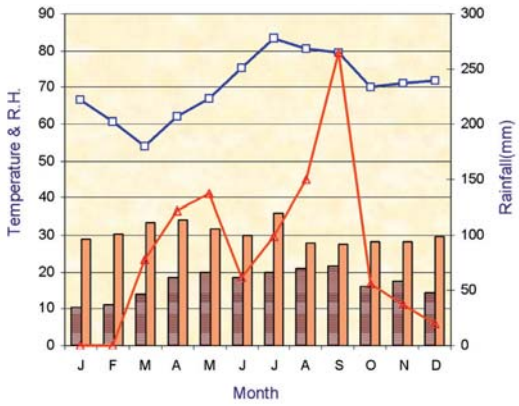
Aliyarnagar



Ambajipeta



Arsikere



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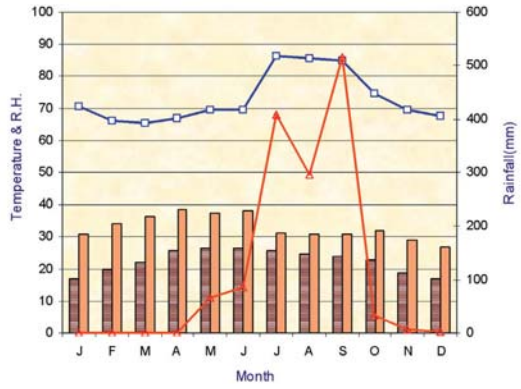
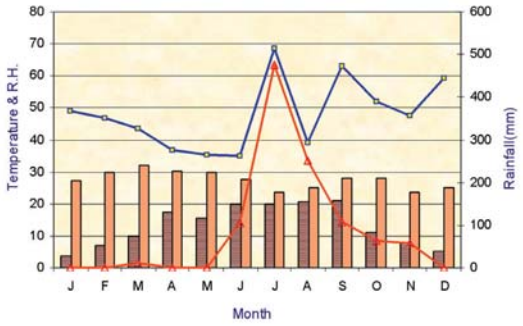
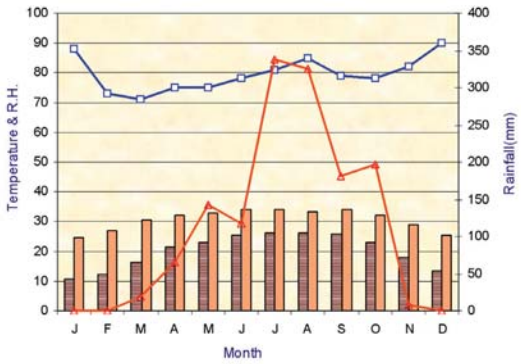


Coconut Centres

Jagadalpur



Kahikuchi



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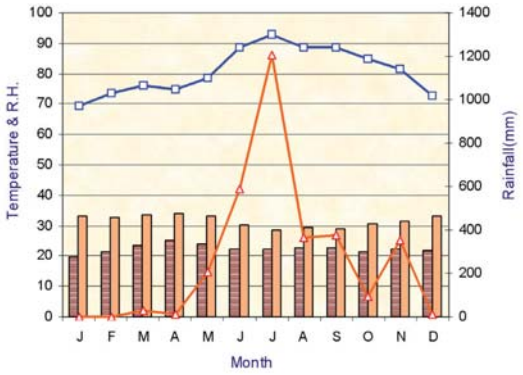

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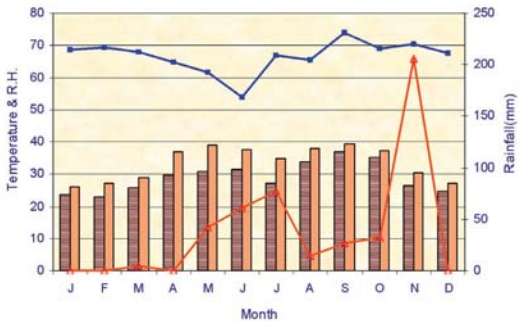

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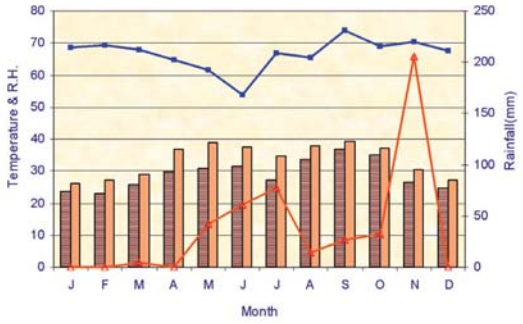

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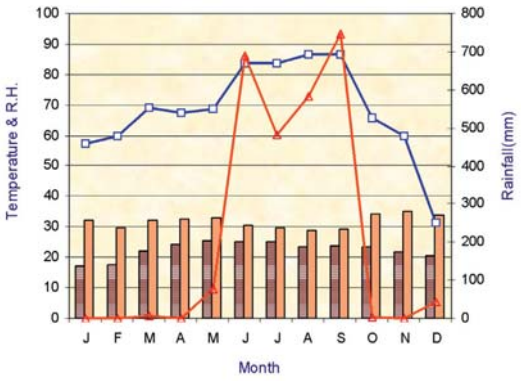
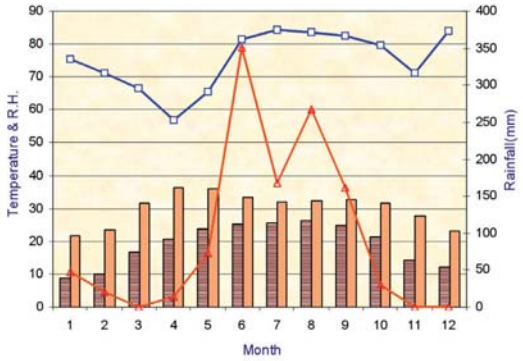
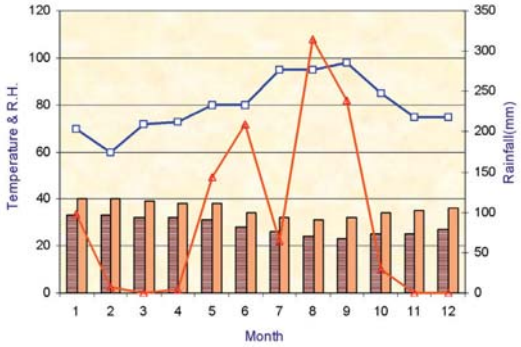


