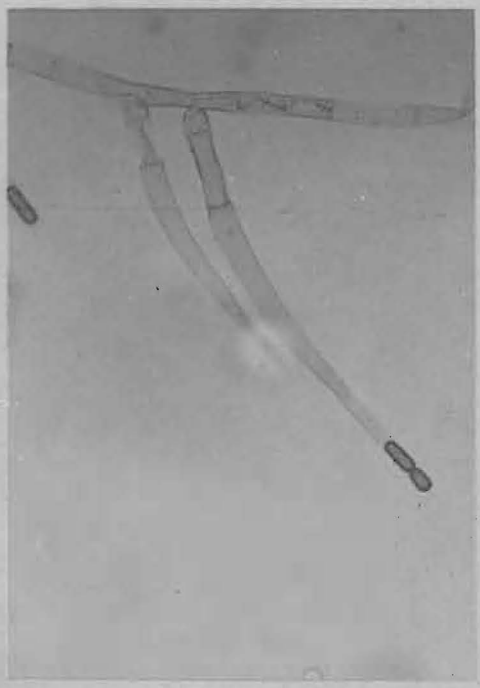
RESEARCH HIGHLIGHTS 1988



भाकृअनुप
ICAR

CENTRAL PLANTATION CROPS RESEARCH INSTITUTE
KASARAGOD 670 124 KERALA, INDIA.

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1988

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RESEARCH INSTITUTE
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Published by

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Cover Photographs

Top right: A young bearing Malayan Yellow Dwarf Coconut palm.
Bottom right: A demonstration plot showing coconut-based High Density Multispecies Cropping System.
Bottom left: Conidial stage of *Thielaviopsis paradoxa,* the incitant of stem bleeding of coconut.
Top left: Low cost large sized copra dryer.

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INTRODUCTION

The Central Plantation Crops Research Institute established in 1970, conducts and coordinates research on the production, protection and post-harvest technology of coconut, arecanut, oil palm and cocoa and acts as a Centre for Transfer of Technology with respect to these crops. The Institute has a network of two Regional Stations, two Research Complexes, five Resarch Centres, a Seed Garden and a World Coconut Germplasm Centre, spread over five States and two Union Territories.

The 'Research Highlights' of the Institute for the year 1988 presents in a concised form the important research results obtained during the year and is arranged according to the major areas of thrust, namely, production, protection, post-harvest technology and transfer of technology.

Addition to germplasm bank in cocoa, identification of sterile *pisifera* oil palms, flowering of the first batch of indigenously produced *tenera* palms, electron microscopic evidence for the presence of MLOs in the salivary glands of *Proutista moesta,* the putative vector for coconut root (wilt) and yellow leaf disease of arecanut, the usefulness of coconut water as an excellent medium for the culture of biocontrol agent *Metarhizium anisopleae,* control of rats damaging coconut by Bromadiolone and the commissioning of a demonstration palm oil mill extracting edible grade oil suitable for smaller holdings are some of the important findings of the year.

(M.K. Nair)
Director
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Kasaragod
31 January 1989

भूमिका

केन्दरीय रोपण फसल अनुसंधान संस्थान जिसकी स्थापना सन् 1970 में हुई, नारियल, सुपारी तेल-ताड़ तथा कोको के उत्पादन, सुरक्षा एवं कटाई-उपरान्त की शिल्प विज्ञान पर अनुसंधान करने तथा इन पर हो रहे अनुसंधान के समन्वयन एवं शिल्प-विज्ञान के स्थानान्तरण केन्द्र, के रूप में कार्यरत है। संस्थान के अन्तर्गत दो क्षेत्रीय अनुसंधान केन्द्र, दो अनुसंधान सम्मिश्र, पांच अनुसंधान केन्द्र, एक बीज-उत्पादन बाग तथा एक विश्व नारियल जनन द्रव्य संग्रह केन्द्र का जाल पांच राज्यों तथा दो केन्द्र शासित प्रदेशों में फैला हुआ है।

वर्ष 1988 में उपलब्ध महत्वपूर्ण परिणामों को संस्थान के 'अति-दीप्त' में मुख्य क्षेप क्षेत्र जैसे उत्पादन, सुरक्षा, कटाई-उपरान्त शिल्प-विज्ञान तथा स्थानान्तरण शिल्प-विज्ञान के आधार पर संक्षिप्त में प्रस्तुत किए गये हैं।

