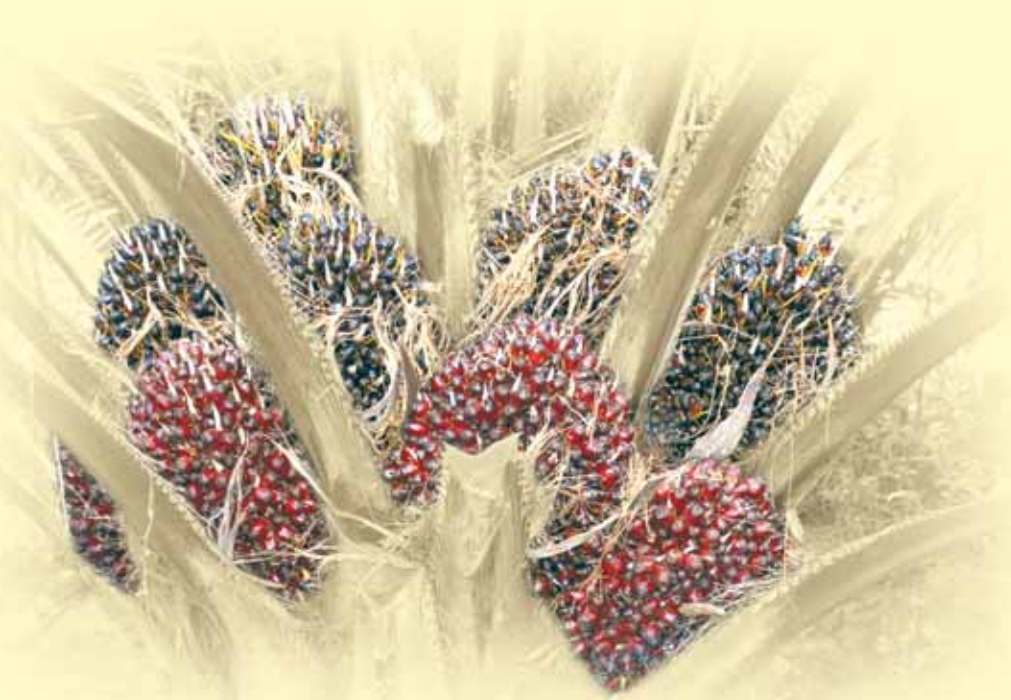
भाकृअनुप
ICAR

वार्षिक प्रतिवेदन
ANNUAL REPORT
2007-08



National Research Centre for Oil Palm

राष्ट्रीय तेल ताड़ अनुसंधान केन्द्र

(भारतीय कृषि अनुसंधान परिषद)

पेदवेगी-534 450, प. गोदावरी जिला, आ.प्र.

National Research Centre for Oil Palm

(Indian Council of Agricultural Research)

Pedavegi-534 450, West Godavari Dt., A.P.

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Newly planted oil palm seedling

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National Research Centre for Oil Palm

NRCOP, Annual Report, 2007-08

ISBN : 81-87561-19-X

Published by

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Cover Page

1) Oil palm crown with profuse bunching
2) View of high yielding oil palm

Correct Citation

Annual Report 2007 - 08
National Research Centre for Oil Palm
Pedavegi - 534 450, A.P., India

Printed at

Swapna Art Home
Vijayawada 520 002, Ph : 0866 6520675

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Preface

In the history of National Research Center for Oil Palm, year 2007 has been a remarkable year as the Laboratory cum Administrative building was inaugurated and dedicated to the nation by Dr. Managala Rai, Director General, ICAR in the presence of Dr. H. P. Singh, DDG (Hort.), ICAR on 31st May, 2007. I take this opportunity to thank the DG and DDG for their keen interest in the development of oil palm in the country through development of the institute. During February 2-4, 2008, National conference on oil palm with the theme "Oil palm for farmers' prosperity and edible oil security" was organized by Society for Promotion of Oil Palm Research and Development (SOPOPRAD) in association with NRCOP to address the needs of the oil palm community. The conference was attended by about 350 delegates including experts from foreign countries and was a huge success. The eleventh plan EFC memo of the institute was proposed with a total amount of Rs. 1972 lakhs which would boost the oil palm research during XI five year plan period.

After the establishment of the centre in 1995, in these 12 years commendable work both in terms of research as well as infrastructure development has taken place. Oil palm being a relatively new crop to India and is being grown under nontraditional environment i.e., under irrigated conditions, studying the crop under varied agroclimatic conditions of India and developing package of practices for its sustainability, meeting the planting material demand, improving harvest and post harvest management practices are the foremost priorities. Accordingly the research programmes of the institute have been formulated and progressing in the right direction. Work on oil palm tissue culture to develop elite oil palm planting material, which is of great concern to the farming community has been initiated. The Quinquennial Review Team (QRT) under the chairmanship of Dr. K. V. Peter, former Vice Chancellor, Kerala Agricultural University reviewed the work done at the institute during 2001-06 and gave valuable recommendations to fine tune our research programmes. The newly constituted Research Advisory Committee (RAC) under the chairmanship of Dr. V. Rajagopal, former Director, CPCRI has also reviewed the research programmes and suggested priority areas.

In the years to come increase in percapita consumption of oil and population growth will have greater demand for oils and fats and palm oil will be the right choice. NRCOP is taking a lead in this direction through its mandate. I thank the staff of NRCOP for their united effort in running the programmes of the institute for the cause of oil palm community.

M . Kochu Babu
Director

कार्यकारी सारांश

फसल सुधार

जर्म-प्लाज्म एवं उपजातीय विकास कार्यक्रम

छोटा अण्डमान से 22 संग्रहों, बशटांग से 2, थेनी से 5 और नेल्लूर से 4 होनहार ताडों से बीजों का संग्रहण किया गया।

छोटा अण्डमान और पुणे से संग्रह किये गये जर्म-प्लाज्म का पेदवेगी में मूल्यांकन किया जा रहा है। त्वरितगति से अधिक उपज देने वाले ताडों की पहचान की गयी। पालोड क्षेत्रीय स्थान में उपलब्ध जर्म-प्लाज्म श्रोतों के मूल्यांकन प्रक्रिया शुरू की गयी। कई ताडों, जिन में वांछित गुण पाये गया, का मूल्यांकन किया जा रहा है।

जर्म-प्लाज्म ब्लाक में एक बौना सुरिनाम ताड की पहचान की गयी, जिसका विभिन्न लक्षण की दृष्टि से मूल्यांकन किया जा रहा है और इसमे संकरण कार्यक्रम की शुरुवात की गयी। आईल पाम इंडिया लिमिटेड के बाशवान में एक बौना पिसिफेरा पाम की पहजान की गयी। पी.सी.के.एम., अथिरिपल्लि में दो अधिक उपज वाले बोना ताड पाये गये।

विभिन्न अफ्रिकी देशों से एकत्रित जर्म-प्लाज्म द्रव्यों को उनकी अधिक जल प्रयोग दक्षता के लिये परीक्षण किया जा रहा है। उनकी आकृति , शरीर क्रियात्मक और जीव-रसायनिक तत्वों के लिय पर्यवेक्षण किये गये। सिंचाई एवं तनाव वातावरण क्षेत्रों के कुछ अधिक उपज वाले ताडों, जो पूर्व-प्रजनन आबादी विकास के लिए इस्तेमाल किये जा रहे हैं, का अभिप्रमाणित किया गया।

केन्द्र मे अध्ययनों से यह पता चला कि ग्यारह संकरों में गुच्छों की संख्या, एफ.एफ.बी. उपज, औसत गुच्छ भार आदि उपज संबन्धी लक्षणों में ज्यादा सार्थकता नही पायी गयी।

लक्ष्मीपुरम मे चल रहे संकर परीक्षण प्रयोग से संकरों में उपज संबन्धी तीन मुख्य लक्षणों (गुच्छों की संख्या, एफ.एफ.बी. उपज एवं औसत गुच्छ भार) में सार्थक अन्तर पाया गया तथा हर वर्ष यह अन्तर बहुत सार्थक देखा गया। संकरों मे एफ.एफ.बी. उपज में अत्यधिक अंतर पाया गया।

जैव-प्रौद्योगिकी

पौधे के विभ्ज्योतिकी ऊतकों को अभिप्रमाणित करने के लिए, विकसित पौधे तथा पौधों के ऊतकों से पाये गये भ्रूंणें, विकसित पत्ते, अविकसित पत्ते, जड एवं पुष्पक्रमों को कठोर अधिष्टापन हेतु 2, 4-डी क माध्यम में विभिन्न गाढापन स्तरों पर संवर्धन किया गया और भ्रूणों और पौधे की पत्ती में आठ सप्ताह की अवधि के अन्दर उनके विभज्योतिकि स्वभाव का प्रतिक्रिया देखी गयी। तेल ताडों तथा बाकी ताडों में, एस.एस.आर. प्राईमरों की कार्यशीलता का परीक्षण करने की प्रक्रिया में, यह पता चला कि 208 प्राईमर तेल ताडों के साथ क्रियाशीलक हैं लेकिन नारियल, सुपारी तथा पनई ताड में 94 प्रईमर और खजूर में 94 प्राईमर क्रियाशीलक पाये गये। बाकी ताडों में एक भी प्राईमर क्रियाशीलक नहीं थे।

यह भी देखा गया कि नूतन पद्धति द्वारा निष्कर्शित डी.एन.ए. पुरानी पद्धति के बराबर था।

बीज बागवान

तेल ताड के नये बाग लगाने के लिए प्राथमिक पादप द्रव्यों का उत्पादन किया जा रहा है। आगे स्थापित होने वाले नये बीज बाग्वानों के लिए, पेदवेगी में पालोड ड्यूरा तथा विदेशी ड्यूरा को इस्तेमाल करते हुए बहुमुखीय ड्यूरा आबादी के पादप द्रव्यों का विकसित किया जा रहा हैं। पांच वर्षों के उपज संबन्धी आंकडों को लेकर, 376 ताडों से 21 ताडों, जिनका औसत एफ.एफ.बी. उपज 125 कि.ग्रा/वर्ष था का भविष्य बीज उत्पादन के लिए जिनका सेल्फिंग शुरु की गयी, का चयन किया गया।

पेदवेगी में, 34 मातृ ताडों का चयन किया गया और ये वाणिज्य स्थर पर बीज उत्पादन हेतु इस्तेमाल किये जा रहे हैं। चयनित ड्यूरा एवं पिसिफेरा ताडों पर गुछ विश्लेशण किया गया और इस प्रकार, चार ताडों का चयन किया गया। टी x टी मे ड्यूरा में 27, टेनेरा में 97 और पिसिफेरा में 28 का पृथ्थक्करण अनुपात अभी तक दर्ज किया गया। बीज उत्पादन में वृद्धि लाने की उद्देश्य से तारका और पालोड में कुछ और ताडों का चयन किया गया।

बीज प्रौद्योगिकी

गुनेन्सिस, ओलिफेरा तथा अन्तर्जातीय संकर बीजों में क्रमशः 72, 45 और 95 प्रतिशत का अंकुरण दर्ज किया गया जबकि ई. ओलिफेरा में अल्प प्रतिशत दर्ज किया गया।

बीज विकास तथा परिपक्वता पर किये अध्ययन के प्राथमिक नतीजों से यह पता चला कि फल के एस-4 (265 दी.ए.ए.) स्तर पर अत्यधिक अंकुरण (97.6%) दर्ज गयी, बीज में नमी दर्ज की गयी जब्कि एस-५ (280 डी.ए.ए.) स्तर पर अंकुरण में क्षीणता देखी गयी। एस-4 एवं एस-5 के दोनों स्तर पर सूखा पदार्थ का अधिक संचयन और अल्प नमी दर्ज किया गया। एस-4 स्तर पर पाये गये अंकुर अति गुणवत्ता वाले साबित हुए।

ड्यूरा बीजों को डी-पेरीकार्पंग मशीन के द्वारा आधा मिनिट से एक मिनिट तक खरोंच कर 20 दिन तक प्री-हीटिंग करने से अंकुरण में काफी तेजी देखी गयी। बीज अंकुरण पर मौसम तथा मातृ ताड का प्रभाव पर गहन अध्ययन करने की आवश्यकता है।

बीज संरक्षण पर किये गये अध्ययन से यह पता चला कि पूर्व-तापन बीजें जब ४ माह तक संचित करने से सभी जीनोटाइपों में अंकुरण साथारण पाया गया (50-90%)।

फसल उत्पादन

तेल ताड़ की सिंचित तथा पोषक तत्वों के प्रबन्ध पर किये गये अध्ययन से यह पता चला कि ड्रिप सिंचाई पद्धति में अत्यधिक उपज (95.39 कि.ग्रा.) अभिलेकित की गयी जहां जेट एवं कुण्डी सिचाई पद्धति दुसरा स्थान पर हैं (88.22 कि.ग्रा/ ताड तथा 23.38 कि.ग्रा/ताड़ जिसका कारण अपर्याप्त सिंचाई था। तेल ताड़ के पुनरोपन प्रौद्योगिकी पर अध्ययन करने का कार्य शुरु किया गया और इसके अन्तर्गत ताड़ की कतायी, तने को सुई देना, क्रमशः एक तिहाई ताड़ों को हटाना और एकान्तर पंक्ती को हटाना जैसे चार उपचार कार्यन्वयन किये गये।

प्रतिवेदन की अवधि में 352 मिट्टी के नमूनें, 203 पर्ण नमूनें, 23 जल नमूने का विश्लेषण किया गया। तेल ताड़ क्षेत्रों में पौष्टिक सूची का मूल्यांकन करने के लिए पश्चिम गोदावरी जिले के 23 मण्डल और कृष्णा जिले के 3 मण्डलों में सर्वेक्षण किया गया। महत्वपूर्ण सीमा की हिसाब से जैव-कार्बन, फास्परस, पोटासियम और सल्फर का वर्गीकरण किया गया तथा सूचीकरण भी किया गया। पुष्ट-मृदा के जैव-कार्बन और पर्ण-गन्धक उपस्थिति के साथ मृदा, उपलब्ध फास्पेट उपस्थिति का सहसम्बन्ध को अभिलेखन किया गया। तेल ताड से निकले अपशिष्टों से खाद बनाने की उचित प्रौद्योगिकी का विकास के लिए पर्ण, मेरुदन्ड, पर्ण वृन्त, नर पुष्पक्रम आदि को एकिकृत किया गया तथा उनके पौष्टिक स्थर का विश्लेषण भी किया गया। किसानों के क्षेत्रों से पाये गये जैविक खाद एवं

वानस्पतिक खादों में उपस्थित जैविक-कार्बन, फास्फरस, पोटासियम, गन्धक एवम सूक्ष्म-पुष्टिकरों के अनुपात में काफी अंतर पाया गया।

बुश पेप्पर, वाईन पेप्पर, पान पत्ते, एन्यूरियम एवं क्रसोंड्रा आदि तेल ताड़ों के वयस्क बागानों में अन्तर-फसल के रूप में उगाये गये इस अन्तर-फसलों के क्षेत्रों में प्रकाश तीव्रता का मापन किया गया। तेल ताड़ के ताजा फल गुच्छों का उपज एवं हेलिकोनिया तथा जिन्जर के लिल्ली के वृद्धि तथा उपज संबन्धी प्रचालों से संबन्धित आंकडे पाये गये। कोको, केला, चमेलि, बुश पेप्पर, एन्थूरियम, क्रोसान्ड्रा जैसे अन्तर-फसलों के वृद्धि तथा अनुपालन संबन्धी अंशों पर अध्ययन किया गया। तेल ताड़ की वृद्धि तथा उपज के जैव-रसायन के आधार पर किये गये अध्ययन से यह पता चला कि फलों के पहले भाग में बाकी तीन भागों से तेल की मात्रा अधिक पायी गयी। नवंबर के महीने में मध्यफल-भित्ति से अधिक मात्रा में तेल पाया गया और फरवरी के महीने तेल की मात्रा न्युनत्तम पायी गयी।

वयस्क तेल ताड़ बागानों में रस-प्रवाह पर किये गये अध्ययन में यह पता चला कि रस-प्रवाह प्रातः काल से धीरे-धीरे बढते हुए दोपहर तक अधिकतम हुए तथा उसके बाद धीरे-धीरे घटने लगा। वयस्क बागानों में भी रस-प्रवाह और वाष्पणीय दबाव की कमी में यही स्थिति देखी गयी। ताडों में रस-प्रवाह में समय-समय पर परिवर्तन भी देखे गये।

केरल के पीट मिट्टियों में तेल ताड़ की अनुपालन का अध्ययन करने के लिए, उपलब्ध बागानों पर आँकडे दर्ज किये गये।

स्त्रोत-अवनति संबन्ध पर अध्ययन करने के लिए तेल ताड़ में विभिन्न स्तरों पर फल एवं पत्र हटाना जैसे उपचारों लागू किये गये और ताडों की वृद्धि तथा उपज पर उनके प्रभाव का अध्ययन किया जा रहा है। उपचार महीने की अवधि में किये जा रहे हैं और आकृतिक तथा उपज संबन्धी अंशों पर आंकडे लिए जा रहे हैं।

कृषीय फसलें तथा मत्स्यकीय में बीज उत्पादन नामक आई.सी.ए.आर. नेट्वर्क परियोजना के अन्तर्गत, विभिन्न कम्पनियों को 4,52,050 अंकुरित बीजों की आपुर्ति की गयी।

फसल संरक्षण

पेदवेगी और पालोड के प्रयोगात्मक क्षेत्रों में रोग आपात की मानिटरिंग की गयी। थाईलेंड तथा कोस्टारिका से आयात की गयी पौधों में, जो मिजोरम सें उगाये जा रहे हैं, पर्ण दाग रोग से जुडे फफून्दों की पहचान की गयी जिस में कर्वुलेरिया, कोलेतोट्रिकम ग्लियोस्पोरियोडेस, कोलेतोट्रिकम तथा नान-स्पोरुलेटिंग पृथकों की उपस्थिति पायी गयी। जिनमें विदेशी रोग जनकें देखी गयी। फाइटोप्लासमा की चरित-चित्रण करने के लिए 22 एस.आर.डी., 20 वाई.एल.डी. तथा आर.डब्लू.डी. ताडों से तमिलनाडु और केरल के विभिन्न क्षेत्रों से 268 नमूनें संकलित किये गये। नतीजों से यह पता चला कि तेल ताड़ का स्पियर राट रोग, अरिकनट का वाई.एल.डी. तथा नारियल का आर.डब्लू.डी. फाटोप्लस्मा के कारण से पाये जाते हैं। इन नतीजों को पुष्ट करने के लिए यह प्रयोग को जारी रखने की अवश्यकता है।

गानोडेर्मा पर किये गये आर.ए.पी.डी. विश्लेषण से पता चलता है कि बेसल स्टेम राट रोग कारक, पृथकों से पांच गुच्छे बने थे। आइ.टी.एस. क्षेत्र आंकडों के अनुक्रमण से यह पता चला कि कई पृथकें *गनोडेर्मा लूसिडम* या *गानोडेर्म अप्लान्टम* हैं।

तेल ताड के नर्सरी तथा वयस्क बागानों में कीडों की व्याप्ति को पता करने आन्ध्र प्रदेश, कर्नाटक, तमिलनाडु, असम और छत्तीसगड़ राज्यों के कई जिलों का सर्वेक्षण किया गया। आन्ध्र प्रदेश के तेल ताड़ बागानों में रिनोसिरस भृंग, साइकिड, पत्ती में जाली बनाने वाले कीडें घोंघा, इल्ली जेसी मुख्य हैं। सर्वे किये गये सभी क्षेत्रों

में कौए तथा मेना का काफी असर देखा गया। ज्वार जैसे धान फसलों के नजदीक स्थित वयस्क बागानों में स्तनधारी से नुकसान कम से संतुलित स्तर पर है।

घोंघा इल्ली को नियंत्रण करने में, *ब्यूवेरिया बेसियाना* (108) कृत्रिम पाइरेथ्रोइड, लम्ब्डा सिहेलोत्रिन के बराबर असरदार साबित हुई। पक्षी एवं चूहा से फसल को संरंक्षित करने के लिए दिये गये नियंत्रण उपाय काफी सफलतापूर्वक साबित हुए। मौसम में कम आर्द्रता से परागणात्मक घुनों की आबादी पर काफी प्रतिकूल प्रभाव देखा गया। मेटर्जियम एनसोफिले की तुलना *ब्यूवेरिया बेसियाना* गुनों की आबादी को हानिकारक पहुन्चाते देखा गया, पर इसकी तीव्रता रसायनिक कीटनाशकों की हानि से बहुत ही कम थी । *एम. एनिसोफिलि* तथा *ट्राइकोडेर्मा विरिडि* जैसे अलग-अलग और एक साथ मिश्रण करने से केचुआ की वृद्धि एवं मृत्युदर पर कोई प्रतिकूल प्रभाव नही पया गया। एफ.वाइ.एम. के साथ नीम केक को उपयोग करना काफी हानिकारक साबित हुई जो एम. एनिसोफिलि आबादी को कम करती है, लेकिन *ट्राइकोडेर्मा विरिडि* के साथ काफी सफलता दिखी गई ।

एम. एनिसोफिलि के संतोषपद वद्दि के लिये तापमान 30°C एवं हवा में 7070 नमी को अनुकुल पाया गया।

कटाई उपरान्त प्रोद्योगिकी

अपरिष्कृत पाम आइल पर किये गये कटाई उपरान्त अध्ययनों से यह पता चला किबन्धीकरण के बगैर निकाले गये तेल में एफ.एफ.ए. की मात्रा परम्परागत पद्धति की तुलना मे अत्यधिक पायी गयी जो लिपेज की उपस्थिति से हुई और जो बन्ध्यीकरण में नाश होती है। तेल निकालते समय होने की पीसाई प्रक्रिया से ब्रूइजिंग में बढोतरी होती है जो लिपेज प्रक्रिया को और बढाती है। बन्धयीकृत तेल में केरेटोनाइड की मात्रा (873 पीपीएम) बन्ध्यीकृत तेल में (790 पीपीएम) ज्यादा पायी गयी। निर्जलीकृत पी.ओ.एम.इ. के अपरिष्कृत प्रोटीन की मात्रा के आधार पर पामाइल स्लड्ज-आधारित कई तरह के खाय पदार्ध बनाये गये और उनका परीक्षण भी किया गया। भैंस के बछडे, भैंस, भेड़ के बछडे, बकरी के बच्चे ताजा मछली रोहु तथा अलंकृत मछली कोइ कार्प ताजी मछली कट्ला कट्ला के चारे में क्रमशः 40%, 60%, 50%, 20%, 60% और 40% स्तरों पर निर्जलीकृत पो.ओ.एम.इ. को सामाविष्ट किया गया।

सामाजिक विज्ञान

प्रतिवेदन की अवधि अप्रैल, 2007 से मार्च, 2008 तक की अवधि में 39 अधिकारियों को तथा 2,247 किसानों को तेल ताड़ के विभिन्न अंशों पर प्रशिक्षण दिया गया।

आयोजित प्रशिक्षण कार्यक्रमों पर प्रशिक्षित अधिकारी तथा किसानों से जो जानकारी मिली उस से पता चला कि उन के लिए आयोजित प्रशिक्षिण कार्यक्रम उनको काफी उपयुक्त पायी गई ।

वितरण अद्ययन के नतीयों से यह पता चला कि वितरण में काफी असमानताएं थे और तेल ताड़ क्षेत्र में काफी विस्तरण की आवश्यकता थी। सिफारिस की गयी पद्धतियों को आचरण में काफी विविधता थी जिस के लिए और विशिष्ट प्रशिक्षण कार्यक्रमों को आयोजित करने की बहुत आवश्यकता है।

किसानों से मिली स्पंदन तथा सुझाओं के अनुसार तेल ताड़ अनुसंधान की आवश्यकतावों पर जोर देने के लिए मानकीकृत प्रश्नावली तैयार किये गये।

तेल ताड़ के डाटा बेस मनेटमेंट पर किये गये अद्ययन से यह पता चला कि सभी तेल ताड़ कर्षक 7-20 दिन के अवधि में बेसन सिंचाई पद्धति को आचरण कर रहे है, अधिक उपज पाने वाले किसान छोटे तथा सामान्य वर्ग में हैं, 22-26 वर्षीय आयु की बागानों से अत्यधिक उपज पायी जा रही है, अत्यधिक उपज पाने वाले किसानों में ज्यादातर लोग फार्म यार्ड मेन्यूर कुकुट खाद या कृमि खाद का प्रयोग करते है तथा उर्वरकों को विभिन्न मात्राओं में प्रयोग करते हैं।

EXECUTIVE SUMMARY

CROP IMPROVEMENT

Germplasm and varietal improvement programmes

Collection of seeds of promising palms (accessions) from Little Andaman (12 nos.), Baratang (2 nos.), Theni (5nos.) and Nellore (4 nos.) was carried out. The germplasm collected from Pune and Andaman & Nicobar Islands are being evaluated in field at Pedavegi. The palms with early high yields have been identified. Evaluation work was initiated for all the germplasm resources available at Palode. Some of the palms having desired traits were subjected to evaluation as per the descriptor details.

One dwarf Surinam palm was identified from germplasm block of Palode. The palm is being evaluated for different characters and crossing programme has been initiated. One more dwarf pisifera has been identified in OPIL estate. Two high yielding viresence type dwarf palms were identified at PCKL, Athirapalli.

The germplasm materials collected from different African countries are being screened for their tolerance to high water use efficiency. Observations were recorded on morphological, physiological and biochemical parameters. Yield promising dura palms have been identified under irrigated and stress environments which are being utilized for developing Pre-breeding populations.

The differences among the eleven hybrids (from four different sources of planting material) for major yield characters like bunch number, FFB weight and average bunch weight were non significant.

In the progeny testing trials planted at Lakshmipuram significant variation among the hybrids for all three major yield traits (number of bunches, total FFB weight and average bunch weight) was observed. It was also observed that year to year variations were highly significant whereas hybrid x year interaction effects were non significant. Variation among hybrids for FFB yield was recorded high.

Biotechnological studies

For identification of meristematic tissues in the plant, all the explants available like embryos, mature leaf, immature leaf, root and inflorescence collected from a mature plant and seedling tissues were cultured in modified MS media with 2,4-D at different concentrations for callus induction. The quick response (within 8 weeks) was found in the embryos and seedling leaf, which revealed its meristematic nature.

While optimizing the PCR reagents for SSR markers, a new methodology with reduced quantity of reagents and lesser volume of reaction mixture was standardized. The cost by the new method is considerably reduced than that of the earlier method.

While testing the functionality of SSR primers with oil palm as well as other palms, it was found that 108 primers were functional for oil palm, where as 94, primer each were found functional for coconut, arecanut, palmyrah, and 95 pairs were for date palm. No primers which were functional for oil palm were found functional for other palms. Agarose gel could produce detectable bands, however, differentiating the difference of fragments when the size difference is less was difficult. Silver staining of PAGE was having the problems of appearance of too many bands. Ethidium bromide staining of PAGE also produced too many bands but due to relative convenience of the staining this method was adopted with either12% or 15% PAGE.

It was observed that the DNA extracted by the new method (avoiding the step of chloroform extraction) was on par with the previous method. The DNA could be restricted with restriction enzyme and amplified with PCR successfully as in the case of previous method.

Seed gardens

The basic planting material for new seed gardens is being generated. At Pedavegi, diverse dura populations utilizing Palode dura and exotic dura are being developed for planting in new seed gardens. Based on five year yield data, of a total of 376 palms 21 palms were selected which are having an average FFB yield of 125 Kg/y and selfing of these palms was started for raising next generation progenies.

At Pedavegi, 35 Mother palms have been selected and are being utilized in commercial seed production programme. Bunch analysis on selected dura palms and pisifera palms has been done, accordingly four pisifera palms have been selected. A segregation ratio of Dura (27): Tenera (97): Pisifera (28) has so far been recorded in TxT population. At Taraka few more mother palms have been selected to increase the seed production. At Palode, based on the yield data 41 palms were selected from the dura-1 block. From dura-II, 15 palms were selected for seed production based on five-year yield data above 110 Kg/yr.

Seed technology studies

A germination percent of 82, 45 and 95 % was recorded in *guineensis*, o*leifera* and inter specific hybrid seeds respectively. E. *oleifera* recorded poor germination percentage.

Preliminary results on seed development and maturation studies indicated that maximum germination (97.6%) occurred when fruit reached S4 (165DAA), where least percentage of moisture content was recorded. At stage S5 (180DAA), decline in germination (94%) was noticed. High dry matter accumulation and low moisture content was recorded in both S4 and S5 stages. Seedlings obtained from S4 showed superior quality. Oil formation initiated (6.62%) at S1and highest content (74.93%) was recorded at S5. The virescense palms showed early maturity, germination and other parameters than normal palms.

Subjecting dura seeds to physical scarification with depericarping machine for half to one minute and pre-heating seeds for 10 days accelerated germination to a satisfactory level. Seasonal and mother palm influence on seed germination need to be studied further.

Conservation studies conducted in oil palm revealed that pre heated seeds when stored for 4 months resulted in normal germination (50-90%) in all the genotypes. i.e., dry storage found to accelerate germination.

CROP PRODUCTION

From the studies on water and nutrient management in oil palm it was observed that Drip irrigation recorded maximum yield of 95.39 kg/palm followed by jet and basin (88.11 kg/palm & 23.38 kg/palm). The yields reported are very low and are attributed to insufficient irrigation water. No significant difference was observed in yield among the different methods and levels of irrigation and also among the fertilizer levels.

Work has been initiated for conducting studies on replanting techniques in oil palm and four treatments were implemented; cutting all palms, giving stem injection, removal of one third palms in a staggered manner, removal of alternate rows of palms.

During the reporting period 352 soil samples, 103 leaf samples and 23 water samples were analyzed for different parameters. For assessing the nutrient index in oil palm growing areas 13 mandals of West Godavari district and 3 mandals of Krishna district were surveyed. Organic carbon, P, K and S contents in the samples were categorized based on critical limits and indexing was done using simple model. Positive correlation of soil available sulphur with organic carbon content of surface soils and leaf sulphur content was recorded.

For development of a suitable composting technique for oil palm wastes viz., leaflets, rachis, petiole, male inflorescence were collected and analyzed for nutrient status. Different organic manures and compost are collected from different farmer's field and analyzed for their nutrient status. Organic carbon, phosphorus, potassium, sulphur and micronutrient contents varied widely among the organic manures and compost collected from different farmer's field.

Bush pepper, vine pepper, betelvine, anthurium and crossandra were planted as intercrops in adult oil palm plantations. Light intensity was measured in intercropped area. Data on FFB yield of oil palm, growth and yield parameters of heliconia and ginger lilly were collected. Observations were made on growth and performance of already existing intercrops - Cocoa, banana, jasmine, bush pepper, anthurium, crossandra etc.

While conducting studies on biochemical basis for growth and yield in oil palm, it has been observed that oil content in the fruits of portion 1 of the bunches (base of oil palm bunches, toward the peduncle), was significantly higher than that of the other three portions of the bunch. Oil content was also found to be significantly higher in the mesocarp during the month of November and lowest during February.

Sap flux measurements in mature oil palm plantations indicated that the sap flux increased gradually in the morning and reached a peak during noon and then decreased. The sap flux in mature oil palm plantations also followed the same trend as that of vapor pressure deficit. Seasonal variations in the sap flux were also noticed in the palms

To study the performance of oil palm in peat soils of Kerala, present performance of the plantations already existing in the peat soils was recorded.

To study the source sink relationship in oil palm treatments like different levels of fruit removal, different levels of frond removal were imposed and their effect on growth and yield of the palms is being studied. The treatments are being imposed at monthly intervals and morphological and yield data are being taken.

To enable Carbon sequestration studies in oil palm, annual increment in biomass and standing biomass were estimated non destructively and samples from leaflets, rachis, trunk were taken for estimation of carbon stocks.

Under the ICAR-Network funded project Seed production in agricultural crops and fisheries 4,51,050 germinated seeds were supplied to different entrepreneurs from Palode. On an average 80.54% germination was achieved. Three thousand oil palm seedlings were raised in secondary nursery at Pedavegi and supplied to farmers.

CROP PROTECTION

Monitoring of disease incidence in the experimental plots of Palode and Pedavegi was carried out. Identification of fungi associated with leaf spot disease of oil palm seedlings raised with imported sprouts from Thailand and Costa Rica at Mizoram revealed presence of *Curvularia* sp., *Colletotrichum gloeosporioides, Colletotrichum sp.*, and non sporulating isolate. No exotic pathogens were encountered in the isolation.

A total of 168 samples from 12 SRD, 10 YLD and 12 RWD palms of various locations in Kerala and Tamil Nadu were collected for characterization of Phytoplasma. Results indicated that the three diseases namely SRD of oil palm, YLD of arecanut, and RWD of coconut are caused by Phytoplasma. The experiment needs to be continued for confirmation of the result.

As per the RAPD analysis conducted on *Ganoderma*, the causal organism of Basal stem rot disease in oil palm apparently 5 clusters were formed by the isolates. Sequencing of ITS region data reveals that most of the isolates are *Ganoderma lucidum* or *Ganoderma applanatum*.

Survey was carried out in various districts of Andhra Pradesh, Karnataka, Tamil Nadu, Assam and Chhattisgarh to find the pest incidence in nursery and adult oil palm plantations. Rhinoceros beetle, psychids, leaf web worm and slug caterpillar were observed as major pests in the oil palm gardens of Andhra Pradesh. Crows and mynahs were observed as major avian pests in all the areas surveyed. Incidence of mammals was observed at low to moderate levels in young palms that were adjacent to cereal crops like maize.

In controlling the slug caterpillar *Beauveria bassiana* (10^8) was found effective which was on par with synthetic pyrethroid Lambda cyhalothrin. In reducing the bird damage impact of nylon nets was observed very prominent where ever they were tied compared

non tied areas. Single application of Warfarin could reduce only 50% of the rat incidence within one week period compared to Zinc phosphide which recorded more than 75% reduction. Two applications of Zinc phosphide continuously twice with no gap between the two applications was found effective.

Relative humidity was observed as critical factor for the incidence of pollinating weevil. No weevil population was observed when the RH was reduced to less than 40%. Temperatures were however not found to have any impact on the population. It was also observed that *Beauveria bassiana* was more harmful to the weevil population compared to *Metarhizium anisopliae*. However the intensity was much less when compared with chemical insecticides

Mixing of microbial agents like *Metarhizium anisopliae* and *Trichoderma viride* individually as well as in combined manner did not show any negative impact on the growth and mortality of the earthworms. Application of neem cake to the FYM proved inefficient as it reduced the spore population of *Metarhizium anisopliae* where as it was found effective in case of *Trichoderma viride*. This confirms the earlier findings.

