RESEARCH HIGHLIGHTS
1996 - '97

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1996 – 2000

Central Plantation Crops Research Institute
(Indian Council of Agricultural Research)
KASARAGOD - 670 124, KERALA

CPCRI

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1996-97

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

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Hirehalli Dwarf arecanut palm

Back cover:

Infloresence of coconut palm

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प्रस्तावना

सून 1995 में तेल ताड़ अनुसंधान के पृथकीकरण के बाद नारियल, सुपारी और कोको केन्द्रीय रोपण फसल अनुसंधान संस्थान की मुख्य फसलें हैं । लेकिन के. रो.फ.अ.सं. अनुसंधान केन्द्र, पालोड़ में चालू परियोजनाएँ और तेल ताड़ अनुसंधान केन्द्र के सहयोग से के.रो.फ.अ. संस्थान के मार्गदर्शन में ही जारी रहेंगी । विभिन्न कृषि विश्वविद्यालय के अधीन 17 समन्वयन केन्द्रों में नारियल, तेल ताड़ और पामैरा पर तदर्थ अनुसंधान परियोजनाओं का समान्वय भी यह संस्थान करेंगा । इस संस्थान का विस्तार अनुभाग परामर्श सेवायें और रोपण फसल पर राष्ट्रीय एवं अन्तराष्ट्रिय स्तर पर प्रशिक्षण कार्यक्रम आयोजित करता है । कृषि विज्ञान केन्द्र और संस्थान ग्राम संपक कार्यक्रम के कार्यन्वयन से इस संस्थान के विस्तार कार्यक्रम को अधिक कार्यक्षम बनाया गया है ।

जैव तकनीकी विभाग की ओर से 20.03 लाख रूपये की वित्तीय सहायता से इस संस्थान के जैव तकनीकी कार्यक्रम को प्रबल किया गया । लम्बे और बौने नारियल प्रजातियों की पत्तियों से एन्ज़ाइम निस्सारण और इलेक्ट्रोंफोरेसिस तकनीकी का मानकीकरण किया गया । नारियल की नव अंकुरित पत्ती से डी.एन.ए. निस्सारण तकनीक का मानकीकरण किया गया । पहले पूर्ण की गई 48 प्रजातियों के अलावा नारियल के २६ प्रजातियों की विवरणिका तैयार की गई । सुपारी के 16 देशी प्रजातियों की विवरणिक भी तैयार की गई है । नारियल बागों में अन्तरफसल के रूप में दवाई एवं कंद फसलों का रोपण आरम्भ किया गया है । प्राथमिक परिणाम प्रोत्साहनजनक है । नारियल आधारित फसल पद्धति से प्रति क्षेत्र से कुल आय अधिक ही प्राप्त ही रही है । जैविक खेती पद्धति और नारियल एवं सुपारी बागों मे सिंचाई के साथ उर्वरक प्रयोग पर संस्थान ने अधिक ध्यान दिया है । प्रान्तीय स्टेशन, कायंकुलम के जैविक नियंत्रण प्रयोगशाला ने नये परजीवी एवं परभक्षमा की पहचान की है । और तदर्थ योजना से जैवनियंत्रण कार्यक्रम को और प्रबल बनाया जा रहा है । इस संस्थान के कटाई अपरान्त तकनीकी विभाग की ओर से पहले विकसित की गई खोपड़ा ड्रायर से भी ज्यादा सक्षम एक खेपड़ा ड्रायर का निर्माण किया गया है । निम्न वाल्टॅज समस्या के उपाय हेतु एक अत्यधिक स्वयं चालित सिंचाई पद्धति का मानकीकरण किया गया है । इस संस्थान के 1996-97 की अनुसंनधान उपलब्धि का विवरण अगले पृष्ठों पर किया गया है ।

एम. के. नायर.

(एम.के. नायर)
निदेशक

कासरगेड़
26 मई, 1997

INTRODUCTION

The mandatory crops of CPCRI are coconut, arecanut and cocoa after delinking research on oil palm during 1995. However, the ongoing projects on oil palm at CPCRI Research Centre, Palode along with processing of palm oil continue to be under the guidance of CPCRI in collaboration with the NRC for Oil Palm. The Institute also continues to coordinate ad hoc research programmes on coconut, oil palm and palmyrah at 17 Co-ordinating Centres under various Agricultural Universities. Th Extension Section of the Institute provides consultancy services and also conducts trainin programmes at national and international level on plantation crops. The extension programme of the Institute is further strengthened by the Krishi Vignan Kendra and implementation of the Institute-Village Linkage Programme.

The Biotechnology programme of this Institute has been intensified during the year with the financial support of Rs.20.03 lakhs from the Department of Biotechnology. Standardization of enzyme extraction and PAGE was done in leaf samples of Tall and Dwarf coconut varieties. A protocol for DNA extraction from newly emerged leaf of coconut has been standardized. Descriptor for 26 cultivars of coconut has been prepared in addition to the 48 accessions completed earlier. Descriptor for 16 indigenous accessions of arecanut has also been completed. A beginning has been made for cultivation of medicinal and aromatic crops as intercrops in coconut garden. Preliminary results are encouraging. Coconut based cropping system continues to give increased net return per unit area. Organic farming system and fertigation in coconut and arecanut are the new areas of research receiving attention from the Institute. The biocontrol laboratory at Regional Station, Kayangulam identified newer parasites and predators and the biocontrol programmes are being intensified through an ad hoc scheme. The Post-harvest Technology wing of the Institute has been able to fabricate a collapsible copra dryer which is more efficient than the earlier dryer developed at the Institute. An auto irrigation system to overcome the problem of low voltage has been standardized and is working very efficiently. The research achievements of the Institute for the year 1996-97 are enumerated in the following pages.

Kasaragod
26th May, 1997

(M. K. NAIR)
Director

CROP IMPROVEMENT

Genetic Resources and Evolving High Yielding Varieties/Hybrids

Coconut

Among the 86 exotic accessions naintained at Kasaragod, the cultivars Philippines Ordinary and Malayan Green Dwarf were superior yielders with 120 and 114 nuts/palm/year respectively. Copra yield in these cultivars was 23 kg and 20 kg/palm/year respectively. Among the 46 indigenous cultivars, Benaulim Tall was the highest yielder with 132.4 nuts/palm/year with a copra out-turn of 20.1 kg/palm/year.

Markham Tall

Fruit component analysis in 26 cultivars had shown that the cultivar Markham Tall was superior in fruit weight (1834.3 g), nut weight (1282.4 g) and kernel weight (603.3 g). The copra content was highest (321 g/nut) in Malayan Tall and oil content was maximum (69.2%) in Ayiramkachi.

Exhaustive descriptors were prepared for additional 26 cultivars, including 21 exotic and 5 indigenous types.

Standardization of enzyme extraction and PAGE was done in leaf samples of WCT and COD palms and two isozyme systems - esterase (EST) and peroxidase (PER) were characterized. Difference in the PER isozyme profile was observed, while the EST banding pattern was almost similar. Total soluble protein profile was determined for 8 accessions through SDS - PAGE.

At World Coconut Germplasm Centre, Andamans, out of a total of 986 palms, including 24 exotic and 6 indigenous types, 967 palms have flowered so far.

For conservation of Pacific Ocean Collections, assisted pollination was carried out in 8 accessions comprising of 90 palms using 4994 female flowers. Among the 24 Pacific Ocean Collections, Acc. No. 8 (Niu Oma Dwarf from American Samoa) was a better yielder with 76 nuts/palm/year.

Tendernut water analysis in 5 Pacific Ocean Collections had revealed that nut

water was maximum (699 ml/nut) in Acc.No. 13 - Tree No. 56 (Tahiti Tall from French Polynesia) and total sugar content was highest (7.1%) in Acc. No. 20 - tree No. 61 (Kiriwana Tall from Papua New Guinea). Organoleptic test score of tendernut water for sweetness was also high in this accession (tree Nos. 61 and 75). Fruit component analysis in 6 accessions comprising of 60 palms and 240 nuts(4 nuts/palm) had revealed that Acc. No. 20 (Kiriwana Tall from Papua New Guinea) was superior in whole fruit weight (1636.3g), nut weight (933.3g), kernel weight (439.2g) and copra weight (232.5g/nut). The oil content was maximum (68%) in Acc. No. 12 (Niu Hake from Tonga Islands).

One hundred nuts of Arasampatti Tall cultivar were procured from Agricultural Research Centre, Aliyar Nagar, Tamil Nadu.

Artificial pollination involving 76 West Coast Tall, 11 Chowghat Green Dwarf and 9 Chowghat Orange Dwarf palms in hot-spots of Kottayam, Alapuzha and Pathanamthitta districts was carried out for generating progenies for screening against root (wilt) disease and also for establishing seed garden. A total of 14438 female flowers of 600 inflorescences were artificially pollinated during the year. Three thousand one hundred and fifteen artificially pollinated nuts from the previous year's crosses were harvested and sown in the nursery. A total of 2000 artificially pollinated seedling progenies were raised in the nursery for planting/distribution during June-July, 1997.

