RESEARCH HIGHLIGHTS 1997-'98



CENTRAL PLANTATION CROPS REASERCH INSTITUTE (Indian Council of Agricultural Research) KASARAGOD 671 124, KERALA, INDIA





RESEARCH HIGHLIGHTS 1997-98



CENTRAL PLANTATION CROPS RESEARCH INSTITUTE (Indian Council of Agricultural Research) KASARAGOD 671 124, KERALA

INTRODUCTION

The Central Plantation Crops Research Institute established in 1970 has undergone vast changes over the years in accordance with the changing scenario. The Institute's mandate as perceived in the perspective plan are (1) Crop improvement, (2) Production of parental lines and elite planting materials, (3) Maintaining a national repository for the genetic resources, (4) Development of appropriate technologies for production, protection and processing of coconut, arecanut and cocoa, (5) Coordinating research programmes under the All India Coordinated Research Projects on Palms and (6) Transferring appropriate technologies to the farmers by establishing linkages with the developmental departments. Apart from the projects on mandatory crops viz. Coconut, Arecanut and Cocoa, those on Oil palm also continue at the Institute.

In addition to the research work undertaken at 11 Centres, multi-location programmes are taken up with the co-operation of Universities in 17 Centres under the All India Coordinated Research Project on Palms. The establishment of Krishi Vigyan Kendra and implementation of Institute Village Linkage Programme have strengthened the technology transfer programmes.

It is with great pleasure, that I am presenting the Research Highlights for 1997-% of CPCRI in the Golden Jubilee Year of Independence. This report outlines in brief, the salient research achievements of the Institute in the divisions of Crop Improvement, Crop Production, Crop Protection, Physiology, Biochemistry & Technology and Social Sciences.

I wish to express my appreciation to all my colleagues who have spared no effort in keeping up the long tradition of the Institute built up over the years.

disnamborn

(K.U.K. Nampoothiri) Director

Kasaragod 15 April, 1998

C

B

A

Published by:

CENTA .

CI

Bc

Ac

K.U.K. Nampoothiri Director Central Plantation Crops Research Institute Kasaragod - 671 124, Kerala

Compiled and Edited by:

V.A. Parthasarathy, Sudha Sukumaran, A.R.S. Menon, A.K. Upadhyay, V. Niral and S. Naresh Kumar

Front cover: Germinating embryo of coconut variety Guelle Rose after 30 days

Photo credits: K. Shyama Prasad

Word processed by: M. Padmakumar

April, 1998

Printed at: Codeword Process & Printers, Mangalore

2

केन्द्रीय रो के अनुसार पिछ फसल - सुधार, रोपण सामग्री का तथा विकास विभ के मुख्य लक्ष्य ई परियोजनायें इस

केन्द्रों में च के अधीन 17 है । कृषि विज्ञान गया है ।

स्वतंत्रता वे हुए मुझे अत्यधिव मैं अपने र

रखने केलिए संभ

कासरगोड़ 15 अप्रैल, 1998

x x

प्रस्तावना

केन्द्रीय रोपण फसल अनुसंधान संस्थान की स्थापना सन् 1970 में हुई और परिवर्तित परिस्थितियों के अनुसार पिछले वर्षों में इसमें अथ्याधिक परिवर्तन आया है । नारियल, सुपारी और कोको के फसल - सुधार, उत्पादन, सुरक्षा एवं संसाधन की उचित प्रौद्योगिकी का विकास, पैत्रृक बीज एवं गुणी रोपण सामग्री का उत्पादन, अखिल भारतीय समन्वित अनुसंधान परियोजना के अर्न्तगत अनुसंधान समन्वयन तथा विकास विभागों के साथ सहसंबंध स्थापित कर उचित प्रौद्योगिकी का स्थानातंरण आदि इस संस्थान के मुख्य लक्ष्य है । नारियल, सुपारी और कोको आदि मुख्य फसलों के अलावा तैलताड़ पर चालू परियोजनायें इस संस्थान में जारी रहीं है ।