Temperature of 30°C and relative humidity of 70% were once again found congenial for the multiplication of microorganism *Metarhizium anisopliae* and thereby to kill the host effectively compared to lower levels. Studies on impact of stirring of the inoculated material indicated that stirring after three days of inoculation was found better and yielded more number of spores compared to immediately after inoculation.

Molecular studies (using SDS PAGE) of the different strains of microorganisms that are used for the management of pests of oil palm indicated molecular level difference among entomo-pathogen microbes and plant pathogens where the latter recorded more number of bands.

POST HARVEST TECHNOLOGY

In the mini palm oil mill trial run conducted after completion of the works, the OER obtained with Dura FFB was 11 .70.

While conducting post harvest studies on crude palm oil it was observed that oil extracted without sterilization had very high amount of FFA in comparison to conventional method. This drastic increase was due to the presence of lipase in un-sterilized oil, which was destroyed in the case of sterilized oil. Crushing done as a part of extraction also increases bruising leading to further increase in lipase activity. The carotenoids value of sterilized oil (873ppm) was found to be more than unsterilized oil (790ppm).

Different feeds containing palm oil sludge as chief source were formulated based on the crude protein content of dehydrated POME and tested. Dehydrated POME could be incorporated in the diets of buffalo calves and buffaloes, lambs, kids (goats), piglets, fresh water fish *Rohu and* ornamental fish *Koi- Carp,* fresh water fish *Catla catla* up to 40 % level, 60 % level, 50 % level, 20 % level, 60% level and 40% level respectively.

SOCIAL SCIENCES

During the year April 07-March 08 a total of 69 officers and 2147 farmers were trained on various aspects of oil palm

Feed back data collected from trained officers and farmers regarding conductance of training programmes, revealed that training conducted was beneficial and need to have refresher trainings on specific subject matter areas.

Diffusion study revealed unequal distribution, indicating to have sustained efforts for area expansion. Skill gap is existing in the practices adopted by the farmers, requires specific training to facilitate them to adopt the recommended technology.

For prioritization of research needs in oil palm based on farmers' perception standardized questionnaires was prepared and mailed to farmers. Judgment of items for their relevancy and non relevancy was carried out.

From the studies conducted on Oil Palm Database management it was observed that all the farmers are following basin method of irrigation with a frequency of 7-10 days, most of the high yielding plantation farmers are in the small and marginal farmers category and highest yields are being obtained from 11-16 years age plantations. Majority of the high yielding plantation farmers are applying Farm Yard Manure or poultry manure/ vermicompost and applying different dose of fertilizers in their oil palm plantations.

It was also observed that a significant correlation coefficient between manure application, fertilizer applied in number of splits, application of magnesium and yield was observed. Size of land holding, age of plantation, quantity of the manure applied, application of nitrogen, phosphorous, potassium and boron had no effect on the high yields achieved.

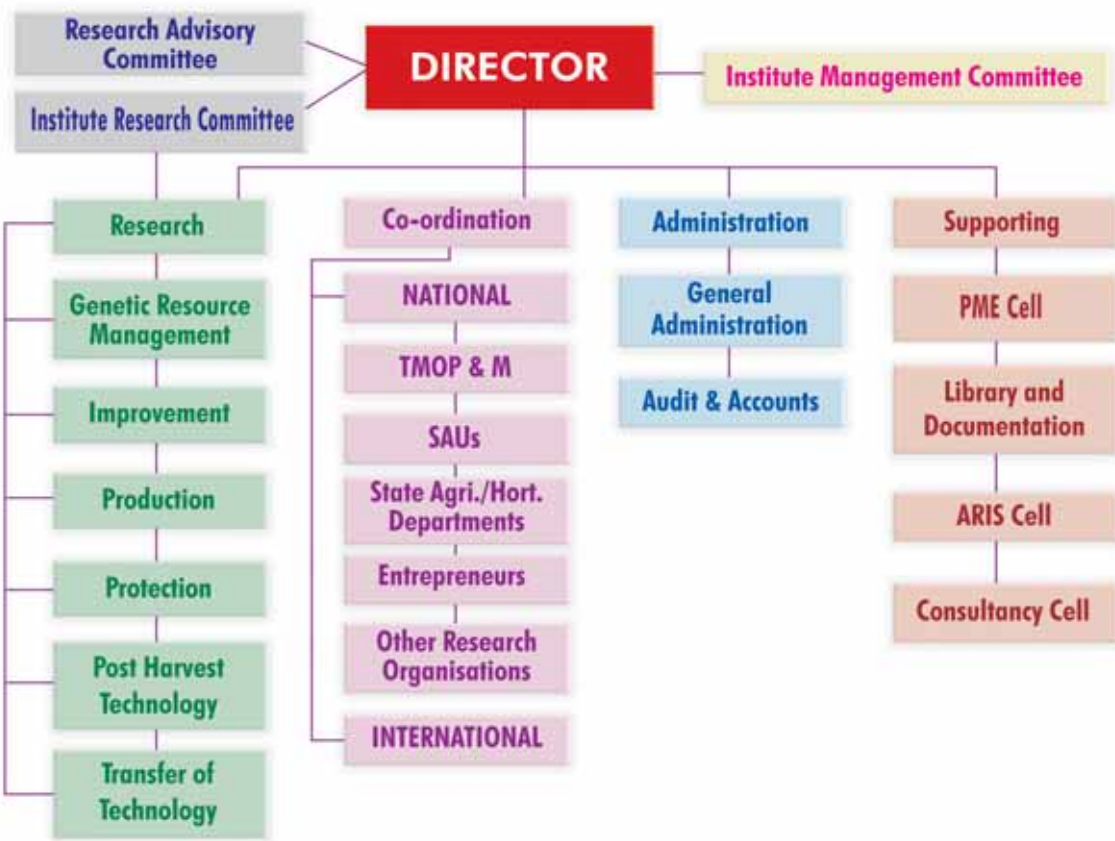
3. INTRODUCTION

The National Research Centre for Oil Palm is a pioneer institute established under the aegis of Indian Council of Agricultural Research (ICAR) at Pedavegi, West Godavari District of Andhra Pradesh on 19th February' 1995. The Centre is 13 Km away from Eluru, which is the district headquarters of West Godavari. The then CPCRI (Research Centre), Palode was merged with NRCOP on April,1999 with a view to unifying oil palm research. The Regional Station Palode is 35 Km away from Thiruvananthapuram, Kerala on Thiruvananthapuram - Schenottah route. NRCOP serves as a Centre of Excellence for conducting and coordinating research on Oil Palm in the fields of germplasm collection and conservation; genetic improvement, production, protection, post-harvest aspects and dissemination of knowledge through transfer of technology.

3.1. Mandate

- To conduct mission oriented research on all aspects of Oil Palm with an objective to improve the productivity and quality
- To serve as national repository for Oil Palm germplasm and clearing house for all research information on Oil Palm and coordinate national research project
- To act as center for training in research methodology and technology of Oil Palm
- To generate nucleus planting material
- To collaborate with national and international agencies in achieving the above

3.2 Organisational setup



3.3 Financial outlay

Head: NON-PLAN

Amount in Rs.

S.No.	Head	Revised Estimate	Utilization
1	Estt. Charges	13500000	13122189
	O.T.A.	10000	9715
2	T.A.	560000	560000
3	Other Charges including equipment	9465000	9531000*
4	Works		
	1) Annual repair & maintenance		
	a) Office building	400000	92500
	b) Residential buildings	465000	318000
	c) Minor works	100000	44500

* An amount of Rs. 510000/- is reappropriated from Non-Plan works to Non-Plan – O.C.

1	Pension and retirement benefits	1800000	1407964
2	P Loans and advances	1000000	816938

Head: PLAN

S.No.	Head	Revised Estimate	Utilization
1	Estt. Charges	120000	116012
2	O.T.A.	0	0
3	T.A.	500000	499739
4	Other Charges including equipment and IT		
	a. Equipment	0	0
	b. Library	550000	550000
	c. Furniture	0	0
	d. Contingencies	12130000	12129593
5	Works	0	0

3.4 Externally Funded Schemes

(Rupees)

S. No.	Name of the Scheme /Project	Opening Balance as on 01.04.2007	Receipts during 2007-08	Expenditure during 2007-08	Closing Balance as on 31.03.2008
1	GxE scheme	-219161	1043000	369761	454078
2	STOP	369739	423000	398912	393827
3	LA LAB	-104567	370000	405387	-139954
4	Strengthening of seed gardens	-219266	664000	178247	266487
5	DST	1092	0	0	1092
6	DST-Development of molecular markers for variety identification in oil palm	342645	0	268366	74279
7	TMOP-Tissue Culture (Use of Biotechnology in Agriculture)	0	3500000	0	3500000
Other deposits					
8	Oil Palm cultivation	8646	0	0	8646
9	Seed garden, Rajahmundry	285838	0	152246	133592
10	Research project techniques in oil palm (OPIL)	0	190000	42850	147150
11	Seed garden, Taraka	138360	0	231470	-93110
12	TMOP - For Chadha Committee report	680	0	680	0
13	Feasibility studies (Min. of Environment)	0	124000	132975	-8975
14	OPDP, Karnataka	109412	0	202179	-92767
15	EMD	53152	5200	1000	57352
16	SD	105606	0	0	105606
17	Miscellaneous	3538	0	0	3538
18	Staff welfare fund	0	6100	0	6100
19	OPDP, Karnataka, Consultancy fund	23214	42700	0	65914
20	R-deposit -national seminar Feb.2005	0	35715	0	35715
21	Training fee, Goa	9260	0	0	9260
22	Hindi seminar	15201	0	0	15201
23	R-deposit training	-33750	33750	0	0
	Grand Total	**889639**	**6437465**	**2384073**	**4943031**

3.5 Resource generation

During the year an amount of Rs. 25.78 lakh has been generated under the following Heads:

Head	Amount generated (Rs in lakh)
Sale of farm produce	22.18
Sale of publications	0.38
License fee	0.56
Analytical and testing fee	0.08
Miscellaneous receipts	2.58
Total	**25.78**

3.6 Staff position

Grade	Sanctioned	Filled	Vacant
RMP	01	01	-
Scientific	22	15	07
Technical	18	18	-
Administration	12	11	01
Supporting	30	26	04
Total	83	71	12

3.7 Library

The institute has a fully furnished library and subscribes 16 foreign and 25 Indian journals. In the library a total of 1091 reference books are available. Four newspapers are also subscribed for the benefit of staff members. Computerized all the library books and issues through barcode system. During 2007-08 an amount of Rs.5.50 lakh has been utilized for procuring books, journals and other essential items. The library has internet, photocopying and binding facilities

3.8 ARIS cell

ARIS cell of NRCOP is furnished with two HP Xeon servers and eight PCs (node). Fully furnished ARIS cell is backed up with UPS and all essential softwares. This cell provides internet facility to all the scientists, laboratories and sections through Local Area Network(LAN). The statistical software and databases are provided in the server for use at the client systems. The servers and PCs are of Pentium IV or above. Internet facility is at present provided through ISDN connection as well as VSAT connection from Ernet. VSAT connection is available round the clock.

Oil palm database is being maintained by the ARIS cell personnel. ARIS cell also takes the responsibility to circulate all the circulars through LAN. Web-page of the institute is hosted by National Informatics Centre. Presently web-site is under the process of upgradation. Important notices like advertisements and tender notices are made available in the website of the institute.

http://nrcop.ap.nic.in is the website maintained by the institute.

3.9 PME Cell

Project Monitoring and Evaluation cell is functional in the institute. PME cell extended its help in carrying out the background work for the Research Advisory Committee meeting, QRT meeting and other meetings attended by the Director. Scientist-in-charge, PME Cell is the member secretary of Institute Research Committee(IRC) and CPC. Routine works such as preparation of monthly reports, quarterly reports, half yearly reports and correspondence with Council and other institutes were also attended by PME cell. PME cell coordinated the preparation of XI Five year plan EFC document (2007-2012) and submitted to council.

3.10 Museum

A Museum is established at NRCOP to create awareness about oil palm among farmers, entrepreneurs, officials of development agencies and general public who visit NRCOP. It is also aimed to provide technical know how of oil palm cultivation and disseminate technologies generated by NRCOP. Oil palm cultivation practices from nursery to harvesting are sequentially depicted for the benefit of visitors. Research attainments of NRCOP, specimens, exhibits, models, charts showing technologies are also on display for the benefit of the visitors. Audio facility highlighting the cultivation practices of oil palm and research attainments of NRCOP is provided. Touch screen facility to get first hand information on facilities available at NRCOP is provided. Facility will be created to provide literature on oil palm cultivation to visitors.

3.11 Right to information Act

In pursuance of the instruction from ICAR, under the Right to Information Act 2005, Dr. G. C. Satisha Sr. Scientist is nominated as Public Information officer and Dr. K. Ramachandrudu Scientist(SS) as Asst. Public Information Officer.

4.0 Research Achievements

फसल सुधार
Crop Improvement

High yielding *virescens* palm

CROP IMPROVEMENT

COLLECTION, CONSERVATION, CATALOGUING AND EVALUATION OF OIL PALM GERMPLASM

Collection of germplasm : A format for oil palm germplasm collection register was prepared. Seeds of promising palms were collected from Little Andaman (12 nos.), Baratang (2 nos.), Theni (5 nos.) and Nellore (4 nos.).

Characterization of germplasm: The germplasm accessions collected from African countries to evaluate their water use efficiency are being characterized for quantitative and qualitative traits. The variations for mesocarp content, fruit size, fruit testa colour, size of bunch and other characters have been recorded.

Evaluation and management of germplasm available at Pedavegi : The germplasm collected from Pune and Andaman & Nicobar Islands, are being evaluated in field. Till the reporting period the palms are in good condition. The palms with early high yields have been identified.

Evaluation of germplasm at Palode: Evaluation work was initiated for all the germplasm resources available at Palode. Some of the palms having desired traits were subjected to evaluation as per the descriptor details.

Identification of new sources of dwarfness: One dwarf Surinam palm was identified from germplasm block at Palode and is being evaluated for different characters. Crossing programme has been initiated. One more dwarf Nigerian sterile pisifera was identified in OPIL estate. Two high yielding viresence type dwarf palms were identified at PCKL, Athirapalli.

Nigerian dwarf *tenera* evaluated and progenies developed

Nigerian collection showed significant variation for bunch characteristics. Characterization of the dwarf tenera palm was done as per the IBPGR descriptor for vegetative and reproductive characteristics. All the characters of Indian dwarf palm were recorded as per Bioversity International (IPGRI) descriptor. Tenera × Pisifera progeny was produced from Indian dwarf palm and commercial *pisifera* and their germinated seeds were supplied to NRCOP Pedavegi.

PRODUCTION, EVALUATION AND IMPROVEMENT OF OIL PALM HYBRIDS

Progeny testing of hybrids (Palode source): Observations on morphological, yield and dry matter parameters were recorded in three progeny testing trials planted at Lakshmipuram. Yield data on FFB weight and number were recorded during every harvest.

Pooled analysis of Variance over four years (2004-08) was done for major yield traits like number of bunches, total FFB weight and average bunch weight. The results showed significant variation among the hybrids for all three major yield traits. It was also observed that year to year variations were highly significant whereas hybrid x year interaction effects were non significant. Variation among hybrids for FFB yield was recorded high.

Progeny testing trial at Pedavegi: Regular agronomical practices are being followed. Palms with early high yield have been identified. Observations on morphological, yield and other growth characters were recorded.

Evaluation of Dura population at Pedavegi: Out of five accessions of dura population at Pedavegi a total of 38 mother palms have so far been selected from Palode sources whereas 13 mother palms have been selected from Costa Rican sources.

Observations on production of leaves, inflorescences (male/ female) were regularly recorded. The annual biometric observations on 17th leaf, height and girth at collar were recoded once in a year. The Fresh Fruit Bunch (FFB) yield was recorded on each harvest basis. Preliminary trend of FFB productivity of Dura mother palms was recorded. In Costa Rican source 13 Dura palms observed promising based on previous two years data were identified. Similarly in Dura population of Palode source 38 palms with FFB yield of more than 150Kg/ year were identified which are being utilized in commercial seed production. The bunch analysis has been carried out on a few selected palms for ascertaining bunch parameters with special reference to oil productivity.

A dura palm in GD3 population has been identified with male spikelets having terminal shape like a snake head.

Evaluation of Tenera x Tenera population at Pedavegi: The Tenera x Tenera population (223T x 86T; progenitors 65D x 30103P) was planted in 2000 by selecting promising Tenera palms at Palode. A segregation ratio of Dura (23): Pisifera (22): Tenera (129) has so far been realized. Two pisifera palms- 33 & 77 were identified as sterile palms. Bunch analysis on suspected pisifera palms was done. Quarterly observations on production of leaves, inflorescences (male/ female) were regularly recorded. The annual biometric observations on 17th leaf, height, girth at collar are recoded once in a year. The Fresh Fruit Bunch (FFB) yield was recorded during harvesting.

Field planting of Progeny testing materials: Field planting of fourth trial of DxP progenies of Rajahmundry seed garden has been completed. The seedlings of the four trials have established well.

Registration of promising palms: The basic data for registration of some accessions have been generated and shall be taken up in the coming year.

Evaluation of selected progeny of inter-specific hybrids for Fatty acids composition of the oils: Fruit samples from 30 palms (three replications each) from a single cross 361 D x 13 P (*Eo*) were analyzed for fatty acids composition (FAC), moisture and oil content in the mesocarp. Cross wise average data were not much different from *Eg* oil. But within the cross, the progenies segregated with respect to FAC, oil and moisture content. Seven palms from 361 D x 13 P (*Eo*) cross under study were having 60% of total unsaturated fatty acids content. Highest unsaturated fatty acids content was found in palm no. 78, but the mesocarp of that palm had more moisture and lesser oil content. This character is observed in the *oleifera* palms from Palode, which had more moisture content and less oil content due to more parthenocarpic fruits. Palm No. 26 had higher oil content as well as better oil quality (total unsaturated fatty acids content =63.51%). Highest oil content in the mesocarp is found in palm no. 80 (59.53%).

Evaluation of inter-specific hybrids at Palode: Morphological and yield parameters were recorded in inter specific hybrids available at Palode. Yield data are presented in Table 1. New inter specific hybrid crosses were made during the reported period by crossing Surinam *oleifera* with African germplasm.

Evaluation of *oleifera* palms: Morphological and yield parameters were recorded on *oleifera* palms at Palode.

Yield performance : Maximum of 8 bunches were recorded in palm numbers 2, 3 and 9. Minimum number of just one bunch was recorded in palm no. 7. Highest FFB weight of 171kg/p/y was recorded in palm no 2 and 9 followed by palm no. 5.

Table 1. Yield data of inter specific hybrids

Sl. No	Accession No	Mean FFB No	Mean FFB weight (kg)
1	12E X 82EG	4.2	13.51
2	19EOX81EG	2.3	8.91
3	16EOX18EG	2.0	16.05
4	360EGX13EO	4.3	9.58
5	361EGX11EO	3.3	6.63
6	DXP Palode	8.0	13.18
7	15EOx18EG	6.5	10.71
8	16EOX 81EG	2.5	7.50
9	10EOX OPEN	3.0	11.22

The vegetative observations are given in Table 2 . Average palm height was more in palm no 2 and 6 which also recorded high leaf weight.

SCREENING OIL PALM GERMPLASM FOR DROUGHT TOLERANCE

In the present experiment the oil palm germplasm materials collected from four African countries (Cameroon, Guinea Bissau, Tanzania and Zambia), are being screened for drought tolerance and/ or high water use efficiency at locations namely Pedavegi, Nellore, & Adilabad (in Andhra Pradesh) and Palode & PCKL (Kerala). The crop is being grown as rainfed at Palode and PCKL (Kerala) and Adilabad (A.P.) locations whereas at other locations it is being grown under water stress conditions (IW/CPE ratio = 0.5).

Quarterly observations on production of leaves and inflorescences (male/female) were regularly recorded. The annual biometric observations on 17th leaf, height, girth at collar were recoded once in a year. The FFB yield was recorded on each harvest basis.

Variability in Germplasm : Significant variability has been recorded within and between the accessions for many characters like, having long stalked male inflorescence, dwarfness, position of leaf lets (to have better exposure to sun light for better photosynthetic activity), producing only female inflorescence, narrow petiole, short rachis length and virescense fruit types with good yields.

A. Evaluation at NRC for Oil palm, Pedavegi (A.P.)

The germplasm accessions at this location were planted in 1998 in replicated and observational designs. The replicated trial was laid in RCBD with three replications keeping plot size of 4 palms. The screening is being done at two moisture levels, irrigated (IW/CPE ratio=1.0) and stress (IW/CPE ratio=0.5), being maintained through drip irrigation system. The experiment is being maintained as per the standard package of practices followed for oil palm. Till the reported period, the crop is in good health.

a. Replicated trial: Quarterly obse-rvations were recorded on leaf and inflorescence production. Number of bunches and FFB weights were recorded as and when harvesting was done and were expressed on annual basis. Annual biometric

Table 2. Vegetative observations on *oleifera* palms

Source	Av.Height(m)	Av. Girth(m)	Av. No. of leaves	Male Infl.	Female Infl.
Malaysia	3.76	3.04	24.48	1.29	3.48
Costa Rica	3.00	3.22	26.00	1.50	3.00

observations on palm height, girth at collar, standard leaf (17th) measurements like rachis length, petiole width, depth and number, length and width of leaflets were recorded to calculate leaf area, leaf dry matter, trunk dry matter production *etc*.

The Zambian accessions were in general highest yielders (142.4kg) and Guinea Bissau accessions were the lowest yielders (105.4kg). The average bunch size of Zambian and Tanzanian accessions was more (14.1 & 14.6 kg, respectively). The Guinea Bissau accessions were having small sized bunches (7.6kg).

Cumulative yield data (Tables 3.1 & 3.2) : The cumulative yield of previous four years (2004-05 to 2007-08) under both irrigated and stress environments showed that the Zambian accessions were the highest yielders (434.9kg/palm) followed by Tanzanian accessions (388.6kg/palm). The yield level of GB accessions was again the lowest (287.7kg/palm).

Guinea Bissau accessions were in general very tall growing, produced more number of bunches but of small size (6.9kg) and moderate yielding. The Zambian accessions were high yielders with medium size of bunches (15-18kg), medium in height and recorded moderate sex ratio. Tanzanian accessions were also of medium height, moderate to high yielders and with medium bunch size.

Under stress conditions similar results as observed under irrigated conditions were observed. Guinea Bissau accessions were very tall growing and recorded highest sex ratio. SLW was recorded highest in Zambian accessions like previous year reflecting the high water use efficiency trait in these materials. Zambian and Tanzanian accessions were found highest yielders; number of bunches were recorded more in GB accessions.

Biochemical parameters:

From the ten different African germplasm accessions 240 palms were analyzed for different biochemical parameters. Half of the palms were under water stressed and the other half were under irrigation. Soluble and total carbohydrate, soluble protein, phenol and proline content, Chlorophyll a, Chlorophyll b, carotenoids were estimated from the leaf samples of the palms during the extreme summer period (during May-June).

There was no significant difference in chlorophyll a, chlorophyll b and carotenoids content among the different accessions. However, there are significant differences observed among the different genotypes in relation to other parameters. Among the different accessions, ZS-2 was found different with respect to many parameters. It exhibited highest level of total and soluble carbohydrate, total chlorophyll and peroxidase enzyme. Higher level of soluble protein content was also found in the Guinea Bissau accessions. However, soluble protein and phenol contents were at a lower level in all the four Zambian accessions (Chart 1.1). For all the parameters under study, there were no significant difference observed between the two Tanzanian accessions and with respect to none of the parameters they have extreme values.

No difference was observed between stress and full irrigation for any of the accessions under study for chlorophyll-a, chlorophyll-b, carotenoids, total carbohydrate peroxidase enzyme and total soluble protein. The accession number ZS-2 showed significant difference under stress than that of full irrigation for soluble carbohydrate and total chlorophyll content (Chart 1.2 and Chart 1.3). Similarly, phenol content was significantly different under irrigated and

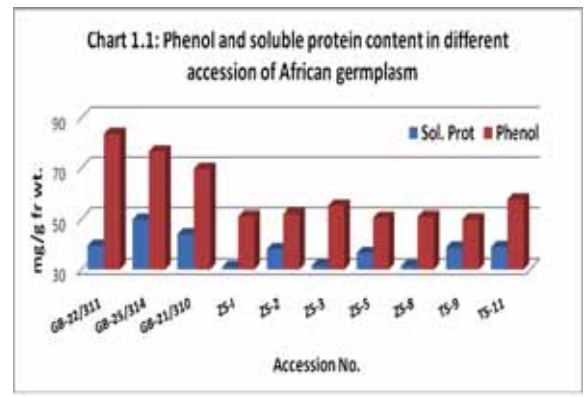
stress condition in case of accession no. GB-21/310 (Chart 1.4).

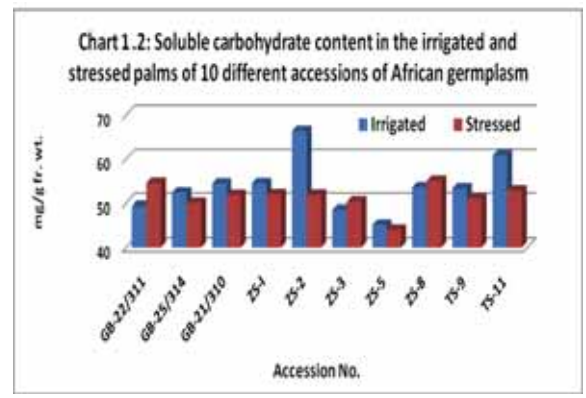
Physiological parameters

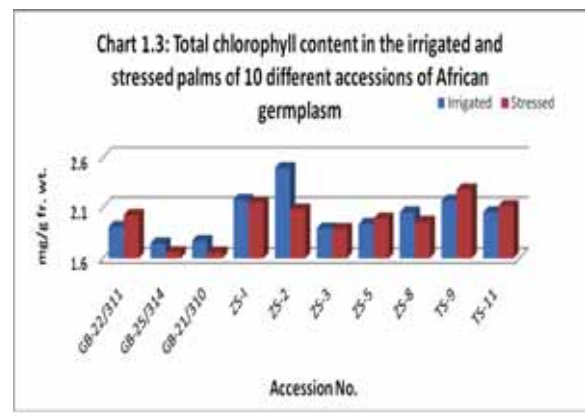
The mean stomatal frequencies in the African duras under the two treatments varied between 268.12 and 301.25. The highest mean stomatal frequency was observed in ZS-5 followed by ZS-3 and TS-11, while the lowest was in TS-9. Duras grown under the irrigated and stress environments did not differ significantly in terms of their mean stomatal frequencies. The mean epidermal frequency in the duras grown under the two treatments indicated that it was highest in TS-11 followed by ZS-5, while GB-22 recorded the lowest. There were no significant differences in epidermal frequencies among the irrigated and stress environments. The mean stomatal index among the duras in the two treatments ranged from 50.51 to 54.58. The lowest stomatal index was recorded in TS-11, while the highest was in GB-22. Significant differences were observed in terms of stomatal index between the two treatments.

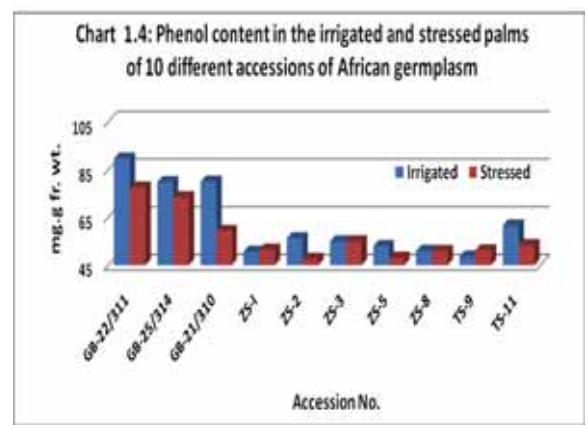
The mean plastids per stomata in the duras grown under irrigated and stress conditions ranged from 11.44 to 14.45. GB-25 and ZS-2 recorded the highest and lowest mean plastids per stomata respectively. No significant differences were observed between the two treatments. The mean guard cell length in the duras under the two treatments varied from 35.02 to 44.49. The highest guard cell length was noticed in GB-22, while it was shortest in GB-21. The mean stomatal pore area ranged from 9.11 in GB-22 to 12.36 in ZS-8. Significant differences were not observed among the irrigated and stress treatments.

The mean transpiration rate in the different duras under the two treatments









ranged from 1.12 to 1.50 mmol.$m^{-2}s^{-1}$. The mean transpiration rate was significantly highest in ZS-2 followed by ZS-5, while the lowest rate was observed in GB-25, which was on par with other duras except ZS-2 and ZS-5. The mean stomatal conductance in the different duras ranged from 0.02 to 0.04 mol. $m^{-2}s^{-1}$and there were no significant differences among the different duras under the two environments. The mean leaf temperature in the different duras under the two treatments varied from 42.65 to 46.54 °C. Among the different duras, ZS-3 recorded the highest mean leaf temperature followed by ZS-5, GB-21 and GB-22, which did not differ significantly among each other. The lowest mean leaf temperature was recorded in TS-11. Among the different treatments, irrigated palms maintained lower temperatures compared to that of stressed palms.

The mean photosynthetic rates among the duras in the irrigated and stress environments varied from 3.82 to 5.11 µmol. $m^{-2}s^{-1}$. The mean photosynthetic rate was highest in ZS-1 followed by ZS-5, which did not differ significantly between each other. The lowest rate was recorded in ZS-2. Duras grown under irrigated conditions recorded higher mean photosynthetic rates than that of grown under stress environment. The mean leaf water potential among the duras grown under different treatments varied from -3.49 to -4.58 Mpa. The highest leaf water potential was recorded in ZS-3 followed by TS-9 and GB-21, while the lowest mean leaf water potential was in TS-11. A comparison of the photosynthetic water use efficiency (PWUE) among the duras indicated that irrigated palms had better efficiencies than grown under stressed conditions. The mean PWUE in the different environments ranged from 2.69 µmol CO_2.mmol H_2O^{-1} in ZS-2 and 4.98 µmol CO_2.mmol H_2O^{-1} in ZS-1.

b. Observational Trial: A number of accessions from all the four African countries are being evaluated under water stress conditions (IW/CPE ratio = 0.5). Data on observational (non replicated) trial comprising genotypes from different countries along with two inter-specific hybrids were recorded.

As observed during the previous year, mean height of Cameroon accessions was lowest while the Zambian accessions were moderate in height. Mean FFB yield performance of ZS-5 accession was 178kg/p which is very high, hense selection in this accession for promising palms is very high.

A total of 44 palms recorded yield above 150kg (a threshold level generally followed in selecting dura mother palms under irrigated conditions). The highest yield was recorded in palm no. 416 of ZS-5 (284 kg) followed by 454 of TS-9 (265kg). These palms could be utilized in breeding programmes aimed at high yield with drought tolerance.

The performance of different palms of various accessions under water stress conditions (IW/CPE ratio = 0.5) is being discussed as under:

Performance of Cameroon accessions (Table 4.1): Among all the accessions, FFB yield of CA-17 was recorded highest (117kg/palm). The number of bunches were recorded highest in CA-11 (11) followed by CA-17 (10.5). The average bunch weight was highest in CA-7 (13.8) followed by CA-13 (13.7).

Performance of Guinea Bissau accessions (Table 4.2) : Amongst the GB accessions the highest FFB yield was recorded by GB-29/318 (129.8kg) which was significantly higher than the general mean

Table 3.1. Performance of African germplasm under irrigated conditions at NRCOP, Pedavegi

Genotype	2004-2005			2005-2006			2006-2007			2007-2008			Cumulative	
	BN	FFBY	ABW	BN	FFBY	ABW	BN	FFBY	ABW	BN	FFBY	ABW	BN	FFBY
GB-22/311	11.6	38.4	3.3	8.8	48.9	5.9	14.1	81.4	5.8	12.1	90.7	7.5	46.6	259.4
GB-25/314	17.5	47.9	2.7	13.4	55.6	4.4	12.3	64.0	5.2	18.6	104.3	5.6	61.8	271.8
GB-21/310	14.5	51.4	3.5	10.6	62.5	7.4	15.7	96.8	6.0	12.3	121.1	9.8	53.1	331.8
GB MEAN	**14.5**	**45.9**	**3.2**	**10.9**	**55.7**	**5.9**	**14.0**	**80.7**	**5.7**	**14.4**	**105.4**	**7.6**	**53.9**	**287.7**
ZS-1	13.6	98.7	7.3	5.8	51.3	8.9	8.4	105.1	13.8	11.5	165.0	14.4	39.3	420.1
ZS-2	15.5	132.0	8.5	5.1	57.1	11.1	12.9	163.5	13.4	11.6	150.2	12.9	45.1	502.8
ZS-3	11.2	89.7	8.0	8.4	76.7	9.1	7.9	97.0	12.6	10.9	139.9	12.8	38.4	403.3
ZS-5	13.8	105.9	7.7	7.3	61.6	8.8	10.0	133.3	12.8	8.0	130.1	16.2	39.1	430.9
ZS-8	11.9	99.3	8.3	6.3	57.8	9.4	10.6	134.1	12.9	8.8	126.1	14.3	37.6	417.3
ZS MEAN	**13.2**	**105.1**	**8.0**	**6.6**	**60.9**	**9.5**	**10.0**	**126.6**	**13.1**	**10.2**	**142.3**	**14.1**	**39.9**	**434.9**
TS-9	11.6	87.5	7.5	8.3	86.5	11.4	9.8	113.8	12.4	8.1	122.5	15.2	37.8	410.3
TS-11	7.7	72.4	9.4	5.5	50.5	8.9	9.7	112.7	11.5	9.4	131.3	13.9	32.3	366.9
TS MEAN	**9.7**	**80.0**	**8.5**	**6.9**	**68.5**	**10.2**	**9.8**	**113.3**	**12.0**	**8.7**	**126.9**	**14.6**	**35.0**	**388.6**

Table3.2. Performance of African germplasm under water stress conditions at NRCOP, Pedavegi

Genotype	2004-2005			2005-2006			2006-2007			2007-2008			Cumulative	
	BN	FFBY	ABW	BN	FFBY	ABW	BN	FFBY	ABW	BN	FFBY	ABW	BN	FFBY
GB-22/311	10.1	29.7	2.9	8.5	51.3	6.3	15.3	81.9	5.4	12.5	100.2	8.0	46.4	263.1
GB-25/314	11.4	24.8	2.2	11.3	59.3	5.3	10.8	49.6	4.5	13.8	85.7	6.2	47.3	219.4
GB-21/310	7.3	22.0	3.0	10.1	34.3	3.5	12.1	77.0	6.6	15.5	102.0	6.6	45.0	235.3
GB MEAN	**9.6**	**25.5**	**2.7**	**10.0**	**48.3**	**5.0**	**12.7**	**69.5**	**5.5**	**13.9**	**96.0**	**6.9**	**46.2**	**239.3**
ZS-1	10.3	73.4	7.1	7.1	56.3	8.4	10.4	113.9	11.2	9.8	121.8	12.5	37.6	365.4
ZS-2	11.5	90.6	7.9	6.9	52.4	8.2	9.0	98.8	11.1	12.3	152.1	12.4	39.7	393.9
ZS-3	7.5	51.3	6.8	11.0	87.2	8.1	9.3	99.8	11.0	8.2	106.3	12.9	36.0	344.1
ZS-5	10.9	80.4	7.4	5.4	53.9	9.4	8.6	103.9	13.5	9.0	132.3	14.7	33.9	370.5
ZS-8	11.5	92.8	8.1	6.3	62.2	9.3	7.7	90.9	12.5	8.7	119.7	13.7	34.2	365.6
ZS MEAN	**10.3**	**77.7**	**7.5**	**7.3**	**62.4**	**8.7**	**9.0**	**101.5**	**11.9**	**9.6**	**126.4**	**13.2**	**36.3**	**368.1**
TS-9	9.8	77.5	7.9	5.6	52.7	9.0	8.3	96.7	12.1	8.0	113.4	14.3	31.7	340.3
TS-11	8.3	56.5	6.8	7.0	67.3	9.8	8.0	87.9	11.0	5.6	71.2	12.7	28.9	282.9
TS MEAN	**9.1**	**67.0**	**7.4**	**6.3**	**60.0**	**9.4**	**8.2**	**92.3**	**11.6**	**6.8**	**92.3**	**13.5**	**30.3**	**311.6**

BN - Bunch number FFBY - Fresh Fruit Bunch Yield (Kg) ABW - Average Bunch Weight (Kg)

(76.6kg). The average bunch weight was also recorded highest in this accession (9.4kg). It was observed that the production of bunches was recorded more in GB accessions when compared to others.