Sabour

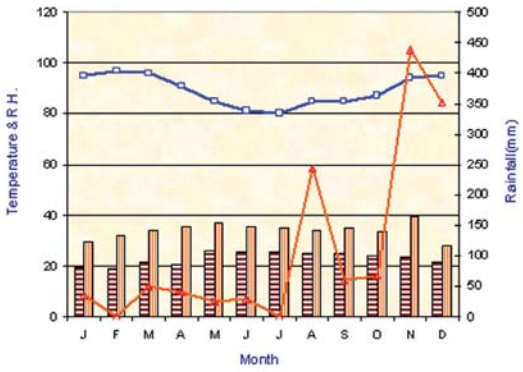


Veppankulam

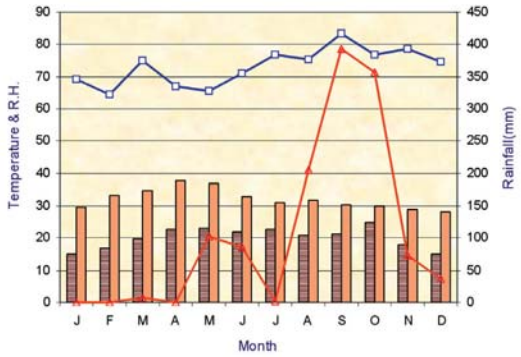


Oil Palm Centres

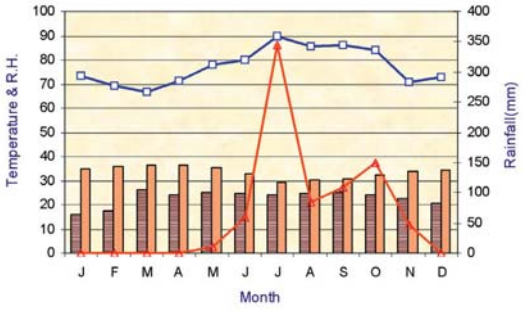
Aduthurai



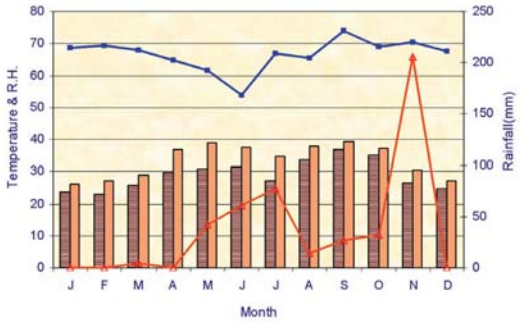
Gangavathi



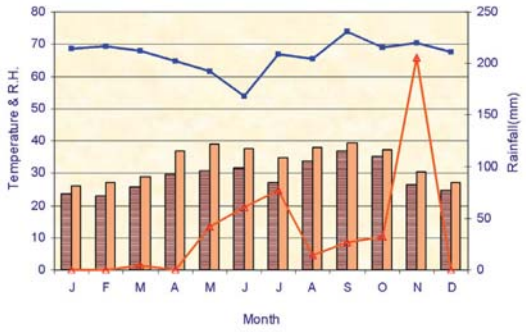
Mulde



Pasighat

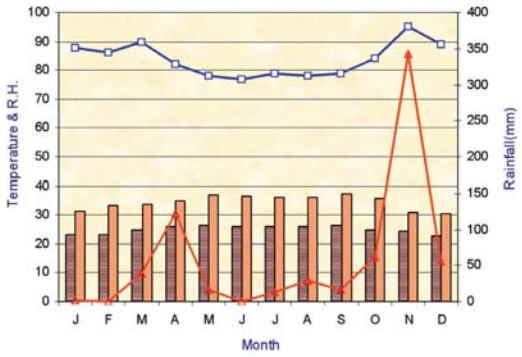


Vijayarai

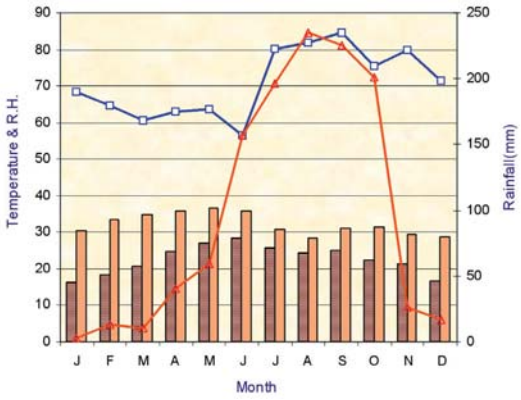


Palmyrah Centres

Killikulam



Pandirimamidi



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