केन्द्रों में चल रहे अनुसंधान कार्य के अतिरिक्त अखिल भारतीय समन्वित अनुसंधान परियोजना के अधीन 17 केन्द्रों में विश्वविद्यलय की सहायता से विस्तृत कार्यक्रम आयोजित किया जाता है । कृषि विज्ञान केन्द्र की स्थापना और संस्थान ग्राम संपर्क कार्यक्रम को अधिक सक्षम बनाया गया है ।

स्वतंत्रता के स्वर्ण जयन्ती वर्ष में संस्थान के अनुसंधान के मुख्य अंश (1997-98) प्रस्तुत करते हुए मुझे अत्यधिक हर्ष का अनुभव हो रहा है ।

मैं अपने सहयोगियों के सहयोग की प्रशंसा करता हुँ जिन्होंने संस्थान की परंपरा को कायम रखने केलिए संभव प्रयत्न किये ।

\$. y. \$. JJY 1212

(के.यु.के. नम्पूतिरि) निदेशक

कासरगोड़ 15 अप्रैल, 1998

CROP IMPROVEMENT

Coconut

- Coconut germplasm has been strengthened by a recent collection of 15 exotic accessions from the Indian Ocean Islands (6 from Mauritius, 4 from Madagascar and 5 from Seychelles) using embryo culture technique for the first time in the world with a success rate of 96 %.
 - During May, 1997, 1342 embryos
 belonging to tall and dwarf accessions
 were field collected from Indian Ocean
 Islands. These embryos were collected
 and stored in sterile water until
 transferred to retrieval media. Only



Germinating embryo of Pemba Green after 35 days in culture

5

3.35% embryos were contaminated during the expedition, while 3.8% of embryos were damaged. The accessions, Pemba Orange (127),



Bulk collection of embryos in sterile water



Six month old in vitro retrieved plantlet (Pemba Green)

Pemba Green (97), Pemba Yellow (14), Pemba Red Tall (24), Dupays (63) and Guelle Rose (50) were collected from Mauritius. The accessions collected from Madagascar were Sambava Tall (68), West African Tall (145), Sambava Green Tall (105) and Comorose Tall (104), while Coco Lerein (113), Coco Lehault (136), Coco Bleu (48), Coco Rasin (153) and Coco Gra (15) were collected from Seychelles.

The germination percentage of embryos collected from Indian Ocean Islands ranged from 55 (Dupays) to 96 (Sambava Tall), with an average of 72%. Of these, 120 plantlets were transferred to rhizogenesis medium and 11 plantlets belonging to accessions Guelle Rose (3), Sambava Green Tall (2), Coco Bleu (2), Comorose Tall (2) and Sambava Tall (2) were transferred to pots for hardening.

- In the comparative yield evaluation trial of 16 cultivars planted during 1972, Laccadive Micro produced highest yield of 129 nuts/palm, while copra out-turn was highest (19 kg/ palm) in Cochin China.
- Large variation in polyphenol content was observed in 26 cultivars with values ranging from 3.56 - 13.03 mg/g fresh leaf weight. The mean

3



Variety - Cochin China

polyphenol content was lowest ir cultivar Blanchissues (5.39 mg/g FW and highest in Cameroon Red Dwar (11.98 mg/g FW).

Divergence was worked out in lissource populations collected from Indian Ocean Islands during 1997 using the Principal Component Analysis. The accession 'Coco Ga Tall', a Makapuno type, was the most divergent. All the Pemb Dwarfs from Mauritius formed one cluster. Husk, leaflet and inflorescence characters contributed more to the divergence.



Cluster diagram showing the diversity of Indian Ocean populations

- Among the four accessions comprising of 12 palms evaluated for quantity and quality of tendernut water, Rennel Tall from Solomon Islands was found to be the best with 580 ml of water/nut and 6.5% total sugar content.
- Nut component analysis in eight accessions revealed that Solomon Tall from Solomon Islands was superior with respect to fruit weight (2168.7g) and nut weight (1000 g). However, Rennel Tall was superior in kernel weight (417.5g/nut) as well as copra weight (247.5 g/nut).
- Two seed gardens were established using *inter se* mated and selfed progenies of parental lines for production of CGD x WCT hybrids

recanut

Survey and collection of arecanut gemplasm from Konkan region was

undertaken during January 1998 and 15 ecotypes were collected from Goa and Raigad and Ratnagiri districts of Maharastra.

