RESEARCH HIGHLIGHTS 1987

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

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Front cover
The black rat feeding on cocoa pod

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INTRODUCTION

The Central Plantation Crops Research Institute conducts and coordinates research on coconut, oil palm, arecanut and cocoa, and also on small-holder plantation crops based farming systems. The primary objective of the on-going research programmes is to find solutions to problems in plantation crops which restrict the production and productivity. After de-linking of research on spices and cashew with the establishment of two National Research Centres, the Institute is left with a network of two Regional Stations, two Research Complexes, five Research Centres, a Seed Garden and a World Coconut Germplasm Centre spread over five States and two Union Territories. The research programmes of the Institute at present consist of 26 Mega Projects out of which 8 are multi-disciplinary projects being implemented at more than one centre.

In each of the four crops on which the Institute is conducting and co-ordinating research, the thrust is on crop improvement, crop management and crop protection.

The Research Highlight of the Institute for the year 1987 presents in a concised form the major research efforts in each of the problems being tackled by the Institute and arranged in the order of priority.

Proof for an MLO etiology for root (wilt) disease of coconut, identifying the pathogen involved in the stem bleeding disease of coconut, demonstrating the compatible combination in coconut based farming systems to increase the net return from unit area, identifying coconut genotypes showing drought tolerance, establishing and expanding laboratory facilities to produce oil palm tissue culture seedlings on a large scale, demonstrating the role of pollinating weevil *Eleidobius kamerunicus* in increasing the fruit set in oil palm and releasing two coconut variaties Banawali Green Round for Maharashtra and ECT×MYD hybrid for Tamil Nadu are some of the major achievements during the year 1987.

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Kasaragod,
6 January 1988

PALMS AND COCOA

Root (wilt) disease of coconut

Further evidences confirming the lace bug, *Stephanitis typica* as a vector of the intraphloemic mollicute integrally associated with the root (wilt) disease of coconut have accrued. Presence of mycoplasma-like organisms (MLOs) in salivary gland and brain tissues of lace bug exposed to root (wilt) affected palms has been reported earlier. Successful insect transmission of MLOs into coconut seedlings in insect-proof cages has now been, accomplished. Three out of four seedlings inoculated with infective bugs by about thirteen months after the first release of the bugs yielded positive reactions in serology, histochemical tests and electron microscopy. Since then two out of these three seedlings have developed flaccidity of leaflets—the most consistent and decisive symptom of root (wilt).

Proof for an MLO etiology for root (wilt) has been further strengthened by obtaining statistically significant remission of symptoms in terramycin treated palms. Degree of remission was pronounced at three to six gram a.i. of this antibiotic at quarterly intervals. Contrastingly, the control palms that received distilled water or Penicillin presented increased disease index scores.

MLOs being fastidious, non-cultivable micropathogens, requirements enunciated to attribute an etiological role for them are demonstrating, constant association of MLOs with the diseased plant host, suspected vector, successful transmission mediated by vectors and remission of disease symptoms subsequent to tetracycline therapy. These have now been accomplished.

Thanjavur wilt, Ganoderma, Stem bleeding Complex diseases

Stem Bleeding

Among the fungi used for inoculation of coconut, progress of disease symptoms was noticed only in the case of *T. paradoxa*. In young palms, the internal decay developed more fast into greater depths.

To quantify the severity of stem bleeding symptoms in coconut, the following index formula has been evolved based on observations on 860 adult diseased palms: $1{\cdot}7\ l + 4{\cdot}0\ t$, where l is the lesion size in 1000 cm^2 and t is the score (0 to 4) for stem tapering.

Ganoderma

In case of *Ganoderma* wilt of coconut the optical density (OD) values of diseased leaf and root samples, extracted using EDTA showed higher values. The OD value in diseased leaf was 0·311 as against 0·248 in healthy leaf. In the case of roots, the corresponding values were 0·298 and 0·222.

Tatipaka disease

The survey conducted in 16 Mandals of East Godavari District of Andhra Pradesh by the co-ordinating centre, Razole jointly with Horticulture and Agriculture Departments revealed the presence of 26889 Tatipaka disease affected palms.

Yellow leaf disease of arecanut

Mycoplasma - like organisms could be observed in the YLD affected palms even during the period when symptoms were masked. Similar bodies were also observed in the salivary glands of *Proutista moesta* having 30 and 31 days acquisition +incubation on diseased arecanut palms. The brain and salivary gland tissues of the spindle bug subjected to 22, 28, 31 and 35 days A+IP did not contain any MLO.

