भाकृअनुप
ICAR

वार्षिक प्रतिवेदन
ANNUAL REPORT
2008-09

तेल ताड अनुसंधान निदेशालय
(भारतीय कृषि अनुसंधान परिषद)
पेदवेगी-534 450, प. गोदावरी जिला, आ.प्र.

Directorate of Oil Palm Research
(Indian Council of Agricultural Research)
Pedavegi-534 450, West Godavari Dt., A.P.

वार्णिक प्रतिवेदन
ANNUAL REPORT
2008-09

तेल ताड अनुसंधान निदेशालय

(भारतीय कृषि अनुसंधान परिषद)

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

Directorate of Oil Palm Research

(Indian Council of Agricultural Research)

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

भाकृअनुप
ICAR

DIRECTORATE OF OIL PALM RESEARCH

DOPR, Annual Report, 2008-09

ISBN : 81-87561-21-1

Published by

Dr. M. Kochu Babu
Director, Directorate of Oil Palm Research
Pedavegi - 534 450, West Godavari (Dt.), Andhra Pradesh
Phone : 08812 - 259409, 259532, 259524
Fax : 08812 - 259531
Grams : PALMSEARCH, Eluru
E-mail : dopr2009@gmail.com
Web site : http://dopr.gov.in

Edited by

Dr. P.K. Mandal

Smt. A. Bhanusri

Correct Citation

Annual Report 2008 - 09
Directorate of Oil Palm Research
Pedavegi - 534 450, A.P., India

Printed at

Swapna Art Home
Vijayawada 520 002, Ph : 0866 6520675

Contents

Preface

I am glad to introduce our institution as Directorate of Oil Palm Research, which has been upgraded from a National Research Centre. Hence forth All India Coordinated Projects (AICRP) on oil palm will be under the control of this Directorate and oil palm research will be under single umbrella. Area under oil palm in India is expanding gradually and it has crossed the boundary of conventional and identified states. Two more AICRP centres have been identified to cater the location specific requirement of this crop, one at Madhopur, under Rajendra Agricultural University, Bihar and another at College of Agriculture and Forestry, Passighat, under the Central Agricultural University, Manipur.

Another important aspect of this reporting year is the approval of XI Five Year Plan EFC with an outlay of Rs.1500 lakh. There is substantial increase in the budget mainly to cater the research needs of this expanding crop in the country. This budget would be very useful in modernizing our laboratories with advanced equipments and other infrastructural facilities. Seed production at Pedavegi has been initiated, which would help in meeting the ever growing demand of the oil palm sprouts to an extent of 5 lakh sprouts per year. Our research activities in various disciplines including crop improvement, crop production, crop protection, post harvest technologies and social sciences were at their best after prioritizing them to cater the needs of the farmers. Emphasis is being given on some of the special issues like development of indigenous tissue culture protocol for clonal propagation, leaf breaking, harvesting and oil extraction ratio.

I am sure with the effort of all the staff of our institution including the Regional station and different AICRP centres, we would be able to develop and transfer the required technologies for oil palm cultivation in the country. This would definitely help in the mission of achieving self sufficiency in edible oil production in near future. Finally, my sincere thanks to Dr. P. K. Mandal and Mrs. A. Bhanu Sri for their dedicated efforts in bringing out the Annual Report in time.

M. Kochu Babu
Director

कार्यकारी सारांश

फसल सुधार

तोल ताड़ जर्म-प्लाज्म के संग्रहण एवं मनकीकरण

आइल पाम इंडिया लिमिटेड, केरल के एरूर तथा कुलतुपुझा बागवानों में सर्वेक्षण करके झैरे तथा श्रोतों से 66 ड्यूरा तथा नेइफ़र श्रोतों से 113 ड्यूरा तथा 35 बौना पिसिफेरा एवं टेनेरा ताडों का चयन किया गया। आन्ध्र प्रदेश के कृष्णा एवं पश्चिमी गोदावरि जिलों में किये गये सर्वेक्षण में 28 ड्यूरा ताड़ों की पहचान की गयी। कर्नाटक के मंगलूर में किये गये सवेक्षण में, 7 संग्रहणों का चयन किया गया।

आफ्रिकन तथा अन्य विदेशी संग्रहणों का लक्षण-वर्णन करने का कार्यक्रम जारी है। उन ताडों, जो अधिक उपज देते है, जिन से अधिक ताजा-फल गुच्छे पाये जाते हैं, जो उच्छतम तेल गुणवत्ता के हैं, का चयन किया गया और उनका प्रयोग पालोड में जारी आबादी विकास संकरण कार्यक्रम में तथा वाणिज्य-स्तर के बीज उत्पादन में किये जा रहे है। आ.ई.बी.पी.जी.आर. (बयोवर्सिटी इन्टर्नेषनल) विवरणक के आधार पर, पालोड केंद्र में विशिष्ट ताडों पर विविरणक अध्ययनें जारी है। गुच्छों का लक्षण-वर्णन पर किये गये अद्ययन में यह पता चला कि नाइजीरियन बौंनों में (टेनेरा) में 20.37% तेल / गुच्छा जोकि ओलिफेरों में 7.7 से 10% तेल.गुच्छा पाया गया। पालोड में उपलब्ध काई विदेशी श्रोतों के चयनित ताडों पर यह अद्ययन जारी है।

तेल ताड़ संकरों का उत्पादन, मूल्यांकन तथा सुधार

वसायुक्त आम्ल की दृष्टि से मूल्यांकन किये गये सात में तीन संकरें तीन इन्टर-स्पेसिफिक संकरों का कार्य-निश्पादन ई. ओलिफेरा मातृ ताडों का बराबर रहा। हर ताड की कार्य-निश्पादन विभिन्न रहने के कारण, पूर्ण असंतूस-वसायुक्त आम्ल तथा ओलिक आम्ल की उपस्थिति की दृष्टि से हर एक इन्टर-स्पेसिफिक ताड का निर्धारण किया गया तथा 20 श्रेष्ट ताडों का चयन किया गया ताकि उन ताडों को पामाईल गुणवत्ता एवं उपजों को जुडकर करने में आगामी संकर कार्यक्रम में प्रयोग कर सकें। इन्टर-स्पेसिफिक संकरों पर किये गये मूल्यांकन से यह पता चला कि अन्य संकरों की तुलना 361 इ.जी x 11 इ.ओ. संकरो का कार्य-निश्पादन ठीक रहा।

देशीय बीज उत्पादन बढाने के लिए बीज केंद्रों की मजबूती

विभिन्न देशीय बीज बागानों से किये जा रहे बीज उत्पादन तथा उनकी आपूर्ति नियंत्रण पर समग्र निगरानी रखी जा रही है। प्रतिवेदन की अवधि में देश में उपलब्ध पांच बीज उत्पादन केंद्रों से 22.21 लाखों का बीज अंकुरों की आपूर्ति की गई और पेदवेगी में स्थित छठी बीज केन्द्र बीज उत्पादन के लिए तैयार है।

नये बीज बागवानों के लिए प्राथमिक पादप द्रव्यों का उत्पादन किया जा रहा है। पेदवेगि में अधिक-उपजाऊ वाली मातृ ताडों का चयन किया गया तथा वाणिज्य स्तर पर बीज उत्पादन की शुरुआत हुई। पेदवेगी मुख्यालय में पालोड ड्यूरा तथा विदेशी ड्यूरा आबादी को इस्तेमाल करते हुए बहुमुखीय ड्यूरा आबादी के पादप द्रव्यों का विकास किया जा रहा है। पेदवेगी में ड्यूरा तथा टी xटी आबादी को विश्लेषण करके मातृ ताडों का चयन किया गया। अभी तक टी x टी आबादी में 27 ड्यूरा, 97 टेनेरा तथा 28 पिसिफेरा का सेग्रिगेशन-अनुपाद दर्ज की गयी।

पिसिफेरा ताड़ों को दिये गये उपचारों से यह निर्धारित हुई कि उपचार प्रतिक्रिया के लिए वांचित अवधि ताडों की आयु तथा जेनोटाइप पर आधारित है और इस अंश पर विश्व-भर में काफी भिन्नता देखी जाती है।

तेल ताड़ में तनाव-सहिष्णुता पर अध्ययन

प्री-प्रजनन आबादी की विकास में, सिंचित तथा तनाव वातावरण के अच्छे ड्यूरा ताडों का चयन किया गया। चयनित ड्यूरा ताडों को इस्तेमाल करके वाणिज्य स्तर पर बीज उत्पादन भी प्रारंभ किया गया। ड्यूरा ताडों में किये गये प्रकाश-संश्लेशक जल-प्रयोग क्षमता की सादृश्य से यह पता चलता है कि सूखा-ग्रस्त क्षेत्रों के ताडों की तुलना सिंचाई क्षेत्रों के ताडों में क्षमता बेहतर है। TS-9 और GB 21/310 की तुलना ZS-3 में औसत पत्र-जल क्षमता अधिकतम दर्ज की गयी जहां TS-11 मे अत्यल्प थी।

जैव-रसायनिक अध्ययनों से यह पता चला कि गुनि बिस्सू-मूल श्रोतों में तनाव-परिस्थियिों के लिए अनुकूल थी। ZS-2, ZS-1 तथा ZS-8 जैसे कई स्त्रोत जल-तनाव परिस्थितियों को सहन सकते है। लेकिन, कई श्रोतों पर किये गये अध्ययन से यह पता चलता है कि सिंचित क्षेत्र के लिए सिफारिस किये गये पानी मात्रा से कम पानी की स्थिति में भी वे अच्छे रहे।

तेल ताड़ जेर्मप्लाज्म के आणाविक लक्षण-वर्णन

प्रतिवेदन की अवधि में, 23 ओलिफेरा ताडों पर जेनेटिक विभिन्नता पर अध्ययन किया गया। ओलिफेरा ताडों में पाच मुख्य समूह बन गये जहां चार ताडें उन समूहों से अलग रहे। तीन जोडों में, जोडी नं. ई.ओ.-07 तथा ईओ-09, इओ-10 तथा ईओ-11, एवं ईओ-20 तथा ईओ-21 अधिकतर एक जैसे रहे लेकिन जोडी नं. ईओ-16 तथा ईओ-01 में भिन्नता पायी गयी। दस आर.ए.पी.डी. प्राइमरों को इस्तेमाल करके 40 अधिक-उपजाऊ ड्यूरा ताडों पर अनुवंशिक विविधता पर अध्ययन किया गया। प्रतिवेदन की अवधि में 10 प्राइमरों को इस्तेमाल किये गये। एस.एस.आर. मार्करों को इस्तेमाल करके आणविक लक्षण-वर्णन करने के लिए, 6 पालोड के देशी श्रोतों सहित, 25 श्रोतों से 90 ताडों को चयन किया गया।

तेल ताड़ में टिश्यू कल्चर प्रोटोकाल का मानकीकरण

अविनाशक सेम्प्लंग की प्रौद्योकि का मानकीकरण किया गया, तेल ताड़ में विभिन्न कल्चरों पर किये गये अध्ययनों से काफी आशाजनक नतीजें पाये गये। आर.ए.पी.डी. तथा लघु-उपग्रह प्राइमरों

की सहायता से किसानों के क्षेत्रों में लगाये गये टिश्यू कलजर्ड क्लोनों में अनुवंशिक विविधता पर समग्र अध्ययन किया गया। क्लस्टर-विश्लेषण तथा डेंड्रोग्राम से यह पता चला कि क्लोनों में या एक समूह क्लस्टरों और अन्य कोलोनों में कोई निरपेक्ष समानता नही है।

तेल ताड़ में किस्मों की पहचान के लिए आणविक मार्करों की विकास

दो टेनेरा संकरों से मिली एफ़-२ पादपों पर डी.एन.ए. निष्कर्षित पादप को अध्ययन हेतु पेदवेगी बीज बागवान में लगाया गया। इस अध्ययन के लिए दस ड्यूरा, पिसिफेरा तथा टेनेरों के डी.एन.ए. को निष्कर्षित किये गये। पेदवेगी बीज बागवान में लगाये ड्यूरा, पिसिफेरा तथा टेनेरा के डी.एन.ए. के पी.सी.आर. अम्प्लिफेशन के लिए इस्तेमाल किये गये 37 प्राइमों ने बहु-रूपी लक्षण प्रकट किये। ड्यूरा, पिसिफेरा तथा टेनेरा बल्कों से यह पता चला कि 17 प्राइमों के बेंडिंग पेट्रन में काफी अंतर थे।

बीज अंकुरण तथा डार्मेन्सी पर विभिन्न वातावरणों का प्रभाव

बीज अंकुरण में सूखा-उष्ण उपचार का प्रतिक्रिया को अध्ययन करने के उद्देश्य से विभिन्न बीज बागवानों से पाये गये बीज अंकुरण डेटा का विश्लेषण किया गया, प्रथमिक नतीजों से यह पता चला कि विभिन्न वातावरण परिस्थितियों से लाये गये तथा प्रजनन काल के विभिन्न चरणों में उगाये गये बीजों के डर्मेन्सी स्तर में काफी अंतर थे। यह भी अवगत हुई कि सूखा-ग्रस्त वातावरण परिस्थितियों में लाये गये बीजों में अंकुरण त्वरित गति से हुई।

फसल उत्पादन

तेल ताड़ में जल एवं पोषक तत्वों क प्रबन्धन

सिंचाई स्तिथि में उगाये जा रहे तेल ताड में 15 टन/हे का ताजा फल गुच्छों का उत्पादन पाने के लिए 900-450-900 ग्रा. मात्रा में एन.पी.के. खाद देने से काफी साबित रहा। ड्रिप-सिंचाई पद्धति में 18.6 टन एफ.एफ.बी/हे. का अधिकतम उपज दर्ज किया गया। और इसके बाद जेट-सिंचाई 17.1 टन का उपज दर्ज की गयी। विभिन्न सिंचाई पद्धतियों में अधिकतम उपज (19.8 तन/हे) दर्ज किया गया।

गुछों के विभिन्न भागों में तेल और एफ.ए.सी. की उपस्थि पर अध्ययन

गुच्छें के विभिन्न भागों में सूखा मेसोकार्प की उपस्थिति में 77.98% -76.67% की भिन्नता देखी गयी लेकिन डेटा विश्लेषण में कोई सार्धक अंतर नही था। ताजा मेसोकार्प के पहला, तीसरा एवं चौथा भागों की तुलना दूसरा भाग में तेल की उपस्थिति अधिकतम पायी गयी जोकि पंचवा भाग में तेल की उपस्थिति बहुत ही कम थी। नमी की उपस्थिति इस से बिलकुल भिन्न रही। फेटी आम्ल की स्थिति में कोई सार्धक विभिन्न नही देखी गयी। मेसोकार्प के पहला भाग में स्टीरिक आम्ल की उपस्थिति अधिकतम पायी गया जो दूसरा और पांचवा भागों की उपस्थिति से बराबर रही।

विरिसेन्स तथा निग्रिसेन्स किस्म के फल गुच्छों पर अध्ययन

विरिसेन्स तथा निग्रेसेन्स टाइपों के फल गुच्छों में भिन्नताओं को अध्ययन करने की उद्देश्य से एक प्रयोग शुरु किया गया। प्रतिवेदित अवधि में 10 विरिसेन्स और 10 निग्रिसेन्स गुच्छें का विश्लेषण पूरा किया गया। इस अध्ययन के लिए दो टेनेरा संकरों (डेली नाइजीरिया तथा डेली नाइजीरिया) का चयन किया गया। तेल/गुच्छा प्रतिशत विरिसेन्स में 30.49 से 18.08 तथा निग्रेसेन्स में 29.34 से 19.28 रही।

तेल ताड़ के तन और फ्राण्ड में रस-प्रवाह पर डेटा-लागर्स की सहाहयता से किये गये अध्ययन में काफी भिन्नताएं नजर आई। इस अध्ययन में यह पता चला कि प्रौढ ताडों की फ्राण्डों की तुलना वयस्क ताडों में रस-प्रवाह अधिकतम पाया गया।

फसल संरक्षण

आंध्र प्रदेश, कर्नाटक, मिजोरम तथा केरल राज्यों के तेल ताड़ बागानों में कीडों की व्याप्ति को अध्ययन करने के लिए रोविंग सर्वेक्षण किया गया। सर्वेक्षण क्षेत्रों में रिनोसिरस भृंग, साइकिड, पत्ती में जाली बनाने वाले कीडें, घोंघा इल्ली जैसे महामारी मुख्य है। चूहों के नुकसान से बचने के लिए वार्फारिन बेटिंग के साथ जिंक फासफाईड देने से काफी सफलता पूर्वक रहा। कौआ, तोता जैसे पक्षियों से फसल संरक्षित करने में हरे और वाइलेट रंग के नाइलान नेटों का प्रयोग काफी सफलता पूर्वक रहा। ब्यूवेरिया बेसियाना जैसे जैव-एजेन्टों को इस्तेमाल करके साइकिड्स को रोकने के लिए जैव-एफिकसी पर अध्ययन किया गया। पेदवेगी और पालोड के बागवानों में रोग-व्याप्ति को नियंत्रण में रखने के लिए आवश्यक कदम लिये गये।

कटाई उपरान्त प्रौद्योगिकी

पेदवेगी निदेशायल परिसर में स्थित छोटे-स्तर के पामाईल मिल में जारी तेल-निष्कर्ष-अनुपात पर ऋतुओं, ताडों की आयु आदि अंशों के प्रभाव पर किये गये अध्ययन से यह पता चला कि जुलाई-दिसंबर महीनों में वयस्क ताडों से पाये ओ.ई.आर. 17.41 रही जहां नवंबर महीनों में प्रौढ ताडों से 19.46 पायी गयी और अगस्त महीने में न्यूनतम पायी गयी।

प्रौद्योगिकी की स्थानांतरण

प्रतिवेदन अवधि में कई प्रशिक्षण कार्यक्रम आयोजित किये गये जैसेः तेल ताड उत्पादन प्रौद्योकिगी पर 148 अधिकारी, तेल ताड संकर बीज उत्पादन पर 10 अधिकारी, तेल ताड़ के पादप संरक्षण पर 9 अधिकारी और नर्सरी प्रबन्धन पर 7 अधिकारी सुशिक्षित किये गये। किसानों के साथ किये गये एक सर्वेक्षण में यह पता चला कि किसानों की मांगों में बिजली की आपूर्ति, बेंकों से वित्तीय सहायता की आवश्यकता, तेल ताड की खेती और ड्रिप सिंचाई की सब्सडी में मढोत्तरी, आदि है। उनकी मुख्य समस्याओं में सिंचाई जल की कमी तथा एफ.एफ.बी. कटाई आदि मुख्य है। निदेशालय की अन्य विस्तार गतिविधियों में तेल ताड खेती फीजिबिलिटी अध्ययन, तेल ताड़ क्षेत्रों का दौरा, सेमिनाम आदि का आयोजन, तेल ताड मेलों में भाग लेना आदि शामिल है।

EXECUTIVE SUMMARY

CROP IMPROVEMENT

Collection and characterization of oil palm germplasm

A total of 66 *dura* palms from Zaire accessions, 113 *dura* from NIFOR accessions and 35 dwarf *pisifera* & *tenera* were selected for further study by surveying Yeroor & Kulathupuzha estates of OPIL, Kerala. In Andhra Pradesh, surveys were made and 7 *duras* were collected and 18 *dura* palms have been identified. Surveyed Mangalore region of Karnataka and 7 collections were made.

Characterization of African germplasm and other exotic germplasm collections is being taken up. Selected palms with desirable traits like high FFB as well as oil yield potential, superior oil quality, dumpiness etc are being utilized in crossing programmes and commercial seed production. Descriptor studies of distinct palms were undertaken at Palode as per IBPGR (Bioversity International) descriptor. Bunch characterization revealed that Nigerian dwarf (*tenera*) recorded 20.37 % Oil /Bunch whereas *oleiferas* recorded 7.7 to 10%. The study is being continued for selected individual palms of various exotic sources available at Palode.

Production, evaluation and improvement of oil palm hybrids

Three inter-specific crosses out of the seven evaluated for fatty acid composition were found on par with the better performing *E. oleifera* parental palms. Since performance of each palm is different, individual inter-specific hybrid palms were assessed based on total unsaturated fatty acid and oleic acid contents and 20 superior palms were selected, which could be employed for further back crossing programme to combine the quality of palm oil and yield. Evaluation of interspecific hybrids available at Palode revealed that 361 *Eg* × 11 *Eo* showed better performance when compared to other hybrids.

Strengthening seed gardens for indigenous seed production

Overall monitoring of oil palm hybrid seed production from different indigenous seed gardens with respect to production and regulation of supply is being done. During the period a total of 22.21 lakh oil palm sprouts were supplied from the five seed gardens existing in the country and the sixth seed garden at Pedavegi is ready for seed production.

At Pedavegi by evaluating *dura* and TxT populations, mother palms (58 nos. in Palode source and 20 of Costa Rican source) have been selected and are being utilized in commercial seed production programme. A segregation ratio of *Dura* (27): *Tenera* (97): *pisifera* (28) has so far been recorded in TxT population.

Basic planting material for new seed gardens is being generated. Diverse *dura* populations utilizing Palode *dura* and exotic *dura* are being developed for planting in new seed gardens.

Frond pruning, root pruning and stress treatments showed positive response for male inflorescence cycle initiation and pollen production in *pisifera* palm (planted during 1998) with stubborn character of producing only female bunches. It was confirmed from the treatment given to the *pisifera* palms that duration required for treatment response depends upon age of the palm, genotype and wide variation was reported worldwide.

Studies on stress tolerance in oil palm

Yield promising *dura* palms have been identified under irrigated and stress environments which are being utilized for developing pre-breeding populations with wide genetic base. Commercial seed production on selected *dura* palms has also been initiated. Comparison of the photosynthetic water use efficiency (PWUE) among the duras indicated that irrigated palms had better efficiencies than those under water stress conditions. The highest mean leaf water potential was recorded in ZS-3 followed by TS-9 and GB-21/310, while the lowest was in TS-11.

From the biochemical studies conducted it can be inferred that accessions from Guinea Bissau were naturally adaptive to stress condition. Few accessions like ZS-02 (increase in peroxidase activity, reduced chlorophyll content)); ZS-01 and ZS-08 (increase in soluble carbohydrate) responded to water stress. But later they adjusted to the water stress condition as indicated by the increase in soluble sugar, peroxidase activity etc. However, most of the accessions were having no difference under stress, indicating that those accessions were already adapted to grow under lesser water than that is recommended for irrigated oil palm.

Molecular characterization of Oil Palm germplasm

Genetic diversity study of the 23 *oleifera* palms revealed that the *oleifera* palms formed 5 major clusters and four palms were standing apart without forming any group. The similarity was found maximum (0.895) between three pairs of palms (palm No. *Eo*-07 & *Eo*-09; *Eo*-10 & *Eo*-11 and *Eo*-20 & *Eo*-21), whereas the similarity was least between palm no. *Eo*-16 & *Eo*-01 among the oleifera palms. Genetic diversity studies of 40 high yielding dura palms are being carried out using RAPD primers and during the reporting period, 10 primers were used. For molecular characterization using SSR marker of the African germplasm, 90 palms from 25 accessions along with 6 palms from indigenous accessions (Palode) were selected.

Standardization of tissue culture protocol for oil palm

The technology for non destructive sampling was standardized. Explants like spear leaves, inflorescence and roots were cultured in several media combinations by making several modifications to the already reported media in oil palm. Good callus induction was obtained with spear leaves. Callus proliferation and plantlet regeneration has also been obtained with these cultures. Callus induction and somatic embryos are also obtained with immature inflorescence. Genetic variation of tissue cultured clones planted in the farmer's field was studied using RAPD and microsatellite primers. The cluster analysis and dendrogram revealed that there is no complete similarity among the clones and clones of one variety cluster with some other clones.

Development of Molecular Markers for varietal identification of oil palm

DNA extraction was carried out with F1 plants obtained by crossing two *teneras* and planted in the Pedavegi seed garden. The DNA of 10 *duras*, *pisiferas* and *teneras* were extracted and bulked, which was used for the study. Out of 37 random primers used for PCR amplification of DNA, 20 primers showed polymorphism. Bulks of *dura*, *pisifera* and *tenera* amplified with 82 microsatellite primers and run in the agarose gel showed differences in banding pattern with 17 primers.

Effect of different environment on seed germination and dormancy

Data from different seed gardens were analyzed for seed germination response to dry heat treatment. The preliminary results revealed that seeds from different environments and produced at different stages of the reproductive period differ in dormancy status. Though they exhibited dormancy regardless of the maternal environment, seeds from dry environment showed early germination response than cooler environments under dry heat treatment.

CROP PRODUCTION

Nutrient and water management in oil palm

In the irrigation cum fertilizer trial initiated during 1997 at Pedavegi which faced a set back for water, fertilizer dose of 900-450-900 g NPK is found to be sufficient to achieve an yield of 15 tonnes FFB/ha. Drip irrigation recorded maximum yield of 18.6 tonnes FFB/ha followed by Jet (17.1 tonnes FFB/ha). Among the different levels of irrigation highest yield (19.8 tonnes/ha) was obtained in 80% followed by 100% (19.0 tonnes/ha) and 60 % (14.8 tonnes).

Studies on oil content and FAC of oil from different parts of bunch

It was observed that the oil content in the dry mesocarp in different parts of the bunch varied from 77.98 – 76.67%. No significant difference was observed from the analysis of data. Oil content in the fresh mesocarp was found highest in Part 2 followed by Part 1, Part 3, Part 4, which were on par, and Part 5 contained significantly lower amount of oil than that of part2. Moisture content in the mesocarp followed the exact reverse trend. With respect to fatty acid composition total saturated/ unsaturated fatty acids also did not show any significant difference. Stearic acid was found highest in Part 1, which was on par with Part 2 and Part 5.

Studies on *virescens* and *nigrescens* type of fruit bunches

Experiment taken up to study differences between *virescens* and *nigrescens* type of fruit bunches in two *tenera* hybrids (Deli X Nigeria and Deli X Nigeria) indicated that Oil/Bunch % ranged from 30.49 to 18.08 and 29.34 to 19.28 for *virescens* and *nigrescens* respectively.

Physiological studies in oil palm

Sap flow measured in trunk and oil palm fronds (frond 17 and 25) continuously with the help of data loggers indicated diurnal variations. The results also revealed that the sap flow was higher in the younger fronds compared to that of older fronds.

Studies on carbon sequestration in oil palm

Standing above ground biomass in the different oil palm hybrids ranged from 55.08 to 91.58 T.ha^{-1}. The highest biomass was recorded in ASD Costa Rica hybrid (Deli X Lame), while the lowest was in ASD Costa Rica hybrid (Deli X Avros). The amount of carbon sequestered by the hybrids ranged between 17.98 and 35.44 T C.ha^{-1}, with Papua New Guinea and Ivory Coast hybrids sequestering the highest and lowest carbon contents respectively.

The specific leaf weight in the different fronds ranged between 0.24 and 0.45, carbon contents ranged from 0.413 to 1.314 kg and nitrogen contents ranged between 11.5 and 26.3 g. Correlation studies have indicated a positive relationship between leaf carbon and leaf nitrogen content. Leaf carbon content was also positively related with specific leaf weight.

Studies on Leaf breaking in oil palm

The percent damage of leaf breaking was more in Deli X Nigeria cross followed by Malaysia and Deli X Ghana crosses. Palms belonging to Palode source were least damaged. Drought susceptibility index was highest in Malaysia (3.22) followed by Deli X Nigeria (3.00) and Deli X Ghana (1.88). Palms from Palode source recorded the lowest drought susceptibility index indicating their better tolerance to drought.

Nutrient indexing of oil palm growing soils

Analysis of the soil samples (collected from 3 depths) from 13 mandals of West Godavari district and 3 mandals of Krishna district indicated that among micronutrients, zinc was found to be the most deficient element and 64.7 per cent of the studied area was deficient and the overall nutrient index value is 1.45.

During the period from April 2008 to March 2009 a total of 319 soil samples, 430 leaf samples and 23 water samples were analysed in the leaf nutrient analysis laboratory at DOPR, Pedavegi and appropriate advisory services were extended for suitable soil and fertilizer management in oil palm plantations.

Studies on Intercropping

Survey conducted to study the performance of cocoa taken up as intercrop in oil palm plantations of farmers indicated that total area under cocoa in oil palm gardens in A.P is about 5000 acres which is just 12.5 per cent of total area of 40,000 acres under cocoa which is mostly grown in coconut gardens. Yield of cocoa in oil palm ranges from 250 g to 1000 g/plant/year whereas in coconut it is ranging from 500 to 2700 g/plant/year. Cocoa is most commonly grown inter crop in oil palm gardens in A.P.

CROP PROTECTION

Roving survey was carried out in different oil palm growing areas of A.P., Karnataka, Mizoram and Kerala for the pest and pollinating weevils' incidence. Psychid, slug caterpillar and leaf web worm were observed as major pests in all the areas surveyed. Zinc phosphide application along with warfarin baiting reduced rat damage significantly. Nylon nets of green and violet colour proved their efficacy in trapping birds including crow, parrot and

bats. Bioefficacy studies using bioagents *Beauveria bassiana* were carried out against psychids and found very effective

Monitoring of disease incidence in the existing oil palm plantations of Pedavegi and Palode was continued. DNA extraction was carried out from native *Trichoderma* isolates which were collected from the oil palm growing regions and genetic diversity study is being carried out using RAPD primers.

POST HARVEST TECHNOLOGY

Study taken up in the mini palm oil mill established at DOPR, Pedavegi for estimating the variation in OER in relation to season, age of the palm indicated that in young palms maximum OER of 17.41% was obtained during July to December and in adult palms it was 19.46 % recorded during the month of November and lowest OER was recorded during August.

The pattern of oil loss through various factory wastes indicated that the highest oil loss during processing was through clarifier sludge (41 to 48 %). This was followed by 33 to 35 % oil loss in EFB and 12 to 21% oil loss in press cake fibre.

TRANSFER OF TECHNOLOGY

Organised officers training on "Oil Palm Production technology" to 148 officers, Oil Palm Hybrid Seed Production" to 10 officers, "Plant Protection in Oil Palm" to 9 officers and "Nursery Management in Oil Palm" to 7 officers.

A total of 32 training programmes organised to 1350 farmers on three subject matter areas of oil palm i.e., 'Oil Palm Cultivation', 'Nutrient and Water Management in Oil Palm', 'Plant protection in Oil Palm'.

Survey conducted with oil palm growers indicated that for oil palm cultivation major suggestions given by the respondents were to provide assured power supply, financial assistance from banks and increasing the subsidy for cultivation and installation of drip system. Major constraints perceived were lack of sufficient irrigation water and problems in harvesting of FFB.

In addition other extension activities like conducting feasibility studies for oil palm cultivation, participation in field visits and exhibitions, organising exposure visits to students, bringing out publications, organizing seminars etc were also taken up.

