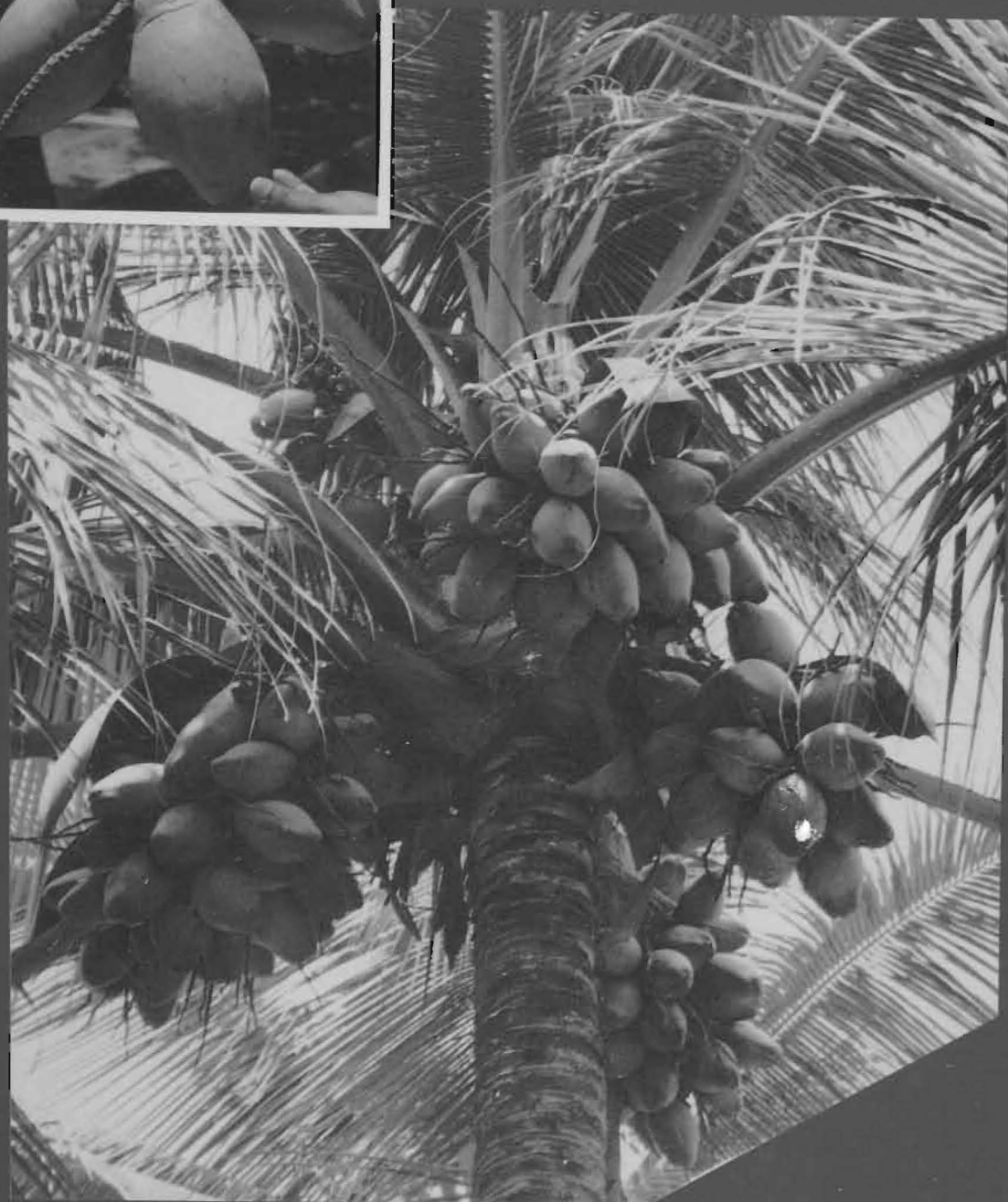


# RESEARCH HIGHLIGHTS 1992-93



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

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## **1992-93**



**CPCRI**

**CENTRAL PLANTATION CROPS RESEARCH INSTITUTE**

**(Indian Council of Agricultural Research)**

**KASARAGOD 671 124, KERALA, INDIA**

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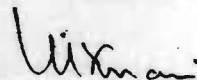
## INTRODUCTION

Considerable strides have been made in the research front of plantation crops since the establishment of Central Plantation Crops Research Institute in 1970. Three coconut hybrids released by the Institute give 20% to 40% more yield than the local cultivar, West Coast Tall. The cropping systems developed at the Institute if adopted not only increase the productivity of coconut but also provide more employment opportunity and higher income from unit area spread throughout the year. The improved input technologies developed at the Institute have the potential to give an average yield of 175 nuts palm<sup>-1</sup> year<sup>-1</sup> in Kerala and over 250 nuts palm<sup>-1</sup> year<sup>-1</sup> under well-maintained gardens in Andhra Pradesh.

Research efforts of the Institute by way of evolving improved varieties and associate technologies combined with vigorous developmental activities had considerable impact in increasing the production and productivity of arecanut in the country.

The Institute had the foresight to initiate research on oil palm at its Palode Centre more than a decade before the Govt. of India embarked upon oil palm area expansion programme in the country. The introduction of cocoa in the early seventies by the Institute and mixed cropping trials with arecanut at Regional Station, Vittal proved that cocoa is one of the profitable intercrops in arecanut garden. These findings had played a significant role in expanding the area under cocoa particularly as a mixed crop in arecanut gardens in the country.

