Research Highlights

1993 - 94

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

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CPCRI

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Published by :

M.K. Nair
Director
Central Plantation Crops Research Institute
Kasaragod - 671 124, Kerala

Compiled and Edited by :

B. Chempakam and A.R.S. Menon

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M.K. Nair

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M. Narayanan and R. Rajasekharan

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INTRODUCTION

The area, production and productivity of plantation crops have increased considerably during the last two decades. After delinking research on spices and cashew, the CPCRI research activities are confined to palms and cocoa only. Since the establishment of CPCRI in 1970 there has been an increase of about 60 per cent in production of coconut and 77 per cent in production of arecanut in the country. During the same period the productivity increase has been about 11 per cent and 42 per cent, respectively. This confirms that the increase in production was not merely due to increase in area, but also due to the adoption of input technologies developed at the Institute and agricultural universities having mandate on palms and cocoa. During two decades of the Institute's existence the research priority has also changed from time to time. Till recently the priority was given to the disease management, germplasm collection, conservation and evaluation, evolving high yielding varieties and hybrids and developing appropriate input technologies to increase the productivity. The priorities are now being changed and we look forward to evolving varieties tolerant to root (wilt) disease of coconut and yellow leaf disease of arecanut, drought tolerant coconut and cocoa varieties, developing integrated control measures against rhinoceros beetle, red palm weevil and whitegrub and increasing income from palm based farming systems.

Production of planting materials in large quantities to meet the farmer's requirement which includes conventional multiplication and clonal propagation, developing appropriate biofertilizers and vermiculture suitable for coconut and arecanut are some of the other programmes receiving attention of the scientists of CPCRI. Designing and fabricating a palm oil extraction mill affordable by small farmers, development of technologies to utilise coconut timber are the major projects being implemented under the post-harvest technology.

The major research results from various ongoing research projects of the Institute are briefly presented in this annual publication.

Kasaragod
23 April 94

(MK NAIR)
Director

भूमिका

पिछले दो दशाब्दी से रोपण फसल के क्षेत्रफल उत्पादन तथा उत्पादकता में विचारणीय प्रगती हुई है। मसाले एवं काजू पर अनुसंधान के.रो.फ.अ. संस्थान से अलग करने के बाद इस संस्थान ताड़ एवं कोको अनुसंधान पर सीमित है। केन्द्रीय रोपण फसल अनुसंधान संस्थान के गठन के बाद भारत के नारियल उत्पादन में 60% तथा सुपारी पर 77% प्रगती हुई है। इसी अवधि में उत्पादन क्षमता क्रमशः लगभग 11% तथा 42% बढी है। इससे यह व्यक्त होता है कि उत्पादनक्षमता न केवल क्षेत्रफल की प्रगती पर, बल्कि ताड़ एवं कोको अनुसंधान के अधिदेशों पर इस संस्थान तथा कृषि विश्वविद्यालयों से विकसित उन्नत तकनीकियों से है। इस संस्थान की स्थापना के दो दशाब्दी से पूर्व ही समय-समय पर अनुसंधान की आवश्यकतानुसार प्राथमिकता रोग प्रबंधात्मकता, जननद्रव्य संकलन, सुरक्षण, मूल्यांकन, नारियल की अधिक उपज देनेवाली प्रजातियों एवं संकरों के विकास तथा उत्पादन बढ़ाने में उचित तकनीकों का विकासन आदी पर दिया गया है। लेकिन अब इन प्राथमिकताओं का परिवर्तन की है कि नारियल के रूट विल्ट रोग, सुपारी के पीतपर्ण रोग, सूखे रोधक नारियल तथा कोको के प्रतिरोध प्रजातियों का पहचान तथा रिनोसेरस भृंग, लाल ताड़ धुन, श्वेत जातक तथा ताड़ आधारित कृषि पद्धति का विकास आदि को दी है।

कृषकों को बीज उपलब्ध कराने हेतु रोपाई चीज़ो का बढी मात्रा में उत्पादन, कृत्तक प्रजनन, नारियल तथा सुपारी केलिए उचित जैवउर्वरक एवं कृमिसंवर्ध का विकासन आदि के.रो.फ़.अ. संस्थान के वैज्ञानिकों को आकर्षित करनेवाले अन्य कार्यक्रम है। ताड तैल निस्सारण मिल की रूप कल्पना एवं निर्माण कर लघु कृषकों केलिए प्रदान करना, नारियल की लकडी उपयोग करने के लिए तकनीकों का विकासन आदी कटाई उपरान्त की तकनीकों में मुख्य परियोजनायें है।

इस संस्थान के विभिन्न अनुसंधान परियोजनाओं के अनुसंधान की मुख्य फलप्राप्ती इस वार्षिक प्रकाशन में दी गई है।

कासरगोड
23 अप्रैल 94

(एम. के. नायर)
निदेशक

CROP IMPROVEMENT

Genetic Resources

Sakhiagopal-I and Jahaji collections from Orissa were added to the coconut germplasm. The nuts of Jahaji accession are of 'Niu-Kafa' type and are long (36.4 cm) with thick husk (4.3 cm). The nuts of Sakhiagopal-I are oblong (29.5 cm long) with thin husk (1.6 cm). The copra weight in this cultivar is 109 g with an oil content of 67%.

Fig. 1. Sakhiagopal accession

Fig. 2. Jahaji accession

Among the 16 cultivars planted in 1972, Laccadive Micro produced maximum number of nuts (162 nuts) as well as highest quantity of copra (18.9 kg copra palm^{-1}year^{-1}). Out of 810 palms maintained at the World Coconut Germplasm Centre, Andamans, 795 palms of the Pacific Ocean collection and 152 out of 200 Nicobar palms have so far flowered.

