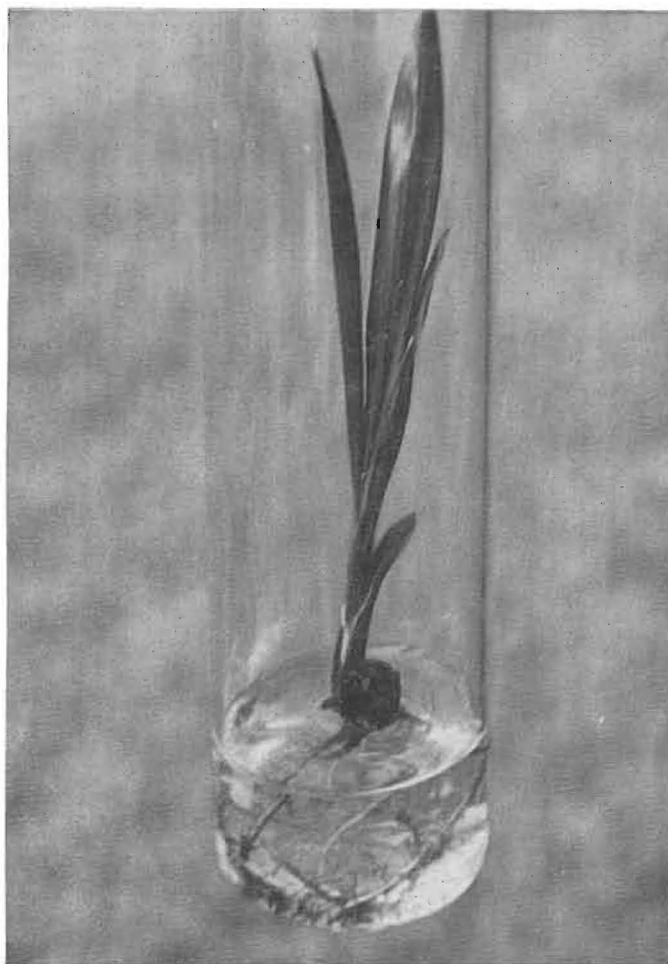


# RESEARCH HIGHLIGHTS 1986



**Central Plantation Crops Research Institute**  
Kasaragod 670 124, Kerala, India



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Clonal plant-let in oil palm

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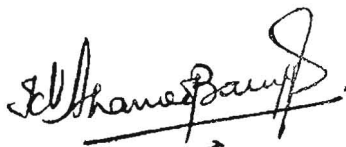
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## INTRODUCTION

The Central Plantation Crops Research Institute tackles problem oriented research programmes on coconut, arecanut, oil palm, cashew, cocoa and spices. Identifying important problems in the plantation crops and finding solutions to them are the primary objectives. To achieve the mandate given to the Institute, it has a net work of 16 centres in four states and three union territories. Research programmes of the Institute are grouped into 29 megaprojects with multi-disciplinary approach and are carried out in more than one centre according to the need. The priorities in research are changed as and when found necessary on the basis of feed back obtained from the field.

The research highlights of the Institute is an annual publication. It presents in a concised form the major achievements and break-throughs made by the scientists in their respective areas of work. Some of the major achievements made by the Institute during 1986 include standardization of tissue culture technique for oil palm, creating facilities for the production of 1,00,000 tissue cultured cardamom plants annually, achieving an increase of productivity of coconut (258%) and arecanut (246%) in the high density cropping systems, standardising a production technology capable of giving 2 tonnes of dried pepper per hectare, control of *Oryctes rhinoceros* in Lakshadweep by introduction of the biological agent baculovirus and fabrication and release of copra moisture meter to the copra industry.

Though it had been programmed to delink the research on spices and cashew after the establishment of two National Research Centres for Spices and Cashew, this could not be implemented since the Director, CPCRI continued to be in charge of these two Centres pending the creation of the posts of Directors for the NRCs. Due to this reason this research highlight covers all the crops but reported separately. It is hoped that from 1987 onwards these two centres will function as independent units.



K. V. AHAMED BAVAPPA  
Director



## PALMS AND COCOA

### Root (wilt) disease of coconut

The integral association of mycoplasma like organisms (MLOs) with root (wilt) disease affected coconut palms has been confirmed. MLOs were present in all the samples from 35 disease affected palms and tissues of all the sixteen healthy palms were free from them. Lace bugs, *Stephanitis typica* became infective only after a fortnight following access to the diseased coconut palms. Nymphs neither acquired MLOs nor transtadially carried over them to imago, since adults emerging from nymphs exposed to leaflets from diseased palms did not carry MLOs. Serial sectioning of spurr embedded lace bugs in feeding position by cold immobilisation technique revealed the termination of the stylet in phloem.

A high performance liquid chromatography (HPLC) method for quantifying tetracycline residues in the edible parts of treated coconut palms has been standardised.

Coconut seedlings in field tanks inoculated with up to one million burrowing nematode, *Radopholus similis* failed to produce root (wilt) symptoms even after four years. Correlation between the presence of *R. similis* and

occurrence of root (wilt) disease could not be established from data on extensive surveys.

A scheme to eradicate the root (wilt) diseased palms and rejuvenate the coconut gardens implemented in collaboration with FACT, IOB and Kerala Agricultural Department at Keragram in Varandarappilly over an area of nearly 50 ha since 1981 showed that the root (wilt) disease could be eradicated from the operational area and its further spread could be checked. The nut yield increased from 20 to 49/palm/year within a period of 3 years in the rejuvenated palms.

Eradication of palms identified as root (wilt) affected in Cannanore district was continued and the surveillance intensified. The surveillance was completed in 19 villages in the northern border of the disease incidence.

### Yellow leaf disease of arecanut

Transmission studies with putative vectors like spindle bug (*Carvalhoia arecae*) and leaf hopper (*Sophonia greeni*) and also using dodder are in progress. Dodder is established on diseased areca

seedlings and they are now connected to healthy areca and periwinkle plants kept under insect proof conditions.

Screening of seedlings against YLD indicated that the disease incidence was maximum in Mangala *inter-se* progenies as well as dwarf hybrids involving Mangala and VTL-12.