Performance of Zambian accessions (Table 4.3) : Amongst the Zambian accessions ZS-5 was the highest yielder (177.8kg). The average FFB production of Zambian accessions was 150.3 kg which was much higher than other accessions.

Performance of Tanzanian accessions (Table 4.4): The average FFB production of Tanzanian accessions was 137.3kg with highest yield of 161.6 kg recorded in TS-4. The average bunch weight was highest when compared to other sources (18.4kg) with medium production of bunches (7.5).

c. Bunch Analysis: Bunch analysis was done to study different components directly or indirectly related with oil yield per unit area. It helps in understanding partitioning of dry matter of bunch into different fractions like fruit, spike, and further into fruit components like mesocarp, shell and kernel. It gives a picture of oil to bunch ratio or in other words about oil extraction ratio of the palm/ genotype as a whole. Through bunch analysis one can also get information on number of infertile/sterile/ parthenocarpic fruits. Bunch analysis carried out during the reported period has shown wide variation for F/B, M/F, K/F and S/F ratios. The activity is in progress. The percent sterile fruits ranged from 5.28 to 44.53%. The per cent oil/ bunch ratio ranged between 2.50% to 19.48% suggesting a wide range of variation for this character.

d. Hybridization: Hybridization programme was initiated to exploit the variation available in the materials for various

Table 4.1. Performance of Cameroon accessions under water stress conditions

Genotype	BN	FFBY	ABW
CA-3	8.8	92.7	10. 5
CA-4	8.6	87.4	10. 2
CA-6	8.8	89.8	10. 2
CA-7	6.8	94.5	13.8
CA-8	7.4	92.8	12.5
CA-9	6.0	70.5	11.8
CA-10	4.5	54.0	12.0
CA-11	11.0	48.5	4.4
CA-12	5.7	47.3	8.5
CA-13	6.3	85.5	13.7
CA-15	7.5	64.0	8.5
CA-16	5.3	61.3	11.7
CA-17	10.5	117.0	11.1
CA-18	9.4	94.2	10.0
CA-12	4.8	43.6	9.0
Mean	**7.4**	**76.2**	**10.5**

Table 4.2. Performance of Guinea Bissau accessions under water stress conditions

Genotype	BN	FFBY	ABW
GB-2/298	15.0	80.0	5.3
GB-5/301	20.0	55.0	2.8
GB-5/310	7.6	42.2	5.6
GB-1 0/306	11.8	70.4	6.0
GB-1 2/308	6.0	21.0	3.5
GB-2 1/308	15.2	89.2	5.9
GB-22/311	5.0	44.7	8.9
GB-23/312	15.0	81.0	5.4
GB-25/314	10.0	53.0	5.3
GB-28/317	12.5	97.5	7.8
GB-29/318	13.8	129.8	9.4
GB-32/321	18.0	102.5	5.7
Mean	11.9	76.6	6.4

characters. Characters like having no empty spike lets, less number of sterile/infertile/ parthenocarpic fruits are highly desirable. The hybridization programme is mainly aimed at development of high yielding Dura palms, high yielding Tenera hybrids, study on genetics of fruit colour and sizes *etc*. Till the reported period three D x D and one DxP progenies are in primary nursery.

Table 4.3. Performance of Zambian accessions and inter-specific hybrids under water stress conditions

Genotype	BN	FFBY	ABW
ZS-1	11.3	154.3	13.7
ZS-2	9.5	148.8	15.7
ZS-4	12.1	160.6	13.3
ZS-5	11.4	177.8	15.6
ZS-6	8.6	140.2	16.3
ZS-9	9.0	120.0	13.3
Mean	**10.3**	**150.3**	**14.64**
360Dx13E.0	6.6	102.4	15.6
361Dx11E.0	5.9	145.0	24.6
Mean	**6.23**	**123.7**	**20.1**

Table 4.4. Performance conditions of Tanzanian accessions under water stress

Genotype	BN	FFBY	ABW
TS-4	9.0	161.6	18.0
TS-5	9.4	151.6	16.1
TS-7	6.0	118.0	19.7
TS-8	7.0	145.0	20.7
TS-9	6.0	122.3	20.4
TS-10	8.0	133.5	16.7
TS-11	7.3	129.0	17.6
Mean	**7.5**	**137.3**	**18.4**

B. Evaluation at Nellore (A.P.): The experiment was planted in 1998 with 14 accessions, planted in a Randomized Block Design with three replications. The plantation is under severe water stress and is being maintained as per standard package of practices. The plantation is being maintained at IW/CPE ratio of 0.5. Quarterly observations on leaf and inflorescence production were recorded. Annual biometric/morphological observations on plant height, girth, and 17th leaf measurements like rachis length, depth, and width were recorded to calculate leaf area and dry matter production.

Palms with high yield have been tagged. Significant variation was recorded among the genotypes for all the characters studied.

C. Evaluation at Adilabad (A.P.): The experiment was laid out in Randomized Block Design with three replications, from three sources like Tanzania, Zambia, and Guinea Bissau. Annual biometrical observations like plant height, girth, standard leaf (17th) measurements *etc*., were recorded.

Variation for rachis length, petiole width, number of leaflets, leaflet length and leaflet width were non significant. Zambian accessions were confirmed as comparatively dwarf like previous year. The highest SLW was recorded in Zambian accessions followed by Tanzanian accessions. In observational trial involving Cameroon accessions, there was production of only female inflorescences on few palms; which could be utilized in breeding programmes.

D. Evaluation at Palode (Kerala): The experiment was planted in 1998 in Randomized Complete Block Design with two replications under rainfed conditions. Potential palm having long stalk was identified from Guinea Bissau accessions.

The bunch analysis was performed on individual palms in different accessions (Table 5). The average bunch weight of GB accessions was the least (6.9kg), and it was highest for Tanzanian accessions (11.9kg). Zambian accessions have moderate bunch size of 9.4kg. Similarly fruit to bunch ratio was highest in Tanzanian accessions (7.3) followed by Zambian accessions (5.4).

Zambian accessions recorded in general high yields followed by Tanzanian accessions. The Guinea Bissau accessions were the lowest yielders. Some tenera palms were also identified in Tanzanian, Cameroon and Zambian accessions.

- Male inflorescence with bottom abortion and tip anthesis recorded from Guinea Bissau accession
- One dura palm from GB showed promising preponderance character
- Two dwarf virecence fruit type palms identified from African germplasm. They were crossed with Palode *pisiferas*

E. Evaluation at PCKL, Athirapally (Kerala): The experiment was planted in 1998 along with other locations. The palms are grown as rain fed. Phenotypic variation in seed, nut and bunch characters were evaluated in African accessions. Observations on individual palms for all characters are being recorded. Bunch analysis on a few palms has been initiated. Fruit typing is in progress for ascertaining the varietal character. The following were identified/observed at PCKL, Athirapally :

- One promising pisifera palm showing high fruit set.
- High yielding virescence dura palm
- Accessions having preponderances of male and female inflorescences

At PCKL, African germplasm was subjected to evaluation and preliminary results revealed that maximum variation exists among palms irrespective of source of germplasm. Palm no. 259 from Guinea Bissau recorded single nut weight of 10g. Maximum bunch weight was recorded in palm no 231 from Palode followed by palm no 103 from Tanzania. Palm no. 365 from Cameroon recorded lowest bunch weight.

STUDIES ON PERFORMANCE OF SOURCES OF OIL PALM PLANTING MATERIALS

At NRCOP, Pedavegi : This experiment was initiated during January 1996 with 11 cross combinations from four different sources, namely ASD Costa Rica, Palode (India), Ivory Coast, and Papua New Guinea. Experiment was planted in randomized block design with three replications. Cultural practices like irrigation (drip system), fertilizer application, weeding etc are being followed to have a healthy plantation. Biometric observations like palm height, number of leaves, inflorescence production and FFB yield were recorded regularly.

Pooled analysis over years (Table 6): The pooled analysis was done over four years (2004-08) to study the variations due to years and hybrids. The results indicated significant variation among the hybrids for number of bunches, FFB yield and average bunch weight. Year to year variation was significant for all the three major yield characters. Genotype x year interactions were significant for number of bunches and FFB yield and non significant for average bunch weight character. Bunch, fruit and seed characterization was carried out through bunch Analysis.

The FFB yield (Table 7) was recorded highest in hybrids of Palode source (118kg/palm/year) followed by PNG hybrid (113.9kg/palm/year). The lowest yield was recorded in hybrids from Costa Rica

(104.3kg/palm/year) and Ivory Coast hybrids (104.9kg/palm/year). The Palode hybrid 12D x 266P produced the highest FFB yield (130.5kg/palm/year); the lowest was recorded in Costa Rican hybrid- Deli x AVROS (94.9kg/palm/year). The highest number of bunches were recorded in Palode hybrids (6.51). PNG hybrid recorded highest average bunch weight (19.2kg). Observations on oil/ bunch ratio, shell/ fruit, kernel/ fruit, mesocarp/ fruit were also recorded; the activity is in progress. Annual biometric observations were recorded and presented in Table 8. It can be observed that the Ivory coast hybrids were shorter in height (424.6 cm) and also had the highest girth (320.1 cm). Differences for leaf production were non significant among the hybrids. Palode hybrids had highest specific leaf weight(0.93 kg/sq.m)reflecting their capacity to tolerate moisture stress.

At NRCOP, RS, Palode: The Fresh Fruit Bunches were harvested from two representative palms each of 17 ASD Costa Rica and two Palode hybrids from the experiment laid out at Palode. Fruit bunches were subjected to nut component analysis in the laboratory. Single fruit weight and nut mass were significantly greater in Palode cross combination (17.33g and 3.97g) than other cross combinations of ASD Costa Rica. The undesirable trait of large shell mass (2.34g) and thickness (2.67mm) was also high in Palode followed by C11067 (1.57g and 2.25mm). Minimum shell thickness was recorded in C65758 (1.26mm) followed by C65635 (1.39mm) with a corresponding low shell weight of 0.63 and 0.43g respectively. Kernel mass was significantly greater in C65711 (1.35g) followed by C11189 (1.07g). The latter one also recorded high oil/kernel content (0.56g). Other tenera palms from ASD and Palode showed very low weight of kernel mass with a range from 0.48 to 0.99g. The lowest oil/kernel (0.23g) was recorded in C11163 which had comparatively high (2.12mm) shell thickness.

There was no significant difference among the hybrids for number of leaves produced. Palode hybrids had the highest specific leaf weight (0.93) which reflects that these hybrids could be tolerant to drought/ water stress.

MOLECULAR CHARACTERIZATION OF OIL PALM GERMPLASM

Testing functionality of designed microsatellite primers: As reported earlier, several oil palm genomic sequences, suspected to be microsatellite sequences are available in National Centre for Biotechnology Information site in the Internet hosted by National Institute of Health, United States of America. 250 such sequences were downloaded and 160 such primers pairs were designed. 118 primer pairs were procured through custom-oligo synthesis service. During the reporting period, 36 primers were assessed for the functionality using oil palm DNA, of which 34 primers found to be functional. PCR procedure for the SSR markers was optimized by considerably reducing the quantity of regents, details of which are discussed in page no 33.

Functionality of SSR primers for other economically important palms: Total 116 SSR primers were tested for their functionality for economically important palms namely palmyrah, coconut, arecanut, date palm. 108 primers were functional for oil palm, where as 94 primer pairs were found functional for coconut, arecanut, palmyrah, and 95 pairs for date palm. No primers were found functional for other palms, which were functional for oil palm. A representative photograph of the SSR primers amplification for all the palms

Table 5. Evaluation of African germplasm at Palode (Kerala)

Source	Ace. No.	P.No.	Bunch Wt. (Kg)	Fruit wt/ Bunch (Kg)	No. of fruits/ Bunch	Single fruit wt.(g)	Single nut wt.(g)	Mesocarp wt./ Fruit (g)	Fruit form
GB	8/304	92	4.98	2.50	664.0	3.52	1.94	0.56	dura
GB	9/305	85	5.64	3.50	968.0	3.20	1.86	1.06	dura
GB	51/320	47	8.60	4.60	520.0	11.18	5.55	2.35	dura
GB	23/311	259	7.68	5.04	250.0	20.13	10.00	2.12	dura
GB	7/303	200	7.72	4.88	612.0	8.54	6.71	0.75	dura
Mean			**6.92**	**4.10**	**602.8**	**9.31**	**5.21**	**1.37**	
TS	TS-2	246	11.24	7.70	1310	5.55	1.55	5.44	tenera
TS	TS-10	163	12.82	5.82	792	10.12	3.98	2.91	dura
TS	TS-11	289	8.90	5.10	600	10.56	4.40	2.34	dura
TS	TS-9	290	11.80	8.44	988	13.15	5.00	4.81	dura
TS	TS-3	103	14.76	9.46	1210	10.74	5.28	3.97	dura
Mean			**11.90**	**7.30**	**980**	**10.02**	**4.04**	**3.89**	

Source	Ace. No.	P.No.	Bunch Wt. (Kg)	Fruit wt/ Bunch (Kg)	No. of fruits/ Bunch	Single fruit wt.(g)	Single nut wt.(g)	Mesocarp wt./ Fruit (g)	Fruit form
CA	CA-15	315	8.94	5.36	913	3.72	3.72	2.44	dura
CA	CA-6	150	6.7	3.96	963	4.507	1.428	2.77	tenera
CA	CA-4	365	3.39	1.88	436	2.80	1.30	0.84	dura
CA	CA-10	370	12.94	6.9	706	10.88	5.927	2.48	dura
CA	CA-12	59	6.58	3.82	610	5.314	4.89	1.163	dura
Mean			**7.71**	**4.38**	**725.6**	**5.45**	**3.46**	**1.94**	
ZS	ZS-4	54	5.0	3.0	1063.0	3.0	1.7	1.3	dura
zs	ZS-7	68	12.9	9.0	796.0	12.8	4.6	4.5	tenera
ZS	ZS-6	368	10.1	6.6	640.0	12.2	6.8	3.4	dura
zs	ZS-4	57	11.0	6.1	1210.0	7.4	4.4	1.9	dura
zs	ZS-8	153	7.7	4.3	1023.0	4.1	2.4	2.7	tenera
Mean			**9.4**	**5.8**	**946.4**	**7.9**	**4.0**	**2.8**	

mentioned above including oil palm DNA are presented in Fig. 1.

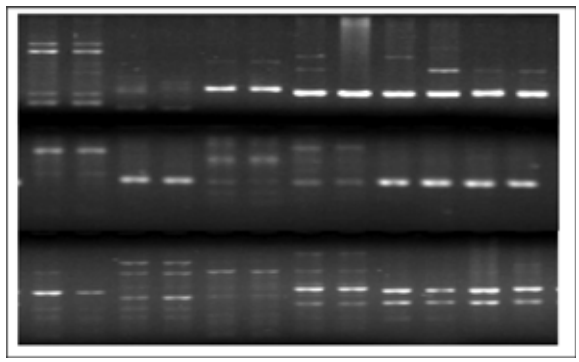


Fig.1. Three pairs of SSR primers used for amplification of DNA of Coconut (Lane 1-2), Arecanut (Lane 3-4), Palmyrah (Lane 5-6), Date (Lane 7-8) and Oil palm (Lane 9-12)

Experiments were taken up for standardization of electrophoretic technique for separating the DNA fragments amplified by SSR primers. Three general methods with different variations were attempted for the study as follows:

i. Agarose gel 3.0-3.5% and staining with ethidium bromide

ii. PAGE (8-15%) and staining with silver stain

Table 6. Pooled analysis of variance for yield and major yield contributing characters over four years

Source of Variation	BN	FFBY	ABW
Year	77.83 **	31352.8**	91.15**
Error (a)	2.35	634.5	8.77
Hybrids	3.94 **	995.6**	18.49**
YxH	3.01 **	986.8**	3.14ns
Error (b)	1.13	430.9	3.15
CV	17.5 %	18.8%	9.6%

Table 7. Pooled analysis of hybrids from different sources over years (2004-2008)

Hybrid ID	No. of bunches		FFB Yield		ABW	
Deli x Avros	5.04	b	94.9	b	20.1	ab
Deli x Ekona	5.40	b	105.5	ab	20.6	a
Deli x Ghana	6.48	ab	112.4	ab	17.6	bc
Deli x Lame	6.08	ab	104.2	ab	17.2	c
Mean	**5.75**		**104.3**		**18.9**	
65D X HIP	6.42	ab	115.3	ab	18.0	abc
12D X 313P	6.02	ab	111.5	ab	19.3	abc
12D X 266P	7.09	a	130.5	a	18.5	abc
128D X 313P	6.52	ab	114.7	ab	17.7	bc
Mean	6.51		118.0		18.4	
18C X 2501	5.77	ab	105.9	ab	18.4	abc
9C X 1001	6.25	ab	103.9	ab	16.5	c
Mean	**6.01**		**104.9**		**17.5**	
1M-0069 D X P	6.02	ab	113.9	ab	19.2	abc
LSD (±)	1.70		33.70		2.88	

Table 8. Annual biometric observations on hybrids from different sources at NRCOP, Pedavegi (A.P.)

S. No.	Genotypes	Stem girth (cm)	Palm height (cm)	No. of leaves	Petiole width (cm)	Petiole depth (cm)	Leaf area (Sq.m)	Leaf DW (kg)	SLW Kg/ sq.m
	ASD Costa Rica								
1	Deli x Avros	273.0	564.5	21.4	10.16	7.83	9.57	8.36	0.88
2	Deli x Ekona	285.4	569.0	22.0	10.41	8.06	9.61	8.80	0.92
3	DelixGhana	313.4	559.1	23.0	9.33	7.31	8.67	7.19	0.83
4	DelixLame	319.1	493.9	22.2	7.92	6.08	7.69	5.13	0.67
	Mean	297.7	546.6	11.1	9.45	7.32	8.88	7.37	0.82
	Palode								
5	65dx111	275.2	545.4	22.8	9.44	7.34	8.20	7.31	0.89
6	12x313	247.9	532.6	23.2	9.10	7.07	7.09	6.81	0.96
7	12x266	277.3	569.9	22.6	9.31	7.29	7.46	7.16	0.96
8	128x31323	267.3	508.6	22.6	9.35	7.27	7.87	7.18	0.91
	Mean	266.9	539.1	22.8	9.30	7.24	7.66	7.11	0.93
	Ivory Coast								
9	18CX2501	329.0	426.8	23.0	8.83	7.04	7.94	6.57	0.83
10	9CX1001	311.1	422.3	23.8	8.71	6.97	7.43	6.42	0.87
	Mean	320.1	424.6	23.4	8.77	7.00	7.68	6.50	0.85
	PNG								
11	1M - 0069DXP	275.7	556.7	23.0	9.14	7.11	8.61	6.86	0.80
	G.Mean	289.9	518.5	22.6	9.23	7.21	8.17	7.06	0.86
	SD(±)	24.9	55.3	NS	0.61	0.45	0.79	0.86	0.08

iii. PAGE (8-15%) and staining with ethidium bromide

Agarose gel could produce detectable bands, however, differentiating the difference in fragments when the size difference is less was difficult. Silver staining of PAGE was having the problems of appearance of too many bands. Ethidium bromide staining of PAGE also produced too many bands but due to relative convenience of the staining this method was adopted with eithe12% or 15% PAGE. (Fig 2)

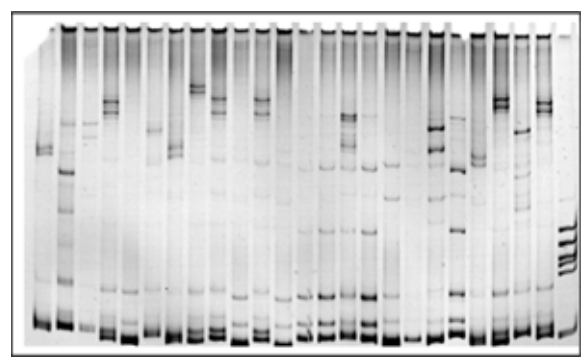


Fig. 2. Oil palm DNA is amplified with SSR primer pair and electrophoresed in 12% acrylamide gel

Experiments on unique DNA extraction from oil palm

This experiment is still continuing. Further modification of this method is also being attempted without a few reagents, which are an essential component of the DNA extraction and storage.

DEVELOPMENT OF MOLECULAR MARKERS FOR VARIETAL IDENTIFICATION IN OIL PALM

DNA samples of dura and pisifera palms were bulked and made into five to six bulks. 20 random primers were custom made and purchased and these were used to amplify the bulked DNA samples. Out of the 20 primers only one primer showed a single band difference among the dura and pisifera bulks. All other primers showed some differences between the bulks but there was no distinct band between the varieties. Hence these primers may not be suitable to use as markers for distinguishing these varieties

Designing of oil palm microsatellites was carried out. Several oil palm genomic sequences, suspected to be microsatellite sequences are available in National Centre for Biotechnology Information site in the Internet hosted by National Institute of Health, United States of America. 250 such sequences were downloaded and 160 such primers pairs were designed. PCR procedure for the SSR markers was optimized by considerably reducing the quantity of regents. The components of PCR amplification reported by Billotte et al (2001) consisted of 50ng template DNA, in a 25Ul final volume of buffer containing 0.2u/m of each primer, 200uM of dNTP's and 1U of Taq Polymerase. In the present study, gradual reduction of all these components was carried out. Initially the PCR reactions using microsatellites were performed using a 25ul reaction mix containing 25ng template DNA, 6ul of each primer, 1ul of 2.5mM dNTP's and 1U of Taq Polymerase. Since microsatellites are always yielding one or two PCR products it was felt that a 10ul volume would be sufficient to yield these and the experiments proved that 10ul volume gives the same results as that of a 25ul reaction mix. The details are given in Table 9. In the process of standardizing the individual components of the PCR reaction it was found that a reduced volume of 10ul reaction mixture with a reduced concentration of each of these components viz. 5ng of template DNA, 1.5ul of each primer, 0.25ul of 2.5mM dNTP's and 0.25U of Taq Polymerase gives consistent results (Fig 3). This method can be recommended for screening large number of samples for PCR based microsatellite amplification in oil palm as well as other palms.

STRENGTHENING OF OIL PALM SEED GARDENS FOR INDIGENOUS SEED PRODUCTION

National Research Centre for Oil Palm (NRCOP) is the nodal agency entrusted to coordinate the demand and supply of hybrid seeds from indigenous seed sources at national level. In India a total of six seed gardens were established namely, i) NRC for Oil Palm, Pedavegi (A.P.), ii) NRCOP- Regional Station, Palode (Kerala), iii) Dept. of Horticulture, Rajahmundry (A.P.), iv) Dept. of Horticulture, Taraka (Karnataka), v) Nava Bharath Agro Products Ltd., Lakshmipuram (A.P.), and vi) Oil Palm India Ltd., Thodupuzha (Kerala).

The seed production activities are being regularly monitored. The quality aspects of oil palm hybrid seeds have extensively been taken care of during the reporting period. These seed gardens are producing about two million sprouts annually.

Oil palm seed garden, NRCOP, Pedavegi: The seed garden was established during 2000 with financial support from UNDP.

Oil Palm seed garden, Thodupuzha (Kerala): The old dura plantation which was the source of present seed gardens was again monitored for re-evaluation of DURA MOTHER PALMS. Of the total 395 palms, 101 palms were observed for various bunch parameters. Of the 101 palms evaluated, 15 were selected earlier and 86 were in unselected category. Among the above 5 palms were of *tenera* fruit character (Palm No. US 23, 37,160,167 and 163). The palms showed variation for the following characters:

- Fruit weight variation(7.29 – 18.75g)
- Fresh mesocarp (3.72 – 12.53g)
- Nut weight (1.54 – 8.23g)
- Shell weight (0.69 – 6.30g)
- Shell thickness (0.85 - 4.37mm)
- Dry mesocarp(0.69 – 8.57g)
- Kernel weight (0.27 – 2.07g)

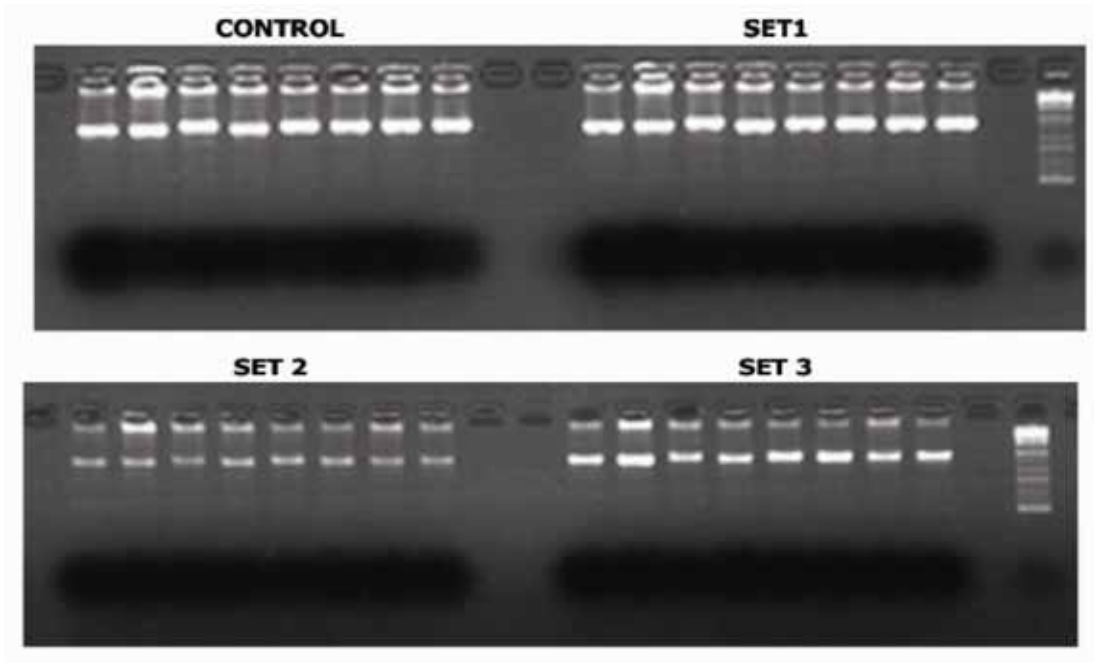


Fig. 3. PCR amplification of oil palm DNA with specific SSR primer pairs with different concentration/quantity of PCR ingredients in different volume of reaction mixture

Table 9. Different concentration/quantity of PCR ingredients in different volume of reaction mixture for amplification of oil palm DNA with SSR primers

Components	CONTROL	SET 1	SET 2	SET 3
Template DNA	50ng	25ng	25ng	10ng
Taq polymerase	1.0 U	0.50 U	0.25 U	0.25 U
Primers	0.2µM	0.05µM	0.05nM	0.05nM
dNTP's	50µM	25µM	25µM	25µM
Final volume	25µl	25µl	25µl	10µl

Measures for strengthening indigenous hybrid seed production

a. Selection of additional mother palms

At Taraka (Karnataka): At Taraka seed garden 16 more mother palms have been selected based on yield and morphological parameters. The palm selection was based on the FFB production in the past four years, bunch size, fruit and shell characters and morphological look of the palm. The seed production activity at this seed garden is going well and there is no complaint on quality of sprouts from this seed garden.

At NRCOP, Pedavegi (A.P.): Preliminary trend of FFB productivity of Dura mother palms was made. In Costa Rican source 13 Dura palms observed promising based on previous two years data were identified. Similarly in Dura population of Palode source 23 palms with FFB yield of more than 150Kg/ year were identified which shall be further observed for performance.

At NRCOP-RS, Palode (Kerala): Based on the yield data 41 palms were selected from the dura-1 block. From dura-II 15 palms were selected for seed production based on five-year yield data. Palms producing FFB yield of above 110 Kg/yr were selected.

b. Initiation of commercial seed production at Pedavegi

Commercial seed production programme has been initiated at NRCOP, Pedavegi seed garden. The first batch of sprouts is likely to come out by end of March 2009.

c. Performance of dura x pisifera progeny testing trials

With a view to select promising Tenera hybrid(s) and general combiner Pisifera/ Dura parent, the DxP progenies of various seed gardens are being evaluated by laying progeny testing trials.

Evaluation of Palode D x P progenies at Lakshmipuram : Three trials each with 14 DxP progenies of Palode source are being evaluated at Lakshmipuram (Tables 10.1, 10.2, 10.3). The plantation is 17 years old. Data recording on yield, morphological, physiological and other biometrical characters was carried out. Quarterly observations on leaf and inflorescence production and annual observations on morphological and biometrical characters including dry matter parameters and FFB weight and number on every harvest basis were recorded. In first experiment variation for number of bunches, FFB weight and bunch index were found significant. In the second experiment variation for height, annual height increment, number of bunches, FFB weight and bunch index were significant. In experiment -3 variation for stem girth and average bunch weight were significant.

ANOVA for major yield traits like number of bunches, total FFB weight and average bunch weight, after pooled analysis over four years (2004-08), showed that Year to year variations were highly significant. Variation among hybrids was also significant. Hybrid x Year interaction effects were non significant. Variation among hybrids for FFB yield was high.

Evaluation of Lakshmipuram D x P progenies at Pedavegi: DxP progenies of Lakshmipuram seed garden are being maintained at Pedavegi. The crop is in good condition. Observations on leaf production, number of inflorescence are being recorded. Early high yielding progenies/ palms have been tagged.

Evaluation of Rajahmundry D x P progenies: The four trials planted last year are in good condition, growth is normal, ablation is going on and overall performance is satisfactory.

Regeneration of elite dura palms for new seed garden

The establishment of new seed gardens has been envisaged in Chadha Committee Report-2006. For this purpose efforts are being made to regenerate the planting material for mother palm block and Tenera x Tenera block. At NRCOP, Pedavegi (A.P.) diverse crosses have been made/ are being made involving Palode Dura with exotic promising Dura identified in African germplasm and Costa Rican hybrid testing trial. Three crosses planted in primary nursery are now in secondary nursery and are in good condition.

DEVELOPMENT OF TISSUE CULTURE PROTOCOL FOR OIL PALM

During the reporting period, required partitioning of the laboratory, sealing of windows, installation of air conditioner was completed in the tissue culture laboratory to initiate work. A tissue culture rack was converted to dark room. Laminar flow was serviced and put to use. The necessary chemicals and glass ware required for tissue culture were procured. With all these preliminary works the tissue culture lab was ready for use from August 2007.

Selection of explants and inoculation into the callus induction media: Inoculation work was initiated in September 2007. All the available explants like spear leaves, embryos, inflorescence, and roots were taken up for tissue culture. Preliminary observations for callusing with leaf explants show that embryo leaves respond very quickly and the response was observed within 8 weeks. Callus induction was observed after 8 weeks in embryo germinated leaf (Fig 4.1), seedling leaf (Fig 4.2) in modified MS media with 2, 4-D (9.06µM).

Since the germination of embryos is a problem in varieties like pisifera of oil palm, germination studies were conducted with embryos collected from mature fruits of dura and pisifera in MS media with different concentrations of BAP. The embryos germinated on all media but maximum germination percentage (83%) was obtained on MS medium with BAP(17.76µM). Some of the embryos formed root and shoot poles simultaneously (Fig 4.3).These formed complete healthy plantlets on MS basal media. (Fig. 4.4).