The oil palm assemblage now consists of seven indigenous and 18 exotic accessions. *Elaeis oleifera* (HBK) Cortes introduced from Malaysia in 1990 started flowering in 20 months after planting. Palode accessions revealed a high sex ratio (34%) as against the Costarican material (28%) during the year.

Fig. 3. 18 months old *Elaeis oleifera* (HBK) Cortes introduced from Malaysia

The eight cocoa scion samples from Kottayam District and 33 from Idukki Dt. were collected. Fourteen indigenous and one exotic accession from University of Reading, U.K. were added to the germplasm bank. In an experiment with 24 accessions ICS-6 gave highest cumulative yield of 72 pods. In another trial, SCR-6 was found to be superior to the other twenty accessions.

Evolving high yielding varieties by selection and hybridization

Preliminary yield evaluation of 36 hybrids and nine parents of the diallel experiment planted in 1972, indicated that differences among the hybrids and parents were significant for cumulative yield (1989-93). Among the hybrids Lakshaganga (LO x GB), and among the parents, Chandrakalpa (Laccadive Ordinary) were the highest yielders (520 and 274 nuts respectively).

Fig. 4. Lakshaganga (LO x GB)

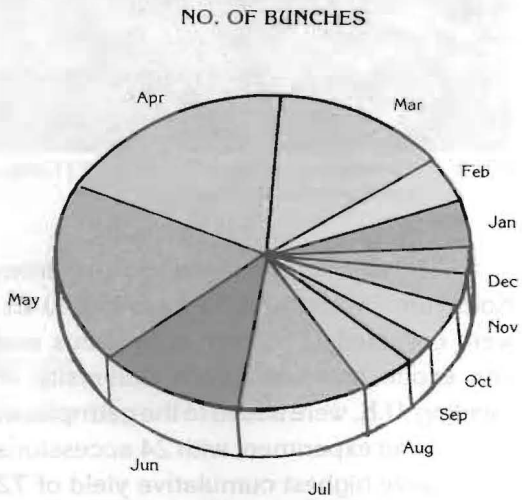

Fig. 5. Average production of oil palm bunches in percentage

The analysis of yield data in four hybrids under rainfed conditions indicated that Kerasankara (WCT x COD) gave the highest cumulative yield of 737 nuts.

In another trial of six hybrids with WCT as control planted during 1984, 100% flowering was observed in WCT x COD and 90% in MYD x Zanzibar, compared to 50% flowering in WCT.

A new trial of F_2 progenies of two Dwarf x Tall palms (HB-175 and HB-123) and two Tall x Dwarf palms (HB-71 and WB-168) was planted in RBD with three replications and nine palms/plot.

A study on the production of 555 oil palms for seven years showed that 65% of the FFB was harvested during March to July. The highest production was in April (19.8%) and the lowest in December (3.3%). Yield of bunches also followed the same trend. These are depicted in figures 5 and 6.