- At Mohitnagar, 15 more indigenous accessions were planted increasing the total holdings to 69 at the alternate germplasm bank.
- In the comparative yield evaluation trials at Hirehalli and Thirthahalli, variety Mangala gave 23.1 and 36% increased ripe nut yield respectively over their local checks, Hirehalli Local and Thirthahalli Local.
 - Among the eight dwarf hybrids and their five parents, under evaluation for high yield and dwarfness since 1991, the cross Mangala x Hirehalli Dwarf showed earliness in bearing compared to other combinations. The cross Hirehalli Dwarf x Sumangala showed

promising trend by yielding 10.2 kg ripe nuts/palm in the first year of bearing.



Hirehalli Dwarf x Sumangala

The segregation pattern and distribution ratios were worked out on the basis of biometrical characters and colour intensity for the seedlings of 13 hybrid combinations. The maximum recovery of Dwarfs and intermediates was noticed in the cross SK Local x Hirehalli Dwarf followed by Hirehalli Dwarf x Mohitnagar and Hirehalli Dwarf x Sumangala.

Oil palm

Two high yielding oil palm hybrids. Palode - I and Palode - II have been recommended for release during the XIII Biennial Workshop of the AICRP on Palms held at Jorhat, Assam in February, 1998. These two hybrids were evaluated since 1976 in a trial consisting of 11 *dura* x *pisifera* hybrids. The highest yield of these varieties was estimated to be around 4.6 tonnes of palm oil per hectare per year under rainfed conditions. Enough parent palms are available at CPCRI (RC), Palode for the commercial production of hybrid seeds.



Palode - 1 (65d x 30.103p) oil palm hybrid recommended for release

CROP PRODUCTION

Coconut Based Cropping Systems

The total output from 1.2 ha of coconut based I generation HDMSCS model during the period July 1996-June 1997 was 23,643 coconuts, 56 kg dry clove, 390.8 kg pineapple fruits, 689.4 kg banana bunches and 58 kg bread fruits. After 14 years, the yield of coconut as well as component crops were substantially reduced when dosage of fertilizer was reduced below 2/3rd of recommended dose. Economic analysis revealed that the annual cost of cultivation at full dose of fertilizer was Rs. 39,500/ha with cost of labour alone constituting about 51% of the total expenditure. The system realised an annual net return of Rs. 1,32,800/ha with a gross return of Rs. 93.300/ha.

Coconut Nursery Techniques

Sowing in potting mixture medium either in polybag or cement tank is beneficial in producing vigorous seedlings and also to get higher recovery.

Nutritional Requirement of Coconut

Among the cultivars, the two year average nut yield was significantly higher in COD x WCT (131 nuts/palm/ year) compared to WCT x COD and WCT. Irrigation produced only 5 extra nuts/palm compared to rainfed condition during 1996-97. The nut yield/palm/year was significantly higher at 1000g N + 1000g P_2O_5 + 2000g K_2O /palm/year level of fertilizer under irrigated condition (159 nuts during 1996-97 and 149 nuts in 1995-97) compared to rainfed and unfertilized palms (95 nuts/ palm in 1996-97 and 106 nuts/palm in 1995-97).

Nutritional Requirement of Arecanut

Pooled analysis of five year data revealed that high yielding varieties of arecanut responded positively to higher fertilizer levels i.e. 200g N: 80g P_2O_5 : 280g K₂O/palm/year with significant increase in chali yield (92%) over control.

Studies on Drip Irrigation in Coconut

- Palms responded favourably to irrigation under laterite and sandy soils. Six emitters/palm were used in sandy soil while in laterite only four emitters were used. Drip system was found to be more advantageous under littoral sandy soil than laterite soil.
- In laterite soil, irrigating the palms with 66% of Eo (32 l/palm/day) was sufficient to produce yield on par with basin irrigation (200 l once in four days) in WCT and COD X WCT.
 - Under littoral sandy soil conditions, 66% of Eo (73 nuts/palm/year) was significantly better than the basin irrigation (56 nuts/palm/year). Mulching increased yield by 7 nuts/ palm/year.