कोको के जीव-द्रव्य बैंक में संकलन, पिसीफेरा तेल-ताड़ में बंध्यता का अभि-निर्धारण, देश में उत्पन्न किए गए टेनरा तेल-ताड़ के प्रथम दल पुष्पित, प्राउटिस्टा मोईस्टा, जो नारियल में 'रुट-विल्ट' तथा सुपारी में 'पीली पत्ती' रोग का वाहक है, की लार ग्रन्थियों में एम.एल.ओ. की उपस्थिति का इलेक्ट्रोन सूक्ष्मदर्शी द्वारा सत्यापन, नारियल जल बायो कंट्रोल एजेन्ट मेटाराइजियम इनीसोप्ली के उत्पादन हेतु उत्तम माध्यम, नारियल को क्षति पहुँचाने वाले चूहों का ब्रोमेडिओलान द्वारा नियन्तरण तथा छोटे तेल-ताड़ के बगीचों के उपयुक्त तेल-ताड़ से खाद्य-तेल निकालने हेतु एक निरुपण तेल मिल की स्थापना, इस वर्ष की कुछ महत्वपूर्ण उपलब्धियाँ हैं।

(एम.के. नायर)
निदेशक
केन्द्रीय रोपण फसल अनुसंधान संस्थान

कासरगोड़
31, जनवरी, 1989

CROP PRODUCTION

Germplasm resources

Characterization of coconut germplasm based on stem, leaf, reproductive, nut and yield characteristics enabled identification of 14 distinct tall cultivars. It is possible to clearly identify cultivars based on ratios for quantitative characters in combination with visual scoring of qualitative characters. 160 palms belonging to 18 accessions have flowered in the exotic collections maintained at World Coconut Germplasm Centre, Sipighat.

Eight cocoa accessions from Wynad were added to the germplasm bank. Studies on incompatibility showed that out of 57 trees, 34 trees are self incompatible while 23 are self compatible. The study revealed that different trees, belonging to the same accession need not be identical with regard to their incompatibility.

Based on detailed fruit studies on oil palm, three sterile *pisifera* palms (97-100% sterility) were identified. This is of significance in production of *tenera* for commercial planting.

Evolving high yielding varieties by selection and hybridisation

Among the four coconut hybrids evaluated, LO × GB gave 85.2 per cent over the WC Tall with regards to copra production, followed by COD × WCT (58.5 per cent), WCT × COD (35.9 per cent) and LO × COD (40.1 per cent). The WCT × COD continues to give higher yields under irrigated conditions. Large scale production of LO × COD and LO × GB has been undertaken during the current year.

In order to screen the arecanut hybrids against yellow leaf disease, fifteen cross combinations were made using Mangala, Saigon, Thirthahalli and Dwarf areca (Thirthahalli). Eleven hybrid combinations involving Mangala, Sumangala, Sreemangala, Saigon, Sreevardhan, Thirthahalli and South Kanara were made for an evaluation trial. Large scale *inter se* mating in Mangala, Sreemangala and Sumangala were carried out.

Evaluation of the available cocoa plants at Kidu has been completed and multiplication of the desirable genotypes started.

The first indigenously produced *tenera* hybrids have flowered in 21 months under the normal recommended package of practices both at Chithara Plantation of Oil Palm India and at CPCRI Research Centre, Palode. The plants under favourable conditions flowered in 18 months and upto 16 bunches were produced in the 3rd year of planting. Two hybrid combinations 120D × 30.103 P and 65D × 30.103 P have been giving highest yields of fresh fruit bunches for the past four years.

Five field experiments using 66 combinations involving indigenous *duras* and *pisiferas* were laid out at Chithara. The first batch of tissue cultured clones (from seedling meristem) were planted along with ordinary seedlings for comparison.

Tissue, anther and cell culture research

Clonal oil palm plantlets were produced from mature oil palm trees. Plantlets from two lines were established in green house.

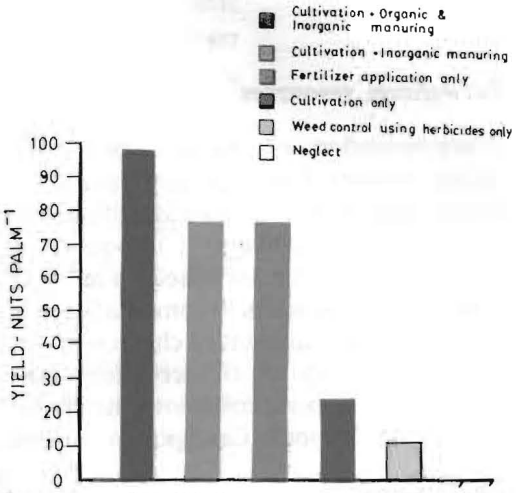
In coconut, somatic embryos were found to develop from tender leaf explants and as well from leaf base. Germination was noticed in a few embryoids. The floral primordia from young inflorescences developed into flowers, callus, shoot like structures and shooting structures.

Coconut embryos could be preserved in artificial media for two years at a stretch under laboratory conditions. Embryos of *Syagrus coronata, Areca catechu, Areca triandra, Actinorhytis calaparia* and oil palm were also found to germinate *in vitro*. The requirements for *in vitro* germination of embryos from all these palms are similar and this method has great potential in using embryoculture as a method for germplasm collection and exchange.