Root samples of all the YLD affected palms examined gave positive results in their flourochrome and staining reactions under light microscopy. This supports the presence of MLOs as observed under EM studies.

The population of spindle bug showed positive correlation with rainfall. The longevity of the bug was 22·5 and 28 days for males and females respectively. The peak population of the plant hopper *P. moesta* was recorded during June, August and December. The longevity of the plant hopper *Oliarus* sp. was 15 days in arecanut and 30 days in grass. The survey on 28 gardens from 2 Districts showed that areca palms are rather free from *Oliarus* sp.

The tree injections with antibiotics as well as transmission trials with dodder *Cassytha filiformis* could not yield positive results. Serodiagnostic method in the identification of disease affected palms was improved.

All the areca palms which received bi-weekly insecticidal applications remained healthy even after 42 months, whereas 7/10 palms in the control got affected during the period. This supports the involvement of an aerial vector in the occurrence of the disease.

Spindle rotting, brittleness of the leaf midrib, reduction of leaf size and erectness of the leaves were recorded as additional symptoms of the disease.

Fresh incidence of the disease in the management garden at Palode was less than 1% during the year.

Among the disease escape hybrids, Saigon × Mangala cross continued to be the best in yield and tolerance to the disease. Out of 61 escapes identified during 1986 through the Hot Spot Survey from all over Kerala, 13 palms took up the disease symptoms this year.

Perennial crop based farming systems

A multistoryed cropping system involving coconut, pepper and cocoa yielded 21,753 nuts, 187 kg dry pepper and 564 kg dry cocoa beans per hectare at its 15th year of establishment under irrigated conditions.

One hectare of mixed farming system yielded during the year under report 13,281 coconuts, 158 kg dry pepper, 317 kg banana, 4584 litres of milk and 547 m^3 of biogas.

In the coconut based high density multi-species cropping model initially started

with 18 crop species in 1983 it was seen that the yield of coconut doubled in the fourth year due to irrigation and complementary effect of component crops.

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

A descriptor was developed for 14 tall and four dwarf cultivars of coconut using 40 growth, floral and yield characters. A data base has been established for retrieval of information on any individual palm/accession/character in 40 accessions. Out of the 24 exotic collections from Pacific Ocean Region and six Nicobar collections maintained at WCGC at Andaman 45 trees on 13 accessions have so far flowered.

Preliminary screening of 46 coconut cultivars indicated that Chowghat Orange Dwarf and Andaman Ranguchan are very good for both tender nut water and tender nut meat. Sixty four cultivars are now under field testing for resistance/tolerance against root (wilt) disease.

The germplasm collections in arecanut was enriched to contain 41 indigenous cultivars, 18 exotic collections and five *Areca* sps.

One Malaysian *tenera* hybrid was added to the oil palm germplasm collections which now consists of 13 exotic collections. In addition to 28 *pisifera* palms at Oil Palm Station, Thodupuzha, nine more *pisiferas* were identified at CPCRI, Palode enabling an increase in the commercial hybrid seed production in the Country.

Among 18 *pisiferas* studied for fruit characters, the predominant types were fruits with mesocarp and kernel but without embryos followed by those with only mesocarp but without embryos.

Studies on nine cocoa accessions from Kew gardens, England grown at Lalbagh Bangalore indicated that ICS 1 and ICS 6 with an annual mean bean yield of 3·6 kg and 2·2 kg/tree respectively are the best accessions. Six high yielding Malaysian cocoa collections are now clonally mass multiplied and distributed to farmers.

Evolving high yielding varieties by selection and hybridization

WC Tall x Chowghat Orange Dwarf continues to give higher yield of 178 nuts/tree/year under irrigated condition. Chowghat Dwarf x WC Tall (DxT) planted in 1940 even at 46 years continues to give an average of 112 nuts under rainfed condition. No superiority could be observed in MAWA hybrid coconut to COD x WCT hybrid. D x T flowered in 47th leaf axil while MAWA flowered in 49th leaf axil in its comparative trial plot. Large scale production of L.O x COD and LO x G has been undertaken. New cross combination using COD, CGD, MYD and MOD as females with WCT, AO, LO, Tiptur Tall and Benaulim has been initiated.

In arecanut a comparative yield trial using VTL–11, VTL–17, Mohitnagar, Hirehalli and Thirthahalli with Mangala as control was laid out. A trial using Mangala, Thirthahalli, and Hirehalli was laid out at Kannara for screening these materials against YLD. Large scale *inter se* mating of VTL–3 (Mangala), VTL–11 and VTL–17 were done at Kidu.