9

Cultural cum Spacing trial in Coconut

 Among the different agro techniques, combination of cultivation + inorganic + organic fertilizer application proved to be the best. The addition of organic fertilizer in conjunction with inorganic fertilizers increased the nut production by 10-15 nuts/palm/year.

Vermicomposting of Palms and Cocoa Wastes

A low cost technology for large scale production of vermicompost from coconut plantation wastes has been standardized and demonstrated by using a large, pigmented and active local epigeic earthworm species. In 75 days, the whole precured coconut palm wastes except mid ribs of the leaves got converted into odourless and granular pure vermicastings having a C/N ratio of 9.95 and N content of 1.8%. The recovery was as high as 70%. Preliminary studies revealed that the same earthworm species can also convert fresh coir pith into vermicastings having a C/N ratio of 22 and N content of 1%.



Vermicompost produced from coconut plantation wastes

Cultivation of Oyster mushroom on Plantation Wastes

Higher biological efficiency of oyster mushroom production (BE 60%) has been achieved in coir pith by using a fermentation technique for coir pith followed by cultivation of Pleurotus eous (APK-1) and Pleurotus ostreatus P. eous was found to be better species for mushroom production in cocon bunch waste with respect to faster spawn production and completion of spawn run in a shorter period with relatively higher yield of mushrooms Mixing coir pith and leaflets with certain other coconut by-products resulted in enhanced yield a mushrooms. Coir pith + leaf stall and bunch waste + leaflets (1:1 ratio was superior to other combinations tested.



Fruit bodies of Pleurotus flabellatus on coconut bunch waste

Biological Nitrogen Fixation in Coconut

The associative symbiotic nitroge fixing bacteria capable of fixin nitrogen in the presence of fertilize nitrogen isolated from the roots coconut palm have been identified as Azospirillum amazoneuse and a diazotroph belonging to β - sub-class of proteobacteria. The proteobacteria is very closely related to Herbaspirillum seropedicae, but capable of growing well in N-free semisolid medium containing tartarate as sole carbon source. Both these diazotrophs were not reported from India earlier.

Stress and Production Physiology in Coconut

The efficiency of thylakoid membranes and PS II complex to carry out photochemical reactions during prestress, stress and post-stress periods was assessed by estimating Hill activity. Among the seedlings of crosses and parents viz; CGD x WCT, WCT x MYD, FMS x MYD, MYD x FMS, CGD, MYD, WCT and FMS, the Hill activity was highest in MYD and CGD x WCT and least in CGD and MYD. When seedlings were subjected to stress, the activity reduced upto 86% compared to pre-stress period. Reduction in activity level was highest in FMS x MYD and least in WCT x CGD. However, in CGD and MYD, Hill activity increased under stress conditions. Upon rewatering, recovery in Hill activity was noted in all cultivars/cross combinations except WCT x MYD. Maximum recovery potential was observed in MYD x FMS.

Photosynthetic characteristics of released cultivars/hybrids viz. WCT,
LO, Benaulim, LO x COD, WCT x
GB, COD x WCT and LO x GB, were studied. LO had least stomatal conductance indicating relative tolerance to drought. Intrinsic and instantaneous water use efficiency was also higher in LO indicating higher maintenance of water balance for dry matter production.

CROP PROTECTION

Screening for Root (wilt) Disease of Coconut

 Sixty two CGD, 55 WCT and 19 COD field tolerant palms were identified based on sero diagnostic tests of 320 elite palms in hot spot areas.

Leaf rot Disease and its interrelationship with Root (wilt) Disease of Coconut

 Maximum suppression of leaf rot disease was obtained by phytosanitation coupled with pouring of Contaf on to the well of crown. Contaf pouring also seems to offer prophylactic protection to palms from fresh incidence or severity of the disease.

Pseudomonas fluorescens (Pfl) was found antagonistic to the pathogens of leaf rot. Application of this antagonistic bacteria with the inoculum of either one or both the main pathogens of the disease (Colletotrichum gloeosporioides, Exserohilum rostratum) under in vitro conditions reduced the leaf rot onset/ development. Screening of native isolates against the main pathogens of leaf rot identified two isolates, one each from phylloplane and rhizosphere effective against the pathogens.