In spite of these achievements, there is no room for complacency since some of the major problems facing the palm and cocoa farmers have eluded remedies so far. Though unquestionable evidences have accrued for the MLO etiology of root (wilt) disease based on electron microscopic studies, transmission trials and the antibiotic therapy, reports often appear questioning the etiology, besides many baseless claims of finding remedies to control the disease. Probably the enormous crop loss caused by this disease attracts attention of every coconut farmer and with this there exists room for controversies and claims. Another major problem facing the Institute is the yellow leaf disease of arecanut which causes very heavy crop loss in Kerala as well as in Karnataka. The Institute faces these and many more challenges and always strives to reorient the research programmes based on the feed back received from the extension specialists and farmers. We present here the achievements made by the Institute during the past one year, on the eve of finalising the research programme for the coming year.



(M.K. Nair)  
Director



## भूमिका

केन्द्रीय रोपण फसल अनुसंधान संस्थान जिसकी स्थापना सन् 1970 में हुई, ने रोपण फसल की अनुसंधान में विचारणीय प्रगती की है। इस संस्थान से उत्पादित तीन नारियल संकरों से सामान्य प्रजाति डब्लू. सी. टी. से 20% से 40% अधिक उपज प्राप्त होती है। इस संस्थान से विकसित संस्थान पद्धति न केवल नारियल की उत्पादन क्षमता पर, बल्कि वर्ष भर में प्रति हेक्टर अधिक आय एवं नौकरी प्रदान करती है। इस संस्थान से विकसित उन्नति तकनीकियों से आन्ध्रप्रदेश में 250 टूटफल/ताड़/वर्ष एवं केरल से 175 टूटफल/ताड़/वर्ष औसत उपज देने की क्षमता रखते हैं।

अनुसंधान प्रयासों से उन्नत प्रजातियों के विकास एवं सम्बन्धित विकासन पद्धतियों की तकनीकों के सहयोग से देश में सुपारी के उत्पादन एवं उत्पादकता बढ़ाने में इस संस्थान में अधिक योगदान दिया है।

भारत सरकार के देश भर में तेल ताड़ के विकास कार्यक्रम के प्रारम्भ करने से एक दशक पूर्व ही इस संस्थान के पालोड़ केन्द्र में तेल ताड़ की खेती प्रारम्भ कर दूरदर्शिता का प्रदर्शन किया। इस संस्थान में कोको तथा सुपारी एवं कोको की मिश्रित खेती के परीक्षण सत्रहवीं दशक के पहले ही क्षेत्रीय स्टेशन विट्टल में प्रारम्भ की गयी थी। इन परिणामों से देश में सुपारी के साथ कोको की मिश्रित खेती के विकास में महत्वपूर्ण भूमिका निभाई है।

इन उपलब्धियों के होते हुए भी संतुष्टी की कोई बात नहीं है क्योंकि ताड़ एवं कोको के मुख्य समस्याओं का सुधार नहीं किया है। यद्यपि सूक्ष्मदर्शी अध्ययन, संक्रामण परीक्षा तथा रोगाणुनाशी चिकित्सा के आधार पर रूट विल्ट के रोग में एम. एल. ओ. हैतुकी के लिए निःसंदेह साक्ष्य प्राप्त होते हुए भी साधारणतः रिपोर्ट हैतुकी पर प्रश्न चिन्ह लगाने के अतिरिक्त रोग नियंत्रण की कुछ कम उपलब्धियाँ हैं। सम्भवतः इस रोग द्वारा भीषण फसल क्षति के कारण ही प्रत्येक नारियल कृषक का ध्यान इस ओर गया है और यह एक विवाद का विषय बना हुआ है। यह संस्थान इनके अतिरिक्त अन्य चुनौतियों का सामना करने के लिए अनुसंधान कृषकों एवं प्रसार अधिकारियों से जानकारी प्राप्त कर अनुसंधान में सुधार लाने हेतु सतत प्रयासरत है। हम अनुसंधान काउन्सिल के समापन के अवसर पर गतवर्ष की उपलब्धियाँ प्रस्तुत करते हैं।

एम. के. नायर

कासरगोड  
15 अप्रैल, 1993

(एम.के. नायर)  
निदेशक

## CROP IMPROVEMENT

### GENETIC RESOURCES

Two hundred and fifty nuts of Gudanjali Dwarf coconut cultivar were collected from Gujarat. Out of 200 nuts sown in the nursery, 120 have germinated. Nut component analysis in this cultivar revealed that weight of whole fruit is 398.7 g, weight of nut is 229 g, with a copra content of 81.2 g and oil content of 68%. In addition to this cultivar, seedlings from cultivars East Coast Tall, Navasi and Hazari were also procured. A total of 130 accessions of coconut cultivars are now available at CPCRI.

The yield evaluation of 16 cultivars planted in 1972 has shown that Laccadive Micro continued to be superior with respect to number of nuts as well as copra out-turn (174 nuts and 25 kg copra palm<sup>-1</sup> year<sup>-1</sup>) compared to other cultivars.

Out of 810 palms from 22 Pacific Ocean collections maintained at the World Coconut Germplasm Centre, Andamans, 789 palms have flowered so far (fig. 1). Oil estimation in 14 of these collections revealed the maximum oil content of 68% in Acc. No. 9 (Tutiala from

American Samoa) and Acc. No. 20 (Tall Kiriwana from Papua New Guinea).

In arecanut, 19 more accessions collected during the year from North-Eastern region of the country were added to the germplasm block at Vittal bringing the total to 87 accessions.

Nineteen cocoa accessions received from University of Reading U.K. through Dr. N. Vikraman Nair of Kerala Agril. University were added to the germplasm maintained at Vittal bringing the total cocoa germplasm holding to 124 accessions.

Among the oil palm introductions planted in 1981 and 1982, the tenera hybrids from Ivory Coast produced significantly more number of bunches and higher fresh fruit bunches (FFB) than those from Nigeria. The teneras introduced from Republic of Zaire and the indigenously produced teneras did not differ significantly in yield.

### Evolving high yielding varieties by selection and hybridization

Leaf analysis of prepotent mother palm (39.2.1/205) and its open-pollinated progenies revealed the presence of higher levels of total protein, total chlorophyll, phenols and higher RNA content as compared to non-prepotent mother palm and its open-pollinated progenies. However, the protein and phenol levels were comparable between the prepotent mother palm and its progenies.