A survey has been initiated to assess the intensity of the disease in Karnataka State by the Institute in collaboration with UAS, Dept. of Horticulture and Dept. of Agriculture, Karnataka.

In an observational trial to study the nature of spread of the disease, areca seedlings kept in the open contracted the disease while all the seedlings kept in insect proof cage did not develop the disease. Similarly, seedlings regularly sprayed with insecticide did not contract the disease while control seedlings developed YLD symptoms. This indicates that the disease is air borne in nature and some insects are probably associated with the transmission of the disease.

### Thanjavur wilt, Ganoderma and Stem bleeding complex diseases of coconut

Further investigation on the etiology of stem bleeding disease showed that in addition to *Thielaviopsis paradoxa*, *Phomopsis coccolina* also causes bleeding symptoms on the coconut trunks within  $1\frac{1}{2}$  to 3 months of inoculation. At Kasaragod the optimum time of infection by *T. paradoxa* was found to be during the rainy and winter months.

*In vitro* evaluation of fungicides against *T. paradoxa* revealed that Bavistin and Aureofungin sol each inhibited the growth of the fungus even at 100 ppm while Calixin and Vitavax inhibited the growth only at 500 ppm and 1000 ppm respectively. These fungicides are now being used in field control trials.

In the case of *Anabe* of arecanut, planting a diseased stump beside a healthy palm and placing the inoculum of *G. lucidum* in the bore hole or grafting a piece of diseased stem block on to healthy stem, produced disease symptoms after three months of inoculation.

Investigation on early detection of *Ganoderma* using fluorescent antibody technique showed that sections of roots from diseased palms when stained with Fluorescein isothiocyanate conjugated antiserum, exhibited brilliant green fluorescence as against dull green fluorescence in healthy root sections. Colorimetric methods using EDTA treated tissues showed higher OD values in the affected leaf and root of coconuts than those of healthy tissues.

In Chittoor subdivision of Palghat district sporadic occurrences of Thanjavur wilt have been noticed. Demonstration cum research trials for the control of the disease have been laid out in four private coconut gardens in the above region in August 1986.

### Tissue, anther and cell culture research

Tissues from three year old *tenera* seedlings were used to standardise the procedure for clonal multiplication of

oil palm through tissue culture. After the induction of callus at the surface, small snow white somatic embryoids emerged from the callus lining. Upto 12 embryoids were produced from a leaf bit of 5 mm which were similar to the sexual embryos with well developed shoot root axis and haustorial regions. These embryoids were found to multiply through budding, the multiplication ratio being over 1:50 in three months time.

The embryoids were cultured on germination medium to obtain well formed plants with shoot and primary root. The formation of adventitious roots were hastened by changing the the hormones in the growth medium. Five plants with 2-3 roots and a shoot length of 5 cm were transferred to a potting mixture of sand, vermiculite enriched with nutrients under high humidity conditions. After hardening, they were planted in soil. The establishment rate was over 80 per cent.

A method for the non-destructive sampling of leaf tissues from mature oil palms was standardised. The palms after extraction of the tissue recouped in six months. Somatic embryos were produced from mature palm tissues. Oil palm plants were produced *in vitro* from dissected embryos of immature nuts. The sexual embryo produced embryoids by budding from the root zone.

### Perennial crop based farming systems

The production from the coconut based multistoreyed cropping involving coconut, pepper and cocoa was 20,685

coconuts, 124 kg dry pepper and 823 kg dry cocoa beans per hectare at its 14th year of establishment under irrigated conditions. The annual average production from one hectare of mixed farming in coconut garden was found to be 15,900 coconuts, 218 kg dry pepper, 695 kg of tubers, fruits and vegetables, 7500 litres of milk and 550 m<sup>3</sup> of biogas.

In the coconut based high density multispecies cropping (HDMSC) model with 18 crop species, it was observed that the yield of coconut nearly trebled in the third year of its establishment due to irrigation and the favourable effect of component crops. The nutrient dynamic studies through system approach in HDMSC experiment indicated that the total nitrogen budget was in the order of 222, 266 and 293 kg per plot of 0.4 ha in 1/3, 2/3 and full dose respectively at the start of the experiment in 1983 and it was in the range of 190, 273 and 297 kg at the beginning of the third year of experiment. The net nitrogen balance was found to decrease markedly during the three years in all the three levels of fertilizer treatments. However, the level of nitrogen application had a positive influence on N balance and budget. Almost a similar trend of result was recorded for P and K where the build up of P and K in the system has been noticed during the course of experiment. The total removal of NPK from the system increased gradually from first year to third year. The budget of Ca, Mg, Zn, Fe, Mn and Cu showed that the net balance after third year has been decreased due to

excessive removal from the system. This is specially true for Mg where the Mg budget of 33 kg per plot during the first year has decreased to 19 kg at the end of the third year.

Growing of *Subabul* (1872 plants/ha) and *casuarina* (6240 plants/ha) in the interspace of coconut palms adversely affected the yield of coconut from the third year of their planting. *Ailanthus* (1872 plants/ha) did not affect the yield of coconut until the third year of its planting.

In arecanut based high density multispecies cropping model with seven crop species, the yield of arecanut was more than doubled in the third year of its establishment indicating the favourable effect of the mixed crops on the main crop.

Acid lime grown under HDMSC system was observed to be comparatively free from canker disease while it was severely affected when grown in the open. Pineapple grown in the HDMSC system was found susceptible to *Diplodia* leaf spot disease compared to the crop grown in the open.

Cocoa and pineapple were found to be free of nematode problems in the different crop models in various locations. These can be profitably utilized in crop models where nematodes are a serious problem.

The microbial biomass of the root region of coconut palms under the mixed farming was more (194  $\mu\text{g/g}$  of soil) compared to the root region of coconut palms in the pure stand (120  $\mu\text{g/g}$  of soil).

Amino acids, sugars, organic acids and phenols were extracted from the soil samples collected from the root region of various crops grown under HDMSC system and as monocrops. No significant variation in their contents was noticed between monocrop and HDMSC system.