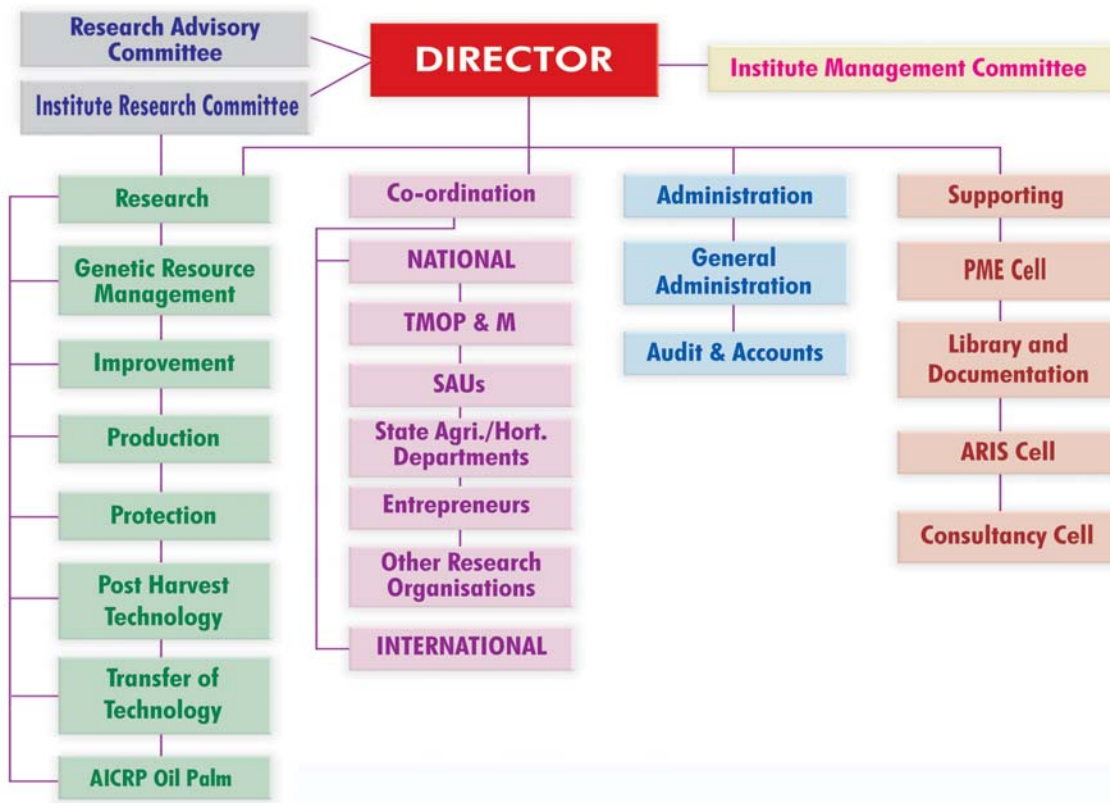
3. INTRODUCTION

The National Research Centre for Oil Palm has been redesignated as **Directorate of Oil Palm Research (DOPR)** during the XI plan to strengthen the research on oil palm in the country. This is a pioneer institution 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 headquarter of West Godavari. The then CPCRI (Regional Centre), Palode was merged with NRCOP in 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. DOPR 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

(Rs. in Lakhs)

S.No.	Heads	Allocation as per RE for 2008-09	Utilization
1.	Plan	**225.00**	**218.25**
2.	Non-Plan	**337.70**	**318.93**
3.	Pension and retirement benefits	**25.00**	**16.94**
4.	P-Loans and advances	**11.00**	**11.00**

3.4 Externally funded schemes

(Rupees)

Sl. No.	Name of the scheme/ project	Opening balance as on 01.4.08	Receipts during 2008-09	Total (3+4)	Expenditure during 2008-09	Closing balance as on 31.3.09
1	2	3	4	5	6	7
	A. DEPOSIT SCHEMES FUNDED BY OUTSIDE AGENCIES					
1	GxE scheme	454078	1384000	1838078	837570	1000508
2	STOP	393827	712000	1105827	526093	579734
3	LA LAB	-139954	1009000	869046	302309	566737
4	Strengthening of Seed Gardens	266487	2895000	3161487	625414	2536073
5	Oil Palm cultivation	8646		8646	0	8646
	Sub-Total	**983084**	**6000000**	**6983084**	**2291386**	**4691698**
	B. OTHER DEPOSITS (EMD/SD ETC.)					
1	DST	1,092	0	1,092	0	1092
2	DST-Development of molecular markers for variety identification	74,279	90,000	164,279	116710	47569
3	Seed garden, Rjy	133592	545000	678592	439372	239220
4	Replanting Techniques in Oil Palm (OPIL)	147150	90000	237150	195876	41274
5	Seed Garden, OPIL	0	465000	465000	196517	268483
6	Establishment of Tissue culture lab	3500000	0	3500000	1924093	1575907
7	Seed garden, Taraka	-93110	293110	200000	210029	-10029
8	Feasbility studies (Min.of Environment)	-8975	0	-8975	0	-8975
9	OPDP, Karanataka	-92767	92767	0	0	0
	Sub Total	**3661261**	**1575877**	**5237138**	**3082597**	**2154541**
1	EMD	57352	15000	72352	21270	51082
2	SD	105606	0	105606	26009	79597
3	Miscellaneous	3538	0	3538	0	3538
4	Surplus U-remittance	0	64068	64068	64068	0
5	Staff welfare fund	6100	25000	31100	31100	0
6	OPDP, Karnataka, Consultancy Fund	65914	0	65914	42700	23214
7	R-depost - national seminar Feb.2005	35715	0	35715	0	35715
8	Training Fee, Goa	9260	0	9260	0	9260
9	Hindi Seminar	15201	0	15201	0	15201
10	SOPOPRAD	0	475000	475000	475000	0
	Sub-Total	**298686**	**579068**	**877754**	**660147**	**217607**
	Grand Total	**4943031**	**8154945**	**13097976**	**6034130**	**7063846**

3.5 Resource generation

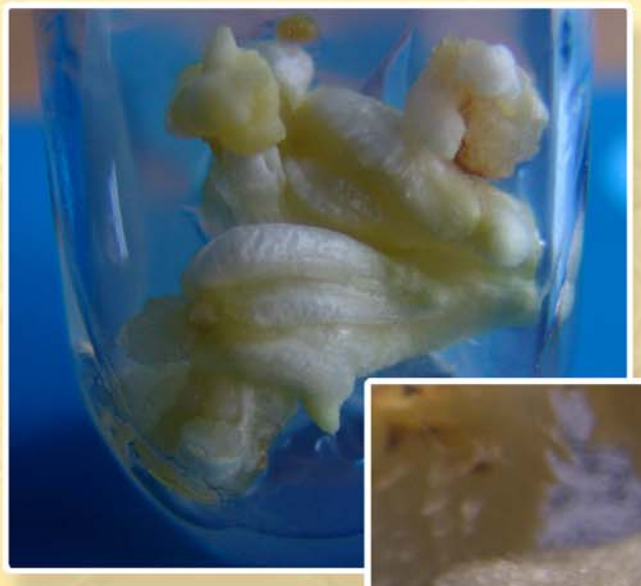
During the year an amount of Rs. 38.60 lakh has been generated towards sale of farm produce, training, analytical test fee, sale of publications and other miscellaneous items

3.6 Staff position

Grade	Sanctioned	Filled	Vacant
RMP	01	01	–
Scientific	22	14	08
Technical	18	18	–
Administration	12	11	1
Supporting	30	26	4
Total	**83**	**70**	**13**

4.0 Research Achievements

फसल सुधार
Crop Improvement



Somatic embryos
from inflorescence

Callus induction from spear
leaf of mature palm

CROP IMPROVEMENT

COLLECTION, CONSERVATION, CATALOGUING AND EVALUATION OF OIL PALM GERMPLASM

Collection of germplasm

During the year survey and collections from exotic oil palm commercial plantations were taken up on a large scale. Seven collections were made from Sulia and Charmudi forests in Mangalore (Karnataka); four from Eturu in Guntur (A.P.) from PNG source; and three *dura* collections were made in T. Gokavaram in West Godavari district (A.P.) which was having Costa Rican source. Survey was taken up in Krishna, Nellore & West Godavari Districts of Andhra Pradesh and 18 *dura* palms have been identified. Collection programme was chalked out for Theni (having Malaysian material) and OPIL plantations (having material from NIFOR, IRHO and ZAIRE sources). It was decided to collect yield data for the last three years and then make the collections. In Yeroor & Kulathupuzha estates of OPIL (Kerala), 66 *dura* palms from Zaire accessions, 113 *dura* palms from NIFOR accessions, 35 Dwarf *pisifera* & *tenera* have so far been identified for further observations.

Evaluation of germplasm

Four palms with high bunch yield and better canopy have been identified in progeny of CD-471. In Pune-1 accession and in one of the accession from Little Andaman, two palms with very high initial yield have been identified. Some more germplasm accessions collected from Andaman have been planted in field.

In nursery, germplasm received from Andaman were evaluated for dry matter accumulation (Table 1). Based on Vegetative drymatter production the vigorous growing seedlings (germplasm) were identified.

Characterization of germplasm

Characterization of African germplasm is continued for morphological, yield, bunch quality, physiological and biochemical characteristics. The variations for mesocarp content, fruit size, fruit testa colour, size of bunch and other bunch characters are being studied through bunch analysis.

At Palode evaluation was undertaken in the field gene bank consisting several exotic germplasm collections planted during 1981-1992 to identify dumpy oil palms. A *tenera* palm (27 years old) from Nigerian (NIFOR) collection and *Elaeis oleifera* (16 years old) from Surinam were characterized based on Bioveristy International (formerly IBPGR) descriptor and evaluated for their yield potential. Nigerian *tenera* had bunch yield of 118kg/palm/year with 9.1 bunch numbers and 24 cm height increment, whereas Surinam had 75kg/year/palm with 6 bunches and 15 cm height increment. It was proved by characterization study that both of them had dumpiness *viz.*, short stem, short leaves and other vegetative characteristics. As per bunch characterization, Nigerian dwarf recorded 20.4 % and 1.08% of mesocarp oil to Bunch and Kernel oil to Bunch, respectively, where as Surinam had 9.25% and 3.1%.

Utilization of selected germplasm

Promising palms have been identified and are being utilized in developing basic planting material for new seed gardens. The Dura x Dura and Tenera x Tenera populations are being developed.

Table 1. Evaluation of germplasm, dura genotypes and hybrids in nursery

Genotype	Ht.	NL	NLL	RL	PL	PW	PD	LLL	LLW	SLA	VDM
AND Tenera	91.9	7.2	58.1	61.4	13.2	1.6	0.90	29.4	2.26	0.587	2.53
And Dura	97.4	7.9	54.1	55.7	12.3	1.7	1.30	27.3	2.19	0.397	3.43
AND T3	112.3	7.5	59.9	70.5	11.6	1.6	1.17	31.8	2.48	0.617	3.04
AND T4	108.6	9.5	58.3	70.1	11.8	1.6	1.22	31.6	2.12	0.483	3.94
AND	101.7	10.2	40.2	60.8	11.9	1.6	1.10	28.5	2.06	0.313	4.03
44CD X 435RJY	126.1	15.6	51.3	80.0	18.7	1.9	1.21	32.6	2.33	0.413	6.78
141X350 GXE	107.8	10.5	49.6	65.6	12.3	1.8	1.32	33.1	2.02	0.380	4.65
85CDX 66PP	102.6	12.0	51.4	68.0	12.1	1.7	1.30	30.7	2.18	0.410	5.56
44 CD X 435 CD	139.3	19.5	62.5	88.3	21.2	2.4	1.67	36.1	2.18	0.410	12.23
60CD X 62 CD	133.1	19.7	60.8	89.1	18.1	2.0	1.52	35.4	2.30	0.490	10.54
GM	112.0	12.0	54.6	71.0	14.3	1.8	1.27	31.7	2.21	0.450	5.67
SD	4.15	0.77	2.26	3.78	1.1	0.1	0.08	1.13	0.09	0.04	0.57

Ht : Height (cm); NL : No of leaves; NLL : No of leaflets; RL : Rachis length (cm); PL : Petiole length (cm); PW : Petiole width (cm); PD : Petiole depth (cm); LLL : Leaflet length (cm); LLW : Leaflet width (cm); SLA : Specific leaf area (Sq.m/kg) ; VDM : Vegetative dry matter (kg)

Cataloguing and documentation

The basic data on evaluation of African germplasm has been documented; the catalogue is being prepared to document the information.

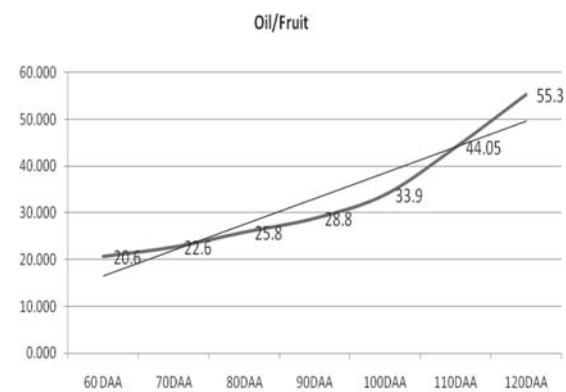
Descriptor study of Palode germplasm

Descriptor studies of distinct palms were undertaken at Palode as per IBPGR (Bioversity International) descriptor. The bunch component characters of the palms which are having distinct characters are given in the Table 2. The study is continued for identified individual palms of various exotic sources available at Palode

Fruit and bunch maturity in Surinam dwarf *Oleifera*

Seed development and maturation of Surinam oleifera palm planted during 1988 was studied. The study revealed that it posses early fruit maturity and ripening as it recorded an average of 4 months 16 days for its fruit maturity which coincided with high seed germination (Table 3). The descriptive changes occurred during fruit seed development is given in the Table 4. Oil to Fruit was high at 120 DAA (55.3), oil formation initiated at about 60 DAA (Fig. 1).

Fig 1. Oil to Fruit % in Surinam dwarf *Oleifera* during different stages of maturity



Conservation of wild Peach (Oil) palm

As a part of conservation of available germplasm at Palode a rare Peach (Oil) palm planted during 1981 was evaluated for bunch and other characters. Seeds were subjected to de-operculum germination technique and seven seedlings were successfully rescued. Two batches of 52 and 55 seeds showed 52 and 21.8 % germination and established as seedlings (Fig. 2).

Table 2. Bunch characteristics of distinct palms available in field gene bank of Palode/Chithara

Year of planting/ characters	Surinam (45)	Nigerian dwarf	Chithara Oleifera (1)	Chithara Oleifera (2)	Malaysian Oleifera (5)	African ZS 7 (68)	African TS 2 (61)
Year of planting	**1992**	**1981**	**1985**	**1985**	**1992**	**1998**	**1998**
Bunch wt. (kg)	12.50	11.22	18.40	16.48	46.12	17.13	8.01
Bunch length (cm)	44.67	32.25	55.00	48.00	70.00	41.50	38.00
Bunch Width (cm)	53.36	87.50	110.00	120.00	166.00	106.00	75.00
No. of Fruits	3829.00	440.00	945.00	690.00	5585.00	852.00	590.00
Fruit /Bunch %	53.36	48.30	59.89	42.96	39.03	46.58	67.86
Mesocarp/Fruit %	75.94	77.18	64.02	56.45	55.25	54.45	72.86
Oil/Wet Mesocarp	22.95	54.64	44.71	44.56	38.66	54.80	34.24
Oil/bunch %	9.25	20.37	17.14	10.80	8.32	13.89	16.90
Kernel/Fruit %	9.51	7.02	7.72	10.61	11.68	17.58	5.86
Shell/Fruit%	11.88	11.07	28.25	32.93	33.05	27.96	21.24
Kernel oil/Fruit %	5.47	2.28	5.10	6.58	2.99	9.89	3.35
Kernel oil/Bunch%	3.13	1.08	3.05	2.58	1.13	4.56	2.24
Special character	Dwarf	Dwarf	High kernel	High kernel	High yield	Dwarf	Vire-scence

Table 3. Duration of bunch ripening in Surinam dwarf *oleifera*

Cross	Bunch weight (Kg)	No of seeds	Bunch & fruit Maturation period
45 x 45	12	539	4 months 20 days
45 x 45	13	352	4 months 14 days
45 x 45	11.5	449	4 months 16 days
45 x 435	12	239	4 months 26 days
45 x 45	11.5	144	4 months 11 days
45 x 435	12	405	4 months 4 days
Open Pollinated	12.1	355	4 months 21 days
Average	12.01	354	4 Months 16 days

Fig. 2. Fruit, kernel and germinated seed of Wild Peach Palm

PRODUCTION, EVALUATION AND IMPROVEMENT OF OIL PALM HYBRIDS

Regeneration of basic planting materials for new seed gardens

Dura population improvement programme: Basic planting material for new seed gardens is being generated. Extensive crossing programme has been effected in developing dura population utilizing new sources like Zambia, Cameroon, Tanzania, Costa Rica. About 140 such crosses have been developed.

Tenera improvement programme: Selection of palms in hybrids of exotic sources (ASD Costa Rica, Ivory Coast, PNG) has been made; crossing programme has been formulated and is being effected for generating T x T planting material.

Technique for inducing pollen production in stubborn *pisifera* : Oil Palm hybrid male parent *(pisifera)* has a consistently high sex ratio associated with bunch failure. Frond pruning, root pruning and stress treatment showed positive response for male inflorescence cycle initiation and pollen production in *pisifera* palm (planted during 1998) with stubborn character of producing only female bunches. It was confirmed from the treatment given to the *pisifera* palms that duration required for treatment response depends upon age of the palm, genotype and wide variation was reported worldwide.

Development of D x P hybrids for inclusion in AICRP system: Ten hybrids, expected to be promising were selected for inclusion in multi-location evaluation under AICRP (Palms). The sprouts shall be supplied during October' 2009.

Accordingly ten hybrids were developed for testing under AICRP (Palms) at two locations namely Madhopur (Bihar) and Passighat (Arunachal Pradesh). And ten hybrid combinations were developed for planting at Krushinagar, IIVR, Varanasi for demonstration purpose.

Table 4. Descriptive changes in Surinam dwarf *oleifera* during fruit/seed development

Days After Anthesis	Descriptive changes
60	Embryo formed, oil formation initiated (20%)
90	Shell formation completed-dark brown colour, endosperm pale white
100	Shell blackening, endosperm light blue in colour
110	Ability to germinate
120	70% germination, least moisture content and more dry matter accumulation

Evaluation programmes

Evaluation of Dura and T x T progeny at DOPR, Pedavegi : Regular FFB data on each harvest basis, quarterly observations on leaf and inflorescence production and annual biometric observations were recorded(Table 5). Bunch analysis on selected dura palms and pisifera palms was done.

Mother palms (46 nos. from Palode source and 36 from Costa Rican source) were selected and are being utilized in commercial seed production programme. Six pisifera palms have been selected for their utilization in crossing programme. Most of the palms selected as mother palms were from the dura population 80DX281D (17 nos) followed by 240Dx281D (8 nos). Fruit typing for ascertaining fruit character is continued.

Dura progeny 80D x 281D recorded highest average FFB yield (100.6 kg/palm/year) and also had the highest bunch index (0.52).

A segregation ratio of Dura (27): Tenera (97): pisifera (28) has so far been recorded in TxT population.

Evaluation of Dura and T x T progeny at Taraka & Rajahmundry seed gardens : Regular monitoring on seed production is being done; quality of sprouts has been taken care. Yield data is being regularly recorded. Ten mother palms at Taraka and 15 at Rajahmundry seeds gardens have been selected to further enhance hybrid seed production. Fruit typing in TxT block is continuing. Experiments on seed quality have been formulated.

Evaluation of DxP progenies of Lakshmipuram at Pedavegi : D x P 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 (Table 6). Hybrid 155 D x 57P recorded the highest FFB yield (131.5 Kg).

D x P progenies of Rajahmundry: All the four D x P hybrid testing trials are in good condition; they are now two years old.

Progeny testing of Palode hybrids at Lakshmipuram : The evaluation of three progeny testing trials of Palode source have been completed.

Pooled analysis over four years (2005-08): ANOVA for major yield traits like number of bunches, total FFB weight and average bunch weight showed that :

- Year to year variations were highly significant.
- Variation among hybrids was also found significant.
- Hybrid x Year interaction effects were non significant.
- Variation among hybrids for FFB yield was recorded high.

Evaluation of Dwarf Tenera progeny: The selfed-progeny is in good condition; palms with less height increment have been observed. Fruit typing was carried out.

Identification of new sources for dwarfness: Two dwarf palms in farmers' fields in A.P. have been observed.

Study on seasonal variation in bunch quality parameters (Table 7): The study was undertaken in nine dura palms to know the effect of seasons on bunch parameters. Oil to bunch was more (21.9%) during rainy season and was low during summer season (16.5%). It could have been due to high mesocarp to fruit ratio, less shell to fruit

Table 5. Performance of dura populations at Pedavegi

Genotype	Girth (cm)	Height (cm)	Height Increment	SR	Leaves (No.)	BN	TBW (kg)	ABW (kg)	BI
240D x 281D	307.1	268.0	83.7	0.36	24.5	5.6	75.4	13.7	0.42
80D x 281D	284.5	274.3	108.1	0.36	25.1	6.5	100.6	15.1	0.52
C487 x 269D	292.7	236.2	104.9	0.33	24.3	6.5	85.1	13.1	0.49
Interspecific	272.0	110.0	18.7	0.25	26.7	5.4	71.7	10.8	0.42
98C x 254D	251.1	231.9	62.2	0.35	26.6	6.9	70.6	10.3	0.45

SR : Sex ratio; BN : Bunch number; TBW : Total bunch weight; ABW : Average bunch weight; BI : Bunch index

Table 6. Evaluation of D X P hybrids under irrigated conditions at Pedavegi (A.P.)

Nos	DETAILS	Girth	Height	Ht. Increment	SR	No. of leaves	SLA	B.No.	B.Wt.	ABW
H-1	47D X 90P	281.9	95.1	34.7	0.46	22.0	0.60	11.5	114.8	10.5
H-2	56D X 90P	283.8	101.3	29.8	0.42	21.5	0.62	10.0	115.9	11.5
H-3	30D X 90P	311.1	99.7	39.2	0.38	22.4	0.68	8.9	86.0	9.5
H-4	113D X 90P	299.4	125.0	44.2	0.49	23.4	0.66	11.6	120.4	10.5
H-5	53D X 57P	297.2	108.3	36.6	0.40	22.6	0.60	10.7	112.0	10.5
H-6	119D X 57P	317.7	128.6	41.0	0.50	21.4	0.65	13.0	121.1	9.3
H-7	165D X 57P	281.4	104.0	36.9	0.33	24.0	0.63	11.8	109.8	9.3
H-8	124D X 57P	280.7	84.7	28.4	0.44	20.2	0.68	8.9	84.8	9.7
H-9	155D X 57P	295.5	92.9	38.3	0.38	21.7	0.68	13.1	131.5	10.2
H-10	139D X 155P	292.2	116.1	41.6	0.41	23.4	0.61	9.3	101.7	10.4
H-11	146D X 155P	302.0	96.3	33.8	0.53	22.1	1.05	13.2	125.9	9.8
H-12	97D X 155P	283.7	100.3	28.6	0.38	20.7	0.60	8.3	79.7	8.6
H-13	135D X 155P	299.1	102.0	32.3	0.50	22.5	0.68	9.2	100.3	10.8
H-14	44D X 155P	302.9	99.2	38.3	0.23	21.4	0.66	12.2	116.4	9.5
H-15	135D X 57P	297.1	110.0	39.8	0.33	23.7	0.69	10.7	105.4	9.5
H-16	222D X 57P	286.6	103.9	38.9	0.33	22.8	0.58	8.7	83.3	9.8
H-17	216D X 90P	300.8	109.2	59.5	0.53	26.4	0.54	10.2	73.4	7.1
H-18	118D x 57P	281.7	102.3	45.4	0.35	20.9	0.68	8.3	88.6	10.1
H-19	(29D X 155P)	280.2	103.1	40.5	0.43	23.9	6.49	10.8	96.2	8.4
	Deli X Nigeria	319.9	98.7	21.2	0.38	20.0	0.38	14.8	145.2	9.8
	Deli X Ghana	316.1	112.7	26.8	0.49	20.5	0.60	14.9	138.6	9.6
	General Mean	295.8	104.5	36.95	0.41	22.3	0.92	10.95	107.2	9.7
	SD (±)	NS	10.2	8.01	0.08	NS	1.28	2.03	19.95	0.9

Table 7. Seasonal variation in bunch parameters in nine dura palms

Bunch Parameters	Rainy	Winter	Summer
Bunch weight (Kg)	9.50	11.20	17.80
Total No. of fruits	918.80	1104.80	1006.80
%sterility	23.50	27.70	29.90
Fruit/ Bunch	0.67	0.58	0.61
% Mesocarp Moisture content	38.10	36.20	39.00
% Mesocarp/ Fruit	72.30	66.50	67.40
% Kernel/ Fruit	4.32	4.69	4.52
% Shell/ Fruit	19.00	23.80	23.40
% oil (dry mesocarp)	73.60	68.10	65.80
% oil (wet mesocarp)	45.50	43.30	40.20
Oil/ Bunch	21.90	16.90	16.50

ratio, and fruit to bunch ratio during rainy season. The study is in progress.

Evaluation of Inter-specific hybrids

At Pedavegi: Regular FFB data on each harvest basis, quarterly observations on leaf and inflorescence production and annual biometric observations were recorded. Bunch analysis on selected dura palms and pisifera palms was done. Comparative height increment of IS 2 was less; frequency of production of Hermaphrodites was recorded. Variation for BI was more. Mean FFB weight & ABW of 361Dx11Eo was more than 360D x 13Eo and also has high variation.

Bunch analysis was carried out on individual palms (Table 8). There was significant variation among palms within a cross for % sterility, seed size, % mesocarp content, oil to bunch ratio *etc*. Oil to bunch ratio had positive and significant correlation with total number of fruits, fruit to bunch, mesocarp to fruit ratio. Percent sterility and shell to fruit were negatively correlated with oil to bunch ratio.

At Palode : The evaluation of interspecific hybrids planted during 1998 at Palode revealed that 361 *Eg* × 11*Eo* showed better performance when compared to other hybrids as per its mean FFB value. The individual palm performance revealed that palm No 25 from 360 Eg × 13 E0 and 47 from 15 Eo × 18 Eg recorded 61 and 127kg FFB weight with bunch numbers of 5 and 10 respectively.

Promising palms from Malaysian *oleifera* and interspecific hybrids planted during 1992 and 1998 respectively were identified based on their performance . The palms with numbers 21, 6, 4, 7, and 18 belonging to Malaysian origin showed superior performance in terms of bunch yield.

Biochemical studies: Fruit samples from 20 interspecific hybrid palms from Pedavegi were analyzed for fatty acids composition of the mesocarp oil (Table 9). Sixteen palms were from a single cross 361 D x 11 P (*Egx Eo*) and 4 were from control cross of *Eg* x *Eg* (115D X 17P). Each palm was analyzed for three bunches (replication). Results revealed that the average unsaturated fatty acid content of 361 D x 11 P (*Egx Eo*) was marginally higher (53.81%) than that of the *Eg* X *Eg* (control) progeny. The cross wise average data were not much different from

Table 8. Correlation among bunch parameters in inter specific progeny palms

Bunch Parameters	Total number of fruits	% sterility	Fruit/ bunch	Mesocarp / fruit	Kernel / fruit	Shell / fruit	Oil/dry mesocarp	Oil/wet mesocarp	Oil/ bunch
Bunch weight	0.90**	-0.34**	0.15	0.02	0.16	-0.13	-0.02	0.08	0.18
Total No. of fruits		-0.50**	0.29*	0.11	0.22	-0.22	-0.13	-0.04	0.25*
% sterility			-0.82**	-0.29*	0.05	0.27*	0.50**	0.50**	-0.38**
Fruit/bunch				0.14	-0.19	-0.09	-0.48**	-0.50**	0.37**
Mesocarp /fruit					-0.12	-0.91**	-0.03	0.06	0.73**
Kernel / fruit						-0.25*	-0.11	-0.06	-0.19
Shell/fruit							0.10	-0.03	-0.65**
Oil/ dry mesocarp								0.81**	0.13
Oil/ wet mesocarp									0.41**

*Sgnificant at %5 level; ** Significant at 1% level

Eg oil. But within the cross the progenies segregated with respect to FAC, oil and moisture content. Seven palms under study were having 60% of total unsaturated fatty acid content from 361 D x 13 P (*Eo*) cross (53.51%). In fact oleic acid content was found higher (41.52%) in control progeny than that of 361 D x 11 P (*Egx Eo*) (39.20), However, Linolenic acid (a poly-unsaturated fatty acid) was higher in 361 D x 11 P (*Eg x Eo*) progeny (13.93) than that of control (11.24%).

Combined analysis of bunch component analysis revealed intermediate values for bunch weight as well as bunch related parameters including proportion of parthenocarpic fruits. However, the oil/ mesocarp and oil/bunch were lower than those of the parents. Fatty acid composition for all the fatty acids showed intermediate value between the two parental species. Wide variability in fatty acid composition was found in progenies of two specific interspecific crosses. No correlation was observed between any two fatty acids. Out of seven interspecific crosses, three were found to be on par with the better performing *E. oleifera* parental palms with respect to fatty acids. Since performance of each palm is different, individual interspecific hybrid palms were assessed based on total unsaturated fatty acid and oleic acid contents and 20 superior palms were selected, which could be employed for further back crossing programme to combine the quality of palm oil and yield (Table 10).