In the comparative yield trial planted in 1981 under rainfed condition, WCT and



Fig. 1. A heavy bearing tree from Fiji maintained at WCGC, Andamans.

COD x WCT were found to be superior with a cumulative nut yield of 137 and 114 nuts respectively compared to only 74 nuts in MAWA.

In arecanut, hybrid seedlings of Hirehalli Dwarf and Mangala and their reciprocals had higher girth at collar and number of leaves and medium height compared to their parents.

Leaf phenolic content of Hirehalli Dwarf and adult palms of Sumangala were significantly different indicating their possible role in auxin metabolism and hence the height of the palm.

In oil palm, cumulative yield data for 13 years (1980-92) showed that the combinations 65 d x 30.103 p and 120 d x 30.103 p were the high yielders among 11 *tenera* hybrids planted in 1976 under rainfed condition. A maximum average yield of 164 kg ffb palm<sup>-1</sup> was obtained in the case of 65 d x 30.103 p in 1986 and the maximum average number of bunches produced was 12.8 in 271 d x 30.433 p. The best individual palm ffb yield was 324 kg (estimated oil yield of 9 MT ha<sup>-1</sup>). During the year 167,361 sprouts/seedlings of oil palm hybrids were supplied to various agencies.

## **Tissue, cell and anther culture**

### **Coconut**

Twenty-three plantlets grown *in vitro* from zygotic embryos collected and inoculated in the field using a portable plexiglass inoculation hood were transferred, after 12 months in culture, to pots containing sterilized soil-sand-coir mixture and irrigated with Hoagland's nutrients. These plantlets could be established in the pots after subjecting them to hardening treatment for two months during which time the humidity in the vicinity of the plantlets was gradually reduced by covering with perforated polythene bags followed by partially lifting the cover during day/night. There was no mortality of plantlets by this method and all the plantlets have produced 1-2 new leaves after transfer to pots. The plantlets are exposed to normal day/night conditions in the open before transplanting to main field.

At Kayangulam, embryos were grown *in vitro* upto planting stage. Research on induction of multiple shooting showed that more than one plantlet can be grown from an embryo by cutting the embryonal axis manually.

## CROP PRODUCTION

### Soil fertility, nutrient dynamics and crop productivity

Studies on slow release N fertilizer showed the superiority of urea formaldehyde over NP tablet and urea in respect of number of leaves, female flowers produced, soil available nitrogen and yield. Higher concentration of leaf Mn in urea treatment and higher leaf Fe, Cu and Zn content in NP tablet treatment were recorded.

Among the sources and levels of Mg used for coconut, magnesium carbonate was superior to magnesium sulphate. Exchangeable Mg concentration in the soil and leaf Na showed significant positive correlation with leaf Mg and leaf Na.

Use of 250 g Na + 750 g K and 500 g Na + 500 g K palm<sup>-1</sup> year<sup>-1</sup> showed potassium level on par in soil. Significantly higher concentration of available sodium was recorded in treatment applied with 750 g Na + 250 g K. Control plot registered significantly lower chloride content compared to other treatments. There was however, no significant difference in coconut yield between treatments.

### Increasing nutrient availability and disease alleviation by micro-organisms

Fungal and bacterial cultures isolated from coconut based cropping systems which were efficient in solubilization of insoluble phosphates, were tested for competitive saprophytic ability and survival in soil, respectively, in order to select suitable cultures for inoculation trials. *Aspergillus niger* and *Penicillium citrinum* were the fungi which pos-

sessed better competitive saprophytic ability whereas bacteria such as *Bacillus subtilis*, *Bacillus polymyxa* and *Pseudomonas* spp. showed better survival in sandy, sandy-loam and laterite soils.

Bioassay using sorghum as test plant showed that *Azospirillum* cultures isolated from coconut roots had growth-promoting effect as evidenced by increased biomass and branching of roots of the test plant.

### Symbiotic association of VAM with coconut and other plantation crops

There was positive relationship between Vesicular Arbuscular Mycorrhiza colonization in roots of coconut cultivars/hybrids and water relation aspects namely stomatal resistance and leaf water potential. Comparison of colonization pattern of VAM during and after the stress revealed the superiority of MYD x WCT over COD x WCT and MOD x WCT in harbouring higher level of colonization in roots during stress period.

Species composition of Vesicular-Arbuscular Mycorrhiza present in the rhizosphere of five each of drought tolerant and drought susceptible Nigerian accessions of cocoa grown at Vittal were studied. A total of eleven species belonging to four genera were recorded in both groups. In general, they did not exhibit any distinct pattern of distribution except for *Glomus versiforme*, the predominant species prevalent in the drought tolerant group. This was encountered in four out of five accessions studied, with an average spore density of 10.4, whereas this was present only

in one out of five of the drought susceptible accessions with an average spore density of 1.6.

### **Stress and Production Physiology**

The screening for drought tolerance of seedlings revealed that the crosses involving FMS and Fiji as male parents with all the three dwarfs viz., MYD, CGD and COD as females had relative tolerance to stress as indicated by lipid peroxidation, an indicator of membrane stability and leaf water potential.

The juvenile stage tolerance to moisture stress was found in LO, WCT x GB, Benaulim, LO x COD and LO x GB, while the drought susceptibility of COD x WCT was further confirmed.

The level of stress proteins increased by 36 to 40% in the drought tolerant palms (LO x GB, LO x COD, WCT x COD and LO) while there was no change in the susceptible palms (GB, COD and MYD) irrespective of the nature of stress (osmotic or desiccation), thereby indicating the association of stress proteins with drought tolerance.

A stress induced increase in RNA levels

with concomitant suppression of DNA was noticed, with variations between the drought tolerant and susceptible genotypes.