Hexaconazole 5% (4 ml), Dithane M-45 (3g), Furadan 3 G (25 g) and Methyl parathion 2% dust (50g) per palm applied twice a year was found to reduce the intensity of leaf rot symptoms as well as protect palms from rhinoceros beetle and red palm weevil. Coconut water, kernel and oil were found free from residues 45 days after application of these chemicals.

Chemical control of Rhinoceros Beetle of Coconut

• Rhinoceros beetle damage on young palms could be controlled by leaf axil filling with naphthalene @ 12 g/palm once in 45 days.

Coreid Bug of Coconut

 Endochus sp., a reduviid predatory bug has been found in the field in association with Coreid bug. However, its predatory role with the pest is yet to be ascertained.

Control of Bud Rot in Coconut

- Root feeding and stem injection of Akomin (16.8 ml) and Calixin (21 ml) gave maximum protection for a period of eight weeks.
- Application of Calixin (2%) and Neem cake (5 kg/palm/year) can control the spread of Ganoderma disease.

Pests of Oil palm

A fungal pathogen identified as *Aspergillus flavus*, was found infesting the plant hopper, *Proutista moesta*, especially during the rainy season. Cream yellow mycelial growth was noticed on the dead plant hoppers. Incidence of the fungal pathogen among the field collected plant hoppers was 16.39%. In laboratory trials, 62.5% mortality was obtained on the 4th day of inoculation.



Proutista moesta infested with Aspergillus flavus

Integrated Nematode Management

- Introduction of VAM, *Pasteuria penetrans* and *Paecilomyces lilacinus* in the nursery and at transplanting time considerably increased plant growth and reduced the population buildup of the burrowing nematode on coconut, arecanut and black pepper.
- Neem oil cake @ 1.5 kg/plant, Pongamia cake @ 1.5 kg/plant and Glyricidia leaves @ 5 kg/plant applied twice in a year during May/June and October/November controlled the burrowing nematode population in arecanut, banana and pepper in arecanut based cropping system.

HARVEST AND POST HARVEST TECHNOLOGY

Design and Development of Smoke Free Dryer of 1000 nuts capacity

A simple smoke free collapsible copra dryer has been designed, developed and tested to suit medium sized plantation crop holdings and processing units. The dryer consists mainly of a burner, a galvanized iron heat exchanger and mild steel angles as supporting frame with ventilation holes. It can hold upto 1500 coconuts per batch with a drying time of 24 hours. The thermal efficiency of the dryer is 31.25%. It costs about Rs. 12,000/- and requires a housing area of 8 m². The cost of drying is Rs. 1.80/kg.

Design of an Electronic Tensiometer and Auto Irrigation System

A sequential irrigation system

particularly suitable for drip irrigation was fabricated and installed in the field. The system will switch on a solenoid valve for any pre-set period of time. As per the present setting, the system gives 45-50 litres of water per palm for one hour every day. The approximate cost of the system is Rs. 2,000/-, excluding the cost of drip irrigation material.



Collapsible copra dryer

AGRICULTURAL STATISTICS AND ECONOMICS

Refinement of Experimentation Techniques in Plantation Crops

For oil palm field experiments, a plot of 10 palms was found to be optimum. Among the different shapes, linear plots, with more number of rows was found to be best. Total weight of fresh fruit bunches (FFB) was related more to number of bunches than mean weight of bunches, and both had linear relationship with total weight of FFB.

Cox and Stuart test and Daniel's test, used for estimating trend, gave results similar to conventional test of correlation, suggesting use of non-parametric methods.

Trend in Area, Production and Productivity of Arecanut in India

• The secondary data analysis for the period 1985-86 to 1995-96 indicated a Compound Growth Rate of 2.84 % per annum for area and production. Assam had highest growth rate of 3.72 % in area, while Kerala and Karnataka had highest growth rate of production of 1.25 and 0.08 %, respectively.

TRANSFER OF TECHNOLOGY

Training of Extension and Research Workers and Farmers

• During the year 52 participants attended the training programmes listed below.

