
CENTRAL
CROPS RESEARCH INSTITUTE
KERALA INDIA
Research
Highlights 1983

Front cover: A view of the coconut based multispecies cropping system at CPCRI Kasaragod

RESEARCH HIGHLIGHTS 1983

CENTRAL PLANTATION CROPS RESEARCH INSTITUTE
Kasaragod 670 124 Kerala India

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INTRODUCTION

The Central Plantation Crops Research Institute conducts and co-ordinates research on coconut, arecanut, oil palm, cashewnut, cocoa and spices. Among the spices, pepper, cardamom, ginger, turmeric, nutmeg, clove and cinnamon are the more important crops being researched upon. The activities of the Institute are spread over 16 centres. During the 11th Annual Research Council meeting of the CPCRI held in January 1983, 91 Research Projects were approved for various crops and disciplines for execution during the year. In addition to the thrust areas on crop improvement, management and plant protection, a highly multidisciplinary project on cropping systems was taken up for investigation. In general, efforts were directed to reduce the number of projects into major areas of crop production and protection. The eight priority areas identified in this context for 1983 were (1) Root (wilt) disease of coconut, (2) Yellow leaf disease of arecanut, (3) Quick and slow wilt diseases of pepper, (4) Rhizome rot of ginger and turmeric, (5) Thanjavur wilt, Ganoderma and stem bleeding disease complex, (6) 'Katte' disease of cardamom, (7) High density multispecies cropping system, and (8) Cashew production improvement. Concerted efforts to generate breeder's stock and parental lines for hybrid seed production in different crops for establishing seed gardens on a country wide basis were also made during the year. Intensive effort on transfer of available technology through effective training programmes was the other area which received priority attention.

The highlights of the research findings of CPCRI during 1983 are covered in this publication.

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Kasaragod
April 21, 1984

I. Priority Areas

1. Root (wilt) disease of coconut

Presence of typical mycoplasma like organisms (MLOs) in the phloem tissues of root (wilt) affected palms was further confirmed when ultra thin sections of the tissues were examined under ZEISS EM 109R electron microscope. MLOs were not observed in tissues of healthy palms. Light microscopic studies with nucleic acid specific stains and flurochromes lent support to this finding.

As putative vectors, the leaf hopper *Sophonia greeni* and a plant hopper *Proutista moesta* were observed on coconut in addition to the already recorded lace-bug. Tetranychidae are the more common mites on foliage. Eriophyid mites occur less abundantly. Periwinkle proved to be an acceptable host plant to all insects and mites tested for transmission. Fresh incidence of disease had a linear correlation with abundance of lacebugs.

The sero–diagnostic test developed could detect diseased conditions of palms about 3 – 9 months before the expression of visual symptoms. Absorption of antisera with normal host protein increased rapidity of the test with a saving of 50% time.

High stomatal resistance with low transpiration rate was detected in healthy and apparently healthy palms in contrast to diseased palms (Fig. 1). A significant correlation between disease index and transpiration rate was established (Fig. 2). Comparisons with visual symptoms and serological test indicated that measurement of transpiration rate at mid–day could differentiate between apparently healthy and diseased palms.

Growing *Pueraria phaseoloides* in coconut basin and incorporating the same resulted in significant increase in total microbial population. Soil enzymatic activities of coconut rhizosphere also increased significantly due to green manure addition.

2. Yellow leaf disease of arecanut

Electron microscopic examination of root tissue from yellow leaf affected arecanut palms showed pleomorphic forms of mycoplasma like organisms in the sieve tubes of roots (Fig. 3). Occasionally a tailed bacteriophage was found attached to the MLOs. Histochemical staining of phloem with Diene's stain and fluorescence microscopic studies strengthened the evidence for the presence of MLOs in tissues of diseased palms. Though none of the available variety/hybrid has been found resistant, *Mangala* and dwarf hybrid have shown less susceptibility.

3. Quick and slow wilt diseases of pepper

Seventy eight seedlings raised from open pollinated seeds of various cultivars of pepper showed preliminary resistance to *Phytophthora* since they did not take up infection with artificial inoculation. Twenty one seedlings out of 1200 screened against *Meloidogyne incognita* showed tolerance, while none was resistant to *Radopholus similis*. Occurrence of