### Collection, conservation, evaluation and documentation of genetic resources in plantation crops

A total of 137 accessions of coconut germplasm which include 86 exotic cultivars and 41 indigenous types are being maintained at CPCRI. Of this, 24 exotic collections from Pacific Ocean region and six Nicobar collections have been planted at World Coconut Germplasm Centre (WCGC) at Andaman. In germplasm the high yielding cultivars can be identified by their cumulative yield recorded at tenth year after planting. The maximum yield recorded at 10th year of planting was in Laccadive Ordinary (242 nuts) followed by SS Green (146) and Andaman Ordinary (136). The same cultivars also had maximum cumulative yield in their 20th year.

In cocoa, evaluation of pod characters in 17 selections indicated that Tree No. 1/29 (Amelanado  $\times$  Na 33) 11 and 18 (Landas 364) were the best as far as dry bean yield is considered. Eleven trees were self incompatible. Among the 11 Malayan accessions, Landas 358 (3.9 kg/tree) and Landas 364 (3.77 kg/tree) gave highest yield of dry bean.

Out of the nine *tenara* × *tenera* palms examined, eight were *tenara* and the other one was *dura*. Detailed studies on *pisifera* palms at Thodupuzha indicated high variation for fruit characters. A total of 5680 sprouts/seedlings were distributed for multilocation trials. A comprehensive survey to identify suitable areas for cultivation of oil palm in Karnataka was made.

### Evolving high yielding varieties by selection and hybridization

With a view to assessing the hybrid recovery in D × T crosses, four different Dwarf parents were selfed, and based on the seedling progeny characters, homogeneous parents would be selected from CDO, MDY, MDO, and MDG. In addition, the production of MDO × WCT and CDO × WCT has been initiated.

In arecanut, intervarietal hybrids have been produced involving Mangala, VTL-11, VTL-13, VTL-17, Saigon, Srivardhan, Thirthahalli and Mohitnagar, for screening them against YLD in hot-spot area at Palode. Secondary selection was continued in Mangala, VTL-11, VTL-13 and VTL-17 blocks, where the off-types were emasculated at Kidu, to generate pure breeder-seed.

Intervarietal crosses in two different promising combinations in cocoa were carried out at Lal bagh, Bangalore. In oil palm, a total of 3,97,492 *tenera* seeds were produced during the year, using indigenously available

*dura* and *pisifera* parents. A remarkable increase in yield of oil palm was noticed during the year at Palode and the main factor contributing to the increased yield, was the introduction of the pollinating weevil *Elaeidobius kamerunicus* during 1985.

### Water management and stress physiology

West Coast Tall conserves moisture better than CDO × T or T × CDO, under conditions of moisture stress through effective stomatal regulation and higher leaf epicuticular wax content. This reflected on dry matter production and nut yield.

Studies on coconut genotypes under low and high intensities of drought situations showed that leaf stomatal resistance could be used as a very sensitive index of water stress. Screening of coconut genotypes revealed that Laccadive Ordinary × Gangabondam and Laccadive Ordinary × Chowghat Dwarf Orange are relatively more tolerant to drought than others.

Under water stress conditions, the activities of acid phosphatase and Glutamate-oxal-acetate transaminase enzymes in coconut leaf were several times higher than under irrigated conditions showing that they could be used as sensitive indicators of water stress.

### Nutritional requirement and crop management

Response of genotypes to fertility levels under rainfed and irrigated conditions revealed that on

an average hybrid CDO  $\times$  WCT produced 154 nuts/palm/year as against 127 and 140 nuts/palm/year obtained in WCT and WCT  $\times$  CDO respectively. All the genotypes responded significantly upto 500g N + 500g P<sub>2</sub>O<sub>5</sub> + 1000g K<sub>2</sub>O. Irrigation at weekly intervals with 75% of cumulative pan evaporation produced 163 nuts/palm/year as compared to 117 nuts under rainfed condition. Hybrid responded better to irrigation than WCT.

#### Increasing nutrient availability and disease alleviation by micro-organisms in plantation crops

Inoculation with two VAM fungi, *Gigaspora margarita* and *Glomus fasciculatum* resulted in the suppression of the deleterious effects of root-knot nematode on cardamom seedlings and caused several fold increase in growth. There was also marked reduction in the nematode population in the root when inoculated with VAM and nematode as compared to those in nematode alone inoculated seedlings. A comparative study of the effectiveness of 10 different VAM fungi revealed the superiority of *Glomus epigeum* in enhancing growth of pepper. The pepper cultivar Kalluvally showed maximum root colonisation (66.4%) by native VAM fungi under field conditions compared to Panniyur I (60.8%) Karimunda (50.4%) and Balankotta (48.0%).

*Azospirillum* (associative nitrogen fixing bacteria) isolates from

coconut and other crops from the coconut based farming systems exhibited considerable nitrogenase activity (0.91-63.33 nM C<sub>2</sub>H<sub>4</sub> tube<sup>-1</sup> h<sup>-1</sup>) when assayed by acetylene reduction method. Population of non-symbiotic nitrogen fixing bacterium, *Beijerinckia*, was found to be more in the rhizosphere of coconut in the multistoreyed cropping and mixed farming plots as compared to those in neglected, fertilizer+manure+tillage plots and farmer's fields.

#### Soil fertility, nutrient dynamics and crop production

Under the project on investigations with inorganic and organic soil toxicants, effect of heavy metals on the sub-cellular nutrition of coconut was studied. All the heavy metals imposed, adversely affected the phosphorus nutrition of nucleic acid, polar compounds, proteins and polysaccharides. The K content in proteins and polar compounds reduced with the treatment of Al, Cu, Pb and Cd. Heavy metal application reduced the calcium content in lipids, pigments and organic acids, while Ca content enhanced in the pectates and cellulose. The magnesium content in the lipid, pigments, proteins and pectates was not affected due to heavy metal treatment significantly. But organic acids, nucleic acid and polysaccharides tended to contain less of magnesium. Among

micronutrients, heavy metals influenced directly or indirectly on the sub-cellular fractions. It was noticed that zinc incorporation in the nucleic acid has significantly reduced by almost all the metal ions. In general, Al, Cu, Pb, Ba, Bi, Cd and Cr affected the essential elements in the sub-cellular fractions.