A total of 197 artificially pollinated seedling progenies were planted for screening them against root (wilt) disease, raising the total number of seedlings under trial to 2107. Two hundred *inter-se* mated/selfed progenies each were planted at CPCRI RC Kannara and Coconut Development Board farm at Neriamangalam for establishing seed garden.

Arecanut

Selfing/*inter se* mating was carried out in released varieties of arecanut, namely, Mangala, Sumangala, Sreemangala, Mohitnagar and Calicut - 17 and a total of 8849 seednuts were produced and sown in the nursery at Kidu.

Quinquennial observations comprising of 14 morphological characters were recorded in F1 hybrids of Hirehalli dwarf and released varieties. In general, hybrids showed lesser height and developed more stem girth and produced equal number of leaves as the parents. The hybrid combination Hirehalli Dwarf x Mangala showed earliness in flowering and fruit setting as compared to other combinations. Application of plant growth substances, IAA and GA3 on Hirehalli dwarf seedlings at quarterly intervals for over one year was found to have no significant effect on the sheath height (stem height) of the plants.

Descriptor is prepared for 16 indigenous accessions of arecanut which includes data for 17 morphological and 14 inflorescence and fruit characters.

Oil Palm

A comprehensive collection of oil palm germplasm was made under the aegis of FAO. The collection consists of 41 drought tolerant accessions from Guinea

Bissau, Tanzania and Zambia and 18 cold tolerant accessionsfrom Cameroon.

Among the 11 *tenera* hybrids planted in 1976, palms of the combination 125 d x 30.103 p gave an estimated oil yield of 5.2 MT/ha under unirrigated conditions at Palode. The peak yields of fresh fruit bunches (ffb) obtained in 1986 (111 kg/palm/year), 1990 (131 kg) and 1996 (130 kg) indicated a 4/5 year cycle in oil palm under Kerala conditions. The yearly variations for single bunch weight was negligible, the values varying between 21 and 25 kg since 1989.

Tissue and Embryo Culture in Coconut

The protocol for DNA extraction from newly emerged leaf of coconut was standardized. Higher yield of high molecular weight (>25 kb) DNA was obtained at pH 8.0 than at pH 9.0 with different concentrations of detergents viz. cTAB and SDS.

MS media with appropriate modifications like inclusion of IBA at 1.0 and 1.5 mgl^{-1} induced the growth of tertiary roots which grew at a rate of 3-5 mm per month.

The freshly cultured roots were found to produce the secondary roots readily on 1.0 and 1.0 mgl^{-1} IBA. The tertiary roots produced were transferred to the same media as well as on to a reduced concentration of 0.5 mgl^{-1} and kept at 30°C and 10°C. The tissues did not tolerate the low temperature. The cultures having 1.5% agar had a longer shelf life than the ones in medium containing 0.8% agar.

In root cultures, a filamentous type callus with occasional branching was obtained.

CROP PRODUCTION

Inter-cropping of Kacholam (*Alpinia galanga*) and Arrowroot in Coconut garden

During 1996-97, Kacholam produced higher rhizome yield (5.19 t/ha) in a stand of 300 thousands plants per hectare. Among the different organic manure treatments, FYM + NPK recorded significantly higher yield (6.3 t/ha) and was on par with Vermi-compost (VC) treatments. Composted Coir Pith (CCP) recorded significantly lower yield (4-4.2 t/ha) compared to other organic manures. The chlorophyll a and b content of leaves were higher under FYM, VC, FYM + NPK & NPK alone treatments. The oil content (%) under organic manure treatments ranged from 1.8% - 2.1% whereas, it was 1.6% - 1.7% under control treatment. The oleoresin (%) content was enhanced by organic manure treatments (3.4 - 4.0%) compared to control (3.1 - 3.2%).

The fresh rhizome yield of arrowroot was significantly higher (15.1 t/ha). Plots treated with CCP had significantly lower yield (10.1 - 12.2 t/ha) compared to

other organic manures. Unfertilised control plots gave significantly lower yield (7.7 t/ha). The chlorophyll a and b content of leaves were higher under FYM, VC, FYM + NPK & NPK alone treatments.

Soil physical properties like maximum water holding capacity (MWHC) (30.2 - 33.2%), Porosity (38.1 - 44.4%) were improved by the application of FYM, VC and CCP compared to control and NPK alone treatments (MWHC = 22.4 - 26.9%, Porosity = 32.7 - 36.8%). There was marginal decrease in the bulk density of the soil under FYM, VC treatments (1.38 - 1.44 g/cc) compared to CCP, NPK alone and control treatments (1.48 - 1.57 g/cc). The organic carbon content was higher in FYM, VC treated plots (0.38 - 0.59%) compared to CCP treated plots (0.33 - 0.44%). The NPK alone and control treatments recorded the lower organic carbon content (0.23-0.27%).

N, P and K content in coconut leaf increased when compared to pre-experimental status, with the inter-cropping of Kacholam and Arrowroot.

Coconut Based Cropping Systems

The total output from 1.2 ha area coconut based HDMSCS model during the period July 1995 to June 1996 was 28,841 coconuts, 19 kg dry clove, 274 kg of pineapple fruits, 238 kg of banana bunches and 41 kg of bread fruits. The coconut yield ranged from 133.1 to 165.2 nuts/palm/year under graded levels of fertilizers. Yield of the pineapple and banana was maximum with full dose of recommend fertilizers with an average fruit weight 712 g in pineapple and 5.51 kg/bana bunch as against only 599 g/pineapple fr and 3.56 kg/banana bunch under control pl Clove tree also gave substantially high yie with fertilizer application.

The biomass production in pin apple and banana under different leve of fertilizers varied substantially. pineapple, biomass production/plant w maximum with full dose of recommende fertilizers (587g oven dry wt.), and gradually decreased as the fertilizer leve decreased and in control plot, the dry matt production was only 321g/pineapple pla (Fig. 1). Similarly, banana which receive full dose of fertilizers yielded highest dr weight of 5612g/plant compared to 4365 in two-third dose, 3460 g in one-third dose 3467 g in one-fourth dose, 2561 g in one fifth dose and 2428g/plant in control.

The second generation HDMSCS models at Kasaragod, at present consists o the following crops; Model-1: Coconut + Pepper on Coconut + Cocoa + Pineapple, Model-2 : Coconut + Pepper on coconut, Model-3: Coconut + Clove + Pepper on Coconut +Banana and Coconut monocrop. The total output from 0.22 ha model-1 was 3852 coconuts, 59.75 kg pineapple, 2.2 kg dry pepper and 287 cocoa pods during the period from July 1995 to to June 1996. The model-2 gave a total out put of 3615 coconuts and 29.41 kg dry pepper yield from 0.17 ha area, while from model-3, a total of 2906 coconuts, 53 kg banana

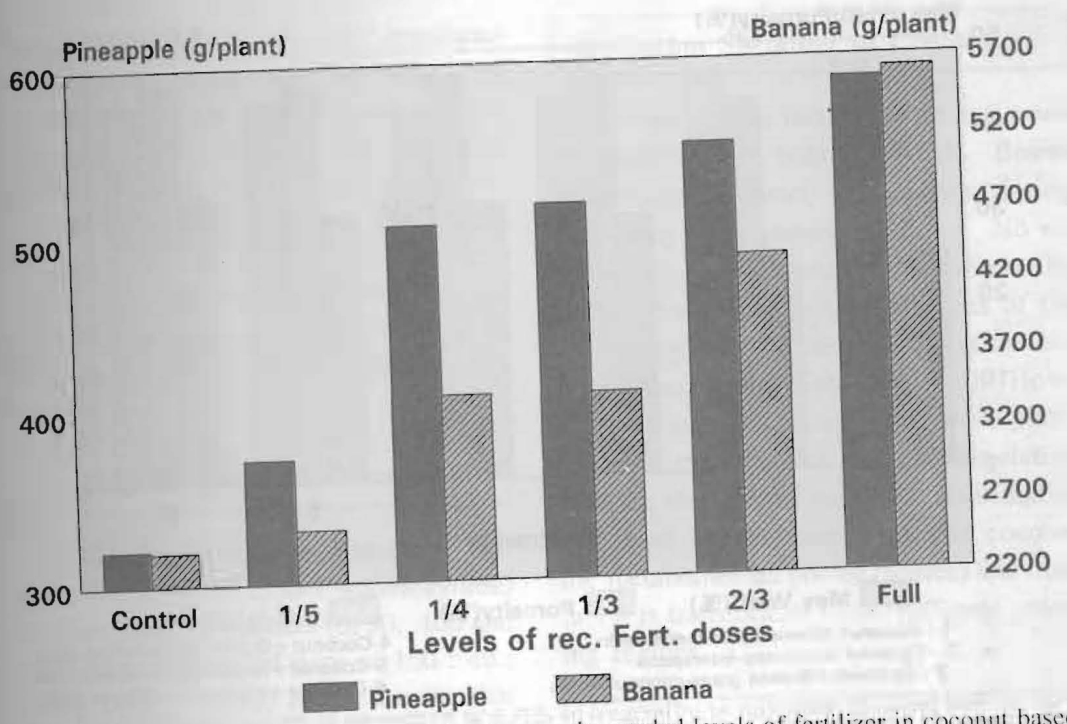


Fig. 1. Drymatter production in component crops under graded levels of fertilizer in coconut based HDMSCS model at Kasaragod.

bunches and 3.9 kg dry pepper from 0.17 ha was harvested. The coconut monocrop yielded a total output of 3166 coconuts from 0.21 ha. The mean yield of coconut (nuts/palm/year) was 103.7 in control, 121.3 in model-1, 150.6 in model-2 and 121.1 in model-3. In model-1, the cocoa crop recorded a leaf fall of 1640 g/tree (oven dry wt.) per year.