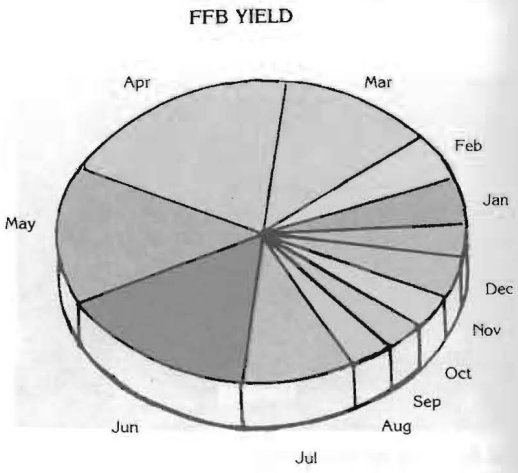

Fig. 6. Average yield of FFB in percentage

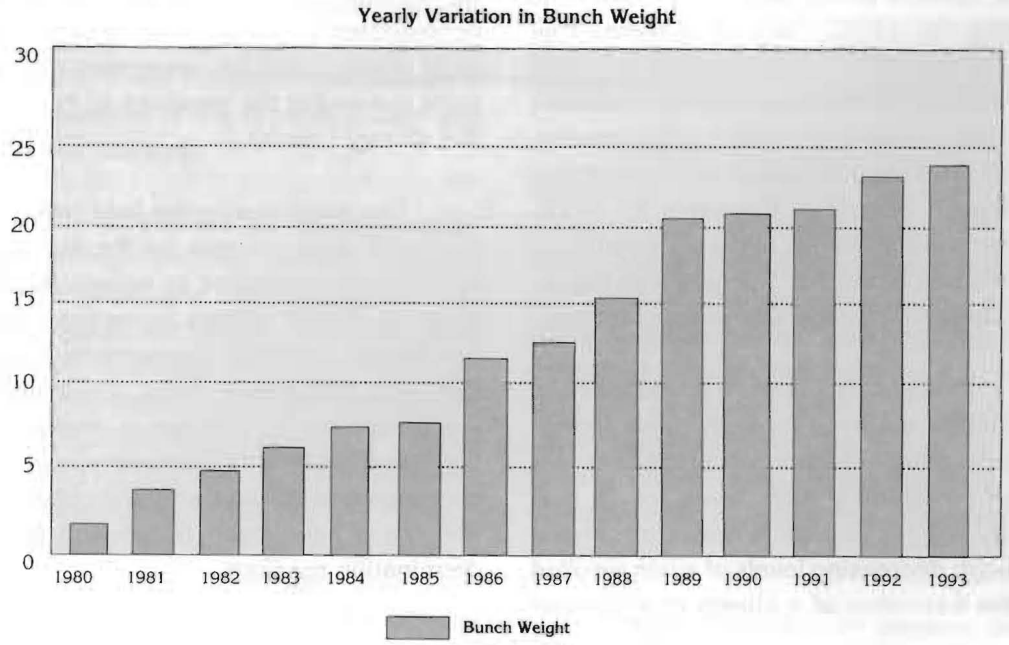

Fig. 7. Yearly variation in oil palm bunch weight from 1980 to 1993

There appears to be a four year cycle since bumper yields were obtained in 1986 and 1990 followed by a decline in FFB production in the subsequent years. However the single bunch weight showed a steady increase over 14 years (Figure 7).

A total of 2,27,370 oil palm sprouts/ seedlings were distributed to ten agencies in Andhra Pradesh, Karnataka, Kerala, Madhya Pradesh, Tamil Nadu and Tripura.

Tissue, Cell and Anther Culture

Coconut

Short-term storage of both mature (11-12 m) and immature (8-10 m) zygotic embryos of coconut (var. WCT) was achieved in a minimal growth medium such as Eeuwen's Y3 basal nutrients devoid of sucrose and activated charcoal,

Fig. 8. Short term storage of coconut embryos (S-1 : Eeuwen's Y3 medium without charcoal, S-2 : Eeuwen's Y3 medium without sucrose, S-3 : Sterile water alone, S-4 : Complete Eeuwen's Y3 medium, ie; control)

or even in sterile water alone, for a period of 2 months under laboratory conditions (temp. 30 ±2°C). It was observed that 66.7% and 80% levels of germination occurred in Y3 medium without charcoal, sucrose and in sterile water alone respectively. This experiment was replicated thrice alongwith control of Eeuwen's Y3 (complete formula) media, and a germination of 66.7% was obtained. Success with immature embryo storage was not satisfactory.

Multiple shoots were produced from immature embryos through callus formation. Callus induction occurred in a medium containing high levels of 2, 4-D (100 mg/1) which when transferred through decreasing levels of auxin resulted in the formation of a cluster of shoot-like structures. These structures turned green on transfer to light and showed further development in the presence of GA3. One such shoot could be separated out and roots induced in the presence of NAA and IBA (2 mg/1 each).

The technique for the field collection of zygotic embryos was for the first time, successfully employed to collect 86 embryos of Pacific Ocean accessions from the World Coconut Germplasm Centre (WCGC), Andamans using the portable inoculation hood. The rate of contamination was 6% with only four embryos getting contaminated 15 days after the collection, and these have been transferred to the germination medium.

CROP PRODUCTION

Soil fertility, nutrient dynamics and crop productivity

Palms which received slow release nitrogenous fertilizers once in two years performed at par with palms which received straight fertilizers. In a laboratory simulation study to work out the loss of applied nitrogen from different sources of nitrogen, it was observed that maximum loss of ammoniacal nitrogen through leaching occurred in nimin coated urea followed by urea on day 44 by which time 1300 mm rainfall has been simulated. Maximum loss of nitrate nitrogen occurred on day 54 at 1500 mm rainfall simulation with prilled urea followed by nimin coated urea and urea-form.

In a treatment involving sodium and potassium applied to coconut palms, significantly higher potassium and sodium contents in the leaf were recorded in 100% K and 50% Na treatments respectively. Leaf chloride content was observed to be maximum in the treatment with Na and K in the ratio 75:25. Potassium application increased the K/Na ratio of the soil while application of Na reduced the K/Mg and K/(Ca+Mg) ratios significantly.

Application of 375g MgO palm^{-1} recorded maximum yield with an increase of 57 per cent over control. Significantly high exchangeable Mg was recorded by applying 500g MgO as magnesium carbonate.

Laboratory incubation studies involving coir-pith, coconut sheddings, coconut leaves and green leaf manure was initiated to study the pattern and extent of decomposition of the organic matter and release of nutrients.

The experiment on fertilizer requirement of high yielding coconut cultivars under irrigated and rainfed conditions revealed significant results. The mean yield due to M_0 (control), M_1 (500 N:500 P_2O_5: 1000 K_2O g palm^{-1} year^{-1}) and M_2 (1000 N: 1000 P_2O_5:2000 K_2O g palm^{-1} year^{-1}) levels were 88.1, 112.4 and 117.7 nuts palm^{-1} year^{-1} respectively. Among the coconut cultivars, COD x WCT gave significantly higher yield (113.2 nuts palm^{-1} year^{-1}) followed by WCT x COD and WCT (102 nuts palm^{-1}year^{-1}). Irrigation gave significantly higher yield (117.8 nuts palm^{-1} year^{-1}) over rainfed condition (94.2 nuts palm^{-1} year^{-1}).

In the nursery fertilizer management trial, percentage recovery of healthy seedlings ranged from 53 to 82 due to various treatments although it was not statistically significant among the treatments. The maximum recovery was recorded in FYM (25 t/ha) treatment followed by FYM+N and K (80 kg each/ha) and FYM+N and K (160 kg each/ha) treatments as soil application in three splits. The maximum dry weight and leaf area per seedling was also recorded in FYM+N and K (160 kg each/ha) as soil application treatment at 12th month. It is also found that FYM+N and K (80 to 160 kg each/ha) as soil application in three splits is superior in respect of all the growth observations such as height, girth at collar and number of leaves at 12th month reflecting the healthy and vigorous nature of seedlings.