Table 9: Fatty acid composition of mesocarp oil from interspecific hybrid palms from Pedavegi

Palm No.	Cross	Type	C14:0	C16:0	C18:0	C18:1	C18:2	C18:3	TSFA	TUFA
29	361 D X 11 Eo	ISH	2.06	35.17	7.82	39.71	13.63	1.61	45.05	54.95
30	361 D X 11 Eo	ISH	0.97	40.60	5.32	37.44	15.16	0.50	46.90	53.10
31	361 D X 11 Eo	ISH	0.79	40.25	4.86	39.26	14.14	0.69	45.90	54.10
32	361 D X 11 Eo	ISH	0.70	38.75	4.04	43.57	12.25	0.68	43.50	56.50
33	361 D X 11 Eo	ISH	0.73	44.20	2.99	33.23	18.21	0.64	47.93	52.07
35	361 D X 11 Eo	ISH	1.33	42.54	4.13	41.23	10.42	0.35	47.99	52.01
37	361 D X 11 Eo	ISH	1.11	36.79	2.48	39.38	19.65	0.60	40.37	59.63
39	361 D X 11 Eo	ISH	0.74	41.20	3.77	37.73	16.16	0.41	45.70	54.30
42	361 D X 11 Eo	ISH	1.17	40.65	3.17	41.13	13.14	0.74	44.99	55.01
44	361 D X 11 Eo	ISH	1.49	44.14	3.60	37.97	12.27	0.53	49.23	50.77
45	361 D X 11 Eo	ISH	0.86	38.22	3.06	42.55	14.50	0.83	42.13	57.87
46	361 D X 11 Eo	ISH	1.18	47.86	4.63	35.34	10.28	0.71	53.67	46.33
55	361 D X 11 Eo	ISH	1.36	36.45	4.46	43.51	13.72	0.50	42.27	57.73
58	361 D X 11 Eo	ISH	1.38	42.24	4.44	37.95	13.51	0.49	48.05	51.95
60	361 D X 11 Eo	ISH	1.20	45.06	3.90	37.89	11.40	0.56	50.16	49.84
66	361 D X 11 Eo	ISH	1.42	40.56	3.38	39.32	14.51	0.82	45.36	54.64
Average			1.16	40.92	4.13	39.20	13.93	0.66	46.20	53.80
47	115 D X 175 P	Control	0.42	39.59	4.61	41.75	13.05	0.58	44.62	55.38
48	115 D X 175 P	Control	1.08	39.33	4.65	43.27	10.94	0.72	45.06	54.94
52	115 D X 175 P	Control	1.16	45.42	4.57	36.95	11.17	0.73	51.15	48.85
71	115 D X 175 P	Control	1.20	37.97	5.96	44.10	9.80	0.97	45.13	54.87
Average			0.96	40.58	4.95	41.52	11.24	0.75	46.49	53.51

C14:0 - Myristic acid; C16:0 - Palmitic acid; C18:0 - Stearic acid; C18:1 - Oleic acid; C18:2 - Linoleic acid; C18:3 - Linolenic acid; TSFA - Total saturated fatty acid; TUFA - Total unsaturated fatty acid

BREEDING FOR HIGH YIELD AND DROUGHT TOLERANT OIL PALM

Evaluation of African germplasm: 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 different locations in India. The very objective of the experiment is to identify germplasm suitable for a particular location in order to develop location specific varieties. The accessions were planted at locations like Pedavegi, Nellore, & Adilabad (Andhra Pradesh) and Palode & PCKL (Kerala). At all the locations the crop is maintained well and standard practices of cultivation are being followed. The crop is being grown as rainfed at Palode and PCKL locations whereas at other locations it is being grown under water stress conditions (IW/CPE ratio = 0.5). Observations on morphological, yield, bunch, biochemical & physiological parameters were recorded.

Exploitation of variability available in African germplasm: Hybridization programme is continuing to exploit the variation available in the African germplasm

Table 10: List of 20 superior interspecific oil palm hybrids and their fatty acid composition

Palm No.	Cross	C14:0	C16:0	C18:0	TSFA	C18:1	C18:2	C18:3	TUFA
PD_26	360 D x 13 Eo	0.49	32.88	2.59	35.97	48.66	14.38	1.00	64.03
PD_2	360 D x 13 Eo	0.63	34.30	3.00	37.93	48.10	12.93	1.04	62.07
PL_10	15 Eo X 18 Eg	0.73	35.32	2.13	38.18	48.82	12.54	0.47	61.82
PD_8	360 D x 13 Eo	1.11	33.93	3.51	38.55	45.56	15.19	0.70	61.45
PD_11	360 D x 13 Eo	0.53	34.54	3.57	38.64	47.52	13.54	0.29	61.36
PD_72	360 D x 13 Eo	0.97	35.41	2.90	39.28	47.38	12.65	0.69	60.72
PL_36	12 Eo X 82 Eg	0.78	34.87	3.77	39.42	49.36	10.28	0.93	60.58
PD_16	360 D x 13 Eo	0.55	35.86	3.30	39.72	47.27	12.12	0.89	60.28
PD_15	360 D x 13 Eo	0.81	36.34	2.71	39.87	44.10	14.64	1.39	60.13
PL_28	12 Eo X 82 Eg	0.54	36.48	3.99	41.02	44.51	13.77	0.70	58.98
PD_6	360 D x 13 Eo	0.86	34.96	5.43	41.25	45.90	11.89	0.95	58.75
PL_11	19 Eo X 81 Eg	1.06	36.76	3.65	41.47	44.09	13.73	0.72	58.53
PD_21	360 D x 13 Eo	1.75	37.18	2.64	41.56	44.97	12.29	1.18	58.44
PD_80	360 D x 13 Eo	0.75	36.13	4.94	41.83	47.09	10.54	0.54	58.17
PD_81	360 D x 13 Eo	0.65	36.79	4.66	42.09	46.52	11.05	0.34	57.91
PL_23	16 Eo X 81 Eg	1.00	37.25	3.84	42.09	43.73	13.44	0.74	57.91
PD_45	361 D X 11 Eo	0.86	38.22	3.06	42.13	42.55	14.50	0.83	57.87
PD_84	360 D x 13 Eo	0.66	36.84	4.67	42.17	45.26	11.54	1.03	57.83
PL_26	12 Eo X 82 Eg	0.59	39.23	2.40	42.22	45.74	11.21	0.83	57.78
PD_55	361 D X 11 Eo	1.36	36.45	4.46	42.27	43.52	13.72	0.50	57.73
	CD at 5%	**0.40**	**4.72**	**1.12**	**7.71**	**3.75**	**3.02**	**0.41**	**7.71**

C14:0 - Myristic acid; C16:0 - Palmitic acid; C18:0 - Stearic acid; C18:1 - Oleic acid; C18:2 - Linoleic acid; C18:3 - Linolenic acid; TSFA - Total saturated fatty acid; TUFA - Total unsaturated fatty acid

materials. The dura x dura populations are being developed to isolate superior transgressive segregants at later stage. Development of high yielding tenera hybrids, study on genetics of fruit colour and sizes *etc*. are the traits keept in mind while making DxP and DxD crosses.

Study on variation within bunch : A study has been initiated to see the variation among fruits within bunch.

Variability in Germplasm: Significant variability has been recorded within and between the accessions for many characters like, having long stalked male inflorescence, height increment, some palms are producing only female inflorescence, narrow petiole, having short rachis length, and Virescens fruit types very much seen with good yields.

EVALUATION AT PEDAVEGI (A.P.): Quarterly observations on production of leaves, inflorescences (male/female) were regularly recorded. The annual biometric observations on 17th leaf, height, girth at collar were recoded once in a year. The Fresh Fruit Bunch weights (FFB yield) were recorded on each harvest basis.

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 by arranging water drippers. The experiment is being maintained as per the standard package of practices followed for oil palm. Till the reported, the crop is in good health.

Replicated trial (Tables 11a & b): Quarterly observations were recorded on leaf and inflorescence production. Number of bunches and FFB weights were recorded as and when the harvesting was done and were expressed on annual basis. Annual biometric observations on palm height, Girth of stem, standard leaf (17th) measurements like rachis length, petiole width, depth, number, length, width of leaf lets, were recorded to calculate leaf area, leaf dry matter, trunk dry matter production *etc*.

During 2008-09, under irrigated conditions highest yield (169.03 Kg) was recorded by Tanzanian accessions TS-9 followed by Zambian accession ZS-8 (122.14 Kg). Guinea Bissau accessions were the lowest yielders (73.99 kg/palm). The average bunch size of Tanzanian accessions was more (18.44 kg). The Guinea Bissau accessions were having small size bunches (6.97 kg).

Under water stress conditions Zambian accession ZS-3 was the highest yielder (150 Kg) followed by Tanzanian accession TS-9 (142 Kg); GB accessions were the lowest yielders (74.86kg/palm). The average bunch size of Tanzanian accessions was highest (14.66 kg). GB accessions had small bunches (7.14 kg). Among Cameroon accessions FFB yield of CA-9 was recorded highest (163 kg/ palm). The number of bunches were recorded highest in CA-11 (14) and CA-15 (13). ABW was highest in CA-8 (14.7) and CA-9 (14.1 Kg). Among GB accessions, the highest FFB yield was recorded by GB-29/ 318 (140 kg). The ABW was also highest in this accession (11.2 kg). Amongst the Zambian accessions ZS-6 was the highest yielder (149 kg). Average FFB yield of Tanzanian accessions was 134 kg with highest yield of 184 kg recorded in TS-7. ABW was highest when compared to other sources (16.1 kg).

The average yield of previous four years (2005-06 to 2008-09) under both irrigated and stress environments showed that the Zambian accessions were the highest yielders followed by Tanzanian accessions. The yield level of GB accessions was again recorded the lowest under both the environments. The average yield loss of Guinea Bissau accessions under water stress conditions was 10%. The Zambian accessions and Tanzanian accessions have shown a yield loss of 9.2% and 14.1% respectively.

These accessions have significant variations for characters like palms are very strong, robust, compact canopy, having long stalked male inflorescence, dwarfness, position of leaf lets, have maximum exposure to sun light for better photosynthetic efficiency, some palms are producing only female inflorescence, without male flowers, narrow petiole, having short rachis length and *virescens* fruit forms are very much seen with good yields.

Bunch Analysis : Bunch analysis was done in African Germplasm 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. Through bunch analysis one can also get information on number of infertile/sterile/ parthenocarpic fruits. The bunch analysis was carried out in Zambian, Cameroon and Tanzanian accessions. Wide variation has been

Table 11a. Performance of African germplasm under Irrigated conditions at DOPR, Pedavegi

Genotype	2004-05			2005-06			2006-07			2007-08			2008-09			Average		
	BN	FFBY	ABW	BN	FFBY	ABW	BN	FFBY	ABW	BN	FFBY	ABW	BN	FFBY	ABW	BN	FFBY	ABW
GB21/310	13.36	45.17	3.84	10.64	62.54	7.39	15.69	96.78	6.00	12.33	121.07	9.97	9.83	72.14	7.08	12.12	88.13	7.61
GB22/311	10.83	35.67	3.67	8.78	48.89	5.91	14.08	81.39	5.79	12.14	90.72	8.06	9.58	75.25	7.69	11.15	74.06	6.86
GB25/314	13.83	34.75	2.48	13.44	55.61	4.36	12.33	64.00	5.22	18.59	104.27	6.21	12.08	74.58	6.13	14.11	74.61	5.48
GB Mean	12.68	38.53	3.33	10.95	55.68	5.89	14.04	80.72	5.67	14.35	105.35	8.08	10.50	73.99	6.97	12.46	78.94	6.65
TS11	7.36	69.79	8.91	5.47	49.96	8.89	9.72	112.69	11.51	9.42	131.29	14.02	6.33	107.44	17.61	7.74	100.35	13.01
TS9	11.17	86.13	8.25	8.33	86.46	11.37	9.75	113.75	12.40	8.05	122.48	14.94	9.36	169.03	19.27	8.87	122.93	14.50
TS Mean	9.26	77.96	8.58	6.90	68.21	10.13	9.74	113.22	11.96	8.74	126.88	14.48	7.85	138.24	18.44	8.31	111.64	13.75
ZS1	12.75	94.53	7.97	5.81	51.33	8.92	8.44	105.14	13.77	11.50	165.03	14.85	8.83	113.25	14.43	8.65	108.69	12.99
ZS2	14.94	129.47	8.88	5.14	57.07	11.06	12.89	163.53	13.36	11.63	150.17	12.40	6.94	101.72	14.69	9.15	118.12	12.88
ZS3	9.58	79.83	8.27	8.42	76.70	9.15	7.92	97.00	12.61	10.93	139.92	12.84	7.92	110.25	14.56	8.79	105.97	12.29
ZS5	12.78	99.19	8.03	7.28	61.64	8.78	10.00	133.33	12.81	8.02	130.08	16.07	7.33	110.00	13.90	8.16	108.76	12.89
ZS8	10.50	92.50	9.27	6.25	55.99	9.15	10.58	134.08	12.91	8.82	126.12	14.00	8.11	122.14	15.65	8.44	109.58	12.93
ZS Mean	12.11	99.11	8.48	6.58	60.55	9.41	9.97	126.62	13.09	10.18	142.26	14.03	7.83	111.47	14.65	8.64	110.22	12.80

BN : Bunch number; FFBY : Fresh Fruit Bunch yield; ABW : Average bunch weight

Table 11b. Performance of African germplasm under water stress conditions at DOPR, Pedavegi

Genotype	2004-05			2005-06			2006-07			2007-08			2008-09			Average		
	BN	FFBY	ABW	BN	FFBY	ABW	BN	FFBY	ABW	BN	FFBY	ABW	BN	FFBY	ABW	BN	FFBY	ABW
GB21/310	5.44	18.03	3.83	10.08	60.55	6.27	12.08	77.03	6.65	15.49	102.03	6.74	11.42	92.13	7.76	12.27	82.93	12.27
GB22/311	10.58	31.00	2.97	11.25	59.27	5.28	15.33	81.92	5.37	12.46	98.52	8.19	9.92	73.08	7.45	12.24	78.20	12.24
GB25/314	10.33	25.13	2.74	10.11	34.57	3.53	10.81	49.64	4.48	13.65	85.68	6.38	9.72	59.36	6.20	11.07	57.31	11.07
GB Mean	8.79	24.72	3.18	10.48	51.46	5.03	12.74	69.53	5.50	13.87	95.41	7.10	10.35	74.86	7.14	11.86	72.81	11.86
TS11	7.81	53.97	6.91	5.64	52.70	9.00	8.03	87.94	11.03	5.59	80.84	12.86	9.69	131.69	13.78	7.24	88.29	7.24
TS9	9.33	73.92	7.75	6.98	67.34	9.84	8.25	96.67	12.10	7.95	113.37	14.33	9.33	142.08	15.55	8.13	104.87	8.13
TS Mean	8.57	63.94	7.33	6.31	60.02	9.42	8.14	92.31	11.56	6.77	97.10	13.60	9.51	136.89	14.66	7.68	96.58	7.68
ZS1	9.83	71.13	7.15	7.08	56.29	8.37	10.17	111.60	11.24	9.74	120.43	12.03	8.88	117.50	12.80	8.97	101.46	8.97
ZS2	12.83	103.25	8.26	6.87	52.42	8.20	9.00	98.75	11.15	12.27	152.09	12.51	10.00	134.92	13.63	9.53	109.54	9.53
ZS3	6.67	44.75	6.77	11.00	87.15	8.12	9.33	99.83	11.02	8.24	106.28	13.13	10.25	149.67	14.20	9.71	110.73	9.71
ZS5	9.50	70.71	7.84	5.42	53.94	9.44	8.64	103.89	13.50	9.01	132.31	15.62	8.67	121.56	13.78	7.93	102.92	7.93
ZS8	11.25	91.17	7.97	6.33	62.15	9.29	7.67	90.92	12.53	8.72	119.70	13.78	6.83	98.17	14.70	7.39	92.73	7.39
ZS Mean	10.02	76.20	7.60	7.34	62.39	8.68	8.96	101.00	11.89	9.60	126.16	13.42	8.93	124.36	13.82	8.71	103.48	8.71

BN : Bunch number; FFBY : Fresh Fruit Bunch yield; ABW : Average bunch weight

observed for F/B, M/F, K/F and S/F ratios, moisture content of the mesocarp and moisture contents of nuts (Table 12). The activity is in progress.

The highest oil percentage was observed in Tanzanian Accession TS-9 with 24.1% followed by Zambian Accession ZS-8 with 16.9% of oil and the lowest oil percentage was observed in ZS-2 (16.5%). Variation for other bunch quality parameter has also been recorded. The highest fruit/bunch ratio was recorded in TS-9 (0.67) followed by CA-12 (0.65) and ZS-5 (0.64).

Observational Trial: A number of accessions from all the four African countries are being evaluated for water stress conditions (IW/

Table 12. Evaluation of African germplasm for various bunch quality parameters at Pedavegi

Genotype	Para-meters	Total number of fruits	sterile fruit (%)	Fruit/ bunch	moisture content of mesocarp(%)	mesocarp /fruit	kernel /fruit	shell /fruit	moisture content of nuts(%)	oil/ bunch
ZS-1	Mean	1615.0	18.7	0.5	43.9	54.4	14.9	25.0	13.0	12.8
	SD	18.4	3.9	0.0	5.5	6.2	1.6	4.6	1.9	1.4
	MAX	1628.0	21.4	0.5	47.7	58.7	16.0	28.2	14.3	13.7
	MIN	1602.0	15.9	0.5	40.0	50.0	13.7	21.7	11.6	11.8
ZS-2	Mean	1200.9	25.4	0.5	30.3	56.6	10.9	27.3	12.1	16.5
	SD	274.4	6.9	0.1	2.9	12.0	2.4	9.0	1.5	4.5
	MAX	1658.0	37.7	0.6	34.8	73.2	14.8	39.8	15.0	21.0
	MIN	978.0	18.9	0.4	26.6	39.6	8.0	14.8	11.0	8.9
ZS-3	Mean	1562.5	18.1	0.6	35.6	53.7	11.3	28.8	13.5	15.7
	SD	326.2	3.6	0.0	1.1	2.4	0.9	1.6	1.0	0.0
	MAX	1962.0	22.5	0.7	37.0	56.6	12.4	30.8	14.8	15.7
	MIN	1163.0	13.7	0.6	34.3	50.8	10.2	26.8	12.2	15.7
ZS-5	Mean	1405.3	18.0	0.6	29.9	48.7	11.8	32.4	12.6	16.5
	SD	146.7	4.3	0.0	7.6	4.9	1.9	4.0	0.7	1.7
	MAX	1562.5	24.6	0.7	35.6	53.7	14.2	37.0	13.5	19.5
	MIN	1226.0	13.1	0.6	19.1	41.2	9.6	27.8	11.8	15.6
ZS-8	Mean	1208.1	21.8	0.6	31.4	55.0	11.5	25.6	13.5	16.9
	SD	354.7	2.5	0.1	4.6	10.1	2.4	5.2	0.6	4.5
	MAX	1698.0	25.1	0.7	34.9	69.6	14.0	29.6	14.2	23.7
	MIN	873.0	19.1	0.5	26.1	47.5	8.4	18.0	12.8	14.3
TS-11	Mean	1182.7	24.1	0.6	29.4	39.7	12.8	32.1	13.0	13.3
	SD	144.1	11.2	0.1	NR	22.2	2.5	7.1	1.1	3.5
	MAX	1349.0	37.0	0.6	29.4	59.2	15.6	37.2	14.2	17.3
	MIN	1095.0	17.5	0.5	29.4	15.6	11.0	24.0	12.2	10.5
CA-12		1250.9	15.1	0.65	38.8	40.6	15.2	38.6	9.4	11.5
TS-9		1852.0	12.8	0.67	28.8	68.0	9.6	18.4	12.5	24.1

CPE ratio = 0.5). Data on observational (non replicated) trial comprising genotypes from different countries along with two inter-specific hybrids were recorded.

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 13a): Among all the accessions, FFB yield of CA-9 was recorded highest (162.5 kg/palm). The number of bunches were recorded highest in CA-11 (13.5) followed by CA-15 (13). The average bunch weight was highest in CA-8 (14.7 kg) followed by CA-9 (14.1 kg).

Performance of Guinea Bissau accessions (Table 13b): Amongst the GB accessions the highest FFB yield was recorded by GB-29/318 (140 kg) which was significantly higher than the general mean (66.6kg). The average bunch weight was also recorded highest in this accession (11.16kg). It was observed that the production of bunches was recorded more in GB accessions when compared to others.

Performance of Zambian accessions (Table13c): Amongst the Zambian accessions ZS-6 was the highest yielder (149 kg). The average performance of Zambian accessions was 109.3 kg.

Table 13a. Performance of Cameroon accessions under water stress conditions

Genotype	BN	FFBY(kg)	ABW(kg)
CA-3	7.3	81.7	11.1
CA-4	8.2	93.8	11.4
CA-6	7.8	90.4	11.6
CA-7	8.2	101.5	12.4
CA-8	6.1	84.8	14.7
CA-9	11.5	162.5	14.1
CA-10	5.5	62.0	11.3
CA-11	13.5	71.5	5.3
CA-12	7.8	70.6	9.2
CA-13	4.7	46.7	10.0
CA-15	13.0	127.5	9.7
CA-16	7.8	82.8	10.7
CA-17	7.8	82.0	10.6
CA-18	6.2	58.6	9.5
Mean	**8.2**	**86.9**	**10.8**

BN : Bunch number; FFBY : Fresh Fruit Bunch yield; ABW : Average bunch weight

Table 13b. Performance of Guinea Bissau accessions under water stress conditions

Genotype	BN	FFBY(kg)	ABW(kg)
GB-1/309	13.00	99.00	7.62
GB-2/298	6.00	30.50	5.08
GB-5/301	2.83	27.33	9.65
GB-5/310	12.40	77.80	6.27
GB-10/306	11.60	69.40	5.98
GB-12/308	4.00	31.00	7.75
GB-21/308	11.60	80.20	6.91
GB-22/311	5.71	57.10	10.00
GB-23/312	7.10	45.40	6.39
GB-25/314	10.00	72.00	7.20
GB-28/317	9.00	92.00	10.22
GB-29/318	12.57	140.00	11.16
GB-32/321	4.60	43.40	10.40
Mean	**8.50**	**66.60**	**8.00**

BN : Bunch number; FFBY : Fresh Fruit Bunch yield; ABW : Average bunch weight

Table 13c. Performance of Zambian accessions under water stress conditions

Genotype	BN	FFBY(kg)	ABW(kg)
ZS-1	11.7	126.7	10.8
ZS-2	5.8	79.4	13.7
ZS-4	8.8	128.8	14.7
ZS-5	7.4	114.0	15.4
ZS-6	9.6	149.0	15.5
ZS-9	9.0	58.0	6.4
Mean	**8.7**	**109.3**	**12.8**

BN : Bunch number; FFBY : Fresh Fruit Bunch yield; ABW : Average bunch weight

Performance of Tanzanian accessions (Table 13d): The average FFB production of Tanzanian accessions was 133.6 kg with highest yield of 184 kg recorded in TS-7.The average bunch No was (11.0) recorded in TS-7. The average bunch weight was highest when compared to other sources (16.1kg)

Table 13d. Performance of Tanzanian accessions under water stress conditions

Genotype	BN	FFBY(kg)	ABW(kg)
TS-4	9.4	139.0	14.8
TS-5	8.3	129.2	15.7
TS-7	11.0	184.0	16.7
TS-8	7.5	153.5	20.5
TS-9	8.0	115.3	14.4
TS-10	10.5	117.5	11.2
TS-11	5.0	96.6	19.3
Mean	**8.5**	**133.6**	**16.1**

BN : Bunch number; FFBY : Fresh Fruit Bunch yield; ABW : Average bunch weight

Physiological studies

Ten exotic oil palm duras from Guinea Bissau (GB), Zambia (ZS) and Tanzania (TS) were screened for drought tolerance in terms of their stomatal responses, gas exchange and water relations in irrigated (IW/CPE = 1.0) and water stress (IW/CPE = 0.5) environments. Photosynthetic rate and its associated parameters along with stomatal characters and leaf water potential were taken during the study. Results revealed that lowest mean stomatal index was recorded in TS-11, while the highest was in GB-22/311. The mean photosynthetic rate was highest in ZS-1 followed by ZS-5, which did not differ significantly between each other and the lowest rate was recorded in ZS-2. Comparison of the photosynthetic water use efficiency (PWUE) among the duras indicated that irrigated palms had better efficiencies than those under water stressed conditions. The highest mean leaf water potential was recorded in ZS-3 followed by TS-9 and GB-21/310, while the lowest was in TS-11. Among the ten duras, ZS-1 was the most drought tolerant, while TS-9 was the least tolerant.

Biochemical characterization

Comparative evaluation of 10 selected African germplasm accessions under water stress vis- à -vis under full irrigation (under the replicated trial) was carried out. Some of the important biochemical parameters (photosynthetic pigments like chlorophyll-a, b, total chlorophylls and carotenoids; total and soluble carbohydrates; soluble proteins, proline, phenol and peroxidase activity etc.), which directly or indirectly affected by water stress were estimated. Result of water stress experiment indicated that water stress did not have significant effect on photosynthetic pigments under IW/CPE ratio = 0.5 except for accessions no. GB-25/314 and ZS-02. Both soluble and total carbohydrates did not show any significant difference under stress except for the three accessions (ZS-01, ZS-08 and TS-11). It was observed that all the three Guinea Bissau accessions were having highest range of soluble protein, proline and phenol content under both the treatments. However, none of the accessions showed any significant change under water stress with respect to soluble protein and proline content, whereas GB-21/310 exhibited significant reduction in phenol content. Two accessions (GB-21/310 and ZS-02) exhibited significant increase in peroxidase activity under water stress. From the experiment it can be inferred that accessions from Guinea Bissau were naturally adaptive to stress condition. In the case of a few accessions like ZS-02 (increase in peroxidase activity, reduced the

chlorophyll content); ZS-01 and ZS-08 (increase in soluble carbohydrate) responded to water stress. But they are adjusted to the condition as indicated by the increase in soluble sugar, peroxidase activity etc. However, most of the accessions were having no difference under stress, indicting that those accessions were already adopted to grow under lesser water than that is recommended for irrigated oil palm.

Fatty acids composition of mesocarp oil from African Germplasm

Fatty acids composition from the fruit samples of 30 palms with 3 replications was carried out during the reporting period. The palms were from 5 Guinea Bissau accessions (8 palms), 5 Zambian accessions (6palms), 4 Tanzanian accessions (7 palms), 4 Cameroon accessions (7 palms) and two palms from two Palode accessions

EVALUATION AT NELLORE (A.P.) : It has been decided to revive the trial. Annual biometric observations on palm height, stem girth, number of male and female inflorescences, number of leaves, leaf area and leaf dry weight were recorded. GB accessions were found tall growing; having small leaves, and narrow leaflets. Sex ratio was least in Zambian accessions. Drought tolerance indicator trait, SLW was recorded maximum in Zambian accessions.

EVALUATION AT PALODE (KERALA) : Major yield parameters of African germplasm evaluated at DOPR-RS, Palode are presented in Table 14. The highest number of bunches were recorded in GB accessions followed by single Cameroon accession and Zambian accession. Zambian accessions were found highest yielders (100.6 kg/palm). In GB accessions variation was found maximum, thus suggesting a scope for effective selection programme.

The evaluation of African germplasm planted at PCKL, Athirapilli, Kerala is continued. Fruit and seed analysis results showed very high co-efficient of variation in nut, kernel and shell weights in African germplasm consisting accessions of Guinea Bissau, Tanzania and Zaire. The mean, minimum and maximum values of different fruit and seed characteristics recorded in the African germplasm are given in the Table15.

STUDIES ON PERFORMANCE OF SOURCES OF OIL PALM PLANTING MATERIALS

The experiment is being conducted at the NRCOP, Pedavegi; it was planted 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 were recorded regularly.

Pooled analysis over years : Pooled analysis was done over five years (2004-09) to study the variations due to years and hybrids (Table 16). 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, it was non significant for average bunch weight character. Bunch, fruit and seed characterization was carried out through bunch Analysis.

FFB yield was recorded highest in hybrids of PNG source (131.1 kg) followed

Table 14. Evaluation of African Germplasm at Palode

Genotypes	No. of Bunches	Bunch Weight (kg)	Average Bunch Weight (kg)
GB 24/311	11.0	69.0	6.3
GB 27/36	9.0	15.0	1.7
GB 29/318	2.0	19.0	9.5
GB 9/305	4.0	23.5	5.8
GB 30/310	8.5	52.0	5.9
GB 23/312	21.0	86.0	4.1
GB 10/306	15.0	62.5	4.2
GB 28/317	7.5	31.3	2.1
GB 12/308	9.0	17.8	2.3
GB 7/307	16.5	50.5	3.1
GB 8/305	10.5	70.0	7.1
GB 32/321	14.0	39.0	2.6
GB 27/316	10.0	20.5	2.1
GB 81/309	12.5	73.0	5.8
GB 3/299	7.0	36.5	5.2
GB 8/304	22.0	83.3	3.8
GB 26/311	15.5	65.0	4.2
GB 30/319	18.0	115.5	6.3
GB 21/310	16.0	118.0	7.4
GB Mean	**12.1**	**55.1**	**4.7**
CA-4	**12.0**	**49.0**	**4.08**
TS-2	3.7	20.6	6.9
TS-10	3.0	40.5	8.4
TS-8	9.2	73.1	7.7
TS-11	4.0	67.5	16.8
TS Mean	**5.0**	**50.4**	**9.9**
ZS-8	11.6	103.5	8.8
ZS-4	9.7	89.2	7.4
ZS-7	7.5	109.0	13.5
ZS Mean	**9.6**	**100.6**	**9.9**

Table 15. Over all variation among African germplasm planted at PCKL, Athirapilli, Kerala

Statistics	Fruit Wt.(g)	Nut wt.(g)	% Meso/ Fruit	Kernal Wt.(g)	Shell Thick (mm)	% Kernal /Fruit	Shell Wt.(g)	% Shell /Fruit	Oil/ Dry Mes	% Oil/ Fruit
Mean	7.07	3.54	47.22	0.84	2.08	12.88	2.67	40.15	0.74	24.99
Min	1.64	0.00	24.04	0.00	0.00	0.00	0.00	0.00	0.39	5.79
Max	21.89	11.28	98.91	2.73	4.00	30.68	8.99	73.93	0.94	54.84
STDEV	4.97	2.46	12.57	0.59	0.75	4.64	1.90	11.36	0.08	8.89
VAR	24.73	6.06	157.98	0.34	0.56	21.48	3.62	129.10	0.01	79.12
CV%	70.29	69.51	26.62	69.67	35.85	35.98	71.33	28.30	11.43	35.59

Table 16. Performance of hybrids from different sources during 2005-06 to 2008-09 at Pedavegi (A.P.)