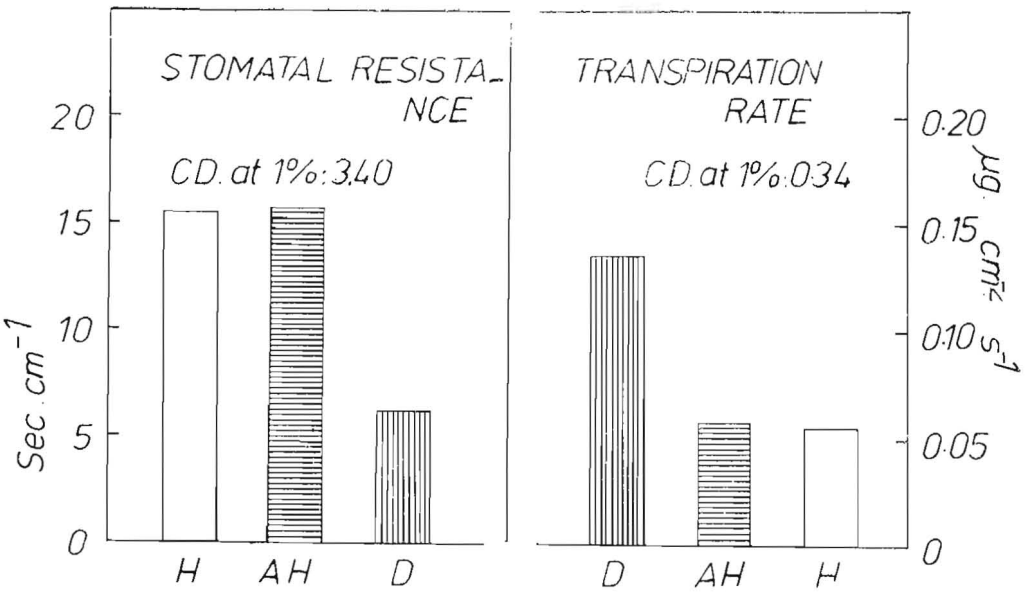


Fig. 1. Stomatal resistance (Sec. cm^{-1}) and transpiration rate (μg, cm^{-2} Sec^{-1}) in healthy (H) apparently healthy (AH) and diseased (D) coconut palms (30 to 35 years old).

Meloidogyne sp. *R. similis* and *Trophotylenchulus floridensis* together was found in 40% of the pepper gardens surveyed in Cannanore district.

4. Rhizome rot of ginger and turmeric

Low incidence of disease and higher yield in ginger were obtained in plots treated with Metacid. Though Dithane M-45 application did not have any significant influence on disease incidence, higher yield was observed in plots treated with it. Storing seed ginger in sand lined pits gave higher recovery compared to other storage methods. Treating seed rhizomes with Dithane M-45, 0.3% or Bavistin 0.2% was also equally effective in preventing deterioration/ infection.

5. Thanjavur wilt, Ganoderma wilt and stem bleeding disease complex of coconut

Phomopsis cocoina and a basidiomycetous fungus were isolated from the palms affected by stem bleeding disease at Kayangulam. Drenching with 0.1% Calixin at 25 litres/palm once in two months was effective in checking the intensity of stem bleeding disease at Pilicode.

6. 'Katte' disease of cardamom

Cross inoculation studies indicated that six strains of 'Katte' identified earlier are related and they protect mutually. Electron microscopic examination of tissue samples from disease affected clumps showed flexuous rod shaped virus particles (Fig. 4). The crop loss

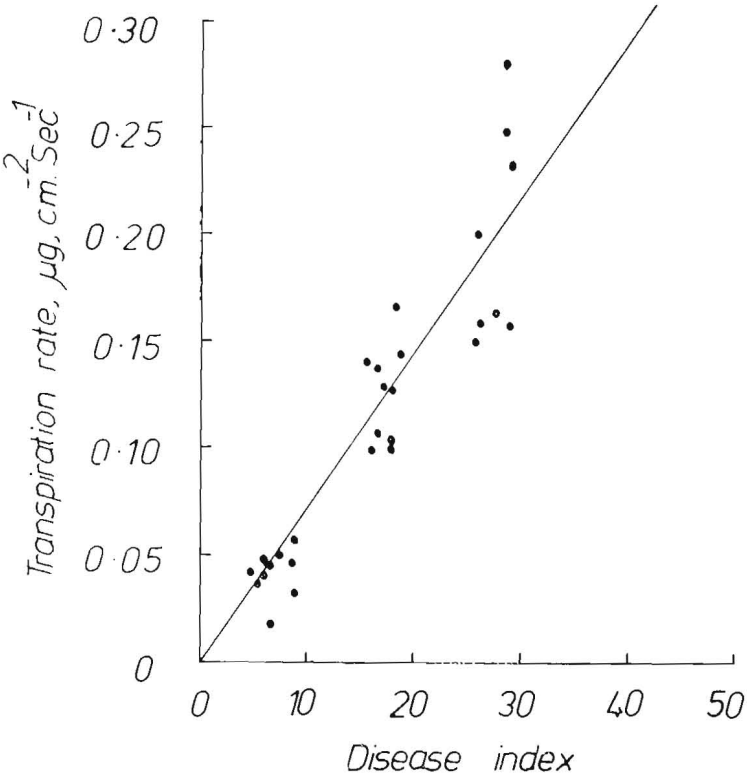


Fig. 2. Relationship between disease index and transpiration rate in root (wilt) disease affected coconut palms

due to the disease ranged from 15 to 90% depending on the interval after infection, maximum being after three years. The disease in severely affected plantations can be managed in a phased replanting programme over a period of three years.

II. Other Areas of Interest

1. Crop production

The germplasm bank in plantation crops maintained at the Institute represents the largest collection available anywhere in the world in this group of crops. During the year, 119 cultivated and 28 wild types of pepper, 66 accessions of cashew and 36 accessions of ginger were added to the already available collections. Variability available in the indigenous Tall coconut cultivars was characterised and collection models were prepared. In cocoa, four high yielding self-incompatible accessions were identified. In oil palm, *pisifera* pollen introduced from Nigeria was found to be superior to other indigenous *pisifera* types in production of *tenera* hybrids. In coconut, five WCT families were identified as prepotents on the basis of high mean and low coefficient of variability for seven