Increasing nutrient availability and disease alleviation by micro-organisms

Nitrogen contribution from the shoot biomass of *Mimosa invisa* and *Calopogonium mucunoides* was 144.8 and 95.8 g basin^{-1} in the green manure legume - *Rhizobium* nitrogen substitution experiment. Coir dust incorporation significantlly enhanced nitrogen fixation by native bacteria and inoculated *Beijerinckia* in acidic sandy loam soil. *Beijerinckia indica* has been identified as the predominant species of asymbiotic nitrogen fixing bacteria in coconut soil.

Twenty *Azospirillum* isolates were obtained from coconut roots with nitrogen fixing capacity ranging from 63.6 to 784.64 n MC_2H_4 tube^{-1} h^{-1}. *Azospirillum lipoferum* has been found to be the major species. One efficient strain HB 43 with acid tolerance has been demonstrated to promote the growth of test plants.

Amendments with cowdung, neem cake, coir dust, mimosa powder and *Calopogonium* powder at 2.5% level along with rock phosphate (2.5%) and inoculation of P-solubilizers increased the population of P-solubilizers in all treatments compared to control. Neem cake amended soil recorded highest population of P-solubilizers, while available P was higher in cowdung amended soils.

Better survival of phosphate solubilizing bacteria such as *Bacillus polymyxa*, *Bacillus subtilis* and *Pseudomonas* spp. was recorded in cowdung, neem cake, coir dust,

mimosa and *Calopogonium* added soils under sterile condition as compared to soil alone as control.

Symbiotic association of VAM with coconut and other plantation crops

A survey conducted to assess the VAM status in palm based farming systems revealed that oilpalm had the highest VAM status with 65.5% colonization and 40.5% infection grading. This was followed by coconut (Kasargod) for which corresponding figures were 55 to 20. Arecanut (Vittal) had 28.8% colonization and 13.6% infection grading. Coconut palms growing at Kayangulam [root (wilt) tract] had the least viz. 26.8% colonization and 12.5% infection grading respectively.

It was observed that palms in inter-cropped gardens had better VAM status than pure crop.

Soil type appeared to have a direct bearing on VAM status of the crops. In general, crops grown in Vijayarai (Andhra Pradesh) with sandy loam soil had better VAM status in contrast to crops grown at Kahikuchi with a predominant clay component.

Water management and stress physiology

Further screening of coconut seedlings for drought tolerance based on water potential, wax content and lipid peroxidation showed that certain combinations involving GB (GBxJava, GBxFiji, GBxWCT) exhibited more tolerance, while most of the COD combinations have less tolerance. As in the previous year, the crosses involving CGD and MYD exhibited similar pattern, in having relative tolerance to drought.

When leaf samples from tolerant and susceptible palms were subjected to various stresses, viz. osmotic stress, air desiccation and high temperature stress, an increase (13-25%) in the protein levels were seen, which is an indication of stress induced proteins. The lipid peroxidation levels also increased in response to stress, which was more prominant in the case of high temperature stress.

The response to stress in the above parameters varied between tolerant and susceptible palms, indicating a protective role of the stress induced proteins.

Chlorophyll fluorescence indices and gas exchange characteristics were also studied in drought tolerant and susceptible cocoa accessions. The seasonal means showed that F_0 (initial flourescence) values were significantly higher in susceptible trees showing that the PSII was affected to greater extent. However, the F_M (maximal flourescence) and F_V (variable flourescence) and P_N (net photosynthetic rate) were lower in tolerant accession types. The stomatal diffusive resistance was higher in tolerant types as compared to susceptible ones, which resulted in reduced transpiration rate which is a major adaptive feature.

Perennial crop based farming systems

In the coconut based high density multispecies cropping system (HDMSCS)

model, the productivity of coconut and other component crops did not vary due to influence of graded doses of fertilizers. The mean yield of coconut per palm was 151, 150 and 150 in one third, two third and full dose of fertilizer respectively indicating scope for rationalising the chemical fertilizers by proper management and recycling the by-products.

The second generation mixed farming unit started in 1989 in a one hectare coconut garden yielded 17,674 coconuts, 384 kg banana, 7877 litre of milk, 2819 hen eggs, 4084 quail eggs, 307 kgs poultry (live weight), 112 nos. of quail birds, 28 kgs rabbit (live weight) and 350 kg fish. The total revenue from the system was Rs. 1,66,712 and expenditure excluding cost of family labour was Rs. 1,11,567 resulting in a net income of Rs. 55,145. This included Rs. 21,056 realised from the sale of eggs, poultry birds, quails and rabbits.

In the vegetable based intercropping system, among the amaranthus varieties Kanaralocal (4992 kg/ha), in brinjal, Pusa Purple Cluster (5162 kg/ha) and in snake gourd, Arka Sheetal (5872 kg/ha) gave highest yields compared to other varieties tried. Among the rabi crops also three varieties each of bottle gourd, ridge gourd and bhendi were evaluated. Among the bottle gourd varieties tried, Arka Bahar (6121 kg/ha), in the case of ridge gourd, Pusa Nasdar (3861 kg/ha) and in the case of bhendi, Pusa Sawani (2772 kg/ha) gave highest yields over other varieties.

In the arecanut based HDMSCS model-1 at Vittal, the system yielded 2719 kg chali, 4026 kg of cocoa pods, 132 kg of dry pepper and 24 kg of clove.