Source	Tenera ID	2005-06			2006-07			2007-08			2008-09			Average		
		BN	FFBW	ABW	BN	FFBW	ABW	BN	FFBW	ABW	BN	FFBW	ABW	BN	FFBW	ABW
ASD Costa Rica	Deli x Avros	4.5	82.1	19.0	5.7	114.6	22.8	5.0	98.3	19.8	8.8	179.8	20.4	6.0	118.7	20.5
	Deli x Ekona	3.3	72.4	21.8	7.1	149.5	22.8	5.1	113.1	22.2	9.1	202.3	22.2	6.2	134.3	22.3
	Deli x Ghana	5.6	104.9	18.7	6.9	125.6	19.0	6.5	128.6	19.9	8.2	181.0	22.1	6.8	135.0	19.9
	Deli x Lame	4.2	68.7	16.2	6.0	113.4	18.4	7.0	127.9	18.3	8.7	177.6	20.4	6.5	121.9	18.3
	Mean	**4.4**	**82.0**	**18.9**	**6.4**	**125.8**	**20.8**	**5.9**	**117.0**	**20.0**	**8.7**	**185.2**	**21.3**	**6.4**	**127.5**	**20.2**
Palode	65D x 111	3.7	65.4	17.9	9.9	186.7	18.8	6.0	113.2	19.0	7.9	171.2	21.7	6.9	134.1	19.3
	12 x 313	3.0	67.6	22.8	9.9	182.7	19.0	3.2	71.8	22.4	7.8	191.5	24.6	6.0	128.4	22.2
	12 x 266	4.3	88.4	20.8	10.3	202.6	19.1	4.8	98.7	20.7	8.1	184.5	22.6	6.9	143.6	20.8
	128 x 31323	4.2	70.5	17.0	8.9	166.8	18.9	7.2	138.5	19.2	8.4	183.1	21.9	7.2	139.7	19.3
	Mean	**3.8**	**73.0**	**19.6**	**9.8**	**184.7**	**19.0**	**5.3**	**105.5**	**20.3**	**8.0**	**182.6**	**22.7**	**6.7**	**136.5**	**20.4**
Ivory Coast	18C x 2501	4.3	83.9	19.5	7.0	131.9	19.3	8.4	164.9	19.6	6.6	135.3	20.5	6.6	129.0	19.7
	9C x 1001	4.5	77.5	17.1	8.3	138.2	16.6	9.9	182.8	18.4	8.2	134.4	16.4	7.7	133.2	17.1
	Mean	**4.4**	**80.7**	**18.3**	**7.7**	**135.1**	**18.0**	**9.2**	**173.8**	**19.0**	**7.4**	**134.8**	**18.5**	**7.2**	**131.1**	**18.4**
PNG	**1M - 0069**	**4.5**	**91.8**	**20.1**	**7.3**	**145.8**	**20.6**	**5.2**	**121.6**	**23.6**	**8.4**	**197.1**	**23.5**	**6.3**	**139.1**	**22.0**

BN : Bunch number; FFBW : Fresh Fruit Bunch weight (kg); ABW : Average bunch weight(kg)

by Palode hybrid (127.8 kg). The lowest yield was recorded in hybrids from Ivory Coast (121.4 kg). The Palode hybrid 12D x 266P produced the highest FFB yield (135.1kg/ palm/year); the lowest was recorded in Costa Rican hybrid- Deli x AVROS (111.7kg/ palm/year). The highest number of bunches were recorded in Ivory Coast hybrids (6.8) and lowest no of bunches were recorded in ASD Costa Rica (6.3). Palode hybrids recorded highest average bunch weight (20.9 kg)and lowest in Ivory coast (16.8 kg).

Annual Biometric Observations : The annual biometric observations were recorded on parameters like height, girth, no of leaves and 17th leaf observations like number of leaflets, petiole width, petiole depth *etc*., and presented in Table 17. Among the four accessions bunch index was recorded highest in ASD Costs Rica material (0.59) followed by PNG (0.51). Height of Palode hybrids were recorded at par with ASD Costa Rica and PNG hybrids; Ivory Coast hybrids recorded least height (393.9 cm). It was interesting to note that Palode hybrids recorded highest SLW (Specific Leaf Weight=0.78) thus, reflecting their promiscuity towards drought/ water stress tolerance. Bunch analysis was also done on a few palms per accessions, the activity is continued.

EVALUATION AT PALODE: The evaluation of hybrids from different sources like ASD Costa Rica, and Palode were compared for their yield parameters like number of bunches, total bunch weight and average bunch weight. The hybrids from both sources were found at par (Table 18). Further evaluation of performance of hybrids was continued during the reported period.

STRENGTHENING OF SEED GARDENS FOR INDIGENOUS SEED PRODUCTION (TMOP&M FUNDED)

Monitoring seed production programme at National level : DOPR is the nodal agency for monitoring oil palm seed production activity at the National level. The seed production activities are being regularly monitored. The quality aspects of oil palm hybrid seeds have extensively been taken care during the reporting period. These seed gardens are producing about two million sprouts annually.

Single fruit analysis : Single fruit analysis was carried out in dura palms on certain parameters like length, width, fresh mesocarp wt, shell wt, dry mesocarp wt, nut wt, kernel wt, oil per single fruit etc. The fruit size (length/breadth ratio) is negatively correlated with mesocarp content (-0.42) and thereby oil to fruit ratio (-0.67).Variation for fruit size was recorded least in palm no 436 which eventually had the lowest fruit size. Oil/fruit ratio varied between 0.25 and 0.41%. Study on DXP seed based on seed size have been formulated, the preliminary results indicate that seed size shows effect on nursery performance. Bunch analysis of *dura* and *pisifera* palms is regularly being done.

Regeneration of planting material for new seed garden : Planning is on for the establishment of New Seed Gardens so as to enhance the indigenous hybrid seed production.

Dura x Dura and Tenera x Tenera planting material is being generated; formulated crossing programme is being followed.

Table 17. Annual biometric observations on hybrids from different sources at DOPR, Pedavegi (A.P.)

Genotypes	Stem girth (cm)	Palm height (cm)	No. of leaves	Petiole width (cm)	Petiole depth (cm)	SLW	BI
Deli x Avros	295.0	574.6	21.6	10.7	7.8	0.79	0.51
Deli x Ekona	299.0	557.3	22.7	10.6	8.0	0.63	0.43
Deli x Ghana	321.5	487.8	21.1	9.8	7.1	0.65	0.71
Deli x Lame	327.8	443.2	24.3	8.7	6.4	0.58	0.70
Mean	**310.8**	**515.7**	**22.4**	**10.0**	**7.4**	**0.66**	**0.59**
65D x 111P	290.5	517.2	22.9	10.2	7.7	0.73	0.39
12D x 313P	263.8	499.8	23.7	10.0	7.6	0.79	0.49
12D x 266P	283.4	542.3	21.4	10.4	7.4	0.79	0.52
128D x 31323P	276.9	499	24.5	9.4	7.7	0.80	0.46
Mean	**278.6**	**514.6**	**23.1**	**10.0**	**7.6**	**0.78**	**0.47**
18C X 2501	338.7	379.6	24.3	9.2	7.3	0.62	0.47
9C X 1001	335.5	408.3	24.9	9.5	7.1	0.61	0.49
Mean	**337.1**	**393.9**	**24.6**	**9.3**	**7.2**	**0.61**	**0.48**
1M - 0069DXP	**291.2**	**557.1**	**24.0**	**9.8**	**7.2**	**0.61**	**0.51**
G.Mean	**304.5**	**495.3**	**23.7**	**9.8**	**7.3**	**0.67**	**0.51**
SD (±)	**25.48**	**70.44**	**1.0**	**0.3**	**0.18**	**0.08**	**0.05**

SLW : Specific Leaf Weight; BI : Bunch Index

Table 18. Yields of different sources of planting materials at Palode

Genotype no.	No. bunches	Total bunch wt. (Kg)	Av. bunch Wt.(kg)
C 65711	2.96	36.46	10.03
C 11067	5.88	66.13	11.76
C 11239	3.63	42.88	11.21
C 11225	4.88	65.13	10.79
C 11143	4.25	66.25	18.17
C 11146	5.50	80.38	11.87
C 65635	4.75	73.75	15.62
C 11044	8.63	134.50	15.49
C11076	4.50	51.38	10.22
C 11053	2.00	28.75	12.77
C 65893	4.13	42.25	6.07
C 11142	3.50	38.13	10.76
C 65758	4.63	57.13	14.33
C 11169	3.17	43.33	10.38
C 11163	3.13	45.50	11.01
C 11189	5.88	83.13	11.74
C 11092	5.88	58.63	9.27
C 11075	4.29	45.08	11.34
Palode	3.50	40.75	12.25

Fruit and seed characterization of Thodupuzha mother palms : A total of 341 Thodupuzha mother palms planted during 1960 were subjected to fruit and seed characterization during 2007-09 to know the pattern of variation existing among the palms. Information was collected on a total of eight characteristics. Fruit form testing revealed that seven out of 341 plams were suspected to be *tenera* fruit forms as they had fibre ring around the shell. The co-efficient of variation varied between 17 to 153.6 among different characteristics. Very high co-efficient of variation was observed for mesocarp oil followed by seed weight and kernel weight. Low value of variation recorded for shell thickness.(Table 19) The palms which showed superior characteristics have a greater prospect for success in breeding programmes.

MOLECULAR CHARACTERIZATION OF OIL PALM GERMPLASM

Genetic diversity study of *oleifera* palms: Genetic diversity study of the 23 *oleifera* palms was completed. Ten more primers were used and total 54 random primers were employed for the study. Total 238 alleles (bands) were scored of which 173 were found polymorphic (72.69%).

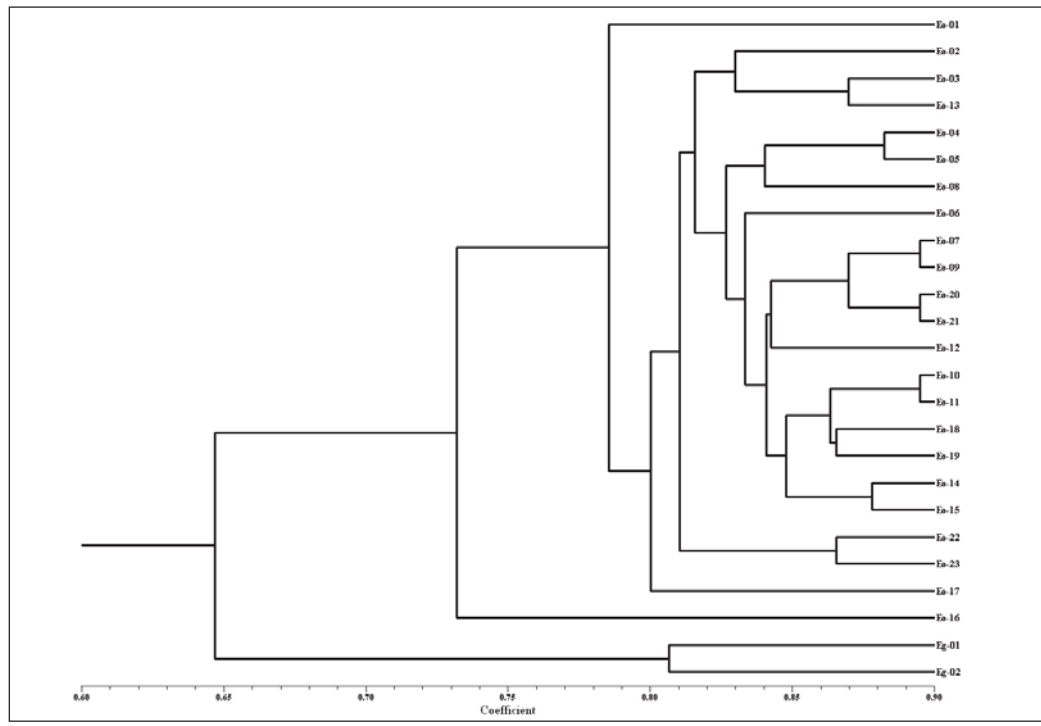
The *oleifera* palms formed 5 major clusters (Fig. 3) and fours palms were standing apart without forming any group. The similarity was found maximum (0.895) between three pairs of palms (palm No. *Eo*-07 & *Eo*-09; *Eo*-10 & *Eo*-11 and *Eo*-20 & *Eo*-21), whereas the similarity was least between palm no. *Eo*-16 & *Eo*-01 among the oleifera palms. However, *Eo*-16 & *Eg*-01 least similar umaong the plams under study. *E. guinensis* palms formed distinct separate group. There were quite a few primers which could identify *E. guinensis* from *E. oleifera*. This result combining with fatty acids composition would be useful for *oleifera* improvement programme.

DNA fingerprinting of *dura* mother palms: Forty high yielding dura palms were identified and DNA extraction and purification from all the palms were completed. Genetic diversity study of the above palms is being carried out using RAPD primers and during the reporting period, 10 primers were used.

Table 19. Fruit Seed characteristics of Thodupuzha mother palms

Statistics	Fruit wt.(g)	Meso. wt.(g)	Seed wt.(g)	%Seed to fruit	Shell wt.(g)	Shell thick (mm)	% shell to fruit	Kern wt(g)	Mes Oil %	Kernel Oil %
MAX	22.03	16.31	9.69	73.25	7.24	4.37	44.53	3.56	88.51	85.64
MIN	3.83	1.20	0.36	9.44	0.30	0.59	7.78	0.10	28.53	35.94
MEDIAN	9.97	6.32	3.25	32.62	2.22	2.22	21.72	0.79	76.03	63.70
STDEV	3.43	2.19	1.63	9.47	1.28	0.78	6.51	0.40	8.38	7.99
VAR	11.75	4.78	2.67	89.63	1.64	0.60	42.41	0.16	70.21	63.80
Mean	10.46	6.57	3.56	33.34	2.48	2.23	21.86	0.84	74.65	63.94
CV%	32.75	33.27	45.92	28.39	51.68	34.90	29.79	47.04	11.22	12.49
CD (.05)	2.95	1.83	7.90		1.08	0.53		0.41		12.09
SEd	1.50	0.94	4.03		0.55	0.27		0.21		6.16

Fig. 3: Dendrogram showing the diversity among the 23 *oleifera* and two *guinensis* palms based on RAPD analysis



Use of SSR marker for genetic diversity of African germplasm : For molecular characterization using SSR marker of the African germplasm, 90 palms from 25 accessions along with 6 palms from indigenous accessions (Palode) were selected. DNA extraction and purification was completed for all the 96 palms. Initial standardization also completed with a few sets of SSR primers and in Acrylamide gel with Ethidium bromide staining (Fig. 4).

Modified method of DNA extraction from oil palm : Oil palm crude DNA extraction was successful without few major reagents like detergents, Tris buffer. Also the pigment extraction step with chloroform was avoided (Fig 5a & 5b). This modified method reduced the use of costly chemicals and also reduced the time considerably. This can be used as routine DNA extraction for oil palm hence forth. It is now attempted to standardize a common DNA extraction protocol for palms.

Development of mapping population : Crossing programme was carried out for mapping population development during the reporting period.

Fig. 4: A representative photograph of SSR amplification pattern of African germplasm using Acrylamide gel with Ethidium bromide staining

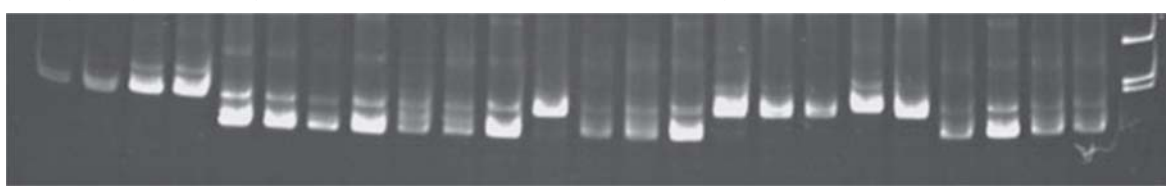


Fig. 5a. Pure DNA extracted by modified method from oil palm

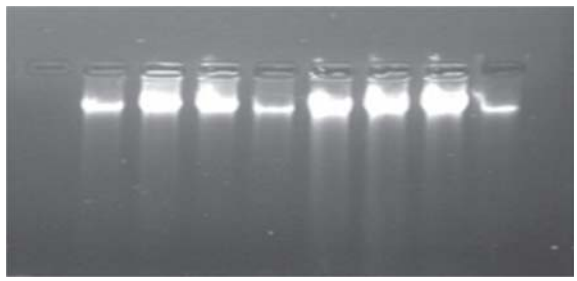
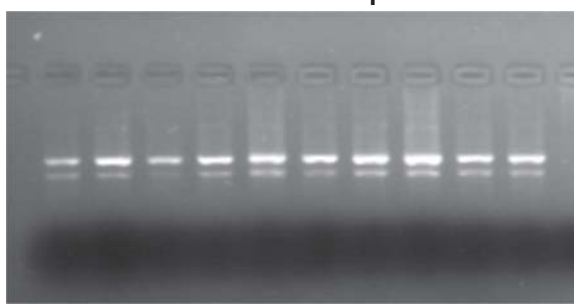


Fig. 5b: RAPD using DNA extracted by modified method from oil palm



DEVELOPMENT OF TISSUE CULTURE PROTOCOL FOR OIL PALM

Nine field planted mature palms (Palm No.'s 754, 649, 379, 361, 397, Palode, 433, 505, 559) were used for the experiments on tissue culture. The palms given for the tissue culture experiment were border palms which were not showing good growth due to the electrical line above the plants. The palms were more than 5 years old and one among them was >20 year old palm from Palode. The palm from Palode was felled and the spear leaves were collected and transported by air to Pedavegi and then it was cultured. For collection of meristem explants from these palms both destructive and non destructive sample collection was tried. The technology for non destructive sampling is working well and the plants are found to be surviving. Explants like spear leaves, inflorescence and roots were cultured in several media combinations by making several modifications to the already reported media in oil palm.

Spear leaf : Spear leaves along with the meristem were brought to the laboratory and after surface sterilization with alcohol were taken to the laminar flow chamber. The leaves were cut into fine pieces of 1-2mm in size and inoculated. Explants 100 - 400 in number from spear leaves of each tree were inoculated into different media. The media were prepared after making several modifications to the already reported media in oil palm and the auxins were gradually increased from very low concentration to very high concentration. The explants after inoculation were kept in dark for 12 weeks. Though from the first four palms significant callus induction were not observed, good callus induction started from the spear leaf collected from palm No. 397 onwards. (Fig. 6) Contamination was a major problem which has been solved to some extent by frequent fumigation. Browning of tissues was another problem which was overcome by adding antioxidants like activated charcoal and PVP-40. After 12 weeks from the date of inoculation the calli obtained with palm No. 397 and Palode palm were subcultured to fresh media and again kept in dark. Embryogenic calli of nodular consistency was seen in 4% of the cultures after eight weeks (Fig. 7 & 8). These nodular calli were again sub cultured to a media with reduced auxins and kept in light. Callus proliferation was seen after one month (Fig. 9) in these cultures. When these were transferred to regeneration media plantlet initiation is observed in these cultures. In one culture the root growth was very vigorous and the somatic embryos appeared to be closed and failed to regenerate. There was direct organogenesis from spear leaves resulting in root formation in several of the cultures.(Fig.10).

Inflorescence: Apart from spear leaves, inflorescence was also inoculated for callus induction. The inflorescence responded well

Fig. 6. Callus induction from spear leaf

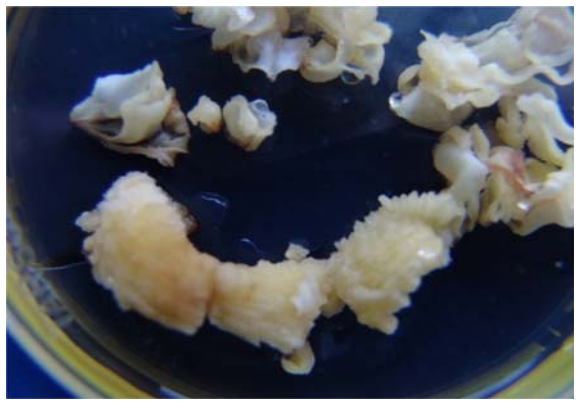
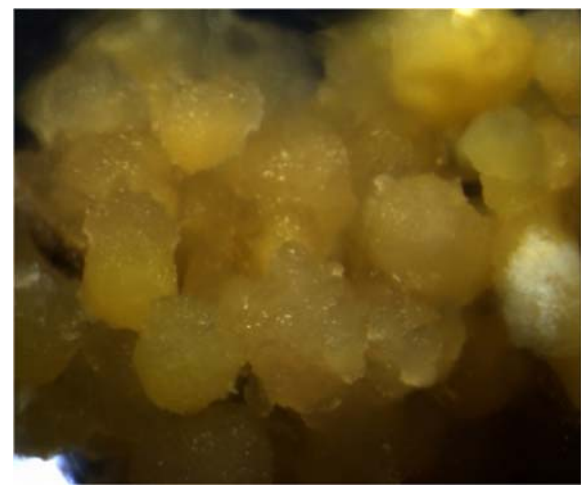


Fig. 7. Embryogenic Calli from Spear leaf of palm No. 397

Fig. 8. Embryogenic Calli of Palode palm

Fig. 9. Proliferation of embryogenic calli



to the media reported by Texeira *et al.* (1994). Immature inflorescence showed callus induction after a period of 6 months. (Fig. 11) Inflorescence calli were subcultured to fresh media after 3 months and globular somatic embryo formation was observed in 20% of the cultures after a period of 6 months (Fig. 12a & 12b) . Inflorescence tissues were found to be very sensitive that after each subculture the tissues turn dark brown in colour. Somatic embryos obtained with inflorescence are still in culture and they are put for maturation. Mature inflorescence also responded in culture and they produced embryo like structures (Fig. 13a & 13b).

Genetic variation studies in tissue cultured plants: Tissue cultured clones were imported from ASD Costa Rica by a private firm Godrej Agrovet and planted in farmers' field in West Godavari District of Andhra Pradesh. These clones named as Fran Tornado, Zeus, Emerald, Ruby and Conte has been planted in the year 2006. The genetic uniformity of these clones was tested using some of the molecular techniques like RAPD and microsatellites. 40 plants were selected at random from 6 different clones named as Fran Tornado, Zeus, Emerald, Ruby and Conte planted from the farmers' fields. Eight plants of Fran, Six plants of Zeus, Eight plants of Emerald from two locations, Five

Fig. 10. Direct root regeneration from spear leaf explant

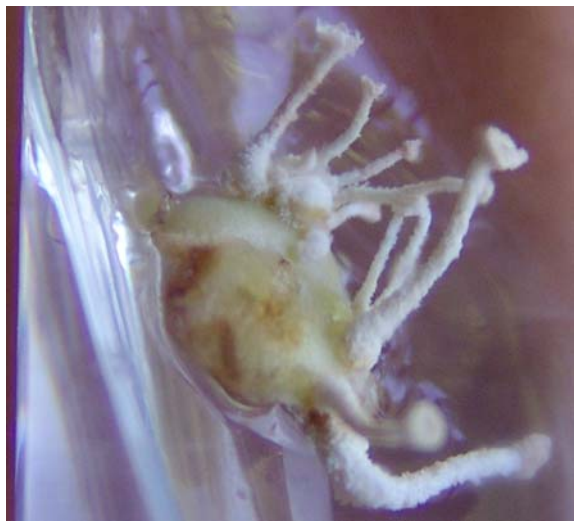
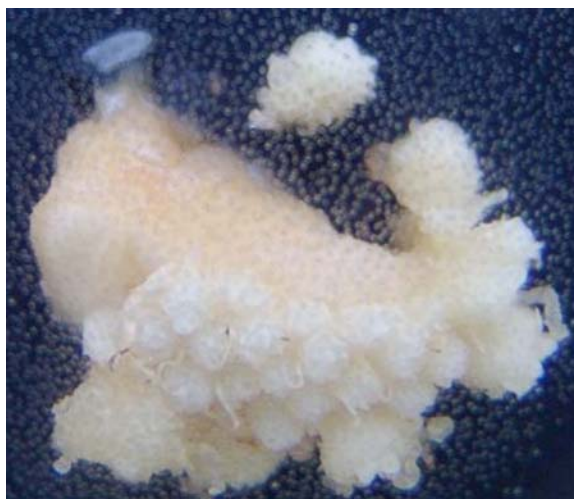
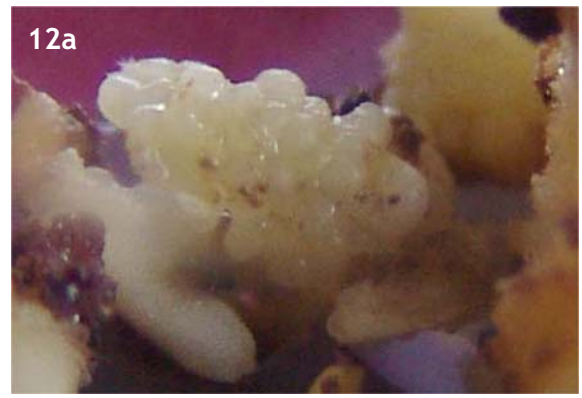


Fig. 11. Callus induction from immature inflorescence



plants of Ruby and eight plants of Tornado and five plants of Conte were collected. Leaf samples (0.5-1 gm) were collected from these clones at random and brought to the laboratory. DNA was extracted by the modified method of Jayanthi *et al*. (2004) without CTAB and subsequently it was treated with RNase and purified with phenol-chloroform method. RAPD was performed using 10 nucleotide random primers purchased from Operon Inc,USA and some were custom made from Sigma. PCR was carried out in a 10 µl volume containing

Fig. 12a & 12b. Somatic embryos from callus of immature inflorescence



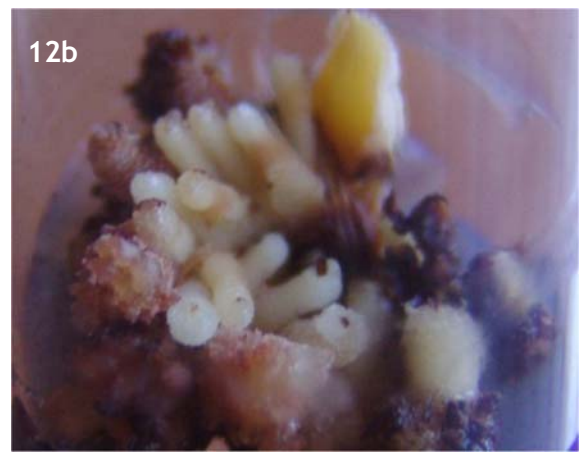


Fig. 13a & 13b. Response of mature inflorescence under *in vitro* condition

10 ng of template DNA, 0.05 µM of RAPD primers, 25 µM of dNTP's, (Bangalore Genei) and 0.25 unit of Taq Polymerase (Bangalore Genei) with a 10X buffer containing 15 mM $MgCl_2$. The PCR reactions were performed in a thermal cycler (DNA engine BIORAD, USA). Oil palm microsatellite primers were

designed using the oligos v62 software using the available microsatellite sequences in the NCBI site. The primers were custom made and purchased from Imperial Biomedics, India. PCR with microsatellite primers also carried out using the optimized protocol (Jayanthi *et al*. 2008) in a 10 µl volume containing 10 ng of template DNA, 0.05 µM of each primer, 25 µM of dNTP's, (Bangalore Genei) and 0.25 unit of Taq Polymerase (Bangalore Genei) with a 10X buffer containing 15 mM $MgCl_2$. The PCR programme was as follows: denaturation at 95 °C for 5 min, followed by 40 cycles of 1 min at 94 °C, 52 °C for 1 min and 72°C for 1 min and a final elongation step at 72 °C for 10 minutes. Annealing temperature of 52 °C was set as the annealing temperature of most of the primers was around 55-56°C. The amplification products were mixed with loading buffer and run on agarose gels (1.2% for RAPD products and 3% high resolution agarose gel for microsatellite products) in 0.5X TBE buffer at a constant voltage. The gel was stained with ethidium bromide and photographed and documented in a gel documentation system (UVI doc, UK). The bands were scored as present (1) or absent (0) for both the markers in a binary form. Genetic similarity values were computed based on Nei's coefficient using NTSYS-PC software Version 2.02. Cluster analysis was performed based on similarity matrix generated using UPGMA (Unweighted paired group method with arithmetic mean) and the grouping of these varieties were visualized as dendrogram. In the present study, we adopted the use of two PCR-based techniques, RAPD and SSR. The use of two types of markers, which amplify different regions of the genome, allows better chances for identification of genetic variation among the clones if any are present and it also confirms the uniformity. Out of the 10 RAPD primers used to study the genetic uniformity six primers gave monomorphic bands (Table 20). The number of bands ranged from one to seven. RAPD primers produced a total of 26 bands. The primers which showed polymorphism, are OPP 7, OPO 13, Sigma 35 and Sigma 32. All the microsatellite primers gave monomorphic bands. The representative figure showing polymorphism with RAPD and

Table 20. Details of amplification obtained with tissue cultured clones using RAPD primers

RAPD Primers	Primer sequence	No. of bands obtained	No. of polymorphic bands
OPO-13	GTCAGAGTCC	7	6
OPO-16	TCGGCGGTTC	2	0
OPP-7	GTCCATGCCA	4	3
OPO-14	AGCATGGCTC	1	0
OPP-17	TGACCCGCCT	1	0
OPP-19	GGGAAGGACA	2	0
OPN-11	TCGCCGCAAA	1	0
OPN-16	AAGCGACCTG	2	0
Sigma 32	GTGTGGTGGG	5	3
Sigma 35	CCCAACACCC	1	1
		26	13

microsatellite primers is given in (Fig. 14). The dendrogram (Fig. 15) revealed that there is no absolute similarity among the clones and clones of one variety cluster with some other clones.

DEVELOPMENT OF MOLECULAR MARKERS FOR VARIETAL IDENTIFICATION IN OIL PALM

Palms of pedavegi seed garden were selected for fruit typing and the shell thickness was estimated. Shell thickness ranged from 0.75-2mm in teneras, 3-3.9 mm in duras and 0 in pisifera. After fruit typing, leaf samples (0.5-1 gm) were collected from these selected palms and brought to the laboratory. DNA was extracted by the modified method of Jayanthi *et al*. (2004) without CTAB and subsequently it was treated with RNase and purified with phenol-chloroform method. DNA was extracted from the selected palms.