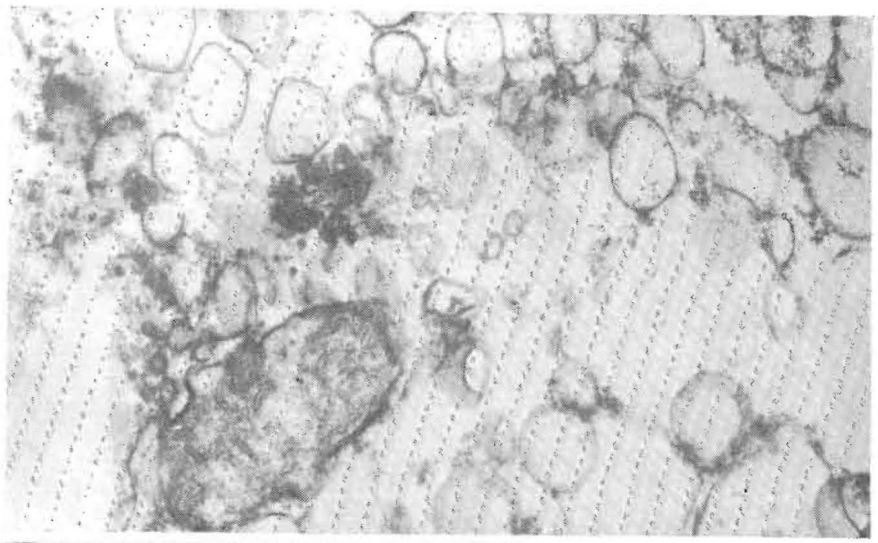


Fig. 3. MLOs in root tissues of yellow leaf disease affected arecanut palm × 36,000

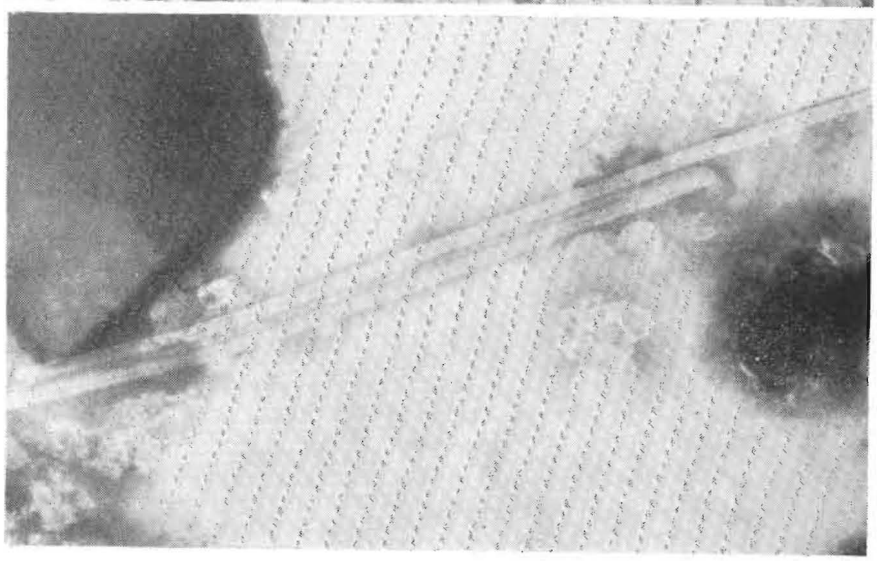


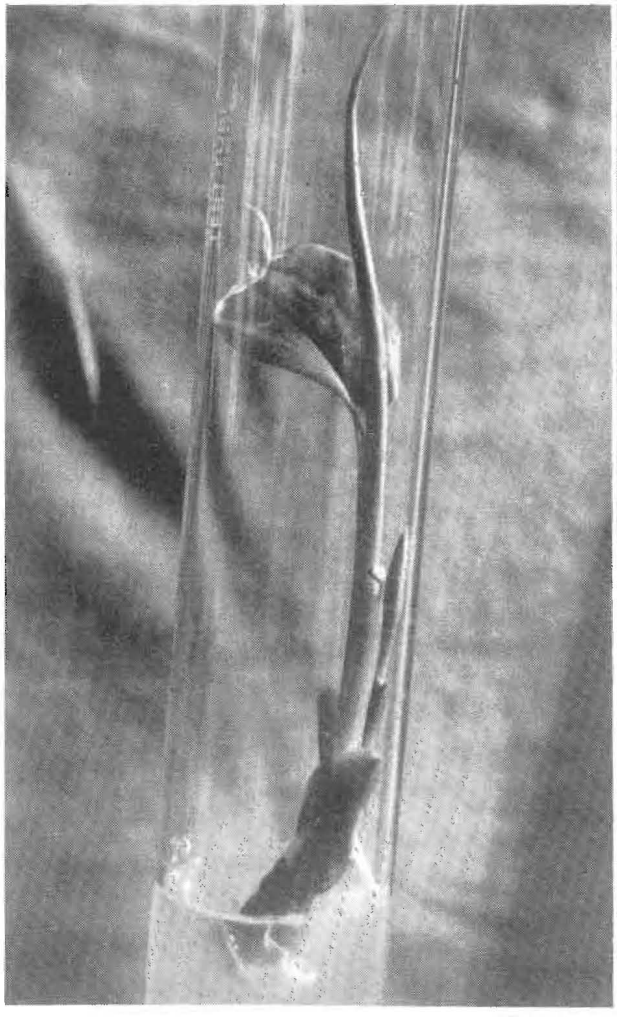
Fig. 4. Flexuous rod shaped virus particles in leaf tissues of 'Katte' affected cardamom plants × 86,000

seedling characters. Three families among them had high progeny means over general mean, one of them being the progeny of an established prepotent palm. Some of the dwarf parents were identified to be more homogeneous and gave over 80% hybrid recovery in CDO × WCT crosses. Similarly in D × T hybrid combinations with Kenya and Zanzibar cultivars as pollen parents, the hybrid recovery was good. Higher yield potential in CDO × WCT hybrid is due to the inheritance of high female flower and

spathe production from male parent and high setting percentage from female parent.