A progeny trial involving 9 crosses and F3 progenies of 4 Malaysian hybrids in cocoa

were planted as an intercrop in Arecanut at Vittal and as an intercrop in coconut at Kasaragod. Four blocks of biclonal orchard have been planted at Kidu farm. A large scale planting of ICS6 x Sca 6 have been done at Vittal.

Two *tenera* hybrid combinations in oilpalm 120 D x 30·103 P and 65 D x 30·103 P continued to give higher fresh fruit bunches.

Tissue, anther and cell culture

In the somatic embryogenesis pathway the shoot and root developed in a single step in oilpalm. The plants were very much similar to the plants raised through embryo-culture except that the haustorium was green in somatic embryos. The plants were very healthy and normal. The plantlets subjected to isozyme patterns did not show any variation between plants.

The callus on regeneration produced many abnormalities like bunch shoots, *in vitro* flowering etc. The regeneration was initiated by vascularization in the callus. Later shoot primordia appeared over the callus. The shoots were connected to each other by vasculature and had to be cut through the callus to separate shoots. These shoots were then rooted to realize plants. As variation was observed among such plants this method was not adopted to produce plantlets.

A simple method for the establishment of *in vitro* plants in soil was standardized. The plants at about 5 cm stage were planted directly in potting mixture containing organic manure, coirdust and soil in 1:1:1 ratio soaked with 500 ppm solution of KH_2PO_4. Such plants were kept in the green house. Over 90% of the plants established.

Three tissue cultured plantlets were planted in the field and are growing vigourously.

In coconut embryoids were produced from leaf tissues. Anatomical studies have confirmed the formation of shoot pole but they failed to develop further. Callus was induced from embryonic tissues and are now maintained for further differentiation.

Water management and stress physiology

Coconut genotypes and cocoa accessions were screened for drought tolerance using the sensitive parameters. viz. stomatal regulation and enzyme activities. Based on the parametric relationship with drought tolerance, the ranking of the genotypes/accessions was carried out. Among coconut genotypes WCT x WCT, FMS, LO x COD, Java Giant, Fizi, Philippines Ordinary, Andaman Giant, LO x GB, COD x COD, WCT and Cochin China, and among cocoa accessions NC 23, NC 29, NC 31, NC 39 and NC 42 possessed the desirable traits to withstand drought. A rapid method was developed, based on leaf water potential changes and sensitive enzyme activities, to screen coconut and cocoa for drought tolerance.

A comparison of three genotypes viz. WCT, WCT x COD and COD x WCT under sandyloam and laterite soils revealed that the hybrids could withstand drought better under laterite than under sandyloam soil. The susceptibility of the two hybrids to moisture stress under sandyloam was also indicated by the presence of two additional fast-moving bands (isozymes) of polyphenol oxidase, as compared to a relatively tolerant WCT.

COD x WCT palms tended to show higher

yield with drip irrigation than WCT palms. From the same number of nuts obtained in COD x WCT with the basin irrigation (EO 100%, by hose) and 66% of EO by drip system, it is clear that about 35% of water can be saved with the latter method. Discharge rate of 4 lit.h^{-1} was found to be favourable regarding moisture movement.

Regression equations were developed to estimate biomass of cocoa plants using three independent variables viz. canopy area, stem girth and height.

Nutritional requirement and crop management

All the three genotypes viz. high yielding WCT, COD x Tall and Tall x COD responded significantly only upto 500 g N+500 g P_2O_5+1000 g K_2O per palm per year. Irrigation with 20 mm of water at weekly interval produced 125 nuts/palm/yr. as, compared to 108 nuts/palm/yr. under rainfed condition.

Palms receiving cultivation+organic+inorganic fertilizers continued to record highest production of nuts (82 nuts/palm/yr.). The cumulative yield in this treatment was 513 nuts/palm since bearing, whereas in total neglected plot, only one palm (out of 12) so far produced only one nut.

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

Synergistic interaction was observed due to dual inoculation with Rhizobia and VA–mycorrhizal fungi in increasing nitrogen fixation and growth of green manure legumes viz. *Pueraria phaseoloides, Mimosa invisa* and *Calapogonium mucunoides. Beijerinckia* (asymbiotic nitrogen fixing bacteria) isolates from coconut soils exhibited large variation in the nitrogenase activity. In the Agroforestry plot, mycorrhizal status of coconut showed an overall increase over control in subabul, eucalyptus, casuarina and mango treatments. Prior inoculation with VA–mycorrhizal fungi was found to be effective in alleviating pathogenic effects of both *Pythium aphanodermatum* and *Meloidogyne inzognita* in soft rot of ginger.