In arecanut based second generation HDMSCS model at Vittal, the increase in arecanut yield due to one third and full dose of fertilizers over control was 45 and 59 per cent respectively. Pepper was found to respond only upto one third of the recommonded dose. But in the case of cocoa, yield increased with increased fertilizer level. When compared to 747 kg pods per hectare in control, due to full dose of fertilizer, the yield realised was 2840 kg pods per hectare.

At Hirehalli, 0.92 ha of arecanut based HDMSCS model-I yielded 3384 kg of chali, 10290 kg of cocoa pods and 7737 kg black pepper (wet). The model-II yielded 2110 kg chali, 2552 kg of banana fruits and 2184 kg of lime.

CROP PROTECTION

Root (wilt) disease of coconut

Mycoplasma - like organisms (MLOs) associated with coconut root (wilt) disease, being fastidious like other plant MLOs, are not amenable for cultivation in cell-free media. *In vitro* micropropagation for maintenance of MLOs in infected plant tissues was attempted. Roots developed from tender leaf explants of diseased seedlings in culture since May '92 and January '93 are periodically subcultured and propa-

gated.

Having established the mycoplasmal etiology of the disease and proved the vector role of lace bug, a field experiment was initiated in July 1990 to assess the effect of insect vector control on incidence of disease. The experimental seedlings and the existing palms in the treatment plot were sprayed alternately with 0.2% endosulfan and monocrotophos at fortnightly intervals. While none of the sprayed seedlings have contracted the disease so far, five out of thirty eight unsprayed control seedlings exhibited disease symptoms.

Breeding for resistance/tolerance to root (wilt) disease has been further strengthened during the year. The total number of mother palms under artificial pollination was increased from the existing 94 to 140 with the addition of newly identified disease-free and high yielding palms at Karunagapally, Thiruvalla, Chengannur and Kottayam. New trials involving a total of 486 progenies belonging to 30 cross combinations and six families of OP (open pollinated) seedlings were laid out and are being maintained and monitored for their reaction to root (wilt) disease. Thirty progenies of the cultivar Gudanjali Dwarf collected from Gujarat were also planted for screening.

Leaf rot disease of coconut

Fungal isolations made progressively from spindles of leaf rot affected palms led to identification of 14 species of fungi and have been grouped under three categories: Group A fungi are regarded as causes of leaf rot, as their association with the disease is predominant and more regular. They are: *Colletotrichum gloeosporioides, Exserohilum rostratum, Gliocladium vermoeseni, Fusarium solani* and *F. moniliforme* var. *intermedium*. Group B fungi - *Thielaviopsis paradoxa, Rhizoctonia solani* and *Cylindrocladium scoparium* - are not in regular association with the disease and designated as notable species. Group C fungi - *Mortierella elongata, Curvularia* sp., *Acremonium* sp., *Thielavia microspore, T. terricloa* and *Chaetomium brasiliense* - occur usually in very low frequency.

Seasonal influence on the frequency pattern of major fungi are apparent. Pathogenic status of all the predominant fungi are confirmed in *in vitro* inoculations. Field pathogenicity tests of major fungi on apparently healthy and root (wilt) affected palms tend to indicate general aggressiveness of the pathogens over palms of later group. Further studies on *in vitro* interactions showed that the predominant fungi grew into one another without major interactions/inhibitions.

The data for the second year from the field control trial involving Calixin (0.1%), Dithane M-45 (0.3%) and Fytolan (0.5%) indicated either pouring of calixin into axil around the spindle of the crown of leaf rot affected palms or spraying Dithane M-45 over the foliage relatively reduced the disease intensity on leaves that emerged after commencement of trial as compared to control and other treatments.

Stem bleeding disease of coconut

Contaf, 5%EC (10ppm) and Borax

(0.3%) were found to be inhibitory to *Thielaviopsis paradoxa* among the different chemicals tested *in vitro*. Among the different oil cakes tested against the fungus, Mahua cake was found to be fungistatic.

Screening of germplasm against *T. paradoxa* using detached frond inoculation technique revealed that all the nine varieties screened (J.G., C.C., Fiji, A.K., FMS, SSA, A.G., SSG and P.O) were susceptible to *T. paradoxa* in different degrees. Maximum lesion size was noticed on Philippines Ordinary (138.55 cm^2) and the minimum lesion was observed on Jawa Giant (73.98 cm^2).

Tanjavur wilt/Ganoderma of coconut

The mycorrhizal status of areca palms suffering from Ganoderma infection was distinctly poorer as revealed by an average colonization of 9% (range being 10-40%), 4% infection grading (2.5-25% range), and 42 spores/100g soil (0-50) in comparison to healthy palms which had 36% colonization (range 10-50%), 14% infection grading (2.5-25%) and a spore count of 96/100g of soil (68-114).

Spear rot and other diseases of oil palm

Spear rot disease (SRD) incidence was noticed to the extent of 1.04% in Kerala State with 0.83 - 58.3% incidence in different plots. The spread of the disease was erratic and patchy (0.25 - 1.30%). Oil palms planted under YLD affected arecanut palms have higher annual rate of spread (2.87%) of SRD.

Fig. 9. Symptoms of SRD on oil palm in experimental transmission of MLOs from YLD affected arecanut to oil palm using *Cassytha filiformis* L.

Yield loss studied for 16 yrs indicated a loss of 3.40 to 55.64 tonnes FFB/ha.

Occurence of SRD only in the YLD-RWD tracts of Kerala, its absence in YLD affected arecanut palms, positive correlation of SRD occurrence with the abundance of YLD and RWD and the common mycoplasmal etiology indicated that YLD and RWD serve as the source of inoculum for SRD.