2. Tissue culture

Somatic embryoids of coconut showing root-shoot axis were induced in WCT seedling leaf cultures on modified Y-3 medium containing high m-inositol, NAA and traces of formalin. Embryo cultures of WCT on modified Y-3 medium gave healthy seedlings with normal haustorium and vigorous rooting. Roots excised from these and cultured on Y-3 medium gave callus at the cut ends (Fig. 5).



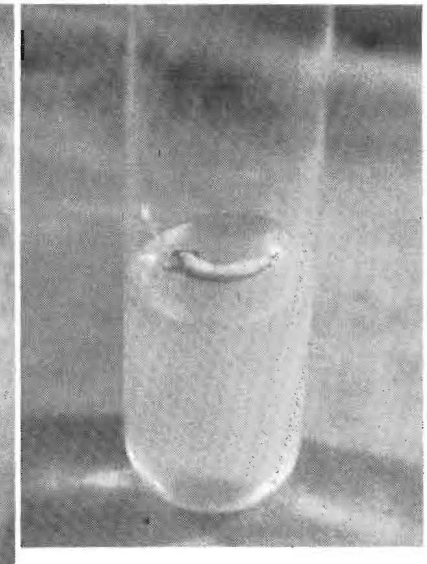


Fig. 5. Somatic embryoid in coconut (above)

Fig. 6. Sub culture of cardamom with buds (left)

Lateral buds of Malabar cardamom cultured on modified MS medium, supplemented with NAA, BAP, Kinetin and coconut water sprouted and rooted in 6–7 weeks. On sub culture, more buds appeared near the base (Fig. 6).

3. Water management and stress physiology

Physiological studies on water relations indicated that root (wilt) disease affected coconut palms lose greater amount of water through leaves compared to healthy palms which conserve water.

4. Production physiology

The estimated dry matter production rate of coconut is 12 tonnes/ha. The annual productivity index ranged from 0.36 to 0.51 in average yielding palms. CDO × WCT hybrid seedlings were found to possess significantly higher NR activity, chlorophyll content and shoot dry weight than the dwarfs, and intermediate types of hybrids with orange petiole colour.

5. Nutritional requirement and crop management

In arecanut, palms receiving P in a single application in September and N and K in two equal splits in September and March yielded 2471 kg *chali*/ha compared to 2207 kg/ha by palms receiving annual dose of fertilisers in a single application, the increase being nearly 12%. CDO × WCT coconut hybrids performed better than high yielding WCT and WCT × CDO under all fertility levels. Under no fertiliser application also CDO × WCT gave the higher mean yield of 45.9 nuts compared to 33.7 nuts by Tall and 26.4 by WCT × CDO. (Table I) Application of heavy metals like Cd, Ae, Cr, Ba, Bl, Pb and Cu adversely affected the nutrition of coconut palm. For oil palm, fertiliser dose of 1200g N+600g P_2O_5+1200g K_2O/palm/year was found to be adequate.

6. Soil fertility and nutrient dynamics in relation to crop productivity

Blending of organic matter with inorganics for coconut in sandy soils

TABLE I. Mean yield of high yielding coconut genotypes at different fertiliser levels (July 1981 to June 1983)

Variety/hybrid	Yield (nuts/palm/year)		
	M_0	M_1	M_2
High yielding WCT	33.7	66.9	84.4
CDO × WCT	45.9	92.2	94.7
WCT × CDO	26.4	79.2	80.4

M_0 : no fertiliser application; M_1 : 500g N + 500g P_2O_5 + 1000g K_2O/palm/year
M_2 : 1000g N + 1000g P_2O_5 + 2000g K_2O/palm/year

helped in moisture and nutrient conservation and better productivity.

7. Plant protection

a. Diseases : Leaf rot disease of coconut caused by *Bipolaris halodes* can be controlled effectively by spraying 1% Bordeaux mixture or 0.3% Dithane M–45.

In arecanut, use of polythene covering with and without Bordeaux mixture spray was found effective in controlling *Koleroga* disease. Captan 0.3% drenching was effective in checking further spread of *Anabe* disease to neighbouring healthy palms.

b. Pests : Nut loss due to coreid bug infestation in coconut was estimated to range from 1.1 to 17.3%. Spraying 0.05% carbaryl or 0.1% endosulfan was effective in reducing coreid bug infestation. Placement of phorate granules in polythene packets with pinholes in the inner leaf axils was found efficacious for the control of spindle bug on arecanut.

8. Integrated pest management

a. Biological control : Baculovirus of *Oryctes* (Fig. 7) was introduced to Minicoy, Lakshadweep for biological suppression of coconut rhinoceros beetle. Indications of establishment of the virus in the natural population of beetles and in their breeding sites were obtained.

Techniques were developed for rearing the carabid predator *Parena nigrolineata* and two ichneumonid pupal parasites *Xanthopimpla punctata* and *X. nana nana* for biological suppression of *Opisina arenosella*. Sampling technique for monitoring *Opisina* population in the field was tested. Studies on fixing doses for release of indigenous parasites individually were completed.

b. Chemical control : Soil application of heptachlor at 1.4 kg a i/ha in June or two applications of BHC at 5 kg a i/ha each in June and September gave effective control of white grub, *Leucopholis coneophora* infesting coconut. Rescheduling of insecticide treatment for cocoa mealy bug has been carried out by spot application of fenthion 0.05% at the initial level of infestation instead of the normal practice of blanket sprays during peak periods.

c. Mechanical control : As the adults of *L. coneophora* do not feed or congregate on any host plant, tackling this pest by the mechanical means or by spraying the host plant is not feasible. Collection and destruction of beetles at the time of their *en masse* emergence reduced the beetle population numerically and the pest infestation.