Soil fertility, nutrient dynamics and crop production

In the field trials using slow release nitrogen sources the urea nitrogen fraction continued to release nitrogen beyond 105 days from urea formaldehyde treated plots. The nitrogen content in the leaf of urea treated coconut palm was on par with other sources. Among P–fractions in the soil, superphosphate applied treatment showed high Al–P than rock phosphate which increased with time. Almost a similar trend was recorded for Fe–P fraction. The NP tablet treated palms recorded nitrogen on par with urea split. NP tablets were found to release nitrogen at the rate of 180 mg/day/palm from 1·92 kg tablets. Thus the persistance of tablet in the soil is worked out to be over 1400 days.

A diagnosis and recommendation integrated system has been worked out for WCT by using leaf nutrient ratio. The DRIS norms for NPK were 0·486, 0·107 and –0·594 respectively showing the order of requirement as K>P>N to achieve the yield of 89 nuts/palm/year. An optimum ratio of N:P, N:K, K:P and N:P:K was found to be 17·2, 1·6, 10·8 and 17·2:1·0:10.8 respectively. The distribution of nutrient elements in various subcellular fractions of six genotypes indicated that D x T contain high concentration of

nutrients in majority of physiologically active subcellular components which in turn reflects the hybrid vigour. The correlation studies indicated that the P content in pigments is negatively correlated while insoluble fraction gave a positive relationship with yield. The Ca and Cu content in cellulose and lignin gave a similar relationship with yield.

The crownchocking disease affected palms of Assam and West Bengal showed significantly higher Ca and lower Boron content compared to healthy palms. The field trial with the application of 70 gms of Borax/palm/year showed complete recovery of palm from this malady.

In a study to ameliorate low productive problem soils with respect to Cd, Bi, Cr and Ni, the application of compost (5% O.C.) and phosphate (1000 ppm P) were found to be very effective in ameliorating Ni and Bi while phosphate and lime for Cd.

Production physiology of plantation crops

The hybrid seedlings of MYD x WCT, MQD x WCT and COD x WCT were analysed for some biochemical components. Out of 13 parameters studied, NR activity, total chlorophyll, soluble protein and malic dehydrogenase activity were higher in MYD x WCT hybrids. Genotypic differences in qualitative composition of wax components in these hybrids were also observed, the significance of which is yet to be known.

Disease management

MLOs were observed in tissues of apical meristem, inflorescence, root tip and petiole of Quick (yellow) decline disease affected coconut palms. Serodiagnostic test using root (wilt) disease antiserum was positive for O(Y)D also. O(Y)D is restricted to RWD affected areas. Many palms which exhibit symptoms of O(Y)D alone in the beginning, develop root (wilt) disease symptoms subsequently. These findings suggest that O(Y)D and root (wilt) disease are one and the same.

Investigations on leaf rot disease of arecanut in North Kanara district have shown that the intensity of the malady was more in young palms. Fungi *Phyllosticta arecae* and *Colletotrichum gloeosporiodes* were isolated from the affected leaves.

Twentytwo isolates of *Phytophthora* spp. were isolated from black-pod disease affected cocoa pods and four isolates from the stem lesions of cocoa affected by stem canker. All the isolates belong to *Phytophthora palmivora* MF1.

Methyl bromide at a concentration as high as 40 g/m^3-12 hr did not adversely affect germination of oil palm seeds. Treatment with Emesan 0·1% could eliminate seed microflora.

Pest management

Electron microscopic examination of ultrathin sections of midgut tissues of the scarabaeid beetle, *Xylotrupes gideon* L., collected from coconut palms in Dakshina Kannada district, Karnataka, revealed the occurrence of typical baculovirus particles. Gut aspirate of beetles fed to Oryctes grubs, by mixing with the feed, also produced typical symptoms of baculovirus infection. Thus, it has been confirmed that baculovirus disease is prevalent in the natural population of *X. gideon*, which also infests coconut palms.

Baculovirus of *Oryctes* was introduced to Andamans for biological suppression of the pest, during May, 1987 as a collaborative research programme with CARI, Port Blair. A total of 206 beetles collected from the crowns of coconut palms were infected with baculovirus and released at two locations.