In the field trial with slow release fertilizer against urea, the soil available nitrogen showed an increasing trend with urea up to three month's time. Urea formaldehyde showed a steady trend up to six months.

In case of neem coated urea and coir dust coated urea, there was increase of available nitrogen upto six months. Slow release N; P tablets showed in the field a release of 50 per cent of ammoniacal nitrogen as compared to urea and further release was gradual upto four months. Urea N appeared to have been released equally in urea and N; P tablets.

### Production physiology of plantation crops

Major differences in the peroxidase isozyme profiles were observed among the coconut genotypes. The total protein banding patterns of the coconut genotypes were also different. These observations have confirmed the use of isoenzyme analysis in identification of coconut genotypes.

### Pest management

Observations on the impact of introduction of baculovirus of *Oryctes* for biological suppression of

coconut rhinoceros beetle in Minicoy, Lakshadweep, recorded during May 1986 (37 months after introduction) revealed a mean reduction of leaf damage by 83%, inflorescence damage by 94% and damage on spear leaves by 96%. A mean of 50% baculovirus infection was noticed in the natural population of beetles in the Island.

The entomopathogen *Metarrhizium anisopliae* was successfully cultured using coconut water as the medium.

A field control trial laid out in Kayangulam Kayal Farm revealed significant reduction in mealy bug infestation on nuts, inflorescences and rachillae of palms sprayed with dimethoate and fenthion 0.1%.

A cheaper model of red palm weevil sensor was designed in collaboration with College of Engineering, Trivandrum. The feeding sound of the grubs is having a wave frequency of 0.3 k hz and of two signals of 50 and 75 m sec. duration. In the new design, optical technique is incorporated to isolate the filter unit and amplifier unit to avoid feed back.

The insect responsible for tender nut drop in arecanut was identified as *Halyomorpha marmorea* (Pentatomidae) and its biology studied.

### Disease management

The initial diagnostic symptom of the quick yellow decline of coconut disease is the sudden yellowing of one or two leaves in the middle or upper whorl of the crown. The



yellowing starts at the tip of the leaf and progresses towards the base and within a year all the leaves of the affected palm develop yellowing except the central spindle and a few leaves immediately below. Spots develop on the lamina of the affected leaves which later coalesce resulting in severe blight. Necrosis of the distal ends of inflorescence rachillae (even in the unopened spathe) is noticed in majority of the cases. There is also heavy shedding of buttons and drying of inflorescence. Disease affected palms in the Institute farm were eradicated in order to study its effect on fresh incidence.

The symptomatology studies of spear rot disease of oil palm has revealed abortion of inflorescence and tapering of stem. A number of fungi have been isolated from the spear leaves of affected palms.

#### Nematode management

Cocoa, pineapple, tapioca, cinnamon, nutmeg and clove were found free from nematode problems. These crops are recommended as intercrops in coconut and arecanut based farming systems.

Populations of *Radopholus similis* isolated from coconut, arecanut and black pepper have a haploid number of 4 chromosomes ( $n=4$ ). The burrowing nematode was found to complete one life-cycle in 25–30 days on black pepper and arecanut.

#### Tatipaka disease

A survey was conducted jointly by the Co-ordinating Centre (Razole), APAU, and Department of Horticulture, in

two Samithies viz., Razole and Ganavaram comprising of 48 villages and it was found that 11,132 palms (1.72%) in Razole and 4656 palms in Ganavaram affected by Tatipaka disease, while 20,082 and 4773 palm respectively in the above two samithies affected by Ganoderma wilt disease.

#### Vertebrate pest management

The black rat, *Rattus rattus wroughtoni* was found to breed throughout the year with two small peaks, one during early summer (February–March) and the other during monsoon (July–August). The incidence of pregnancy was at its lowest during hot summer months (May). The observed percentage of pregnancy ranged from 6.6 in May to 26.4 in February.

The three mice species, viz., the house mouse, *Mus musculus urbanus*, the field mouse, *M. booduga booduga* and the tree mouse, *Vandeleuria oleracea* found in this region were known to prefer split forms of grains to whole grains and powders.

Among the 'live' traps, the wooden 'live' trap was found to be most effective in trapping the black rat and the house rat (*R. r. rufescens*), whereas the Sherman 'live' trap selectively trapped the field mouse and the house shrew (*Suncus murinus*).

#### Harvest and post-harvest technology research

##### Marginal holders dryer using agri. waste as fuel

A mini dryer suitable for marginal plantation holdings has been designed



and developed. The dryer has a capacity to dry 100 coconuts or 35 kg of arecanut per batch. The drying time required is 32 hrs and 85 hrs for copra and arecanut respectively. The dryer costs only Rs. 500/- and is suitable for holdings of 0.5 ha size.

#### **Low-cost cardamom dryer**

A low cost small holders dryer for drying 20 kg of small cardamom costing Rs. 4000/- has been developed. The dryer works on natural convection principle and it uses agri. waste or small pieces of waste wood as fuel.

#### **Low-cost copra dryer for large holdings**

A low cost natural convection type dryer to dry 3000 coconuts per batch has been designed and it is under fabrication.

#### **Popularisation of copra moisture meter**

The copra moisture meter developed by the Institute has been formally released for adoption by the Hon'ble Union Minister of State for Agriculture and Rural Development in August 1986. Thirty pieces of the moisture meter are being used by the Kerala State Warehousing Corporation for their copra procurement programmes.

#### **Refinement of experimentation techniques in plantation crops**

Using fertilizer trial data, it has been established that the optimum plot size for oil palm field experiments is eight palms, under Bharathipuram conditions. Studies made on the forecasting of

coconut yield based on weather variables revealed that the prediction model involving relative humidity, hours of sunshine, vapour pressure and temperature (min) at selected periods of the year, during one to three years prior to the year of harvest, explains about 91% of the variations in yield. The intensity of dry spell, as measured by the number of weeks with little or no rains during March-May, was found to have an adverse effect on the yield in the coming year, whereas it has a favourable effect on yield, one year after.