Scheduled training programmes conducted

Sl.No.	Location	Training Programme
I	Kasaragod	Coconut Production Technology Coconut Based Farming System Hybridization Technique in Coconut
2	Kayangulam	Pest, Disease and Nematode management in Coconut Biological Suppression of Coconut Pests
3	Vittal	Arecanut and Cocoa Production Technology
4	Palode	Oilpalm Production Technology

- A special training programme on Coconut Based Farming System was organized at Kasaragod for the officials from Perennial Crop Development Project, Sri Lanka.
- A familiarization visit for ten days was organized at Kasaragod for three officials from Coconut Research Institute, Sri Lanka.
- An Off-campus training programme on Production technology of coconut arecanut and cocoa was conducted a Goa for 26 officers of the Department of Agriculture, Goa.
- Twenty two extension workers from Sri Lanka were trained on Pest and disease management of coconut.
- One day training on various aspects of coconut and arecanut cultivation practices were given to 1120 farmers. 338 extension personnel and 2461 students at Kasaragod, Kayangulam and Vittal.



Visit of officials from Perennial Crop Development Project, Ministry of Lands, Agriculture and Forestry, Sri Lanka to the demonstration plot on coconut based HDMSCS in farmers' field.

Other Extension Activities

Maintenance of research-cumdemonstration plots, conducting exhibitions and dissemination of information on the mandate crops.

Supply of Planting Materials

During the year 1259 WCT seednuts,

6771 WCT seedlings, 6940 seedlings of coconut hybrids and other varieties, 392309 areca seednuts, 49190 areca sprouts and seedlings and 70700 oil palm sprouts were distributed to farmers from different centres of the Institute.

INSTITUTE VILLAGE LINKAGE PROGRAMME

- During Kharif 1997, eight interventions for small production system and one miscellaneous intervention covering 235 farm families were implemented in the project villages namely, Edneer, Pady and Nekhraje. Besides, three training programmes on pest control in paddy, use of balanced fertilizer application in paddy and scope for intercropping in coconut gardens were conducted for 60 farmers in the project villages.
 - In Rabi season, eight interventions for small production system, one for green revolution production system and three miscellaneous interventions were implemented, covering 290 farm families in the project area. During the Kharif season, the On-farm research conducted in 20 farmers field to evaluate performance of medium duration high yielding varieties of paddy revealed that among the four varieties viz. Kayama, Athira, Aiswarya and Jayanthi, Aiswarya

performed better, yielding 2.5 - 3.0 t/ acre as against 1.5 - 2.5 t/ acre in other varieties.

Under miscellaneous interventions, introduction of Giriraja poultry in the homesteads of small and marginal farmers attracted good response. Each family was supplied with five birds of eight weeks old. The programme covered 89 families. Within three months, the birds gained 3 - 3.5 kg live weight as compared to only 1.5 kg/local bird (live weight).



Giriraja poultry birds growing along with local bird in the backyard of farmer

KRISHI VIGYAN KENDRA

During the year, 78 On-farm and Off-campus trainings were conducted for practising farmers, rural youth, rural women and extension functionaries on Crop Production, Crop Management, Home Animal Science. Husbandry, Agricultural Engineering, Beekeeping, Floriculture etc. A total of 1894 trainees, 1081 male and 813 female including 348 people from SC/ ST category attended these training programmes.

With a view to evaluating the suitability of the research results in real farm situation under On-farm Testing (OFT) programme, 25 demonstrations viz. 10 on management of Rhinoceros beetle in coconut, 10 on management of vegetable pests and 5 on management of stem bleeding disease in coconut were laid out in nine villages of Kasaragod district.

In the Watershed Development Programme area in Yethadka village of Kumbadaje Panchayat, four training programmes and three seminars on soil and water conservation, fertilizer management, vanilla cultivation, pest and disease management in coconut arecanut and cashew, pepper cultivation, processing etc. were conducted. Apart from this, a Panchayat level animal welfare camp a mass campaign on control of sten bleeding disease of coconut and sel



Manugement of stem bleeding disease in coconut - A field demonstration at Yethadk

employment oriented trainings on hand embroidery, preparation of jams, squash, masala powder etc. for women were also undertaken.