Fig. 4.1 : Callus induction from seedling leaf

Fig. 4.2 : Callus induction from embryo leaf

Fig. 4.3 : *Dura* Embryo germination

Fig. 4.4 : *Dura* Plantlet formation

Table 10.1. Performance of Palode hybrids under irrigated conditions in India (Experiment 1)

S. No.	Genotype	Stem girth (m)	Palm height (m)	Height increment (m)	Sex ratio	No. of leaves	SLA	BN	FFBW (Kg)	ABW (Kg)	BI (%)
1	147D x 111P	2.63	5.59	0.80	0.50	24.8	1.29	5.0	118.9	24.0	0.20
2	198D x 111P	2.85	6.37	0.76	0.51	25.9	1.70	5.6	112.8	20.2	0.20
3	104D x 111P	2.87	5.17	0.68	0.57	25.7	1.41	5.6	120.6	21.5	0.21
4	34D x 111P	2.64	5.18	0.65	0.58	26.4	1.74	5.7	125.1	22.2	0.24
5	115D x 111P	2.74	5.38	0.55	0.64	26.9	1.21	4.9	109.5	22.3	0.18
6	35D x 111P	2.55	5.77	0.74	0.65	26.0	1.66	5.6	123.3	22.0	0.22
7	156D x 111P	2.55	5.89	0.68	0.50	25.3	1.64	5.5	120.8	21.5	0.23
8	128D x 111P	2.64	5.26	0.68	0.55	26.5	1.72	5.8	123.1	21.3	0.23
9	41D x 98P	2.60	5.86	0.65	0.42	25.9	1.58	6.4	132.4	20.7	0.26
10	220D x 98P	2.50	6.47	0.76	0.75	26.1	1.49	5.8	123.2	21.0	0.22
11	35D x 98P	2.49	5.68	0.63	0.51	26.8	1.14	5.4	110.8	20.5	0.19
12	148D x 98P	2.71	5.94	0.73	0.72	24.5	1.44	6.7	148.8	22.1	0.24
13	26D x 98P	2.73	4.52	0.50	0.61	25.8	1.72	6.7	164.9	24.5	0.30
14	65D x 266P (C)	2.46	5.09	0.68	0.60	26.8	1.53	7.0	159.8	22.8	0.29
	CV(%)	NS	NS	NS	NS	NS	NS	9.9	15.1	NS	17.80

Table 10.2. Performance of Palode hybrids under irrigated conditions in India (Experiment2)

S. No.	Genotype	Stem girth (m)	Palm height (m)	Height increment (m)	Sex ratio	No. of leaves	SLA	BN	FFBW (Kg)	ABW (Kg)	BI (%)
1	35D x 266P	2.57	5.28	0.79	0.53	27.8	1.56	6.7	150.0	22.6	0.27
2	148D x 266P	2.65	4.71	0.72	0.60	26.7	1.48	6.8	153.1	22.7	0.27
3	124D x 266P	2.69	4.73	0.66	0.39	27.3	1.16	6.6	158.6	24.0	0.26
4	12D x 266P	2.43	4.79	0.75	0.49	27.3	1.65	5.7	120.4	21.0	0.23
5	108D x 266P	2.76	5.08	0.78	0.24	26.4	1.60	6.5	159.4	24.2	0.27
6	109D x 91P	2.74	4.79	0.69	0.26	27.8	1.67	6.1	142.5	23.5	0.26
7	18D x 291P	2.64	4.51	0.75	0.29	26.8	1.17	5.9	121.4	20.5	0.22
8	115D x 291P	2.73	4.78	0.72	0.39	27.8	1.39	6.0	138.1	22.8	0.24
9	27D x 291P	2.69	5.17	0.82	0.50	27.8	1.71	6.5	148.6	23.0	0.25
10	114D x 291P	2.73	5.52	0.72	0.39	27.5	1.74	7.1	140.4	19.8	0.25
11	35D x291P	2.60	4.32	0.58	0.53	26.7	1.33	5.9	142.5	24.2	0.26
12	139D x 291P	2.39	6.12	0.86	0.58	27.9	1.59	6.0	132.6	22.2	0.25
13	65D x 98P	2.47	5.14	0.79	0.56	26.7	1.51	3.4	83.2	24.2	0.18
14	65D x 266P (C)	2.63	5.46	0.77	0.21	27.5	1.51	3.4	72.9	21.6	0.14
	CV(%)	NS	9.79	10.01	NS	NS	NS	14.6	16.7	NS	13.31

Table 10.3. Performance of Palode hybrids under irrigated conditions in India (Experiment3)

S. No.	Genotype	Stem girth (m)	Palm height (m)	Height increment (m)	Sex ratio	No. of leaves	SLA	BN	FFBW (Kg)	ABW (Kg)	BI (%)
1	129D x 310P	2.55	5.52	0.86	0.60	27.7	1.84	5.3	117.4	22.1	0.22
2	139D x 283P	2.59	6.74	0.95	0.56	28.0	1.57	3.9	85.7	21.8	0.14
3	307D x 214P	2.66	6.15	0.88	0.53	26.6	1.85	4.5	103.4	22.7	0.16
4	18D x 32P	2.79	7.15	0.94	0.55	27.3	1.94	5.1	113.6	22.1	0.17
5	11D x 32P	2.34	6.33	0.92	0.62	27.5	2.08	4.5	98.5	22.0	0.18
6	104D x 32P	2.93	6.30	0.91	0.55	26.8	1.97	4.9	108.9	22.1	0.17
7	128D x 32P	2.57	5.60	0.81	0.45	27.2	1.19	3.6	78.4	21.9	0.13
8	115D x 32P	2.77	6.47	0.84	0.52	27.7	2.28	4.2	95.3	23.1	0.16
9	57D x 313P	2.82	6.16	0.90	0.57	26.9	2.09	4.9	103.1	21.1	0.17
10	35D x 313P	2.47	5.79	0.85	0.49	25.2	1.97	3.1	67.0	21.3	0.13
11	115D x 313P	2.51	5.54	0.78	0.47	26.9	1.59	3.4	75.9	22.1	0.15
12	12D x 313P	2.38	6.21	0.85	0.61	26.4	1.66	3.1	74.3	23.7	0.13
13	104D x 313P	2.88	6.45	0.93	0.53	27.9	2.10	3.9	93.7	23.9	0.15
14	65D x 266P (C)	2.60	5.75	0.84	0.66	27.9	1.44	5.2	113.4	21.7	0.18
	CV(%)	7.42	NS	NS	NS	NS	NS	NS	NS	4.2	NS

ACCELERATION OF GERMINATION IN OIL PALM HYBRID SEEDS

Mechanical scarification using depericarper

The endosperm and seed coat tissues in the freshly harvested seeds are compactly arranged which prevents instant seed germination apart from other physical barriers. To get early initiation of germination fresh seeds were subjected to mechanical scarification using depericarper for half a minute and one minute followed by soaking in water and pre-heating treatments. One minute mechanical scarification showed maximum germination compared with that of half a minute in dura seeds. 0.5 minute depericarping is suitable for DxP seeds which showed 74% germination. Germination initiated within a short period of 13days.

Needle method

Sterilized needle is injected into the seed up to 2.4mm in the germ pore and soaked in water for 10 days. Needle method showed no satisfactory germination percentage. The ungerminated seeds were examined by removing kernel. It was noticed that the embryo was damaged due to needle insertion in the ungerminated nuts.

Alternate soaking and heating

DXP seeds were processed and subjected to alternate soaking and drying for 5, 8, 10 and 12 days and observed for germination. This study is under progress.

Reduced dry heat treatment with de-operculum technique

Initial soaking for 3 days + pre-heating for 40 days + water soaking for 3 days

resulted in > 80 % germination in majority of the cross combinations. Ungerminated seeds can be subjected to de-operculation followed by paper roll towel method to ensure 100 % germination within shortest period of time. Approximately one month could be reduced for breaking dormancy when compared to usual dry heat treatment.

SOME BASIC STUDIES ON SEED TECHNOLOGY

Conservation studies: The seeds of the three genotypes of open pollinated tenera of Malaysian source collected from a farmer's field at Theni district of Tamil Nadu were successfully germinated.

Pre heated seeds were stored for 4 months and obtained normal germination (50-90%) in all the genotypes. This study revealed that dry storage can accelerate germination. Ten palms are selected for this study. Maximum germination is noted in ThD6158´ $ThP_2$54. Least germination is noted in $ThD_1$159´ $ThP_4$15.

Seed characterization and germination behavior: 82, 45 and 95 % of germination was recorded in *guineensis*, o*leifera* and inter specific hybrid seeds. E. *oleifera* recorded poor germination percentage.

Seed development & maturation studies : Preliminary results indicated that maximum germination (97.6%) occurred when fruit reached stage S4 (165DAA), where least percentage of moisture content was recorded. At stage S5 (180DAA), decline in germination (94%) was noticed. High dry matter accumulation and low moisture content was recorded in both stages, S4 and S5. Seedlings obtained from S4 showed superior quality. Oil formation initiated (6.62%) at S1and highest content (74.93%) was recorded at S5.

Seed development and maturation biology of virescence fruit type palm was studied and results revealed that virescence fruit form showed early maturity when compared to normal fruit form.

DxP embryo weight estimation : Popular DxP hybrid seed embryos were excised and estimated for their weight so as to get DxP combination having thick plumule growth, which can be attempted for selling as premium seed.

Bulk dura seed storage : From among the popular cross combinations, 10 crosses were selected and used in storage studies (before & after pre-heating), observations were recorded every month.

Mother palm influence on seed dormancy: Top yielding palms were selected from the germplasm block and experiment was carried out. Observations revealed that mother palm-22(2) subjected to 30 days heating showed maximum germination (85%) and least germination percentage was noted when subjected to 10 days heating (33%). In mother palm -7(2) 30 days heating and 50 days heating showed equal germination percentage (57.5%).

CROP IMPROVEMENT

Germplasm collection Programme-1

Germplasm collection Programme-2

Identification of dwarf palm in farmer's field

Identification of high yielding *dura* palm

Initiation of crossing programme at Pedavegi

4.0 Research Achievements

फसल उत्पादन
Crop Production

Oil palm planting material in nursery

CROP PRODUCTION

FERTILIZER REQUIREMENT OF OIL PALM DURING PREBEARING STAGE

A study was taken up to find out a suitable fertilizer dose during first two years of planting i.e., during prebearing stage and its subsequent effect on initial yield performance of palms. The project was continued for a period of five years and is concluded during the reporting period. The following six levels of NPK were included in the study (g/palm/year) :

Treat-ments	I year	II year	III year onwards
T1	0-0-0	0-0-0	0-0-0
T2	200-100-200	400-200-400	600-300-600
T3	300-150-300	600-300-600	900-450-900
T4	400-200-400	800-400-800	1200-600-1200
T5	500-250-500	1000-500-1000	1500-750-1500
T6	600-300-600	1200-600-1200	1800-900-1800

Salient findings

- Fertilizer doses of 300-150-300 g NPK and 600-300-600 g NPK were found to be optimum for producing maximum growth performance in palms during first and second year of planting under replanting situation.
- Yield performance of palms during initial years showed that T3 produced maximum no. of bunches and T_4 resulted in maximum FFB yield. However, the difference was not significant except for control.
- Since the yield difference among the fertilizer doses was not significant up to fifth year of planting, it can be concluded that there is possibility of reducing the fertilizer requirement of palms during initial years of replanting.

EFFECT OF DIFFERENT ORGANIC MANURES ON GROWTH AND VIGOUR OF OIL PALM SEEDLINGS

Preliminary study on effect of five types of organic manures and soil (1:1 ratio) and their mixtures (1 :0.5 :0.5 ratio) on growth and vigour of oil palm seedlings was taken up. Treatments were: soil (control), termite mound soil, soil+fym, soil+goat manure, soil+pig manure, soil+vermi compost, soil+poultry manure, soil+poultry manure + goat manure, soil+fym+poultry manure, soil+vermi compost+poultry manure and soil+vermi compost+goat manure. Nutrient analysis was done for all manures, termite mound soil and soil and observations were recorded on various morphological characters.

All the treatments except termite mound soil were significantly superior in all the parameters to the control. Seedling height was the maximum in soil + fym (155.36cm) while the minimum height was recorded in termite mound soil (85cm). The highest number of leaves (14.03) was counted in soil + vermi compost + poultry whereas it was the lowest (6.47) in termite mound soil. More stem girth was noticed in soil + pig manure (26.70cm) and closely followed by soil + poultry (25.60cm) and soil + vermi + poultry (25.51cm). Leaf length was found better in soil + fym (99.80cm) and soil + pig manure (95.53cm) and it was poor in termite mound soil (57.46cm). Leaf width was observed the maximum in soil + vermi compost which was on par with soil + vermi

compost + goat manure, soil + fym, soil + pig manure, soil + vermi + poultry and soil + goat manure. And the minimum leaf width was noticed in termite mound soil (45.3lcm) followed by soil (48.83cm). Among the treatments, maximum rachis width (1.70cm) and rachis depth (2.81cm) was observed in soil + pig manure and the minimum (1.05cm and 2.01cm) was recorded in termite mound soil. It can be concluded from the results that soil +fym and soil + pig manure were found as good media for growing oil palm seedlings.

STUDIES ON REPLANTING TECHNIQUES IN OIL PALM

The project was initiated during 2007 in OPIL Estates, Bharathipuram in the 1972-planted area. A financial estimate of Rs. 5 lakhs was given to OPIL to meet the contingent expenses in connection with the project and got approved. A continuous 4 ha area was selected for the study and was divided into 4 blocks of one hectare each to utilize for each treatment. All the palms were cut from one plot and in another plot the palms were given stem injection. One-third of the palms were removed in a staggered manner in one block and alternate rows of palms were cut in yet another treatment. Since the old palms are not planted strictly in a triangular manner with equal spacing, the effect of last 2 sets of treatments may be affected to some extent. The other works of fresh planting and pruning of existing palms are in progress.

STUDIES ON WATER AND NUTRIENT MANAGEMENT IN OIL PALM

Morphological observations like height, girth, number of leaves and the initial yield data were recorded during the reporting period and the data were subjected to statistical analysis. Physiological observations in different treatments were also taken. Regarding yield parameters, Drip irrigation recorded maximum yield of 95.39 kg/palm followed by Jet and Basin (88.11 kg/palm & 23.38 kg/palm). Number of bunches per palm were highest in Drip (6.56) followed by Jet (6.19) and Basin (2.42). These yields reported are very low and are attributed to insufficient irrigation water. The quantity of water given during the summer months varied between 100 and 200 litres per palm per day, which is much lower than the estimated water requirement of about 300-350 litres per palm per day during the summer months.

Because of non-availability of sufficient irrigation water the irrigation levels could not be maintained and as a result the yields are very poor. This is also reflected in number of unopened leaves even in the drip and Jet treatments. The number of spindles ranged from 2.37 to 2.84 among the different irrigation methods and there was no significant difference among the methods, irrigation levels and fertilizer levels.

The gas exchange rate and chlorophyll fluorescence in oil palm under different methods (basin, jet and drip) and levels of irrigation (1.0, 0.8 and 0.6 based on Irrigation water IW/Cumulative pan evaporation CPE) were studied. Palms irrigated with drip and jet irrigation methods recorded higher photosynthetic rates, chlorophyll contents, water use efficiency, leaf water potential, Fv/Fm ratio, Fv/Fo ratio and electron transport rate. The Fv/Fm ratios decreased as the irrigation levels decreased from 1.0 to 0.6. There was a decreasing trend in the photosynthetic rate, chlorophyll content, water use efficiency, leaf water potential, Fv/Fm ratio and Fv/Fo ratio as the amount of applied water decreased. Photosynthetic rate exhibited

significant positive correlations with total chlorophyll content, water use efficiency, leaf water potential and Fv/Fm ratio.

ESTABLISHMENT OF LEAF ANALYSIS LABORATORY

Studies on nitrogen and potassium management in adult Oil palm- on farm trial under the scheme establishment of leaf analysis laboratory

A field experiment was started during 2003-2004 in a farmer's field near NRCOP, Pedavegi with an objective to assess the nitrogen and potassium requirement of an adult oil palm. The treatments consisted of 3 levels of nitrogen (600, 900, 1200 g N per palm per year) and three levels of potassium (1200, 1800, 2400 g K per palm per year), laid out in a factorial randomized block design with 5 palms in each plot and replicated three times. The yield data from the on-farm trial were collected and statistically analysed. Number of bunches (Table 11) for the four years varied between 3.73 and 5.89 bunches per palm per year among different treatments. The bunch weight (Table 12) for the four years varied between 67.84 and 87.50 kg per palm per year among different treatments. Both these parameters were not affected by the treatments during the four year period. It is also observed that most of the palms had more than two un-opened spindles (Table 13), which indicates that the palms are under stress. On an average there were more than four broken leaves per palm which is also an indication of water stress. Since the farmer was not able to irrigate sufficiently, the palms were under stress and as a result the palms could never yield up to their potential and could not utilize the higher doses of fertilizer applied.

The leaf nutrient status was estimated before and after imposition of the treatments and no significant difference was observed among different treatments

Soil nutrient indexing in oil palm growing areas of India

Representative soil samples at different depths (0-15, 15-30 and 30-60cm) from thirty seven villages comprise of thirteen mandals

Table 11: Number of bunches as affected by levels of nitrogen and potassium

Treatment	No. of Bunches				
	2003	2004	2005	2006	Adjusted
Nitrogen (g/palm/year)					
600	4.29	4.33	3.96	5.00	10.25
900	4.29	5.38	4.11	4.96	13.81
1200	4.41	3.97	4.47	5.73	11.71
F- test	NS	Sig	NS	NS	NS
Potassium(g/palm/year)					
1200	4.48	4.56	4.76	5.89	12.39
2400	4.27	4.83	3.73	4.78	11.16
3600	4.24	4.29	4.04	5.02	12.21
F- test	NS	NS	NS	NS	NS
CV %	10.25	13.23	35.51	33.52	31.36

Table 12 : Bunch weight as affected by the levels of nitrogen and potassium

Treatment	Bunch weight (kg/palm)				
	2003	2004	2005	2006	Adjusted
Nitrogen (g/palm/year)					
600	74.53	79.03	68.91	72.03	87.60
900	80.16	86.04	76.52	79.70	83.60
1200	84.43	70.88	80.12	82.00	77.60
F- test	NS	NS	NS	NS	NS
Potassium (g/palm/year)					
1200	87.50	84.36	82.56	86.10	91.20
2400	74.83	83.70	74.43	70.90	78.80
3600	76.79	67.90	67.84	74.20	78.80
F- test	NS	NS	NS	NS	NS
CV %	33.43	41.25	35.19	40.82	27.02

Table 13. Number of spindles and leaf buckling as affected by levels of nitrogen and potassium

Treatment	No. of Spindles	No. of leaves buckled
Nitrogen (g/palm/year)		
600	2.67	4.51
900	2.54	4.96
1200	2.70	5.42
F- test	NS	NS
Potassium(g/palm/year)		
1200	2.53	4.62
2400	2.69	4.60
3600	2.69	5.67
F- test	NS	NS
CV %	13.12	48.37

representing the intensive oil palm growing areas were collected, processed and analyzed for physico-chemical properties. Organic carbon, P, K and S contents in the soils were categorized based on critical limits and indexing was done.

Important physico-chemical characteristics of soils are given in Table 14 and analytical data indicated that the soils were very acidic to slightly alkaline in nature. The pH of the soils ranged from 4.17 to 8.30 with mean value of 6.69. The values of electrical conductivity of the soils were low, varying from 0.015 to 0.352 dS m^{-1} with an average value of 0.102 dS m^{-1}. The organic carbon content of the soils in general was very low and the contents varied from 2.2 to 12.1 g kg^{-1} with a mean value of 5.2 g kg^{-1}. The soils of Nallajerla and Denduluru mandals contained relatively higher organic carbon contents (5.3 to 12.1 and 3.2 to 11.0 g kg^{-1}, respectively) compared to other soils of the district. There was no definite pattern in distribution of organic carbon content in these soils with depth.

The range and average values of available phosphorus, potassium and sulphur content of soils are shown in Table 15. The available phosphorus status of the soils was medium to high and their contents varying from 10.8 to 145.6 kg ha^{-1} in surface soils and no definite pattern was observed with depth. The available potassium content of the soils of the district varied between 31 kg ha^{-1} and 694 kg ha^{-1}. The available sulphur content of the soils of W.G. district ranged from 2 to 167 mg kg^{-1} with a mean value of 19.49 mg kg^{-1}.

Table 14. Important physicochemical characteristics of soils

Mandal	pH (1:2.5 w/v)		Electrical conductivity (dS m^{-1})		Organic Carbon (g kg^{-1})	
	Range	Mean	Range	Mean	Range	Mean
T.Narsapuram	4.17-7.02	6.05	0.017-0.259	0.067	3.1-10.5	6.8
Buttayagudem	4.17-6.03	5.23	0.038-0.127	0.071	2.2-7.0	5.1
Pedavegi	7.08-8.30	7.74	0.062-0.217	0.119	3.1-7.4	5.0
Jangareddygudem	4.58-6.32	5.30	0.27-0.234	0.089	2.8-8.2	5.3
Nallajerla	4.18-7.87	6.44	0.015-0.169	0.076	2.4-12.1	5.3
Devarapalli	6.67-7.30	7.06	0.029-0.054	0.039	2.3-4.7	3.0
Chagallu	6.75-7.67	7.33	0.029-0.096	0.063	2.4-9.8	5.1
Nidadavol	7.16-7.92	7.62	0.044-0.108	0.070	2.4-7.5	4.2
Tadepalligudem	5.89-7.52	6.92	0.049-0.175	0.096	2.4-9.4	4.4
Bhimadole	6.55-7.52	6.94	0.037-0.104	0.066	3.2-7.8	5.4
Denduluru	6.98-7.48	7.32	0.184-0.293	0.234	3.2-1.1	6.2
Eluru	6.42-7.05	6.71	0.239-0.352	0.302	2.8-6.3	4.3
Over all	4.17-8.30	6.69	0.015-0.352	0.102	2.2-12.1	5.2

Table 15. Range and average values of available phosphorus, potassium and sulphur content of soils

Mandal	Phosphorus (kg ha^{-1})		Potassium (kg ha^{-1})		Sulphur (ppm)	
	Range	Mean	Range	Mean	Range	Mean
T.Narsapuram	12.3-50.2	36.0	45.0-515.0	179.1	9.0-28.0	15.6
Buttayagudem	28.1-90.1	61.0	134.0-470.0	269.3	11.0-45.0	24.0
Pedavegi	20.1-78.8	42.4	47.0-750.0	274.6	2.0-17.0	10.1
Jangareddygudem	4.2-161.9	67.6	46.0-258.0	120.5	6.0-39.0	21.3
Nallaerla	5.9-145.3	30.6	45.0-694.0	179.3	2.0-35.0	9.9
Devarapalli	6.3-39.7	23.6	72.0-166.0	102.3	3.0-19.0	7.7
Chagallu	15.9-50.0	34.3	56.0-650.0	259.0	5.0-51.0	20.6
Nidadavol	28.5-82.9	45.4	103.0-638.0	269.3	9.0-28.0	18.0
Tadepalligudem	4.5-88.5	50.8	78.0-1008.0	331.9	4.0-42.0	19.9
Bhimadole	24.3-77.4	56.0	90.0-193.0	135.7	2.0-33.0	12.8
Denduluru	11.1-41.6	28.0	202.0-493.0	304.0	21.0-167.0	67.0
Eluru	10.6-37.8	26.8	206.0-381.0	303.7	9.0-14.0	12.3
Over all	4.2-161.9	41.1	45.0-1008.0	225.8	2.0-167.0	19.5

Table 16. Available phosphorus status of soils

Mandal	Per cent distribution in the indicated category of P status			Nutrient Index values (NI)
	Low	Medium	High	
T.Narsapuram	75.0	25.0	0.0	1.25
Buttayagudem	33.3	50.0	16.7	1.83
Pedavegi	63.6	36.4	0.0	1.36
J'reddygudem	40.0	30.0	30.0	1.90
Nallajerla	77.3	13.6	9.1	1.32
Devarapalli	100.0	0.0	0.0	1.00
Chagallu	88.9	11.1	0.0	1.11
Nidadavol	71.4	28.6	0.0	1.29
Tadepalligudem	33.3	66.7	0.0	1.67
Bhimadole	16.7	83.3	0.0	1.83
Denduluru	100.0	0.0	0.0	1.00
Eluru	100.0	0.0	0.0	1.00

Table 17. Available potassium status of soils

Mandal	Per cent distribution in the indicated category of K status			Nutrient Index values (NI)
	Low	Medium	High	
T.Narsapuram	33.3	50.0	16.7	1.83
Buttayagudem	0.0	66.7	33.3	2.33
Pedavegi	36.4	36.4	27.2	1.91
J'reddygudem	60.0	40.0	0.0	1.40
Nallajerla	45.5	40.9	13.6	1.68
Devarapalli	83.3	16.7	0.0	1.17
Chagallu	44.4	22.2	33.3	1.89
Nidadavol	28.6	42.9	28.6	2.00
Tadepalligudem	46.7	13.3	40.0	1.93
Bhimadole	50.0	50.0	0.0	1.50
Denduluru	0.0	55.6	44.4	2.44
Eluru	0.0	66.7	33.3	2.33

The status of phosphorus and potassium and their nutrient index values are given in tables 16 and 17. Levels of low status of phosphorus was highest in Devarapalli, Dendulur, Eluru and Chagallu mandals while of potassium was in Devarapalli (83.3 %) and Jangareddygudem (60.0 %) mandals. The nutrient index values of phosphorus and potassium in the district varied from 1.00 to 1.90 and 1.17 to 2.44 respectively.

Percent distribution of deficient class of plant available sulphur in different mandals of W.G. district are presented in Table 18. The magnitude of sulphur deficiency was highest in Devarapalli mandal of the district at 83 per cent followed by soils of Nallajerla. The nutrient index value of Devarapalli mandal was found to be lowest (1.17) as compared to other mandals. The overall, 44.3 per cent of the studied area was deficient in S and the nutrient index value is 1.93.

PERFORMANCE OF OIL PALM IN PEAT SOILS OF KERALA

An oil palm demonstration plot developed by Oil Palm India Ltd., in Kallara village (Kari lands) of Kottayam district in Kerala was surveyed. A view of oil palm plantation taken up in the kariland soils is presented in Fig.5. The area comprises of 84.65 ha planted with oil palm from 2002-03 onwards. But majority of the seedlings were to be replaced due to the subsequent floods and heavy rat damage.

Fig. 5. View of oil palm plantation in Kariland soils

Table 18. Available Sulphur status of soils

Mandal	Per cent distribution in the indicated category of S status			Nutrient Index values (NI)
	Low	Medium	High	
T.Narsapuram	41.7	33.3	25.0	1.83
Buttayagudem	0.0	50.0	50.0	2.50
Pedavegi	54.5	45.5	0.0	1.45
J'reddygudem	40.0	10.0	50.0	2.10
Nallaerla	68.2	9.1	22.7	1.55
Devarapalli	83.3	16.7	0.0	1.17
Chagallu	44.4	11.1	44.4	2.00
Nidadavol	14.3	57.1	28.6	2.14
Tadepalligudem	20.0	33.3	46.7	2.27
Bhimadole	66.7	0.0	33.3	1.67
Denduluru	0.0	0.0	100.0	3.00
Eluru	16.7	83.3	0.0	1.83

Thus the average age of the plantation can be considered as 3-4 years only. Continuous rains and water logging hindered the development of palms in the initial stage, but the collective efforts of farmers to deepen the channels and raising the mounds have been completed. Sufficient drainage is ensured by way of regular pumping and presently the crop stand is satisfactory. The palms have started flowering and yielding. Observations on the growth and flowering were recorded from 40 palms each in North, East, South and West blocks representing the whole area. Growth parameters recorded during 2008 per palm are presented in Table 19.

Table 19. Average growth parameters of oil palm in Kari land soil, Kerala

Block	Height (m)	Girth (m)	No. of functional leaves	LA 9th leaf (sq.m)
Block I	3.84	1.86	30.3	1.90
Block II	4.68	1.99	28.6	2.54
Block III	4.31	1.88	28.6	2.43
Block IV	3.46	1.55	26.8	1.51
Normal-4yrs	4.23	1.42	21.0	1.99

Physico-chemical characterization of Kari land soils

The physico-chemical characteristics of kari land soils were studied. Chemical heterogeneity of these soils was identified and its possible management for cultivation of oil palm was formulated based on earlier research publications.

Representative soil samples (0-15, 15-30 and 30-60 cm depth) from both basin and inter plant space were collected from different blocks representing entire kariland under oil palm. Morphologically, the soils were soft, dark grey/brown in colour at the surface and yellow and/or yellowish brown mottles or concretions in the subsurface layers. The physico-chemical characteristics of the soils are shown in Table 20. In general, soils were highly acidic in nature with pH values ranging from 2.61 to 3.27 and 3.17 to 3.62 in basin and interplant areas of surface layer respectively. The acidity tended to increase in the lower layers. The soils had very high amount of soluble salts ranging from 4.14 to 7.08 dS m^{-1} in top layers and 4.73 to 9.72 dS m^{-1} in the bottom layers irrespective of the sampling sites. Organic carbon content in general, was very high in surface soils which further increased substantially with depth (70.2 to 94.0 g kg^{-1} in basins and 78.0 to 88.1 g kg^{-1} in inter plant area at North block). However, they were low in available phosphorus (2.03 to 4.75 kg ha^{-1}) but relatively high in available potassium (154 to 291 kg ha^{-1}) and values decreased with increase in depth.

The existence of high acidity in kari land soils might be associated with the accumulation of organic residues under submergence for quite a long time leading to the release of hydrogen sulphide (H_2S). Upon drying, soils become highly acidic due to the oxidation of pyrite (FeS_2) into sulfuric acid and thus these soils are often called as Acid Sulphate Soils. The high status of available sulphur in these soils (1050 to 2388 ppm) reaffirmed this hypothesis. Acidification accompanied by the formation of high amounts of Al^{+++} and P deficiency due to precipitation of Al phosphates are the root cause of poor crop growth and low productivity. Subsurface drainage could remove this chemical heterogeneity of soil.

Table 20. Physico-chemical characteristics of Kari land soils of Kerala

Block	Depth (cm)	pH	EC (dS/m)	Organic carbon (g/kg)	P (kg/ha)	K (kg/ha)	S (ppm)
Basin							
North Block	0-15	3.12	5.40	70.2	2.03	291	1950
	15-30	3.14	4.94	92.8	2.10	204	1515
	30-60	2.36	4.73	94.0	3.39	202	1758
West Block	0-15	2.61	3.95	61.5	4.75	154	2233
South Block	0-15	3.27	4.61	74.8	4.75	167	1845
Inter plant space area							
North Block	0-15	3.45	5.83	78.0	1.35	217	1248
	15-30	3.53	8.76	88.5	1.35	347	1898
	30-60	3.29	9.72	88.1	2.03	226	1817
West Block	0-15	3.17	7.08	82.7	4.07	157	2073
	15-30	2.98	8.42	73.3	3.39	176	2362
	30-60	2.82	8.77	92.1	7.46	165	2388
South Block	0-15	3.62	4.14	75.7	5.43	179	1050
	15-30	3.18	4.93	53.8	5.43	146	1049
	30-60	4.03	5.70	90.7	2.03	184	1595

STUDIES ON THE PHOTOSYNTHETIC EFFICIENCY, DRY MATTER PRODUCTION AND PARTITIONING IN RELATION TO GROWTH AND YIELD IN OIL PALM HYBRIDS

The project was taken up to understand the performance of different oil palm hybrids obtained from various countries in terms of photosynthetic efficiency, dry matter production and yield under irrigated conditions. The study has been completed and final report submitted. The salient findings of the project are given below:

Significant variations in plant girth were observed among the different oil palm hybrids studied and it ranged from 91.3 to 117 cm. It was maximum in ASD Deli X Ghana followed by IC 18C X 2501 and ASD Deli X Lame, which didn't differ significantly among each other, but differed significantly from that of other hybrids. Lower plant heights were observed in IC 18C X 2501 and IC 9C X 1001, which didn't differ significantly with each other. The number of leaves per palm ranged from 23.70 to 27.20 and was more in IC 18C X 2501 followed by 128 X 31323, ASD Deli X Avros and PNG 1M-0069, which were on par with each other. The maximum number of leaflets was observed in 12 X 266 followed by ASD Deli X Lame, which didn't differ significantly with each other. The leaf area in the different hybrids ranged from 106.2 to 200.9 sq.m and it was maximum in ASD Deli X Ekona which was significantly different from that of the other hybrids.

Variations in stomatal parameters were observed in the different hybrids. Highest stomatal frequency was observed in ASD Deli X Avros followed by ASD Deli X Ekona and

ASD Deli X lame, which were on par with each other. Significantly lower stomatal frequencies were observed in 12 X 313 and 12 X 266, which indicates their better adaptation to drought. Higher epidermal cell frequencies were observed in ASD Deli X Ekona, ASD Deli X Lame, 12 X 266 and 12 X 313, which didn't differ significantly among them. Stomatal index was more in IC 18 C X 2501 followed by ASD Deli X Ghana and IC 9C X1001 and lower stomatal indices were observed in 12 X 313 and 12 X 266. More stomatal plastids were observed in ASD Deli X Avros followed by 12 X 313, ASD Deli X Ekona and IC 9C X 1001. Highest guard cell length was observed in ASD Deli X Ghana followed by IC 9C X 1001 and PNG 1M -0069, 12 X 266.

The photosynthetic rates in the different oil palm hybrids ranged from 1.74 to 3.84 $\mu mol.m^{-2}s^{-1}$. Highest photosynthetic rate was observed in 12 X 313 followed by IC 9C X 1001, while it was lowest in ASD Deli X Avros. Maximum transpiration rate was observed in ASD Deli X Ekona followed by 128 X 31323, which were on par with each other but significantly differed from that of other hybrids. The leaf temperatures in the different hybrids ranged from 44.25 to 49.58 °C and it was maximum in IC 18 C X 2501 followed by ASD Deli X Avros and ASD Deli X Ghana. Significant variations in the photosynthetic water use efficiency (PWUE) were observed in the different oil palm hybrids and it ranged from 1.19 to 3.85 µmol CO_2.mmol H_2O^{-1}.

Significant variations in leaf dry weight were observed among the different oil palm hybrids. The leaf dry weight was more in 12 X 266 followed by ASD Deli X Avros and PNG 1 M -0069 which didn't differ significantly among them, while it was lowest in ASD Deli X Lame. The trunk dry weight ranged from 12.8 to 21.0 kg/palm/year and was highest in Costa Rica hybrids followed by Ivory Coast and Papua New Guinea hybrids. The vegetative dry weight in the different oil palm hybrids ranged from 91.28 to 122.11 kg/palm/year. The maximum bunch dry weight was observed in IC 9C X 1001 followed by ASD Deli X Ekona and it was lowest in IC 18C X 2501. The bunch index in the different hybrids varied from 0.31 to 0.43. The bunch indices obtained in the study for the different hybrids were between the indices obtained at Malaysia and Nigeria. Hybrids from Palode i.e., 65D X 111 and 12 X 313, which recorded comparatively better bunch indices also had better photosynthetic water use efficiencies. On the contrary, ASD hybrids, which also had better bunch indices, recorded poor water use efficiencies.