Nutritional requirement and crop management

In a long-term experiment with WCT, cultivation + organic manure + inorganic fertilizers continued to record highest yield of nuts (95 nuts/palm/year). The cumulative yield in this treatment since the time of first bearing was 628 nuts/palm as against only one nut in the totally neglected plot, where only one palm (out of 12) has come to bearing.

From fertilizer trials conducted in oil palm, it was observed that maximum yield of FFB was obtained in the treatment of 1200 g N + 600 g P_2O_5 + 1200 g K_2O per palm per year which is the present recommended dose for oil palm. The mean FFB yields obtained from different treatments over a period of three years from 1985-88 were within the range of 77 and 96 kg/palm/year.



Response of rainfed coconut to management practices: Long term effect of cultivation, herbicides and manuring on yield.

Increasing nutrient availability and disease alleviation by micro-organisms

Nitrogenase assay of soil cores by acetylene reduction method revealed higher activity in interspaces of high density multispecies cropping plot when compared to that of coconut monocropped plot. *Beijerinckia* isolates from different genotypes of coconut fixed nitrogen in the range of 1.49 to 46.54 $nMC_2H_4ml^{-1}$ culture h^{-1}. Bioassay tests indicated that N_2 - fixing isolates of *Beijerinckia* from coconut soils also possessed the ability to increase root biomass. A pot culture trial to evaluate the performance of *Azospirillum* using black pepper as test plant revealed appreciable gain on dry weight in *Azospirillum treated plants.*

Local isolates of Va-mycorrhizal fungi from high yielding coconut palms were effective in increasing plant biomass to the extent of 48 to 97 per cent when evaluated using cocoa as test plant in sterile soil. Root isolates were more effective than soil isolates in enhancing growth. Mycorrhizal effects decreased with the increase in level of phosphorus application when VAM fungus *Glomus versiforme* was inoculated to black pepper supplied with varying doses of soluble phosphorus. A comparative trial using different VAM endophytes revealed the superiority of *Gigaspora margarita* in increasing growth of clove.

Soil fertility, nutrient dynamics and crop production

Studies on the internal recycling of nutrients in the coconut crown indicated that a net afflux of nutrient to the extent of 43.95 g N, 6.14 g P, 183.58 g K, 1.96 g of Mg and 122.44 mg Cu, occurred annually. On the other hand, 13.49 g Ca, 359 mg Fe, 9.97 mg Zn, were imported during the same period. NP tablets and Urea formaldehyde proved to be efficient slow release nitrogen fertilizers in the respective order. A single dose of 500 g Nitrogen supplied through NP tablets during 1986 sustained the demand of the coconut palm for three years in littoral sandy soils, without adversely affecting the N concentration in leaf and nut yield.

Water management and stress physiology

The study on coconut revealed that the most tolerant genotypes like WCT × WCT had well balanced water economy through better extraction of soil moisture and low transpiration rate, while the most susceptible genotype MOD, though could extract high levels of soil water, cannot retain the same as it was lost through relatively high transpiration. The drought tolerant hybrid LO × GB was characterised by high

A Drought affected coconut palm showing drooping and drying of leaves.

epicuticular wax content and low transpiration, whereas a reverse trend occurred in MYD, another susceptible genotype. Qualitative differences in the wax composition, detected through thin layer chromatography, were also discernible between the tolerant and susceptible palms. There was less increase in the activity of acid phosphatase under stress conditions in the tolerant WCT palms than in the susceptible COD × WCT. Heat tolerance test showed that the tolerant genotypes viz., WCT × WCT, Java Giant, Fiji and LO × GB maintained a more stable *in vivo* nitrate reductase activity, a desirable trait, than the susceptible ones like COD × WCT, MGD and MYD. Higher dose of potassium (2000 g/palm) in the fertilizer trials for WCT imparted tolerance to moisture stress than lower doses (1000 g or no K) in terms of enzyme responses.

Drought tolerant cocoa accessions had higher stomatal resistance during dry

months. However this did not significantly affect their net photosynthetic rate. Water stress reduced the total lipid contents by 30 to 37% in leaves, the decrease being prominent in drought susceptible accessions. Polar lipids decreased and neutral lipids increased due to water stress. Tolerant trees exhibited an increase of 22 to 27% in epicuticular wax content as compared to susceptible trees in dry season.

Perennial crop based farming systems

A one hectare mixed farming unit produced 15732 coconuts, 95 kg dry pepper, 402 kg of banana and 6480 litres of milk during the year resulting in a net return of Rs. 24,450/- excluding the wages earned by the farm family (Rs. 24,348/-). From a mixed farming experiment in the root (wilt) diseased area at Kayangulam a net return of Rs. 17,500/- could be realised during the year.