Coconut Based Mixed Farming

During 1995-96, the system yielded 19,388 coconuts, 10201 lit milk, 512 kg poultry (live wt.), 50 nos. quails, 3150 nos. hens eggs and 1018 nos quails eggs and 400 kg fish.

The soil physical properties were improved by following this system. There was reduction in the bulk density (BD) (1.4 - 1.42 g/cc), increase in the MWHC (30.4 - 33.6%) and porosity (46.2 - 47.2%) of the soil under mixed farming system compared to monocropping (BD = 1.5 - 1.52 g/cc, MWHC = 25.2 - 24% and Porosity = 42.6 - 43.4%) (Fig. 2). The organic carbon status of the soils under mixed farming system was found to increase marginally (0.64 - 0.74%) over monocrop (0.38 - 0.4%). The bacteria and fungi counts were more in root region of both coconut + napier and coconut + guinea grass when compared to sole crop. The N_2-fixers and phosphate solubilizing bacteria were more in the mixed farming system as compared to coconut monocropping. The soil enzyme activities (urease and dehydrogenase) and soil microbial biomass were higher in coconut based mixed farming compared to coconut monocropping.

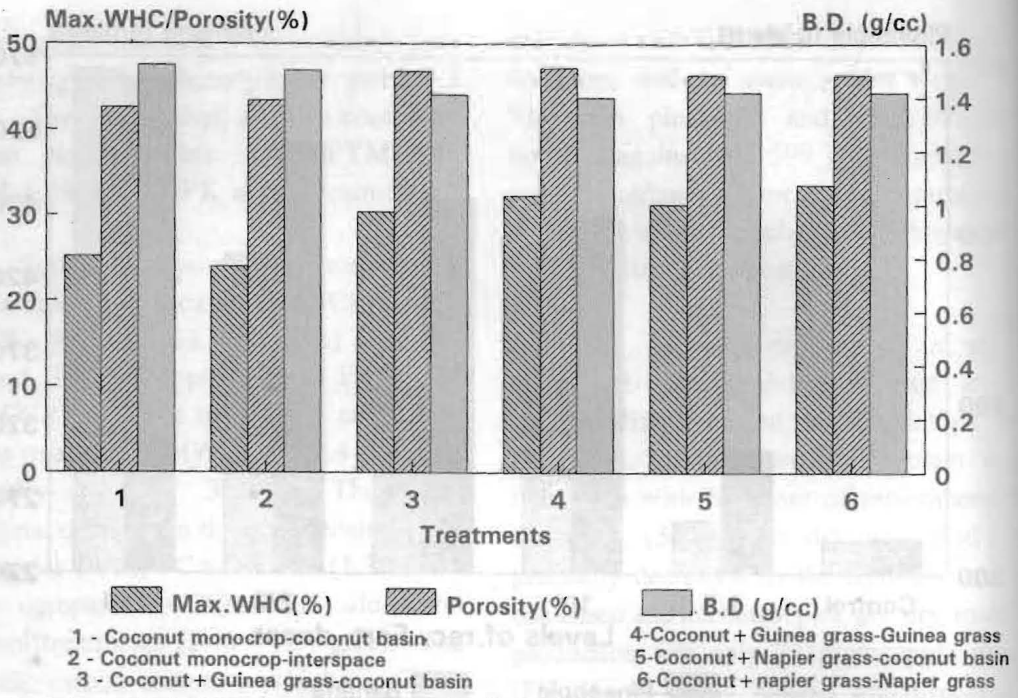


Fig. 2. Soil physical properties as influenced by different treatments in coconut based mixed farming system.

The leaf nutrient content with respect to N,P,K, Ca and Mg was found to be higher under mixed farming when compared to that of monocropping. The nut yield obtained under mixed farming was 101 nuts/palm/year compared to pre experimental yield of 88 nuts/palm/year.

Economic analysis of the system for the year revealed that total variable cost for maintaining the system was Rs. 1,24,151/-. Out of this Rs. 1,01,466/- was spent for the purchase of cattle, poultry and fish feed. Total return from the system was Rs.2,25,327/-. Contribution from dairy was Rs.1,02,010/- and poultry was Rs.30,537/- . Net return to a family of two workers for management of the system was Rs.84,776/- per annum.

Total nutrient reserve have been computed in second generation HDMSCS. Organic C (20.89 t/ha for coconut - pineapple - cocoa and 18.23 t/ha for coconut - clove - banana) and total N (6.36 t/ha for coconut - pineapple - cocoa and 6.48 t/ha for coconut - clove - banana) was lower than coconut monoculture (23.04 t/ha Org. C and 6.98 t/ha total N). However, build up of soil available K (491 kg/ha for coconut - pineapple - cocoa and 504 kg/ha for coconut - clove - banana) in IInd generation HDMSCS was observed compared to coconut monoculture (327 kg/ha). Average P was found to be enriched in coconut - clove - banana model (391 kg/ha but was depleted in coconut - pineapple - cocoa model (256 kg/ha) compared to monoculture (282 kg/ha).

Comparatively lower reserves of organic carbon and total N in the soil may be due to the higher demand for nutrients in the high density cropping systems. Since,

the root proliferation is more compared to monocrop, there will be more of root exudates/acids which along with favourable soil climate for microbial proliferation leads to higher rate of decomposition of organic matter. About 90% of nitrogen in soil is in the organic fraction, Organic N on periodical mineralisation gets either absorbed by component crops or is lost from the system due to volatilization/ leaching.

Drip Irrigation in Coconut

The studies with three levels of irrigation viz. 10 l, 20 l, 30 l water/day/tree) and four levels of fertilizer (0, 50, 100 and 150% of recommended doze of 100 : 40 : 140 g NPK/tree/year) have shown that irrigation and fertilizer interaction was significant with the I2F3 (20 lit + 100% NPK) treatment combination giving maximum yield.

Under the two experiments I and II (in laterite soil) the quantity of water applied at 33% of Eo through drip irrigation produced comparable yield with the higher level of irrigation under both basins and drip method, evidently proving that, there was a saving of 67% of water through drip irrigation.

In the experiment III (in sandy soil), control plot differed significantly from the other irrigation treatments which were on par indicating that irrigation at 66% of Eo is sufficient which resulted in 34% of irrigation water saving and yield is on par with higher level of irrigation. The higher yield was due to better moisture availability resulting in better nutrient absorption.

Button Shedding in Coconut

Among the factors which influence the shedding of buttons, female flower production had direct relationship during both rainy and summer seasons. No relationship was observed between the carbohydrate and nitrogen fractions of the subtending leaf and the retention of buttons in the bunches growing in its axil. However, taking into account the whole plant, the C/N ratio showed negative correlation with the shedding of buttons. This implies that in an indeterminate crop like coconut the metabolites are pooled (source) and from this it is translocated to the different growing regions.

Drought Tolerance in Coconut

The seedlings of two talls viz., WCT and FMS and two dwarfs viz., CGD and MYD and their reciprocal crosses were screened for tolerance to drought during non-stress (with irrigation), stress (withholding irrigation) and recovery (re-watering) using physiological and biochemical parameters. Among the groups, stability during stress period in net assimilation rate and photosystem II was observed in WCT x MYD seedlings. This is substantiated by the increased Hill activity expressed in terms of Dichlorophenol indophenol (DCPIP) photo reduction. Among the talls and dwarfs higher stability was observed in FMS and CGD than WCT and MYD during stress period. The CGD x WCT showed lesser reduction in leaf water potential under stress and also tended to recover better than the other crosses. The drought adaptive

nature of FMS is also confirmed by the leaf anatomy which indicated thicker cuticle on the upper and lower epidermis as compared to the drought susceptible cultivar MYD.