Under NWDPRA, for the IX plan, a new Watershed was selected and preliminary survey conducted in Malenkai village of Bellur Panchayat. A Panchayat level seminar on Agriculture and Watershed Management was also organized at Bellur in co-ordination with NWDPRA and RATTC, Taliparamba.

A detailed survey for Front Line Demonstrations on horticultural crops, cereals and pulses in Cheralu-Bayar village was conducted by adopting PRA technique.

ALL INDIA COORDINATED RESEARCH PROJECT ON PALMS

COCONUT

Crop Improvement

- At Mondouri, Jamaican Tall produced the highest yield of 77 nuts/palm/year and cumulative yield of 764 nuts/palm.
- At Ambajipeta, Philippines Ordinary and Laccadive Ordinary continued to give the highest cumulative yield of 1885 and 1604 nuts/palm, respectively.
- At Aliyarnagar, in the germplasm evaluation trial, the annual (158 nuts/ palm/year) and cumulative (457 nuts/ palm) yield were highest in Arasampatti Tall. West Coast Tall gave an annual yield of 220 nuts/palm/ year with a cumulative average yield of 98 nuts/palm/year and copra yield of 12.2 kg/palm/year. Among the dwarfs, Malayan Green Dwarf gave

the maximum yield of 103 nuts/palm/ year.

At Konark, survey of local elites of Sakhigopal Local was done in Sakhigopal, Bramagiri, Konark and Katatapur area. Based on the shape, size and colour of nuts, 16 strains were identified.

In the trial of promising seed materials,

- At Ambajipeta, the 13 year cumulative yield was highest in COD x WCT (768 nuts/palm) followed by ECT x GB (763 nuts/ palm);
- At Mondouri, the six year cumulative yield was highest in Laccadive Micro (366 nuts/palm); copra weight was highest in Laccadive Ordinary (278 g/nut)

followed by Philippines Ordinary (274g/nut);

- At Konark, WCT x GB gave highest number of functional leaves on the crown (27), number of leaf produced per year (11.2), number of spadices per year (10.2) and nuts/palm/year (58);
- At Veppankulam, highest annual yield (84 nuts/palm/year) and copra yield (9.4 kg/palm/year) were recorded in WCT x MYD;
- At Aliyarnagar, SSG gave highest nut yield (102 nuts/palm/year) and copra yield (17.3 kg/palm/year) followed by WCT x GB with a nut and copra yield of 99 nuts/palm/ year and 15.1 kg/palm/year, respectively

Crop Production

- In the NPK nutritional trial at Mondouri, maximum nut yield of 75 nuts/palm/year was recorded in treatment N₃P₃K₁ (1500:750:750 g/ palm/year) followed by 74 nuts in N₃P₂K₃ (1500:500:750 g/palm/year).
- At Ambajipeta, a fertilizer dose of 2 kg urea + 2 kg super phosphate + 2 kg muriate of potash/palm/year was found to be a reasonable dose for higher nut yield for East Coast Tall.
- At Konark, palms receiving 1000g N,

500g P_2O_5 and 750 g K_2O /palm/year produced highest annual yield of 36 nuts/palm/year with a cumulative yield of 190 nuts/palm.

- In the NPK nutritional trial on COD x WCT palms at Aliyarnagar, the main effects of N, P and K were significant giving maximum yield of 63, 57 and 65 nuts/palm/year, respectively.
- At Veppankulam, highest nut yield of 179 nuts/palm/year was recorded in treatment N₂P₁K₀ (1000:250:0 g/palm/ year) followed by 177 nuts in N₂P₁K₁ (1000:250:1000 g/palm/year).
- At Mondouri, highest yield of 105 nuts palm/year was recorded in treatment $N_0P_1K_1$ (0:250:1000 g/palm/year) followed by 104 nuts/palm/year in $N_2P_1K_2$ (1000:250:2000). Highest copra weight (307 g/nut) was observed in treatment $N_1P_1K_1$ (500:250:1000 g/palm/year).
- At Ambajipeta, growing of intercrops like banana, yam and turmeric was found to give higher returns compared to other crops. At Veppankulam in the HDMSCS trial, higher cost-benefit ratio (1:4.35) was observed in r.odel-IV with mango, pepper, banana, lime. Sirukizhangu and Bhendi as intercrops followed by model-III (1:4.18) with clove, betelvine, banana, curry leaf and colocasia as intercrops.