Of the different crop combinations tried in an areca based mixed farming experiment in YLD affected area at Palode, areca + pepper + fodder grass N.B. 21 + subabul combination was found to increase the yield of Mangala variety of areca by 224 per cent over control. Experiments with areca based cropping systems at Hirehalli have shown that cocoa, pepper, banana and betelvine are the best inter/mixed crops for maidan parts of Karnataka.

An agro-forestry experiment with different tree species and coconut have shown that with high population of subabul, *Casuarina* and *Eucalyptus,* the coconut yield is adversely affected whereas *Ailanthus* though slow growing, appears to be compatible with coconut. An experiment on agroforestry in oil palm at Palode has revealed that Australian black wood, *Casuarina, Eucalyptus, Albizzia* and *Lucaena* adversely affects the yield of oil palm.

Nutrient budgeting studies in a coconut + cocoa mixed cropping system showed that N, Ca, Mg and micronutrients steadily decreased in the course of years.

Studies on PAR in an arecanut based high density multi-spices cropping system at Vittal involving banana, clove, cocoa etc. have shown that upto 90-95 per cent of the PAR could be successfully tapped.

Of the 62 isolates of fungi and 26 isolates of bacteria obtained from the rhizosphere of coconut and arecanut, ten isolates of *Trichoderma* spp., *Aspergillus* spp., *Pencillium* spp. *Fusarium* sp. and three isolates of bacteria could inhibit the growth of *Phytophthora.*

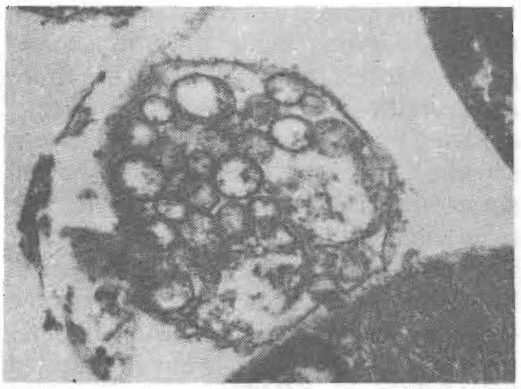
CROP PROTECTION

Root (wilt) disease of coconut

Earlier evidence on the successful transmission of MLOs of coconut root (wilt) disease through lace bug was strengthened by the observation of the organism in all the four experimental seedlings inoculated with lace bug, 27 months after the first release of the insect.

MLOs have also been observed in the salivary glands of the plant hopper - *Proutista moesta,* another putative insect vector after an acquisition plus incubation period of 40 to 59 days on root (wilt) disease affected palms.

The management technology for root (wilt) diseased gardens evolved by this Institute was tested in a number of farmer's fields around Kayangulam during the last five years. It was observed that the average yield of palms had increased by 19.6 nut per year, amounting to 50 per cent increase over the control.



Electron micrograph of an ultra thin section of the salivary gland of *Proutista moesta* showing MLOs.

A breeding programme to develop improved varietiesw of coconut with high yield and resistance to root (wilt) disease has been initiated during the year. Twenty six root (wilt) free West Coast Tall (WCT) palms identified in 'hot spot' areas are being utilised for *inter-se* crossing and selfing. Likewise root (wilt) free Chowghat Green Dwarf (CGD) palms located in 'hot spots' are being utilised in crosses with disease free WCT palms.

Stem bleeding disease of coconut

The method for isolation of the pathogen *Thielaviopsis paradoxa* from stem bleeding affected palms was standardised. The present method consists of inoculating frond pieces (cut from old leaves) with a plug cut from the suspected tissue. Such inoculated pieces covered with polythene bags are incubated at 30°C for 10 days. Re-isolations made on sugarcane juice agar from the margins of these lesions has yielded 98% success in respect of *T. paradoxa*.

Spectrophotometric and bioassay methods were standardised for detection of methyl-2-benzimidazole-carbamate (active ingredient of Bavistin) in stem tissues and tender nut water. The fungicide was detected for 20 days and upto 1 m height from the feeding side when palms were root fed @ 0.5 g Bavistin/palm and upto 2 m for more than 120 days at 10.0 g/tree treatments. The fungicide was not detected in tissues from the remaining sides of treated palms at both concentrations tested. Only negligible amounts of the chemical were detected in tender nut water from the treated palms and these are within safety limits to cause any health hazard.

To estimate the population of diseased palms, a comprehensive survey has been initiated in Cannanore and Kasaragod districts with the collaboration from Department of Agriculture, Kerala.

Thanjavur wilt/Ganoderma wilt

Early diagnosis by using Fluorescent Antibody Technique (FAT) was found useful in detecting latent infection of *Ganoderma*. Preliminary serological studies showed that isolates of *Ganoderma* of coconut and arecanut are distinctly different. Calixin treated, *Ganoderma* affected arecanut palms have shown significant improvement when compared to control. At Palghat, Calixin and Aureofungin sol treated palms have shown marked improvement over control as revealed by research-cum-demonstration trials.