Soil Fertility and Crop Production

In the field trial on the role of common salt and its interaction with K in coconut, higher values of coconut yield, per cent nut setting and leaf production per palm were recorded in treatments receiving 50% K + 50% Na. In leaf nutrients, K level was found to be high (2.25%) in 100% K treatments and sodium and chlorine were high in palms receiving 25% K + 75% Na.

A trial to study the long term effects of practices like cultivation, application of herbicides to check weeds, application of organic and inorganic manures etc. singly and in combination was initiated in 1919 and was remodelled in 1972. It was found that the highest yield (110.4 nuts/palm/year) were recorded in plots which received organic and inorganic manuring and cultivation. Palms which received continuously inorganic fertilizers only along with tillage gave 96.7 nuts while palms in the control treatment which received no manures or cultivation gave only 9.7 nuts/palm/year.

Nutritional Requirement of Coconut under Different Soil Types

The nutritional experiments in WCT coconut in littoral sandy soil at Kasaragod gave the following results: Different levels of NPK fertilizer application recorded a mean nut yield of 37.2 nuts/palm compared to only 6.8 nuts/palm/year in the unfertilized control. Further, application of Ca and Mg in conjunction with $N_3P_3K_3$ (N 1500 g, P 750 g and K 1750 g/palm/year) fertilizers gave a mean nut yield of 48.3 in 1995-96 and mean nut yield of 67.2 nuts/palm/year in 1994-96 as against only 16.6 and 26.9 nuts/palm/year in 1995-96 and 1994-96, respectively in the palm receiving only NPK.

With respect to leaf nutrient contents, in general, application of higher levels of N and K gave relatively higher leaf N contents, but higher levels of P application showed decreasing leaf N contents. The leaf P content did not vary much due to different levels of NPK and recorded in the range of 0.11-0.12% P in leaf in various treatments. Application of K at third level gave significantly higher leaf K (1.32%) as compared to other two levels (0.97-1.03%). Application of N at third level gave significantly lower K (0.93%) compared to N at first level (1.32%). Phosphorous application at different levels did not induce much variation in leaf K concentration (91.05 to 1.19%).

Experiment conducted in red sandy loam soil to study the response of WCT, COD x WCT and WCT x COD to three levels of fertilizers, namely M_0 - No fertilizer, M_1 - 500:500:1000 g NPK and M_2 - 1000:1000:2000g NPK/palm/year under rainfed and irrigated conditions at Kasaragod revealed that nut yield differed significantly due to fertilizers, variety/hybrids and between rainfed and irrigated conditions. The mean nut yield/palm/year under M_1 and M_2 levels were 120.7 and 126.2, respectively and were significantly

superior to M_0 (95.2 nuts/palm/year). The yield at M_1 and M_2 levels was on part in 1995-96. Among coconut variety/hybrids, COD x WCT gave significantly higher nuts of 132.2/palm/year compared to WCT x COD hybrid (111.9) and WCT variety (105.0). The mean nut yield under irrigated condition was significantly higher (124.9 nuts/palm/year) as compared to rainfed condition (103.1 nuts/palm/year). The female flower production was not significant for fertilizer levels, variety/hybrids and between rainfed and irrigated condition in 1995-96. However, in general, hybrids had relatively higher number of female flowers/palm/year compared to WCT variety, and among fertilizer levels, palms which received M_1 and M_2 levels had higher female flowers/palm/year compared to M_0. The mean female flower production with irrigation was 281.8/palm/year compared to 256.9 flowers/palm/year under rainfed condition.

Leaf K concentration varied significantly due to fertilizer levels. Leaf K was 1.22% in palms which received M_2 level of fertilizer followed by 1.10% in M_1 level and 0.98% in M_0 level. However, leaf N and P concentrations did not vary significantly due to fertilizer levels. Available K and P in soil also at both 0-25 and 25-50 cm depths varied significantly due to fertilizer levels. Application of fertilizers at M_2 level increased significantly the available K and P in soil at both depths compared to M_1.

Coconut Nursery Techniques

A field experiment was laid out to study the influence of ten different methods of sowing viz., T1- Conventional field nursery, T2- Polybag with sand, T3- Polybag with coir dust, T4- Polybag with potting mixture, T5- Polybag with coir dust + sand (1:1 V/V), T6- Cement tank with sand, T7- Cement tank with coir dust, T8- Cement tank with potting mixture, T9- Cement tank with coir dust with sand and T10- germination and then planting in field nursery, in different media at Kasaragod. Results revealed that germination at 3rd and 5th months varied significantly due to various treatments. At 3rd month, sowing in polybag with coir dust (35.67%), polybag with potting mixture (26.33%) and polybag with sand + coir dust (25.00% significantly increased germination followed by sowing in cement tank with sand + coir dust (19.00%), cement tank with potting mixture (18.00%) and cement tank with coir dust 14.67% as compared to rest of the treatments. At 5th month, sowing in polybag with coir dust gave significantly highest germination (94.00%) compared to sowing in polybag with sand (81.33%). However, the other treatments were on par (88.33 to 90%). The growth characters such as seedling height, number of leaves and girth at collar at 9th month were significantly superior in sowing in potting mixture either poly bag or cement tank. The lowest seedling height, number of leaves and girth at collar were recorded in the conventional method.

Biological Nitrogen Fixation

Field experiment on N_2 substitution by green manure legume - *Rhizobium* system indicated that upto 50% of the ferilizer Nitrogen for the coconut palm can be substituted with the N_2 fixed by

Calopogonium mucunoides or *Mimosa invisa* in symbiotic association with *Rhizobium.*

Associative symbiotic nitrogen fixing bacteria capable of fixing introgen in the presence of NH_4Cl has been found to be the predominant nitrogen fixers in the root zone of coconut palm.

Peat, lignite and 1:1:1 mixture of FYM, coir dust and soil has been found to support a population of 10^7 cells/gram of associative symbiotic bacterial biofertilizer after 4 months of preparation.

Organic Farming Technology in Oil Palm

Organic waste materials such as dried leaves and empty fruit bunches available to the tune of 15-17 tonnes/ha annually from an oil palm plantation would effectively be recycled by composting and utilizing them as a source of nutients. Of the five methods tried for composting, chemical digestion proved to be the best technique for nutrient enrichment. Nutirents to the extent of 170 kg N, 45 kg P, 135 kg K and 35 kg Mg valued at Rs. 4,000/- can be obtained every year per hectare of plantation. Thus almost the full requirement of potasium could be met by recycling of waste material available in a plantation.

Though vermicompost produced by *Eudrillus eugineae* has comparable nutrient values, it was not cost effective.

CROP PROTECTION

Stem Bleeding Disesae of Coconut

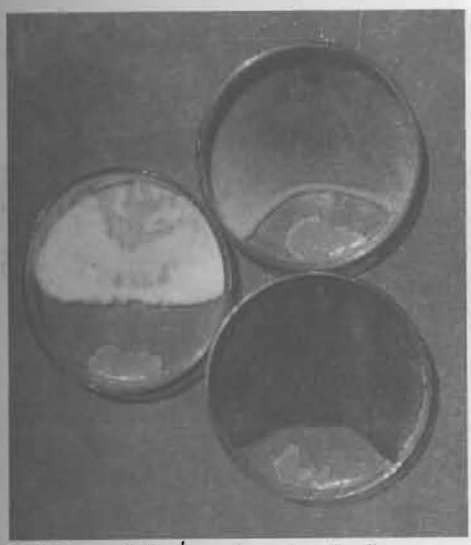
Lime application to the stem bleeding affected coconut palms @6, 12 and 18 kg/palm/year for two years did not show any ameliorative effect on the disease intensity or spread.

Among different isolates of *Pseudomonas fluorescence* tested for antagonistic effect on *T. paradoxa in vitro,* Pf1 isolate from TNAU, Coimbatore showed maximum inhibitory effect on *T. paradoxa* with an inhibitory zone of 1.2 cm.

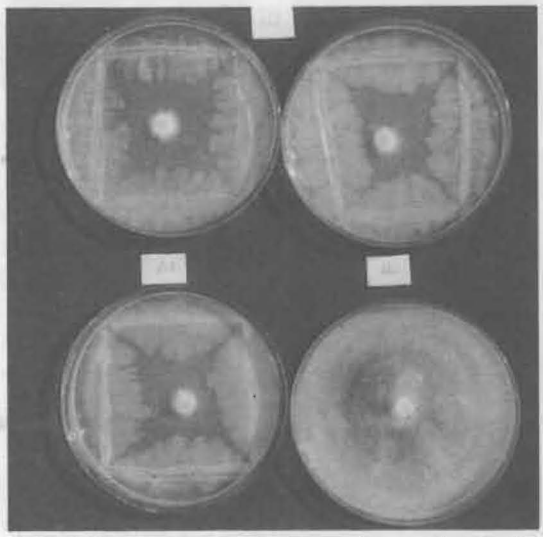
Among the different plantation wastes and their composts tested as substitutes for mass production of four biocontrol fungi of stem bleeding disease, coffee husk vermicompost provided maximum growth and sporulation of *Gliocladium virens* (563 x 10^6 cfu/g), *Trichoderma harzianum* (716x10^6 cfu/g), *T. virides* (616 x 10^6 cfu/g) and *T. hamatum* (663 x 10^6 cfu/g) after 15 days.