In the drip irrigation cum fertilizer trial at Aliyarnagar, highest nut yield (124 nuts/palm/year) was obtained in drip irrigation at 100% Eo combined with slow release fertilizer application. At Veppankulam, basin irrigation with slow release fertilizer gave 104 nuts/ palm/year followed by drip irrigation at 100% Eo with slow release fertilizers (101 nuts/palm/year). The effects of basin irrigation and drip irrigation at 100% Eo were on par.

Crop Protection

- Electron microscopic studies at Ambajipeta, confirmed the phytoplasmal etiology of Tatipaka disease.
 - In the pathogenicity trial at Aliyarnagar, it was found that dwarf varieties are highly susceptible to *G*. *applanatum*. In the management trial on Ganoderma, lowest disease incidence (7.9%) was recorded in the palms that received soil drenching of Carbendazim (0.3%) followed by soil application of neem cake 10 kg/palm (18.5%). In the management trial-I, lowest disease incidence (3.3%) was recorded in the palms that received root feeding of Tridemorph (2%) + 5 kg neem cake/palm/year. In the management trial-II, minimum disease

incidence (1.6%) was recorded in Aureofungin sol 2% root feeding or Calixin 2% root feeding alongwith 5 kg neem cake.

- At Veppankulam, *T. harzianum* with green leaves, FYM + Bordeaux mixture and neem cake gave lesser disease incidence and highest nut yield than other treatments. In another trial, *T. harzianum* with phosphobacteria was found to be effective in the managment of Thanjavur wilt. ECT x ECT was found to be tolerant to Thanjavur wilt.
- At Ambajipeta, there was widespread and severe occurrence of the coconut defoliator, *Phalaera* sp., two months after the cyclone in November, 1996. This new pest of coconut can be controlled by root feeding of Monocrotophos @ 10 ml/ 10 ml water.
- At Aliyarnagar, with the release of parasitoids, *Bracon hebetor* and *Goniosus nephantidis*, the pest population decreased from 888/palm to 110/palm. The percent parasitation by Braconids increased from 3.27 to 21.56% and Bethylids from 0.675 to 12.72%. The damage caused to coconut leaves, spindle and spathe was reduced drastically after the

augmentative release of baculovirus inoculated adult beetles. Traps containing phagostimulants (feeding stimulants viz. castor cake suspension coconut stem log, acetic acid, yeast) and sex pheromone chemicals (sachets) are being tried for rhinoceros beetle. Another set of traps using sex pheromone chemicals (sachets) and feeding attractants viz. sugarcane, molasses, toddy, neera with acetic acid and yeast are being tried for trapping red palm weevil. Encouraging results are being obtained and further work is in progress.

OIL PALM

Crop Improvement

- At Gangavathy, annual leaf production was highest in 109 *dura* x 291 *pisifera* (25) followed by 220 d x 98 p (24).
 - At Vijayarai, maximum yield of 28.6 kg ffb/palm/year was recorded in 104 d x 98 p followed by 148 d x 98 p (26.6 kg ffb/palm).

 At Mulde, maximum yield of ffb (41 kg/palm) was recorded in the hybrid combination 1.28 d x 291 p followed by 82 d x 266 p (27 kg/palm).

Crop Production

- In the drip irrigation cum fertilize experiment at Vijayarai, highest yiek (190 kg ffb/palm) was obtained in treatment I_1F_3 (conventional irrigation with a fertilizer dose of 1200 N: 60 P: 2700 K g/palm/year) followed by drip irrigation I_2I_3 (105 kg ffb/palm)
- At Mulde the effects of irrigation fertilizer and interaction effects were all significant on the yield of ffb/palm Maximum yield was obtained in treatment I_2F_2 (drip irrigation with 800:400:1800 g of NPK/palm/year

Crop Protection

 At Ambajipeta, a modified staining procedure was standardised for detecting baculovirus infection in the midgut epithelial cells of adults and grubs.