9. Nematodes

Sterilisation of the nursery soil with methyl bromide or drenching with 2% formalin was found effective in controlling burrowing nematodes in coconut nurseries. Damaging level/inoculum threshold of *R. similis* on coconut seedlings was found to be 100 nematodes/seedling or one nematode in 625 cm^2 or 900 g sandy loam soil.

10. Vertebrate pest management

Two anticoagulant rodenticides, Brodifacoum 0.005% and 0.002% and Bromadialone 0.005% were effective in reducing rodent populations in Minicoy Island. In Car Nicobar and S. Andaman Islands, rodent damage to coconut, oil palm and cashew (seedlings) was assessed to be 35%, 45% and 65% respectively. Poison baiting and trapping operations were effective on crown of coconut palms rather than at ground level.

Regular rodent trapping and intermittent rodenticidal applications increased production by about 10–12 times in cocoa and 20% in coconut in Kerala and Karnataka. Two periods (April and December) were found to be suitable for controlling squirrel infesting cocoa and fruit crops.

11. Quality studies

In sixteen high yielding accessions of cashew evaluated for kernel, protein, total and reducing sugars, starch, testa

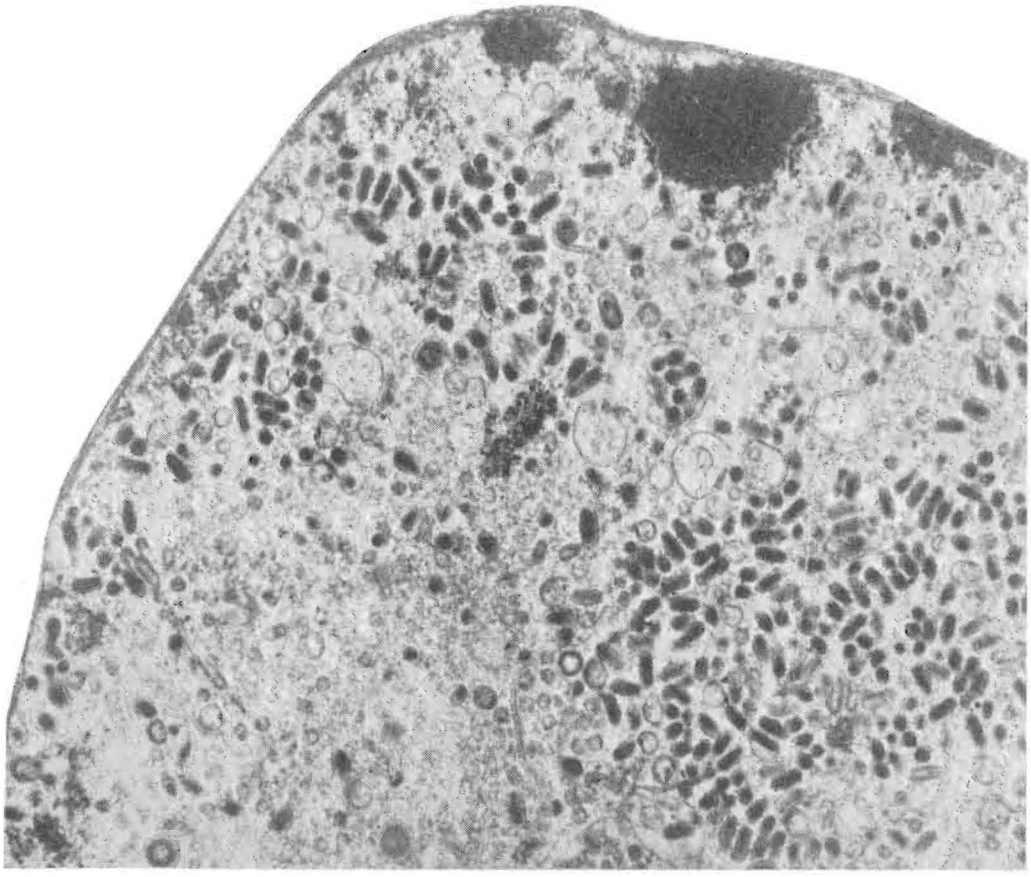


Fig. 7 Infected nucleus of the midgut cell of rhinoceros beetle filled with baculovirus particles × 25,000 Bar=500 nm

tannin and fat contents, no significant variation in characters between plants within an accession was observed. A wide variation in testa tannin content was noticed among different varieties. In pepper cultivar Kottanadan very high oleoresin content (17%) was recorded. In turmeric the highest percentage of curcumin (10.9) and oleoresin (19.2) were found in Edapalayam and Konni respectively.

12. Harvest and post-harvest technology research

A modified coconut dehusker (leg operated) having outturn of 960 nuts/8 hr was developed (Fig. 8). A handy copra moisture meter was designed and is under evaluation.