Thanjavur Wilt of Coconut

The chemical control trials on Thanjavur wilt at Hirehalli have shown that root feeding of 'Anabe' affected coconut palms with Calixin (Tridemorph) at 2% concentration coupled with soil application of neem cake @ 5 kgs/palm/year can control the disease incidence and spread.



Inhibition of *T. Paradoxa* by *P. fluorescence*



Inhibition of *P. palmivora* by endophytic bacterium

Bud rot of Coconut

A spore forming *Bacillus* species occurring as a benign endophyte in the spear leaves of WCT seedlings in the nursery at CPCRI, Kasaragod was found to exert a strong inhibitory action towards *Phytophthora palmivora*, the causal organism of Bud rot of coconut. The population of this bacterium was found to be 4 x 10^2 CFU per gram of tissue.

Biological Control of Pests

Coconut

Clear difference was observed in the protein pattern of baculovirus infected and healthy grubs of *Oryctes rhinoceros*. *Trichogramma embryophagum* gave 6-8% parasitism on *Opisina* eggs in the field.

Arecanut

In a study carried out to determine the substrate that supports best growth *in vitro* for growth of the fungal antagonists *Aspergillus* (2 isolates), *Trichoderma* (3 isolates), *Myrothecium vernucaria* (one isolate) and two unidentified fungi, coffee husk was found to be the best. This was followed by cotton seed cake and rice bran respectively.

Pseudomonas fluorescence (TNAU isolate Pf.1) and six other bacterial isolates collected locally showed antagonistic effect on *Phytophthora meadii*, on causal agent of fruit and bud rot of arecanut.

Cocoa

A naturally occurring entomopathogenic fungus was noticed controlling the high populations of the membraciids *Gargara mixta* and *Leptocentrus taurus* on cocoa.

Chemical Control of Rhinoceros Beetle

By filling the inner most 2 leaf axils of young coconut palms with 12 g of naphthalene (4 bolls of 3 g each) and covering them with sand once in two months, rhinoceros infestation can be controlled.

Leptocentrus sp. infested with entomopathogenic fungus

Coried Bug of Coconut

Coreid bug incidence on guava plants harbouring ant fauna was found to be significantly low when compared to the pest incidence on trees having no ant activity.

Pests of Oil Palm

Halictophagus sp.(Strepsitera : Halictophagidae) was recorded as an endoparasitoid of the plant hopper *Proutista moesta* Westwood, a vector of phytoplasma diseases of palms. Parasitization was observed in both the sexes of the plant hopper population. Parasitism was the highest from December to February.

Caterpillars of *Amsacta transiens* Walker (Lepidoptera : Arctiidae) was recorded for the first time to infest the primary nursery seedlings of oil palm. Caterpillars voraciously feed on the lamina leaving behind the midrib.

Halictophagus as an endoparasitoid of plant hopper (A - Cephalothorax, B - Body mass)

Rhinoceros beetle was found to bore into the male and female inflorescence even before anthesis. Proper fruit development is hindered in the affected portion.

Integrated Nematode Management

The coconut cultivars Cochin China, Nuileka and Cameron screened were found to be highly susceptible to the burrowing nematode. Very high population of burrowing nematode was reported from the rhizosphere of arecanut and the subsidiary crops banana and pepper in the areca based HDMSCS plots in Kasaragod. The application of Thimet, *Glyricidia* leaves, neem and pongama cakes reduced the

population level of burowing nematode in the systems.

The pathogenic effect of the bio-control agents viz. *Paecilomyces lilacinus, Pasteuria penetrans* and VAM on the burrowing nematode individually and in combination was proved on arecanut and black pepper.

A native isolate of *Heterorhabditis indicus* was isolated from soil from root zone of coconut.

Sixteen plants were used to study the effect of leaf extracts on the mortality of second stage larvae of *Meloidogyne incognita*. Among these, cent percent mortality was observed with *Moringa pterigosperma* at 1:5 dilution after 24 hours.

Nine leaf extracts were used to study their effect on the mortality of J2 and J3 juveniles of *Radopholus similis*. Of these, *Ricinus communis* showed highest per cent mortality followed by *Crotalaria juncea, Glyricidia maculata* and *Pueraria phaseoloides*.

Among the diffusates of different plants tried, reduction in hatching of eggs of *M. incognita* over control was 65% with *Sesbania aculeata* and the root diffusates were not much effective on the mortality of *R. similis*.

R. similis population could be cultured on carrot disc tapioca pearl medium (10%). In comparison with 1% water agar, final population was found to be same in both media after 45 days. Tapioca pearl at 10% concentration is ten times cheaper than 1% water agar.

PRE AND POST HARVEST TECHNOLOGY

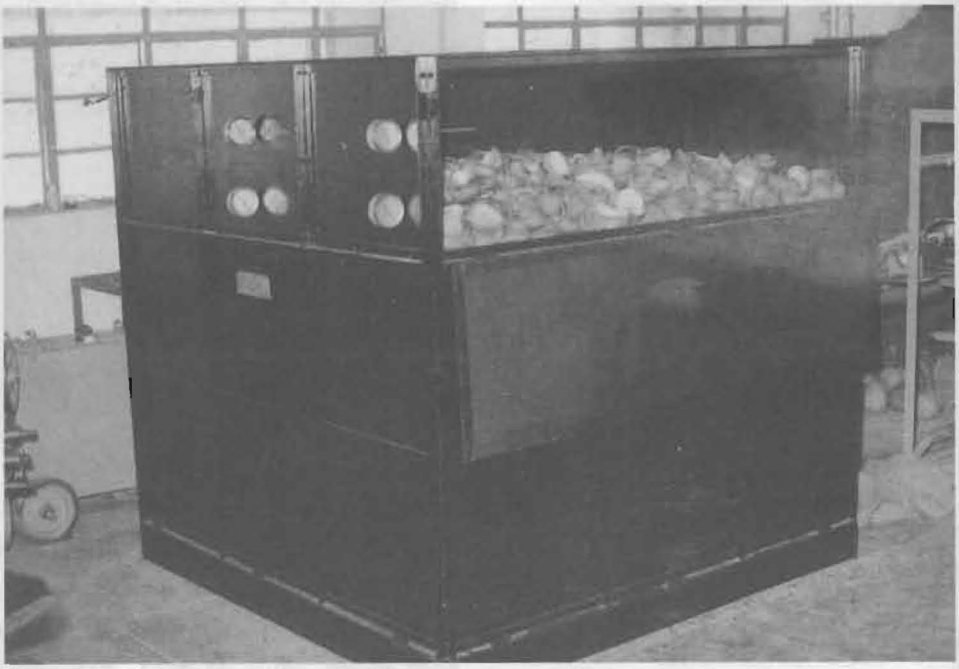
Collapsible Copra Dryer

Recently the Institute has developed a collapsible dryer. This completely collapsible type copra dryer has a capacity of 1000 coconuts. The unique burner of this dryer can generate smokeless heat for about eight hours. The heat exchanger is of GI sheet. The ventilation holes provided at the bottom facilitates the control of temperature and thereby improving the efficency of the dryer.

Auto Irrigation System

In order to overcome the problem of low voltage/no voltage, the auto irrigation system using DC (battery) was fabricated.

The DC control system can actuate the solenoid valve according to the signals received from the tensiometer.



Collapsible Copra Dryer

AGRICULURAL ECOCNOMICS AND STATICTICS

Price Analysis of Coconut

The variability in monthly wholesale prices of coconut, indicated by the Coefficient of Variation (C_2V) had increased from 15.96% during 1980-81 to 27.28% during 1990-91. However, the same had declined to 6.33 during 1995-96. In case of arecanut chali, C_2V had marginally declined from 14.47% during 1983-84 to 10.67% during 1995-96.

Production and Yield Analysis of Cocoa

Secondary data analysis of state-wise area, production and yield of cocoa for the period 1983-84 to 1993-94 indicated that the area under cocoa in the country had declined by about 50% and the production had increased by 19% indicating an increase in the average productivity. The compound growth rate (CGR) (%) for area, production and productivity are -6.34, 1.34 and 8.2 respectively. Further, it revealed that Kerala and Karnataka continues to dominate Indian cocoa production sector with a share of about 99% in area and production. Kerala has a CGR (%) of 7.7 for area and 1.89 for production and for Karnataka the respective figures are -0.14 and -0.93.