Coconut water was found to be an ideal medium for mass culturing the entomopathogen *Metarhizium anisopliae*. Dry mycelial weight of the fungus cultured in 200 ml coconut water medium was 2·493 g, as against 2·168 g in 200 ml potato dextrose broth. The number of spores produced in coconut water medium on the thirtieth day of inoculation was 52·65 x 10^6/ml, as against 18·75 x 10^6 ml in potato dextrose broth.

Maintenance of a trap crop of *Stylosanthes gracilis*, raised on beds (distributed in 100 m^2 in a cacao garden of 0·82 ha) with phorate granules applied to soil @30g/m^2, thrice a year, was found to be quite effective in reducing *Myllocerus curvicornis* infestation on cacao. This has helped in total elimination of foliar application of insecticides against the pest at regular intervals.

The pollinating weevil, *Elaeidobius kamerunicus* Faust increased the fruit-set in oil-palm from 36·87% to 56·10%, resulting in 40% increase in bunch (FFB) weight and 11% increase in F/B ratio. The % of parthenocarpic fruits was also reduced, resulting in 23·4% reduction in P/F ratio. Similarly, introduction of *E. kamerunicus* in the oil palm plantations of Little Andamans also increased the average bunch weight from 5 to 12 kg.

Protection of the ripe fruit bunches with wirenet (75 cm x 60 cm) was most effective, resulting in 72% reduction in bird damage than the other methods like shooting and scaring (24%) and trap bunches (30%).

Vertebrate pest management

In the field, the juveniles of black rat (*Rattus rattus* wroughtoni) attained maturity within 2–3 months of their weaning. Nearly 50% of the rats which were captured as juveniles for the first time did not remain in the population for more than four months and none after 12 months.

The black rats did not exhibit any trap shyness. Whole/split grains of raw rice with 2% jaggery were found to be the best bait combinations to mix poison for the control of this pest. Among the two second generation rodenticides, viz. Brodifacoum and Bromadiolone, the former was found to be more toxic to black rats than the latter. At a dosage of 0·50 mg/kg body weight Brodifacoum killed all the test animals, whereas Bromadiolone killed only 50% of them. Exposure of Brodifacoum baits for one day resulted in 100% mortality in black rats while Bromadiolone baits produced only 93% mortality.

In the field, the Indian field mouse, *Mus booduga booduga* was found to breed throughout the year with a peak during September to December. The sub-adults were recruited to the population mostly during November to February.

Ripe banana sandwitched with carbofuran (3 g) granules @ 0·5 g per fruit was found to be the ideal poison bait for the control of palm civets in cacao gardens.

Nematode management

The experiment initiated in October 1982

in 6' x 6' x 4' soil tanks to study the pathogenicity of the burrowing nematode, *Radopholus similis* on coconut under field conditions with varying levels (log series) of nematode inoculum has clearly brought out the pathogenicity of the nematode on coconut, evidenced by considerable reduction in growth rate of inoculated seedlings compared to uninoculated seedlings. An inoculum level of 10 nematodes per 35,640 ccc of soil caused 13, 12 and 24 per cent reduction with regard to height, number of leaves and girth compared to 17, 14 and 35 per cent reduction over control with an inoculum of 100 nematodes per 35,640 ccc of the soil. The average field population at Kayangulam is 26 nematodes per 35,640 ccc of soil. At a higher inoculum level of one nematode in 3·5 ccc of soil the percentage reduction over control in height, number of leaves and girth were 44, 30 and 51 per cent respectively.

Population of *R. similis* on banana were found to have a haploid number of four chromosomes (n=4). Studies on survival of *R. similis* revealed that annual recurrence of infestation is brought about by the persistence of the nematode as adult females through summer months in infested roots.

Coconut and marotti *(Hydnocarpus wightiana)* oil cakes were found to be excellent media for multiplication of the biocontrol fungus, *Paeciliomyces lilacinus*. Neem and groundnut oil cakes and cow dung were also found to support the growth of this fungus. Cyst-forming nematode, *Heterodera oryzicola* was found associated with bunch failure in banana variety Nendran.

Occurrence of the burrowing nematode, *Radopholus similis* and cyst-forming nematode, *Heterodera oryzicola* were reported on banana in Goa.

Harvest and post harvest technology

Evaluation of copra moisture meter: As per the performance evaluation report received from M/s. Kerala State Warehousing Corporation, the copra moisture meter is found very reliable, time-saving and easy to handle.