Drought tolerant palms showed a positive correlation between stomatal conductance and photosynthetic rate. The harvest index was highly correlated with total dry matter and reproductive dry matter but not with vegetative dry matter.

### **Perennial crop based farming systems**



Fig. 2. Day old Giriraj chicks hatched from Incubator kept in the mixed farming system.

In the coconut based high density multispecies cropping system model (HDMSCS) established in 1983 at Kasaragod, the productivity of coconut was not affected



Fig. 3. A view of harvesting fish in the pond attached to the mixed farming system.

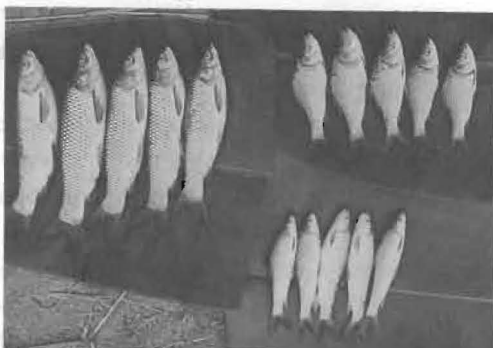


Fig. 4. A view of different varieties of fish.



by the application of graded levels of fertilizers to coconut and other component crops. The mean yield of nuts palm<sup>-1</sup> year<sup>-1</sup> during the period July 1991 to June 1992 was 143, 145 and 145 in one-third, two-thirds and full doses of manuring respectively, indicating scope for reducing the quantity of chemical fertilizers applied to HDMSC systems by recycling the available biomass within the system.

The second generation mixed farming unit started in 1989 in a one hectare garden having 30 year old coconut palms, yielded 16,733 coconuts, 9305 litres of milk, 250 kg banana, 608 kg poultry (live weight) (fig. 2), 965 hen's eggs, 276 numbers of quails, 3359 quails' eggs, 24 kg rabbit (live weight) and 130 kg fish (fig. 3 & 4). The total revenue from this farming system was Rs. 1,56,621/- and expenditure excluding cost of family labour was estimated at Rs. 1,05,343/- resulting in a net income of Rs. 51,278/-. This included Rs. 10,603/- realized from the sale of poultry birds, quails, eggs, rabbits and fish.

Among the vegetable crops grown as intercrops in coconut garden during rainy season, snakegourd gave the highest yield (5180 kg ha<sup>-1</sup>), followed by brinjal (4060 kg ha<sup>-1</sup>), and amaranthus (3640 kg ha<sup>-1</sup>). In rabi season under irrigation, bottlegourd gave the highest yield (4800 kg ha<sup>-1</sup>) followed by *coccinia* (2840 kg ha<sup>-1</sup>) and ridgegourd (2500 kg ha<sup>-1</sup>). Economic analysis of the data revealed that in rainy season snakegourd gave the highest net returns (Rs. 7740 ha<sup>-1</sup>) followed by brinjal (Rs. 6235 ha<sup>-1</sup>) and bittergourd (Rs. 3520 ha<sup>-1</sup>). In rabi, bottlegourd gave the highest return (Rs. 4780 ha<sup>-1</sup>) followed by *coccinia* (Rs. 4440 ha<sup>-1</sup>).

In the arecanut-based HDMSCS model at Vittal started in the year 1983, the yield of arecanut was reduced during the year due to the incidence of *Mahali* disease. It was only 1819 kg ha<sup>-1</sup>. This cropping system also yielded 4875 kg cocoa pods (210 trees), 89.1 kg dry pepper (450 vines) and 15.5 kg dry clove (180 trees).

At Hirehalli, 0.92 ha of Model-I of arecanut-based HDMSCS yielded 3540 kg arecanut chali, 4755 kg cocoa pods and 986 kg dry pepper. The Model-II (0.89 ha) consisting of arecanut + banana + lemon + betelvine produced 3470 kg arecanut chali, 2761 kg banana fruits and 685,800 number of betel leaves.

In the second generation arecanut based HDMSCS model at Vittal, the productivity of arecanut and cocoa had increased with increasing levels of fertilizer application. The arecanut yield increased from 1277 kg ha<sup>-1</sup> under 'no fertilizer application' to 2395 kg ha<sup>-1</sup> under 'full dose' of fertilizers. Similarly, the cocoa yield increased from 366 kg pods ha<sup>-1</sup> (no fertilizer application) to 1896 kg ha<sup>-1</sup> (full dose). However, in the case of black pepper, the yield increase was noticed only upto the one-third dose of fertilizer application.

At Hirehalli, the productivity of arecanut in the second generation arecanut based HDMSCS model started in 1990, was higher in the different cropping systems compared to the monocrop of arecanut. Yield of arecanut in the monocrop (control) was only 2571 kg chali ha<sup>-1</sup> as against 3016 kg ha<sup>-1</sup> in arecanut + banana, 2876 kg ha<sup>-1</sup> in arecanut + pepper and 2964 kg ha<sup>-1</sup> in arecanut + banana + pepper.

## PRODUCTION OF PARENTAL MATERIALS AND BREEDERS' STOCK

In coconut, over 50,746 WCT seednuts were produced of which 29,080 seednuts were supplied to various agencies including 14,000 seednuts to Coconut Development Board, Cochin. Over 12,000 WCT seedlings, 1601 seedlings of dwarf varieties, 1674 seedlings of released hybrids, 627 seedlings of open pollinated varieties and 867 seedlings of *inter se* varieties were supplied to farmers/DRDA, Kasaragod.

In arecanut, 5,29,107 seednuts and about 90,701 sprouts/seedlings of released cultivars were supplied to farmers and Department of Horticulture.

In oil palm, a total of 2,39,103 seeds, 1,59,182 sprouts and 6196 seedlings were produced. Out of these, 1,58,365 sprouts and all the seedlings produced, were supplied to different agencies.