Yellow leaf disease of arecanut

Typical mycoplasma like bodies were observed in the salivary glands of *P. moesta* subjected to 30, 31, 36, 37, 38 and 41 days acquisition plus incubation periods on diseased palms rendering the insect as likely vector of Yellow Leaf Disease of Arecanut. No fresh incidence of the disease was recorded on areca seedlings receiving monthly and quarterly insecticidal applications, even after a lapse of 28 months of planting; whereas

25 per cent of the plants in the control contracted the disease. Siagon x Mangala cross continued to be the best hybrid with respect to yield and tolerance to the disease. Fresh incidence of the disease was less than 2 per cent during the year in the management garden at Palode having 360 experimental palms.

Disease management

In oil palm, spear rot without yellowing could be cured by drenching the crown with 0.2% carbendazim after cleaning the affected portion. The disease was not noticed in *Dura* and *Pisifera*. Bunch refuse and mesocarp waste could be effectively utilised for cultivating mushrooms.

Spraying of Bordeaux mixture (1%) at biweekly interval was more effective in controlling black pod disease of cocoa as compared to other fungicides.

Captafol (0.2%) and Manocozeb (0.3%) were found to be promising chemicals in reducing the intensity of leaf spot disease of arecanut in Uthara Kannada district of Karnataka.

Coconut palms affected by crown choke in Assam and West Bengal showed recovery when treated with borax; the response being more evident in palms in the early stage of the disease.

Pest management

Baculovirus of *Oryctes* was introduced to Androth Island, Lakshadweep for biological suppression of rhinoceros beetle, during April, 1988. Pre-release observations of experimental sample palms revealed 55.0 per cent leaf damage, 7.3 per cent spathe damage and 23.5 per cent fresh incidence of spindles. Site occupancy of the pest was also recorded. Natural incidence of baculovirus disease was nil, as revealed from the observations made on 350 sample groups collected from 55 breeding sites from all over the Island. Samples of beetles collected from Ambajipet, Andhra Pradesh screened for baculovirus disease, showed symptoms of disease incidence. Further reduction in the intensity of rhinoceros beetle infestation and site occupancy of the pest in breeding places was observed in the experiment on evaluation of the impact of re-release of baculovirus in an already infected contiguous area.

Laboratory studies revealed that coconut water, which is being wasted from copra making industry, is an ideal medium for mass culturing the entomopathogen, *Metarhizium anisopliae*. This medium supported better growth and sporulation of the fungus over the PDB medium. Further, the fungus produced more spores both in the filter sterile coconut water and that taken aseptically from nuts than in the autoclaved coconut water. Coconut water could be drawn aseptically from nuts before breaking them for copra making and made use of for massculturing the green muscardine fungus.

Two species of tetranychid mites viz., *Oligonychus iseilemae* (Hirst) and *Tetranychus ludeni* (Zacher) infest the adaxial surface of the coconut leaflets. Feeding by the mites ultimately results in drying up of the affected leaflets. Maximum population of *O. iseilemae* occurred during May and that of *T. ludeni* during February. Phytoseiid, cunaxid and stigmacid mites were recorded as major predators. The overall predator prey ratio was observed to be 1 : 3.95.

Vertebrate pest management

Field studies have revealed that the rat damage to tender coconuts could be completely controlled by the application of

10 g bromadiolone (0.005%) baits on the crowns of palms two times at an interval of 12 days.

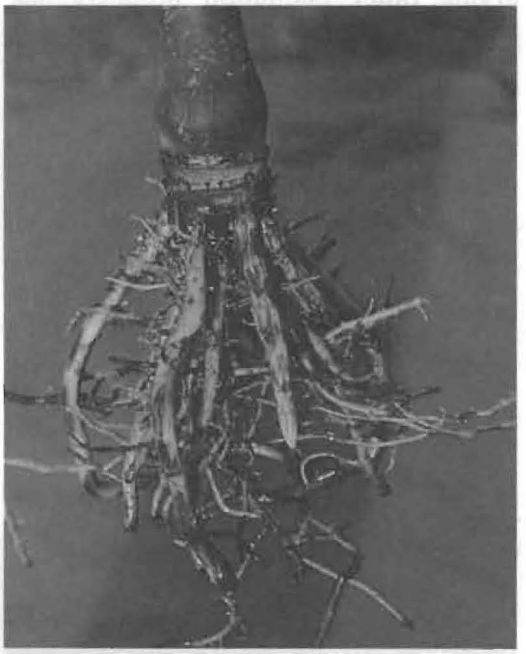
R. wroughtoni was observed to damage the seedlings of oil palm for the first time. In a nursery, out of 425 seedlings raised, 193 were found to be totally destroyed by this pest.