It is evident from the study that photosynthetic efficiency and dry matter production are important components for yield in oil palm and significant variations existed in the different hybrids. Among the different relationships worked out for the dry matter production among the hybrids, it was found that bunch dry matter was positively correlated with total dry matter (r^2 = 0.61*) and bunch Index (r^2 = 0.85**). Another interesting observation amongst the relationships was a negative association of bunch index with the vegetative dry matter. A positive relationship has been observed for photosynthetic water use efficiency with total dry matter production (r^2 = 0.58*) as well as bunch index (r^2 = 0.60*) indicating that higher dry matter production leading to higher bunch index could be due to the efficient regulation of stomata in lowering the transpiration rate and increasing the water use efficiency. It also highlights the importance of water use efficiency in terms of increased dry matter production in the water-limited environments. This study will aid the breeders in the long run in selecting the most suitable hybrid for higher

photosynthetic efficiency and bunch index from the existing germplasm.

ENVIRONMENTAL MONITORING OF OIL PALM USING SAP FLUX PROBES

Sap flux measurements in mature oil palm plantations indicated that the sap flux increased gradually in the morning and reached a peak during noon and then decreased. The sap flux in mature oil palm plantations also followed the same trend as that of vapor pressure deficit. Seasonal variations in the sap flux were also noticed in the palms.

STUDIES ON SOURCE SINK RELATIONSHIP IN OIL PALM

One of the possible ways of understanding the source sink relationship in oil palm is removing inflorescences and fronds and studying their influence on growth and yield parameters of oil palm. The experiment consists of the following treatments namely - a. No disbudding; b. 50 % disbudding; c. 75% disbudding; d. 100% disbudding. Nine palms per each treatment were selected for the above experiment. Before the treatments were imposed pre experimental data like number of leaves, plant height, girth and number of bunches were recorded. The different treatments (different levels of fruit removal) were imposed monthly and data on the yield and morphological parameters were recorded at monthly intervals. Also along with this, a new experiment has been started by removing the fronds at different levels to know its effect on growth and yield of the palms. The treatments are being imposed at monthly intervals and morphological and yield data are being taken. The number of leaves in the palms ranged from 32 to 60, while the plant height ranged from 150 to 305 cms. The plant girth ranged from 72-100 cm. The number of bunches per palm ranged from 1-8.

CARBON ASSIMILATION, WATER USE AND ENERGY BALANCE IN OIL PALM PLANTATIONS USING EDDY COVARIANCE METHOD

Carbon sequestration work has been taken up in oil palm and the annual increment in biomass and standing biomass were estimated non-destructively. Samples from leaflets, rachis and trunk were taken and carbon stocks are being estimated.

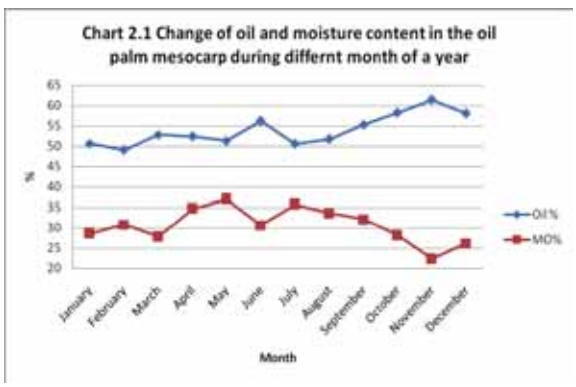
BIOCHEMICAL BASIS FOR GROWTH AND YIELD OF OIL PALM

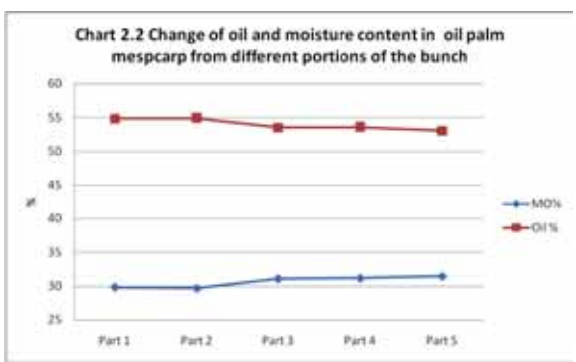
Studies on oil content and FAC of oil from different parts of bunch : To study the qualitative and quantitative differences of oil in the different portions of FFB, samples were collected for a period of one year. Each month five fully ripened bunches were collected randomly from *tenera* palms (source ASD Costa Rica) and each bunch was divided into five portions. Replicated fruit samples were collected from each portion. During this year the samples collected during the month of December were analyzed in the laboratory and the experimental work was completed. Data were collected on moisture content, oil content and fatty acids compositions of the major fatty acids (Myristic, Palmitic, Stearic, Oleic, Linoleic and Linolenic). Similarly the three parts of the fruit were analyzed for the parameters mentioned above. Tabulation of data on portions of bunch and also on part of fruits was completed. Data analysis is in progress.

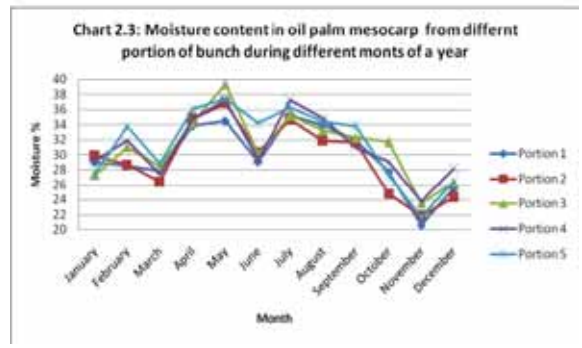
So far the analyzed data reveals that the oil content in the mesocarp is more in the Portion 1 and Portion 2 of the bunch (base of oil palm bunches, toward the

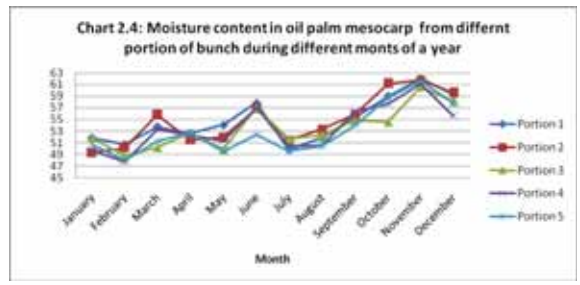
peduncle), which was significantly higher than that of the other three Portions of the bunch (Chart 2.1). Moisture content exhibited reverse trend with respect to different Portions of the bunch (Chart 2.1). When the month wise data were analyzed, oil content was found significantly higher in the mesocarp during the month of November, followed by December and October. Lowest oil content was observed during the month of February followed by July and January (Chart 2.2). The moisture content was not exactly reverse to oil content during different months, though the moisture content was lowest during the month of November. The moisture and oil content in different portions of the bunch during the different months of the year showed similar trend (Chart 2.3 and Chart 2.4).

Analysis of data on different portions of bunch and also on different parts of fruit would be completed in the next year and some conclusion could be drawn.









AGROTECHNIQUES AND LAND USE SYSTEMS FOR SOIL, WATER AND NUTRIENT CONSERVATION IN OIL PALM PLANTATIONS OF HILL SLOPES

A field experiment (under NATP) was conducted in a mature oil palm plantation to evaluate different agro-techniques, to develop suitable agro-forestry/agro-horticultural models and to study soil and water conservation techniques for sustainability and increasing the productivity of oil palm plantations. The project is closed and the salient findings are presented:

Treatments : Agronomic/engineering techniques:

1) Oil palm alone (Inorganic alone)
2) Oil palm + combination of conservation engineering techniques viz., middle across slope + trenching + basin cutting (half moon circular) (Inorganic + cultivation).
3) Oil palm + organic agronomic technique such as mulching Empty Fruit Bunches + Leaves + addition of compost (Organic alone).

4) Trenching and in situ vermi composting of palm wastes. (Organic + inorganic + cultivation).

5) Heaping palm leaves and EFB between palm rows and micro irrigation in palm basins (4 + irrigation in basin).

Agri-Horti land use system:

6) Oil palm + black pepper on oil palm + cocoa, cinnamon + Anthurium and sprinkler irrigation.

7) Oil palm + black pepper on Glyricidea + Medicinal plants + orchids on oil palm and sprinkler irrigation.

8) Oil palm + fodder + cover crop + orchids and pepper on oil palm.

Salient findings:

- Evolved half moon basin cutting and forming trenches in between palm lines as soil and water conservation method for hill slopes.
- In situ vermi composting of oil palm plantation wastes such as fronds and empty fruit bunches and also when used as mulch were found to be advantageous for nutrient enrichment as well as soil and water conservation.
- Different agrihortisystems were found to improve the productivity per unit area and also to enrich soil nutrient, soil microflora and the ecoclimate.
- Fodder grasses are found to establish well in oil palm plantation offering the scope for mixed farming system both for ecological and economic advantages for farmers.
- A combination of cocoa and cinnamon planted in interspaces of oil palm in alternative rows, pepper trailed on palms and anthurium planted in intra row spaces is an ideal cropping model for an established plantation under rainfed conditions.

INTERCROPPING OF COCOA IN OIL PALM

Before starting an experiment on intercropping with cocoa, a survey was taken up during four years from 2002-03 to 2005-06 in a total of 72 farmers' fields where intercrops were existing in oil palm plantations. The project is concluded and the final report is presented. Survey data revealed that a maximum of 38 % light penetrated the oil palm canopy which is much below the quantity of light required (75%) for the saturation of photosynthetic activity of cocoa. Lack of any positive correlation between oil palm age and light infiltration below the oil palm canopy with cocoa yield probably indicates that besides the light energy other management practices for maximum productivity are also important. Data recorded in some of the oil palm gardens are as presented below:

Parameter	value
No. of gardens surveyed	34 + 20
Age of gardens (years)	9-19
Yield of oil palm (t/ha)	7.2-32
Age of cocoa (years)	1-7
Yield of cocoa (kg/tree)	0-1
Radiation above the canopy (µ moles/m2/s)	1849 - 801
Radiation below the OP canopy (µ moles/m2/s)	39.67-591.77
Infiltrated light as per cent of total radiation.	2.51 - 37.08

STUDIES ON INTER CROPPING IN MATURE OIL PALM GARDENS

There is a scope to grow shade loving and shade tolerant crops in grown up oil palm gardens under irrigated conditions. So, work has been initiated to evaluate the performance of inter crops in oil palm gardens and to study interaction between base crop and test crops and impact on base crop. Cocoa, banana, bush pepper, vine pepper, betel vine, heliconia, ginger lily, crossandra, jasmine and anthurium were

planted. Age of oil palm is 12 years and average light intensity in the oil palm block was 271 µm (ranged from 204 to 355 µm).

Heliconia reached flowering stage by 85 days and yielded 11 commercial spikes on an average. Ginger lily took 120 days to reach flowering stage and recorded yield/ plant was 9.3 spikes. Heliconia and ginger lily are shade loving crops and both are grown commercially for cut flower purpose in coconut gardens in South India. Comparatively, the overall performance of heliconia and gingerlily was satisfactory. So, they can be grown commercially in adult oil palm gardens under irrigated conditions.

Performance of jasmine *(Jasminum sambac)* and crossandra was very poor and results indicate that they are not fit for cultivation in oil palm gardens. Observations on bush pepper, banana, cocoa, vine pepper, betel vine and anthurium are in progress.

STUDIES ON MIXED FARMING IN IRRIGATED OIL PALM PLANTATIONS OF ANDHRA PRADESH

All the existing perennial intercrops were continued for demonstration. Observations were made on performance of various inter crops like banana, papaya, curry leaf, drumstick, heliconia. Yield data of oil palm and inter crops were collected. Yield levels were found higher in Deli x Nigeria and Deli x Ghana crosses whereas moderate in Palode and low in Malaysia cross. Banana and heliconia emerged as most promising inter crops compared to others. Napier grass was introduced into the system. A total of 10.25 tonnes of vermi compost was generated using dung and biomass produced in the farming system. Mixing of microbial agents like *Metarhizium anisopliae* and *Trichoderma viride* individually as well as combined manner did not show any negative impact on the growth and mortality of the earthworms.

Both Deli X Nigeria and Deli X Ghana crosses recorded high yields during first year of harvest where as it was moderate in Palode and low in Malaysian crosses. No impact of competition was observed with the intercrops that are existing in the above oil palm crosses on the yield levels.

Rhinoceros beetle infestation was observed higher in Malaysian cross followed by Palode material. Both the Costa Rican crosses namely Deli X Ghana, Deli X Nigeria recorded low infestation. No pest was found migrating from intercrop to main crop and vice versa during the reported period.

BIOGAS PRODUCTION FROM POME AND UTILIZATION OF SLURRY AS NUTRIENT SOURCE FOR OIL PALM

On an average, one lakh kg of FFB is being processed in the one tonne capacity mill of the Regional Station. From this the quantity of solid wastes expected was worked out approximately as 3000kg. Accordingly, a 6m^3 capacity biogas plant was suggested for regular functioning. The project could be started only after the construction of the biogas plant, the proposal of which is pending for sanction.

PRODUCTION AND DISTRIBUTION OF QUALITY PLANTING MATERIAL IN OIL PALM

With an objective of supplying quality planting material to farmers under Mega Seed Project-Seed production of Agricultural crops and Fisheries, three thousand seedlings of hybrids 68 x 435 and 183 x 66 brought from NRCOP Regional Station, Palode were raised at NRCOP, Pedavegi in primary and secondary stages of nursery using drip system of irrigation. Seedlings were healthy and vigorous and supplied to farmers through APOILFED, Govt. of A.P.

The details of sprouts supplied to various agencies from NRCOP, RS, Palode during 2007-08 are presented in Table 21.

Table 21. Sprouts supply to various agencies from NRCOP, RS, Palode during 2007-08

Name of agency	Apil 07	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan. 08	Feb.	Mar.	Total
Lakshmi balaji AP	11,000	0	0	0	0	0	0	0	0	0	0	0	11,000
Agro corporation	11000	0	0	0	0	11000	0	0	0	0	11000	0	33,000
Cauvery Palm	24000	51000	21510	22000	11000	28300	22000	57450	11000	15000	13000	0	2,76,260
Ruchisoya Guj	0	0	22000	0	0	0	0	0	0	0	0	0	22,000
Godrej Orissa	0	0	0	11000	0	11000	0	0	4400	0	0	0	26,400
Simhapuri Kar	0	0	0	0	5500	5500	0	0	0	11000	0	11000	33,000
MAC OilPalm	0	0	0	0	11000	0	0	0	0	0	0	0	11,000
PalmTech	0	0	0	0	16500	0	0	0	0	0	0	0	16,500
Godrej AP	0	0	0	0	0	0	0	0	0	11000	0	0	11,000
Srinivasa	0	0	0	0	0	10890	0	0	0	0	0	0	10,890
Total	46,000	51,000	43,510	33,000	44,000	66,690	22,000	57,450	15,400	37,000	24,000	11,000	4,51,050

·Total number of germinated seeds supplied : 4,51,050 Total revenue : Rs. 45,10,500/-

4.0 Research Achievements

फसल संरक्षण
Crop Protection

Rhinoceros beetle damage

CROP PROTECTION

STUDIES ON INSECT PESTS OF OIL PALM AND THEIR MANAGEMENT

Survey was carried out in West and East Godavari, Krishna, Khammam, Nellore, Vizianagaram and Visakhapatnam districts of Andhra Pradesh; Mysore, Mandya and Bellary districts of Karnataka; Madurai and Theni districts of Tamil Nadu; Guwahati of Assom; Narayanapur, Jagadalpur and Dantewada districts of Chhattisgarh to find the pest incidence in Oil palm. Rhinoceros beetle was observed in all the areas surveyed including Assom. Level of incidence was however low to very low. Incidence of leaf defoliators was found increasing in Andhra Pradesh with Psychids occupying highest position followed by leaf web worm and slug caterpillars. The incidence of Psychids was observed through out the year with more than 10 bags per leaf let during February-March. Leaf web worm was observed in all the periods with more incidence during winter months. Slug incidence was reported during the summer months only. Infestation of Psychids was found more in the gardens that were having flood irrigation and are more than 6 years old with the intermingling of leaves of adjacent palms. Lambda cyhalothrin was found to give good control of the leaf defoliators. Microbial agent *Beauveria bassiana* was also found on par with chemical insecticides. Shoot borer incidence was observed increasing in the nurseries of both Andhra Pradesh and Karnataka. Incidence of rat problem was observed severe in the young oil palm gardens that are adjacent to maize plots.

BIOEFFICACY STUDIES ON LEAF EATING CATERPILLARS

Bioefficacy studies on leaf eating caterpillars were carried out using conventional pesticides and biopesticides. *Beauveria bassiana* was found to cause effective control of the slug caterpillars and leaf web worms on par with the conventional insecticides namely quinalphos and Lambda cyhalothrin. SDS PAGE studies carried out to find the protein variations among different microbial organisms indicated the molecular level difference among entomo-pathogen and plant pathogen where the latter recorded more number of bands compared to the other one.

Microbial agents of *Metarhizium anisopliae* and *Trichoderma viride* were proved harmless to the earthworms when mixed along with the input material in the vermicompost pits. These microbes were found effective in producing more amount of vermicompost. Microbes that were mixed to the compost material were ingested by earthworms and grown in the gut portion without causing any harm to the earthworms.

Incubation of rhinoceros beetles infected with *Metarhizium anisopliae* at different temperatures reveals that grubs that were incubated at 30^{o}C recorded more bands in SDS PAGE indicating more protein compared to other temperatures.

Temperature of 30^{0}C and relative humidity of 70% were once again found

congenial for the multiplication of microorganism *Metarhizium anisopliae* and thereby to kill the host effectively compared to lower levels.

Application of neem cake to the FYM proved inefficient as it reduced the spore population of *Metarhizium anisopliae* where as it was found effective in case of *Trichoderma viride*. This confirms the earlier findings.

Studies on impact of stirring of the inoculated material indicated that stirring after three days of inoculation was found better and yielded more number of spores compared to immediately after inoculation. Impact studies of microorganisms on the pollinating weevil revealed that *Beauveria bassiana* was more harmful to the weevil population compared to *Metarhizium anisopliae*. However the intensity was much less when compared with chemical insecticides

MANAGEMENT OF AVIAN AND MAMMALIAN PESTS ON OIL PALM

Survey carried out in Andhra Pradesh, Karnataka, Tamil Nadu, Chhattisgarh and Assom for avian and mammalian pests revealed that crows were more common pests on oil palm in all the areas including Assom and Chhattisgarh where gardens are isolated. This indicates that preference of the oil palm for the crows in all the areas is same.

Fishnet traps were found to give good control of bird attack with low infestation in the net tied areas compared to control. Incidence of eagles and vultures were recorded on the cooked bunches that were kept in the factory before processing.

STUDIES ON DISEASES OF OIL PALM AND THEIR MANAGEMENT

Molecular detection and characterization of phytoplasma : Spear rot disease affected samples of oil palm were collected from Trivandrum and Kottayam districts of Kerala. Yellow leaf disease affected arecanut palms and root wilt disease affected coconut palms were also sampled from the two districts. Destructive sampling was carried out and DNA from tender leaf, rachis and rachila were isolated.

Eight pairs of phytoplasma specific primers (A&Sf & A&Sr, P1&P4, P1&P7, P4&P6 f45&rU3, Rhodef & Rhoder, R16F2 and F16R2, R16mF2 & R16mR1) were procured, which were already reported during the previous year and were used for amplification of spear rot and other phytoplasma affected plant DNA samples.

DNA from brinjal leaf affected by little leaf of brinjal (LLB) disease was isolated and used as standard phytoplasma DNA. Different DNA samples from phytoplasma affected palms mentioned above, along with standard phytoplasma DNA were amplified in PCR with all the above eight pairs of phytoplasma specific primers. Some of the primers showed amplifications with some samples and they were not consistent. However, A&Sf-A&Sr primers could amplify the DNA samples from all the phytoplasma affected palms (SRD of oil palm, YLD of coconut and RWD of coconut) along with the standard phytoplasma DNA from LLB affected brinjal plant. No amplification was observed in the DNA from healthy oil palm and brinjal. The same primers could amplify the DNA isolated from *Proutista moesta* insect, which were allowed to feed on SRD affected oil palm. These results indicated that the three

diseases namely SRD of oil palm, YLD of arecanut and RWD of coconut are caused by phytoplasma. However, subsequent analysis of the same DNA did not show clear band, but a smear during PCR amplification with the A&Sf and A&Sr primers. This might be due to instability of the phytoplasma DNA. Hence the experiment needs to be continued for confirmation of the result.

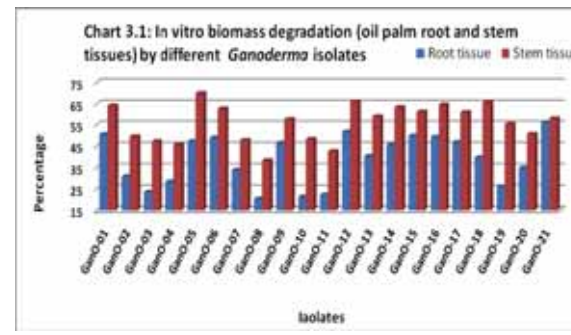
Molecular characterization of *Trichoderma* isolates : The *Trichoderma* isolates available with this Centre have been subcultured and DNA was isolated from all the isolates for further analysis.

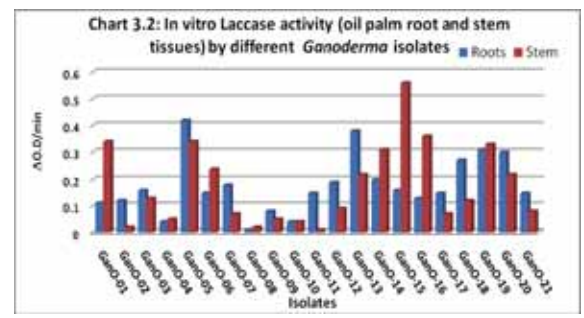
WILT OF CROPS WITH SPECIAL REFERENCE TO CULTURAL, MORPHOLOGICAL, MOLECULAR CHARACTERIZATION AND PATHOGENIC VARIABILITY OF ISOLATES IN INDIA

Pathogenicity tests of isolates of *Ganoderma spp.*: The oil palm seedlings were inoculated with different *Ganoderma* isolates, but no symptoms were observed even after 2 years of inoculation. *In vitro* pathogenicity study was conducted by estimating the biomass degradation and laccase activity.

***In vitro* biomass reduction study:** Healthy oil palm root bits and stem tissues were inoculated with 21 *Ganoderma* isolates and the biomass reduction was estimated 9 weeks after inoculation. Biomass reduction was observed more in stem tissues than in root tissues. *Gan*O-21 isolate showed the highest biomass reduction of root tissue. In case of stem tissue maximum reduction was observed with *Gan*O-5 isolate (Chart 3.1).

Extra cellular laccase activity was estimated for all the 21 isolates. Two grams of oil palm root and stem tissue powders were mixed with 100ml of Potato Dextrose Broth. Isolates were inoculated and estimated the O.D change for min. Enzyme activity was more in *Gan*O-5 isolate grown on Potato dextrose broth containing root tissue powder. *Gan*O-15 isolate exhibited the highest enzyme activity in case of stem tissues (Chart 3.2).

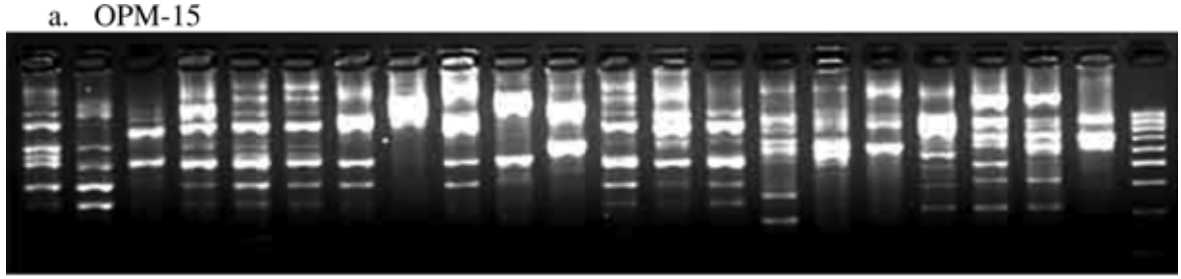




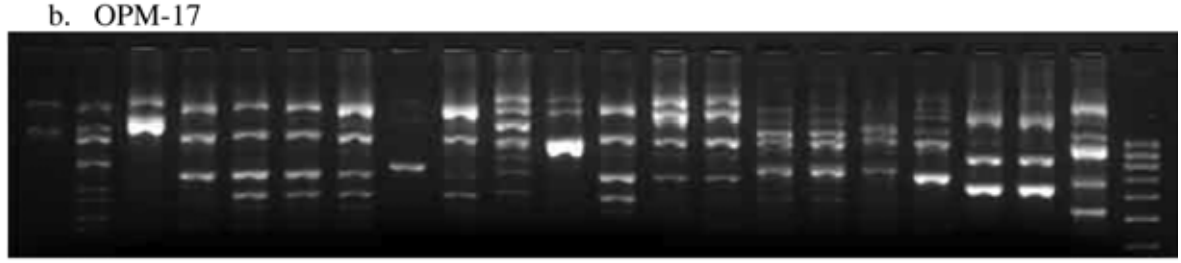
Molecular characterization of morphologic and pathogenic variants from oil palm: All the isolates were confirmed by PCR amplification with two pairs of primers – Gan1 & Gan2 and Gan ET & Gan ITS. Genetic variability of the positive isolates (21 isolates) was studied. Fifty four random RAPD primers were used for testing the molecular variability of the 21 *Ganoderma* isolates. Data was scored based on the presence and absence of the band as 1 and 0 respectively. Total 585 bands were observed and all are polymorphic. Data analysis was done by using the NTSYS software. For preparing the dendrogram (Fig. 7) cluster analysis method using simple matching coefficient calculation was adopted. Few representative photographs were given in Fig. 8

Fig. 7: Representative photographs of RAPD pattern of 21 *Ganoderma* isolates

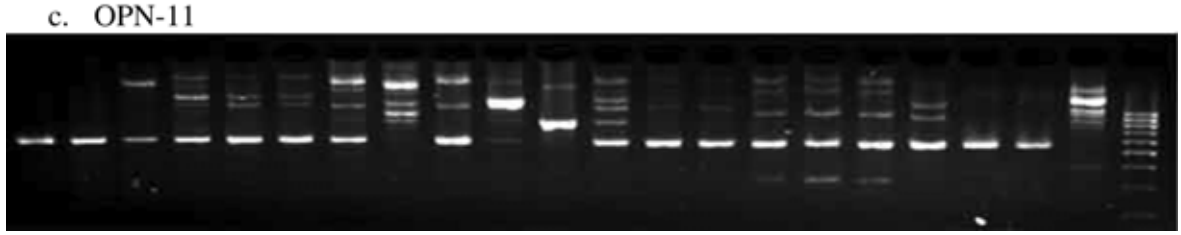
a. OPM-15

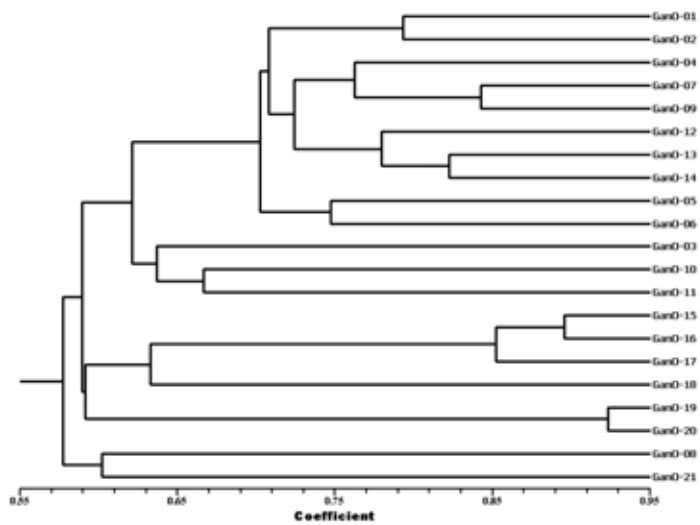


b. OPM-17



c. OPN-11





Sequencing of amplified fragments from ITS region and comparison of 21 *Ganoderma* isolates : DNA sequencing of the amplified ITS region was carried out for all the 21 isolates and the sequences were matched with available database. Though the exact species identification was not possible, it was found to be either *Ganoderma lucidum* or *Ganoderma applanatum*.

4.0 Research Achievements

कटाई उपरान्त प्रोद्योगिकी
Post Harvest Technology

Utilization of palm oil mill effluent

POST HARVEST TECHNOLOGY

POST HARVEST STUDIES ON PALM OIL

Experiment on oil quality of crude palm oil extracted from sterilized and un-sterilized fruits: The crude palm oil is usually extracted by a standard procedure called sterilization that involves heating the fruit bunches up to 121°C at 15 lb pressure for 1 hour. Upon sterilization the lipase is inactivated and it facilitates removal of fruits from the oil palm bunches and further extraction of oil from the mesocarp. However, there is a chance of reduction of carotenoids content as well as change oil quality in terms of in fatty acids composition due to heat treatment of the bunches prior to extraction of oil. It is not known how the quality of oil differs if the extraction of oil from the mesocarp is carried out without any sterilization. It is also not clear how the quality of un-sterilized oil would change on storage at different temperatures for different duration in comparison to the extracted by standard procedure.

A study has been taken up to find out the differences in quality of oil extracted from sterilized and un-sterilized bunches. Spikelets from fully ripen bunches were separated manually from the bunches and they were divided into two halves for extraction of oil by two different methods. 70 to 80 spikelets were obtained from each bunch. Uniform size spikelets were selected for extraction of oil for further studies.

Half of the Spikelets were used for extraction of oil by following the principle of conventional palm oil mill. Spikelets were sterilized at 15 lbs pressure at 121°C temperature for one hour. Fruits were separated from the Spikelets, Mesocarp was separated from the seeds and kept in the hand operated mini screw press for oil extraction. The obtained paste or the homogenized mesocarp was heated for 10 minutes in boiling water bath and subsequently centrifuged at 5000 rpm. The red palm oil is collected for further experimental analysis.

From the other half of the spikelets fruits were separated and mesocarp from the fruits was scraped out manually. The mesocarp obtained is crushed in the hand operated screw press as mentioned above to extract oil.

FFA and carotenoids content and fatty acids composition were estimated in the oil samples extracted by two different methods. Oil extracted without sterilization had very high amount of FFA (43.75%) in comparison to conventional method (2.33). This drastic increase was due to the presence of lipase in un-sterilized oil, which was destroyed in the case of sterilized oil. Moreover the crushing done as a part of extraction increases bruising leading to further increase in lipase activity.

The carotenoids value of sterilized oil (873ppm) was found to be more than unsterilized oil (790ppm). Though some amount of carotenoids get degraded while sterilizing the FFB, the sterilization process helps in releasing the carotenoids along with the oil from the cells.

There was marginal difference in fatty acids composition of the oils extracted by the two methods (Table 22). Studies on

Table 22: Fatty acid composition of palm oil extracted from sterilized fruits and un-sterilized fruits

Method	C14: 0	C16: 0	C18: 0	C18: 1	C18: 2	C18: 3	TSFA	TUFA
Sterilized	0.70	40.50	7.11	41.35	10.09	0.24	48.32	51.68
Un-sterilized	0.79	39.62	6.78	41.84	10.67	0.30	47.19	52.81

C14:0-Myristic acid, C16:0-Palmitic acid, C18:0-Stearic acid, C18:1-Oleic acid, C18:2-Linoleic acid, C18:3-Linolenic acid.

storage of the oil extracted by the two methods are in progress

UTILIZATION AND RECYCLING OF PALM OIL MILL EFFLUENT

The project was started during 2004 to carry out a systematic study on standardization of techniques for utilization of POME and PKC as animal and fish feed, microbial culturing and for use as organic manure so as to evolve value added products as well as ecofriendly disposal of POME. The study was concluded during the reported period and the salient findings are as follows:

- Physico-chemical and biological characterization of POME has been done and the present scenario of POME characters at various palm oil industries in A.P. has been reported.
- Seven predominant species of fungi and four predominant and native species of bacteria which exist in POME were isolated and identified
- Different feeds containing palm oil sludge as chief source were formulated based on the crude protein content of dehydrated POME.
- Dehydrated POME could be incorporated in the diets of buffalo calves and buffaloes up to 40 % level without any depression in growth rate and milk production with marked economic advantage over guinea grass and paddy straw based feeding system.
- Growth trial on lambs revealed that dehydrated POME could be included at 60 % level in the concentrate mixture without any adverse effect on the fattening of the lambs.
- Growth trial on kids (goats) revealed that POME could be included at 50 % level in the concentrate mixture for feeding of kids.
- A marked economic advantage was obtained in the trials of the experimental animals fed with POME in comparison to that of control concentrate mixtures.
- POME could be included at 20 % level in the diets of the piglets in grower stage. Further the costlier ingredient *i.e.*, rice bran can be safely replaced with POME in the diets of piglets up to 20 % level and can spare the rice bran for feeding of other species.
- Dried Palm Oil Sludge (POS) based fish feed trial showed promising body mass increase up to 60% inclusion in Fresh water fish *Rohu* as well as ornamental fish *Koi- Carp* while 40% of inclusion of POS in fish feed found suitable for fresh water fish *Catla catla*

- Inclusion of Palm Kernel Cake (PKC) in the diets of fresh water fish variety Rohu showed good growth rate with 10% inclusion of PKC and reduced the fish feed cost up to 10%
- Usage of Palm Oil Mill Effluent (POME) and Palm Oil Sludge (POS) as source of fertilizer for oil palm nursery seedlings showed good vigour and vegetative growth comparable with conventional inorganic and organic fertilizers.
- Usage of POME and POS in Oil Palm plantation reported increasing bunch production while being ineffective to the plant growth and vigour.
- POME and POS were also tried as a fertilizer source in vegetable intercrops of Oil Palm and found to have an adverse effect on production.
- Biogas production from the sludge of palm oil mill effluent settling tanks was evaluated and results proved that POME slurry is comparable and even better than cow dung which is a conventional medium used for biogas production.
- Composite formulation of essential microorganisms comprising *Saccharomyces*, *Lactobacilli* and *Rhodopseudomonas* improved the quality of POME by reducing BOD and COD to the eco-friendly level.