#### **Estimation of crop losses**

Two rounds of survey in the six northern districts of Kerala were undertaken by CPCRI and Department of Agriculture, Kerala in collaboration with Coconut Development Board, Directorate of Economics and Statistics, Centre for Development Studies, Kerala Agricultural University, SADU and CPPS Cochin. The total number of palms is estimated as 60 million with 41 million bearing and 19 million non-bearing palms. The average yield per palm varied from 53 nuts (Kasaragod) to 68 nuts (Calicut) among the districts.

#### **Cost-benefit analysis of crop production and farming systems**

The economic potential of coconut-based multistoreyed cropping under irrigation involving pepper and cocoa reveals that the net return per ha from this system could be as high as Rs. 23,200 as compared to Rs. 6,900

from rainfed coconuts and Rs. 11,400 from irrigated coconuts raised as monocrop. If we take into account the family labour earnings along with the net profit the total return to the family increases to Rs. 28,800/ha in this system from Rs. 10,000/- under rainfed monocrop. (Table 1)

Coconut-based mixed farming system involving production of fodder (hybrid Napier NB 21 and Guinea Grass) in the inter-spaces of coconut, training of pepper on coconut palm, growing vegetables and banana around farm house, rearing of five units of milch cows and 30 units of rabbit gives a net return of Rs. 14,500/ha/year. Since this system is highly

labour intensive the total returns to the family including the family labour wages is estimated at Rs. 35,000/- ha/year. This system could be an ideal model for the self-reliant small-holder because of its high turnover and resource use efficiency. (Table 1)

**Agriculture, animal sciences and fishery research at ICAR Research Complex for Goa (CPCRI)**

### **Crop Sciences**

#### **Paddy**

CR 94-721-3 and IET 7918 were found resistant to gall midge and CSR 4 was found to be tolerant to medium salinity.

Table 1. *Relative economics of coconut based farming system*  
(1 ha model)

|                                | Multistoreyed<br>cropping<br>system | Mixed farming<br>system |
|--------------------------------|-------------------------------------|-------------------------|
| <i>Inputs</i>                  |                                     |                         |
| Labour (Mandays)               |                                     |                         |
| Family labour                  | 200                                 | 730                     |
| Hired labour                   | 135                                 | 120                     |
| Total                          | 335                                 | 850                     |
| Fertilizer cost for the system | Rs. 2,100                           | Rs. 2,300               |
| Plant Protection cost          | Rs. 1,000                           | Rs. 500                 |
| Cattle cost                    | —                                   | Rs. 12,600              |
| <i>Yield</i>                   |                                     |                         |
| Coconut (Nuts)                 | 15,750                              | 15,900                  |
| Pepper (kg)                    | 141                                 | 218                     |
| Cocoa (Wet beans in kg)        | 1,750                               | —                       |
| Milk (litres)                  | —                                   | 7,500                   |
| Subsidiary crops               | —                                   | Rs. 4,500               |
| Total cost                     | Rs. 23,700                          | Rs. 56,500              |
| Total return                   | Rs. 46,900                          | Rs. 71,100              |
| Net return                     | Rs. 23,200                          | Rs. 14,500              |
| Earnings by family labour wage | Rs. 5,600                           | Rs. 20,500              |
| Total returns to the family    | Rs. 28,800                          | Rs. 35,000              |

## **Pulses**

As a rabi crop, cowpea varieties S 288 and 61 B (both vegetable types) and S 488 (grain type) and pigeonpea variety Pankhenjore were suitable for rice fallows. Cowpea UPC-89 was found to be the best fodder legume for all seasons.

## **Maize**

Ganga 5 was found to yield about 15 t/ha of green cobs and thus forms a valuable rabi crop for *kher* lands and lateritic soils having irrigation facilities.

## **Tuber crops**

Out of the 24 tapioca varieties tested, H 165, H 1687, S 856, 14/75, H 123, H 2304 and 590 appeared promising with a yield potential of 15 to 20 t/ha. Out of 27 sweet potato varieties tested, Cross 4, S-30 Kalmegh, 76 (OP) 217 and 76 (OP) 219, and R-S-5 yielded on an average 30 t/ha which is twice the yield of local types.

## **Animal Sciences**

### **Cattle**

Clomiphenecitrate oral administration were sixty per cent successful to induce oestrus and conception in the crossbreds.

### **Rabbit**

Four exotic meat type rabbits *viz.*, Soviet Chinchilla, Grey Giant, White Giant and New Zealand White were introduced to Goa. Pure breeding and cross breeding was done successfully. The average exotic litter size, birth weight and daily weight gain was 7.73,

55.05 gm and 13.21 gm respectively, whereas the same for local  $\times$  exotic crossbreds were 5.50, 50.25 gm and 13.07 gm respectively.

## **Poultry**

In broiler parental stock, clomiphene citrate was tried for the first time and found to increase egg production by 27 per cent.

## **Agriculture, animal science and fishery research at ICAR Research Complex for Lakshadweep (CPCRI)**

Observations on flowering, frond production rate, number of total functioning leaves and number of chlorotic leaves on the crown of experimental palms revealed that the frond production rate and the reduction in chlorosis were markedly influenced by fertilizer application. Maximum response was shown by K followed by N and P respectively.

## **Production of parental materials and breeder's stock of plantation crops**

During the year the thrust was to produce adequate parental materials required for the coconut seed gardens in the country. In Dwarf, 1,55,525 nuts and 1,365 seedlings and 9,835 seed nuts and 2,100 seedlings of Talls were supplied to various seed gardens. Seedlings of 2000 D $\times$ T hybrids, 1500 cultivars and 1000 high yielding Talls were distributed to farmers. In arecanut, over 0.225 million seednuts and 10,000 seedlings in various selections were distributed to farmers. In oil palm over 20,000 *tenera* hybrids

were pretreated for germination. Two thousand sprouts have been distributed to Karnataka and Andhra Pradesh

## ALL INDIA CO-ORDINATED RESEARCH PROJECT ON PALMS

### Crop improvement

The performance of Andaman Giant, Andaman Ordinary, New Guinea and Cochin China were better in terms of nut and copra yield at various centres. The highest copra yield of 19.5 kg/palm/year was obtained in Andaman Giant at Veppankulam. Laccadive Ordinary and Benolium have yielded 153 and 152 nuts respectively per palm per year in the Konkan coast of Maharashtra. At Veppankulam, Gangabondam  $\times$  ECT recorded the highest nut yield followed by ECT  $\times$  Dwarf Yellow. The performance of T  $\times$  D continued to be better in Andhra Pradesh, Tamil Nadu and Maharashtra.