The Western Ghats squirrel, *Funambulus tristriatus* was observed to exhibit bait shyness within a day of exposure to zinc phosphide mixed baits. This bait shyness persisted for seven days in the animals. The squirrels infesting cocoa in Hirehalli area were identified as the South Indian palm squirrel, *Funambulus palmarum* Linn.

Nematode management

The experiment initiated in October, 1982 to study the pathogenicity of the burrowing nematode, *Radopholus similis* on coconut under field conditions revealed the pathogenic effect of the nematode on coconut. Of the five uninoculated control plants three have flowered. The earliest flowering was recorded in December, 1987. Two palms that have received the lowest initial inoculum level (100 nematodes/ seedling) have also flowered, showing that an initial inoculum level of even 100 nematodes per seedling can delay flowering by six months. Control palms have produced an average of ten inflorescences as against the 3.5 inflorescences produced by the inoculated palms. The control nas 58 nuts in comparison to the 9 nuts of the inoculated palms.

Detailed studies on the morphology of various isolates of *R. similis* populations from coconut, arecanut, banana and black pepper from different areas in South India revealed that they do not differ morphometrically from each other and as well from populations that exist in other countries, even though positive evidence for pathotypes were obtained. Screening trials on arecanut germplasm against *R. similis* revealed that the hybrid VTL-3 x Dwarf was very highly susceptible.



Symptoms of *Radopholus similis* attack on areca hybrid VTL-3 x Dwarf.

HARVEST AND POST HARVEST TECHNOLOGY

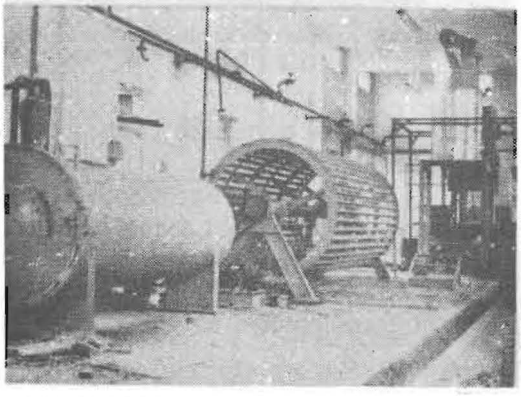
Low cost, large size copra dryer

A low cost copra dryer of capacity 3,000-4,500 nuts per batch, using agricultural waste as fuel has been developed. The cost of the dryer is Rs. 10,000/- and the cost of drying per kg of copra works out to Rs. 1.18/-. This dryer is more useful for large holdings and for co-operative societies and can also be used for

drying other plantation products like arecanut.

Demonstration plant for palm oil extraction

A demonstration plant for extraction of edible grade palm oil has been established at CPCRI Research Centre at Palode at a cost of Rs. 16.5 lakhs as a joint venture of CSIR and ICAR. The plant can process 0.75 tonnes FFB/hr. All the equipments have been designed by the Scientists of Regional Research Laboratory, Trivandrum and fabricated indigenously. The agro-waste fired boiler to supply steam for the plant makes use of the factory and plantation residues. The technology has been optimised with all essential process controls to obtain edible quality raw palm oil. With the commissioning of the mill, the oil palm cultivation can now be extended to small farmer holdings in the vicinity of the mill.



Inside view of the recently commissioned demonstration plant for extraction of edible grade palm oil.

ESTIMATION OF CROP LOSSES

A three stage sample survey conducted in the five districts of Assam, viz., Golpara, Kokrajhar, Kamrup, Barpeta and Nowgoan revealed that 10.8 per cent of the coconut palms were affected by crown choking disease and 5.9 per cent of areca palms by *Anabe roga*. The loss due to crown choking disease was estimated at 6.38 million nuts.

REFINEMENT OF EXPERIMENTATION TECHNIQUES IN PLANTATION CROPS

In order to compare the extent of bienniality for coconut yields, in different populations, even when they are based on varying number of years, the Bienniality Index developed earlier was further modified as $(3T\text{-}T')/2T1$ where T is the sum of the ranks obtained for the set of rank correlation coefficients between alternate years and T' is the maximum possible rank sum for alternate years. This index was having a range of 0 to 1. Bienniality was found to be more in high yielders.

Principal component analysis showed that, in weather studies the number of variables can be reduced from 11 to 4, when 12 week averages are used. The first four principal components accounted for 83-88% of the variation. The first PC associated with RH/VP factor and the second PC with temperature (Max.).

ECONOMICS OF PLANTATION CROPS

The Compound Growth Rates (CGR) of wholesale prices for coconut products, namely, nuts, copra and oil are found to be around 10 per cent per annum between 1970 and 1988. The price trends however reveal that the relative prices of those commodities are declining, eventhough the

absolute prices show significant growth. The correlation co-efficients (r) between wholesale prices of coconut products are assessed as 0.99. The analysis further indicates that the coconut markets in Kerala as well as Bombay are highly competitive. The co-efficient of variation (C V) of the average monthly prices of coconuts in Kerala varied between 5.16 per cent and 42.78 per cent during 1981-88 suggesting higher instability in the commodity prices.