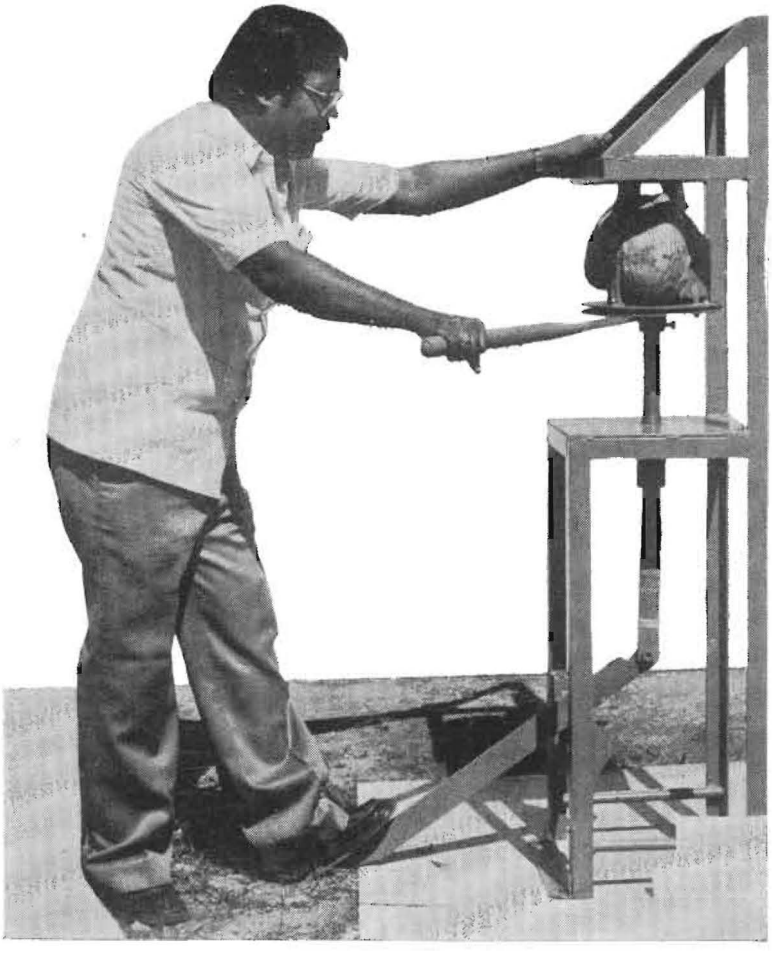


Fig. 8. Modified coconut dehusker

13. Refinement of experimentation techniques in plantation crops

The yield of individual cashew tree can be predicted based on number of nuts at all stages of maturity, canopy area and condition of flowering during the peak flowering phase. Whole plant yield of pepper vines can be estimated with reasonable accuracy using visual yield score and yield per metre length. The annual yield of coconut can be estimated by counting nuts on the crown alone. In turmeric three beds of size 1m × 1m is the optimum for field experiments. For field experimentation with D × T coconut palms, optimum plot size is about eight palms.

14. Estimation of crop losses

Survey for estimating the incidence of pepper (wilt) disease was carried out in seven selected villages of Calicut district. The disease incidence was found in 0.40% – 6.20% of vines. The overall percentage of disease incidence in Calicut during the year in these villages is estimated at 3.02%.

15. Cost–benefit analysis of crop production and farming systems

The cost of production for small holder plantation crops per kilogram was estimated on the basis of prevailing cost of inputs in Kerala (Table II). They were Rs. 9.25 for pepper, Rs. 102 for cardamom, Rs. 3.90 for ginger, Rs. 3.85 for cashew, Rs. 9.10 for cocoa bean, Rs. 9.00 for copra and Rs. 10.60 for arecanut *(chali.)* Economic evaluation of coconut–based inter–cropping experiments carried out at Kasaragod under rainfed conditions showed that the net added return per hectare was the highest in the case of elephant foot yam (Rs. 3190) followed by ginger (Rs. 1650), turmeric (Rs. 1275), tapioca (Rs. 1230), lesser yam (Rs. 1035) greater yam (Rs. 950) and sweet potato (Rs. 735) (Table III).

III. ICAR Research Complex - Goa

1. Crops

IET 6223 (short duration), IET 6213 (medium duration), Mahshuri (long duration) varieties of paddy perform better under Goa conditions. R. P. 79–5 and IET 6223 varieties of paddy seemed to be tolerant to blast with high yield potential.

2. Animal sciences

In the cross breds, only 40% exhibited oestrus within 60–90 days and 16% of the animals had first post-partum oestrus without ovulation. This finding would be of help in artificial insemination. Imbalances of calcium and phosphorus was found to be one of the reasons for infertility in cattle. A new feed formula for dairy cattle replacing costly wheat bran with locally available cheap rice bran could bring down the cost of production of milk by 34 paise/litre. Incorporation of locally available by–products like rice bran, brewery grain waste, molasses etc. could bring down the feed cost by 25% in poultry starter and grower rations. Homeopathic medicine Ipecac–200 was found very effective and economic in controlling infectious bronchitis in poultry.