4.0 Research Achievements

सामाजिक विज्ञान
Social Sciences

Interaction with farmers

SOCIAL SCIENCES

CRITICAL ANALYSIS OF TRAINING OF TRAINERS PROGRAMME IN RELATION TO OIL PALM GROWERS KNOWLEDGE AND ADOPTION PATTERN

From the feed back data collected from 31 oil palm growers on skill gap existing in the adoption of recommended practices, it can be inferred that technology need to be disseminated to the highly skill gap category farmers at first followed by medium and low skill gap category farmers. Results from the table 23 revealed that there is significant difference in knowledge, adoption and skills of trained and untrained farmers. Hence it is required to provide training on Oil Palm cultivation to all the oil palm growing farmers to adopt all the recommended practices to obtain highest and sustained yields. With this the project has been concluded as follows:

Trained officers expressed that the training is beneficial. Subject matter dealt was relevant. Officers are disseminating the technology through farm and home visits and distributing literature during the field visits/ group discussions/training programmes. They indicated to have refresher courses on specific subject matters. Hence these topics may be considered and included in future training programmes. Training need assessment may be made prior to training to assess the requirement of various trainees / officials.

Marginal farmers having juvenile and adult plantations attended the training programme to learn about oil palm cultivation. It is required to disseminate the technology to small and big farmers. Majority of the farmers have attended the training either at NRC for oil palm or at their place, hence facilities may be created to have good learning climate. Many of the farmers learnt crop production practices, so as to adopt recommended practices and get higher yields. Farmers were categorized into low, medium and high skill gap category. Hence it is required to organise skill oriented training programmes to the identified farmers. The frequency of visits by the extension staff to the farmers' plantations may be increased to disseminate the technology or to attend field problems. Though majority of the farmers are in high knowledge category, they are in medium adoption category and this may be due to various constraints expressed by them. Hence those constraints need to be addressed, so as to adopt all package of practices and get good yields. Refresher training courses need to be conducted on the topics indicated by the farmers.

Table 23. Variation among farmers in their knowledge, adoption and skill

	Knowledge		Adoption		Skill	
	Trained	Untrained	Trained	Untrained	Trained	Untrained
Mean	12.02	4.45	31.97	9.09	20.59	8.96
Variance	12.33	3.45	84.38	28.75	59.03	23.03
"t" value between groups	14.64 **	16.19**	9.52**			

** Significant at 1 percent.

PRORITIZATION OF RESEARCH NEEDS IN OIL PALM BASED ON FARMERS PERCEPTION

Interview schedule was developed and standardized. Judgment of items for their relevancy and non relevancy was carried out. Out of 24 major researchable areas and 81 subject matter topics/items/activities identified, the major non relevant subject matter topics/items/activities perceived by the judges are viz., method of land preparation, pit size, control of pests & diseases in nursery, raising seedlings in nursery, pollinating weevil-species, requirement of weevil population in different soil conditions etc.,

Other suggested areas are as follows viz., Under planting in oil palm, Bio-diesel, Nutritional aspects of palm oil, By-products of oil palm, Harvesting schedules - variation in different agro climatic conditions, Pseudo ripening in oil palm, Lean and peak harvesting seasons in oil palm, Oil Extraction ratio-Age of plantation wise - Bunch size wise, OER Vs Fertilizer doses, Impact of weather on FFB yield potential, Harvesting standards, Survival of pollinating weevil in isolated plots, Oil Palm waste utilization in oil palm plantations, Crow and wild boar damage, Dormancy breaking during germination, Integrated nutrient management Vs inorganics use in oil palm, Effective methods involved in Transfer of Technology and Mass media communication.

Standardized the Questionnaire and the data collection from farmers is in progress.

OIL PALM DATA BASE MANAGEMENT SYSTEM

Data was collected from 150 high yielding plantation farmers on Adoption of Package of Practices. Results are as follows.

1). Land Holding

Majority (29%) of the high yielding plantation farmers are having 1-2 ha followed by (26%) less than I ha; 15 % are having 2-4 ha and 13% are having 3-4 ha. The data reveals that 12% of the farmers having > 6 ha. Most of the high yielding farmers are in the category of small and marginal farmers category.

Sl. No.	Farm Size (Ha)	Number of farmers	Percentage
1.	< 1.0	39	26
2.	1.0-2.0	44	29
3.	2.0-3.0	23	15
4.	3.0-4.0	19	13
5.	4.0-5.0	5	3
6.	5.0-6.0	2	2
7.	> 6.0	18	12
Total		150	100

2). Age of *Plantation*

Majority of the high yielding plantation farmers are obtaining the highest yields from their 11-16 years age oil palm plantations.

Sl. No.	Age of Plantation	Number of farmers	Percentage
1.	5 - 10 years	3	2
2.	11- 16 years	146	97
3.	> 16 years	1	1
Total		150	100

3). Type of Organic Manures applied

Majority (93%) of the high yielding plantation farmers are applying Farm Yard Manure or poultry manure / vermi compost to their oil palm plantations.

	Number of farmers	Percentage
Manure applied Farm yard manure Others	139 4	93 2
Manure not applied	7	5
Total	150	100

4).Distribution of respondents according to fertilizer application -

The results showed that majority of the high yielding plantation farmers are applying different dose of fertilizers in their oil palm plantations.

a. Nitrogen, Phosphorus, Potassium

Sl. No.	Quantity applied (gms.)		Number of farmers			Percentage		
	N & K	P	N	P	K	N	P	K
1.	≤ 300	≤ 100	14	5	19	9	3	13
2.	301-600	101-200	28	12	25	19	8	17
3.	601-900	201-300	22	10	5	15	7	3
4.	901-1200	301-400	28	30	28	19	20	19
5.	1201-1500	401-500	35	13	1	23	9	1
6.	1501-1800	501-600	1	4	15	1	3	10
7.	1801-2100	601-700	15	23	3	10	15	2
8.	2101-2400	701-800	—	18	24	—	12	16
9.	2401-2700	801-900	3	—	52	—	3	
10.	2701-3000	901-1000	2	20	5	1	13	3
11.	> 3000	> 1000	2	15	20	1	10	13
	Total		**150**	**150**	**150**	**100**	**100**	**100**

b. Magnesium Sulphate, Borax

Sl. No.	Quantity applied (gms.)		Number of farmers		Percentage	
	Magnesium Sulphate	*Borax*	*Magnesium Sulphate*	*Borax*	*Magnesium Sulphate*	*Borax*
1.	<250	<50	8	33	5	22
2.	250-500	50-100	46	44	31	29
3.	>500	>100	33	4	22	3
4.	Not applied	Not applied	63	69	42	46
	Total		**150**	**150**	**100**	**100**

5). Frequency of fertilizer application

Sl. No.	Frequency of application / year	Number of farmers	Percentage
1.	1	10	7
2.	2	34	22
3.	3	52	34
4.	4	49	33
5.	5	1	1
6.	6	3	2
7.	8	1	1
	Total	**150**	**100**

6). Correlation coefficient (r) between parameters/cultivation practices and yield N= 150

The results of correlation coefficient revealed that the size of land holding, age of plantation, quantity of the manure applied, application of nitrogen, phosphorous, potassium and boron had no effect on the high yields achieved. A significant correlation coefficient between manure application, fertilizer applied in number of splits, application of magnesium

sulphate and yield was observed. Hence these three variables are significantly affecting the high yield levels in oil palm.

Sl. No.	Independent variables	Yield (r)
1	Land holding	0.03926 N S
2	Age of plantation	-0.00539 N S
3	Manure application	0.231968 * *
4	Manure quantity	-0.02278 N S
5	No of splits (fertilizers applied)	0.232696 * *
6	Nitrogen	0.003125 N S
7	Phosphorous	0.03044 N S
8	Potassium	0.028659 N S
9	Magnesium	0.237778 * *
10	Boron	0.031243 N S

7. Irrigation: It was observed that most of the farmers are following basin method of irrigation with a frequency of 7-10 days.

TREND OF OIL PALM YIELD BASED ON BIOMETRICAL/ PHYSIOLOGICAL CHARACTERS AND WEATHER PARAMETERS UNDER IRRIGATED CONDITION

Available data on Fresh Fruit Bunches weight (FFBW), number of bunches (BN) and average bunch weight (ABW) for 24 hybrids (395 palms) for four years (8_11th year after planting) were subjected to different statistical models of Analysis of Variance (ANOVA). In first model, individual palm wise data were considered (unequal number of observations from each plot) for studying the effects of hybrids, replication, years and hybrid x year interaction. In the second model, plot wise data (averaged over palms) were considered and the same model is fitted. In the third model, plot wise data averaged over years were considered to study the effect of hybrids and replications. Further, scores for above three characters were assigned to hybrid performance to study consistent performance of hybrids over years.

ACTIVITIES UNDER SOCIAL SCIENCES

On farm training on oil palm cultivation

Farmers from Mizoram visiting oil palm processing unit

Training on plant protection in oil palm – Demonstrating identification of pest incidence symptoms to the officers

Training on oil palm production technology – Demonstrating fertilizer application to the officers

Training on oil palm hybrid seed production – Demonstrating pollination technique

Participation in exhibition at Horticulture Summit, CISH, Lucknow

5. TRANSFER OF TECHNOLOGY AND EDUCATION

MULTIDISCIPLINARY APPROACHES FOR TRANSFER OF TECHNOLOGY AND AREA EXPANSION IN RELATION TO OIL PALM DEVELOPMENT IN INDIA

North East region:

An assignment was taken up by Dr. P. Kalidas, Dr. R.K.Mathur and Dr. G.C.Satisha to conduct feasibility studies for growing oil palm in Zhum cultivation areas of NE states namely, Meghalaya and Arunachal Pradesh. The study was taken up based on request from The Ministry of Forest and Environment for which an amount of Rs.1.54 lakh has been sanctioned. Before conducting the survey preliminary discussions were had with the co-investigators of Jadhavpur University, Kolkata during November, 2007. Exhaustive survey was carried out in Zhum cultivation areas in NE region during December 10-14, 2007 and detailed report was submitted. Oil palm cultivation can be takenup in the Zhum cultivation areas.

Andhra Pradesh

Based on the request received from the state department of Horticulture, Andhra Pradesh committees were constituted to identify the potentiality for oil palm cultivation in non-identified mandals of a few districts on scientific basis. The committees surveyed the areas and interviewed the enthusiastic farmers to get the first-hand information on the socio-economic conditions and awareness regarding Oil Palm cultivation.

Dr. P. Kalidas, Mr. K. J. Prabhakara Rao and ADH (Anantapur dt) conducted feasibility studies for oil palm cultivation in Uravakonda, Vajrakaruru, Kudair, Bommanahal and Kanekal mandals of Anantapur district during 4-5 December, 2007.

Dr. V. M. Reddy, Dr. M. V. Prasad and Dr. K. Ramachandrudu conducted feasibility studies for oil palm cultivation in Anantagiri mandal of Visakhapatnam district on 4 March, 2008.

Chhattisgarh

Dr. P. Kalidas and Dr. K. Suresh surveyed Dhamtari, Kanker, Narayanpur, Jagadalpur and Dante Wada districts of Chhattisgarh state in relation to oil palm cultivation during 28-31 August, 2007.

Karnataka

Dr. P. Kalidas submitted report on visit to Oil palm plantations and nursery of Mysore and Bellary districts of Karnataka along with the suggestions on improvement.

Tamil Nadu

A presentation on Oil Palm cultivation, development and prospects in Tamil Nadu was made to Government of Tamil Nadu on 19 July, 2007.

Dr. P. Kalidas, Dr. R.K. Mathur and Dr. P. Murugesan surveyed the oil palm orchards of Theni and Madurai districts of Tamil Nadu and submitted the report for the improvement of the gardens during September, 2007.

Kerala

Dr. M. V. Prasad and Dr. S. Sunitha surveyed the villages and Oil Palm Development Programme areas and Kari lands of Kottayam District, Kerala. Data collected from individual farmers on adoption of package of practices. Case study & SWOT analysis report was prepared and submitted.

TRAINING OF EXTENSION, RESEARCH WORKERS AND FARMERS INVOLVED IN OIL PALM PRODUCTION

The following officers and farmers training programmes were conducted during 2007-08:

Officers training programmes

Organized officers training (Table 24) on "Oil Palm Production technology"(38 officers), Oil Palm Hybrid Seed Production"(9 officers), "Plant Protection in Oil Palm" (16 officers) and "Nursery Management in Oil Palm" (6 officers). Training schedule was developed, sent to all the organizations/ agencies involved in oil palm development programme in the country. Nominations were received and trainings were organized to confirmed nominees. Lectures delivered by concerned scientists on subject matter; Demonstrations were organized on planting, application of fertilizer, collection of 17th leaf for leaf analysis etc.; visits to field and processing units were also arranged; Compendium of lectures delivered, literature on oil palm was distributed to the participants. Pre and post evaluation was conducted. Certificates were issued to the trainees after successful completion of the training.

Specialised Training programme at NRCOP, RS, Palode : Organised Special Training programme to newly recruited Research Officer of Oil Palm India Limited on Oil Palm Hybrid seed production Technique during May 7-9, 2007

Farmers training programmes

A total of 39 training programmes organized to 2147 farmers on three subject matter areas of oil palm cultivation (Table 25).

Organised 15 training programmes on "oil palm cultivation" at NRC for Oil Palm,

Table 24. Training programmes organized for officers.

Sl. No.	Date	Programme	Venue	Trainees represented from	No. of Participants
1	20-25. 08. 2007	Oil Palm Production Technology	NRCOP, Pedavegi, A. P.	Andhra Pradesh, Mizoram, Tamil Nadu, Karnataka, Orissa, Chhatisgarh.	38
2	19-21.09.2007	Oil Palm Hybrid Seed Production	NRCOP, RS, Palode	A. P. , Kerala	9
3	17-19.10.2007	Plant Protection in Oil Palm	NRCOP, Pedavegi, A. P.	A. P., Mizoram, Tamil nadu, Karnataka, Kerala	16
4	14-16.11.2007	Nursery Management in Oil Palm	NRCOP, Pedavegi, A. P.	Gujarat, Orissa, Karnataka, A. P.	6
				Total	**69**

Table 25. Farmers training programmes

Sl. No	Training programme	No of programmes organized	No of farmers participated
1	Oil Palm cultivation		
	Organized at NRC for oil palm, Pedavegi	15	449
	Organized at Farmers plantations	15	1158
2	Irrigation and Nutrient Management in Oil Palm Organized at Farmers plantations	3	130
3	Plant Protection in Oil Palm Organized at Farmers plantations	6	410
	A. Total	**39**	**2147**

Table 25 a. Farmers training on "Oil Palm Cultivation" organized at NRCOP, Pedavegi

Sl. No.	Date	Place & state of farmers represented	No. of Participants
1	10.04.2007	Bellari, Karnataka	46
2	25.04.2007	Lunglai, Kolasib, Mamit, Mizoram	22
3	30. 04.2007	Anantapur, A. P.	31
4	03.05 2007	Srikakulam, A. P.	23
5	24. 09. 2007	Valsad, Gujarat	19
6	25-26 October 2007	Belgaum Dist., Karnataka	21
7	27.11.2007	Surat, Gujarat	32
8	3.12.2007	Mizoram	25
9	26-28 December 2007	Valsad, Gujarat	33
10	17.3.2008	Krishna Dist., A. P.	33
11	18.3.2008	Krishna Dist., A. P.	25
12	18.3.2008	Tanjavur, Tamil Nadu	50
14	19.3.2008	Krishna Dist., A. P.	47
15	24.3.200842	Chittoor Dist, A. P.	42
		Total	**449**

Pedavegi to 449 farmers from Gujarat, Karnataka, Mizoram and A. P. ; fifteen on farm trainings on "Oil Palm cultivation" were conducted to 1158 farmers in A.P. and Orissa; three on farm trainings were conducted on "Nutrient and Water Management in Oil Palm" to 130 farmers and 6 on farm trainings were conducted on "Plant protection in Oil Palm" to 410 farmers in A.P. Lectures delivered in respective subjects and farmers doubts were clarified, field visits were organised and literature on oil palm was also provided.

Consultancy project on "Research-cum-Development Project on Oil Palm in Karnataka

A Consultancy Project on "Oil Palm Development in Karnataka" was taken up with the Govt. of Karnataka during November 2004 and was successfully completed by August 2007. The project helped in bringing more area under oil palm cultivation in Karnataka state. Besides this, it has also helped in boosting the productivity of oil palm plantations by identifying the constraints faced by the growers and their critical solution. The major activities under the project are as under:

- Project assistants (16 nos.) posted under this project listed the problems faced by the oil palm growers; they did analyze the management practices and suggested the measures to improve the overall productivity of the plantation.
- The basic data on oil palm growers (like area under cultivation, type of soil,

Table 25 b. On Farm training on "Oil Palm Cultivation"

Sl. No	Date	Place at which the Training Programme organized	No. of Participants
1	07. 06. 2007	Berhampur, Orissa	271
2	12. 06. 2007	Makkinavari Gudem, T. Narsapuram Mandal, W. G. Dist	80
3	14. 08. 2007	Taniyali, Nellore, A. P.	65
4	30.10.2007	Gandepalli, E. G. Dist, A.P.	43
5	30.10.2007	Rangampeta, E. G. Dist, A.P.	41
6	20.12.2007	Sitanagaram, E. G. Dist., A. P.	45
7	20.12.2007	Tokada, E. G. Dist, A. P.	51
8	17.1.2007	Medepalli Village, Khammam District, A.P.	75
9	25.1.2007	Chebrolu, West Godavari Dist. A.P.	60
10	14.2.2008	Saripalle, Koyyalagudem Mandal, West Godavari Dist. A.P.	72
11	25.2.2008	Palwancha, Khammam Dist. A.P.	50
12	26.2.2008	Enkoor, Khammam Dist. A.P.	50
13	28.2.2008	Parvatipuram, Vizianagaram Dist. A.P.	150
14	5.3.2008	Boddavara, S.Kota Mandal, Vizianagaram Dist. A.P.	50
15	22.3.2008	Chintalapudi, West Godavari Dist. A.P.	55
		Total	**1158**

source of irrigation, cultural practices being followed, attitude of farmers towards oil palm etc) were generated through schedules.

- Survey on pests and diseases in oil palm growing areas was conducted
- Survey indicated that Oil palm plantations generally suffer from water stress and poor agronomic management; harvesting from tall palms was also reported to be a major problem.
- The project has also helped in motivating farmers for going for adoption of micro-irrigation systems to a greater extent.
- The project has in general helped in identifying the basic problems at individual plantation level and the probable factors responsible for low productivity.

Field days organized

Field days on "Cocoa as intercrop in Oil palm" were organized by Dr. P. Kalidas, Pr. Scientist at Aswaraopet, Khammam Dt., and Eleswaram, E.G.Dt., on 27th and 30th October 2007 respectively. At Eleswaram, Dr. M. Kochu Babu, Director, NRCOP presided over the meeting and Dr. V. Krishna Murthy, Director, CTRI was the chief guest. These programmes were organized in collaboration with Directorate of Cashew and Cocoa Development Board, Cochin.

Farmers meets attended

Dr. P. Kalidas

Attended the following farmers meetings/awareness campaigns organized by the department of horticulture of respective states and delivered lectures on oil palm pest management:

Table 25 c. On farm training on "Nutrient and Water Management in Oil Palm".

Sl. No	Date	Place at which the Training Programme organized	No. of Participants
1	6.11.2007	Jaggampeta, E. G. Dist, A. P.	43
2	6.11.2007	Tuni, E. G. Dist., A. P.	57
3	20.2.2008	Bhimadole, West Godavari Dist.	30
		Total	**130**

Table 25 d. On Farm training on "Plant Protection in Oil Palm".

Sl. No	Date	Place at which the Training Programme organized	No. of Participants
1	18.12.2007	Pallerlamudi, Krishna Dist, A. P.	50
2	18.12.2007	Velpucherla, Musunuru Mandal , Krishna Dist, A. P.	50
3	26.12.2007	Rangannagudem, Nuzvid Mandal, Krishna Dist, A. P.	50
4	13.1.2008	Attada, Raigadh, Orissa	100
5	6.2.2008	Nidadavole, West Godavari Dist, A. P.	60
6	22.3.2008	Vegavaram, Jangareddygudem Mandal, West Godavari Dist, A. P.	100
		Total	**410**

- At Taniyali of Doravarisatram mandal of Nellore Dt., Andhra Pradesh on August 14, 2007
- At Bapulapadu and Musunur mandals of Krishna Dt., A.P. on December 18, 2007
- At Rangannagudem, Nuziveedu mandal, Krishna Dt., A.P. on December 26, 2007
- At Purushottampalli, Nidadavolu mandal, West Godavari Dt., A.P. on February 6, 2008
- At Vegavaram, Jangareddygudem mandal, West Godavari Dt., A.P. on March 22, 2008.
- At Attada, Rayagada Dt., Orissa, on January 12, 2008

All India Radio Programmes

Dr. V. M. Reddy

Participated in Live Phone-in-Programme conducted by All India Radio, Vijayawada on "Oil palm lo yeruvula mariyu neeti yajmanyam" (Nutrient and water management in oil palm) on 11-10-2007.

Dr. P. Kalidas

Interview on integrated pest management practices in Oil palm for the benefit of oil palm growers on 22nd October, 2007 at All India Radio, Vijayawada (Broadcasted on 14th November, 2007 from 7.15pm to 7.45pm).

Dr. M. V. Prasad

Radio Talk (interview) on Oil Palm cultivation, Government Support Programmes, Constraints, Suggesting appropriate technologies and Training etc., on 14.4.2007 at All India Radio (AIR), Vijayawada, A. P.

Radio Talk on Oil Palm Sagu – Live Phone in Programme at All India Radio (AIR), Vijayawada, A. P. broadcasted on 9.8.2007.

Radio Talk (interview) on Oil Palm sagu, Government Support Programmes, broadcasted through All India Radio (AIR), Vijayawada, A. P on 15.12.2007.

Television programmes

Dr. M. V. Prasad

Organized video recording (on 21.2.2008) of following programmes viz., irrigation management, pest and disease management in oil palm production for Doordarshan, Vijayawada, A. P. for telecasting in Kisan Programmes.

Participated in the farmers meetings / interaction programmes organized by Doordarshan Kendra, Hyderabad at Surappagudem village (Bhimadole Mandal), Krishanayapalem (Tadepalligudem Mandal) on 12.2.2008 and 13.2.2008 respectively. Farmers doubts / questions pertaining to oil palm cultivation were clarified. Entire programme was live recorded and telecasted on 4.3.2008 and 5.3.2008 in Saptagiri channel.

Dr. P. Kalidas

Acted as resource person for Doordarshan, Prasara Bharathi, Vijayawada recording on "Research on oil palm held in oil palm plantations of NRCOP" on 21 February, 2008.

Dr. V. M. Reddy

Participated in following video recordings for ETV on 19 May, 2007 and for Doordarshan, Prasara Bharathi, Vijayawada on 21 February, 2008;

- Oil Palm – Summer management to sustain yields.
- Efficient water management in summer for oil palm.
- Integrated nutrient management in oil

palm plantations- age wise.

- Package of practices for new growers. Soil preparation, method of planting, no. of plants/acre, basal dosage of fertilizers and manures.

Digital video film on Oil Palm

A Digital Video film "THE GOLDEN PALM" was brought out. The video film was shot in two schedules at various locations in A. P. Completed the shooting of video film, compiled and edited for Master video copy in English. The video film in English is completed. Arrangements were made to translate and bring out the film in 8 more Indian languages viz., Hindi, Telugu, Tamil, Malayalam, Kannada, Oriya, Mizo and Gujarati.

Digital video film on Oil Palm Production Technology useful for the farmers and officers for gaining the basic information in oil palm cultivation was taken up and it is in the process of shooting.

Video CD covering all the aspects of Oil Palm hybridization, seed processing, sprouts development is being prepared for the benefit of seed production personnel and others.

Exhibitions

Material required for exhibition and kisan mela i.e. posters; charts, models and specimens were prepared for participation in Exhibitions and Kisan melas.

Pedavegi

Participation in Exhibitions

- Horticulture Summit 2007 by Central Institute for Subtropical Horticulture at Lucknow during 16-19 June 2007.
- National Conference on Oil Palm-"Oil Palm for Farmers' Prosperity and edible oil security" held at Vijayawada, A. P. during 2-4 February, 2008.
- Horticulture Show organized by Department of Horticulture, Govt. of A. P. during 23-25 February, 2008 at Eluru, West Godavari Dist. A. P.

Provided Exhibits to the following

- Exhibition organized at "National Conference on Banana" during 25-28 October, 2007.
- Rytu Sadassu organized by B. Sc Final Year students of RHWEP & RAWEP at Vijayarai and Bhimadole during 8-9 January 2008.
- A.P. Oilfed to participate in the Horticulture Trade Fair 2008 held at Hyderabad, A. P. during 25-29 January, 2008.
- International Horticulture Expo during 31 January 2008 to 2 February 2008 at New Delhi.

Palode

Participated in the exhibitions as per details given below:

S. No.	Period	Exhibitions Participated - Palode
1	26.03.07 to 02.04.07	Thumbodu, Kallara, Trivandrum
2	25.10.07 to 28.10.07	NRC for Banana, Trichi, Tamil Nadu
3	26.12.07 to 30.12.07	Agri Fair at Neyyattinkara, Trivandrum
4	07.02.08 to 15.02.08	Agri Fair at Palode, Pacha, Trivandrum

Queries on oil palm

- Queries of oil palm growers regarding cultivation practices received through letters and phone calls were attended and replies were given for successful cultivation of oil palm. Entrepreneur/ developmental department letter queries were also answered from time to time.

Students Visit to NRCOP, Pedavegi

During the reporting period several student exposure visits were organised at the centre. The details of such visits are given in the table below :

Academic activities

Dr. P. K. Mandal delivered lectures on Application of Biotechnolgy and Biochemistry for Oil Palm Improvement and Dr. M. Jayanthi conducted Lab demonstration to the Under Graduate and Post Graduate students of the following colleges who visited NRCOP:

- Koneru Lakshmaiah Engineering college, Vijayawada

Sl. No	Date	College	Number of students
1	3.10.2007	Koneru lakshmaiah college of Engineering, Guntur, A. P.	60 B. Tech students
2	2.11.2007	College of Agriculture, Bapatla and Aswaraopet, A. P.	30 B.Sc (Ag.) Final year RAWEP students from Bapatla. 21 B.Sc (Hort.) Final year RAWEP students from Aswaraopet, A.P.
3	30.11.2007	Government College for Women, Guntur.	30 Final year students of Micro biology and Bio chemistry
4	11.12.2007	Andhra Loyola College, Vijayawada.	56 M. Sc Botany Final Year students

At NRCOP, RS, Palode

Six one day training programs were conducted to students at RS, Palode during 2007- 2008. The details are as given below:

S. No	Date	No. of students	Particulars
1	22.08.2007	24	Adhiparasakthi Agricultural College, Vellore, Tamil Nadu
2	04.10.2007	6	Govt UP School, Peringamala, Trivandrum
3	05.10.2007	92	Annamalai University, Tamil Nadu
4	10.10.2007	41	-do-
5	02.11.2007	8	Govt UP School, Anachal, Trivandrum
6	08.02.2008	17	Aspee College of Horticulture And Forestry Navasari
	TOTAL	**188**	

- Government College for Women, Guntur
- Loyala college, Vijayawada

Dr. P. K. Mandal

Delivered lectures on different aspects of Molecular Biology and Biotechnology to the Lecturers and Graduate Students of Biotechnology and Microbiology at St. Theresa's College for Women on September 10, 2007.

Dr. M. Jayanthi

Delivered lectures on the following topics to students and staff of St. Theresa's college, Eluru on August 4, 2007.

- Social and Ethical issues in Biotechnology
- DNA fingerprinting techniques with emphasis on RAPD and RFLP

Demonstrated Tissue culture techniques to the staff of St. Theresa's college, Eluru on 14^{h} December 2007

Postgraduate studies committee:

A post graduate studies committee is under operation at the institute which coordinates the Post-graduation & PhD Programmes that are being taken up by the students of various universities and also by the staff of NRC for Oil palm.

NRC for Oil palm entered into MOU with Acharya Nagarjuna university, Guntur, A.P and Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu. Through the memorandum of understanding NRC for Oil palm and Acharya Nagarjuna university; NRC for Oil palm and Tamil Nadu Agricultural University enter into mutual research collaboration that would benefit the students of the universities as well as staff of NRCOP.

Many students from various universities have taken up project works at NRCOP under the guidance of the NRCOP scientists in partial fulfillment of their B.Tech/ M.Sc./ M.Phil./ Ph.D. programmes.

The following is the list of scientists recognised as research guides in various universities:

Name of the scientist	Discipline	University
Dr. M. Kochu Babu Director	Biotechnology Botany Microbiology Environmental Sciences	Acharya Nagarjuna University, Guntur, A.P
Dr. V. M. Reddy	Botany	Acharya Nagarjuna University, Guntur, A.P
Dr. P. Kalidas	Biotechnology	Acharya Nagarjuna University, Guntur, A.P
Dr. R. K. Mathur	Botany Genetics & Plant breeding	Acharya Nagarjuna University, Guntur, A.P ANGRAU, Hyderabad, A.P(for M.Sc(Ag) students)
Dr. P. K. Mandal	Biochemistry, Biotechnology Genetics & Plant breeding	Acharya Nagarjuna University, Guntur, A.P ANGRAU, Hyderabad, A.P(for M.Sc(Ag) students)
Dr. P. Murugesan	Botany Biotechnology	Acharya Nagarjuna University, Guntur, A.P
Dr. K. Suresh	Botany Biochemistry	Acharya Nagarjuna University, Guntur, A.P
Dr. M. Jayanthi	Biotechnology	Acharya Nagarjuna University, Guntur, A.P

PROJECT WORKS CARRIED OUT BY STUDENTS AT THE INSTITUTE:

Name of the student	Discipline & College	Period of project work	Title of project work	Guide
Ms. E. Neharika	B.Tech. Biotechnology Al Ameer College of Engineering and Information technology, Visakhapatnam	April, 2007	Studies on oil quality in crude palm oil extracted from sterilized and un-sterilized fruits	Dr. P. K. Mandal
Mr. Samrat Laha	M.Sc. Plant breeding Agricultural College, ANGRAU, Bapatla	Continuing	Genetic diversity study of two different species of oil palm (*Elaeis oleifera* and *Elaeis guineensis*) using RAPD and SSR markers.	Dr. P. K. Mandal(As Chairman of the Advisory Committee)
Mr. Mihir Ranjan Mohanty	M.Sc. Plant breeding Agricultural College, ANGRAU, Bapatla	Continuing	Use of RAPD and SSR markers to study genetic diversity of high yielding dura oil palm (*Elaeis guineensis* Jacq.)	Dr. P. K. Mandal(As Chairman of the Advisory Committee)
G. Sujatha	Ph. D. (Biotechnology), Nagarjuna University, Guntur	Continuing	Use of RAPD and SSR markers to study genetic diversity of high yielding dura oil palm (*Elaeis guineensis* Jacq.)	Dr. P. K. Mandal
Ms.M. Gouthami Krishna Kumari	M. Sc (Biotechnology), Nagarjuna University, Guntur	Jul-07	Random amplified polymorphic DNA studies with bulked DNA of Dura, Pisifera and Tenera of oil palm *Elaeis guineensis (Jacq)*	Dr. M. Jayanthi
Ms . Koneti Jaya Lakshmi	M. Sc (Biotechnology), Nagarjuna University, Guntur	Jul-07	Screening RAPD primers in bulked DNA of Dura and Pisifera of oil palm *Elaeis guineensis (Jacq)*	Dr. M. Jayanthi
Mr. G Srinivas Rao	M. Sc (Biotechnology), JJ College of Arts and Science, Pudukottai, Tamil Nadu	Mar-08	Assessment of genetic variation in oil palm collected from farmers fields using microsatellite primers	Dr. M. Jayanthi

Name of the student	Discipline & College	Period of project work	Title of project work	Guide
Mr. M. Naveen Kumar	M. Sc (Biotechnology), JJ College of Arts and Science, Pudukottai, Tamil Nadu	Mar-08	Estimation of shell thickness, moisture and oil content in three different fruit forms of oil palm (*Elaeis guineensis* Jacq)	Dr. M. Jayanthi
Ms. R. Vijaya Swarupa	M. Sc (Biotechnology), DNR college of PG courses, Bhimavaram, A.P	Jul-07	Estimation of shell thickness, moisture and oil content in three different fruit forms of oil palm (*Elaeis guineensis* Jacq)	Dr. P. Kalidas
Ms. G. Hope Evangeline	M.Tech (Biotechnology), Nagarjuna University, Guntur	Jul-07	Studies on comparative protein variations in *Metarhizium anisopliae*, *Tricoderma viride* and *Beauveria bassiana* using SDS-PAGE	Dr. P. Kalidas
Ms. P. Sushma Josphin	M. Sc (Biotechnology), Nagarjuna University, Guntur	Jul-07	Studies on the impact of biotrends on the earthworms in vermi compost beds	Dr. P. Kalidas
Ms. I Suneetha	M. Sc (Biotechnology), (Biotechnology), Nagarjuna University, Guntur	Jul-07	Studies on the impact on mixing of neem cake with growth media on sporulation of bioagents	Dr. P. Kalidas
Ms. S.V.L.Lalitha	M. Sc (Microbiology), CRR college for women, Eluru, A.P	Jul-07	Studies on impact of bioagents and chemical pesticides on the growth of pollinating weevils of oil palm	Dr. P. Kalidas
Ms. B. Vijayalakshmi	M. Sc (Appl. Microbiology), Vivekananda college of Arts & Science Elayampalayam, Tamil Nadu	Mar-08	Studies on impact of stirring of inoculated cultures of *Metarhizium anisopliae* on the production of spores and their infectivity on the oil palm pests	Dr. P. Kalidas
Mr. C.V.Chandra sekhar	M. Sc (Appl. Microbiology), JJ College of Arts and Science, Pudukottai, Tamil Nadu	Mar-08	Studies on protein variation in Rhinocerus beetle due to *Metarhizium anisopliae* and abiotic factors	Dr. P. Kalidas

Name of the student	Discipline & College	Period of project work	Title of project work	Guide
Mr. P.V.Gupta Rao. Ch	M. Sc (Appl. Microbiology), JJ College of Arts and Science, Pudukottai, Tamil Nadu	Mar-08	Studies on impact of mixing of neem cake with growth media on sporulation of bioagents	Dr. P. Kalidas
Mr. S. Srinivas	M. Sc (Appl. Microbiology), JJ College of Arts and Science, Pudukottai, Tamil Nadu	Mar-08	Studies on efficacy of *Beauveria bassiana* on leaf eating caterpillar of oil palm	Dr. P. Kalidas
Ms. J. Rani	M.Sc (Biotechnology), SVKP Dr, KS Raju College, Penugonda	Mar-08	Studies on comparative protein variations in *Metarhizium anisopliae*, *Tricoderma viride* and *Beauveria bassiana* using SDS-PAGE	Dr. P. Kalidas

6. AWARDS AND RECOGNITIONS

- Dr. M. V. Prasad is a member Internal Quality Assurance Cell and Academic council of CH. S. D. St. Theresas college for women, Eluru and attended Academic Council meeting on 2.3.2008

- Best poster award was received for the paper "Optimization of PCR Reagents for amplification of micro-satellites in oil palm" by M. Jayanthi, G. Sujatha and P. K.Mandal in the Second Indian Horticulture Congress on Opportunities and linkages for Horticulture Research and Development held at ICAR Complex for NE region, Barapani, Meghalaya during April 18-21 2007

- Second best poster award was received for the contributory article "Influence of different growth media on growth of germinated oil palm hybrid seeds" by P. Murugesan and G. Bijimol in the National conference on Oil palm for farmers' prosperity and edible oil security held at Vijayawada, A.P during February 2-4 2008

7. LINKAGES AND COLLABORATION

National Research Centre for Oil Palm is maintaining linkages with the following National and International Institutes / Agencies:

A. National

- Technology Mission on Oil Seeds Pulses and Maize (TMOP&M)
- National Agricultural Innovation Project (NAIP)
- State Departments of Agriculture/ Horticulture, Govt. of Andhra Pradesh, Tamil Nadu, Karnataka, Kerala, Goa, Gujarat, Orissa, Mizoram and Chattisgarh
- State Agricultural Universities of oil palm growing states
- Entrepreneurs involved in oil palm development
- Agricultural Finance Corporation
- Oil Palm India Ltd (OPIL), Kottayam, Kerala
- CIRCOT, Mumbai

B. International

- Malaysian Palm Oil Board, Malaysia
- ASD Costa Rica
- IDEFOR, Ivory Coast
- DAMI, Papua New Guinea
- CIRAD-CP, Montpellier, France
- BUROTROP - Paris, France
- UNIVANICH, Thailand

This centre has been providing technical advice to TMOP&M and State Agriculture/ Horticulture Departments on all aspects of oil palm cultivation. The TMOP&M funds are being utilized for the following programmes:

- Strengthening of training on oil palm production in which the staff involved in oil palm research and development as well as farmers are trained.
- Leaf nutrient analysis laboratory meant for analyzing the leaf samples for effective scheduling of fertilizers.
- Strengthening of oil palm seed gardens for indigenous seed production which is aimed at improving the indigenous oil palm hybrid seed production
- Research cum demonstration of oil palm genotypes under varied environments
- Establishment of tissue culture laboratory for oil palm to strengthen the infra structure facilities for tissue culture programme.