Hole driller for laterite rocks: A tractor PTO shaft operated hole driller to drill a planting hole of about 6 feet depth and about 7 inches diameter has been designed and developed. It consists of a drill bit, pulley, mainshaft, squarethreaded shaft for depth controlling, Bevel gear arrangement, wheel and axle assembly, handle etc. The power has been taken from tractor PTO shaft with the help of the PTO pulley and V–belt mechanism. It has been tested in laterite rocks and found working except that scooping out of the soil by drill bit was not proper. It is being modified, by improving drill bit for better scooping out of the soil and at handle for better and comfortable operation for up and down motion of the drill bit.

Low-cost cardamom dryer: The low cost cardamom dryer using agricultural waste as fuel was modified by redesigning the top-cover of drying chamber to avoid condensation and for easy exit of the moist air.

Refinement of experimentation techniques in plantation crops

Based on the rank correlation coefficients for yields obtained in adjacent years and alternate years, a measure of bienniality

for coconut yields was worked out. Using this measure, it was shown that there is a reduction in the bienniality in irrigated coconut gardens, compared to pre-irrigation periods.

Studies conducted on the relationship between weather variables and quarterly yields in coconut showed seven lag periods, viz. 6–8, 10–12, 17–18, 22–23, 30–31, 35–36 and 44–46 months as important. These correspond to some of the important development phases of the inflorescence.

Data on growth of agriculture in Kerala during 1952–53 to 1985–86 has indicated a steady decline in the relative area under food crops. Crops like paddy, tapioca, arecanut and tea recorded substantial increase in production during this period, due to the increase in productivity of these crops. In the case of cardamom, coffee, rubber and cashewnut, increase in production was achieved through area expansion. For coconut and pepper, no appreciable increase in production was noticed.

Estimation of crop losses

Based on a garden to garden survey of YLD in the DK district of Karnataka, the total number of areca palms in Sullia taluk was worked out as 82 lakhs with 55 lakhs bearing and 27 lakhs non-bearing palms. 98·31% of the palms were of local variety and 1·7% Mangala variety. Only 0·14 percent of the palms were found diseased.

Economics

Cost-benefit study: Economics of coconut genotype experiment at Kasaragod involving WCT cultivars, and D x T and T x D hybrids was worked out. The cost of production of nut under rainfed condition is shown in the following Table.

Table: *Cost of Production of coconut* (Rs./nut)

Genotype	Fertilizer Level		
	M_0	M_1	M_2
WCT	0.90	0.73	0.68
DXT	0.75	0.51	0.52
TXD	0.90	0.45	0.64

(M_0 = No fertilizer, M_1—500:500:1000g NPK/Palm/yr, M_2=1000:1000:2000 g NPK/Palm/yr.

This study reveals that net profit is highest (Rs. 40,400/ha/yr) in the case of T x D at M_1 level followed by D x T at M_2 level (Rs. 37,000) and D x T at M_1 level (Rs. 34,000) while considering the farm-gate price @ Rs. 2/nut.

Coconut holding survay: A study on the nature of cultural practices followed by the coconut holdings was carried out in Kuttanad area in which both the SADU participants and non-participants were included as respondents. It was observed that while 89 percent of the holdings under the SADU Scheme were applying fertilizers to the palms, in the case of non-participants mere 7 percent were found to do that. As regards the disease management and inter/mixed cropping practices, there was no marked difference between the two categories of the holdings. The average number of nuts harvested per palm comes to 44·6 for the SADU Scheme participants and 33 for the non-participants.

Economic evaluation of development project: Field evaluation of coconut plantations in Canal embarkment of Orissa revealed that the policy of the allotment of 20 palms to each of the beneficiaries has failed to

generate the desired motivation in the weaker section to become effective participants in the programme. However, a small proportion of the beneficiaries who have taken some efforts in the maintenance of the palms are found to earn a net income of Rs. 1500 to Rs. 2000 per annum from 20 palms.

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

A. Crop Sciences

Tuber crops: In a trial of *Dioscorea alata*, clones Da 80 (16·0t/ha) and Da 60 (12·9 t/ha) proved to be the best-yielding ones.

Vegetables: Tomato varieties BWR–1, BWR–5 and MST 20/13 and brinjal variety SM–6 were found to be resistant to bacterial wilt. Okra varieties Sel–4, Sel–10, and Parbhani kranti were observed to be free of yellow vein mosaic during kharif.

Sugarcane: CO 7527 yielded significantly more cane (118 t/ha) and C.C.S. (16 t/ha) amongst the six peninsular varieties tested. Nitrogen at 250 kg/ha was found to be the most economical dose.