Amplification with RAPD primers : Thirty seven random primers were taken up for PCR amplification of DNA of Dura, Pisifera, and tenera bulks of Pedavegi seed garden. 374 fragments were obtained. All primers

Fig. 14. Genetic uniformity testing of commercial tissue cultured clones using RAPD and microsatellite markers

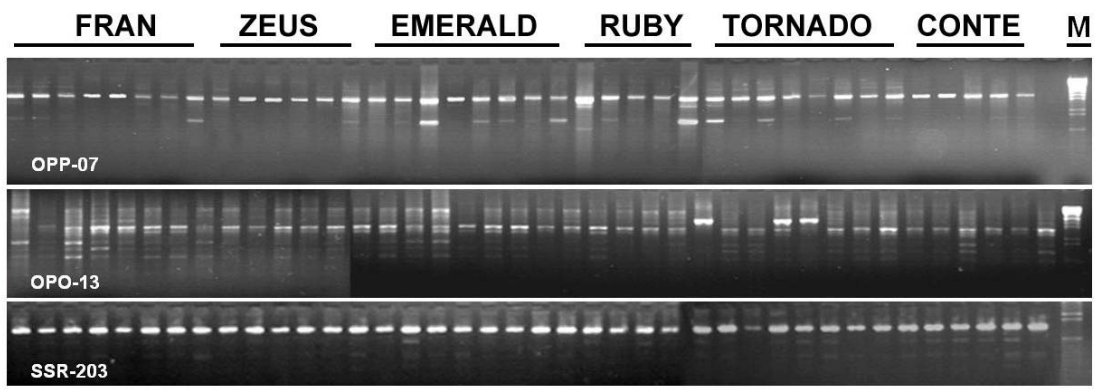
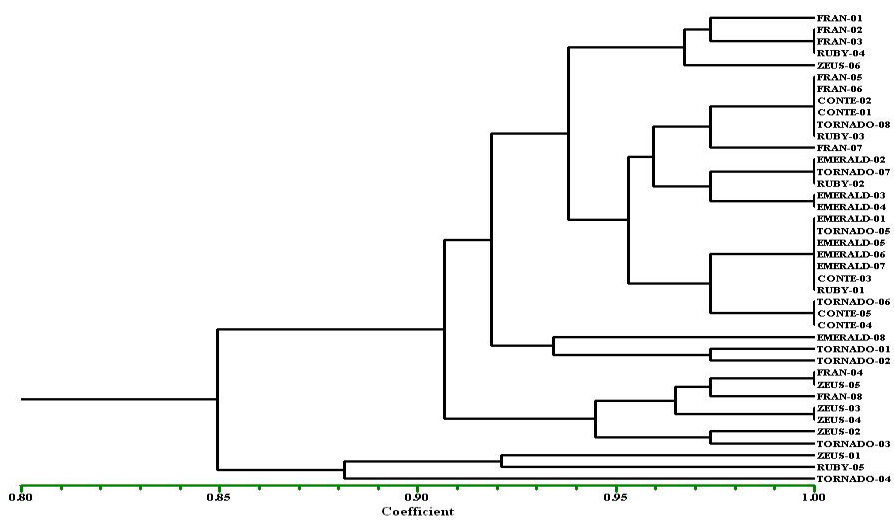
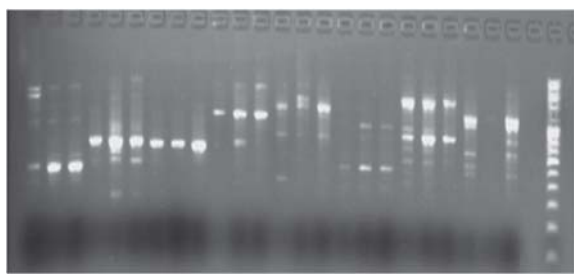


Fig. 15. Dendrogram showing the genetic distance among the commercial tissue cultured clones



produced amplification with three bulks. Although thick bands were noted, few of them were faint and not repeatedly found in all individuals of the bulks. 17 primers gave monomorphic bands in bulks, 20 primers showed polymorphism. In total 141 bands were obtained. The details of the number of bands produced by 37 primers are given in Table 21. Fig. 16 shows the amplification pattern obtained with bulked DNA using RAPD primers.

Fig. 16. Amplification with RAPD primers in bulked DNA of *dura*, *pisifera* and *tenera* (each three lanes from 1st lane onwards represent a set of *dura*, *pisifera* and *tenera* respectively)



In total 141 bands were observed and 124 bands were obtained with *dura* and 125 bands were obtained with *pisifera* & *tenera*. Of these the number of monomorphic bands was 106 and the polymorphic bands were 35. The number of bands ranged from 1 to 6. The maximum numbers of bands were obtained with RPG-13 and SIGMA-B17.

Of the 37 primers screened with bulk 20 primers showed polymorphism. So they were retested with the individual samples. The 20 primers selected for individual testing are SIGMA B08, SIGMA B09, SIGMA B10, SIGMA B12, SIGMA B15, SIGMA B16, SIGMA B18, SIGMA B19, SIGMA B20, OPM 18, OPP 12, OPN 14, OPN 6, RPG 22, OPN 8, OPO 10, RPG 16, OPP 19, OPM 12, OPO12.

Amplification obtained with microsatellite primers : Bulks of Dura, pisifera and tenera amplified with 82 microsatellite primers and run in the agarose gel showed differences in banding pattern with 17 primers. 65 primers gave monomorphic bands and 17 primers gave polymorphic bands. The number of bands ranged from one to six. The size ranged from 150 bp to 300 bp. Primers which gave polymorphic bands in the first run was repeated again. Primers which gave polymorphic bands are indicated in Table 22.

SEED TECHNOLOGY STUDIES

Germination of germplasm material

Germplasm seeds collected from Mangalore area (Mangalore I, II, III, IV, V, VI and VII) were subjected to dry heat treatment at Palode and germinated seeds were supplied to Pedevegi for further evaluation in the nursery and field planting. The per centage germination obtained in dry heat treatment was 94, 88,33,19,78,90 & 88 for the Mangalore germplasm with code numbers I,II,III,IV,V,VI and VII respectively.

Studies on fruit and seed size variation

Fruit and seed size variation and its influence on germination was studied in African germplasm (E77,E801, E802, E71 and E61). Medium size fruits are more in the bunch and significant difference in kernel weight and nut weight was recorded among different palms. The medium size nuts recorded significantly high germination when compared to big and small seeds. Similarly shell thickness was more in big size seeds followed by medium and small nuts. (Table 23 and 24).

Effect of environment on seed germination and dormancy

Seed germination data from different seed gardens were analyzed for seed germination response to dry heat treatment.

Table 21. The details of amplification obtained with 37 RAPD primers

S.No	Primer Number	No. of Bands			Total No. of Bands	Monomorphic or polymorphic
		Dura	*Pisifera*	*Tenera*		
1	SIGMA-B01	5	5	5	5	Monomorphic
2	SIGMA-B02	3	3	3	3	Monomorphic
3	SIGMA-B03	4	4	4	4	Monomorphic
4	SIGMA-B04	3	3	3	3	Monomorphic
5	SIGMA-B05	3	3	3	3	Monomorphic
6	SIGMA-B06	3	3	3	3	Monomorphic
7	SIGMA-B07	5	5	5	5	Monomorphic
8	**SIGMA-B08**	1	2	2	2	**Polymorphic**
9	**SIGMA-B09**	5	2	2	5	**Polymorphic**
10	**SIGMA-B10**	2	2	3	3	**Polymorphic**
11	SIGMA-B11	3	3	3	3	Monomorphic
12	**SIGMA-B12**	4	3	3	4	**Polymorphic**
13	**SIGMA-B13**	2	2	1	2	**Polymorphic**
14	SIGMA-B14	2	2	2	2	Monomorphic
15	**SIGMA-B15**	3	1	3	3	**Polymorphic**
16	**SIGMA-B16**	4	3	4	4	**Polymorphic**
17	SIGMA-B17	6	6	6	6	Monomorphic
18	**SIGMA-B18**	4	3	4	4	**Polymorphic**
19	**SIGMA-B19**	5	6	4	6	**Polymorphic**
20	**SIGMA-B20**	1	4	1	4	**Polymorphic**
21	RPG-13	6	6	6	6	Monomorphic
22	**RPG-16**	5	3	4	5	**Polymorphic**
23	**RPG-22**	4	3	3	4	**Polymorphic**
24	RPG-26	3	3	3	3	Monomorphic
25	**OPN-6**	3	2	2	3	**Polymorphic**
26	**OPN-8**	5	4	4	5	**Polymorphic**
27	**OPN-14**	1	3	2	3	**Polymorphic**
28	OPN-17	1	1	1	1	Monomorphic
29	**OPO-10**	5	5	4	5	**Polymorphic**
30	OPO-11	2	2	2	2	Monomorphic
31	**OPO-12**	3	5	5	5	**Polymorphic**
32	OPP-8	4	4	4	4	Monomorphic
33	OPP-11	5	5	5	5	Monomorphic
34	**OPP-12**	2	5	5	5	**Polymorphic**
35	**OPP-19**	2	3	3	3	**Polymorphic**
36	**OPM-12**	1	4	4	4	**Polymorphic**
37	**OPM-18**	4	3	3	4	**Polymorphic**

Table 22. List of microsatellite primers that produced polymorphism

S.No.	Primer No.	Left Primer	Right Primer
1.	25	CTGGGTCTAAACGCAACTGG	GATTCTTGGATGTGCATGGG
2.	114	CAT GTC CTG CTG TCA TGC C	GTACGAGCATACATCACCACTCC
3.	117	GCA GGT GAT GTG GTG AGG	GCT TAA AAA TGT GCA GGA CAG G
4.	119	GTG AGG TGT GAT GCT GAA GGC	GGA TCG GTT ATA GCT TCC TCC
5.	131	TCTGCTCCAATTGGACAGCC	GCCGCTCACACACTTTCTCC
6.	143	GGA TCT CAA AGC CCA TCT CC	CCG TAT ATG ACC CCT CTC TCC
7.	156	GAA CAT TAC AAG CAT AGC ACC	GAT GTT GCT TCT TTG ATC TCG
8.	159	GCT TGC TTA TGT GTG TGT GCG	GAT GTT GCT TCT TTG ATC TCG
9.	169	GTG GGT TGG CTT GTT GG	CGA CTC AAA AGC ACC TTT CC
10.	170	GAA CAG TTA CAA TCT CCA C	TAA CTT CTG CCC TGA AAC C
11.	184	GGT CAT GGT TTG TGC GTC GG	GTA TGC TGC TGC TGC CTC C
12.	196	GGA GCT CTC CCA TAT GGT CG	CCA TTC CAA GCT TCT CTG CC
13.	225	CCA TGT GCA ATG CTT GTG TGG	ACA CCC AGC TTG GCC TA
14.	231	GAA GTC AAT TGG CAC CAG G	CTC CGC TAA AAC TGG GAG G
15.	242	GAA GTC AAT TGG CAC CAG G	CTT TCT GGC AAC TGC TGG
16.	304	CCACAAACAATCCAAGCAAGT	TGGCATACACGAAAGCATAA
17.	465	GTTTCCGGCCACCAGAGAGC	GGTGGACCTTAGCCATTCCC

Table 23. Fruit and seed size variation in African germplasm

Palm No	Fruit weight proportion (%)			Nut wt. (g)			Kernel wt. (g)		
	Size			Size			Size		
	Big	Med	Small	Big	Med	Small	Big	Med	Small
E 77	28	40.5	31.0	11.0	6.0	4.0	2.60	1.4	0.90
E801	21	30.1	47.6	11.9	4.3	1.8	3.10	1.5	0.42
E802	21	43.8	35.7	10.6	6.5	3.6	2.10	1.4	0.90
E71	30	38.2	31.4	7.6	3.0	0.6	2.05	0.8	0.091
E61	45	38.3	16.6	8.5	3.7	0.3	1.75	0.4	0.021

Table 24. Shell thickness and germination in hybrid seeds

Palm No	Shell thickness (mm)			Germination (%)		
	Size			Size		
	Big	Med	Small	Big	Med	Small
E 77	3.95	3.07	2.30	49.3	68	69
E801	3.87	3.24	2.32	62.0	65	17
E802	4.05	2.97	2.50	60.0	70	54
E71	2.89	1.91	1.38	54.6	92	57
E61	3.57	2.99	1.15	53.3	70	20

The preliminary results revealed that seeds from different environments and produced at different stages of the reproductive period differ in dormancy status. Though they exhibited dormancy regardless of the maternal environment, seeds from dry environment showed early germination response than cooler environments under dry heat treatment. This investigation is continued in all the seed gardens *viz.*, Lakshmipuram, Palode, Taraka, Thodupuzha and Rajahmundry.

De-operculum germination technique

At Palode seed garden as a result of dry heat treatment, 74.10 % germination was attained and the remaining 25.9 % of seeds showed no germination even after two months of incubation under germination room. These ungerminated seeds were again subjected to aseptic de- operculation technique for germination and made to germinate without any loss.

RF SCHEME : INDIGENOUS PRODUCTION OF OIL PALM HYBRID SEEDS

Supply of germinated oil palm seed

During 2008-09 2,97,000 germinated oil palm seeds were supplied to different oil palm companies and agencies (Table 25). Analysis of germination results revealed that germplasm block B consisting of 20 dura palms showed high germination (85.6%) followed by block D. The average number of crossed bunches was also high in block D (Table 26).

Table 25 : Sprouts supplied to various agencies

Name of Entrepreneurs	Apr'08 - Feb'09
M/s Godrej Agrovet Ltd., Valsad, Gujarat	20000
M/s Godrej Agrovet Ltd., Khammam Dt., A.P	35000
M/s Lakshmi Balalji Oils Pvt. Ltd., Parvathipuram, A.P	30000
Sri Srinivasa Palm Oil Mill, Lingalavalasa, Sreekakulam Dist. A.P	25000
M/s Ruchi Soya Industries Ltd., Anand, Gujarat	25000
M/s MAC Oil Palm Ltd., Ampapuram, Krishna Dt., A.P	25000
M/s Vaidehi Properties Ltd., Kolkata	20000
M/s Vaidehi Properties Ltd., Tamilnadu	20000
M/s Vaidehi Properties Ltd., Orissa	10000
M/s Food fats and fertilizers Ltd., Dhenkanal, Orissa	25000
M/s Food Fats and Fertilizers Ltd., A.P	55000
Total	**290000**

Table 26. Germination % in seed blocks at Palode

Block	Av. No. of bunches	Average germination %				Final
		1st	2nd	3rd	4th	
B	5.2	23.57	17.09	21.3	23.71	85.6
C	7.5	24.06	19.44	16.14	12.50	72.1
D	12.8	33.60	18.10	13.60	7.96	73.2
E	4.3	16.20	38.29	10.90	1.75	67.1

4.0 Research Achievements

फसल उत्पादन
Crop Production

Cocoa - a suitable companion crop in oil palm

CROP PRODUCTION

STUDIES ON WATER AND NUTRIENT MANAGEMENT IN OIL PALM

Three different levels of irrigation and fertilizers along with three irrigation methods are being evaluated in a split plot design. Physiological and morphological parameters as well as yield were recorded during the current year. The plant height ranged from 241.67 to 483.33 cms. In general, plant height was more in palms irrigated with 1.0 (IW/CPE) and decreased as the level decreased. The plant girth ranged from 218.33 to 381.67 cm. similar trend was noticed as that of plant height. The leaf dry weight of the 17th leaf ranged from 1.21 to 2.90 in the different treatments and was highest in palms irrigated with drip at 0.8 IW/CPE. The leaf area of the 17th leaf in the different treatments ranged from 6.52 to 11.42 sq.m. Palms irrigated with drip at 1.0 IW/CPE recorded better leaf area than that of others. Petiole and rachis length were also taken and compared for the different treatments. Photosynthetic rate was maximum in palms irrigated with Jets at 1.0 level followed by drip at the same level. In general, palms irrigated with Jets recorded higher photosynthetic rates. The stomatal conductance was low in palms irrigated with Jets than drippers. Carotenoids were more in palms irrigated with drip at 0.6 level and lower values were recorded in palms irrigated with jets at 0.8 level. Higher chlorophyll 'a' content was observed in palms irrigated with drip at 0.8 level, while lower content was in palms irrigated with Jets at 1.0 level.

Regarding yield parameters, Drip irrigation recorded maximum yield of 18.6 tonnes FFB/ha followed by Jet (17.1 tonnes FFB/ha). Number of bunches per palm were highest in Drip (7.9) followed by Jet (7.3). Among the different levels of irrigation highest yield (19.8 tonnes/ha) was obtained in 80% followed by 100% (19.0 tonnes/ha) and 60 % (14.8 tonnes). Number of bunches obtained in different levels of irrigation were 7.9 (100%), 8.2 (80%) and 6.6 (60%). Among different fertilizer levels the yield decreased (18.3, 18.4 and 17.0 tonnes FFB/ha) with increased fertilizer (F1 to F3), while the bunch number was not affected (7.6 per palm). A fertilizer dose of 900-450-900 g NPK is sufficient to achieve a yield of 15 tonnes FFB/ha.

STUDIES ON REPLANTING TECHNIQUES IN OIL PALM

The work of this Project was started during 2007, in OPIL Estates, Bharathipuram in the 1972-planted area. The palms meant for replanting were cut and removed as per treatments. The remaining palms were pruned and being harvested and yield recorded. Single terraces were taken in slopes and seedlings were planted during July. First dose of N and K fertilizers were also applied. The field is being maintained by periodical weeding, basin cleaning and plant protection works.

Marotti cake –sand mixture was applied in leaf axils and pheromone traps were set for the control of rhinoceros beetles. Rat damage is severe in the estates this time including the experimental area. Morphological observations were recorded from seedlings. In general, the growth of seedlings was affected to some extent by the lack of sufficient rainfall during this year. The soil samples collected were analysed

for available nutrient status. The soil is acidic, and high in organic matter status, medium in available nitrogen and potassium and low in available phosphorus.

PERFORMANCE OF OIL PALM IN PEAT SOILS OF KERALA

An area of about 88 hectares developed as oil palm demonstration plot by Oil Palm India Ltd., in Kallara village of Kottayam district in Kerala. Oil palm was planted from 2002-03 onwards. But majority of the seedlings were to be replaced due to the subsequent floods and heavy rat damage. Thus the average age of the plantation can be considered as 4-6 years only. Sufficient drainage is ensured by way of regular pumping and since the rainfall received is less during the year, the crop did not suffer from excess water logging. The palms have started yielding. Observations on the growth and flowering were recorded from 40 palms each in North, East, South and West blocks representing the whole area. Recommendations were given for proper management of palms, basin management, fertilizer application, nutrient deficiency symptoms and plant protection aspects. The yield data of selected blocks were recorded which showed that the yields are equal to or more superior to those grown under normal soils. Growth parameters recorded during 2009 per palm are presented in the table below :

Palms	Height (m)	Girth (m)	No. of functional leaves	LA 9th (m^2)
Block I	4.89	2.24	31.43	2.68
Block II	5.02	2.29	27.90	3.63
Block III	5.62	2.14	25.28	3.38
Block IV	4.02	2.02	25.30	2.97
Normal-6yrs	7.25	2.71	27.35	5.16

Physico-chemical characterization of Kari land soils of Kerala

During the reporting year, soil samples at different depths from both basin and inter plant space areas were collected from different blocks during rainy and summer seasons. Morphological observations indicate that 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.

In general, soils were highly acidic in nature. The acidity tended to increase in the lower layers and also during summer season. 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 layer irrespective of the sampling sites. Organic carbon content in general, was very high in surface soils which further increased substantially with depth. Soils were low in available phosphorus but relatively high in available potassium and values decreased with increase in depth with season. Soil samples collected during summer season in both basin and interplant space areas contained relatively higher content of sulphur compared to soils of rainy season. This is indicating that upon drying, soils become highly acidic due to the oxidation of pyrite (FeS_2) in to sulfuric acid. However, studying various characteristics of subsoils at different season is important to understand the behavior of translocation of salts from upper to lower layers and its effect on soil pH. In addition, chemistry of sulphur flux in these soils (because of high concentration) is also important aspect to be studied.

LEAF BREAKING IN OIL PALM

The morphological parameters like plant height, girth, leaf area and leaf dry

weight were recorded in the Mixed Farming System(MFS) and GXE experiments where symptoms of leaf breaking were observed. The four different sources in the MFS experiment were used for the study. The percent damage was more in Deli X Nigeria followed by Malaysia and Deli X Ghana. Palms belonging to Palode source were least damaged. Non destructive estimation of leaf area and dry matter production was also calculated for all the sources. The drought susceptibility index was highest in Malaysia (3.22) followed by Deli X Nigeria (3.00) and Deli X Ghana (1.88). Palms from Palode source recorded the lowest drought susceptibility index indicating their better tolerance to drought.

ENVIRONMENTAL MONITORING OF OIL PALM USING SAP PROBES

Sap flux probes were inserted in the 17th and 25th fronds along with trunks in mature palm plantations. The results indicated that the sap flux increased gradually in the morning and reached a peak during noon and then decreased, which followed the same trend as that of vapor pressure deficit. The sap flux in 17th frond was 0 cm/h in the morning and reached peak fluxes ranging from 40 to 45 cm/h. The peak sap flux in the 25th frond was comparatively less than that of 17th frond which ranged from 30-35 cm/h. While in the trunk, the peak sap flux was on the lower side (6-8 cm/h). The data suggests that the sap flux is more towards the upper part of the palm indicating the importance and maintenance of growing parts for the palms.

STUDIES ON SOURCE SINK RELATIONSHIP IN OIL PALM

Two trials are undertaken by manipulating the source (pruning of fronds 9, 17, 25, 33 and control) and sink (removal of floral buds - 25, 50, 75, 100 % and control). Imposition of the above treatments is being done regularly at every fortnight. Recording of morphological observations along with yield was also undertaken. In the source manipulation experiment, when the fronds were pruned from 9th onwards, the yield was very less (5.37 t/ha/y). Among the different treatments, highest yield was obtained in the treatment where fronds were pruned from 25th onwards (16.8 t/ha/y). The other treatments recorded intermediary yields. In the sink manipulation treatment, the yield recorded in the different treatments ranged from 0-17 t/ha/y). When the percent floral buds were retained in the palms to the tune of 25, 50 and 75 %, the yield recorded was 12.68, 14.52 and 16.25 t/ha/y respectively. The control palms recorded 17.30 t/ha/y.

CARBON SEQUESTRATION POTENTIAL OF OIL PALM

Eleven mature oil palm hybrids belonging to four different sources *viz.*, ASD Costa Rica, Ivory Coast, Papua New Guinea and Palode were taken up for the study. Results revealed that the standing above ground biomass in the different hybrids ranged from 55.08 to 91.58 T.ha^{-1}. The highest biomass was recorded in ASD Costa Rica hybrid (Deli X Lame), while the lowest was in ASD Costa Rica hybrid (Deli X Avros). The amount of carbon sequestered by the hybrids ranged between 17.98 and 35.44 T C.ha^{-1} with Papua New Guinea and Ivory Coast hybrids sequestering the highest and lowest carbon contents respectively.

The total leaf biomass in the fronds belonging to six year old palm ranged from 1.65 to 2.74 kg. The specific leaf weight in the different fronds ranged between 0.24 and 0.45. The carbon content in the different fronds ranged from 0.413 to 1.314

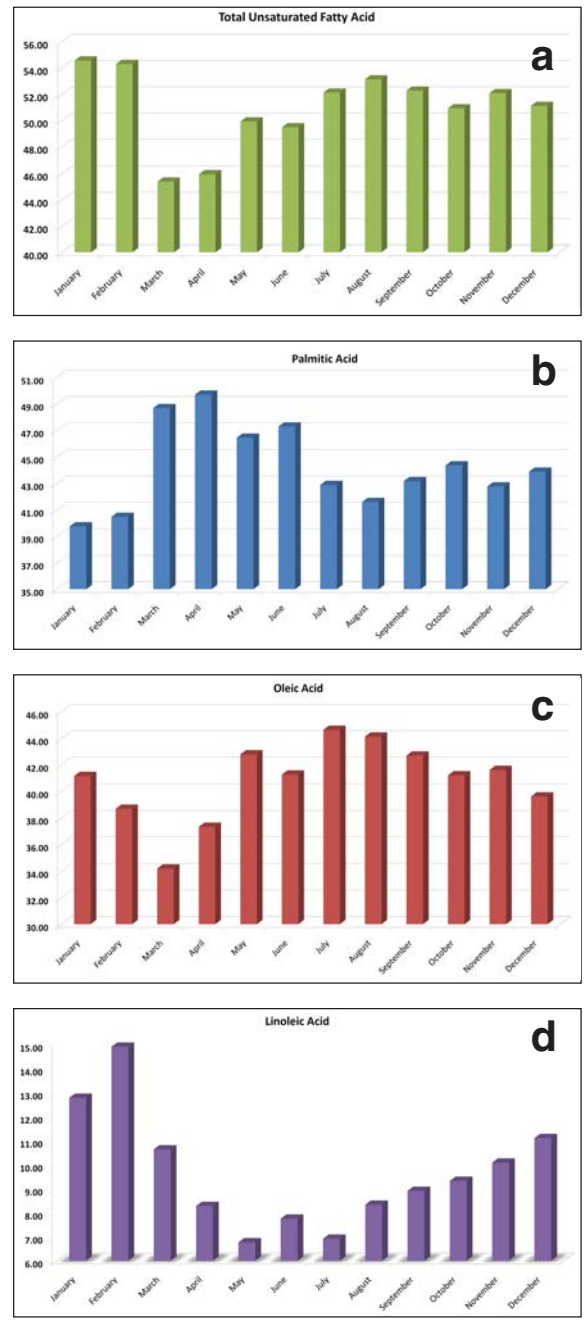
kg and was lower in younger leaves and did not show any pattern among middle and lower whorls. The nitrogen contents in the fronds ranged between 11.5 and 26.3 g and were less in younger fronds. Correlation studies have indicated a positive relationship between leaf carbon and leaf nitrogen contents.

BIOCHEMICAL BASIS FOR GROWTH AND YIELD OF OIL PALM

Studies on oil content and FAC of oil from different parts of bunch

The data analysis of oil content and fatty acid composition during different months of the year and in the different parts of the bunch is completed. It was observed that the oil content in the dry mesocarp in different parts of the bunch varied from 77.98 - 76.67%. No significant difference was observed from the analysis of data. Oil content in the fresh mesocarp was found highest in Part 2 (53.99%) followed by Part 1 (53.65%), Part 3 (52.22%), Part 4 (51.77%), which were on par, and Part 5 (51.39%) contained significantly lower amount of oil than that of part 2. As expected, the moisture content in the mesocarp followed the exact reverse trend, highest in Part 5 (33.21%) followed by Part 4 (32.46%, Part 3 (32.17%), Part 1(31.30%). Part 2 (30.45%) had significantly lower amount of moisture than that of Part 5. With respect to fatty acid composition in the different parts of the bunch, major fatty acids (Palmitic, Oleic and Linoleic) did not show any significant difference among the different parts of the bunch, Hence, the total saturated/ unsaturated fatty acids also did not show any significant difference. Stearic acid was found highest in Part 1 (4.01%), which was on par with Part 2 (3.79%) and Part 5 (3.76%). However, Part 4 (3.61%) and Part 3 (3.59%)were significantly lower than that of Part 1. Two minor fatty acids (Myristic and Linolenic) were found significantly lower in the Part1 of the bunch, and other Parts of the bunches were on par (Fig 17a-17d).

Fig. 17. Major fatty acid content during different months of a year: a) Total unsaturated fatty acid; b) Palmitic acid; c) Oleic acid; and d) Linoleic acid



Studies on *virescens* and *nigrescens* type of fruit bunches

This experiment was taken up to study differences between *virescens* and *nigrescens* type of fruit bunches (Fig 18). Bunch component analysis as well as qualitative and quantitative differences in oil from both types of bunches would be studied. During the reporting period, bunch analysis of 10 *virescens* and 10 *nigrescens* bunches has been completed. Two *tenera* hybrids (Deli X Nigeria and Deli X Nigeria) were selected for the study. Oil content in the mesocarp of *virescens* fruits ranged from 58.45 to 36.10%, whereas in *nigrescens* fruits it was 66.08 to 37.76%. Oil/ Bunch % ranged from 30.49 to 18.08 and 29.34 to 19.28 for *virescens* and *nigrescens* respectively. One palm from indigenous *tenera* (Palode) also showed *virescens* bunches, for which bunch analysis was carried out. However, since so far no Palode hybrid produced virescens bunch, it might be a contami-nation, which needs to be confirmed. Oil quality analysis from those bunches is in progress.

Fig. 18. *Nigrescens* (top) and *Virescens* (botum) fresh fruit bunch at unripened stage

SOIL NUTRIENT INDEXING IN OIL PALM GROWING AREAS OF INDIA

Soils of thirteen mandals of West Godavari district and 3 mandals of Krishna district, A.P were studied for important physico-chemical properties and micronutrients. Survey of Dwarka Thirumala, Kamavarkota and Chinthalapudi Mandals in West Godavari was also done. Morphological characteristics of these oil palm gardens were studied and recorded. The status and management of oil palm gardens of these mandals was also recorded in the form of schedule.

Representative soil samples at different depths (0-15, 15-30 & 30-60 cm) from thirty seven villages comprise of thirteen mandals representing the intensive oil palm growing areas were collected and studied for nutrient status using standard procedures. The data (Table 27) revealed that the soils

were very acidic to slightly alkaline in nature. 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 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 cation exchange capacity of the soils varied from 5.21 to 19.05 cmol (p+) kg^{-1}. The available phosphorus and potassium ranged from 4.2 to 161.9 kg ha^{-1} and 45 to 1008 kg ha^{-1} respectively.

DTPA extractable micronutrients varied widely in oil palm gardens (Table 28). Soils were well supplied with DTPA extractable Mn and Cu. Among micronutrients, zinc was found to be most deficient element and overall, 64.7% of the studied area was in deficient class. Soils of Bhimadole and Dendulur were very low in Iron and Zinc status and all the oil palm orchard soils in the district were DEFICIENT in Zinc. Zinc deficiency fairly wide spread in oil palm growing soils to a tune from 14 to 100%. Considering low and medium as potential deficient, 90% of the studied area was deficient and the overall nutrient index value is 1.45.

Oxidisable carbon content and its relationship with availability of mineral nutrients in oil palm growing soils

Oil palm removes large amounts of nutrients through harvested fresh fruit bunches and also immobilized in the trunk. Thus, nutrient mining and soil productivity decline are the major concern in oil palm

Table 27. Some physico-chemical characteristics and nutrient status of oil palm growing soils

Soil Parameter	Range‡	Mean	Critical Level#	Fertility class (% samples)		
				low	medium	High
pH (1:2.5 w/v)	4.17-8.30	6.69	-	-	-	-
Electrical conductivity (dS m^{-1})	0.015-0.352	0.102	-	-	-	-
CEC (cmol(p+)kg^{-1})	5.21-19.05	9.66	-	-	-	-
Organic carbon (g kg^{-1})	2.2-12.1	5.2	1.2	99.0	1.0	-
Available phosphorus (kg ha^{-1})	4-162	41.1	33.6	66.4	28.6	5.0
Available potassium (kg ha^{-1})	45-1008	226	141	37.8	39.5	22.7
Available sulphur (mg kg^{-1})	2-167	19.5	10	40.3	26.1	33.6

#Fairhurst (1997), ‡(N=196)

Table 28. Micronutrient status (DTPA Extractable) of soils under oil palm

DTPA Extractable (mg kg^{-1})	Range	Mean	Critical level	Fertility class(% samples)			Reference
				low	medium	high	
Fe	1.21-54.30	9.84	6.0	37.0	28.6	34.4	Boer & Reisenauer(1973)
Mn	1.33-62.85	13.50	1.0	0.0	4.2	95.8	Lindsay & Norvell (1978)
Zn	0.01-2.20	0.56	0.6	64.7	25.2	10.1	Sakal et al (1984)
Cu	0.08-3.86	1.05	0.2	3.4	35.3	61.3	Lindsay & Norvell (1978)

growing regions and so also soil quality. The soil oxidisable carbon (SOC - labile pool) turns over relatively rapidly, and it plays an important role in oil palm production, through beneficial influence on microbial turnover of nutrients in soils and also sensitive indicator of changes in soil quality.

Soils of one hundred twenty nine oil palm orchards from nineteen mandals representing three districts (fourteen mandals from West Godavari, three from Krishna and two from Khammam Districts) were collected by compositing and studied for present status of SOC and mineral nutrients. The soils were very acidic to slightly alkaline in nature. SOC in general was very low (Table 29) and the contents varied from 1.6 to 12.9 g kg^{-1} in West Godavari, 1.9 to 10.5 g kg^{-1} in Krishna and 2.3 to 16.0 g kg^{-1} in Khammam district with a mean value of 5.4, 5.5 and 7.0 g kg^{-1} respectively. Soils of Khammam district were relatively high in SOC and total oxidisable carbon (TOC) status compared to soils of other districts (Table 30).