Experimental transmission of MLO's from affected oil palms to healthy oil palms through dodder (*Cassytha filiformis*) was established by symptom reproduction and electron microscopy.

Electron microscopic detection of MLOs in the salivary glands of *Proutista moesta* after an acquisition and incubation period of 31 days and above on SRD affected palms indicated the insect's ability to acquire and sustain multiplication of MLOs of SRD.

Oil palm bunch refuse is an ideal natural breeding substrate of *P. moesta*.

Pest Management

A technique for mass multiplication of *Apanteles taragamae*, a parasitoid on early instar larvae of *Opisina arenosella* was standardised. The inoculum load of the bacterial pathogen *Pseudomonas aeruginosa* infecting red palm weevil grubs was 10^3-10^4 cells per grub. Natural population of the weevil was also found to have latent infection by a NPV. Feeding potential of the mirid and chrysopid which are predaceous on *Stephanitis typica* was found to be 20 and 12 lacebugs per day respectively.

Mealy bugs on coconut palm could be effectively managed by the application of 0.125 per cent dimethoate or monocrotophos at 45 days interval.

Feeding by nymphs of coreid bug on coconut buttons in their early developmental period resulted in button shedding ranging from 68.6 to 93 per cent.

Three species of scale insects could be observed on arecanut palm.

Survey for incidence of white grubs on coconut conducted in 15 villages of Thrissur district revealed the absence of *Leucopholis* spp. in this area. Adults of *Leucopholis coneophora* were found to congregate on their emergence from the field around mating pairs. A gregarian protozoan was found in association with the adults of white grubs.

A new species of shoot borer was found on oilpalm seedlings in Honnali, Shimoga district. On an average one per-cent pest infestation could be recorded seedlings. The pest could be managed by 0.1 per cent Monocrotophos spraying.

Fig. 10. Shoot borer infested oil palm seedling (Inset) Borer-tunnelled rachis

A chrysopid larva was found to be predaceous on nymphs and adults of *Helopeltis antonii* in cacao gardens.

Intergrated Nematode Management

Occurrence of a mycelial and endospore forming obligate bacterial parasite, *Pasteuria penetrans* on nematode is reported from Kerala.

Survey for the plant parasitic nematodes associated with oil palm conducted in Kerala, Andhra Pradesh and Kahikuchi in Assam revealed the association of two endoparasitic nematodes viz. *Radopholus similis* and *Pratylenchus* sp. with roots of oil palm. Among these, *R. similis* was widely distributed followed by *Pratylenchus*. The root-knot nematode *Meloidogyne* sp. was reported from root samples of oil palm in

Andhra Pradesh.

Leaf extracts of *Vitex negundo* and *Chromolena odorata* tested against the nematodes killed *R. similis* to the extent of 98.5% and 67.5% respectively within 72 hours.

The application of phorate, neem cake and Glyricidia leaves twice a year on arecanut + banana, arecanut + black pepper and arecanut alone have significantly brought down the nematode population.

STATISTICS AND AGRICULTURAL ECONOMICS

Refinement of Experimentation Techniques in Plantation Crops

Based on the studies conducted for four years, a regression equation of the form $y = 1.73\ x_1 + 19.31\ x_2 - 21.61$ has been proposed to estimate the annual yield of oil palm (wt. of FFB in kg/palm) where x_1 is the average bunch weight of the previous year and x_2 is the total number of bunches available.

Regression models were worked out to predict the annual yield of WCT, TxD and DxT palms, growing under rainfed and irrigated conditions. Prediction is possible with reasonable accuracy (R^2 around 0.90) at any time of the year based on a single observation of the total number of nuts present in the crown, or on the basis of two observations at 6 month intervals, of the count of older nuts in half of the number of bunches present. TxD and DxT palms have stabilized their yield around 15 years of their planting where as WCT and LO x GB were found to have yield stabilisation at about 20 years after planting.

A menu-driven software package on different aspects of arecanut cultivation and processing has been developed for ready reference. A Project Information System was also developed to retrieve informations like year of start, year of ending, research workers and their manmonths, decisions taken during the RC meeting etc. of ongoing projects of the Institute.

Cost-benefit analysis of coconut cultivation in Kerala

The Cash-Flow analysis for coconut cultivation was done at present factor costs and product price for different situations viz., WCT under rainfed, WCT under irrigated and for hybrids under irrigated conditions. The respective benefit-cost ratio were found to be 1.29, 1.45 and 1.85, and the Net Present worth were as high as Rs. 27138, 54174 and 100845 and Internal Rate of Return (%) were respectively 19, 20 and 25 which are higher than the bank interest rates. From this it is evident that coconut continues to remian as a profitable crop inspite of increase in labour wages and other factor costs and decline in output price. Hybrids perform better than local cultivars in terms of economic benefits.

Coconut production in India

In India, the area under coconut has increased by 144 per cent and production by 181 per cent during the year between 1950-51 and 1991-92. During the same period, TamilNadu recorded the maximum growth rate of 264 per cent and 495 per cent in production over a period of 41 years in Karnataka, the expansion in area was of the order of 156 per cent but the production increase was 232 per cent. In Kerala the area under coconut recorded an increase of 107 per cent and production by 108 per cent. The compound growth rates worked out for each of the five year periods were generally positive for all the states with regard to area as well as production.