Secondary data analysis of Indian and international prices of cocoa for the period

1982-83 to 1995-96 indicated that the wholesale prices of dry cocoa beans had increased from Rs.15/kg to Rs. 48.96 in Indian markets (by 226%) and from Rs. 17.26/kg in International markets (by 154%) and the wholesale prices of cocoa in India had high degree of positive correlation (0.796) with that of international prices. It was also found that the Compound Growth Rate of prices of dry cocoa beans was 6.24% in India while the same at international level was 5.56%.

The multi period partial budgeting analysis worked out for the coconut based high density multi species cropping system model at Kasaragod revealed that coconut + pineapple had the highest Marginal Rate of Return (MRR) of 52.7% followed by coconut + banana + pineapple with 29% and coconut + banana (9.7%). The MRR realized for the system as a whole was 4.8%.

Refinement of Experimentation Techniques

Empirically it has been shown that inference need not be the same by following alternative procedures to study the treatment-by-time interaction in coconut, emphasizing the need for testing the assumptions and marking a judicious choice.

The contribution of genetic variability was re-estimated by including component 'special environmental' in the model and found to be only 42% in contarary to more than 70% reported without taking into account this component.

TRANSFER OF TECHNOLOGY

Training of Extension and Research Workers and Farmers

Eight scheduled training programmes, viz., Production technology of coconut, Coconut based farming systems, Hybridization technique in coconut, Pest, disease and nematode management in coconut, Biological suppression of coconut pests, Identification of burrowing nematode and rice cyst nematode, Arecanut and cocoa production technology and Oil palm production technology were organized benefitting 216 trainees.

A training programme on Nematology research methods for a research assistant from University of Peradeniya, Sri Lanka, on Coconut based farming system for a research scholar from Federal University, Brazil, on Coconut production technology for five officials from Agricultural Researach Institute, Mikocheni, Tanzania and on Control of disease of palm trees and insect pests of coconut for two scientists from Brazilian Agricultural Researach Corporation (EMBRAPA) were organized during the year.

Besides these, one day unscheduled training/visit programmes were organized for the benefit of 715 farmers, 289 officials and 2265 students.

Research-cum-demonstrations

Four research-cum-demonstrations on root (wilt) management practices and one on mixed farming in coconut at Kayangulam, one each on coconut based HDMCS and vegetable intercropping at Kasaragod and one on arecanut based mixed cropping at Mohitnagar were maintained.

Other extension activities

During the year, the Institute participated in four exhibitions. Sixteen popular articles written by the scientists were published in various farm journals and 22 radio talks by the scientists were broadcasted through All India Radio. A farmers' day was organized in connection with the World Food Day celebrations on 16th October 1996 at Muliyar, Kasaragod District in collaboration with the Krishibhavan at Muliyar.

Supply of planting materials

A total of 6,729 WCT coconut seedlings, 2,781 hybrid seedlings and 2,417 seedlings of other coconut varieties were distributed from Kasaragod and Kayangulam. From Vittal 13,999 arecanut sprouts, 5,570 areca seednuts, and 29,065 cocoa grafts and from Palod 1,52,145 oil palm *(tenera)* sprouts were distributed.

Institute Village Linkage Programme (IVLP)

CPCRI was selected by ICAR as one of the implementing centres for the pilot project on Technology Assessment and Refinement through Institute Village Linkage. The concept is based on participatory mode ensuring greater scientist-farmer linkage in a 'bottom up' approach. The major objectives of the project are to introduce technological intervention with emphasis on stability and sustainability along with productivity of small production systems, to assess the socio-economic impact of the technological interventions and to identify extrapolation domains for technology modules.

For the implementation of the project, villages namely, Edneer, Pady and Nekhraje which are about 15 kms from the Institute were selected covering about 690 families. The project was started during July, 1996. A core team of Scientists from various disciplines was drawn to execute the project. The detailed agroecosystem analysis of the project area was done through Participatory Rural Appraisal Techniques. Problem cause analysis of the microfarming situations was done and technology interventions were formulated. The detailed project report was prepared and got approved from ICAR. An amount of Rs. 23.4 lakhs was sanctioned for the implementation of the project for two years, out of which Rs. 1.6 lakhs was released during the year 1996-97.

KRISHI VIGYAN KENDRA

This Krishi Vigyan Kendra was started in 1993 with the objectives of organizing skills and production oriented trainings, 'on farm' and 'off campus' for practicing farmers, field level functionaries, rural women and unemployed youths, organizing training programmes and non-formal educational activities, especially for the farm women and organizing farm science clubs, and Mahila mandals in villages to their own farm or for self employment.

During the year 1996-97, 49 trainings in the field of Agriculture, Horticulture, Home Science, Agril. Engineering and Sericulture were conducted in which a total of 991 trainees attended. Evaluation and feedback was also constantly monitored for all these training programme. Under village adoption programmes, six villages namely, Madhur, Mugu, Muliyar, Pullur, Bombrana and Manimoola were adopted under the developmental programmes like Lab to Land, National Demonstration and SC/ST development. Altogether 98 beneficiaries under Lab to Land, 116 beneficiaries under national demonstration and 69 beneficiaries under SC/ST development programme were benefited.

Regular follow-up activities like field visits, monitoring of demonstrations in each village, group discussions with farmers and distribution of inputs to the beneficiaries were also under-taken.

Under on-farm research (OFR) activities, 25 demonstrations were initiated on 'Management of stem bleeding disease in coconut' in six villages and 12 demonstrations on 'Control of Mahali in arecanut' in four villages and 8 demonstrations on, 'Control of leaf eating caterpillar in coconut' were undertaken.

Watershed Development Programme was taken up in Yethadka village. The total area of watershed is 788 ha, out of which cropped area is only 315 ha where crops like arecanut, paddy, coconut and cashew are raised as main crops and pepper and banana as intercrops. Further, KVK has conducted 12 different trainings, seminars and meetings for the watershed beneficiaries in different aspects like cropping pattern, soil and water conservation methods etc.

The KVK faculty were attending farmers' calls for their problems by visiting their fields, participating in farmers club meetings, seminars and science forums. They also participated in three exhibitions and two District level science meet.

ALL INDIA COORDINATED RESEARCH PROJECT ON PALMS

COCONUT

Crop Improvement

At Aliyarnagar, maximum cumulative yield for the last four years was 280 nuts/palm for S.S.G. followed by 215 nuts/palm for ECT. At Veppankulam, WCT had the highest annual yield of 159 nuts/palm followed by ECT (149). Among the dwarfs, MGD had the highest annual nut yield of 117 per palm followed by Gangabondam (106). At Ambajipeta, Philippines Ordinary produced maximum cumulative yield since 1980-81 (1856 nuts/palm) followed by Laccadive Ordinary (1565). The copra content per nut was maximum in Philippines Ordinary (246g) followed by Cochin China (225 g). Among the hybrids, WCT x COD and COD x WCT produced cumulative yields (since 1980-81) of 1420 and 1314 nuts/palm, respectively. GB x LO, GB x Fiji and ECT x GB were found superior to other hybrids with regard to mean cumulative nut yield and other morphological characters. In the trial on promising seed materials, the hybrids COD x WCT, ECT x GB and WCT x COD were found superior to other cultivars and hybrids with regard to their cumulative nut yield and copra content. At Konark, sixteen forms of original local were identified based on size, shape, colour and number of nuts/palm. Six forms such as Jahaji, Surya bana, Sakhigopal local, Local triangular, Dhanei and Local Green brown have been collected and planted. At Kahikuchi, the growth performance of cultivar Gonthembili and B.S.I. were found better over others. Maximum annual nut yield was recorded in local tall (79.7) followed by WCT (68.7) and MDY x WCT (65.7). At Mondouri, maximum yield was recorded in Zanzibar (61.9 nuts/palm/year) followed by Hazari and St. Vincent (60.3 and 54.5, respectively). The copra content/nut was highest (164 g/nut) in St. Vincent. In the trial of promising seed materials, the highest yield and copra weight were recorded in Laccadive Ordinary (82.5 nuts/palm/year and 275 g/nut, respectively). At Ratnagiri, Laccadive Ordinary produced the highest yield of 151.3 nuts/palm/year followed by Pratap (129 nuts/palm/year). Among the Banawali types, Banawali Green Long produced the highest yield of 114.5 nuts/palm/year.

Crop Production

In the NPK nutritional trial on Ordinary Tall coconut at Mondouri, maximum yield of 76.5 nuts/palm/year was recorded in treatment N2P2K1 (1000:500:1000 g/palm/year). Maximum copra yield was recorded in treatment N3P3K1 (1500:750:750 g/palm/year) (15.08 kg/palm/year). At Ambajipeta, there were increases in yield due to higher levels of N and P whereas higher levels of K had depressive effect on yield. Lower levels of N, P and K gave highest copra content/nut.