The Land Equivalent Ratio (LER) in coconut + cocoa system was worked out as 1.46, while the Monetary Advantage (MA) for the system was estimated at Rs. 14,920/ha/yr. In arecanut + cocoa system, the LER and MA were assesed as 2.18 and Rs. 19,163/ha/yr under the existing factor product market situation.

ICAR RESEARCH COMPLEX FOR GOA (CPCRI)

A. Plant science

Rice: Among ten short duration varieties, Annada continued to out yield all other varieties with an average of 6.16 t/ha. Sarjoo, a medium duration variety performed well during kharif 1988 (6.73 t/ha). Among twelve medium duration varieties screened against insect pests, the variety BPT-1235 even though was found to be resistant to Gall midge attack, was highly susceptible to leaf roller attack.

Tapioca: Among the 22 varieties tried for three years, H-123 (30.56 t/ha) and H-2304 (27.31 t/ha) with ten months duration and H-165 (26.54 t/ha) of seven months duration were found to perform consistently well in respect of yield, harvest index and other attributes.

Sweet potato: Evaluation of 27 varieties for the past three years revealed that Cross-4 with a duration of 105 days is the best yielder (28.87 t/ha) having good tuber quality. Screening of six varieties against weevil infestation indicated that infestation was lowest in the variety 76 (OP) 217.

Tomato: To overcome the problem of bronze wilt it is suggested to grow tomato in summer (February to May). Among the 25 varieties screened against wilt, Sonali, MST 25/7, MST 32/1 were found to be promising.

Brinjal: Among the three IIHR varieties evaluated, IIHR-21 recorded the highest yield (12.9 t/ha). This variety, besides being wilt resistant, has good fruit quality.

Bhindi: Screening of five bhindi varieties against yellow vein mosaic virus indicated that Selection 4 and Selection 10 were resistant.

B. Animal science

Cattle: The extent of manifestation of oestrum in crossbred cattle was almost uniform in summer (34.9%) and winter (34.9%) but the rate of fertile heat was higher during monsoon (36.8%) and winter (36.3%) and hence cross-bred cows should be keenly observed for breeding during these periods for better fertility. Oral administration of 'Clomiphene Citrate' @ 1 mg/kg body weight in cross-bred cattle resulted in satisfactory conception rate (70%). However, it appeared that it cannot be very effective in synchronising oestrus as wide variation (2-15 days) in evincing heat after administration was observed.

Pig: The farm bred pure Yorkshire matured at an average of 313 days. Local × Yorkshire crossbred pigs were

successfully produced with litter size of 7 and 4 respectively. The average birth weight of Local × Landrace was higher (0.83 kg) than the other cross (0.72 kg). An economic pig feed was formulated by incorporating 40% tapioca to giving a growth rate of 190 g/day as compared to 83 g per day with the commercial feed.

Rabbit: From kindling percentages of three exotic and one local, it was found that Soviet Chinchilla had highest kindling percentage (78.6%). The other two exotic breeds, namely, White Giant and New Zealand White had 50% and 41% kindling respectively, which were lower than the local (68.6%). The Soviet Chinchilla and its crosses were found to be more efficient in feed conversion (feed efficiency 2.9 and 3.2 respectively) and they maintained higher growth rate (16-20 g/day) than local. The nutrient requirement of Soviet Chinchilla crossbreds were identified to be 12% crude protein and 2400 KCL of digestible energy/kg feed. Major health problems observed in rabbits were gastro-enteritis and pneumonia.

Poultry: In Japanese Quails, seasonal variation was observed in egg production. Highest production (64.3%) was obtained during February-April and the lowest (27.6%) was during rainy season. Feeding experiment in Japanese Quails indicated that they require minimum 23% protein in the layer ration for optimum production as compared to 18% protein in poultry. The performance of 'White Pekin' ducks showed that they started laying at 189 days and attained peak production (65.2%) during 8th month. The average adult body weight was 2.87 kg and egg wt. was 61.5 g.

C. Fisheries

For the research-cum-demonstration of Livestock-cum-fish combination, three ponds had been established and stocked with fingerlings of Major Carps and Common Carp. A floating duckhouse has been prepared. For demonstrating composite fish culture, a unit of 0.5 ha pond with 1200 carpseeds was established in a farmer's place.

ICAR RESEARCH COMPLEX FOR LAKSHADWEEP (CPCRI)

In coconut, highest number of nuts were recorded in NPK treatment combination 500 g N, 320g P_2O_5 and 1200 g K_2O/palm/year, a 120 per cent increase over control in six year old palms.