## CROP PROTECTION

### Root (wilt) Disease of Coconut (RWD)

EM examination showed that MLOs were not present in RWD suspected palms in Kasaragod district and Minieoy.

Root (wilt) disease, a debilitating malady of coconut characterised by the flaccidity of leaflets manifests certain distinct changes in the vascular tissues. Sieve tubes of tender roots and rachilla of diseased palms exhibit an elaboration of the membrane system and related cell organelles, accumulation of P-protein (slime bodies) and clusters of electron dense crystals. Protophloem elements were often compressed and had osmiophilic bodies indicating necrotic obliteration. These anomalies reflect the host-parasite interaction.

Breeding for resistance/tolerance to root (wilt) disease has been further intensified. At present, 94 disease-free and high yielding mother palms in 'hot spots' are being artificially pollinated for raising progenies for screening against root (wilt) disease. New trials involving 429 progenies of 46 cross combinations

made in 'hot spots' of Alapuzha, Kottayam, Kollam and Pathanamthitta districts were laid out in CPCRI (RS) Kayangulam farm. A Cess Fund Scheme on 'Hot spot survey for elite disease-free coconut palms and breeding for resistance/tolerance to root (wilt) disease' is in operation.

An amount of Rs. 82,200/- was disbursed as compensation for the RWD palms removed in the belt area of Thrissur. One hundred and twenty DxT seedlings were distributed among the cultivators in Thrissur district in lieu of their RWD palms removed. One hundred thirty three palms were confirmed as Root (wilt) diseased in Kannur district during 1992-93.

### Leaf rot disease of coconut

Fungal isolations from spindles of leaf-rot affected coconut palms established preponderant association of *Colletotrichum gloeosporioides*, *Exserohilum rostratum*, *Gliocladium vernoesei* and *Fusarium* spp. (*F. solani* and *F. moniliforme* var. *intermedium*), with the disease. *Thielaviopsis paradoxa*,



*Rhizoctonia solani*, *Cylindrocladium scoparium*, *Pythium* sp. and *Acremonium* sp. were isolated generally in low frequency from advanced lesions. Independent occurrence of different fungi from early lesions assumes significance in the etiological complex of leaf rot.

Studies on *in vitro* interactions among different fungi showed that except *F. moniliforme* var. *intermedium*, *Cylindrocladium scoparium* and *Acremonium* sp. all other fungi were fast growing. Two extreme ends of interactions observed were : (i) where the predominant fungi grew into one another without any sign of interaction to, (ii) where the fungi *F. solani* and *F. moniliforme* var. *intermedium* independently showed strong antibiosis on *T. paradoxa*, *R. solani* and *Pythium* sp. Such an antibiosis effect was also observed in the combinations of *C. scoparium* on *T. paradoxa*, *T. paradoxa* on *R. solani* and *R. solani* on *Pythium* sp.

Field control trial involving calixin (Tridemorph) (0.1%), Dithane M-45 (0.3%) and Fytolan (0.5%) indicated that pouring of 1 litre of any of these chemicals into axil around the spindle of the crown of leaf rot affected palms, reduced the disease intensity on leaves that emerged after treatment in comparison to control. Spraying Dithane M-45 was more effective compared to calixin.

#### Stem bleeding disease of coconut

Field control trials involving various systemic fungicides applied to the stem bleeding affected palms, through different methods of application, showed that Calixin (5%) when applied through root feeding was effective in reducing the spread of the lesion on the trunk, in addition to stem injection

method reported earlier.

Eleven bacterial isolates obtained from stem bleeding management trials at Uduma and Edaneer were found to be antagonistic to *T. paradoxa*. Four isolates of *Gliocladium virens* (A4, 10B, 3B and C.G) produced diffusible substances which were fungicidal to *T. paradoxa*. Survival of *T. paradoxa* in the soils amended with *G. virens* and *Trichoderma harzianum* was found to be less (65% and 67.5% bait infection respectively) as compared to the non-amended soils (95.2% bait infection).

Screening of germplasm against *T. paradoxa* using detached frond inoculation technique revealed that all the nine varieties/hybrids screened (COD, CGD, MGD, Tiptur tall, Benaulim, COD x WCT, WCT x COD, LO x COD and LO x GB) were susceptible to *T. paradoxa* in different degrees. Maximum lesion size was noticed on MGD (370.6 cm<sup>2</sup>) and the minimum lesion size was observed on Benaulim (64.5 cm<sup>2</sup>).

#### Studies on Thaniavur wilt/Ganoderma wilt

In the pathogenicity trials of *Ganoderma* on coconut, stem block inoculation technique produced gummosis on two palms out of 10 palms inoculated, showing the disease pick up after a lapse of 26-28 months.

The cross inoculation studies using *Ganoderma* isolates from arecanut and coconut revealed that six out of ten arecanut palms inoculated with coconut isolate of *Ganoderma* picked up disease so far while one out of ten coconut palms inoculated with arecanut isolate of *Ganoderma* picked up the infection.

Serological studies showed fairly high

degree of resemblance between coconut and arecanut isolates of *Ganoderma*.

### **Yellow leaf disease of arecanut**

Biochemical investigation on nucleic acid and soluble proteins in the leaf tissue of YLD affected areca palms was carried out during May (symptom dormant period) and November (symptom expression period) DNA and RNA contents were quantified separately to work out the DNA/RNA ratio as marker for early diagnosis of the diseased and apparently healthy palms. The ratio did not differ between the two categories of palms. However the RNA contents were found to be higher by 30 to 50% during the disease dormant period, in both the categories of palms. Higher nuclease (RNase) activity may thus be suspected during the disease expression period.

Trials run so far have not indicated any change in the leaf protein profile of the diseased and apparently healthy palms by SDS-PAGE electrophoresis.

In the fourteen field trials conducted at three locations viz., Palode, Kannara and Vittal, the only significant observation is the continued high yield and low disease index of the cross combination Saigon x Mangala in experiment No. 2 laid out at Palode.