TABLE II. Estimated cost of production of crops under ideal management

Crop	Cumulative cost/ha upto 12 years (Rs.)	Cumulative yield/ha upto 12 years (tonnes)	Cost of production/kg (Rs.)
Pepper	98,950	10.70	9.25
Cardamom	77,130	0.76	102.00
Cashew	19,300	5.00	3.85

Crop	Cumulative cost/ha upto 25 years (Rs.)	Cumulative yield/ha upto 25 years	Cost of production/kg (Rs.)
Coconut	179,850	1.56 lakh nuts	1.15/nut
Arecanut	555,370	53.85 tonnes	10.10/kg

Crop	Annual cost (Rs.)	Annual production (tonnes)	Cost of production/kg (Rs.)
Ginger (dry)	20,280	5.2	3.90
Turmeric (dry)	15,550	5.0	3.10

TABLE III. Economics of various intercropping systems in coconut gardens at CPCRI Kasaragod (Rs./ha)

Crop(s)	Annual cost	Added cost over monocrop	Annual return	Net profit	Added return over monocrop	Net added return by intercrop
Coconut (monocrop)	5550	-	13860	8310	-	-
Coconut + EF yam	14100	8550	25600	11500	11740	3190
Coconut + Greater yam	17560	12010	26820	9260	12960	950
Coconut + Lesser yam	14475	8925	23820	9345	9960	1035
Coconut + Tapioca	10660	5110	20200	9540	6340	1230
Coconut + Sweet potato	9530	3980	18575	9045	4715	735
Coconut + Ginger	24150	18600	34110	9960	20250	1650
Coconut + Turmeric	23775	18225	33360	9585	19500	1275

IV. All India Co-ordinated Coconut & Arecanut Improvement Project

The performance of Laccadive Ordinary was superior to local Talls in all centres. T × D performance in the initial years was superior to all other cultivars and hybrids in the 'Maidan' tract of Karnataka and Coimbatore and Veppankulam. In arecanut, *Mangala* continued to give higher yields under Coimbatore condition.

For sandy soils of Konkan coast (Maharashtra) a fertiliser dose of 750 : 225 : 900 g N, P_2O_5 and K_2O respectively/ palm/year in two split doses in February and September is recommended. In the sandy soils of Thanjavur tract (Veppankulam) burying coconut husk and leaves in the basins of coconut palms to conserve soil moisture gave higher yields.

Stem injection of Aureofungin-sol 2 g + 1 g copper sulphate in 100 ml of water, thrice in an year, soil drenching with 40 l of 1% Bordeaux mixture thrice a year and application of neem cake (5 kg/palm/year) reduced the intensity of Thanjavur wilt disease.

V. All India Co-ordinated Spices & Cashewnut Improvement Project

1. Cashew

Based on the progeny performance and stability in yield, M-44/3, a selection from Vridhachalam centre has been recommended for clonal/seed propagation.

2. Cardamom

Based on yield and quality of capsule, three selections *viz.*, P_1, P_3, and P_5 were identified for pre-release multiplication at Mudigere. Further, four promising clones *viz.*, CL-664, CL-730, As-1286-37 and NPK 254 were identified for seedling propagation, based on the progeny performance in the comparative yield trial. A fertiliser schedule of 75 : 75 : 150 Kg N, P_2O_5 and K_2O/ha respectively is recommended for cardamom in two split doses. For the control of *azhukal* disease, removal of trash from the basal part of the clump and spraying and drenching with 1% Bordeaux mixture in June and August was found to be effective.

3. Condiments

Two varieties in coriander and two in fenugreek were released. Nine selections in coriander, three in cumin and four in fennel are in the advanced stages of evaluation.

VI. Production of Parental Materials and Breeder's Stock of Different Plantation Crops

The Institute has identified parental materials and breeder's stock with high yield potential in the following plantation crops, based on the selection and hybridisation work carried out at various centres of the Institute, Agricultural Universities and Co-ordinating Centres of two All India Co-ordinated Crop Improvement Projects. Large scale production programme of parental planting materials is in progress at the Institute. Rapid multiplication technique has been developed and standardised for pepper.

Coconut : Talls : High yielding and prepotent W. C. Talls; High yielding E. C. Talls, Benaulim.

Dwarfs : Chowghat Dwarf Orange, Malayan Dwarf Yellow, Malayan Dwarf Orange, Gangabondam.

Arecanut	:	Mangala, VTL–11, VTL–17
Oil palm	:	*Tenera*
Pepper	:	Panniyur–I, Karimunda
Cashew	:	M 44/3, VRI–1, M 6/1, A 18/4, WBDC V, BPP–5, BLA–139–1
Cardamom	:	P1, P3, P5, PV1, PR 107.
Cocoa	:	1/14, 1/56, NC 42/94 and 3/105 for producing hybrids.

VII. Transfer of Technology

Two training courses in spices production technology and six courses in vegetative propagation and production aspects of cashew were organised. Staff of the different coconut seed gardens were trained in the technique of commercial production of coconut hybrids. The Institute staff participated regularly in all the T & V training programmes organised by the Departments of Agriculture of Kerala, Karnataka and Tamil Nadu and also hosted some of these programmes. Field staff of the Departments of Agriculture of the Kerala and Tamil Nadu were trained in the identification of root (wilt) and Tanjavur wilt affected palms respectively. A number of farmers and staff of different organisations were trained in rodent control.

In the operational research project area, fertiliser consumption in terms of NPK increased by 200% as a result of demonstration efforts. The benefit of paddy cum fish culture was so convincing that a number of farmers adopted this technique.

In the Lab to Land programme, the main themes of restructuring the home gardens and mixed cropping and farming system approaches for integrated use of land were demonstrated. Extension leaflets in local language on poultry farming, important diseases of coconut like root (wilt) disease and leaf rot disease; package of practices for plantation crops and congo signal grass cultivation were prepared.