In the nuritional trial on high yielding varieties of coconut at Mondouri, the effect of N was singificant. Highest

yield was recorded in treatment N0P1K1 (0:250:1000 g/palm/year) (122.5 nuts/palm/year) followed by N1P2K1 (500:500:1000 g/palm/year) (121.5 nuts/palm/year). At Ratnagiri, none of the treatment effect was found significant on the annual yield. However, higher levels of N, P and K increased the nut yield, with an average of 74.4 nuts/palm/year. Considering the cumulative yield (1990-96), the effect of N was significant. The interaction effects of NK and PK were also significant. At Kahikuchi, there were significant differences in nut yield due to the main effects of N and K. The highest number of nuts/palm (87) was recorded in the treatment N1P2K2 (500:500:2000 g/palm/year) followed by N1P1K2 (500:250:2000 g/palm/year) (80.4 nuts/palm/year).

In the High Density Multispecies Cropping System trial at Ambajipeta, the coconut yield improved appreciably both in Model-I and Model-II, compared to sole crop of coconut. At Kahikuchi, the mean yield of coconut in Model-I and Model-II were 69 and 73 nuts/palm, respectively whereas coconut sole crop gave only a mean yield of 25 nuts/palm/year. At Ratnagiri, the coconut yields in the intercropped models were increased from 26.8% to 93.3% after 15 years. The average yield per palm of the sole crop remained steady.

In the irrigation cum fertilizer trial on adult coconut palm at Ratnagiri, the mean yield of coconut (1990-95) showed that basin irrigation and 100% drip irrigation were on par and significant over other irrigation levels. At Veppankulam supply of water through drip system 100% Eo resulted in the highest yield of 123 nuts/palm/year as against 116 nuts/palm/year in basin irrigation. Palms which received slow release fertilizer application gave yields of 103 nuts/palm/year as against 90 nuts/palm/year in palms which received straight fertilizer application. At Arsikere, maximum yield of nuts per palm (84) was obtained in drip irigation 66% Eo with slow release of fertilizers. At Aliyarnagar, basin irrigation was on par with drip irrigation.

Crop Protection

Diseases

At Ambajipeta, in the fungicidal trial on Tatipaka disease affected palms, the disease index was less in Triadimefon (Bayleton) treated palms. The antiserum produced against *G. lucidum* (Vijayarai isolate) was found to be specific in gel double diffussion tests. In the trial with different doses of Tridemorph, application of 6 ml/palm was found to be more effective in controlling the disease.

At Aliyarnagar, application of 5 kg neemcake per palm along with root feeding of tridemorph 2% solution was found to be the most effective treatment for the control of basal stem rot. At Veppankulam, early diagnosis tests like EDTA, TTC and Electrical Conductivity were developed for basal stem rot. In the Biological Control trial, the palms which received the treatment *T. harzianum* with green leaves + FYM + Bordeaux mixture and neem cake had least disease intensity. In the varietal screening trial against Basal stem rot, ECT

x ECT was found more tolerant with 67% of survival.

Pests

At Aliyarnagar, in locations where the Baculovirus infected adult beetles were released, the virus got established. It was reported that there was three fold reduction in the population of the Rhinoceros beetle and also reduction in frond damage of the coconut palms. At Ratnagiri, due to the release of Baculovirus infected beetles, the leaf damage came down from 13.08 to 1.23 per cent. At Ambajipeta, after the release of parasitoids, giving parasitization, 7.2 per cent by *B. hebeter* and 0.1% by *Gomisus nephantidis*, the pest population started declining from January, 1996 (789/palm) with 6.45% parasitisation by *B. hebetor*, by March, the pest population had come down to 155/palm and was absent by the month of June.

OIL PALM

Crop Improvement

At Mulde, the maximum yield of FFB was recorded in Cross 128 D x 291 P (30.5 kg/palm/year) followed by 104 D x 291 P(29.9 kg/palm/year). At Vijayarai, all the growth characters observed were maximum in cross 128 D x 291 P. At Gangavathi, maximum height (3.6 m) and maximum number of leaves on the crown (28.9) were recorded in the cross 109 D x 291 P. At Aduthurai, the varietal trial with different crosses *(Dura x Pisifera)* was planted in March, 1996.

Crop Production

At Mulde, the effects of irrigation, fertilizetr and interaction effect of irrigation x fertilizer were all highly significant on the production of FFB/palm. Drip irrigation with a fertilizer dose of NPK (1200:600:2700 g/palm/year) gave maximum FFB yield of 57.8 kg/palm/year. At Gangavathy the number of bunches/palm and fruit weight significantly increased due to the effect of fertilizer application. At Vijayarai, maximum yield was recorded in treatment T1F3 (Basin irrigation with a fertilizer dose of NPK = 1200:600:2700 g/palm/year). The yield of FFB/palm was highly significant due to irrigation, fertilizer levels and interaction of irrigation x fertilizer. At Aduthurai, basin method of irrigation and higher dose of fertilizer (1200:600:2700 g NPK/palm/year) gave higher growth characters and yield.

PALMYRAH

Crop Improvement

During the survey conducted at Pandirimamidi in 1995, thirteen accessions were added, raising the total number of germplasm to 54 in the project. Three accessions were found promising based on the record of leaf number and plant height. At Killikulam, fruits varying in characters were collected from 40 high yielding dwarf palmyrah genotypes and seednuts were sown in November, 1995. In the hybridization programme held during 1995, three hybrid combinations viz. BF 20 x BF 6, BF 20 x BF 27, BF 16 x BF 27 were effected. Seedlings raised from these have established. During 1996, crossing work was taken up in BF 7 x BF 28, BF 34 x BF 24 and BF 20 x BF 27 and the fruits are nearing maturity.

One locally available palmyrah genotype yielded a record 184.75 litres of Neera in a tapping duration of 70 days. This tree would be utilized in the future hybridization programme.

Crop Protection

Diseases

At Killikulam, surveys conducted in the districts of Nellai Kattabomman, Ramnad and V.O. Chidambaranar districts revealed the severity of palmyrah leaf blight caused by *Pestalotia palmarum* and the disease index ranged from 32.6 to 62.6%. Leaf spot disease was also prevalent in five localities with the disease index ranging from 27.0 to 50.9.

In a nursery trial laid out to manage tuber rot caused by *Rhizoctonia solani,* the treatment of soaking seednuts in carbendazim 0.1% reduced the disease incidence by 60% besides enhancing the seednut germination to an extent of 20%. At Pandirimamidi, incidence of bud rot disease in palmyrah was recorded.

Pests

At Killikulam, among the insect pests monitored in palmyrah groves, *Oryctes rhinoceros* was recorded in four places and infestation levels ranged from 5.0 to 6.3%. Infestation of *Opisina arenosella* was recorded in four localities with levels of infestation ranging from 7.7 to 20.0 per cent. Survey also revealed the infestation by Rhinoceros beetle in the East Godavari district of Andhra Pradesh.

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During the year 1996-97, 49 trainings in the field of Agriculture, Horticulture, Home Science, Agril. Engineering and Sericulture were conducted in which a total of 991 trainees attended. Evaluation and feedback was also constantly monitored for all these training programme. Under village adoption programmes, six villages namely, Madhur, Mugu, Muliyar, Pullur, Bombrana and Manimoola were adopted under the developmental programmes like Lab to Land, National Demonstration and SC/ST development. Altogether 98 beneficiaries under Lab to Land, 116 beneficiaries under national demonstration and 69 beneficiaries under SC/ST development programme were benefited.

Regular follow-up activities like field visits, monitoring of demonstrations in each village, group discussions with farmers and distribution of inputs to the beneficiaries were also under-taken.

Under on-farm research (OFR) activities, 25 demonstrations were initiated on 'Management of stem bleeding disease in coconut' in six villages and 12 demonstrations on 'Control of Mahali in arecanut' in four villages and 8 demonstrations on, 'Control of leaf eating caterpillar in coconut' were undertaken.

Watershed Development Programme was taken up in Yethadka village. The total area of watershed is 788 ha, out of which cropped area is only 315 ha where crops like arecanut, paddy, coconut and cashew are raised as main crops and pepper and banana as intercrops. Further, KVK has conducted 12 different trainings, seminars and meetings for the watershed beneficiaries in different aspects like cropping pattern, soil and water conservation methods etc.

The KVK faculty were attending farmers' calls for their problems by visiting their fields, participating in farmers club meetings, seminars and science forums. They also participated in three exhibitions and two District level science meet.