The studies on chlorophyll fluorescence induction parameters of healthy, apparently healthy and yellow leaf diseased arecanut palms revealed the altered values of different fluorescence indices in yellow leaf diseased palms. The results show that overall reduction of photochemical efficiency of PS II was affected in the diseased palms.

### **Black-pod disease of cocoa**

During the studies on *Phytophthora* species associated with black-pod disease of cocoa, three samples collected during 1989-90 from Mavelikkara, Alapuzha and Kottayam areas of Kerala yielded fungal isolates which were distinctly different from the species of *Phytophthora* in their cultural and morphological characteristics. The isolates were identified as *Pythium vexans* de Bary (IMI 351490). The isolates consistently produced dark brown lesions on cocoa pods within 2-3 days and covered the entire pod surface after 19-21 days of inoculation. By then, decay of internal tissues and discoloration of seeds occurred. The symptoms closely resembled that of typical black-pod disease caused by *Phytophthora palmivora*. This is the first report of pod-rot of cocoa caused by *P. vexans*.

Total DNA was extracted from vegetative mycelium of *Phytophthora* spp. causing black-pod disease and digested with two restriction enzymes followed by agarose gel electrophoresis. The ethidium bromide-stained gels examined under U.V. light showed presence of repetitive DNA fragments as discrete bands. The isolates belonging to different species of *Phytophthora* viz., *P. palmivora* and *P. capsici* had a clearly distinct pattern indicating thereby that this is an additional tool in delineating different species of *Phytophthora* causing black pod disease of cocoa.

### **Pest Management**

Re-release of baculovirus of *Oryctes rhinoceros* in a severely affected garden at Chittilappilly, could bring down leaf damage to 6.7% and spathe and spindle damage to zero as compared to 34.4% leaf damage, 12.5% spathe damage and 68.2% spindle

damage, after three years of release of the pathogen.

Under storage in cowdung the inoculum of baculovirus of *Oryctes* could maintain its infectivity upto three weeks. Baculovirus infection reduced the life span of beetles by about half of the healthy adults and minimized the fecundity of the adult females. Infection by baculovirus caused alterations in the protein, amino acid and sugar metabolism of the host. The baculovirus could be stored for a longer period using skimmed milk (0.25 g/ml) kept at 0° to 7° C as protectant.

Release of the laboratory bred bethylid, elasmid and chalcidid parasitoids at fixed norms effected a remarkable reduction in population of the leaf-eating caterpillar *Opisina arenosella* at Thodiyoor on the backwater belt of Kerala.

A rod-shaped virus, an yeast-like organism and *Pseudomonas aeruginosa* were recorded from red palm weevil grubs.

A gregarine pathogen was recorded from coconut root grub *Leucopholis*

*coneophora*. At advanced stages of infection, the grubs become completely fat-free, accumulate translucent mucous within the haemocoel and fermentation chamber becomes almost inconspicuous. In the fat body around the midgut region, milky white, spherical or elliptical cysts are formed. These spores are thick-walled and ornamented (Fig. 5a and Fig. 5b). The infected grubs died in about 30 days.

Feeding potential of the predator *Chilocorus nigritis* was found to be 120-125 crawlers of the scale insect *Aonidiella orientalis*. The scale insect reported on areca palm from Karnataka was identified as *A. orientalis* (Newstead). The predators on this scale insect were identified to be *Chilocorus circumdatus* Gyllenhal (Coccinellidae); *Aleurodothrips fascipennis* Franklin and *Podothrips* sp. (Thripidae).

Predatory mite *Saniosulus nodiceps* was reared in the lab. Preliminary studies on the feeding potential have revealed that about 15 crawlers of *Aonidiella orientalis* are consumed by a single mite in a day.

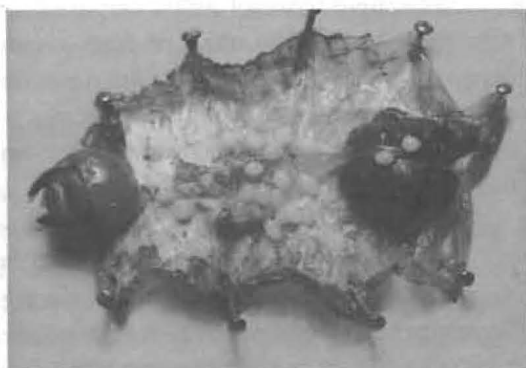


Fig. 5 a. A dissected grub of *Leucopholis coneophora* with protozoan cysts within the fat body.

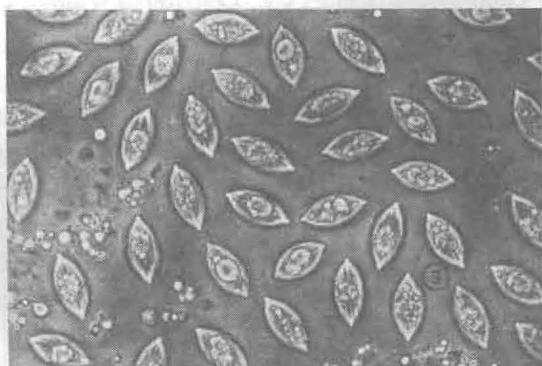


Fig. 5 b. Protozoan spores showing thick walls and ornamentation.

A survey on white grubs was conducted in coconut gardens of 24 villages of Calicut and Malappuram districts of Kerala. Out of the 77 gardens surveyed, 51 revealed the occurrence of *Leucopholis* and *Anomala* species. The degree of infestation was very high in gardens where banana was grown as intercrop. To combat arecanut white grubs, trials have been initiated with botanical pesticides. Among the plant products screened against *Leucopholis* grubs, Pongamia cake @ 2000 kg ha<sup>-1</sup> was found to be much superior to neem cake and *Vitex* leaf powder under laboratory conditions. The light trap studies conducted on *L. coneophora* demonstrated the attraction of both sexes which are in the ratio of 1:5 (female: male). Besides tender leaves of mango, adult beetles of *L. coneophora* were found feeding slightly in tender leaves of cashew, sapota, banana and coconut in laboratory cages. One unidentified species of mite was recovered from the diseased third instar white grubs collected from a field.