B. Animal Sciences

Cattle: In crossbred cows highest fertility (66%) was observed during the cooler months (Nov–Feb.). Average number of insemination per conception was 1·8.

Pig: Two exotic breeds viz. Yorkshire and Landrace was introduced for pure breeding and crossbreeding with local indigenous variety. The average litter size of 8 with an average birth weight and weaning weight of 1·2 kg and 10·2 kg, respectively were recorded in pure Yorkshire. Landrace and local have been successfully crossed overcoming the body disparity and a litter size of 4 has been obtained.

Rabbit: Pure breeding and cross breeding of rabbits were successfully continued. The age at maturity for exotic, crossbred and locals were found to be 8, 7 and 6 months, respectively. The adult body weight ranged between 3·5 to 4·5 kg for exotic, 3 to 4 kg for crossbred and 1·8 to 2·2 kg for locals. The crossbred attained the marketable body weight of 2 kg in 4 months time.

Poultry: Meat type Japanese Quails were successfully introduced. The age at 1st egg was 8 weeks. However, the peak production of 82% was reached at the age of 20th week. The average adult body weight was 140 gm.

In ducks the eggtype breed khaki Campbell and a fast growing meat type breed the 'White Pekins' (1·8 kg body weight in 8 weeks) have been successfully introduced.

C. Fishery

For demonstrating efficient recycling of organic waste (duck dropping) a duck cum fishery unit has been established with white pekin ducks and fish (major carps).

Agriculture, animal sciences and fishery research in ICAR Research Complex for Lakshadweep (CPCRI)

The yield and yield attributes of the NPK experimental palms at the initial year of bearing were influenced to a greater extent

by K. Highest bunch production rate was noticed at N_2 P_2 K_2 (500–320–1200) while female flower production and nut yield were maximum at N_2 P_0 K_2 and the percentage nut set at N_0 P_0 K_2.

Growing of pumpkin as an intercrop in coconut gardens was observed to be highly encouraging. The yield of fruit per year harvested from a 35 cent plot was 656·6 kg which works out to about 4700 kg/ha. Similarly the performance of CO 2 papaya variety as a mixed crop in coconut garden is highly remunerative. Even at the first year of planting, an average yield of 19·4 kg/plant was recorded at the Centre.

A pot culture study has revealed that the incorporation of FYM, at soil to FYM ratio 9:1 by weight had a profound influence on the growth of tomato plants in terms of dry matter production. The increase in dry matter production was about 175 percent. The addition of magnesium sulphate at the rate of 25·0 g/plant/pot had increased the dry matter production by 107% in the absence of FYM while in the presence of FYM the increase was only 51%. Addition of both FYM and magnesium sulphate recorded the highest growth which was nearly five times the growth of control plants.

A high density multispecies cropping system with coconut and arecanut as base crops has been established in a private garden (0·16 ha) in South Minicoy area (Demonstration Plot III), since October 1986 for research-cum-demonstration purpose. Banana, papaya and pumpkin were raised as associated crops. During the year, 52 banana bunches having a total weight of 441·5 kg and 24·0 kg of pumpkin were harvested from the plot.

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

During the year also the thrust was to produce enough planting materials for the seed gardens in the country. In Dwarf 20245 nuts and 525 seedlings and in Talls 22197 nuts and 4085 seedlings were supplied to various seed gardens. In addition to this over 1200 D x T and T x D seedlings, 1400 seedlings of selected cultivars were also distributed to farmers.

In arecanut over 2,98,650 seednuts from Kidu farm alone have been distributed to farmers. In addition to the above over 9080 *inter se* mated seeds in all the selections were made for planting programme as well as for distribution.

Four blocks of biclonal orchard consisting of 200 clones each have been planted at the seed farm for generating hybrids in Cacao. The clones include I 14, I 56, NC 31/94, III–105.

A total of 32,451 sprouts, 11,300 seeds and 3615 seedlings of oil palm were distributed to various agencies.

All India Co-ordinated Research Project on Palms

Crop Improvement

Of the 30 cultivars evaluated at Veppankulam, seven cultivars namely Andaman Giant, Andaman Ordinary, Malayan Green, Dwarf, Federated Malay States, Fiji, Cochin, China and Siam are superior in terms of nut yield as well as copra yield when compared to ECT. The copra yield in ECT is only 9·1 kg/palm/year while in the other cultivars it ranged from 10·3 to 14·6 kg/

palm/year. ECT x MYD has recorded the highest nut yield of 107·5/palm/year which is 26·7% more than that of ECT.