### Crop management

In the sandy loam soils of Veppankulam, application of 1 kg N, 0.5 kg  $P_2O_5$  and 1.75 kg  $K_2O$ /palm/year was found to give higher nut yield

which is 56% more than the control. In Andamans the highest nut yield was obtained in palms receiving 0.5 kg N, 0.75 kg  $P_2O_5$  and 1.75 kg  $K_2O$ /year.

### Disease management

The stomatal diffusive resistant and transpirant rate studies for the Thanjavur wilt affected palms in comparison with the healthy palms indicated that the transpiration rate was lesser and the stomatal diffusive rate higher in the diseased palms. The combined application of injection of Aureofungin sol 2 g and 1 g copper sulphate in 100 ml of water, soil drenching of 1% Bordeaux mixture and application of neem cake at 5 kg/palm/year continued to be effective in reducing the intensity of Thanjavur wilt disease. For Ganoderma wilt disease, a total of 44 gardens covering an area of 196 ha having 3700 palms were surveyed and it was found that 0.19% of palms was affected by Ganoderma and 2.21% by stem bleeding. The survey conducted in Razole taluk of Andhra Pradesh for Tatipaka disease revealed the presence of 12,000 diseased palms in that taluk.

## SPICES

### Black pepper

The yield data obtained from NPK experiment on pepper over a period of six years indicated that application of 100 g N, 40 g  $P_2O_5$  and 280 g  $K_2O$ /vine/year is the optimum dose of fertilizers under Peruvannamuzhi conditions.

Soil sampling at 30 cm away from the base of the vine to a depth of 30 cm is optimum for determining the soil nutrient status of pepper.

The indicator leaf for the determination of nutrient status of pepper is the youngest matured leaf from the middle 1/3 portion of the vine.

Significant correlations were observed between soil and leaf nutrients with yield (leaf P index and yield  $r = 0.81^{**}$ , soil zinc and leaf zinc  $r = 0.89^{**}$ , soil copper and leaf copper  $r = 0.77^{**}$ ).

Seventy two cultivated types and 142 wild accessions in *Piper* spp were collected during 1986. Two new taxa were described (*Piper silentvalliensis* and *P. nigrum* var. *hirtellosum*).

Twelve lines from OP seedlings and four hybrids, tolerant to *Phytophthora* have been planted at Sirsi in arecanut based farming system to evaluate their field tolerance and yield potential.

Field control trials for three years conclusively proved the efficacy of metalaxyl in checking *Phytophthora* infection in black pepper.

Soil application of Ridomil 5 G granules @ 10 and 20 g/vine were effective in checking *Phytophthora* foliar infection, (foliar and collar) of black pepper.

The comprehensive survey for the association of plant parasitic nematodes associated with black pepper in Kerala revealed the following:

1. Out of the fourteen genera recorded, *Meloidogyne incognita*, *Radopholus similis* and *Trophotylenchulus piperis* are the major nematode species associated with the crop.

2. *M. incognita* is widely distributed in Calicut, Cannanore and Idukki district.

3. *T. piperis* is widely distributed in all pepper growing areas in Kerala and its occurrence is high in Idukki district.

4. The concomitant infestation of *M. incognita*, *R. similis* and *T. piperis* is more common (21.9%) compared to their solitary infestation (*M. incognita* 17.8%, *R. similis* 6.0% and *T. piperis* 5.4%).

5. Pepper vines inoculated with *R. similis* alone or in combination with *M. incognita* developed interveinal chlorosis, foliar yellowing—typical of slow wilt disease symptoms. This further confirms the major role of *R. similis* in the etiology of slow wilt disease of black pepper.

Population of *R. similis* is maximum during September/October while population of *M. incognita* reaches its peak level during December/January months in pepper gardens.

An anthocorid bug *Montandoniola moraguesi* and a predatory thrips *Androthrips flavipes* were recorded to be predacious on various stages of gall thrips *Liothrips karnyi* and were widely distributed.

Studies on the residual toxicity of nine insecticides against gall thrips indicated that monocrotophos 0.05% was the most effective causing 90% mortality upto 14 days and 50% mortality 28 days after treatment.

Among 52 Karimunda selections evaluated for their quality characteristics, accession No. 84

contained 7.13% piperine, 12.55% oleoresin and 6% essential oil.

A technique for visually scoring for yield of pepper plants was standardised. It was found that yield of pepper plants could be estimated with a high  $R^2$  value ( $R^2=0.81$ ) using visual yield score as a predictor variable. It was established that by using visual yield score as an ancillary variate in double sampling scheme, the cost of yield estimation could be reduced by half in comparison to that of simple random sampling for estimating the yield of pepper plantations with a given accuracy. The technique for visually scoring for yield potential of pepper was field tested and it was found that the method could be adopted with very little training to the investigators.

To augment pepper productivity to a targeted level of 2.0 kg/vine/year in the farmers field, a large scale demonstration was started in April 1986. The proven technology developed in this Institute like judicious manuring with organics and inorganics, optimum cultural practices, phyto-sanitation and plant protection are transferred in 51 farmers' holdings. The demonstration covers 80 ha block consisting of 24,000 vines out of which 13,400 are experimental vines and the balance untreated control.

### Cardamom

Thirty-seven accessions earlier collected from Wynad, some of them yielding more than 10 kg/plant wet

capsules in the original sites have been clonally multiplied and being planted.

A total of 333  $M_2$  seedlings were produced by selfing 10 'katte' escapes ( $M_1$ ). They were transplanted in the polybags and were inoculated with viruliferous aphids to isolate resistant lines for katte.