A predatory complex consisting of a cecidomyiid, hemerobiid and a coccinellid exerted biological suppression of cocoa aphid during its peak population build-up July. Two cerambycid beetles viz., *Cerosterna scabrator* Fab. and *Glenea* sp. nova *Scapifera* Pascoe, were reported on cocoa.

Incidence of Coreid bug *Paradasynus rostratus* Dist. in 16 randomly surveyed coconut gardens in Quilon and Trivandrum districts (Kerala) ranged from 19-82 per cent. The pest incidence was high in the field from July to January.

Avian pest damage was maximum in October to December ranging from 28.5 to 32.4 per cent of total oil palm fruits. A farmer's

technique of scaring wild boars in annual crops was modified and effectively used against the pest at Palode. The advantages are that it involves no danger to any animal species, is of low cost and high efficiency.

### Integrated Nematode Management

Phorate was found to have least deleterious effect on VAM compared to Carbofuran and Ebufos.

Residues could not be detected using Gas chromatographic method 40 days later in water and meat of tender coconuts and in water, meat, copra, coconut oil and oil cake of mature nuts of palms treated with Nemacur @ 3 g a.i. palm<sup>-1</sup> in the crown and 10 g a.i. palm<sup>-1</sup> in the basin. The treatments were repeated after three months on the same palms. Second set of samples collected 46 days after the treatment also did not show residues beyond tolerance limit.

The coconut cultivars viz., Gujarat Zanzibar and Nicobar were found to be highly susceptible to the burrowing nematode, *Radopholus similis*.

The field control trials initiated at Kasaragod in 1990 by using phorate, neem cake and glyricidia leaves in different doses on arecanut, arecanut + banana and arecanut + black pepper have significantly brought down the nematode population.

A nematode survey was conducted in Kerala, Karnataka and Tamil Nadu during September and October 1992. A total of one hundred and fifty one samples (both soil and root) were collected from oil palm (77), coconut (45) and cacao (29).

## HARVEST AND POST HARVEST TECHNOLOGY

### Small scale palm oil extraction unit

A small scale palm oil extraction unit has been developed at a cost of Rs. 3 lakhs. This unit with a capacity to process 200 kg of fresh fruit bunches per hour, can cater to the need of upto 30 ha of oil palm plantation. All the equipments and parts of this unit were designed and fabricated indigenously. The required

steam for processing is met from a non-IBR steam boiler which can be operated by using oil palm bunch waste as fuel.

### Oil palm depericarper

To remove the seed from oil palm fruit, a depericarper has been developed at a cost of Rs. 20,000/-. Its capacity is 20 kg of fruit.

## REFINEMENT OF EXPERIMENTATION TECHNIQUES IN PLANTATION CROPS

Phenotypic stability for annual yield of nuts in 11 coconut cultivars planted during 1972 were compared by means of rank stability statistics after correcting the data for genotypic effects as well as for differences in pre-bearing periods. The cultivars Philippines Ordinary, Cochin China and Andaman Ordinary are more stable varieties but poor in yield. West Coast Tall is found to have medium stability as well as good yield.

Investigations on application of non-parametric methods in coconut experiments revealed that tests like Kruskal-Wallis and Mann-Whitney are as efficient as their parametric counter parts CRD and t-tests.

Examination of long term trends in oil palm yield during the first 16 years after planting revealed an increasing trend for total weight of FFB upto the 14th year, whereas the mean bunch weight was showing a rising trend even at the 16th year. The peak yields obtained during 1986 and 1990 (10th and 14th year) were found to be more due to increased bunch production. In general, about 44% of the total

yield was obtained during the quarter April to June, while the five month period March to July accounted for over 2/3rd of the total harvest. The increased share of production during this period was found to be due to both increased number of bunches harvested and proportionately higher weight of bunches. A simple regression equation, using the partial harvest data for March to June as the independent variable was found to predict the annual yield with an  $R^2 = 0.51$ .

Similar studies using cocoa yield data showed that the maximum yield is obtained during June (25%). About 73% of the yield is obtained during the six month period, March to August. Based on crop weather studies a regression model has been developed to predict the quarterly yield of cocoa (no. of pods) three months in advance with an  $R^2 = 0.81$ , based on 21 predictor variables from four observed weather parameters.

Computer softwares for information retrieval of weather data and project information were developed.



## AGRICULTURAL ECONOMICS

### Impact of hike in input prices on coconut production costs and returns

The cost of production of WCT variety of coconuts when grown under rainfed condition with recommended package of practices in a root (wilt) disease-free track of Northern Kerala has been estimated at Rs. 2.59/nut given the

1992-93 input prices. This was only Rs. 1.10/nut under similar situation with 1982-83 factor costs. The rise in production cost by 135% over a period of last ten years could be attributed to the steep rise in the unit costs of inputs mainly labour wages (by 75%), fertilizer costs (by 161.6%) and Bank interest rates (by 40%).

## TRANSFER OF TECHNOLOGY

During the year a total of ten sheduled training courses, three at Kasaragod, two at Kayangulam and five at Palode were organized. One hundred officials from 11 states and two union territories attended the courses at Kasaragod, Kayangulam and Palode. The institute also organised 56 one-day special training for 1467 trainees, and 16 short duration training (3-15 days) courses for 263 trainees from different states and union territories. In addition, the technologies on plantation crops management have been passed on to about 2000 farmers/students/officials including 3 FAO Sponsored Sri Lankan Coconut Development Officers who visited the Institute during the year.