TRANSFER OF TECHNOLOGY

During the year, a total of ten scheduled training courses, three at Kasaragod, two at Kayangulam and five at Palode were organized and officials from the states of Andhra Pradesh, Arunachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra and Pondicherry attended the courses. The major aspects of the training were production technology of coconut and oil palm, disease management and hybridization techniques in coconut. A subject matter workshop cum seminar on coconut based farming system was organised at Kasaragod in collaboration with Directorate of Extension, Ministry of Agriculture, Govt. of India, New Delhi during 14th to 21st December, 1993. The Institute had organized 37 one day special training at Kasaragod, Kayangulam and Palode for about 1,200 trainees. Special Training/Seminar were held for the farmers, organized by NMG Bank, KERAFEED, FACT and Chathannoor Kera Samrakshana Samithi etc. Special trainings were also held for the Officers and Staff/Students of DIET, RATTC Kozha, Vyttilla and Kazhakoottam. Trainees from RUDSET, Supervisory Officers from the Department of Horticulture, Karnataka, unemployed youths sponsored by Coconut Development Board and Carpet Trainees from TBGRI Palode, etc also participated. Four ARS Trainees deputed from NAARM in two batches were imparted Field Experience Training for 45 days each. Five ARS probationeries who had joined at this institute in February for six months attachment training are being given training in 17 days orientation. In addition, the technologies on plantation crops management have been passed on to about 6000 visitors consisting of farmers from Karnataka, Tamil Nadu, Andhra Pradesh and Goa, students of BSc (Ag.), MSc (Ag.) from TNAU, KAU, Vocational Higher Secondary Schools, DIET, Botany students of St. Aloysius College, Mangalore, BSc. and MSc. students from Thrissur, Kolancherry and Palakkad.

CPCRI along with CMFRI and CIFT Kochi organized an ICAR stall in the Thrissur Pooram Exhibition from 26th April to 23rd May, 1993. The stall bagged Gold medal, Certificate and Trophy for the best display in the category 'Pavilion Semi Major'. Insti-

tute participated in the exhibitions arranged by District Agricultural Fair 1993 at Idukki, State Agricultural Department at Attingal on 25th May, Iqbal College, Perigamala from 19th to 23rd November, 1993 and 'Festival Karavali Utsava' at Mangalore and the India International Trade Fair organized by the Ministry of Agriculture, Govt. of India during November, 1993 at Delhi. Scientists of this institute gave 27 radio talks on various aspects on plantation crops at AIR Kannur, Mangalore and Kahikuchi and a TV interview at DD Trivandrum on the oil palm technologies.

ALL INDIA CO-ORDINATED RESEARCH PROJECT ON PALMS

COCONUT

Crop Improvement

At Ambajipeta, the highest nut yield per palm per year was recorded in Laccadive Ordinary (126.7 nuts) followed by Philippines Ordinary (123.6 nuts). The maximum cumulative yield/palm was recorded in Philippines Ordinary (1511 nuts) followed by Laccadive Ordinary (1293.6 nuts). Maximum copra yield per palm per year was recorded in Philippines Ordinary (24.4 kg) followed by Laccadive Ordinary (22.4 kg) and Cochin China (20.8 kg). The performance of Gangabondam x Laccadive Ordinary and COD x WCT were found superior to other hybrids. Considering the mean nut yield for 10 years at Veppankulam, maximum nut yield was recorded in Laccadive Oridnary (98 nuts palm^{-1}year^{-1}) followed by Kappadam (81 nuts). Maximum copra yield was recorded in New Guinea (16.89 kg palm^{-1}year^{-1}) followed by Laccadive Ordinary (16.84 kg palm^{-1}year^{-1}) and FMS 15.79 kg palm^{-1} year^{-1}. In VHC-2 (ECT x MYD) average yield of 95 nuts palm^{-1} year^{-1} with copra yield of 9.4 kg palm^{-1}year^{-1} was recorded. Based on the number of nuts and copra content, Andaman Ordinary was identified as superior to local tall (ECT) and it was released as VPM-3 by the Tamil Nadu State Variety Release Committee. Considering the overall performance the hybrid, ECT x MRD is promising with copra yield of 18.4 kg palm^{-1}year^{-1}. In the germplasm trial at Ratnagiri 15 years average yield was maximum in Laccadive ordinary (150 nuts palm^{-1}year^{-1}) followed by Pratap (145 nuts). In oil yield, Philippines Oridnary stood first (15.76 kg palm^{-1}year^{-1}) followed by Laccadive Oridnary (15.64 kg palm^{-1}) and Pratap (15.03 kg palm^{-1}). At Mondouri, average nut yield per/palm was highest in Jamaical Tall (79.7 palm^{-1}) followed by FMS Big (73.8 palm^{-1}). Among the hybrids, average nut yield palm^{-1}year^{-1} was maximum in COD x WCT (52 nuts palm^{-1}year^{-1}) followed by WCT (39.6 per palm). Tender nut water was found sweet in Andaman Oridnary, Philippines Oridnary and MYD x WCT.

Crop Production

At Ambajipeta, the highest nut yield (98.2 nuts per palm) was recorded

in the treatment $N_1P_3K_1$ (500:750:750 gm/palm) followed by $N_3P_3K_2$ (1500:750: 1250gm palm^{-1}year^{-1}) with 95.5 nuts per palm. Maximum copra yield per palm (17.2 kg) was recorded in $N_2P_2K_2$ (1000:500:1250 g palm^{-1} year^{-1}) treatment followed by $N_1P_3K_1$ (500:750:75) g palm^{-1} year^{-1}) with 14.4 kg per palm.

At Konark, maximum annual and cumulative nut yield were recorded in treatment $N_3P_3K_3$ (1000:750:1750 g palm^{-1} year^{-1}). At Mondouri, nut yield recorded was maximum (399.1 per palm) in treatment $N_3P_1K_1$ (1500:250:750 g palm^{-1} year^{-1}) followed by $N_3P_1K_2$ (1500:250:1250 g palm^{-1} year^{-1}) with 381.6 nuts per palm.