The performance of Banawali Green Round is good with an annual yield of 151 nuts/palm while WCT yielded only 93 nuts at Ratnagiri. The performance of T x D hybrid was superior at Ratnagiri, Coimbatore, Veppankulam and Ambajipeta centres. At Ratnagiri, the T x COD hybrid yielded 138 nuts with a copra yield of 23·7 kg/palm/year.

Crop management

The fertiliser application of 1 kg N, 0·5 kg P_2O_5 and 1·75 kg K_2O/palm/year recorded the highest nut and copra yields in the sandy loam soils of Thanjavur district.

The coconut based high density multi-species cropping system programme is in progress at Arsikere, Ambajipet, Kahikuchi, Ratnagiri and Veppankulam centres. The performance of Clove, Nutmeg, Cinnamon, Allspices are good at Ratnagiri centre. At Kahikuchi, the performance of coffee, banana and pineapple are good.

Disease management

Ganoderma applanatum and *G. lucidum* were isolated from the roots of Thanjavur wilt affected palms. In the field control trial, application of neem cake recorded the lowest disease intensity, followed by the current recommendation of neem cake 5 kg+drenching of 1% Bordeaux mixture at 40 litres and stem injection of Aureofunginsol 2 g+copper sulphate 1 g in 100 ml water once in a quarter.

Tatipaka disease

Out of 26889 diseaseed palms identified by the field staff, the Scientists have confirmed 4673 palms affected by Tatipaka disease in East Godavari District. Further confirmation is in progress.

The pathogenicity trial at Arsikere has indicated that burial of ganoderma wilt affected bole as well as stem block insertion have started showing the bleeding symptoms.

Management trials for Ganoderma wilt control at Arsikere has shown the same results as that of Veppankulam.

8th Workshop of AICRPP

The 8th workshop was held at OUAT, Bhubaneswar from 24–27 October, 1987. The workshop recommended the large scale cultivation of Banawali Green Round for Maharashtra and ECT x MYD hybrid for Tamil Nadu, based on the performance. It was also suggested to include Palmyrah and Cocoa under the project.

Transfer of technology network

Training programme

Eight training courses for 138 officials from 14 states and one Union Territory were organised. Ten ARS Scientists, 35 Bank Officers from NABARD and 35 farmers from Lakshadweep were trained on various aspects of plantation crops management. At Krishi Vigyan Kendra, Goa, 26 short duration (1–7 days) and two long duration (1–3 months) courses were conducted for 708 persons in 50 batches on crop production, horticulture, livestocks production, fisheries and homescience.

Lab to Land Programme

This programme is being carried out in 305 farm families at Kasaragod, Vittal, Kayan-

gulam and Goa. A total of 282 uneconomic palms affected by root (wilt) disease were eradicated by giving a compensation of Rs. 23,000/– at Kayangulam.

Research–cum–Demonstration plots

Twentyfive research–cum–demonstration plots are maintained in farmers' fields. An increase of 41·4% and 17·25% coconut yield over control was noticed at Kasaragod under mixed farming in coconut and coconut based cropping system respectively. From D x T demonstration plots farmers could get a net income of Rs. 1,475/– from Ginger and Rs. 325/- from Banana planted as intercrops in an area of 0·15–0·22 ha. at Kayangulam.

Kisan Melas and Exhibitions

One Kisan Mela was organised under the joint auspices of CPCRI and Kerala Agriculture Department to enlighten the farmers the importance of eradication of root (wilt) affected palms for preventing spread of the disease. Exhibits were sent to ICAR for Council's participation in Science and Technology exhibition in U.S.S.R.

Farm Advisory Service

A total of 796 farmers and 2563 students have visited the Institute and they were shown the experimental plots of the stations. 642 enquiries from farmers were answered by the Scientists at the headquarters. Visits to the farmers fields were undertaken by Scientists to study their problems and suggest on the spot remedial measures. Seminars and village meetings organised by Governmental agencies and other voluntary organisations were attended to by different Scientists.

Extension literature published/ reprinted

The following literatures were brought out from the Institute:

(a) Book entitled 'Research at CPCRI' *(b)* Pamphlet on drip Irrigation *(c)* Pamphlet on Oil Palm *(d)* folder on Copra moisture meter and *(e)* folder on rodent pest management in Coconut and Cacao.

Participation in AIR

The Scientists of the Institute gave 19 radio talks on AIR on several aspects of plantation crops management in different languages and also assisted in shooting a T.V. film and a documentary film on the achievement and activities of ICAR.