A total of 11 Research-cum-Demon-

stration plots were maintained during the year. A net income of Rs. 7,055/- has been realized from a 0.4 ha arecanut-based mixed cropping system model started in 1984 in a farmer's field. From the coconut-based mixed cropping plot of 0.25 ha, the farmer got an additional income of Rs. 4,000/- from the subsidiary crops viz., banana and pineapple.

A Kisan Mela along with an Exhibition was organized at CPCRI Research Centre, Hirehalli during 6-7 November, 1992. The Institute also participated in 2 other exhibitions and brought out 5 extension publications and 2 books. Scientists of the institute gave 20 radio talks on plantation crops technologies and published 5 popular articles during the year.

## ALL INDIA CO-ORDINATED RESEARCH PROJECT ON PALMS

### COCONUT

#### Crop Improvement

At Ambajipeta, the cultivars Laccadive Ordinary and Philippines Ordinary yielded 127 and 118 nuts palm<sup>-1</sup> year<sup>-1</sup>, respectively and were found superior to other cultivars. Among the promising hybrids, GB x LO was found superior to other hybrids with an yield of 81 nuts palm<sup>-1</sup> year<sup>-1</sup>. At Veppankulam, the out-turn of copra for the three hybrids viz., VHC-2, WCTxCGD and VHC-1 was more than 18 kg palm<sup>-1</sup> year<sup>-1</sup>. The average number of nuts palm<sup>-1</sup> year<sup>-1</sup> (av. for 14 years) at Ratnagiri for Laccadive Ordinary and Pratap were 150 and 146 respectively. At Mondouri, the cultivar Jamaican Tall gave the highest yield of 92 nuts palm<sup>-1</sup> year<sup>-1</sup> followed by B.S. Island (80 nuts palm<sup>-1</sup> year<sup>-1</sup>).

#### Crop Production

At Ambajipeta, the highest yield was recorded in the fertilizer treatment of N3P1K2 (1.5 kg N + 0.25 kg P<sub>2</sub>O<sub>5</sub> + 1.25 kg K<sub>2</sub>O) with 102 nuts palm<sup>-1</sup> year<sup>-1</sup> followed by the treatment N<sub>3</sub>P<sub>1</sub>K<sub>1</sub> (1.5 kg N + 0.25 kg P<sub>2</sub>O<sub>5</sub> + 0.75 kg K<sub>2</sub>O) with 92 nuts. At Veppankulam, the treatment 1 Kg N + 0.5 kg P<sub>2</sub>O<sub>5</sub> + 1.75 kg K<sub>2</sub>O per palm gave the highest mean yield of 69 nuts palm<sup>-1</sup> year<sup>-1</sup> compared to 31 nuts palm<sup>-1</sup> year<sup>-1</sup> in the control (N<sub>0</sub>P<sub>0</sub>K<sub>0</sub>). At Mondouri, the higher levels of nitrogen significantly increased the nut yield palm<sup>-1</sup> (82 nuts).

At Ambajipeta, in coconut based HDMC system, the coconut yield in Models I and II was 138 and 143 nuts palm<sup>-1</sup> year<sup>-1</sup>, respectively, which was 90 and 104 per cent increase over pre-treatment yield. In the coconut based HDMSC system at Kahikuchi, Model-I and

Model-II gave a gross return of Rs. 37,325/- and Rs. 34,627/- per ha, respectively as against Rs. 12,012/- per ha in coconut monocropping. At Veppankulam, banana and turmeric were found distinctly advantageous giving additional income of Rs. 7,000/- and Rs. 10,000/- per ha, respectively. The yield of coconut also increased by 20% as compared to control (no intercrop). In the drip irrigation trial in adult coconut palms, receiving 46 litres of water through drip had lowest button shedding and immature nut fall and highest cumulative nut yield of 165 palm<sup>-1</sup> (July 1988 to June 1991), compared to 127 nuts palm<sup>-1</sup>, in the control.

#### Crop Protection

##### Pathology

At Ambajipeta, the pathogenicity of *Ganoderma applanatum* in causing Ganoderma wilt disease has been established. A specific antiserum against *Ganoderma applanatum* was produced as part of an early detection procedure on Ganoderma wilt disease.

*Phytophthora palmivora* was isolated from fruit-rot on coconut and its pathogenicity was established.

At Veppankulam, a case study of 100 palms in the hot spot area for two years indicated that EDTA test is not only a dependable method, but also helpful in detecting the disease 5 to 11 months prior to the onset of external symptoms.

The field experiment conducted to study the efficacy of fungicides and neem cake indicated that, root feeding of tridemorph (2 ml in 100 ml of water at quarterly interval) is the



most effective treatment (disease index = 44.2) followed by root feeding of aerofungin sol 2 g with 1 g of copper sulphate in 100 ml water + soil drenching of 40 litres of 1% Bordeaux mixture (AF + BM + NC) which gave a disease index of 51.1 as compared to 275.1 in control. In the biological control experiment, *Trichoderma harzianum* treated Thanjavur wilt affected palms had a disease index of 18.1 as compared to 55.3 in control palms.

### Entomology

At Ambajipeta, after the release of larval parasitoids, the mean population of coconut leaf eating caterpillar has fallen steeply (93.3%). After the release of prepupal and pupal parasitoids, due to the activity of parasitoids, the

mean population of leaf eating caterpillar decreased to 188 palm<sup>-1</sup>. Ninety per cent pest suppression was achieved.

### OIL PALM

Varietal trial in oil palm is in progress at six centres and manurial-cum-irrigation trial at 4 centres. The effect of irrigation and manure was significant on growth characters in all the centres.

Seven insect pests were recorded in oil palm at Ambajipeta which included some new records on oil palm viz., a horn caterpillar *Elymnias hypermnestra undularis* along with its parasitoid *Apanteles* sp. and another leaf eating caterpillar *Phalaera* sp.