At Ratnagiri palms receiving highest dose of 'N' (1000 g per palm) recorded highest nut yield. The yield was also influenced by PxK interaction. On P_1K_0 (250:0g) and P_2K_2 (500:2000 g), yield of 54.4 and 54.4 and 54.32 nuts palm^{-1} yr was recorded respectively. Treatment combinations $N_2P_2K_2$ (1000:500:2000) recorded highest annual yield (131.4 nuts). At Veppankulam, the NPK ferilizer treatments on EC Tall coconut did not show any statistically significant difference in yield. However, economic dose was fixed based on the cost of fertilizer. The treatment $N_2P_2K_3$ (1000:500 g/palm) recorded an average yield of 73.1 nuts palm^{-1} year^{-1} with fertilizer cost of Rs. 24.65 palm^{-1} year^{-1} whereas treatment $N_1P_2K_1$ (500:500:750 g palm^{-1} year^{-1}) recorded an average yield of 72.1 nuts palm^{-1} year^{-1} with a fertilizer cost of only Rs. 15.35 palm^{-1} year^{-1}.

In the irrigation cum fertilizer trial at Veppankulam the mean nut yield increased in post treatment period in all the treatments. Basin irrigated palms recorded an average yield of 81.1 nuts palm^{-1} year^{-1} which is 22.9% more over control. The next best treatment was irrigation @ 100% E_0 recording 2 nuts/palm. Lowest button shedding was noticed in basin irrigated plots. At Ratnagiri basin irrigation was significantly superior increasing the yield (69.2 nuts palm^{-1} year^{-1}) as compared to 62.6 nuts in drip irrigation.

In the mixed cropping trial at Ratnagiri the yield of coconut palm has increased gradually after planting the mixed crops. As compared to the pre-treatment yield, the average yield palm^{-1}year^{-1} has increased from 30.8 to 95.1 per cent at the end of 11th year in different blocks. The maximum yield increase was in clove block and least in black pepper block. At Veppankulam, mixed cropping Model-I with banana and pineapple gave highest total net return per unit area (Rs. 2,055/ha) followed by Model-II with banana, guava and yam (Rs. 16,764/ha). The cost benefit ratio worked out for the system was 1:4.2, 1:3.3 and 1:2.6 in Model-I, Model-II and control plots respectively. At Ambajipeta, there was significant increase in coconut yield when compared with the yield prior to the imposition of crop models. In Model-I, the coconut yield per palm was 158.1 nuts as against the pre-treatment yield of 72.3 nuts; whereas in Model-II, it was 147.9 nuts per palm as against pre-treatment yield of 70.0 nuts per palm. At Kahikuchi high density cropping was found better rewarding than monocropping of coconut. Model-I with black pepper, banana, Assam lemon, pineapple and ginger was found

more remunerative over Model-II and control.

Crop Protection

Pathology

At Ambajipeta, preliminary tests by ELISA technique showed positive reaction of the *Ganoderma* antiserum with root, stem and leaf samples from diseased trees only. Three more isolates of *Ganoderma sp.* have been obtained from coconut and other trees. None of the coconut cultivars/hybrids tested was found resistant to *Ganoderma* wilt disease.

Out of the four methods tried artifically at Aliyarnagar, to prove the pathogenicity, there were no progress in the disease in three methods. Subabul seedlings planted near the apparently palms did not rot. Increase in soil temperature influenced the progress of the disease and that has reflected in the increase in the bleeding patches. Minimum wilt (Ganoderma) was noticed in neem cake 5 kg + Tridemorph 0.3% drenching and neem cake 5 kg + Kitazin 0.3% drenching (25%) treatments, whereas the control plot recorded 100% wilting. In the field trial initiated during 1987 at Veppankuam, the disease intensity recorded upto September, 1993 indicated that root feeding of Tridemorph was the most effective treatment (D.I. = 52.4) followed by AF+BM+NC (58.6) as compared to 98.5 in control. In the study with *Trichoderma harzianum* in different organic amendment in the management of Thanjavur wilt, observations recorded upto October, 1993 indicated that *T. harzianum* in green leaves (50 kg) neem cake (5 kg) and FYM (50 kg) + Bordeaux mixture 1% (40 lit.) treatment was effective. At Aliyarnagar, out of the 2370 palms inspected, five palms were found infected with root (wilt) disease. Two palms were removed and destroyed and the spread of the disease is being monitored.

Entomology

At Aliyarnagar, survey with incidence of coconut leaf eating caterpillar *Opisina arenosella* was continued in the coconut growing areas of Pollachi tract, Udumalpet and nearby areas, and the incidence was found to be nil. The surveillance of coconut pest rhinoceros beetle *Oryctes rhinoceros* on palms was continued in the garden at Pollachi, Palghat and border areas of Udumalpet taluks. Mass culturing of coconut rhinoceros beetle and baculovirus are in progress. Post release observations were taken.

At Ratnagiri, highest pest population of coconut leaf eating caterpillar was recorded during the month of October. Observations on the record of larval parasitisation indicated that the *Goniozus nephantidis* ranged from 5 to 8.33 per cent. The pupal parasitisation ranged from 6.7 to 25 per cent. From infested palms 25 grubs and 20 beetles of rhinoceros were collected. The visual observations of 15 grubs indicated the presence of virus disease in the natural population of rhinoceros grubs.


WELCOME