8. AICRP/CO-ORDINATION UNIT/NATIONAL CENTRES

The activities of oil palm under All India Coordinated Research project on Palms (AICRP, Palms) are being monitored by the Project Coordinator (Palms) at Central Plantation Crops Research Institute (CPCRI, Kasaragod).

9. PUBLICATIONS

Research papers

- Kalidas, P., Prabhakar Rao, K.J. and Kochu Babu, M. 2007. Economics of oil palm *Elaeis guineensis* Jacq. nursery maintenance in Andhra Pradesh, *Journal of Oilseeds Research* **24**(2):354-355
- Murugesan, P., Mathur, R.K., Bijimol, G. and Ravi Kumar, M. 2008. Effect of extended dry heat treatment on germination and seedling growth in Oil Palm (*Elaeis guineensis*, Jacq.) var. dura mother palms, *Journal of Plantation Crops* **36**(1): 250-253

Popular articles

- Kochu Babu, M. 2007. Oil palm-A sustainable oil yielding crop. Souvenier-2nd M.S.Swaminathan Award 2007. Agriculture for Tomorrow: catering to the needs of under privileaged classes RICAREA, 2007 Eds PSPV Vidya Sagar and MVS Sastry. pp 62-65.
- Prasad, M.V. and Sampath Kumar, P. 2008. Oil Palm nurserylo culling-Telugu (Culling in oil palm nursery). Annadata monthly Telugu Agricultural Journal, January 2008. pp 52-53.

Technical bulletins/compilations/books

- Vision-2025 of NRC for Oil Palm. Compiled and edited by Kochu Babu, M., Suresh, K., Mandal, PK., Bhanusree, A., and Mathur, R.K. 2007. Published by M. Kochu Babu, Director, NRCOP, Pedavegi (A.P.), pp-54.
- Souvenir and Abstracts, National conference on oil palm, "Oil palm for farmers' prosperity and edible oil security", Hotel Fortune murali park, Vijayawada, A.P., India. February 2-4 2008. Eds P. Rethinam and P.K. Mandal
- Annual report 2006-07
- Newsletter volume 11, January-December 2006, Issues 1&2
- Technical bulletin on Quality seed from NRC Oil Palm Palode. 2008. Compiled by Murugesan, P, Krishnakumar, T., Santhoshkumar, J., Salini, C., Gopakumar, S. and Mathur, R.K. 2008. (Eds. P. Murugesan and M. Kochu Babu) Published by M. Kochu Babu, Director, NRC for Oil Palm, Pedavegi (A.P.)
- Prasad M. V. 2008. Oil Palm cultivation, National Research centre for Oil Palm, Pedavegi.

Electronic Publications

- Prasad, M.V., Suresh, K. and Mandal, P.K., 2008. The Golden Palm. Published by Dr. M. Kochu Babu, Director, NRCOP, Pedavegi (20 Minutes DVD).

Scientific review papers

- Kalidas, P., Kochu Babu, M. and Chander

Rao, S. 2008. Pest and disease management in oil palm-Indian context. In: Souvenir and Abstracts, National conference on oil palm, oil palm for farmers' prosperity and edible oil security. Vijayawada, A.P. February 2-4 2008. pp. 39-47.

- Kochu Babu, M. 2008. Oil palm research in India – A national perspective. In: Souvenir and Abstracts, National conference on oil palm, oil palm for farmers' prosperity and edible oil security. Vijayawada, A.P. February 2-4 2008. pp 10-14.
- Mandal, P.K., Jayanthi, M. and Kochu Babu, M. 2007. Oil palm Biotechnology-A Status Paper. In: Proceedings of the National Seminar on Horticulture Biotechnology, Present status & Future action plan. IIHR, Bangalore. December 8 2007. pp 209-215 .
- Mandal, P.K., Kochu Babu, M. and Jayanthi, M. 2007. Molecular Diagnostics Of Oil Palm Diseases – A Status Paper. In: Proceedings of the National Seminar on Horticulture Biotechnology, Present status & Future action plan. IIHR, Bangalore. December 8 2007. pp. 253-257.
- Mandal, P.K., Jayanthi, M. and Kochu Babu, M. 2007. Oil Palm Tissue Culture-A status report. In: Proceedings of the National Seminar on Horticulture Biotechnology, Present status & Future action plan. IIHR, Bangalore. December 8 2007. pp. 76-77.
- Mandal, P.K. and Jayanthi, M. 2008. Biotechnological Strategies for improving oil palm. In: Souvenir and Abstracts, National Conference on Oil Palm, Oil palm for farmers' prosperity and edible oil security, held at Vijayawada, 2-4 February pp. 23-29.
- Mathur, R.K., Murugesan, P. and Jayanthi, M. 2008. Status of oil palm hybrid seed production in India. In: Souvenir and Abstracts, National conference on oil palm, oil palm for farmers' prosperity and edible oil security. Vijayawada, A.P. February 2-4 2008. pp. 30-32
- Prasad, M.V., Rethinam, P., Kochu Babu, M. and Dhander, D.G. 2008. Oil palm-technology dissemination and it's adoption. In: Souvenir and Abstracts, National conference on oil palm, oil palm for farmers' prosperity and edible oil security. Vijayawada, A.P. February 2-4 2008. pp. 48-53.
- Reddy, V.M. and Suresh, K. 2008. Oil palm production research in India under irrigated conditions In: Souvenir and Abstracts, National conference on oil palm, oil palm for farmers' prosperity and edible oil security. Vijayawada, A.P. February 2-4 2008. pp. 33-38.

Book Chapters

- Mandal, P.K. and Pillai, R.S.N. 2007. Screening of PCR primers for oil palm (*Elaeis guineensis* Jacq.) shell thickness marker. In: recent Trends in Horticulture Biotechnology (Eds. Raghunath Keshvachandran *et al.*), New India Publishing Agency, New Delhi. pp 613-617.
- Murugesan, P. 2007. *Elaeis guineensis* In: Advances in Seed Science and Technology Vol 4 Forest Tree seed Production (Eds K. Vanangamudi *et al*) Agrobios publishers, Jodhpur India. pp. 176-216

Seminars/symposia/conference and other fora

- Ananta Sarkar, Mathur, R.K., Reddy, V.M., Kochu Babu, M. and Raghu, K.

2008. Application of statistical models in selection of promising hybrids. Contributory article In: Souvenir and Abstracts, National conference on oil palm, oil palm for farmers' prosperity and edible oil security. Vijayawada, A.P. February 2-4 2008. pp. 112

- Jayanthi, M., Sujatha, G. and Mandal, P.K. 2007. Optimization of PCR Reagents for amplification of micro-satellites in oil palm. In: Abstracts of the Second Indian Horticulture Congress on Opportunities and linkages for Horticulture Research and Development. ICAR Complex for NE region, Barapani, Meghalaya. April 18-21 2007. pp 105-106.
- Jayanthi, M. and Mandal, P.K. 2008. Biotechnological tools to detect somaclonal variation in oil pam . Contributory article. In: Souvenir and Abstracts, National Conference on Oil Palm, Oil palm for farmers' prosperity and edible oil security, held at Vijayawada, 2-4 February. pp. 74.
- Jayanthi, M. and Mandal, P.K., Suresh, K. and Sunitha,B. 2008. Preliminary observations on tissue culture of oil palm . Contributory article. In: Souvenir and Abstracts, National Conference on Oil Palm, Oil palm for farmers' prosperity and edible oil security, held at Vijayawada, 2-4 February. pp. 80.
- Kalidas, P. and Satyavani, V. 2007. Biopesticides and their role in environmental protection. Souvenir and abstracts 'National seminar on recent trends in Plant sciences' held in Guntur during 28-29 June, 2007. pp. 11-14.
- Kalidas, P., Satyavani, V. and Kochu Babu, M. 2007. Role of Biotechnology in the production of Biopesticides. Souvenir and Abstracts 'National seminar on Advances in Environmental Biotechnology' held in Vuyyuru during 17-18 August, 2007. pp. 122-123.
- Kalidas, P. 2008. Integrated pest management in oil palm. Invited article In: Souvenir and Abstracts, National conference on oil palm, oil palm for farmers' prosperity and edible oil security. Vijayawada, A.P. February 2-4 2008. pp. 98
- Kalidas, P. 2008, Multiplication of biopesticides and commercial out look. Paper presented in the 'National Seminar on Industrial biotechnology-its scope and perspectives' held at JKC college, Guntur on 23 February, 2008.
- Kochu Babu, M. 2008. Integrated disease management in oil palm. Invited article In: Souvenir and Abstracts, National conference on oil palm, oil palm for farmers' prosperity and edible oil security. Vijayawada, A.P. February 2-4 2008. pp. 99
- Mandal, P.K., Krishna Kumar, T. and Sujatha, G. 2007. Studies on the parthenocarpic fruits of *Elaeis oleifera* species of oil palm for their oil content and fatty acids composition. In: Abstracts of the Second Indian Horticulture Congress on Opportunities and linkages for Horticulture Research and Development. ICAR Complex for NE region, Barapani, Meghalaya. April 18-21 2007. pp 117.
- Mandal, P.K. and Ravi Kumar, M. 2007. Qualitative and quantitative changes in mesocarp oil during fruit maturation of Dura oil palm *Elaeis guineensis*. In: Abstracts of the Second Indian Horticulture Congress on Opportunities and linkages for Horticulture Research and Development. ICAR Complex for NE region, Barapani, Meghalaya. April 18-21 2007. pp 270.

- Mandal, P.K., Rajesh, M. and Venkateswarulu, T. C. 2007. Esterase and Peroxidase isozyme profile and peroxidase activity in all the healthy leaves of *dura* and *pisifera* variety of oil palm (*Elaeis guineensis* Jacq.). In: Abstracts of International Symposium on Management of Coastal Ecosystem: Technological Advancement and Livelihood Security. CSSRI, Canning Town, West Bengal. October 27-30, 2007. pp. 42.
- Mandal, P.K. and Jayanthi, M. 2008. Oil Palm Biotechnological in India- Past, Present and Future. Invited article. In: Souvenir and Abstracts, National Conference on Oil Palm, Oil palm for farmers' prosperity and edible oil security, held at Vijayawada, 2-4 February pp. 72-73.
- Mandal, P.K., Satyavani, V. and Kochu Babu, M. 2008. Studies on colony morphology and sporulation of different *Ganoderma* isolates, detected by PCR, causing basal stem rot disease of oil palm. Contributory article In: Souvenir and Abstracts, National conference on oil palm, oil palm for farmers' prosperity and edible oil security. Vijayawada, A.P. February 2-4 2008. pp. 101..
- Mandal, P.K. and Sujatha, G. 2008. Gas Chromatograph Mass Spectroscopy method for analysis of fatty acids composition of palm oil using BPX-70 capillary column. Contributory article. In: Souvenir and Abstracts, National conference on oil palm, oil palm for farmers' prosperity and edible oil security. Vijayawada, A.P. February 2-4 2008. pp. 101..
- Mathur, R.K., Saritha, K., Ravi Kishore, P. and Anuradha, B. 2008. Bunch component analysis in oil palm. Contributory article In: Souvenir and Abstracts, National conference on oil palm, oil palm for farmers' prosperity and edible oil security. Vijayawada, A.P. February 2-4 2008. pp. 76
- Murugesan, P. 2008. Status of indigenous oil palm hybrid seed production. Invited Article In: Souvenir and Abstracts, National conference on oil palm, oil palm for farmers' prosperity and edible oil security. Vijayawada, A.P. February 2-4 2008. pp. 79-80
- Murugesan, P., Bijimol, G., Mathur, R.K. and Gopakumar, S. 2008. Nut component analysis of exotic and indigenous sources of oil palm (*Elaeis guineensis*, Jacq) planting materials. Contributory Article In: Souvenir and Abstracts, National conference on oil palm, oil palm for farmers' prosperity and edible oil security. Vijayawada, A.P. February 2-4 2008. pp. 73
- Murugesan, P. and Gopakumar, S. 2008. Phenotypic variation in nut and kernel traits of oil palm (*Elaeis guineensis*, Jacq) exotic and indigenous hybrids. Contributory Article In: Souvenir and Abstracts, National conference on oil palm, oil palm for farmers' prosperity and edible oil security. Vijayawada, A.P. February 2-4 2008. pp. 81
- Murugesan, P. and Bijimol, G. 2008. Influence of different growth media on growth of germinated oil palm hybrid seeds. Contributory Article In: Souvenir and Abstracts, National conference on oil palm, oil palm for farmers'prosperity and edible oil security. Vijayawada, A.P. February 2-4 2008. pp. 81.
- Murugesan, P. and Bijimol, G. 2008. Effect of PIT pre-heat treatment on germination of oil palm (*Elaeis guineensis*, Jacq) dura seeds. Contributory Article In: Souvenir and

Abstracts, National conference on oil palm, oil palm for farmers' prosperity and edible oil security. Vijayawada, A.P. February 2-4 2008. pp. 82

- Prasad, M. V. and Kochu Babu, M. 2007. "Multidimensional approaches for human resource development in oil palm production" National Seminar on Appropriate Extension Strategies for Management of Rural Resources, UAS, Dharwad, Karnataka Souvenir & Abstracts. pp. 209.
- Prasad, M.V. 2008. Farmer's initiatives in oil palm development in India-steadily marching ahead. Invited Article In: Souvenir and Abstracts, National conference on oil palm, oil palm for farmers' prosperity and edible oil security. Vijayawada, A.P. February 2-4 2008. pp. 113
- Prasad, M.V., Rethinam, P., Kochu Babu, M. and Dhander, D.G. 2008. Oil palm-technology dissemination and it's adoption. Invited article In: Souvenir and Abstracts, National conference on oil palm, oil palm for farmers' prosperity and edible oil security. Vijayawada, A.P. February 2-4 2008. pp. 110
- Raghava Rao, E., Begum, A., Kochu Babu, M. and Venkata Seshaiah, Ch. 2008. Utilization of feeds containing palm oil mill effluent (POME) in buffaloes. Contributory article In: Souvenir and Abstracts, National conference on oil palm, oil palm for farmers' prosperity and edible oil security. Vijayawada, A.P. February 2-4 2008. pp. 107
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- Reddy, V.M. and Prasad, M.V. 2007. Banana - A potential intercrop in juvenile oil palm plantations in Andhra Pradesh. Poster paper In: Souvenir and Abstracts, National Conference on Banana. Tiruchirapalli, Tamil Nadu. October25-28, 2007. Pp 126-127
- Reddy, V.M. and Suresh, K. 2008. Oil palm based cropping systems under irrigated conditions-Indian scenario. Invited article In: Souvenir and Abstracts, National conference on oil palm, oil palm for farmers' prosperity and edible oil security, Vijayawada, A.P. February 2-4 2008. pp. 87-88.
- Reddy, V.M. and Suresh, K. 2008. Nutrient uptakes in oil palm based cropping system during juvenile phase. Contributory article In: Souvenir and Abstracts, National conference on oil palm, oil palm for farmers' prosperity and edible oil security, Vijayawada, A.P. February 2-4 2008. pp. 92-93
- Satisha, G.C., Sunitha, S., Swarna Latha and Kochu Babu, M. 2008. Kari land soils of Kerala, India: physico-chemical characteristics and constraints for oil palm cultivation. Contributory article In: Souvenir and Abstracts, National conference on oil palm, oil palm for farmers' prosperity and edible oil security, Vijayawada, A.P. February 2-4 2008. pp. 94
- Srinivasulu, B., Kochu Babu, M., Satyavani, V. and Mandal, P.K. 2008. Status and IDM of basal stem rot (*Ganoderma* Wilt) disease in oil palm and coconut. Contributory article In: Souvenir and Abstracts, National

conference on oil palm, oil palm for farmers' prosperity and edible oil security. Vijayawada, A.P. February 2-4 2008. pp. 100.

- Sunitha, S. and Varghese, P.T. 2008. Biomass production and potential nutrient contribution from oil palm plantation annually and at felling. Contributory article In: Souvenir and Abstracts, National conference on oil palm, oil palm for farmers' prosperity and edible oil security, Vijayawada, A.P. February 2-4 2008. pp. 89-90.
- Sunitha, S. and Varghese, P.T. 2008. A multi tier cropping model for oil palm under rain fed conditions. Contributory article In: Souvenir and Abstracts, National conference on oil palm, oil palm for farmers' prosperity and edible oil security. Vijayawada, A.P. February 2-4 2008. pp. 90.
- Suresh, K. and Nagamani, Ch. 2007. Partitioning of water flux in oil palm plantations - Seasonal variations in sap flow under irrigated conditions. In: Proceedings of International workshop on advanced flux nut and flux evaluation (Asiaflux workshop, 2007) held during 19-21 October, 2007 at Taoyuam, Taiwan.
- Suresh, K. and Nagamani, Ch. 2008. Screening of African duras for drought tolerance based on physiological markers. Contributory article In: Souvenir and Abstracts, National conference on oil palm, oil palm for farmers' prosperity and edible oil security, Vijayawada, A.P. February 2-4 2008. pp. 93.
- Suresh, K., Nagamani, Ch. and Reddy, V.M. 2008. Physiological responses of oil palm hybrids to water stress at seedling stage. Contributory article In: Souvenir and Abstracts, National conference on oil palm, oil palm for farmers' prosperity and edible oil security, Vijayawada, A.P. February 2-4 2008. pp. 93-94.

10. TRAININGS, VISITS AND PARTICIPATION IN CONFERENCES, SEMINARS, SYMPOSIA, MEETINGS ETC

Trainings and workshops attended

Dr. M. Kochu Babu

- Workshop on "Exploring opportunities of creating carbon revenues in rural and allied sectors" organized at MANAGE Hyderabad on August 11, 2007
- Interactive workshop on Administrative and Financial Matters held at Bangalore as convened by ICAR headquarters during October 26-27, 2007.

Dr. P. K. Mandal

- Training programme on "General management progarmme for senior scientists" at the Administrative staff college of India, Hyderabad from August 20-31, 2007

Dr. P. Murugesan

- International training course on *in vitro* and cryopreservation techniques for conservation of plant genetic resources sponsored by Bioversity International and conducted at NBPGR, New Delhi during November 14 to 29, 2007
- Brain storming session on "Adoption of Technologies and Research gaps in Coconut, Areca nut and Cocoa" at CPCRI, Kasaragod on February 18, 2008
- Second workshop on "Precision farming in Oil Palm" at Villar Village, Tanjore, Tamil Nadu on March 27, 2008 jointly organized by Tamil Nadu Agricultural University, Department of Agriculture and Cauvery Palm Oil Limited. A technical lecture on 'Advances in oil palm cultivation' was delivered

Dr. G. C. Satisha

- Training programme on "Introduction of GIS and its application" at National Remote Sensing Agency, Hyderabad for the period from April 9 to May 4, 2007
- Workshop on "Instrumentation techniques for Elemental analysis" and participated in Analytical Anacon 2007 at Hitech city, Hyderabad.
- Workshop on "Management of E-Resources through library consortia in Agricultural and Allied sciences" on March 5, 2008 at ANGRAU, Hyderabad

Dr. M. Jayanthi

- Programme on "Negotiating strategies in Work Environment for Scientists" sponsored by the DST, GOI, New Delhi at Administrative Staff College of India during May 21 to June 1, 2007
- Workshop on "Communication skills for Scientists" conducted at CCMB, Hyderabad on August 31, 2007
- Training on "Real Time PCR" conducted by Lab India Ltd. at Gurgaon, Haryana on September 1, 2007
- Workshop on "Agricultural Biotechnology - A hands on training in advanced tissue culture and molecular biology techniques" at The Energy and Resources Institute, New Delhi during February 18-23, 2008

Dr. K. Ramachandrudu

- Winter School on "Organic farming in rainfed and tribal areas, strategies for cost effective production of quality inputs" at CRIDA, Hyderabad during November 1 to 21, 2007.

Dr. Ananta Sarkar

- Foundation Course for Agricultural Research Service (FOCARS) training at National Academy of Agricultural Research Management (NAARM), Hyderabad during January 8, 2007 to May 7, 2007.
- Training programme on 'Oil Palm Production Technology' at NRCOP, Pedavegi during August 20-25, 2007
- Training programme on "Intelligent Reporting System'(IRS)" at NAARM, Hyderabad during August 30-31, 2007
- Short training programme on "Agribusiness and Market Intelligence" at Indian Agricultural Statistics Research Institute, New Delhi during October 6-15, 2007

VISITS

Dr. P. K. Mandal

- Visited Uttar Banga Krishi Viswa Vidyalaya, Pundibari, Coochbehar, West Bengal on April 24, 2007 and delivered a lecture on "Oil palm scenario in India with special reference to biotechnology in crop improvement"

Dr. R. K. Mathur

- Visited Theni, Tamil Nadu for collection of Malaysian Dura from farmer's field during September 4 to 7, 2007

CONFERENCES, SEMINARS, SYMPOSIA, MEETINGS ETC attended

Dr. M. Kochu Babu

- Review meeting convened by the TMOP&M at Bangalore during April 9-10, 2007.
- Meeting of the Directors of Horticulture Division at New Delhi during April 26-28, 2007
- Annual Directors' Conference at ICAR Hqrs., New Delhi during July 16-18, 2007
- Meeting chaired by Honourable Agriculture Minister, Tamil Nadu for formulating strategies for Oil Palm development in the state at Chennai on July 19, 2007
- Assessment Committee meetings/ evaluation for assessment of NRC-OP scientists at ASRB, New Delhi during August 1-3, 2007.
- OPIL Board meeting held at NRC-OP Regional Station, Palode on August 14, 2007.
- Meeting convened by Horticulture Division of ICAR for discussion about the XI Plan document of NRC-OP at Bangalore during August 18 to 20, 2007
- Farmers meet organized by Coconut Development Board , Vegiwada on September 2, 2007 in connection with world coconut day.
- Review meeting convened by TMOP on implementation of **National Food Security Mission - Pulses and ISOPOM** at Hyderabad on September 24, 2007.

- Meeting convened by TMOP&M to discuss and finalize the R&D proposals of NRC-OP and to identify the areas of foreign collaborations for Oil Palm R&D during XI Plan period at New Delhi on November 13, 2007
- 15th meeting of Board of Directors of National Horticultural Board, Gurgaon chaired by the Honourable Union Agriculture Minister and President, ICAR at Bangalore on December 17, 2007.
- Meeting convened by DDG(Hort), ICAR to discuss about the EFC and other matters of Horticulture Division at IIHR, Bangalore on December 18, 2007.
- Participated in the Golden Jubilee Celebrations of CPCRI Research Centre, Mohitnagar and made a presentation on the scope for Oil Palm cultivation in West Bengal on March 14, 2007

Dr. M. Kochu Babu, Dr. V. M. Reddy, Dr. P. Kalidas, Dr. R. K. Mathur, Dr. G. C. Satisha

- XVIII AICRP Biennial workshop held at ANGRAU, Rajendranagar, Hyderabad during November 27-29, 2007

Dr. M. Kochu Babu, Dr. V. M. Reddy, Dr. G. C. Satisha, Dr. P. K. Mandal

- Meeting convened by the DDG(Hort) at CPCRI, Kasaragod to discuss and finalize Action Plan for Oil Palm on February 17, 2008

Dr. M. Kochu Babu, Dr. V. M. Reddy and Dr. P. Murugesan

- National conference on Banana held at Trichy during October 25-28, 2007

Dr. M. Kochu Babu and Dr. M. V. Prasad

- "Horticulture Summit 2007" held at Lucknow during June16-19, 2007. Dr. M. Kochu Babu delivered a talk on "Oil Palm for meeting the future oil requirement"

Dr. M. Kochu Babu and Dr. P. Murugesan

- Interactive meeting for finalization of "Hand book of seed and planting material testing manual and labels for Horticultural crops" held at CISH, Lucknow during March 11-12, 2008.

Dr. P. Kalidas

- National seminar on Recent trends in Plant sciences at TJPS college, Guntur during June 28-29, 2007
- National seminar on Advances in Environmental Biotechnology held at Vuyyuru during August 17-18, 2007 and gave an oral presentation.
- Seminar on Modern Botany held at Andhra Loyola College, Vijayawada on November 17, 2007 and gave a lead talk.
- National Seminar on Industrial biotechnology-its scope and perspectives held at JKC college, Guntur on February 23, 2008 and gave a lead talk.

Dr. R. K. Mathur

- ISOPOM meeting at Bangalore on April 10, 2007 and at Vishakhapatnam on September 26, 2007.
- National conference on oil palm, oil palm for farmers' prosperity and edible oil security held at Vijayawada, A.P. during February 2-4, 2008 and gave a presentation on oil palm breeding in India.

Dr. M. V. Prasad

- National seminar on "Appropriate extension strategies for management of rural resources" at UAS, Dharwad during December 18-20, 2007.

Dr. P. K. Mandal

- International Symposium on "Management of Coastal Ecosystem:

Technological Advancement and Livelihood Security" at Central Soil Salinity Research Institute, Canning Town, West Bengal during October 27-30, 2007.

- Final review meeting of the wilt network project at ICAR, NASC Complex, New Delhi on February 14, 2008.

Dr. P. K. Mandal and Dr. M. Jayanthi

- Second Indian Horticulture Congress on "Opportunities and linkages for Horticulture Research and Development" at ICAR Complex for NE region, Barapani, Meghalaya during April 18-21, 2007.
- National Seminar on "Horticulture Biotechnology, Present Status & Future action plan" at IIHR, Bangalore on December 8, 2007.

Dr. P. Murugesan

- Meeting on "Maintenance of accession register" on January 4, 2008 on behalf of Director at CPCRI Kasaragod.
- First meeting of Standing Committee of PLACROSYM XVIII at NRC Cashew, Puttur, Karnataka on 26.02.2008 (as a member of working committee).

All the scientists of the Institute attended the National conference on oil palm, oil palm for farmers' prosperity and edible oil security held at Vijayawada, A.P. during February 2-4, 2008.

11. LIST OF ONGOING PROJECTS

	Project No	Name of Project	Name of PI and Co-PI(s)
		CROP IMPROVEMENT	
1	GEN I	Collection, conservation, cataloguing and evaluation of oil palm germplasm	RK Mathur, P Murugesan
2	GEN II	Production, evaluation and improvement of oil palm hybrids	RK Mathur, P Murugesan, PK Mandal
3	GEN V	Breeding for high yield and drought tolerant oil palm (TMOP&M funded)	RK Mathur, P Murugesan PK Mandal, K Suresh
4	GEN VI	Studies on performance of different oil palm planting materials	RK Mathur, P Murugesan
5	BIO II	Molecular characterization of oil palm germplasm	PK Mandal, RK Mathur, M Jayanthi
6	BIO IV	Development of tissue culture protocol for oil palm	M Jayanthi, PK Mandal, K Suresh
7	EFP III	Strengthening of seed gardens for indigenous seed production	RK Mathur, P Murugesan,
8	EFP IV	Acceleration of germination in oil palm	P Murugesan, RK Mathur
9	EFP V	Development of molecular markers for variety identification in oil palm	M Jayanthi
		CROP PRODUCTION	
1	AGR IV	Studies on water and nutrient management in Oil palm	VM Reddy, K Suresh,
2	AGR VI	Studies on the mixed farming in the irrigated oil palm plantations of A.P	M Kochu Babu, P Kalidas, K Ramachandrudu
3	AGR IX	Studies on replanting techniques in oil palm	S Sunitha
4	AGR XII	Fertigation in oil palm plantations	GC Satisha, VM Reddy
5	AGR XIII	Biogas production from POME and utilization of slurry as nutrient source for oil palm	S Sunitha, Shinoj Subramannian
6	AGR XIV	Performance of oil palm in peat soils of Kerala	S Sunitha, GC Satisha
7	HORT I	Intercropping in bearing oil palm gardens	K Ramachandrudu
8	BIO III	Biochemical basis for growth and yield in oil palm	PK Mandal, M Jayanthi
9	PHY II	Environmental monitoring of oil palm using sap flux probes	K Suresh
10	PHY III	Effect of different levels of fruiting activity on growth and yield of oil palm	K Suresh, K Ramachandrudu

EFP - Externally funded project

	Project No	Name of Project	Name of PI and Co-PI(s)
11	PHY IV	Carbon assimilation, water use and energy balance in oil palm plantations using Eddy covariance method	K Suresh
12	PHY V	Light transmission studies in oil palm plantations	K Suresh, VM Reddy, K Ramachandrudu
13	SS I	Nutrient indexing in oil palm growing areas	GC Satisha, MV Prasad
14	SS II	Development of composting techniques for oil palm wastes	GC Satisha, S Sunitha
15	SS III	Biological activity and organic matter dynamics in oil palm plantations and its impact on soil health	GC Satisha
16	EFP VI	Establishment of Leaf Analysis Laboratory	GC Satisha
17	EFP VII	Seed production of agricultural crops and fisheries	M Kochu Babu, P Murugesan, K Ramachandrudu
		CROP PROTECTION	
1	PATH II	Studies on diseases of oil palm and their management	M Kochu Babu, PK Mandal, M Jayanthi
2	ENT I	Studies on insect pests of oil palm and their management	P Kalidas
3	ENT III	Studies on avian and mammalian pests of Oil palm and their mgmt	P Kalidas
4	ENT .IV	Commercial production of green muscardine fungus *Metarhizium anisopliae* for the control of insect pests	P Kalidas
5	EFP VIII	Wilt of crops with special reference to cultural, morphological, molecular characterization & pathogenic variability of isolates in India	M Kochu Babu, PK Mandal
		POST HARVEST TECNONOLGY	
1	PHT V	Mechanization in oil palm plantations and farm level processing	Shinoj Subramannian
2	PHT VI	Utilization of oil palm plantation and industry wastes	Shinoj Subramannian
3	PHT VII	Development of a grading system for oil palm FFB and estimation of factory level OER	Shinoj Subramannian
4	PHT VIII	Post harvest studies on palm oil	PK Mandal
5	EFP IX	Utilization and recycling of palm oil mill effluent	M Kochu Babu, Shinoj Subramannian

	Project No	Name of Project	Name of PI and Co-PI(s)
		TRANSFER OF TECHNOLOGY & COMPUTER APPLICATIONS	
1	EXT IV	Multidisciplinary approaches for TOT and area expansion in relation to oil palm development in India	Director and all scientists
2	EXT V	Prioritization of research needs in oil palm based on farmers perception	MV Prasad
3	EFP XI	Training of extension, research workers and farmers involved in oil palm production	MV Prasad, S Sunitha
4	CA I	Oil palm database management system	MV Prasad, Ananta Sarkar
5	STAT I	Trend of oil palm yield based on biometrical/ physiological characters and weather parameters under irrigated conditions	Ananta Sarkar

Projects sanctioned (with external funding)

Sl. No.	Title of the project	Amount (Lakhs)	Funding source	PI & Co PI
1.	Establishment of a tissue culture laboratory for oil palm	70.00	TMOP&M	M. Jayanthi and P. K. Mandal

12. CONSULTANCY, PATENTS AND COMMERCIALIZATION OF TECHNOLOGY

The consultancy Processing Cell of NRC for Oil Palm gives broad guidelines for consultancy work, brings out consultancy information system, prepares and processes the Training / Consultancy /Contract Research/ Contract Service proposals, identifies the team for assignments, coordinates the work related to consultancy assignment and monitors the progress of work assigned. The facilities offered by NRC for Oil palm are as under:

1. Training Programmes (National and International)

Training programmes in the following areas to the officers involved in oil palm development.