The proportion of SOC in TOC increased with increasing soil organic matter (SOM) content of the soils.

Table 29. Oxidisable carbon and macronutrient status of oil palm orchard soils

District		pH	EC	SOC	Available nutrients		
					P	K	S
W. Godavari	Range	4.17-8.30	0.02-1.00	1.6-12.9	4-162	45-1008	2-167
	Average	6.30	0.110	5.4	47	216	19
Krishna	Range	6.58-9.09	0.029-0.282	1.9-10.5	13-151	48-368	8-103
	Average	8.41	0.160	5.5	46	142	30
Khammam	Range	4.25-8.28	0.02-1.80	2.3-16.0	4-130	40-914	3-96
	Average	5.86	0.180	7.0	28	278	29

Table 30. Status of SOM, SOC and TOC (in g/kg)

District		SOM	SOC	TOC
W. Godavari	Range	2.76-22.24	1.6-12.9	2.9-16.0
	Average	9.31	5.4	6.8
Krishna	Range	3.27-18.10	1.9-10.5	2.5-13.9
	Average	9.49	5.5	7.6
Khammam	Range	3.97-27.58	2.3-16.0	3.0-21.1
	Average	12.07	7.0	9.2

Table 31. Coefficient of correlation 'r' between the SOC and mineral nutrients

District	P	K	S	Fe	Mn	Zn	Cu
West Godavari	-0.026	0.108	0.498**	-0.088	-0.017	0.035	0.298*
Krishna	-0.046	0.465*	-0.367	0.062	-0.229	-0.195	-0.242
Khammam	0.355	0.192	-0.157	0.593**	-0.188	0.508**	-0.50

Relationship of SOC with availability of phosphorus (P) is not significant in all the soils suggesting that the available P included mostly inorganic P and organic P is low. A positive significant relation (r = 0.465*) was obtained with available potassium (K) (Table 31) in soils of Krishna district indicates that the release of K from organic complexes, but a positive and non-significant relationship in West Godavari and Khammam districts suggest that the labile carbon can not be used as a measurement of available K in these soils. There was a significant positive correlation of SOC with available sulphur (S) (0.498**) in soils of West Godavari district but it was significant and negative (-0.367*) in soils of Krishna district. SOC showed significant and positive relation with iron (Fe) and zinc (Zn) (r = 0.597** and 0.508**) indicating the tendency of organic matter to control Fe and Zn content in soils of Khammam district. Similarly, copper (Cu) in soils of West Godavari district correlated significantly and positively with SOC. Thus, it can be concluded that availability of S, Fe, Zn and Cu is dominantly influenced by SOC.

Standardization of appropriate methods

Both total and available or active forms of nutrients are important. However, analytical values, by themselves have a limited meaning in biological materials and these will give meaning only when their concentrations and amounts can be related to soil fertility, nutrient availability, plant growth, and yield and product quality.

In most cases, only a small fraction of the nutrients present in soils are in available form. Usually there is more than one method for the assessment of available nutrient status. The method which can extract nutrient forms that are correlated with plant growth for a given soil-crop situation is accepted as the one of practical utility. Hence, attempts are being made to establish the specific protocol especially for phosphorus, potassium and some micronutrients. Because most of the data is used either for advising farmers on the fertilizer needs of their fields/overall soil management for monitoring changes in soil fertility over a period of time.

Analysis of soil/leaf/water samples

The soil and leaf samples received from oil palm growing farmers, samples through oil palm factories and samples of on-going research projects were analysed for various parameters/nutrient elements. A total number of 319 soil, 430 leaf and 23 water samples were analysed during the reporting period. Appropriate advisory service was extended for suitable soil and fertilizer management in oil palm gardens of Andhra Pradesh.

STUDIES ON INTER CROPPING IN BEARING 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 study interaction between base crop and test crops and it's impact on base crop. Cocoa, banana, bush pepper, vine pepper, betel vine, heliconia, ginger lily, crossandra and anthurium were planted as inter crops. Age of oil palm is 13 years and average light infiltration through the canopy of oil palm was 23 per cent.

Observations on growth and yield parameters of banana, heliconia, ginger lily, cocoa, bush pepper, betel vine and crossandra were recorded. Ginger lily, heliconia and betel vine have been found

to be successful inter crops and same can be recommended for commercial cultivation. Yield recorded in banana, ginger lily, heliconia, betel vine, bush pepper and crossandra was 8.61kg, 9.4 spikes, 17.8 spikes, 142 leaves, 178 g and 27 g/plant/year, respectively. Crossandra is not fit for intercropping in oil palm as the performance of the crop was very poor.

Interaction between oil palm and inter crops has been found non significant as compared to the control.

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

Implemented the technologically sound practices in the mixed farming system trial for demonstration purpose. These include, vermicomposting using leftover material of oil palm, use of Biopesticides along with earthworms in the vermicompost units to observe the impact on worms, implementation of cultivation practices including intercropping.

Observations on yield of oil palm and the existing perennial intercrops were recorded. During 2008-09 (6th year after planting) Costa Rican cross Deli X Ghana recorded highest FFB yield of 15.32 t/ha followed by Deli X Nigeria (12.41 t/ha) and Palode cross 4.25 t/ha. Competition effect of intercrops was however not found.

Pest incidence was recorded very negligible. Disease symptoms manifested on one palm of Malaysian origin. Demonstration of fishnet technology for the bird menace was carried out which was found effective in reducing the incidence.

Vermicompost beds were effectively used to carryout the research on the impact of microbes as decomposers on Empty Fruit Bunches as well as Mesocarp waste. Continuous use of biogas unit using palm oil sludge as input was carried out all the year round to estimate the efficiency of the system. A family of two members was engaged continuously to work in the experiment so as to get the First Hand Information on the cost economics of Mixed Farming systems.

INTER-INSTITUTE PROJECT WITH CPCRI-MULTILOCATION TRIAL FOR COCOA VARIETIES

Cocoa in coconut has become quite popular in A.P and similarly cocoa in oil palm is picking up in the state. A study has been taken up to evaluate the performance of 12 cocoa varieties of CPCRI in oil palm in comparison with coconut. Average light intensity (PAR) measured at monthly intervals in oil palm (19 year old) and coconut (19 year old) gardens was 19 and 37 percent, respectively. Observations were made on plant height, plant spread, stem girth and number of branches/plant. Cocoa growth in terms of plant height, plant spread and stem girth was doubl in coconut when compared to oil palm. Poor growth of cocoa in oil palm can be attributed to insufficient light.

OBSERVATION TRIAL ON MAXIMIZATION OF YIELD IN OIL PALM UNDER IRRIGATED CONDITIONS

With an objective of studying the effect of higher dose of potassium on yield, a trial with three levels of NPK i.e., 1200:600:1200, 1200:1200:3600 and 600:1200:2400g/plant/year has been initiated. Treatments have been imposed in the month of March 2009 and recording of observations on growth and yield parameters of oil palm is in progress.

TREND OF OIL PALM YIELD BASED ON BIOMETRICAL/ PHYSIOLOGICAL CHARACTERS AND WEATHER PARAMETERS.

Eleven oil palm tenera hybrids (four each from ASD Costa Rica and Palode, two from Ivory Coast and one from Papua New Guinea) maintained under irrigated conditions at Directorate of Oil Palm Research, Pedavegi, Andhra Pradesh and four plants for each hybrid were used for the study. Data on girth, height, number of leaves, number of leaflets, leaf area, leaf dry weight, specific leaf weight, trunk dry weight and bunch dry weight from 44 palms for 5 years (2001-2005) have been considered and subjected to statistical analysis. Bunch index (BI) was calculated using the formula BI = Bunch Dry Weight/ (Bunch Dry Weight + Leaf Dry Weight + Trunk Dry Weight) and relationship of above morphological and physiological parameters with bunch index has been studied for all 11 hybrids as well as for each source separately, using stepwise multiple linear regression analysis. The results are shown in Table 35 and 36.

From the estimates it is observed that increase in bunch dry weight and leaf area lead to increase in bunch index. The range of estimates of bunch dry weight (0.00388 - 0.00434) and leaf area (0.000115 - 0.000284) indicates the similarity in contribution of these two parameters towards bunch index among the four different sources.

Further, data on stomatal characters *viz*. stomatal index, number of plastid per leaf, guard cell length, transpiration rate, leaf temperature, stomatal conductance, photosynthetic rate and photosynthetic water use efficiency have been collected for the last year and contribution of all these parameters along with the previously said morphological and physiological parameters to bunch index has also been studied for the last year using stepwise multiple linear regression analysis. Among the significant parameters, parameter estimates of bunch dry weight (0.238160, SE = 0.020170) and girth (0.000250, SE = 0.000097) imply that increase in bunch dry weight and girth led to increased bunch index.

Table 35 : Relationship among bunch index, dry matter production and morphological parameters in different oil palm tenera hybrids (Pooled data of 5 years and 4 sources)

Variable	Estimate	SE	R Square*	VIF
Intercept	0.36594000	0.01894000		
Bunch Dry Weight	0.00413000	0.00008049	0.4896	1.0782
Leaf Dry Weight	-0.00132000	0.00007629	0.9067	4.1139
Leaf Area	0.00014507	0.00002763	0.9420	3.6483
Trunk Dry Weight	-0.00142000	0.00023894	0.9644	5.1720
No. of Leaflets	-0.00022967	0.00005374	0.9665	3.8445
Girth	-0.00049240	0.00013652	0.9682	4.0601
Height	-0.00008115	0.00003653	0.9688	5.0125
Specific Leaf Weight	-0.01594000	0.00792000	0.9694	6.8304

C(p) = 8.1158; * R Square value after entering the variable into the model.

Table 36 : Relationship among bunch index, dry matter production and morphological parameters in oil palm tenera hybrids belonging to ASD Costa Rica, Ivory Coast, Papua New Guinea and Palode.

Variable	Estimate	SE	R Square*	VIF
Source: ASD Costa Rica				
Intercept	0.375670	0.02900000		
Leaf Dry Weight	-0.002030	0.00015527	0.4195	5.7249
Bunch Dry Weight	0.003980	0.00012506	0.9010	1.1204
Leaf Area	0.000115	0.00002838	0.9327	1.9277
Trunk Dry Weight	-0.001070	0.00034644	0.9590	4.2180
No. of Leaves	0.002030	0.00080153	0.9620	5.2925
Height	-0.000160	0.00005626	0.9634	5.2251
No. of Leaflets	-0.000222	0.00007881	0.9661	3.7249
Girth	-0.000300	0.00019670	0.9672	3.2429
C(p) = 8.0805				
Source: Ivory Coast				
Intercept	0.446840			
Bunch Dry Weight	0.003990	0.000214	0.6758	1.4529
Leaf Dry Weight	-0.001520	0.000144	0.9497	2.6150
Leaf Area	0.000199	0.000054	0.9635	1.5390
Girth	-0.001630	0.000379	0.9734	4.8190
No. of Leaflets	-0.000334	0.000129	0.9778	3.7809
C(p) = 4.2535				
Source: Papua New Guinea				
Intercept	0.258820	0.02205000		
Trunk Dry Weight	-0.001770	0.00049376	0.5871	2.2535
Bunch Dry Weight	0.003880	0.00036705	0.7932	1.3234
Leaf Dry Weight	-0.001430	0.00013764	0.9434	2.0750
Leaf Area	0.000284	0.00005645	0.9790	1.2066
C(p) = 0.9989				
Source: Palode				
Intercept	0.326510	0.02387000		
Bunch Dry Weight	0.004340	0.00011449	0.5762	1.1795
Leaf Dry Weight	-0.001230	0.00007745	0.9086	2.2338
Leaf Area	0.000204	0.00002600	0.9536	1.7702
Trunk Dry Weight	-0.001620	0.00029877	0.9768	5.0975
No. of Leaflets	-0.000282	0.00007268	0.9789	3.5881
Girth	-0.000627	0.00018913	0.9816	4.4523
C(p) = 7.2399				

* R Square value after entering the variable into the model.

4.0 Research Achievements

फसल संरक्षण
Crop Protection

Ganoderma on oil palm underplanted in coconut garden

CROP PROTECTION

STUDIES ON INSECT PESTS OF OIL PALM AND THEIR MANAGEMENT

Roving survey was carried out in different oil palm growing areas of A.P., Karnataka, Mizoram and Kerala for the pest and incidence of pollinating weevils'. In Andhra Pradesh survey was taken up in West and East Godavari, Krishna, Khammam, Nellore and Visakhapatnam districts, where as in Karnataka it was done in Mysore, Mandya and Chamarajnagar districts. In Mizoram the districts of Aizawl and Kolasib and in Kerala the districts of Idukki, Kottayam and Thiruvananthapuram were surveyed.

Incidence of Rhinoceros beetle was observed in all the states surveyed including Mizoram, but at low levels. Slug caterpillar was observed causing moderate to heavy incidence restricting to summer months. Increased incidence of psychids was observed in Andhra Pradesh and Karnataka. In Andhra Pradesh heavy to very heavy incidence of leaf web worm was observed in West and East Godavari districts with restricted appearance confining to few gardens. The slug caterpillar incidence was however found more in East Godavari district with more on coconut compared to oil palm giving the indications that the pest is showing more inclination towards coconut which is its native plant.

In Kolasib district of Mizoram nursery shoot borer incidence was found restricted to primary seedlings whereas grass hopper damage was observed at moderate levels causing defoliation of primary as well as secondary nursery plants. Water stagnation and presence of weeds were found to be the congenial conditions for the pest incidence in nursery. In Kuttanad area of Kerala psychids were observed at problematic levels due to heavy humidity.

Among the different tissue culture oil palm plants of Costa Rica origin that were planted in West Godavari district, no variety was found resistant to the pests. On cocoa, which is grown as intercrop in oil palm, incidence of hairy caterpillar and mealy bugs were observed at low to moderate levels. Incidence of rats was found increasing. Leaf web worm that was found as severe pest on oil palm was also observed at lower levels on cocoa.

STUDIES ON AVIAN AND MAMMALIAN PESTS AND THEIR MANAGEMENT

Rat incidence has decreased with the continuous application of Zinc phosphide baits in West Godavari district of Andhra Pradesh where as in East Godavari the incidence was at moderate levels as the pest is found to migrate from adjacent sugarcane and paddy fields. In the Kuttanad area of Kerala rat incidence was found decreased compared to earlier years due to continuous precautions followed by the farmers like covering the boll region with iron mesh, planting the nursery plants with chicken wire mesh and pumping out the backwaters at frequent intervals.

In the Kolasib district of Mizoram crows and mynahs continued to feed and cause heavy damage to FFB and rat incidence was also observed at moderate levels feeding on the FFB. In Mysore district, crows were observed as major pests feeding on FFB on palms where as in the processing factory sites, all types of birds were observed

feeding on both fresh fruits as well as boiled ones. Eagles and vultures were also observed feeding on FFB apart from dogs and foxes.

Tying of fishnets in between two palms as volleyball nets reduced the bird menace to 50% but came to normal immediately after the removal of the nets. Maintenance of the nets is found important in reducing the bird incidence.

New Pest on oil palm in Mizoram

A mammalian pest commonly called as *Boi* in Mizo language (India) is found feeding on the roots of young oil palm plants in Mizoram state (Fig. 19). The pest which is a rodent, *Canonys bius* bores into the root zone of the plant and feeds on the boll region making the plant to die. It bores 5-10" below the ground level and attacks the young palms of 1-5 years old. The plants do not show any visual symptoms except drying of spindle initially followed by drying of surrounding leaves. Within 3-4 days of attack the palms are found dried. A heap of soil is observed at far off places but not near the palms as seen in case of rat's damage. The pest is seen burrowing to the root zone of the plants and then feeds on the boll region. It is found to move both in horizontal and vertical directions. The pest is found more in Kolasib and Mami districts.

The pest is a big size rat weighing about 1-2 kgs. It is having big size teeth and found to feed on bunches also. Incidence is more during rainy season coinciding with bamboo flowering. Found to live in burrows and feeds on rice and other crops. People prefer to kill and eat where ever it is found.

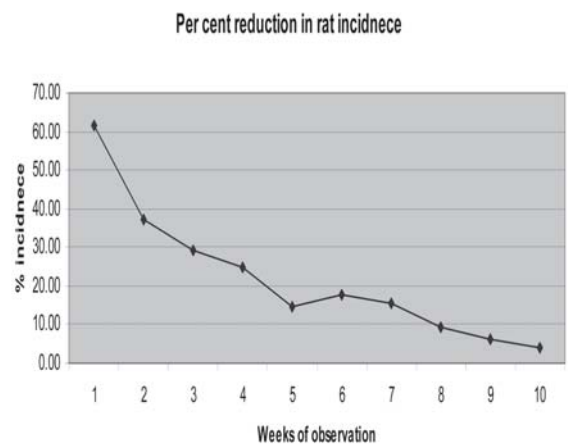
Impact of various control measures on reducing the rat menace in oil palm

To find the effective management practice for rat menace, a trial was laid out

Fig. 19. Boi- *Canonys bius* a new pest on oil palm in Mizoram-

in the young oil palm plantations using various treatments namely, Japanese sticky glue trap, zinc phosphide and bromodiolone. The per cent intensity of rat attack was recorded by counting the number of packets kept initially and number of packets remained after rat attack at weekly interval. It has been observed that the per cent rat incidence which was 61.42 during the initial period of experimentation has come down to mere 4.04 within 65 days period (Fig. 20). Of the various treatments, Japanese sticky glue trap recorded no reduction while bromodiolone showed 48.73 per cent

Fig. 20. Impact of control measures on rat incidence



reduction. Zinc phosphide caused maximum per cent reduction of 83.56 and proved more efficient and effective treatment.

Comparative efficacy of Zinc phosphide with and without following the hygienic practices

Experiments were carried out in the farmers' fields of Pedavegi mandal of West Godavari district to find the effectiveness of Zinc phosphide on the rat control using news paper and banana leaves with and without wearing gloves by the operators. The trials were laid out in one year old young garden that is adjacent to maize plantation and having the incidence of burrowing rat, *Tatera indica*. Rats were found to migrate and feed on the bole region of the oil palm plants existing in the outer rows. Zinc phosphide baiting was done using boiled rice and wrapping in the used news paper with bear hand and by keeping in the banana leaf packets by wearing gloves. Continuous application of baits at fortnightly interval was carried out. It has been observed that the per cent reduction of incidence was 52.11 when the zinc phosphide baits were kept in used news paper packets and operated with bare hands while it was 83.56 when the traps were kept in banana leaf packets wearing gloves during the operation (Table 32). The difference in per cent reduction is attributed to the character of rats that they are more sensitive and shy bearers to the human touch, which is evident from the current experiment.

Table. 32. Impact of Zinc Phosphide on per cent reduction of rats

Treatments	Rat reduction (%)
Zinc phosphide in news paper with out gloves	52.11
Zinc phosphide in banana leaf packet with gloves	83.56

GROWTH STUDIES AND COMMERCIAL PRODUCTION OF MICROBIAL AGENTS

Oil palm and cocoa ecosystem enhanced the number of *Trichoderma viride* spores compared to coconut and cocoa ecosystems. Presence of more functional roots at low depths in oil palm plantations compared to coconut was found to be the main reason.

Temperatures of 30°C and humidity of 63.6% were found highly congenial for the maximum viability of the green muscardine fungus *Metarhizium anisopliae* causing 100% mortality of rhinoceros beetle grubs. Similarly the lethal time for causing 100% mortality of the pest was found to be within 9 days for the grubs present in Farm Yard Manure and above 17 days for the grubs present in oil palm mesocarp waste. Farm Yard Manure is the best suited media for the growth of *Metarhizium anisopliae* rather than oil palm mesocarp waste.

Microorganisms that were subjected to shaker application immediately after inoculation and exposed to UV radiation caused poor growth of spore population indicating the negative impact of UV radiation and shaker application on the molecular weight of the protein content of the fungi, *Metarhizium anisopliae* and *Trichoderma viride*. The germicidal effect of UV radiation reduced the protein content of mats and thereby the reduction in the molecular weight. Shaker application was however found effective in increasing the spore content of bacteria, *Bacillus thuringensis* when used immediately after the inoculation.

Studies on Biopesticide *Beauveria bassiana*

Some basic studies on white muscardine fungus, *Beauveria bassiana* that is effective in controlling the lepidopteron pests were conducted and the observations are as follows:

- Compatibility studies carried out for *Beauveria bassiana* with green muscardine fungus *Metarhizium anisopliae* and *Trichoderma viride* revealed that *Beauveria bassiana* has the compatibility with *Metarhizium anisopliae* where as it has antagonistic effect with *Trichoderma viride* indicating the non suitability of mixing both the microbes together.
- *Beauveria bassiana* has the enzyme called Exochitinase. It was subjected to SDS PAGE and found that the relative mobility of the band was 4.9 k. Da corresponding to the molecular weight of 35 k. Da.
- *Beauveria bassiana* was found effective in controlling the egg stages of plant parasitic mites feeding on okra causing 66.00% mortality. The egg stages which are hard to kill with the chemicals were easily controlled with *Beauveria bassiana* within 5 days after application.
- Commercial formulation of *Beauveria bassiana* was found effective in causing heavy mortality to the leaf web worm, *Acria* sp. compared to broth formulation. The talc powder that is used as filler material is enhancing the mortality compared to microbial organism alone present in broth.
- *Beauveria bassiana* was found on par with the insecticides in managing the pest problem. Re inoculation studies carried out using the dead psychids confirmed the mortality of the pest due to Biopesticides.
- Confirmation of earlier results on the control of slug caterpillar using *Beauveria bassiana* was found on par with the chemical treatment of Lambda cyhalothrin (0.005%).

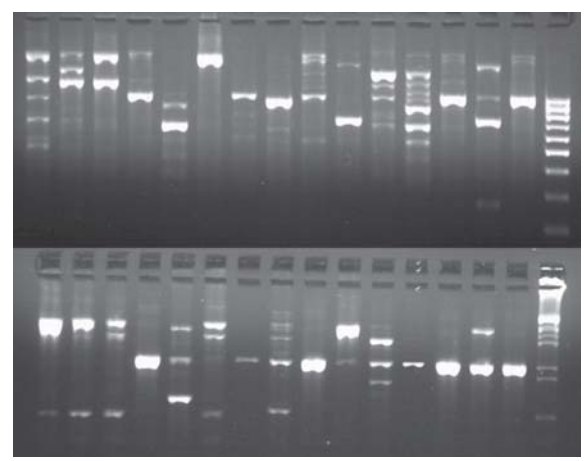
STUDIES ON DISEASES OF OIL PALM AND THEIR MANAGEMENT

Monitoring of disease incidence in the existing oil palm plantations of Pedavegi and Palode was done. Basal stem rot incidence on oil palm under planted in coconut gardens was observed.

Molecular characterization of *Trichoderma* isolates

Native *Trichoderma* isolates which were collected from the oil palm growing regions of Andhra Pradesh were sub-cultured and DNA was extracted from mycelia of all the 15 isolates. They were purified and quantified. So far 10 RAPD primers are used for molecular characterization of the isolates. A representative photograph with OPN-11 and OPO-13 was presented in Fig. 21.

Fig. 21. RAPD pattern of *Trichoderma* isolates with OPN-11 and OPO-13 primers (from top to bottom)



4.0 Research Achievements

कटाई उपरान्त प्रोद्योगिकी
Post Harvest Technology

View of mini palm oil mill

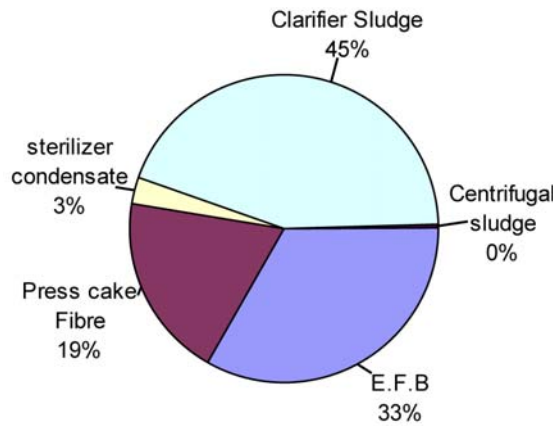
DEVELOPMENT OF GRADING SYSTEM FOR OIL PALM FFB AND ESTIMATION OF FACTORY LEVEL OER

Estimation of OER of FFB from palms of different age and season

The study was taken up in the mini palm oil mill established at DOPR, Pedavegi for estimating the variation in OER, in relation to season, age of the palm as well as the extent of mill oil loss. FFB for the study was collected from young (6 years old) and adult (15 years old) palms of Palode material. The results indicated that :

- In case of young palms maximum OER of 17.41% was obtained during July to December, whereas for adult palms maximum OER of 19.46 % was obtained in the month of November.
- Pattern of oil loss through various factory wastes indicated that the highest oil loss during processing was through clarifier sludge (41 to 48 %). This was followed by 33 to 35 % oil loss in EFB and 12 to 21% oil loss in press cake fibre. Percent mill oil loss with respect to FFB of adult palm is given in Fig. 22.

Fig. 22. Pattern of oil loss in the mini mill for bunches from adult palms



Preliminary studies on grading

The experiment on grading was conducted with bunches of varying ripeness viz. Unripe, Under ripe, Ripe and Over ripe. The image of these bunches were captured using digital camera and was then analyzed using NI vision software to convert the image into the three basic colors (RGB) and the intensity was measured in terms of digital numbers. Biochemical analysis was carried out for the same samples for coloring pigments like total chlorophyll and carotene in addition to oil percent.

The results are presented in Table 33 and Fig. 23 & 24. The results of the study indicated that the carotene content which is mainly responsible for the typical orange red color of fruits increased during the process of ripening. The rate of increase was steep from under ripe (284.4 ppm) to optimum ripeness stage (835.183ppm). There after the rate of increase was minimal (913.98ppm). Thus carotene content was correlated positively with stage of ripeness (0.912).

The oil content of the fruits (FFB) was very low during unripe stage and it increased to 15 % during the partial ripening (under ripe) phase. During optimum ripeness stage the oil content reached 21.25 %.

The color value (digital numbers) obtained by analyzing the images indicated

Fig. 23. Relation of oil content with ripeness stage

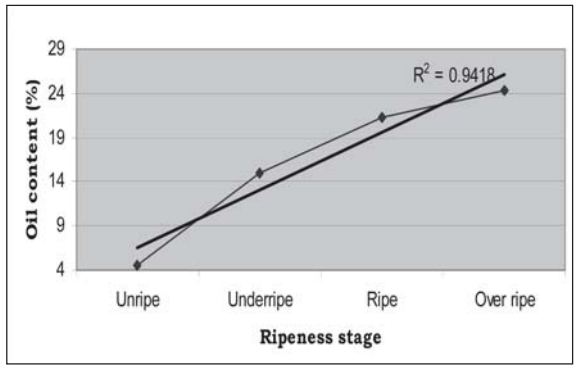
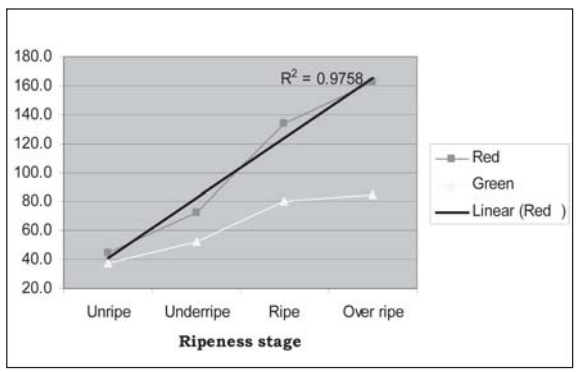


Fig. 24. Relation of colour values with ripeness stage



that the red color showed the best possible correlation (0.976) with ripeness stage. This could be attributed to the formation of carotenoid pigments as evident from biochemical analysis of fruits. To arrive at a dependable criterion of distinguishing bunches of optimum ripeness; the direct and inverse ratio of red and green color was worked out. The ratio was 0.5 during the unripe stage and it widened gradually and reached 1 or above once the fruits reached proper ripeness. So these differential ratios derived from the color values could be taken as the index for deciding correct ripeness stage.

The maximum correlation of red color with ripeness indicated the suitability of the same for distinguishing fruits into different ripeness classes. Biochemical studies were in agreement of this trend, where the carotene content (which imparted the typical orange red color to fruits) was directly correlated to oil content up to optimum ripeness stage.

POST HARVEST STUDIES ON PALM OIL

An experiment on quality of crude palm oil extracted from sterilized and un-sterilized fruits is continuing. Oil samples extracted from the fruits after sterilization at 121°C at 15 lb pressure for 1 hour and without sterilization were stored for three weeks period at ambient, lower (10°C) and higher (60°C) temperatures. Oil quality in terms of FFA, carotenoids content and fatty acids composition of both the oil samples extracted with and without sterilization was recorded during storage.

Table. 33 Variation in biochemical parameters* and colour values with ripeness stage

Ripeness stage	Carotene (ppm)	Oil content (%)	Red	Green	Blue	Red/green
Immature	142.475	4.60	44.2	37.1	31.8	1.2
Under ripe	284.9444	15.00	72.5	52.5	46.0	1.4
Ripe	835.1827	21.25	133.7	80.0	56.6	1.6
Over ripe	913.9871	24.38	162.2	84.9	58.9	1.9

*Average of four samples

Upon storage of oil at 60°C and room temperature, there was a drastic increase in FFA content but when stored at 10°C, increase in FFA content was less. Similar trend was observed in the case of oil extracted from both sterilized and unsterilized fruits. Interestingly, when the fruits were incubated/ stored at lower temperature and oil was extracted, FFA content increased to a very high percentage (>25% within a week). However, in the present experiment, the oil was first extracted from the fruits and stored. Hence, storage of fruits and oil leads to contradicting results.

Carotenoids decreased relatively in both the oils (extracted from sterilized and un-sterilized fruits) stored at 60°C from 1st week to 3rd week. However, not much difference was observed with samples stored at 10°C and room temperature (Fig. 25a and Fig. 25b). There was marginal difference observed in total saturated fatty acid (TSFA) and total unsaturated fatty acid (TUFA) content in the oils extracted from both sterilized and un-sterilized fruits from 0 day to 3rd week when stored at 60°C. However, the experiments are being repeated for confirmation of results.