Nendran banana and papaya (CO-2) were found to be very remunerative associate crops in the high density cropping trial. An additional income of Rs. 13,000/- from banana and Rs. 1900/- from papaya per hectare was recorded under local conditions. Coconut yield in terms of nut number and size were found to increase in a square system of planting with a spacing of 8 × 8m as against quincunx planting within this spacing.

Preliminary studies on coconut have revealed that there is increase in plant girth and height with the application of 15 g of ferrous sulphate.

ALL INDIA CO-ORDINATED RESEARCH PROJECT ON PALMS

Crop Improvement

Coconut: At Arsikere, 'Zanzibar' and 'Malayan Yellow Dwarf' came to flowering in 2,065 days. At Veppankulam, 'Andaman Giant', 'Malayan Green Dwarf' and 'Andaman Ordinary' recorded copra yields

of 14.6, 14.3 and 12.8 kg/palm/year, respectively. At Ambajipet, 'Philippines Ordinary' and 'Java' recorded yield of 107.8 and 82.9 nuts/palm/year. 'Laccadive Ordinary' continued to give highest yield followed by 'Banawali Green Round', the newly released variety from Ratnagiri.

Arecanut: The cumulative yield data for over a period of 10 years recorded at Coimbatore revealed Mangala to be the best followed by Mettupalayam Local.

Oil Palm: At Seethapuram of West Godavari District in Andhra Pradesh, 60 *tenera* hybrid seedlings raised under recommended management conditions started flowering from the 12th month of planting and continued even during the hot summer.

Monitoring the seed gardens: Technical guidance were given to the Coconut Seed Gardens at Ettankulam, Naulok, Neyveli Putalur (Tamil Nadu) and Dharmaveera (Karnataka).

Disease management

Thanjavur/Ganoderma wilt disease: The present recommendations of neem cake application @ 5 kg/palm/year and root feeding of aureofungin sol coupled with drenching with 1% Bordeaux mixture continued to give effective containment of Thanjavur wilt disease.

PRODUCTION OF PARENTAL MATERIALS AND BREEDERS' STOCK OF PLANTATION CROPS

During the year 24,293 selected West Coast Tall seednuts were supplied to different states from Kidu Seed Garden. Another 6252 dwarf seednuts and 3,694 dwarf seedlings were supplied to various seed gardens in the country. For the establishment of parental materials in seed gardens 620 Laccadive Ordinary and 240 Andaman Ordinary seedlings were also supplied during the year. Besides these, 2810 hybrid seedlings were supplied to farmers.

In arecanut 1,56,495 seed nuts and 14,907 seedlings of different cultivars were supplied from Vittal and Kidu Centres to areca growers.

Inter se mated seedlings were used for gap filling in the respective blocks. In cocoa, the polyclonal and biclonal orchards planted in the seed gardens were maintained. A total of 3,722 seedlings, 233 grafts and 107 pods were supplied to farmers during the year.

In oil palm, *tenera* hybrids have been planted on a commercial scale for the first time in Andhra Pradesh and Karnataka. Over 45,000 sprouts were supplied for the demonstration projects sponsored by Department of Bio Technology in the above two states and as well to Maharashtra.

TRANSFER OF TECHNOLOGY

During the year, 13 training courses were organised for 137 officials from 11 states and one union territory. At Kasaragod 5 Vietnamese officials were also given training on coconut processing technology. The first subject matter workshop-cum-seminar on oil palm production technology was conducted from 12-17 September 1988 at CPCRI (Research Centre), Palode. Twenty two officers from Kerala, Andhra Pradesh, Madhya Pradesh, Orissa and West Bengal participated. In Krishi Vigyan Kendra, Goa, 25 training courses in Crop Sciences, Horticulture, Animal Sciences, Fisheries and Home Sciences were conducted for 582 persons in 46 batches. Apart from this, a

special training on different aspects of crop improvement in Lakshadweep was conducted by a team of 5 scientists from CPCRI in collaboration with the Directorate of Agriculture, Lakshadweep.

In Goa, one hundred farm families were adopted under the Lab-to-Land Programme. Critical inputs like cross-bred chicks and rabbits along with improved quality seed/seedlings, farm implements, fertilizers and plant protection chemicals were supplied.

Thirty four Research-cum-Demonstration plots were maintained in farmers' fields at different centres. Thirteen new plots were selected at Kayangulam for coconut. Two more demonstration plots for arecanut (one for VTL-11 and the other for VTL-17) were laid out at Vittal.

A total of 114 areca palms affected by Yellow Leaf Disease were removed from 26 gardens distributed in six villages of Puttur Taluk. Healthy seedlings of VTL-11 were supplied free of cost to replace the palms removed.

Twelve exhibitions were arranged by CPCRI in different parts of the country for the benefit of the farmers and Extension workers. Scientists of this Institute gave as many as 53 radio talks on plantation crops technologies.