- Oil palm nursery management
- Oil palm production and processing technology
- Harvesting of oil palm FFB
- Oil palm seed production
- Plant protection in oil palm

Training on advanced biology mainly on plant biochemistry and biotechnology

2. Consultancy services

- Oil palm hybrid seed production
- Production of quality planting material
- Oil palm tissue culture
- Setting up of oil palm nurseries and their management
- Designing of experiments and Data analysis
- Oil palm crop feasibility studies/surveys
- Techno - advisory services
- Project preparation, evaluation and management
- General consultancy for Oil palm development
- Agronomic aspects of plantation management
- Intercropping in oil palm plantations
- Soil and nutrient management
- Assessment of soil fertility status and advisory services on nutrient disorders.
- Plant health centre for Pest & Disease management
- Molecular and biochemical characterization of plants, fungi, bacteria

- PCR based detection of oil palm diseases
- Pollinating weevils
- Maturity, harvest, post harvest management
- Oil palm processing
- Oil quality analysis
- Value addition of palm oil and EFB fibre
- Management of oil palm plantation and mill wastes
- Impact studies, Socio economic studies, SWOT analysis, Case studies Diffusion studies, Constraint analysis in oil palm

3. Contract Research

- Testing of Agro-chemicals, Fertilizers, Bio-fertilizers, Bio-pesticides, and Growth regulators suitable for oil palm.
- Projects on all aspects of water, nutrient, pest and disease management in oil palm / oil palm based cropping system.

4. Contract services

- Analysis of water and soil to test the suitability for oil palm
- Leaf nutrient analysis
- Lab and field evaluation of fertilizers, herbicides, pesticides on oil palm
- Diagnosis of damages caused by insect pests and diseases in oil palm plantations and suggest control measures
- Oil analysis
- Bunch analysis

Consultancy services taken up

Consultancy Project on "Oil Palm Development in Karnataka" with Director of Horticulture, Govt. of Karnataka: The project started during November 2004 and completed by August 2007. A total amount of Rs. 3.33 lakh has been received as consultancy,

Consultancy project on "Production of quality oil palm hybrid seeds and management of Rajahmundry seed garden" with Commissioner of Horticulture, Govt. of Andhra Pradesh: The project was taken up during March 2008

Commercialization of technologies

The following technologies though had the commercial element were transferred free of cost to support oil palm development in the country. They are being widely adopted by the oil palm industry.

- Technology for production of oil palm planting material (sprouts)

- Oil Palm Empty Fruit Bunch Fiber Extractor (A Deed of Licence cum Agreement signed with a firm, Ekuipment Engineers, Coimbatore for popularizing the unit)
- Nursery management technology
- Economic and time saving method for estimation of oil from oil palm mesocarp
- Software for computerization of oil palm plantations, seed garden and processing units

Technologies ready for transfer or commercialization:

- Novel method of DNA extraction
- Technology for vermicomposting of oil palm wastes
- Technology for reestablishment of oil palm trees uprooted during cyclone
- Techniques for multiplication of microbial agents *Metarhizium anisopliae* and *Trichoderma viride*
- Safe application of microorganisms along with the input material in vermicompost units
- Edible mushroom production technology on oil palm factory wastes
- Extraction of carotenoids from crude palm oil
- Mechanized process for making window shades from oil palm rachis
- Mini palm oil mill

Patents

The following two patent applications were filed during the reported period:

Date of filing application in patent office	Application number allotted by patent office	Title	Innovator(s)
17-08-2007 Provisional application filed	1831/CHE/2007	A process for making stripes from oil palm frond using an improved wood planer cum cutterand oil palm frond stripe made thereby	Mr. Shinoj Subramannian
17-08-2007 Complete application filed	1832/CHE/2007	An improved stripper for sterilized oil palm fruit bunches and process thereof for improved palm oil extraction	Mr. Shinoj Subramannian

13. QRT, RAC, IRC, IMC AND IJSC MEETINGS

Quinquennial Review team (QRT)

Quinquennial Review Team (QRT) to review the work done by the National Research Centre for Oil Palm, Pedavegi during the period from 1.4.2001 to 31.3.2006 was constituted during 2006.

Composition of QRT

Dr. K. V. Peter, — Chairman
Former Vice-Chancellor,
KAU, Thrissur, Kerala

Dr. Srikant Kulkarni, — Member
Professor & Head,
Dept. of Plant Pathology, UAS, Dharwad,

Dr. Alapati Satyanarayana, — Member
Former Dir. of Extn.,
ANGRAU, Hyderabad

Dr. H.Hameed Khan — Member
Former Project Coordinator (Palms)
Coimbatore

Dr. K. John Thomas, — Member
Former Dean,
KAU, Thrissur

Dr. P.Kalidas, — Member Secretary
Sr. Scientist, NRCOP

Final meeting of the QRT was held during 4-6 July. 2007. Report was submitted to ICAR and approval has been received. Recommendation of the QRT are as given below :

1. Since oil palm has a narrow genetic base and it is difficult to get a number of new varieties in a short span of time using the available germplasm and breeding programmes may take quite a number of years to achieve success, it is advisable to find out the promising *Dura, Pisifera* and *Tenera* from the existing plantations, including introductions from Costa Rica, Papua New Guinea (PNG), IRHO, Malaysia and Thailand and to use them for mother palm selection, which needs to be given top priority.
2. DNA fingerprinting and gene mapping are to be carried out for identification of palms in young age for qualities like drought tolerance, high yield and cold tolerance. This will save precious time of breeders waiting for the crop to stabilize, which may take about 8-10 years. Palms suited to local environmental conditions can be identified in young stage itself, instead of waiting for maturity stage and based on which selection can be made.
3. Raising intercrops in oil palm and selection of crops suited to the host crop based on light penetration and its availability at different years of establishment should be studied carefully. Work on sink source ratio

should be carried out on priority, which will help in selection of suitable intercrops and designing Oil palm idiotypes.

4. As the oil palm passes juvenile phase of first three years after planting, farmers have to wait till that period without any income. To over come this, experiments on intercropping should be initiated in both juvenile and adult plantations with cost benefit ratio studies.

5. Studies on plant idiotypes with favourable sink : source ratio can be taken up for better under standing of canopy of the palms and there by spacing and intercrops etc.

6. Presently, the economic life of palms is fixed 25 years as it is possible to harvest the Fresh Fruit Bunches till that period using harvesting sickles. Though, the palms still have the capacity to yield, because of its height, it is recommended to replace them with new palms. It is essential to give top priority to work on marker assisted gene selection in identification of dwarf palms.

7. Oil Palm is a long lasting palm and naturally attains more height in the course of its growth. This causes problem in harvesting of the Fresh Fruit Bunches in the later stage of the plantations. Hence the team opines that there is an urgent need to develop transgenic oil palm varieties utilizing dwarf genes available elsewhere which will not only solve the harvesting problem but also enhance the economic life span of the plant.

8. Collaboration with other research institutes located in India and abroad where research on oil palm is being carried out is essential to achieve success in different activities. Names of the institutes and areas of work for collaborative research should be specified and institutes should be contacted to have the MOU signed.

9. Pricing for Oil palm FFB is based on the Oil Extraction Ratio of the produce. Work on measures to stop the loss of oil from the FFB from harvest to processing may be carried out as the OER, which is a burning issue, is linked with it.

10. In the whole world, oil palm is cultivated under rain fed conditions and hence research is also concentrated to rain fed crop only. Since National Research Centre for Oil Palm, Pedavegi is the only research institute in the world carrying out research on irrigated oil palm, it is necessary to give more emphasis to quality research.

11. Though oil palm is recommended to cultivate under irrigated conditions using ground water resources, the availability of water may vary from area to area in the recommended zones causing moisture stress on the crop leading to yield reduction. To over come this the QRT felt that studies should be carried out on utilization of available germplasm in the development of varieties suited to moisture stress areas.

12. This Centre should take up work on standardization of in *vitro* regeneration of nucleus material through micro propagation, as it is need of the hour to multiply oil palm seedlings within short period without much variation.

13. Tissue culture is one of the upcoming areas in agriculture. Enhancement of genetic diversity through generation of somaclonal variation or enrichment of germplasm from center of origin by utilizing the tissue culture techniques should be taken up by this Centre to save time and money. The germplasm with broad genetic base should be used.

14. With the renewed interest and increase in area under Oil palm cultivation, the demand for planting material has increased considerably. Presently the gap between demand and supply of indigenous seed sprouts is more than 100% and it's widening with the increased importance for palm oil as vegetable oil as well as bio diesel through out the world. Since indigenous seed production is inadequate to meet the area expansion, new seed gardens should be established.
15. Cultivation of oil palm using irrigation is a new concept worldwide. Naturally, these palms require altogether different nutritional requirements to obtain maximum yield. It is recommended that on farm trials on fertilizer requirement of the crop should be taken up on priority as it is already delayed.
16. Due to short supply of indigenous seed sprouts a plenty of seed material is being imported every year from countries like Coast Rica, Thailand and PNG. Since the result of G x E and varietal trial experiments of NRCOP are non significant with regard to FFB yield trials on yield performance of imported materials compared to indigenous ones have been taken up on priority. Similarly, yield maximization trials should also be carried out using various planting materials of both indigenous and imported ones.
17. Integrated nutrient management practice using the available biomass, as component should be tried.
18. Since oil palm produces a lot of biomass in the form of leaves, dried male inflorescences, mesocarp waste and empty fruit bunches, trials on successful utilization of them using microbial organisms should be taken up.
19. The potential areas identified for oil palm cultivation in India are varied in all respects viz. soils, agro climatic conditions, altitude as well as latitude of the growing areas. Specific fertilizer and irrigation schedules based on agro climatic conditions of the areas need to be developed on priority basis.
20. Leaf analysis report of any crop is a tool for finding nutritional requirement of the crop. Even though the leaf analysis laboratory is working since the inception of the Centre, not much progress has been made in evolving a fertilizer recommendation based on leaf analysis. Hence the team recommends that fertilizer recommendation based on the leaf nutrient analysis should be given priority.
21. Oil palm responds well to micronutrients like boron and magnesium. These nutrients cause yield losses in case of deficiency. Experiments on micronutrient requirements should be taken up immediately as it is the most important aspect for absorption of the other major nutrients.
22. DRIS norms for oil palm should be developed for every state where oil palm is being cultivated.
23. Even after 19 years of successful establishment of the crop, the basic information on various aspects of irrigation management of the palms has not been brought out. Method and quantity of irrigation suited to different agro climatic areas of oil palm cultivation should be studied on top priority.
24. Since most of the potential areas of oil palm cultivation fall under sub tropical conditions where lot of evaporation occurs from both plants as well as soil, this ultimately depletes soil moisture content and affects the yield. It is suggested to take up studies on the impact of mulching on plant growth and yield.

25. The team in its visits to various oil palm plantations observed leaf breaking and crown collapsing symptoms whose causes are not known. Since the problem persists for the last 10 years, it is felt that NRC for Oil Palm should take up studies on leaf and crown breaking immediately to find out reasons and remedial measures.
26. Studies on carbon sequestration potential of Oil Palm should be carried out for carbon trading.
27. Studies on the role of ethylene inhibitors in extending the immature stage of the FFB should be worked out.
28. Though the oil palm is an imported crop, it is very well said that only sprouts are being imported after thorough checking in quarantine centers located in different airports as well as carrying out the Post Entry Quarantine (PEQ) checking at regular intervals to clear the consignments. Even then pest population is found increasing, though not reached to alarming situation. Hence the QRT recommends carrying the survey for pests and diseases in all the oil palm growing areas at regular interval by correlating the pest incidence with the existing crops and abiotic factors.
29. Since biological control is the important ecofriendly component in IPM system, efforts should be strengthened for their usage against all the pests.
30. Of the various pests recorded on oil palm, leaf-eating caterpillars are the important ones causing yield losses in a shorter period of its attack. Hence the center should give much attention on the management of them and experiments should be taken up on these lines.
31. Since oil palm fruits carry oil, which is the important component of the diet of living beings, most of the avian pests, are attracted to feed on the ripened bunches. Experiments on integrated management of avian and mammalian pests of oil palm should be intensified as they cause direct economic loss to the yield.
32. Many diseases, etiology of which are reported as unknown in elsewhere have also been found in the country causing economic loss. Hence, the team recommends to carryout the studies on etiology of the diseases on priority using molecular techniques.
33. Use of PGPR for induced systemic resistance in the management of plant diseases should be carried out.
34. Harvesting of FFB is the laborious and time consuming in oil palm cultivation. Since the palms attain more height, it creates difficulty in identifying the ripened bunches from ground level. This is the main draw back in oil palm processing as the unripe bunches that are harvested lower the OER of the mill. Development of harvesting tools of most modern nature and work efficient ones which are power driven should be developed on priority to over come the above.
35. The team also suggests take up the experiments on maturity standards for oil palm in FFB harvests in different agro climatic zones. For this purpose, studies should also be carried out on oil palm FFB grading by developing electronic gadgets.
36. Palm oil is rich in Vitamins A and E and hence value added products from both palm oil and palm kernel oil should be developed.
37. Experiments on utilization of mesocarp waste for compost making using earthworms and microorganisms should be carried out. Utilization of Empty

Fruit Bunches for product utilization should be given top priority.

38. Studies on utilization of POME as feed in aquaculture as well as in animal husbandry in an effective manner should be carried out.

39. Since oil palm is a new crop to India it is essential to create awareness among farming community on the cultivation aspects of the crop. Development of expert extension practices on VCD for effective transfer of technologies need to be carried out.

40. Studies on systemic training needs suited to oil palm farmers of various states should be identified and accordingly training programmes should be arranged.

41. As the crop is new to the country and not much research work has been done any where in the world on irrigated oil palm, the team feels appropriate for recommending Human Resource Development through deputation of scientists to the best and advanced laboratories abroad.

42. Since many new areas (states) having varied agro climatic conditions are coming forward for Oil palm cultivation research work has to be taken up to develop region specific production technologies through multi location trials by establishing coordinating centers at different places. For this purpose, the present set up of NRC can be upgraded as Directorate, which will be the best fit for such work.

RESEARCH ADVISORY COMMITTEE (RAC)

Composition of Research Advisory Committee

Dr.V. Rajgopal, Formerly Director, CPCRI, Kasaragod	Chairman
Dr.A.N. Maurya, Formerly Director Institute of Agril. Sciences, BHU, Varanasi	Member
Dr. R.Samiappan, Director, Centre for Plant protection studies TNAU, Coimbatore	Member
Dr.C. Arumughan, Director Grade Scientist, RRL, Trivandrum	Member
Dr.A. K. Sadanandan, Formerly project Coordinator AICRP on Spices, Calicut	Member
Asst.Director General (Hort-II), ICAR , New Delhi.	Member
Director, NRC Oil Palm,Pedavegi , A.P	Member
Non-official members nominated in IMC	Members
Dr.P.Kalidas, Principal Scientist , NRC OP RS, Palode Trivandrum	Member Secretary

RAC meeting was held during 9-10 August, 2007 at NRCOP, Pedavegi. Dr. V. Rajgopal, Chairman of RAC, Dr. A. K. Sadanandan, Dr. A. N. Maurya , Dr. C. Arumughan members of RAC participated in the meeting. Proceedings were communicated to ICAR and approval has been received

Institute Management Committee

Composition

Director NRCOP, Pedavegi	Chairman
Dr. S.N. Pandey Asst. Director General (Hort.-I), ICAR, New Delhi	Member
Dr. C.P.R. Nair Head, CPCRI, RS, Kayamkulam	Member
Dr. P. Harishu Kumar Pr. Scientist, CTRI, Rajahmundry	Member
Dr. V.M. Reddy Pr. Scientist, NRCOP, Pedavegi	Member
Dr. R.K. Mathur, Senior Scientist, NRCOP, Pedavegi	Member
AAO NRCOP, Pedavegi	Member Secretary

Institute Management Committee meeting was held on 5th January, 2008 at NRCOP, Pedavegi. The nomination for the representatives of State Governments, SAU, Non official members and Finance member is still awaited from council.

Institute Joint Staff Council

Composition

Dr. M. Kochu Babu, Director	Chairman
Official Side	
Dr. M.V. Prasad	Member
Dr. P.K. Mandal	Member
Dr. R.K. Mathur	Secretary
A.A.O	Member
A.F.A.O	Member
Staff Side	
Mr. A. Lakshmana Rao	Member (upto 11-04-07)
Mr. K.V. Rao	Member
Mr. M. Ananda Rao	Member
Mr. S. Sudhakaran Nair	Member
Mr. G. Raju	Member
Mr. K. Ravindran	Secretary

The Institute Joint Staff Council (IJSC) meetings were held on April 20, 2007 at NRCOP, RS, Palode and on December19, 2007 at NRCOP, Pedavegi.

Institute Research Committee (IRC) meeting

The tenth Institute Research Committee meeting was held during 27-29 June, 2007 at Pedavegi. Dr. V. Krishnamurthy, Director, CTRI; Dr. S. N. Rao, eminent Horticulturist & Retd. Dean, ANG Ranga Agril. University; Dr. A. N. Murthy, Retd. FAO expert; Dr. M. Rajamannar, Retd. Prof. of plant pathology, ANG Ranga Agril. University chaired various sessions.

14. WORKSHOPS, SEMINARS, SUMMER INSTITUTES, FARMERS' DAY AND OTHER MEETINGS ORGANISED

Inauguration of Lab cum Administrative building

The Lab cum Administrative building of NRCOP, Pedavegi was inaugurated by Dr. Mangala Rai, Director General, Indian Council of Agricultural Research (ICAR) & Secretary, Department of Agricultural Research and Education(DARE) on May 31, 2007 in the presence of Dr. H. P. Singh, Deputy Director General (Horticulture), ICAR. Dr. P. Rethinam, founder Director of NRCOP and Dr. T. Radha, MD, AP Oil Fed also graced the occasion. In connection a one day interface meet on "Towards yellow revolution through Oil Palm" was organised. Director & Scientists of NRCOP, Officials of state department of Horticulture, Entrepreneurs and oil palm farmers attended the meet. Dr. Mangala Rai, in his talk emphasized the need for introducing tissue culture oil palm seedlings and also importance of value addition and Byproduct utilization of oil palm. He informed the farmers that ICAR is making all efforts for area expansion under oil palm in the country. He appreciated the efforts made by NRCOP Scientists and also urged for developing high yielding oil palm varieties. The dignitaries also visited the research laboratories, experimental plots, farmers fields and other infrastructural development of NRCOP. Dr. H. P. Singh, inaugurated the Museum developed at the centre depicting information about oil palm and also about Institute activities.

Seed Meet 2007

A Mid Term Review meet of Oil Palm Seed Production was conducted at NRCOPRS, Palode on July 10, 2007

The Oil Palm Seed Meet 2007-08 was organized at National Research Centre for Oil Palm, Pedavegi on December 27, 2007. The meet was attended by all the officers and Research fellows of Seed gardens, representatives of oil palm processors and entrepreneurs and scientists of NRCOP. There were deliberations on quality control measures in hybrid seed production programme, support to indigenous seed production programme, necessity for sourcing parental palms in exotic plantations, improving indigenous production, production of drought tolerant hybrids, current status of seed production, shortage from some of the seed gardens, reasons for shortfall etc.

The house appreciated NRCOP for the systematic seed production programme. It was also felt that there is need for establishing new seed gardens in various oil palm growing states to meet the future demand of planting material.

Other Important decisions taken in the meeting

- Uniform packing materials required for oil palm germinated seeds can be made available for all the seed gardens for reducing the unit cost
- Strict quality control measures should be followed by all the seeds gardens for quality seed production
- Allocation shall be done to the oil palm companies based on target given and assessment of seedling availability
- Number of selected mother palms shall be increased to augment seed production
- Infrastructure facilities in the seed garden shall be strengthened to scale up seed production

Deliberations were also made on bringing out the quality standards to be adopted for indigenously produced oil palm sprouts. General guidelines for uniform adoption by seed gardens/ entrepreneurs were discussed. Dr. P. Murugesan delivered a lead talk on Quality standards of Oil Palm planting materials.

National Conference on Oil Palm

A National Conference on oil palm "Oil palm for farmers' prosperity and edible oil security" was held during 2-4 February, 2008 at Vijayawada, Andhra Pradesh, organised by the Society for Promotion of Oil palm Research and Development (SOPOPRAD) in association with National Research Center for Oil palm. The conference was attended by more than 350 delegates consisting of oil palm growers, processors, development officers of State department of Agriculture/Horticulture from Andhra Pradesh, Tamil Nadu, Karnataka, Orissa, Gujarat, Kerala, Goa and Mizoram. Scientists and experts from India, Malaysia, Indonesia, Israel and Thailand participated and presented papers in technical sessions. Apart from Inaugural session and Plenary session there were 6 technical sessions, one open forum where in farmers and processors interacted and brought out their issues. One ministerial workshop was also held to discuss developmental issues. An exhibition was organised on the occasion at the venue. A factory cum field visit was organised for the delegates.

The following publications were released during the conference:

- Digital video film "The golden palm" containing oil palm cultivation practices.
- A technical bulletin "Quality seed from NRC Oil palm Palode".

Foundation day

Thirteenth foundation day of the institute was celebrated on 19 February, 2008. Dr. K. V. Ramana, Former ADG(Hort-II), ICAR, New Delhi was the chief guest. The institute was open for the farmers, school and college students on that day. Around 500 students from various schools and colleges visited the institute and the on going research activities were explained to them.

EVENTS DURING THE INAUGURATION OF LAB CUM ADMINISTRATIVE BLOCK

Inauguration of the building

Visit to oil palm plantations

Visit to Museum

Ceremonial planting

In the Director's chamber

Interface meet organized on the occasion

EVENTS DURING THE NATIONAL CONFERENCE ON OIL PALM, VIJAYAWADA 2-4TH FEB. 2008

Welcome address by Dr. M.Kochu Babu,
Vice President, SOPOPRAD

Introductory remarks by Dr. P.Rethinam,
President, SOPOPRAD

Felicitation to one of the progressive farmers,
Mr. T.T.Krishnamurthy

Visit to exhibition stalls by the dignitaries

A view of secretarial meeting

A view of delegates

15. कार्यालयीन भाषा क्रियान्वयन गतिविधियाँ

भारत सरकार की राज भाषा नीति के अनुसार राज भाषा हिन्दी को बढावा देने की दृष्टिकोण से केन्द्र के मुख्यालय, पेदवेगी तथा क्षेत्रीय स्टेशन, पालोड़ में कार्यरत सभी अधिकारियों तथा कर्मचाारी गणों में हिन्दी के प्रति जागरूकता बढायी गयी। इस संदर्भ में हिन्दी कक्ष से चलाई गयी गतिविधियां निम्न प्रकार हैं:

1) हिन्दी में ज्ञान बढाने के लिए प्रति दिन एक शब्द के नाम से कार्यप्रणाली अभ्यासित की जा रही है, जिसके अंतर्गत तीनों भाषाओं में - हिन्दी, अंग्रेजी तथा क्षेत्रीय भाषा तेलुगु में रोज एक शब्द स्वागत कक्ष के नजदीक लगाये गये बोर्ड पर नियमित रुप से लिखा जा रहा है।

2) केन्द्र के सभी अधिकारियों को भेजने की डाक की मार्किंग हिन्दी में की जा रही है।

3) फाईल में टिप्पणी भी हिन्दी में चलाने का प्रयास किया जा रहा है।

4) हिन्दी में प्राप्त सारे पत्रों को नियमित अधिकारियों की जानकारी के लिए अंग्रेजी में अनुवाद करके भेजे जा रहे है। उसके पश्चात उनके जवाब उचित रुप से हिन्दी में दिये जा रहे हैं।

5) राज भाषा कार्यान्वयन समिति की बैठक नियमित रुप से आयोजित की गयी जिनमें राज भाषा को बढावा देने संबन्धी कार्य प्रणाली पर गहण रुप से चर्चा की गयी। समिति में लिए निर्णयों का अनुपालन भी किया गया।

उपर्युक्त गतिविधियों के अलावा, प्रतिवेदन वर्ष में 14 सितंबर, 2007 से 14 अक्तूबर, 2007 तक अवधि में हिन्दी चेतना माह का आयोजन किया गया इस अवसर पर हिन्दी-अंग्रेजी अनुवाद, हिन्दी समाचार पठन, हिन्दी अन्ताक्षरी, हिन्दी में निबन्ध लेखन, हिन्दी में वार्तालाप, आदि प्रतियोगिताएं भी आयोजित की गयी। जवाहर नवोदया विद्यालय के अद्यापक न्याय निर्णेताओं के रुप में आमंत्रित किये गये। इस कार्यक्रम के समापन के दिन मुख्य अतिथि के कर कमलों से विजेताओं को पुरस्कार प्रदान भी किये गये।

निदेशक महोदय के अमूल्य वचन

माननीय कृषि मन्त्रि का संदेश पढना

हिन्दी में अन्ताक्षरी कार्यक्रम

मुख्य अतिथि व्दारा पुरस्कार वितरण

16. DISTINGUISHED VISITORS

Details of the Visitor(s)	Date of Visit
Dr. Mangala Rai, Secretary to Government of India, DARE and Director General, ICAR, New Delhi **Dr. H.P. Singh**, Deputy Director General (Hort.), ICAR	May 31, 2007
Dr. SN Rao, Retd. Director of Research, ANGRAU, Hyderabad **Dr. A.N. Murthy**, Retd. FAO Expert, Hyderabad. **Dr. M. Rajamannar**, Retd. Professor, ARS, Maruteru **Dr. V. Krishna Murthy**, Director, CTRI, Rajahmundry	June 29, 2007
Dr. K.V. Peter, Former Vice Chancellor, KAU, Vellanikkara **Dr. Srikant Kulkarni**, Professor and Head, Dept. of Plant Pathology, UAS, Dharwar; **Dr. H. Hameed Khan**, Retd. Project Coordinator (Palms), CPCRI, Kasaragod **Dr. John Thomas**, Retd. Dean, KAU; **Dr. Alapati Satyanarayana**, Retd. Director of Extension, ANGRAU, Hyderabad	July 4-6, 2007
Dr. V.Rajgopal, Retd. Director, CPCRI, Kasargod; **Dr. A.N. Maurya**, Retd. Officer, BHU, Varanasi; **Dr. C. Arumugan**, Director Grade Scientist, Regional Research Laboratory of CSIR, Trivandrum;	August 9-10, 2007
Dr. A.K. Sadanandan, Retd. Project coordinator (Spices), Calicut. Six-member Mynamar Delegation sponsored by Government of India	August 23, 2007
Dr. G. Chinna Reddy, Honble Minister for Rural Development, Govt. of A.P.	August 31, 2007
Shri S.L. Bhat, I.A.S., Additional Secretary, Ministry of Agriculture, Government of India, New Delhi; **Shri P.K. Sharma**, Director, TMOP&M, Ministry of Agriculture, Government of India, New Delhi **Smt. G. Jayalakshmi**, I.A.S., District Collector, West Godavari, Eluru	September 24, 2007
Dr. Kapil Deo Singh, Retd. Director, CTRI, Rajahmundry	December 28, 2007
Dr. S.N. Pandey, Asst. Director General (Hort.), ICAR Headquarters, New Delhi	January 05, 2008
Dr. C.P.R.K. Nair, Head, CPCRI Regional Station, Kayangulam **Dr. K.V.A. Bavappa**, Retd. Director, CPCRI, Kasaragod; **Dr. N Rajanaidu**, Consultant, MPOB, Kuala Lumpur, Malaysia; **Ho, Yuk Wah**, Tissue Culturist, Malaysia	February 04, 2008
Dr. K.V. Ramana, Retd. ADG (Plantation Crops), ICAR Hqrs., New Delhi	February 19, 2008
Mr. Ashish Roy, SAO, DOR, Hyderabad	February 28, 2008

GENERAL ACTIVITIES

Independence Day celebrations

Republic Day celebrations

Address by chief guest (Dr. K.V.Ramana, Retd. ADG, ICAR) on Foundation day

Cake cutting on Foundation day

School children visiting the institute

College students' exposure visit to NRCOP

17. PERSONNEL

RMP

Dr. M. Kochu Babu	Director

STAFF POSITION AT HEAD QUARTER - PEDAVEGI

Scientific Staff

Dr. V.M. Reddy	Pr. Scientist (Agronomy)
Dr. P. Kalidas	Pr. Scientist (Ag. Entomology) w.e.f. 23-04-06
Dr. R.K. Mathur	Sr. Scientist (Plant Breeding)
Dr. M.V. Prasad	Sr. Scientist (Ag. Extension)
Dr. P.K. Mandal	Sr. Scientist (Bio-Chemistry)
Dr. K. Suresh	Sr. Scientist, (Plant Physiology) w.e.f. 01-02-06
Dr. G. C. Satisha	Sr. Scientist, (Soil Science)
Dr. M. Jayanthi	Sr. Scientist, (Biotechnology)
Dr. K. Ramachandrudu,	Scientist SS (Horticulture)
Mrs. K.L. Mary Rani	Scientist SS (Comp. Appl.) on study leave from 07-02-06
Dr. K. Sunil Kumar	Scientist (Horticulture) (transferred from ICAR RC for NEH Region, Imphal on 14-08-07)
Er. Shinoj Subramannian	Scientist (AS&PE) on study leave from 28-08-07
Dr. Ananta Sarkar	Scientist (Agril. Statistics)

Administrative Staff

Sri B. Satish	A.A.O. (on deputation to IISR, Cardamom RC, Madikeri from 16-07-07)
Sri T.D.S. Prakash	Assistant Finance & Accounts Officer
Sri K.V.V.S. Narayana	Private Secretary
Sri K.S.N.D. Mathur	Assistant
Sri P. Gowrishankar	Assistant
Mr. T.V. Rama Krishna	Personal Assistant
Mr. K. Ravindran	Upper Division Clerk (transferred to RS, Palode on 31-05-07)
Mr. A. Lakshmana Rao	Lower Division Clerk (transfered to CTCRI RS, Bhubaneswar on 12-04-07)
Mr. Dharma Raju	Upper Division Clerk w.e.f. 28-02-08
Mr. S.K. Saida	Lower Division Clerk w.e.f. 28-02-08

Technical Staff

Mr. V.G. Sasidharan	T-5 (transferred to RS, Palode on 08-06-07)
Mr. B. Parthasaradhi	T-5
Mrs. A. Bhanusree	T-4
Mr. K. V. Rao	T-4
Mr. J. Mohan Rao	T-3
Mr. M. Ananda Rao	T-2
Mr. V.V.S.K. Murthy	T-2
Mr. M. Rambabu	T-1
Mr. Ch. Subba Raju	T-2 (Driver)
Mr. P.R.L. Rao	T-2 (Driver)
Mr. E. Perayya	T-2 (Driver)
Mr. A. Papa Rao	T-1 (Tractor Driver)

Supporting Staff

Mr. K. Ananda Rao	SS Gr.II
Mr. G. Raju	SS Gr.II
Mr. I.V. Sundar	SS Gr.II (passed away on 05-07-07)
Mr. G. Venkateswara Rao	SS Gr.II
Mr. A. Dhana Raju	SS Gr.II
Mr. A. Joji Showri	SS Gr.II
Mr. U. Rama Rao	SS Gr.II
Mr. A. Ganga Raju	SS Gr.II
Mr. S. John	SS Gr.II
Mrs. Y. Chaitanya	SS Gr.I
Mr. A. Nagarjuna Rao	SS Gr.I
Mr. G.S.N. Babu	SS Gr.I
Mrs. N.V.V. Sathya Lakshmi	SS Gr.I
Mr. M. Satyanarayana	SS Gr.I
Mr. Ch. Venkata Durga Rao	SS Gr.I
Mr. M. Appa Rao	SS Gr.I
Mr. B. Gopala Krishna	SS Gr.I

STAFF POSITION AT NRCOP, REGIONAL STATION, PALODE

Scientific Staff

Dr. S. Sunitha	Sr. Scientist (Agronomy) and Scientist-in-charge
Dr. P. Murugesan	Sr. Scientist (Seed Technology)

Administrative staff

Mrs. E.J. Mary	Assistant
Mrs. V. Satyabhama	Upper Divisional Clerk (transferred to CTCRI Trivandrum on 19-04-2007)
Sri P. Prasad	Private Secretary (w.e.f. 09-11-2000)

Technical Staff

Mrs. N. Sujatha Kumari	T-6
Mrs. I.C. Rajamma	T-5
Mr. C.K. Devadathan	T-5
Mr. K. Soman	T-4
Mr. V. Sunil Duth	T-2
Mr. B. Muralidharan Pillai	T-1

Supporting Staff

Mr. G. Rajappan	SS Gr. II
Mrs. N. Indira	SS Gr. II (Retd. on 31-08-07)
Mrs. A. Radha	SS Gr. II (Retd. on 31-08-07)
Mrs. M. Rebecca	SS Gr. II
Mrs. A. Raceena	SS Gr. II
Mr. H. Dasan	SS Gr. II
Mr. P.K. Rethnakaran	SS Gr. II
Mr. S. Sudhakaran Nair	SS Gr. II
Mr. P. Anil Kumar	SS Gr. II
Mrs. P. Rema	SS Gr. II
Mr. C. Ravi	SS Gr. II

18. METEOROLOGICAL DATA

Meteorological Data of R. S. Palode (2007-2008)

Months	No. of rainy days	Total rainfall (mm)	Average max. temp.(°C)	Average min. temp. (°C)	Average Relative humidity (%)
April 2007	21	255.2	29.48	25.35	51.00
May	19	218.0	28.61	25.01	85.77
June	24	441.8	28.28	23.35	89.33
July	31	403.6	26.03	23.60	93.45
August	26	238.2	26.65	23.32	90.71
September	26	350.8	26.40	23.60	92.36
October	29	408.1	25.95	23.26	91.58
November	30	195.8	26.15	22.91	88.17
December	24	20.6	26.26	22.48	80.94
January 2008	14	6.6	26.76	23.33	73.71
February	23	54.6	27.19	24.67	79.66
March	25	260.0	27.64	23.19	84.61