ALL INDIA COORDINATED RESEARCH PROJECT ON PALMS

COCONUT

Crop Improvement

At Aliyarnagar, maximum cumulative yield for the last four years was 280 nuts/palm for S.S.G. followed by 215 nuts/palm for ECT. At Veppankulam, WCT had the highest annual yield of 159 nuts/palm followed by ECT (149). Among the dwarfs, MGD had the highest annual nut yield of 117 per palm followed by Gangabondam (106). At Ambajipeta, Philippines Ordinary produced maximum cumulative yield since 1980-81 (1856 nuts/palm) followed by Laccadive Ordinary (1565). The copra content per nut was maximum in Philippines Ordinary (246g) followed by Cochin China (225 g). Among the hybrids, WCT x COD and COD x WCT produced cumulative yields (since 1980-81) of 1420 and 1314 nuts/palm, respectively. GB x LO, GB x Fiji and ECT x GB were found superior to other hybrids with regard to mean cumulative nut yield and other morphological characters. In the trial on promising seed materials, the hybrids COD x WCT, ECT x GB and WCT x COD were found superior to other cultivars and hybrids with regard to their cumulative nut yield and copra content. At Konark, sixteen forms of original local were identified based on size, shape, colour and number of nuts/palm. Six forms such as Jahaji, Surya bana, Sakhigopal local, Local triangular, Dhanei and Local Green brown have been collected and planted. At Kahikuchi, the growth performance of cultivar Gonthembili and B.S.I. were found better over others. Maximum annual nut yield was recorded in local tall (79.7) followed by WCT (68.7) and MDY x WCT (65.7). At Mondouri, maximum yield was recorded in Zanzibar (61.9 nuts/palm/year) followed by Hazari and St. Vincent (60.3 and 54.5, respectively). The copra content/nut was highest (164 g/nut) in St. Vincent. In the trial of promising seed materials, the highest yield and copra weight were recorded in Laccadive Ordinary (82.5 nuts/palm/year and 275 g/nut, respectively). At Ratnagiri, Laccadive Ordinary produced the highest yield of 151.3 nuts/palm/year followed by Pratap (129 nuts/palm/year). Among the Banawali types, Banawali Green Long produced the highest yield of 114.5 nuts/palm/year.

Crop Production

In the NPK nutritional trial on Ordinary Tall coconut at Mondouri, maximum yield of 76.5 nuts/palm/year was recorded in treatment N2P2K1 (1000:500:1000 g/palm/year). Maximum copra yield was recorded in treatment N3P3K1 (1500:750:750 g/palm/year) (15.08 kg/palm/year). At Ambajipeta, there were increases in yield due to higher levels of N and P whereas higher levels of K had depressive effect on yield. Lower levels of N, P and K gave highest copra content/nut.

In the nuritional trial on high yielding varieties of coconut at Mondouri, the effect of N was singificant. Highest

yield was recorded in treatment N0P1K1 (0:250:1000 g/palm/year) (122.5 nuts/palm/year) followed by N1P2K1 (500:500:1000 g/palm/year) (121.5 nuts/palm/year). At Ratnagiri, none of the treatment effect was found significant on the annual yield. However, higher levels of N, P and K increased the nut yield, with an average of 74.4 nuts/palm/year. Considering the cumulative yield (1990-96), the effect of N was significant. The interaction effects of NK and PK were also significant. At Kahikuchi, there were significant differences in nut yield due to the main effects of N and K. The highest number of nuts/palm (87) was recorded in the treatment N1P2K2 (500:500:2000 g/palm/year) followed by N1P1K2 (500:250:2000 g/palm/year) (80.4 nuts/palm/year).

In the High Density Multispecies Cropping System trial at Ambajipeta, the coconut yield improved appreciably both in Model-I and Model-II, compared to sole crop of coconut. At Kahikuchi, the mean yield of coconut in Model-I and Model-II were 69 and 73 nuts/palm, respectively whereas coconut sole crop gave only a mean yield of 25 nuts/palm/year. At Ratnagiri, the coconut yields in the intercropped models were increased from 26.8% to 93.3% after 15 years. The average yield per palm of the sole crop remained steady.

In the irrigation cum fertilizer trial on adult coconut palm at Ratnagiri, the mean yield of coconut (1990-95) showed that basin irrigation and 100% drip irrigation were on par and significant over other irrigation levels. At Veppankulam supply of water through drip system 100% Eo resulted in the highest yield of 123 nuts/palm/year as against 116 nuts/palm/year in basin irrigation. Palms which received slow release fertilizer application gave yields of 103 nuts/palm/year as against 90 nuts/palm/year in palms which received straight fertilizer application. At Arsikere, maximum yield of nuts per palm (84) was obtained in drip irigation 66% Eo with slow release of fertilizers. At Aliyarnagar, basin irrigation was on par with drip irrigation.

Crop Protection

Diseases

At Ambajipeta, in the fungicidal trial on Tatipaka disease affected palms, the disease index was less in Triadimefon (Bayleton) treated palms. The antiserum produced against *G. lucidum* (Vijayarai isolate) was found to be specific in gel double diffussion tests. In the trial with different doses of Tridemorph, application of 6 ml/palm was found to be more effective in controlling the disease.

At Aliyarnagar, application of 5 kg neemcake per palm along with root feeding of tridemorph 2% solution was found to be the most effective treatment for the control of basal stem rot. At Veppankulam, early diagnosis tests like EDTA, TTC and Electrical Conductivity were developed for basal stem rot. In the Biological Control trial, the palms which received the treatment *T. harzianum* with green leaves + FYM + Bordeaux mixture and neem cake had least disease intensity. In the varietal screening trial against Basal stem rot, ECT

x ECT was found more tolerant with 67% of survival.

Pests

At Aliyarnagar, in locations where the Baculovirus infected adult beetles were released, the virus got established. It was reported that there was three fold reduction in the population of the Rhinoceros beetle and also reduction in frond damage of the coconut palms. At Ratnagiri, due to the release of Baculovirus infected beetles, the leaf damage came down from 13.08 to 1.23 per cent. At Ambajipeta, after the release of parasitoids, giving parasitization, 7.2 per cent by *B. hebeter* and 0.1% by *Gomisus nephantidis*, the pest population started declining from January, 1996 (789/palm) with 6.45% parasitisation by *B. hebetor*, by March, the pest population had come down to 155/palm and was absent by the month of June.

OIL PALM

Crop Improvement

At Mulde, the maximum yield of FFB was recorded in Cross 128 D x 291 P (30.5 kg/palm/year) followed by 104 D x 291 P(29.9 kg/palm/year). At Vijayarai, all the growth characters observed were maximum in cross 128 D x 291 P. At Gangavathi, maximum height (3.6 m) and maximum number of leaves on the crown (28.9) were recorded in the cross 109 D x 291 P. At Aduthurai, the varietal trial with different crosses *(Dura x Pisifera)* was planted in March, 1996.

Crop Production

At Mulde, the effects of irrigation, fertilizetr and interaction effect of irrigation x fertilizer were all highly significant on the production of FFB/palm. Drip irrigation with a fertilizer dose of NPK (1200:600:2700 g/palm/year) gave maximum FFB yield of 57.8 kg/palm/year. At Gangavathy the number of bunches/palm and fruit weight significantly increased due to the effect of fertilizer application. At Vijayarai, maximum yield was recorded in treatment T1F3 (Basin irrigation with a fertilizer dose of NPK = 1200:600:2700 g/palm/year). The yield of FFB/palm was highly significant due to irrigation, fertilizer levels and interaction of irrigation x fertilizer. At Aduthurai, basin method of irrigation and higher dose of fertilizer (1200:600:2700 g NPK/palm/year) gave higher growth characters and yield.

PALMYRAH

Crop Improvement

During the survey conducted at Pandirimamidi in 1995, thirteen accessions were added, raising the total number of germplasm to 54 in the project. Three accessions were found promising based on the record of leaf number and plant height. At Killikulam, fruits varying in characters were collected from 40 high yielding dwarf palmyrah genotypes and seednuts were sown in November, 1995. In the hybridization programme held during 1995, three hybrid combinations viz. BF 20 x BF 6, BF 20 x BF 27, BF 16 x BF 27 were effected. Seedlings raised from these have established. During 1996, crossing work was taken up in BF 7 x BF 28, BF 34 x BF 24 and BF 20 x BF 27 and the fruits are nearing maturity.

One locally available palmyrah genotype yielded a record 184.75 litres of Neera in a tapping duration of 70 days. This tree would be utilized in the future hybridization programme.

Crop Protection

Diseases

At Killikulam, surveys conducted in the districts of Nellai Kattabomman, Ramnad and V.O. Chidambaranar districts revealed the severity of palmyrah leaf blight caused by *Pestalotia palmarum* and the disease index ranged from 32.6 to 62.6%. Leaf spot disease was also prevalent in five localities with the disease index ranging from 27.0 to 50.9.

In a nursery trial laid out to manage tuber rot caused by *Rhizoctonia solani,* the treatment of soaking seednuts in carbendazim 0.1% reduced the disease incidence by 60% besides enhancing the seednut germination to an extent of 20%. At Pandirimamidi, incidence of bud rot disease in palmyrah was recorded.

Pests

At Killikulam, among the insect pests monitored in palmyrah groves, *Oryctes rhinoceros* was recorded in four places and infestation levels ranged from 5.0 to 6.3%. Infestation of *Opisina arenosella* was recorded in four localities with levels of infestation ranging from 7.7 to 20.0 per cent. Survey also revealed the infestation by Rhinoceros beetle in the East Godavari district of Andhra Pradesh.