For multiplication of selected clones, young suckers were field sterilised and after trimming and further sterilisation, inoculated on semisolid MS medium supplemented with NAA (0.2 to 0.5 mg/l) and BAP (0.5 to 1 mg/l). Initially, 3-5 plantlets were produced within 40 to 60 days. These plantlets, after rooting in white's media, were subcultured for multiplication on MS liquid media. Each culture produced 5 to 7 shoots within 20 to 30 days. These plantlets were separated, rooted and again put for multiplication.

Other method used for multiplication was reversion of floral buds by inoculating young panicle buds and recemes of the mature panicle. This was found useful especially during rainy season when contamination rate was found to be higher with vegetative buds and also during flowering season when a large number of explants can be obtained from each clone as compared to vegetative buds.

A suspension culture system was established for *in vitro* screening for disease resistance in cardamom.

Ridomil-ziram @ 0.75 ml and 1.5 ml/sq.m nursery was very effective in controlling damping off and rhizome rot of cardamom seedlings.

Fifty six natural 'katte' escapes were collected from hot spot areas of Uthara Kannada. These collections are under multiplication for further evaluation.

Field demonstration of High Production Technology in Cardamom was launched during 1986 in collaboration with Cardamom Board. Forty-two plantations were identified covering an area of 67.80 ha accommodating 2,28,900 seedlings supplied from the departmental nurseries on subsidy along with other financial assistance from Cardamom Board.

Among the three cardamom cultivars, 'Mysore' contained 6.46% essential oil and 3.91% oleoresin. Among the germplasm accessions, accession No. 37 contained 10% essential oil and 5.75% oleoresin.

## Ginger

Quality analysis in 14 ginger cultivars collected at different maturity periods, showed that dry recovery was maximum (22.2%) in Nadia, starch was maximum (49.7%) in Karakkal and the fibre content varied from 4.85% (Jamaica) to 6.9% (Sleevea Local). At 150th day after planting the maximum essential oil content was observed in Ernad Chernad (4.0%) and the cultivar Vengara Selection had the highest oleoresin content (10.4%).

Gingerol content varied from 9.1% in Vengara Selection to 28.1% in Jugijan at different maturity periods. Protein content reached maximum at 180th day in all the 14 cultivars, maximum being 14.8% in Vengara Selection. Correlation matrix between different quality parameters was worked out and based on the studies, cultivar Maran, Ernad Chernad, and Nadia are recommended for fresh as well as for dry ginger.

Efforts were made to standardise a medium for *in vitro* propagation of ginger. Callus formation was observed in MS basal medium supplemented with 0.2 mg/l kinetin, 0.24 mg/l NAA and 0.16 mg/l of 2, 4-D. Vegetative buds developed into plantlets cultured in MS basal medium+0.2 mg/l of NAA and 1 mg/l of kinetin and 0.2 mg/l of BAP.

In a pot culture experiment under artificial inoculation, seed treatment with Apron 35 SD @ 1 g a. i./kg of ginger seeds was effective in controlling rhizome rot caused by *Pythium aphanidermatum*.

## Nutmeg

Steroid degradation in nutmeg is associated with the male sex expression and can be extrapolated for juvenile seedlings screening.

## All India Co-ordinated Spices Improvement Project

### Pepper

Eighty-five wild accessions of pepper have been added to the germplasm.

Kuthiravally gave an yield (6 year mean) of 2.302 kg/vine consistently and was better than other varieties in the comparative yield trial. The data from a long term (8 year) NPK experiment have been analysed and the revised NPK recommendation based on the result is 50:50:150 respectively.

#### **Cardamom**

Cardamom selection Cl. 726 yielded 193.4 g per clump compared to previous best of Cl. 683 and Cl. 679.

#### **Ginger**

At Pottangi, Orissa, local clonal selection PGS 35 out-yielded others, giving 22 t/ha. Blitox-50 @ 0.3% as seed dip helped disease free storage of ginger at Solan. Selections SG 646 and SG 600 gave high yields. Seed rhizomes of 20 g do better at Pottangi and Solan Centres.

#### **Turmeric**

PTS 24 gave the maximum yield (16t/ha) among different cultivars at Pottangi.

#### **Cumin**

Entries UC 61, UC 89, UC 94, UC 40 were high yielders in multilocation trials. The lines from Jobner, Jaipur UC 19, UC 198 and UC had least wilt infection. Essential oil was high in CS-2 whereas total oil was maximum in UC-198.

#### **Coriander**

Entries UD 41, UD 270 and Comp. 1 gave higher yield in Jobner. The Guntur centre has identified varieties suited to different conditions viz., CS 2 for mid-season, grain; CS-4 for late season, grain+leaf; CS-6 for early season; CS-7 for late season, grain+leaf. Powdery mildew is controlled by Sulfex 0.3%, or Bavistin 0.1% or Karathane 0.1% spray. At Coimbatore variety Co 2 yielded 540 kg/ha and was superior to others.

#### **Fenugreek**

At Coimbatore, Co 1 gave highest yield of 273.3 kg/ha, at Guntur, L. S. 1 and Guntur Local gave an yield of 740 kg/ha and 570 kg/ha; at Jobner, UM-5, UM 34 and NLM yielded high. The line NLM showed tolerance to root rot and the mutant M5 (30 Kr-1) showed minimum powdery mildew and recorded high yields. Stem gall in Coimbatore was controlled by drenching with Bavistin 0.1% or Brassicol 0.1%.

#### **Fennel**

Superior performance was shown by UF 32, UF 12 and a few more lines at Jobner; UF 1, UF 112 which performed best last year, continued to be promising.

### **CASHEW**

Among the 161 germplasm accessions available at Vittal, four varieties namely M 16/1, 8/1 Kodur, 8/7 Sompeta and 12/12 Korali were found to be

early flowering (Oct. Nov.) with short flowering duration (40 to 60 days). Except 12/12 Korali all the other three varieties gave an yield of over 5 kg/



varieties gave an yield of over 5 kg/tree/year. Germplasm collection was undertaken in seven districts of Andhra Pradesh with a view to collecting high yielding types with bold nuts, high shelling percentage and short flowering duration. Eight collections were made from trees with yield over 50 kg/year, three collections with nut weight over 9.5 g and two collections with shelling percentage over 35%.