Fig. 25a: Changes in carotenoids content in the unsterilized oil after storage at different conditions

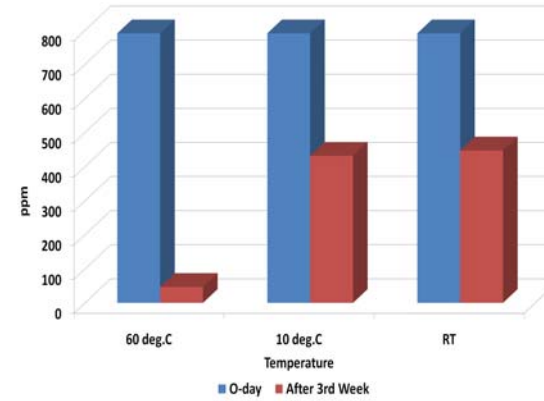
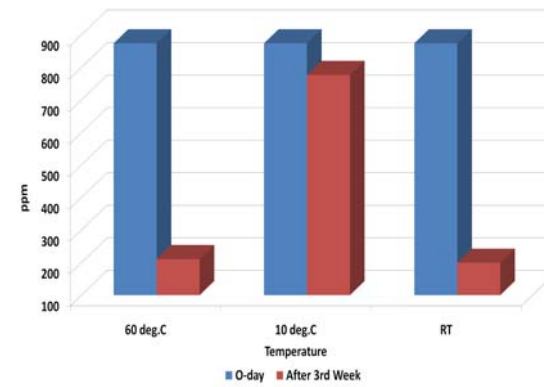


Fig. 25b: Changes in carotenoids content in the sterilized oil after storage at different conditions



4.0 Research Achievements

सामाजिक विज्ञान

Social Sciences

Farmers training programme on oil palm cultivation

SOCIAL SCIENCES

PRIORITIZATION OF RESEARCH NEEDS IN OIL PALM BASED ON FARMERS PERCEPTION

Interview schedule was standardized. Data were collected from 15 oil palm growers regarding perceived technical problems faced in oil palm cultivation and to identify and prioritize the research needs based on their perception on two parameters i.e. Research need and Timeliness of availability of research results. Data were collected for 24 practices on the above parameters. Farmers perceived technical problems in oil palm cultivation and perceived the research need in the following practices in that order (Table 34).

Table 34. Prioritization of research needs in oil palm perceived by oil palm farmers

N=15

Major practice	Total score obtained
Harvesting	28
Planting material	22
Raising seedlings in nursery	20
Fertilizer management	20
Pest management	20
Planting distance	18
Irrigation management	18
Disease management	18
Pruning	18
Basin management	16
Intercrops / Mixed crops	15
Green manuring	14
Waste utilization	14
Land preparation	13
Soils	13
Mulching	12
Pollination	12
Weed management	10
Leaf breaking	8
Training	7
Economics	6
Others	6
Leaf analysis	5
Oil Extraction Ratio	3
Pit making	2
Ablation	2

OIL PALM DATA BASE MANAGEMENT SYSTEM

Data were collected from six high yielding oil palm plantations. Majority of the high yielding plantations are of 8 years age. Majority of the farmers adopted micro irrigation, practicing mulching, applied manures, applied fertilizers in 3-6 splits, adopted weed management practices and innovative methods to minimize losses in micro jets while harvesting the FFB. Most of the farmers are having Cocoa as intercrop. Major constraint expressed by the farmers is harvesting from tall palms.

Data collected form 516 respondents (farmers) were subjected to statistical analysis which revealed that majority of the oil palm growers were marginal (31.59%) and small farmers (27.91%). Wide adoption of oil palm (62.60%) has taken place during the years 1993 to 1997. Most of the respondents (74.61%) were following basin method of irrigation with four to seven days interval (29.84%) to irrigate the palms. More than eighty per cent of the farmers were applying farmyard manure. Most of the respondents were applying lower doses of nitrogen (54.07%), Phosphorus (42.64%) and potassium (34.69%) and majority of the farmers were not applying micronutrients.

Majority of the farmers (34.69%) were applying fertilizers in 2 split doses. The major constraints perceived by respondents were lack of sufficient irrigation water and problems in harvesting of FFB. The major suggestions given by the respondents were to provide assured power supply, financial assistance from banks and increasing the subsidy for cultivation and for installation of drip system.

Participation in Exhibition organised at OUAT, Bhubaneswar, Orissa

Participatinon in Exhibition organised at NRC for Litchi, Bihar

Sri. M. V. Rao, Hon'ble, MLA releasing folder on oil Palm cultivation in telugu in the exhibition organised at Eluru, A.P.

5. TRANSFER OF TECHNOLOGY AND EDUCATION

MULTI-DISCIPLINARY APPROACHES FOR TRANSFER OF TECHNOLOGY AND AREA EXPANSION IN RELATION TO OIL PALM DEVELOPMENT IN INDIA

Feasibility studies

Dr. V. M. Reddy, Dr. M. V. Prasad, Dr. R. K. Mathur, Dr. G. C. Satisha conducted feasibility study for the proposed new seed garden in Srikakulam District, A. P on 31st July, 2008 and submitted report to Commissioner of Horticulture, A.P.

Dr. P. Kalidas submitted report on feasibility for oil palm cultivation in Nalgonda district of A.P. to the Director of Horticulture, Andhra Pradesh

Extension activities

Queries of oil palm growers regarding cultivation practices received through E Mails, 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.

Based on the request received from farmers / entrepreneurs / state department of agriculture / horticulture, nurseries/oil palm plantations in Andhra Pradesh, Karnataka, Kerala Orissa, Mizoram were visited for diagnosing the problems faced by the growers regarding pests, diseases and nutritional disorders were diagnosed and necessary remedial measures were suggested.

Oil palm development programme

Dr. M. Kochu Babu and Dr. P. Kalidas attended the XVI Project Management Committee (PMC) meeting of Andhra Pradesh organised by State department of Horticulture, Govt. of A.P on 26th June, 2008 at Hyderabad.

Dr. P. Kalidas attended the Price Fixation committee meeting of Karnataka on 18th June, 2008 at Bangalore organised by State department of Horticulture, Govt. of Karnataka and Price fixation committee meeting of Andhra Pradesh on 15th November, 2008 at NRCOP, Pedavegi organised by A.P. Oil Palm growers Welfare association

TRAINING OF EXTENSION, RESEARCH WORKERS AND FARMERS INVOLVED IN OIL PALM PRODUCTION (Strengthening of Training on Oil Palm Production Technology sponsored by ISOPOM-TMOP &M)

Following officers and farmers training programmes were conducted during 2008-2009:

Officers' training programmes

Organised officers training on "Oil Palm Production technology" to 148 officers, Oil Palm Hybrid Seed Production" to 10 officers, "Plant Protection in Oil Palm" to 9 officers and "Nursery Management in Oil Palm" to 7 officers. Lectures delivered by concerned scientists on subject matter. Demonstrations were organised on planting, application of fertilizer, collection of 17th leaf for leaf analysis etc.; visits to fields and processing units were also arranged; Literature on compendium of lectures delivered on respective subject matter was distributed to the participants. Pre and post evaluation was conducted.

Details of Officers' training programmes organised

Sl. No.	Date	No. of Participants	Training Programme	Venue	Trainees represented from
1	15-16.04.2008 27.6-3.7.2008 20-27.08.2008	6 15 27	Oil Palm Production Technology	DOPR, Pedavegi, A.P.	Andhra Pradesh Mizoram, Gujarat, Tamil Nadu, Karnataka, Orissa and Kerala
2	17-19.09.2008	10	Oil Palm Hybrid Seed Production	DOPR, RS Palode, Kerala	A.P., Karnataka, Kerala and Gujarat
3	21-23.10.2008	9	Plant Protection in Oil Palm	DOPR, Pedavegi, A.P.	A.P., Gujarat and Kerala
4	25-27.02.2009	7	Nursery Management in Oil Palm	DOPR, Pedavegi, A.P.	Karnataka and A.P.

State level training programme : A state level training programme on oil palm was oraganised to 100 agricultural officers of Mizoram state at Aizwal during September 25-26, 2008. Dr. V. M. Reddy, Dr. P. Kalidas, Dr. M. V. Prasad organised the programme.

Farmers' training programmes

Organized 14 training programmes on "Oil Palm Cultivation" at DOPR, Pedavegi to 395 farmers from Gujarat, Karnataka, Mizoram and A. P.; Eleven on farm trainings on "Oil Palm cultivation" were conducted to 671 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. Coordinated a total of 32 training programmes organised to 1350 farmers on three subject matter areas of oil palm cultivation.

Exhibitions

DOPR, Pedavegi participated in 4 exhibitions conducted on various occasions in A.P., Bihar and Orissa.

Seed production training at Palode

In A.P participated in the exhibition conducted for 5 days during Bharat Nirman Civil Information campaign, at Kovali, Eluru, West Godavari, AP from 16-20th 2008 organised by MHRD, GOI and in the exhibition organized in connection with Horticulture show by Department of Horticulture, A.P at Eluru during 27-29th December, 2008.

In Bihar participated in the exhibition conducted at NRC Litchi, Muzafarpur.

In Orissa participated in exhibition organised at OUAT, Bhubaneswar, Orissa.

Details of farmers' training programmes organised

Sl. No	Training programme	No of programmes organized	No of farmers participated
1	**Oil Palm cultivation**		
	Organized at DOPR, Pedavegi	14	395
	Organised at DOPR, Regional Station, Palode	03	55
	Organized at Farmers plantations	11	671
2	**Nutrient and Water Management in Oil Palm**		
	Organized at Farmers plantations	02	90
3	**Nutrient and Water Management in Oil Palm**		
	Organized at Farmers plantations	02	139
	Total	**32**	**1350**

Farmers' visit to DOPR, RS, Palode

S. No.	Period	No. of Farmers	Place
1	11.11.2008	16	Aizwal, Mizoram
2	12.12.08 to 16.12.08	18	Aizwal, Mizoram
3	22.01.09 to 25.01.09	16	Aizwal, Mizoram
	TOTAL	**50**	

DOPR, Regional Station, Palode participated in 'Karshika Mela' at Palode from 7-15th February, 2009 and bagged second prize among the Government Category.

AIR/Doordarshan programmes

Live Crop Seminar on Oil Palm was organised jointly by Doordarshan Kendra-Saptagiri, Hyderabad and NRC Oil Palm, Pedavegi on 21.06. 2008. The two and half hour programme was live telecasted on Doordarshan – Saptagiri Channel between 4 - 6.30 pm. Programme was conducted with 6 technical (question and answer) sessions. A total of 300 personnel consisting of farmers, officials, entrepreneurs and scientists participated.

Dr. M. V. Prasad : Quiz master for four Ryte Raju Agricultural Programmes for farmers in **Doordarshan** – Saptagiri, Hyderabad telecasted during September-October 2008.

Dr. P. Kalidas was the invited speaker for the Live phone in programme on 'Pests and their management in oil palm' organized by All India Radio, Vijayawada on 1 May, 2008.

Acted as resource person for AIR, Vijayawada to deliver information on 'Pest management in oil palm' for the benefit of oil palm growers during December 2008.

Field visits

A **diagnostic field visit** was organised with the scientists' team of DOPR, Pedavegi

to the oil palm plantations in West Godavari Dist. on 19.2.2009 on the occasion of Foundation day celebrations of DOPR and necessary suggestions were given.

Farmers' meets

Dr. M. Kochu Babu

Attended Farmers' meet at Nalgonda, A.P on 14.07.08

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

Attended Farmers' meet at Vizianagaram organized by Dept. of Horticulture, A.P on 23.07.08

Dr. M. V. Prasad

Attended and delivered lecture on Oil Palm and gave suggestions at the farmers meets organised by M/s. Hariyali and M/s. Coromondal fertilizers in A.P.

Dr. P. Kalidas

Attended and delivered lectures on oil palm pests and diseases and their management at Farmers awareness campaigns/meetings organised at :

- Kothagudem and Palvoncha of Khammam Dt of A.P during April 2008.
- Timmapuram of Dwaraka Tirumala Mandal, W.G. Dt., A.P on 6th Jan 2009.
- Vegavaram of Jangareddygudem mandal, W.G. Dt., A.P on 17th March 2009.

Field days

Externally funded programme for Rs. 0.50 lakhs was obtained from Directorate of Cashew and Cocoa Development Board, Cochin to organize the farmers' awareness meetings on plant protection of cocoa in oil palm.

Dr. P. Kalidas organized the field day on "Cocoa in oil palm" at Visakhapatnam for the benefit of the farmers of the north coastal Andhra Pradesh on 2nd February, 2009.

Students' exposure visits

Period	College
DOPR, Pedavegi	
23.12.08	Triveni Degree College, Jangareddygudem, W.G. Dist., A.P
29.12.08	Karnataka University, Dharwad, Karnataka
DOPR, RS, Palode	
26.08.08	Nalanda T.T.I Nanniode, Pacha, Trivandrum
31.08 - 01.09.08	Adhiparasakthi Agrl. College, Kalavai, Tamil Nadu
03 - 04.09.08	Adhiparasakthi Agrl. College, Kalavai, Tamil Nadu
17.09.08	TNAU, Madurai
18.10.08	Annamalai University, Tamil Nadu
30.01.09	Asppe College of Horticulture & Forestry, Gujarat
03.02.09	Govt. HSS Pirappancode, TVM
10.02.09	Govt. UP School, Edava, Varkala
26.02.09	Kerala Agrl. University, Vellayani, TVM
03.03.09	Mangalore University, Mangalagangothri, Karnataka

PROJECT WORKS CARRIED OUT BY STUDENTS AT DOPR, PEDAVEGI

Name of the student	Discipline & College	Completed during	Title of project work	Guide
Kandula S Naga Jaya Sri	M.Sc. (Biotechnology) Vivekananda College for women, Tiruchengodu (Affiliated to Periyar University)	April 2008	Genetic diversity analysis of different accessions of oil palm collected from farmers field by using Randomly Amplified Polymorphic DNA	Dr. P. K. Mandal
Latha Ippili	M.Sc. (Biotechnology) Vivekananda College for women, Tiruchengodu (Affiliated to Periyar University)	April 2008	Oil palm (*Elaeis guineensis* Jacq.)DNA extraction from leaves using standard and modified methods	Dr. P. K. Mandal
Y. Leena Devi	M.Sc(Microbiology) St. Theresa's College for women, Eluru	June 2008	Studies on compatibility of *Beauveria bassiana* with *Metarhizium anisopliae* and *Trichoderma viridae*	Dr. P. Kalidas
D. Sowmya	M.Sc (Biotechnology) Acharya Nagarjuna University, Guntur	July 2008	Studies on the selection of suitable substrate for multiplication of *Metarhizium anisopliae* at various temperatures and its effect on rhinoceros beetle of oil palm.	Dr. P. Kalidas
V. Sowmya	M.Sc (Biotechnology) Acharya Nagarjuna University, Guntur	July 2008	Separation of chitinase enzyme from *Beauveria bassiana*.	Dr. P. Kalidas
M. Sanath Kumar Reddy	M.Sc (Microbiology) Aditya Degree college, Kakinada	July 2008	Studies on the effect of entomopathogenic fungus *Beauveria bassiana* on mite eggs in Okra	Dr. P. Kalidas
B. Venkata Ramana	M.Sc (Microbiology) Aditya Degree college, Kakinada	July 2008	Studies on the growth patterns of *Trichoderma viride* on different oil palm growing soils	Dr. P. Kalidas

Name of the student	Discipline & College	Completed during	Title of project work	Guide
P. Durga Bhavani	M.Sc (Biotechnology) JKC College, Guntur, A.P	July 2008	Effect of *Beauveria bassiana* on infected pests	Dr. P. Kalidas
K. Manjeera	M. Sc (Biochemistry) Sir. C.R.R college for women, Eluru, A.P	March 2009	Differentiating oil palm varieties using Random Amplified Polymorphic DNA (RAPD).	Dr. M. Jayanthi
G. Sri Shanmukha Srinivas	B. Tech (Biotechnology) AACEIT, Visakhapatnam, A.P	March 2009	Studies on the impact of UV radiation and shaker application on the protein concentration of *Beauveria bassiana*	Dr. P. Kalidas
D. Karunakara Reddy	B. Tech (Biotechnology) AACEIT, Visakhapatnam, A.P	March 2009	Studies on the impact of UV radiation and shaker application on the protein concentration of *Bacillus thuringiensis*	Dr. P. Kalidas
T. Ramya Krishna	M.Sc (Microbiology) PR College, Thanjavur, T.N	March 2009	Studies on impact of *Beauveria bassiana* on management of oil palm pests.	Dr. P. Kalidas
B. Sandhya	M. Sc (Biotechnology) DNR College, Bhimavaram, A.P	March 2009	Studies on the impact of UV radiation and shaker application on the protein concentration of *Trichoderma viride*.	Dr. P. Kalidas
S.S.N.Deepthi	M. Sc (Biotechnology) DNR College, Bhimavaram, A.P	March 2009	Studies on the impact of UV radiation and shaker application on the protein concentration of *Metarhizium anisopliae*	Dr. P. Kalidas
Md.Kousar Jahan	M.sc (Biochemistry) Sir C.R.R. College for Women, Eluru (Andhra University, Vizag, A.P.)	March 2009	Oil Analysis of *virescens* and *nigrescens* fruit types of Oil Palm	Dr. P. K. Mandal

6. AWARDS AND RECOGNITIONS

- Dr. M. Kochu Babu, co-chaired the technical session -II during the National Conference on "Organic Farming in Horticultural Crops with special reference to Plantation Crops" held at CPCRI, Kasaragod during 15-17 October 2008.

- Dr. M. Kochu Babu co-chaired the Technical session IV during PLACROSYM XVIII at NRC for Cashew, Puttur during 10-13 December, 2008.

- Dr. M. Kochu babu , Member of the Constitution of Project evaluation and sanctioning committee for approval of Annual Action Plans under ISOPOM (Ministry of Agriculture, GOI).

- Dr. P. Kalidas has been nominated as Member, IMC of CPCRI, Kasargod for three years from November, 2008.

- Dr. P. Kalidas recognized as supervisor to guide the Ph.D students of Jawaharlal Nehru Technological University, Hyderabad.

- Dr. M.V. Prasad, Member of Academic council of St. Theresa autonomous college, Eluru, A.P.

- Dr S. Sunitha was nominated as the Chairperson of the committee constituted by OPIL for planning replanting schedule of various estates of OPIL in future years. The committee met on 15th May, 2008 and submitted report.

- Dr. P. Murugesan was nomitated as a Member of Special Purpose Vehicle - Tamil Nadu Oil Palm Development Project.

- Dr. M. Jayanthi is recognised as supervisor to guide M.Phil & Ph.D students of the Acharya Nagarjuna University, Guntur.

- The following scientists of DOPR were accredited as P.G teachers for teaching P.G courses and to guide students for P.G research in the respective disciplines in Andhra Pradesh Horticulture University, Tadepalligudem (A.P.).

  Dr. M. Kochu Babu, Dr. P. Kalidas, Dr. R.K. Mathur, Dr. M.V. Prasad, Dr. P. K. Mandal, Dr. M. Jayanthi.

7. LINKAGES AND COLLABORATION

Directorate of Oil Palm Research is maintaining linkages with the following Institutes / Agencies:

- 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 Tripura
- State Agricultural Universities of oil palm growing states
- Entrepreneurs involved in oil palm development
- Agricultural Finance Corporation
- Oil Palm India Ltd (OPIL), Kottayam, Kerala
- Other ICAR institutes

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 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
- Multilocation evaluation of African oil palm germplasm (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

NRCOP was redesignated as Directorate of Oil Palm Research (DOPR) and the existing four AICRP (Oil palm) centres at Vajayarai, A.P; Gangavathi, Karnataka; Aduthurai, Tamil Nadu and Mulde, Maharashtra were brought under the technical control of DOPR. Two new AICRP (Oil palm) centres were also approved one in the state of Bihar and another in the state of Arunachal Pradesh. Subsequent to this a committee was constituted with Dr. S. Arulraj, PC (Palms), Dr. V. M. Reddy, Pr. Scientist, DOPR and the Director of Research, Rajendra Agricultural university, Bihar to select the ideal location for establishing the new AICRP centre among the potential agricultural research stations available in the state of Bihar. The committee members visited and selected the Research Station at Madhopur, West Champaram, Bihar. In the state of Arunachal Pradesh, the committee consisting of Dr. Arulraj, Dr. V. M. Reddy and Dean, College of Horticulture & Forestry, Pasighat, Arunachal Pradesh under Central Agricultural University, Manipur selected College of Horticulture & Forestry, Pasighat for establishing the AICRP (oil palm) centre.

The committees submitted their reports and the programmes envisaged in the reports have been implemented. Oil palms were planted for 'maximization' as well as 'fertigation' experiments by shifting oil palm seedlings from North Andhra Pradesh observing phyotsanitary measures. These experiments are aimed at proving the potential of oil palm in that region and to bring in confidence among the farmers.

Though all oil palm centres are placed under the control of DOPR during XI Plan, over all monitoring is being done by the Project Coordinator (Palms) at Central Plantation Crops Research Institute (CPCRI, Kasaragod).

9. PUBLICATIONS

Research Papers

- Jayanthi, M., Mandal, P.K, Sujatha G., Jaya Sri, K.S., Srinivasa Rao. G., Sunitha. B. and Kochu Babu, M. 2008. Simple sequence repeats and RAPD primers for assessment of genetic uniformity among the field planted clones of oil palm. *Journal of Plantation crops,* 36(3): 235-238
- Jayanthi, M., Sujatha, G. and Mandal, P. K. 2009. Optimization of PCR Reagents for amplification of micro-satellites in oil palm, *Indian Journal of Horticulture,* 66(1): 147-148.
- Kalidas, P., Rajasekhar, P and S.V.L.Lalitha 2008. Impact of pesticides on the pollinating weevils of oil palm. *Journal of plantation crops*. 36(3):460-462.
- Kalidas, P. and Vidyasagar, P. 2009. Impact of conventional pesticides and their methods of application on the management of rat menace in young oil palm orchards. *Journal of Oilseeds Research*. 26(special issue): 246-248
- Murugesan, P., Gopakumar, S., Krishnakumar, T., Santhosh Kumar, J. and Haseela, H. 2008. Performance of *Tenera* × *Tenera* progenies derived from Thodupuzha and Nigerian Oil Palm germplasm under rain fed condition. *Journal of Plantation Crops, 2008, 36 (3): 161-165*
- Murugesan, P., Padma, P., Naga Mangala, U., Mathur, R.K., and Kochu Babu, M. 2008. Preliminary investigations on oil palm *inter se* progenies with special emphasis to pisifera. *Indian J. Hort.*, 65(2): 214-219
- Murugesan, P., Bijimol, G. and Haseela, H. 2008. Effect of different substrates on growth of germinated oil palm hybrid seeds *Indian Journal of Horticulture*, 65(4):
- 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
- Prasad, M. V. 2009. Indigenous knowledge use in Maize cultivation in Andhra Pradesh. *Indian Research Journal of Extension Education* 9 (1): 65-68.
- Prasad M V 2008. Skill gap in cultivation of oil palm (paper accepted for publication in Indian Journal of Plantation Crops).
- Prasad M V, Sunitha S and Kochu Babu M 2008. Adoption of oil palm in karilands of Kerala under rainfed conditions a case study (paper accepted for publication in Indian Journal of Plantation Crops).
- Rajasekhar, P., Sudhakar, P., Sambasivarao, K.R.S., Ravikumar, K. and Kalidas, P. 2008. Cloning, expression and characterization of chitinase from Beauveria bassiana NIM1225. Current trends in Biotechnology and Pharmacy (communicated)
- Sarkar, A., Suresh, K. and Kochu Babu, M. 2008. Contribution of Morphological and Physiological parameters towards Bunch Index in oil palm under irrigated

conditions using Multiple Linear Regression Analysis. *Journal of Plantation Crops*. 36 (3): 344-347.

- Sarkar, A., Mathur, R.K., Reddy, V.M. and Kochu Babu, M. 2008. Application of Statistical Models in Selection of Promising Oil Palm Hybrids. *International Journal of Oil Palm*. (Communicated)
- Suresh, K., Mathur, R.K., Kochu Babu, M. 2008. Screening of oil palm duras for drought tolerance – stomatal responses, gas exchange and water relations. *J. Plant. Crops*. 36(3): 270-275.

Technical/Popular articles

- Kochu Babu, M. 2008. Oil palm production technology adopted in India. Plant Horti Tech. Vol. 8. No. 4. October-November 2008. Pp 33-38
- Kochu Babu, M. 2009. Economics of oil palm cultivation. Plant Horti Tech. Vol 8. No. 6 March-April 2009. pp 23-24
- Kochu Babu, M., Prasad, M. V. and Jameema, J. 2009. Oil Palm lo kaandamu modalu kullu thegulu yajamanyam -Telugu (Basal stem rot disease in oil palm and its management), January 2009. P 42, *Annadata,* a telugu monthly news magazine.
- Kochu Babu, M. 2009. Strategies on development of new seed gardens in India. In technical proceedings of National oil palm seed meet-2009 on production and supply of oil palm sprouts during 2009-10. (Ed: R.K.Mathur and M.Kochu Babu), Directorate of Oil Palm Research, Pedavegi . Pp 13-14
- Prasad, M. V. and Kochu Babu, M. 2008. Management of basal stem rot in oil palm, The Hindu English New Magazine, 11.9.2008.
- Murugesan, P. 2009. Ensuring continuous improvement of oil palm seed quality at Palode. In technical proceedings of National oil palm seed meet-2009 on production and supply of oil palm sprouts during 2009-10. (Ed: R.K.Mathur and M.Kochu Babu), Directorate of Oil Palm Research, Pedavegi . Pp 17-19
- Mathur, R.K. 2009. Strategies for enhancing seed production from indigenous seed gardens. *In* Technical proceedings of National Oil Palm Seed Meet-2009 on production and supply of oil palm sprouts during 2009-10. (Ed: Mathur, R.K., and Kochu Babu, M). Directorate of Oil Palm Research, Pedavegi . Pp 15-16

Electronic publications

- DVD on Oil Palm Production Technology (English). 2009. Dr. M.V.Prasad, Dr. P.K. Mandal and Dr. K.Suresh.

Technical bulletins/Folders/Compilations

- Oil Palm cultivation, (Folder in English and Telugu). 2008. Dr. M. V. Prasad . National Research centre for Oil Palm, Pedavegi
- Frequently Asked Questions in Oil Palm. 2008. Dr. M. V. Prasad, Dr. V. M. Reddy, Mr. P. Sampath Kumar, Mr. D.G.S. Rayaparaju and Ms. J. Jameema, National Research Centre for Oil Palm, Pedavegi.
- Compendium of lectures on oil palm hybrid seed production. 2008. Dr. M. V. Prasad and Ms. J. Jameema. National Research Centre for Oil Palm, Pedavegi, A.P.

- Compendium of lectures on Plant Protection in oil palm. 2008. Dr. M.V. Prasad and Ms. J. Jameema. NRC for Oil Palm, Pedavegi, A.P.
- Compendium of lectures on Nursery Management in oil palm. 2008. Dr. M. V. Prasad and Ms. J. Jameema. National Research Centre for Oil Palm, Pedavegi, A.P.
- Bunch Analysis of Oil Palm. Technical Folder No.8, November 2008. Technical contribution : Dr. P. K. Mandal, NRC for Oil Palm, Pedavegi, A.P.
- Estimation of Mesocarp Oil from Oil Palm Fruits: A Modified Method for Large Number of Sample Folder No.9, November 2008. Technical contribution : Dr. P. K. Mandal, National Research Centre for Oil Palm, Pedavegi, A.P.
- Technical proceedings of National oil palm seed meet-2009 on production and supply of oil palm sprouts during 2009-10. (Ed: R.K.Mathur and M.Kochu Babu), Directorate of Oil Palm Research, Pedavegi.

Book Chapters

- P.K.Mandal and M.Jayanthi. 2009. Strategic application of biotechnology for improvement, management and exploitation of oil palm in India. In: *Diversity of plant - A molecular approach* (Ed. S.John Britto, S.J.). Published by The RApinat Herbarium and Centre for Molecular Systematics.St Joseph's College (Autonomous), Tiruchirapalli - 620002. pp. 146-162.
- M.Jayanthi and P.K.Mandal. 2009. Application of Biotechnology in conservation of rare plants. In: *Diversity of plant - A molecular approach* (Ed. S.John Britto, S.J.). Published by The RApinat Herbarium and Centre for Molecular Systematics.St Joseph's College (Autonomous), Tiruchirapalli - 620002. pp. 163-178 .

Seminars/symposia/conference and other fora

- Jayanthi, M., Murali Mohan, N. and Mandal, P.K. 2008. Selection of a suitable sterilant for *in vitro* culture of mature embryos of oil palm, Abstracts. New R&D Initiatives in Horticulture for accelerated growth and prosperity. 3rd Indian Horticulture Congress 2008 held during 6-9 November, 2008 at Bhubaneswar. pp 432.
- Jayanthi, M. and Mandal, P.K. 2009. Bioprospecting oil palm for useful genes. Abstracts 4th World Congress on Conservation Agriculture 3rd-6th February 2009, NASC New Delhi. India. pp 322.
- Kalidas, P., Leena Devi, Y. and Venkata Ramana, B. 2008. Growth patterns and compatibility studies of different microbial agents in oil palm ecosystem. Abstracts. New R&D Initiatives in Horticulture for accelerated growth and prosperity. 3rd Indian Horticulture Congress 2008 held during 6-9 November, 2008 at Bhubaneswar. pp 15.
- Kochu Babu, M. 2008. Oil palm an emerging oilseed crop of the future. . New R&D Initiatives in Horticulture for accelerated growth and prosperity. 3rd Indian Horticulture Congress 2008 held during 6-9 November, 2008 at Bhubaneswar. pp:433-451
- Kochu Babu, M. 2008. Recent advances in Research and Development of Oil palm in India. Souvenier. PLACROSYM XVIII - Achieving competitiveness through Improvement of productivity and Quality in Plantation Crops held

during 10-13 December, 2008 at NRCC, Puttur. pp:71-81

- Kochu Babu, M. 2009. Research and development strategies in Oil palm. 2009. In: Vegetable oils scenario: Approaches to meet the growing demands (Ed. Hegde,DM). Indian Society of oilseeds research, Hyderabad. pp : 174-194
- Mandal, P.K. 2009. Seasonal Variation in Mesocarp-Oil Content of Oil Palm grown in West Godavari District of Andhra Pradesh. Abstracts. New R&D Initiatives in Horticulture for accelerated growth and prosperity. 3rd Indian Horticulture Congress 2008 held during 6-9 November, 2008 at Bhubaneswar. pp: 331-332.
- Mandal, P.K. Jayanthi, M. and Sujatha, G. 2009. Designing of oil palm microsatellite primers and their potential use as marker for other economically important palm species. Abstracts 4th World Congress on Conservation Agriculture 3rd-6th February 2009, NASC New Delhi, India. pp: 328
- Mathur, R.K. Pillai, R.S.N. Kochu Babu, M. and Nampoothiri, K.U.K. 2008. Performance of DxP Oil Palm hybrids under irrigated conditions in India. Abstracts. New R&D Initiatives in Horticulture for accelerated growth and prosperity. 3rd Indian Horticulture Congress 2008 held during 6-9 November, 2008 at Bhubaneswar. pp:329.
- Mathur, R.K. and Suresh, K. 2008. Selection of promising dura palms under water stress in oil palm. Abstracts Golden Jubilee Conference on Challenges and Emerging strategies for improving plant productivity held during 12-14th Nov, 2008 at IARI, New Delhi. pp : 336.
- Murugesan, P. and Haseela, H. 2009. Preliminary results of seed development and maturation in oil palm (*Elaeis guineensis*, Jacq) under tropical climate of South India. Abstracts 4th World Congress on Conservation Agriculture 3rd-6th February 2009, NASC New Delhi, India. p 243.
- Murugesan, P., Pillai, R.S.N., Gopakumar, S., Mathur, R.K., Nampoothri, K.U.K. and Kochu Babu, M. 2008. Dwarf Oil Palms from Nigeria and Surinam – their characterization and utilization at Palode, India. Abstracts. New R&D Initiatives in Horticulture for accelerated growth and prosperity. 3rd Indian Horticulture Congress 2008 held during 6-9 November, 2008 at Bhubaneswar. pp: 332.
- Satisha, G.C., Prasad, M.V., Swarna Latha, G. and M. Kochu Babu. 2008. Fertility Status and Productive Potential of Oil Palm Growing Soils of Andhra Pradesh. Abstracts. New R&D Initiatives in Horticulture for accelerated growth and prosperity. 3rd Indian Horticulture Congress 2008 held during 6-9 November, 2008 at Bhubaneswar. pp: 205
- Satisha G C, Prasad M V, Swarna Latha, G. and Kochu Babu M. 2008. Delineation of sulphur deficient oil palm growing areas of Andhra Pradesh and its availability in relation to soil properties and plant tissue concentration. Abstracts National Seminar on Land Resource Management and Livelihood Security 10-12 September 2008, Nagpur, Maharashtra. pp. 9-10.
- Satisha, G.C., Swarna Latha, G.,

Manoja, K. and Kochu Babu, M. 2008. Oxidisable carbon content and its relationship with availability of mineral nutrients in soils of oil palm orchards in Andhra Pradesh. Abstracts. National Seminar on Developments in Soil Science-2008, November 27-30, 2008, Bangalore, India, Pp. 415.