In the hybrid evaluation trials, the combinations involving VTH 30 (A 18/4 Kodur—with bold nut) showed precocious bearing habit. Under Shanthigodu conditions using soft wood grafting it was possible to produce grafts of cashew during February to November months with success ranging between 61 to 79%, with best period being July to September. For maintaining the grafts in nursery for longer periods, application of 1 ml/polybag planted graft (50 ppm a.i.) of paclobutrazol was found to be useful in restricting the vegetative as well as root growth of cashew. During the current year over 10,000 grafts of released varieties have been made. Bud—wood orchard of seven released varieties has been established.

The experiments conducted on the time and severity of pruning cashew trees clearly indicated that lateral shoot pruning or leader shoot pruning done during August increased the yield by 80 per cent.

A scoring procedure for screening of germplasm for locating resistance

to tea mosquito has been worked out and five varieties namely M 76/1, V1, Palaparamba, Kundapura and 9/66 Chirala with scores ranging between 3.8 to 4.2 were identified as moderately susceptible while VTH 35 with score of 7.6 was highly susceptible.

### All India Co-ordinated Cashew Improvement Project

Vegetative propagation in cashew was being investigated for over a decade with little success. During the current year it has been possible to standardize soft wood grafting in cashew. Two to three months old root stocks were used for grafting. Procuring the scion for a week was found to be advantageous in realising highest success. Retaining one or two pairs of leaves or root stock till the scion buds sprout enhances success percentage. It is now possible to produce the grafts in cashew in all the seasons of the year using this method. The success ranged between 20% and 80% in different months of the year with best success during March to July in different centres depending upon the location and the availability of scion material.

For rejuvenating old and unthrifty cashew trees, topworking has been standardized under Orissa and Karnataka conditions. Beheading the trees in the month of November–December followed by soft wood grafting on four or five new sprouts in the month of March–April gave 60 to 80% success. Top-worked trees gave an yield of 2 to 3 kg in the

second year compared to 500 g which was being realised from old trees. Stem padding with cotton wool soaked in monocrotophos @ 30 ml/tree was found to be most effective in controlling stem borer infestation

under Goa conditions. Aerial spraying trials conducted for three consecutive years in Kerala have conclusively proved that endosulfan 35 EC at 750 ml/ha was effective in controlling the pest complex occurring on the inflorescences.

## Transfer of technology network

### Lab to Land programme

A total of 305 farm families have been adopted with 48 nos. of scheduled castes, 40 nos. of scheduled tribes and 217 others, under Phase IV of the programme under Zone VIII at Kasaragod, Vittal, Kayangulam and Goa, for transferring modern technologies developed by this Institute. A bench mark survey was conducted and suitable farm plans were prepared for every households incorporating the latest technology. Critical inputs like planting materials, fertilizers and plant protection chemicals were made available based on the requirements. Members of the selected farm families were brought to the Institute and given suitable training.

### Training for research workers, extension workers and farmers

Fifteen training courses in 43 batches were organised on different aspects of plantation crop production technology, in which 201 officials from 12 states and 3 union territories participated. Special training of 3-10 days duration based on the request received from developmental agencies like Coconut Development Board, Kerala Agricultural University,

Vocational Training Centres etc.

were imparted to 494 trainees mainly from Kerala, Karnataka and Andamans. Training for 70 farmers from Karnataka, Mahe and West Bengal were organised. Training programme was also organised for 7 officials of developing countries like Sri Lanka, Nigeria and Zambia.

### Research cum demonstration plots

Twenty four research cum demonstration plots are maintained in farmers' fields to demonstrate the modern technology in cultivation of plantation crops to increase the productivity. The material inputs were supplied at free of cost by the Institute and the cost of labour met by the farmers. Management of root wilt diseases in coconut was also demonstrated in 5 plots at Kayangulam.

### Production of planting material

High yielding planting materials of coconut (28887 seeds and 15510 seedlings) arecanut (356355 seeds and 50954 seedlings), cardamom (123 kg seeds), pepper cutting (36365 nos), cashew (1137 kg seeds and 25052 seedlings) and other spices (1735 nos) were distributed to extension agencies and farmers.

### **Kisan melas and exhibitions**

Kisan Melas were organised at Kasaragod, Palode and Calicut and also participated in exhibitions at Trivandrum, Changanacherry, Jalpaiguri, Coonoor, Congress Centennery Exhibition at Madras, National Horticultural Fair at New Delhi and provided materials for the International Exhibitions organised by ICAR at Qatar and Zimbabwe.

### **Farm advisory service**

Farmers from different regions were continued to visit the Institute and its Regional Stations in large numbers. They were shown the experimental plots of the stations and improved cultivation practices to be adopted for maximising the production of plantation crops. Enquiries from the farmers regarding their problems in the establishment and management of the plantation crops were answered by the scientists during the year. Visits to the farmers fields were under taken by the scientists to give guidance to the farmers in selecting suitable planting sites and laying out new plantations and also for giving advice on plant protection. The scientists of this Institute have also actively participated in seminars and village meetings organised by Governmental, quasi-governmental and private agencies.

### **Extension literature published/reprinted**

Technical Bulletins on : a) 'Katte' disease of small cardamom and its

control, b) Cost of production and cost analysis of small holder plantation crops, c) Small holder's dryer for plantation crops using agricultural waste as fuel, d) Coconut root (wilt) disease—Present status of research and management e) Solar and electrical copra dryer f) Strategy for oil palm research and development in India and g) Guidelines for establishing coconut seed gardens in India were brought out.

Pamphlets on Thanjavur wilt/Ganoderma disease of coconut and Folders on

a) Quick (yellow) decline of coconut, b) Coreid bug, the nut crinkler pest of coconut and c) Spindle bug of arecanut were also published.

In addition to this the package of practices for coconut, arecanut, cocoa, cashew and pepper and folders for arecanut yellow leaf disease, rapid multiplication of pepper, Mangala arecanut were updated and reprinted.

### **Participation in AIR and Doordarshan programmes**

The scientists of the Institute gave several Radio talks in AIR and also assisted in shooting a TV film on the activities of the Institute for the TV National Net Work. The Institute also hosted a Rural Advisory Committee Meeting of the AIR at its headquarters at Kasaragod.