- Sunilkumar,K., Kochu Babu, M., Shinoj Subramannian and Sunitha, S. 2008. Utilization and value addition of oil palm trunk. Abstracts. New R&D Initiatives in Horticulture for accelerated growth and prosperity. 3rd Indian Horticulture Congress 2008 held during 6-9 November, 2008 at Bhubaneswar. pp:366
- Sunitha, S. and Varghese, P.T. 2008. Performance of intercrops in bearing oil palm plantations under rain fed conditions. Abstracts. New R&D Initiatives in Horticulture for accelerated growth and prosperity. 3rd Indian Horticulture Congress 2008 held during 6-9 November, 2008 at Bhubaneswar. pp 191.
- Sunitha, S., Shareef, M.V.M. and Kochu Babu, M. 2008. Potential for Biomass recycling in oil palm (Poster). Programme and abstracts. National conference on Organic Farming in Horticultural crops with special reference to plantation crops. Theme: Promoting Organic Horticulture for safe food and healthy environment. held during 15-18 October, 2008 at CPCRI, Kasaragod. pp: 85
- Suresh, K, Kochu Babu, M. 2008. Carbon sequestration in oil palm under irrigated conditions. Abstracts Golden Jubilee Conference on Challenges and Emerging strategies for improving plant productivity held during 12-14th Nov, 2008 at IARI, New Delhi. pp : 335-336.
- Suresh, K., Reddy, V.M. and Kochu Babu, M. 2008. Biomass, Carbon and Nitrogen Distribution with Leaf Age in Oil Palm. Abstracts. New R&D Initiatives in Horticulture for accelerated growth and prosperity. 3rd Indian Horticulture Congress 2008 held during 6-9 November, 2008 at Bhubaneswar. pp: 230

10. DETAILS OF TRAINING/REFRESHER COURSE/ SUMMER/WINTER SCHOOLS/ WORKSHOPS/meetings ATTENDED WITHIN INDIA AND ON DEPUTATION ABROAD

Trainings/workshops attended

Dr. M. Kochu Babu and Dr. K. suresh

- Brain storming session on Nutrient dynamics in horticultural crops during 14-15 June, 2008 at IIHR, Bangalore

Dr. M. Kochu Babu, Dr. P.K. Mandal

- Brain-storming meeting on Tissue culture in palms on 30 August, 08 at CPCRI RS, Kayankulam

Dr. M. Kochu Babu, Dr. P.K. Mandal, Dr. K. Sunil Kumar and Mr. Shinoj Subramannian

- Interactive workshop on Post Harvest Technology during 23-24 August, 2008 at IIHR, Bangalore chaired by DDG (Hort.)

Dr. R. K. Mathur

- Short course on "Germplasm exchange : policies and procedures" during 17-27 November, 2008 at NBPGR, New Delhi.
- Workshop on RAJBHASHA during 22-27 April, 2008 at Solan (H.P.).

Dr. M. V. Prasad

- Brainstorming session on Use of Innovative Extension Methodologies in Horticulture on 24 June, 2008 at IIHR, Bangalore

Dr. P. K. Mandal

- Work shop on "Dimension of Nanotechnology : Science, Technology, Business and Society" during 09 -13 February, 2009 at National Institute of Advanced Studies, Bangalore

Dr. K. Suresh

- Brain storming session on Global Climate change in horticultural crops during 6-7 September, 2008 at CPRI, Shimla

Dr. G. C. Satisha

- Workshop on "Right to Information Act" conducted by Institute of Secretariat Training and Management (ISTM), New Delhi during 20-21 August, 2008.

Dr. M. Jayanthi

- Training on "Recombinant DNA techniques" during 16th August-5th September, 2008 at Division of Biochemistry, IARI, New Delhi
- Short course on "*In vitro* techniques in plantation crops" during 15-24 January, 2009 at CPCRI, Kasaragod

Dr. K. Ramachandrudu

- Winter School on 'Integrated Farming Systems for Sustainable Production' during 10-30 November, 2008 organized at Birsa Agricultural University, Ranchi.

- Workshop on Cocoa organized by the Department of Horticulture, Govt. of A.P on 16th September, 2008 at Hyderabad, participated in the discussion and delivered a paper on 'Cocoa as an Inter crop in Oil Palm plantations'.

Dr. K. Sunil Kumar

- Winter school on "Innovative approaches for increasing productivity in oil seed crops: a crop improvement perspective" organized by Directortae of Oil seeds Research (ICAR), Rajendranagar, Hyderabad during 4-24 November, 2008

MEETINGS ATTENDED

Dr. M. Kochu Babu

- Academic Council Meeting of A.P. Horticultural University on 28 June, 2008 at Hyderabad
- PSC meeting of ISOPOM projects on 5-8 August, 2008 at Delhi
- XIX meeting of the ICAR Regional Committee-II at OUAT, Bhubaneswar during 26-27 September, 2008
- Annual Review Meeting of ICAR Seed Project "Seed Production in Agricultural Crops and Fisheries" during 5-6 January 2009 at NASC complex, Delhi
- Divisional meeting of Directors of Hort. Division and Directors' Conference during 15-16 January, 2009 at Delhi.
- Launching of the new centre on AICRP (oil palm) at Madhopur, Bihar during 04-06 March, 2009

Dr. M. Kochu Babu and Dr. P. Kalidas

- XVI Project Management Committee meeting of Andhra Pradesh on 26 June, 2008 at Hyderabad.

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

- Zonal meeting of Department of Agriculture, A.P at Eluru on 4 April, 2008
- Regional meeting on Oil Palm at Vizianagaram, A.P. on 23 July, 2008

Dr. R. K. Mathur

- Group Meeting on Commercialization of ICAR Plant Varieties of Vegetatively Propagated and Perennial Crops and Low Volume Varieties" on 28 July 2008 at Sugarcane Breeding Institute, Coimbatore (T.N). and also during 22-24 September, 2008

Dr. P. Murugesan

- Special Purpose Vehicle Committee meeting held on 22 August, 2008 at TRRI, Aduthurai and delivered technical lecture on Advances in Oil Palm cultivation to the farmers
- First executive committee meeting of ISPC at CPCRI, Kasaragod on 12 January, 2009
- Working committee of the PLACROSYM XVIII meet held at NRC Cashew, Puttur
- Screening committee and Working Committee meetings of PLACROSYM XVIII during 24-25 October 2008 at CPCRI, Kasaragod

Dr. K. Sunil Kumar

- Meeting on "Consolidation of research on natural fibres under ICAR institutes" chaired by DDG (Engg.) and attended by DDG (Hort.) and concerned institute directors, held at KAB-II, New Delhi on December 2008.

DETAILS OF SEMINARS/CONFERENCES/ SYMPOSIA/ ATTENDED

Dr. M. Kochu Babu

- Seminar on " Sustainable management of acid soils for higher crop productivity" at Pasighat, Arunachal Pradesh on 22 September 08

Dr. M. Kochu Babu, Dr. P. Kalidas, Dr. R. K. Mathur, Dr. P. K. Mandal, Dr. M. Jayanthi, Dr. S. Sunitha Dr. P. Murugesan

- Third Indian Horticulture Congress held at Bhubaneswar during 06-08 Nov. 08

Dr. M. Kochu Babu and Dr. P. Kalidas

- National Symposium on "Vegetable Oils Scenario: Approaches to Meet the Growing Demands" at DOR, Hyderabad during 29-31.01.09

Dr. M. Kochu Babu, Dr. S. Sunitha and Dr. G. C. Satisha

- National Conference on "Organic Farming in Horticultural Crops with special reference to Plantation Crops at CPCRI, Kasaragod during 15-17.10.08

Dr. M. Kochu Babu, Dr. S. Sunitha and Dr. G. C. Satisha and Dr. P. Murugesan

PLACROSYM XVIII at NRC for Cashew, Puttur during 10-13.12.08

Dr. M. Kochu Babu and Dr. M. Jayanthi

- National seminar on "Biotechnology in conservation of biodiversity" held on 22-11-08 at CRR college, Eluru

Dr. P. Kalidas

- National Seminar on cocoa" held in Coimbatore on 3rd and 4th October, 2008

Dr. R. K. Mathur and Dr. K. Suresh

- Golden Jubilee conference on Challenges and emerging strategies for improving plant productivity held during 12-14 November, 2008 at IARI, New Delhi.

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

- World Congress on Conservation Agriculture held at NASC, New Delhi during 3rd-6th February 2009.

Dr. G. C. Satisha

- National seminar on Developments in Soil science held at UAS, Bangalore during November 27-30, 2008
- National Seminar on Land Resource Management and Livelihood Security, September 10-12, 2008, Nagpur, Maharashtra, India

Presentations in Conferences/ Symposia/ Seminar/ other fora

Dr. M. Kochu Babu

- Presented an invited talk on "Oil Palm – An emerging oilseed crop of the future" in the Technical Session.V: New Emerging Crops during the Third Indian Horticulture Congress held at Bhubaneswar during 06-08.11.08
- Delivered key note lecture on "Biotechnology in conservation of biodiversity" during the National seminar on "Biotechnology in conservation of biodiversity" held on 22-11-08 at CRR college, Eluru.
- Paper on "Status of Oil Palm Nutrition under Indian Conditions" presented during brain storming session on

nutrient dynamics in horticultural crops held at IIHR, Bangalore during 15-16th June 2008.

Dr. P. Kalidas

- Delivered lecture on Pests of Cocoa in oil palm ecosystem - A case study at the National Seminar on cocoa" held in Coimbatore on 3rd and 4th October, 2008.

Dr. R.K. Mathur

- Presentation on "Licensing of oil palm varieties/ parents for commercial use by private seed agencies" during "Group Meeting on Commercialization of ICAR Plant Varieties of Vegetatively Propagated and Perennial Crops and Low Volume Varieties" on 28.07.2008 at Sugarcane Breeding Institute, Coimbatore (T.N.).
- Paper presented on "Scope of DUS testing in Oil palm" in Workshop on Developing DUS procedures for Agri-Horti crop species, conducted on 25.03.2009 at NBPGR, New Delhi.

Dr. P. Murugesan

- Delivered technical lecture on Advances in Oil Palm cultivation to the farmers at the third workshop on "Precision farming in oil palm" held at TRRI Aduthurai on 22.08.2008
- Presented a Oral research paper entitled "Tenera X *Tenera* progenies derived from Nigerian and Thodupuzha germplasm under rain fed condition in the session breeding strategies in plantation crops at PLACROSYM XVIII held at NRC Cashew Puttur on 10th December 2008

Dr. M. V. Prasad

- Delivered lecture on "Transfer of technology and Public Private Partnership in Oil Palm" in the Winter school on "Alternate land use options for resource conservation, emerging market needs and mitigation of climate change in rainfed regions. January 16 - 5th February, 2009, CRIDA, Hyderabad.

Dr. P.K. Mandal

- Delivered lectures on "Biochemistry, biotechnology and molecular biology aspects of research in oil palm" to the Under Graduate and Post Graduate students of the following colleges:

a. Triveni Degree College, Jangareddy Gudem, W.G. Dt., A.P on 23.12.09

b. Karnataka University, Dharwad, Karnataka on 29.12.09

Dr. K. Suresh

- Presented paper on "Impact of climate change on oil palm" during brain storming session on Impact of climate change for research priority planning in Horticultural crops held during 6-7 September, 2008 at Shimla.

Dr. M. Jayanthi

- Delivered a lecture on Application of biotechnology in the conservation of rare endangered plants during the National seminar on "Biotechnology in conservation of biodiversity" held on 22-11-08 at CRR college, Eluru.

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	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
10	EFPXII	Establishment of a tissue culture laboratory for oil palm	M Jayanthi PK Mandal
11	GEN VII	Cryopreservation of different oil palm germplasm	P Murugesan
12	RF scheme	Indigenous production of oil palm hybrid seeds	
		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	VM Reddy, GC Satisha
5	AGR XIII	Utilization of Biogas slurry from POME for nutrient management in oil palm	S Sunitha
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

EFP - Externally funded project

	Project No	Name of Project	Name of PI and Co-PI(s)
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
11	PHY IV	Carbon assimilation, water use and energy balance in oil palm plantations using Eddy covariance method	K Suresh
12	SS I	Nutrient indexing in oil palm growing areas	GC Satisha, MV Prasad
13	SS II	Development of composting techniques for oil palm wastes	GC Satisha, S Sunitha
14	SS III	Biological activity and organic matter dynamics in oil palm plantations and its impact on soil health	GC Satisha
15	EFP VI	Delineation of nutrient deficiencies in oil palm growing areas of India (Establishment of Leaf Analysis Laboratory)	GC Satisha
16		Multi location trial for Cocoa varieties (inter-institute proj. -CPCRI)	K Ramachandrudu
17		Leaf breaking in Oil palm	
		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
		POST HARVEST TECNONOLGY	
1	PHT VII	Development of a grading system for oil palm FFB and estimation of factory level OER	K Sunil Kumar
2	PHT VIII	Post harvest studies on palm oil	PK Mandal

	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

12. CONSULTANCY, PATENTS AND COMMERCIALIZATION OF TECHNOLOGY

The consultancy Processing Cell 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 DOPR 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

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, agro-chemicals/plant protection against fungi, bacteria and insect pests of 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

1. Consultancy project on oil palm hybrid seed production at Taraka (Govt. of Karnataka funded)

Hybrid seed production is going well at this seed garden. In all 112 Dura and 8 Pisifera palms are being utilized in seed production. Basic infra structure has been developed. Construction of bunch analysis lab is completed. Data of seed gardens are being computerized. The oil estimation unit, balances *etc* have been procured.

2. Consultancy project on oil palm hybrid seed production at Rajahmundry (Govt. of A.P. funded)

Hybrid seed production is going well at this seed garden. In all 164 Dura and 11 Pisifera palms are being utilized in seed production. Against target of supply of 4.3 lakhs sprouts during 2008-09, 3.96 lakhs sprouts were supplied. Target for supply of sprouts from this seed garden for 2009-10 is enhanced to 5.15 Lakhs. Basic infra structure for bunch analysis is being developed.

Three DxP progeny testing trials have already been planted in field, from which general performance of some Pisifera palms and Dura palms could be known.

INSTITUTE TECHNOLOGY MANAGEMENT UNIT (ITMU)

The Institute Technology Management Unit (ITMU) constituted at the institute level is looking after the issues of Intellectual Property Rights and patents.

Patents filed

Complete application for the provisional application no. 1831/CHE dated 17/08/2007 entitled *A Process for Making Stripes from Oil Palm Fronds using an improved wood planer cum cutter and Oil Palm Frond Stripe made there by* has been filed with the Comptroller of patents, Chennai.

INSTITUTE BIOSAFETY COMMITTEE (IBSC)

An institute Biosafety Committee with the following members has been constituted at the institute

- Director, NRCOP, Pedavegi - Chairman
- Dr. P. Kalidas, Pr. Scientist (Agril. Entomology), NRCOP, Pedavegi - Member
- Dr.P. K. Mandal, Sr. Scientist (Plant Biochemistry), NRCOP, Pedavegi - Member
- Dr. M. Jayanthi, Sr. Scientist(Biotechnology), NRCOP, Pedavegi - Member
- Dr. K. Sarala, Sr. Scientist(Plant biotechnology), CTRI, Rajahmundry- Member
- Dr. R. Raja Rao, Part time medical practitioner, NRCOP, Pedavegi- Member
- Dr. S. Sokka Reddy, Dept. of Biotechnology, College of Agriculture, ANGRAU, Hyderabad - DBT representative

13. RAC, IMC AND IRC MEETINGS

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, DOPR,Pedavegi , A.P	Member
Non-official members nominated in IMC	Members
Dr. P. Kalidas, Secretary, Principal Scientist, DOPR, Pedavegi	Member

The ninth Research Advisory Committee meeting was held during 16-17th December, 2008 in the Committee Room of DOPR, Pedavegi under the chairmanship of Prof. A. N. Maurya, former Director, IAS, BHU, Varanasi. Dr. A. K. Sadanandan, Dr. R. Samiyappan, Dr. C. Arumughan members of RAC and Scientists of DOPR participated in the meeting. Proceedings were communicated to ICAR and approval has been received.

Institute Management Committee

Composition

Dr. M. Kochu Babu, Director, DOPR, Pedavegi	Chairman
Dr. C.P.R.Nair Head, CPCRI, RS, Kayamkulam	Member
Dr. Harishu Kumar Principal Scientist, CTRI, Rajahmundry	Member
Dr. S. Rajan Asst. Director General (Hort-I), ICAR, New Delhi	Member
Dr. V.M. Reddy Principal Scientist, DOPR, Pedavegi	Member
Dr. R.K. Mathur Senior Scientist, DOPR, Pedavegi	Member
Mr. B. Satish A.A.O, DOPR, Pedavegi	Member Secretary
Mr. T.D.S. Prakash AFA&O, DOPR, Pedavegi	Co-opted Member

The nineteenth Institute Management Committee meeting was held on 9th January, 2009 at DOPR, Pedavegi. Dr. S.Rajan, Dr. C.P.R. Nair and Dr. Harishu Kumar attended the meeting.

Institute Research Committee (IRC) meeting

The eleventh Institute Research Committee meeting was held during 7-9 May, 2008 at NRCOP, Pedavegi. The meeting started on 7th May with invocation and lighting of lamp. Dr. M. Kochu Babu, Director and Chairman, IRC welcomed all the scientists and gave a brief account of the research activities and achievements of the institute. He also urged that all the scientists should plan their research activities considering the priorities set by various high level committees like QRT, RAC and also the research needs of the farming community.

There were five sessions namely crop improvement, crop production, crop protection, post harvest technology and social sciences. Dr. K. Suresh, Dr. R.K. Mathur, Dr. K. Ramachandrudu, Dr. M. Jayanthi and Dr. G.C. Satisha acted as rapporteurs for the above five sessions respectively. Dr. S.D. Shikhamany, Vice Chancellor, A.P. Horticulture University, Hyderabad was the chairman of the plenary session held on 9th May. Dr. P.K. Mandal was the rapporteur. In the address by the vice chancellor the need to work out price structure of palm oil, assessment of performance of exotic planting material in different agroclimatic conditions, use pf phosphate solubilizer, possibility of import of stem shredding machinery, ecofriendly disposal of POME, plantation efficiency analysis, need to get better oil recovery and reduce the cost of production and exploring the possibility of growing oil palm in all areas depending on suitability were highlighted.

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

Live Crop Seminar on Oil Palm

Doordarshan in association with NRCOP has organized a 'Crop Seminar on Oil Palm' at NRCOP on June 21, 2008. The two and half hour programme was live telecasted on Doordarshan – Saptagiri Channel between 4.00 - 6.30 pm. Programme was conducted with 6 technical (question and answer) sessions. A total of 300 personnel consisting of farmers, officials, entrepreneurs and scientists participated. Dr. M.V. Prasad coordinated the programme

Live crop seminar on oil plam organised at NRCOP and broadcasted by Doordarshan, Hyderabad

Organization of Seed Meet - 2008-09

The Oil Palm Seed Meet was organized at DOPR, Pedavegi on 28th January 2009 to have information on production and supply of hybrid seeds/ sprouts from different seed gardens, forecast of demand of oil palm sprouts for the next year and general issues with relation to seed production, supply and quality etc. It was attended by all the officers and Research fellows of Seed gardens, representatives of oil palm processors and entrepreneurs and scientists of DOPR.

Live crop seminar on oil palm in progress

Subsequently, a meeting was held with the scientists from DOPR, officials and research personnel of all seed gardens. There were deliberations on measures to enhance seed production, quality concerns of sprouts, extension of existing seed gardens, conducting Progeny Testing Trials, bunch analysis, database management, enhancement of price of oil palm sprout etc.

Seed meet

Diagnostic Field Visit

Foundation day of the institute was celebrated on February 19, 2009 at NRCOP, Pedavegi. As recommended by ICAR the institute has been declared to be upgraded as "Directorate of Oil palm Research". On this day the scientists of the Centre have taken up diagnostic field visit to the oil palm plantations where specific problems were identified and reported by the Entrepreneurs/Horticulture department.

Diagnostic field visit organised on 19.2.2009

15. कार्यालयीन भाषा क्रियान्वयन गतिविधियाँ

भारत सरकार की राज भाषा नीति के अनुसार राज भाषा हिन्दी को बढावा देने की दृष्ठिकोण 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।

उपर्युक्त गतिविधियों के अलावा, प्रतिवेदन वर्ष में 14 सितंबर, 2008 से 14 अक्तूबर, 2008 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। इस कार्यक्रम के समापन के दिन मुख्य अतिथि के कर कमलों से विजेताओं को पुरस्कार प्रदान भी किये गये।

इस अवसर पर निम्न गतिविधियों का आयोजन किया गया

गदिविधि का नाम	पुरस्कार विजेता	
नोटिंग	प्रधम	: श्री के.वी.वी. सत्यनारायण
	द्वितीय	: श्रीमति भानुश्री
ड्राफ्टिंग	प्रधम	: श्री के.वी.वी. सत्यनारायण
	द्वितीय	: सुसी.यस.वि.एल. ललिता
अनुवाद	प्रधम	: श्री के.वी.वी. सत्यनारायण
	द्वितीय	: सुसी.यस.वि.एल. ललिता
निबन्ध लेखन	प्रधम	: श्रीमति भानुश्री
	द्वितीय	: श्री एस.के. सैदा
	तृतीय	: श्री टी.वी. रामकृष्ण
कविता पढन	प्रधम	: सुसी. वसन्ता
	द्वितीय	: श्री एस.के. सैदा
	तृतीय	: सुसी.यस.वि.एल. ललिता

हिन्दी उत्कर्ष कार्य करने के लिए विशेष पुरस्कार

हिन्दी में वार्तालाप प्रतियोगिता

एक मिनिट तक बोलिए	प्रधम	: श्री पी. दुर्गाराव
	द्वितीय	: श्री ए. धनराजु
	तृतीय	: श्री एस. जान
अनुवाद (शब्द..वाक्य)	प्रधम	: श्री सत्यनारायण
	द्वितीय	: श्री जी. राजु
	तृतीय	: श्री अप्पाराव
एक मिनिट तक बोलिए	प्रधम	: श्री एस.के. सैदा
	द्वितीय	: सुशी ललिता
	तृतीय	: डा.पी.के. मण्डल
आमने-सामने	प्रधम	: डा.पी.के. मण्डल और सुसी ललिता
	द्वितीय	: श्री गौरी शंकर और एस.के. सैदा
	तृतीय	: श्री टी.वी. रामकृष्ण और श्री टी.डि.एस. प्रकाश
तकनीकी सत्त	प्रधम	: डा. पी. कालीदास
	द्वितीय	: सुसी वसन्ता
	तृतीय	: डा. पी.के. मण्डल

हिन्दी में वर्ष २००७-०८ में उत्कृष्ट कार्य करने के लिए विशेष पुरस्कार

१. श्री कुष्णमूर्ति
२. श्री. के.वी.वी. सत्यनारायण
३. श्री टी.वी. रामकृष्ण
४. श्री एस.के. सैदा

इस अवसर पर अन्य प्रतियोगियों को सांत्वना पुरस्कार भी प्रदान किये गये।

मुख्य अतिथि द्वारा द्वीपक का प्रज्वलन

सहायक कर्मचारियों के लिए आयोजित प्रतियोगिता

संस्थान के निदेशक महोदय द्वारा आशीसवचन

वर्षभर में आयोजित हिन्दी में किये गये कार्य का प्रस्तुतीकरण

16. DISTINGUISHED VISITORS

Details of the visitors - DOPR, Pedavegi	Date of visit
Dr. Khatri, Principal Scientist, IASRI, New Delhi	16th April 2008
Dr. M. Anatha Raman, Principal Scientist **Dr. S. Ramanathan**, Principal Scientist CTCRI, Trivandrum, Kerala	19th April
Dr. S.D. Shikhamany, Vice Chancellor, Andhra Pradesh Horticulture University, Tadepalligudem, A.P	23rd April
QRT of CPCRI, Kasaragod **Dr. A.K Baskshi, Dr. Gopalji Trivedi,** **Dr. KUK. Nampoothiri, Dr. S. Arulraj,** **Dr. S. Naresh Kumar**	16th May
Shri K. Madhusudhana Rao, IAS, Commissioner of Horticulture, Govt. of Andhra Pradesh, Hyderabad	17th May
Doordarshan Station Director	21 st June
Dr. S. Chellappa, IAS., APC & PRL. Secretary to Govt., Govt. of Andhra Pradesh, Hyderabad	11th July
Mr. Anantharaman, MD, BSNL, Eluru	13th October
RAC members of DOPR, **Dr. A.N. Maurya**, **Dr. R. Samiyappan,** **Dr. C. Arumughan, Dr. A.K. Sadanandan,**	16-17th December
Dr. S. Rajan, ADG (Hort-I), ICAR, New Delhi Dr. C.P.R. Nair, Head, CPCRI, RC, Kayangulam	9th January 2009
Dr. A. N. Murthy, Retd. Sr. Officer, Seed & Plant genetic resources, FAO of the UN	28th January
Dr. Sundararaju, Principal Scientist, NRC Banana, Trichy	6th Feb
Dr. A.V. Rao, Retd. Principal Scientist (Microbiology), CAZRI, Jodhpur	2nd March
Dr. R.D Rai, Pr. Scientist, NRC for Mushroom, Solan	17-18th March
Details of the visitors - DOPR, RS, Palode	
Dr. S. Arulraj	25th June 2008

17. PERSONNEL

RMP

Dr. M. Kochu Babu	Director

STAFF POSITION AT HEAD QUARTERS - PEDAVEGI

Scientific Staff

Dr. V.M. Reddy	Pr. Scientist (Agronomy)
Dr. P. Kalidas	Pr. Scientist (Ag. Entomology)
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)
Dr. G. C. Satisha	Sr. Scientist, (Soil Science)
Dr. M. Jayanthi	Sr. Scientist, (Biotechnology)
Dr. K. Ramachandrudu,	Scientist Sr. Scale (Horticulture)
Ms. K.L. Mary Rani	Scientist Sr. Scale (Computer Applications)-reported to duty on completion of study leave w.e.f 10-02-2009
Dr. K. Sunil Kumar,	Scientist (Horticulture), Sr. Scale
Dr. Ananta Sarkar	Scientist (Agril. Statistics)

Administrative Staff

Sri B. Satish	Assistant Administrative Officer
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. Dharma Raju	Upper Division Clerk
Mr. S. K. Saida	Lower Division Clerk

Technical Staff

Mr. B. Parthasaradhi	T-5
Ms. A. Bhanusree	T-4
Mr. K. V. Rao	T-4
Mr. J. Mohan Rao	T-3
Mr. M. Ananda Rao	T-3
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. 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
Ms. Y. Chaitanya	SS Gr.I
Mr. A. Nagarjuna Rao	SS Gr.I
Mr. G.S.N. Babu	SS Gr.I
Ms. 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 DOPR, REGIONAL STATION, PALODE

Scientific Staff

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

Administrative staff

Ms. E.J. Mary	Assistant
Mr. P. Prasad	Personal Assistant
Mr. K. Ravindran	Upper Division Clerk

Technical Staff

Ms. N. Sujatha Kumari	T-6
Mr. V. G. Sasidharan	T-5
Ms. I.C. Rajamma	T-5
Mr. C.K. Devadathan	T-5
Mr. K. Soman	T-4
Mr. V. Sunil Dutt	T-2
Mr. B. Muralidharan Pillai	T-1

Supporting Staff

Mr. G. Rajappan	SS Gr. II
Ms. M. Rebecca	SS Gr. II
Ms. 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
Ms. P. Rema	SS Gr. II
Mr. C. Ravi	SS Gr. II

18. METEOROLOGICAL DATA

Meteorological Data of R.S. Palode (2008-09)

Months	No. of rainy days	Total rainfall (mm)	Average max. temp.(°C)	Average min. temp. (°C)	Average pan evaporation	Average Relative humidity (%)
Apr-08	23	245.8	28.12	24.14	-0.141	88.37
May	11	91.0	27.89	25.27	0.12	85.03
June	26	141.8	26.82	24.00	1.46	90.03
July	24	431.2	27	22.85	1.121	91.74
August	22	186.0	26.24	23.77	1.45	89.71
September	10	213.0	26.53	23.77	1.633	89.1
Oct	12	421.9	26.55	23.69	1.39	90.16
Nov	26	208.2	26.06	22.92	1.204	90.63
Dec	27	61.4	25.85	22.01	0.78	82.84
Jan-09	20	26.4	27.10	21.96	2.55	72.68
Feb	24	19.4	28.22	23.39	2.70	74.43
March	21	90.04	28.58	34.64	1.06	81.00

General Activities

Foundation Day Celebration

Independence Day Celebration

New Years Day Celebration

Republic Day Celebration