VIII. Support to Development Agencies

The Institute continued to give technical guidance for the establishment of hybrid coconut seed gardens in the states of Kerala, Karnataka, Orissa and Tamil Nadu. Parent materials and breeder's stocks in coconut, arecanut, cashew and cardamom were produced and supplied. The coconut and cardamom nurseries were surveyed for nematode infestation and suitable advice given on its control. Appropriate multi–species cropping models were prepared and made available to the Departments of Agriculture in Andamans, West Bengal, Kerala and Tamil Nadu. A state level research–cum–development co–ordination committee under the Chairmanship of the Minister for Agriculture, Govt. of Kerala and Director, CPCRI as Convenor was organised and the development and research needs of different plantation crops reviewed. On the basis of recommendation of the committee, legislation on the movement of coconut planting materials in Kerala State was enforced. This committee also recommended that a major project for replanting

coconut in Kerala may be prepared. Technical support was also provided to the Cardamom Board, Export Promotion Councils of different crops and Commodity Directorates.

IX. Special Seminars

During the year, the Institute organised a National Seminar on Plant Tissue Culture and also group discussions on Drip Irrigation and Nematode Problems in Plantation Crops.

1. Tissue culture

A National Seminar on Plant Tissue Culture was organised at the Institute during 2–4 March, 1983. The seminar identified areas where tissue culture technology has been developed and available for transfer as well as centres for exploitation. Accordingly, it was pointed out that the technique is already available for cardamom, ginger and turmeric and CPCRI was identified as a centre for large scale multiplication of elite materials in these spice crops. The seminar also identified the priorities and centres for taking up tissue culture research and among plantation crops, coconut, cashew, pepper and nutmeg were identified as crops of immediate relevance wherein basic research is required. The seminar further recommended that basic research leading to an appropriate viable tissue culture technique in coconut and cashew is to be taken up immediately.

2. Drip irrigation

The Institute organised a group meeting on Drip Irrigation at Kasaragod on 23-11-1983. The group pointed out the inadequacy of present allotment of 5000 drip irrigation units/year for the whole country. The group recommended that agricultural financing agencies like NABARD may consider extending the period of repayment of loans advanced to farmers for installation of drip irrigation, particularly in plantation crops. It also pointed out the need for large number of demonstration plots in plantation crops to be raised in farmers' fields to popularise the drip irrigation system. Finally the group also identified areas where research is to be taken up on priority basis *viz.*, the effect of wetting different root zones, the effect of phased shifting of drip points to wider circles and improving the quality of plastic pipes used for the irrigation to increase efficiency.

3. Nematodes

A group meeting of the research and developmental staff of the different agencies connected with plantation crops was organised by the Institute at Kayangulam on 14–9–1983. Some of the important recommendations emerged at the group meeting were :

a) Raising nematode free nurseries in plantation crops particularly in cardamom by taking adequate precautions like methyl bromide fumigation of potting mixture or drenching with 2% formalin and covering for at least 72 hours.

b) Immediate enforcement of necessary quarantine measures by the concerned state governments to prevent the introduction and spread of nematodes.

c) Crop rotation for highly susceptible crops like ginger and tuber crops with tolerant varieties.

d) Survey for plant parasitic nematodes associated with plantation crops.

e) Screening of varieties of all plantation crops and also those crop plants involved in high density cropping systems against root–knot and burrowing nematodes.

f) Large scale demonstration trials of proven technology developed for nematode control.

X. Important Recommendations to Farmers Arising Out of Research Efforts During 1983

Coconut

1. *To increase the setting percentage in Dwarf × Tall crosses, assisted pollination by dusting pollen - talc mixture in 1 : 9 proportion using the pollen dispenser is advisable.*

2. *Elephant - foot - yam as an intercrop in coconut garden is more profitable than other tubers since it gives a net profit of around Rs. 3000/ha/annum.*

3. *i) Regular trapping of rodents with wooden traps in coconut–cocoa cropping system results in marked reduction in damage to both the crops.*

   ii) In coconut stands, keeping Warfarin (0.025%) wax blocks at three months interval reduces the rodent population and the damage caused by them by 92%.

   iii) For effective rodent control, poison baiting or trapping should be carried out on the crowns of coconut rather than at ground level. If the plantations are in the residential area, rat control should be undertaken in both the places to check reinfestation.

4. *One application of heptachlor 1.4 kg ai/ha (28 kg of 5% dust) in June or two applications of BHC at 5 kg ai/ha each (100 kg of 5% dust) in June and September and raking the top 15 cm soil, would give effective control of the root grubs in coconut.*

5. *i) Dichlorvos (0.02%) spray is recommended for the control of black headed coconut caterpillar as a substitute for BHC (0.2%) and trichlorphon (0.06%).*

ii) Spraying of unopened spathes and bunches (except the newly opened inflorescence) with BHC 0.1% or carbaryl 0.05% or endosulfan 0.1% is recommended for the control of coreid bug on coconut.

Arecanut

1. *Application of 150:60:210 g N, P_2O_5 and K_2O/palm/year in two split doses (February - March and September - October) is recommended for* Mangala. *Full dose of phosphorus need be applied in September.*

2. *Digging trenches (60 cm) deep and (30 cm) wide around the 'Anabe' infested areca palms and drenching with 0.3% Captan prevent the spread of the disease. Phytosanitary measures like cutting and burning of dead palms should be followed strictly.*

Cardamom and pepper

1. *A fertiliser schedule of 75:75:150 kg N, P_2O_5 and K_2O/ha is recommended for cardamom in two split doses.*

2. *The primary and secondary cardamom nurseries and soil and potting mixture in pepper nursery may be fumigated with methyl bromide @ 500 g/ Cu. m. under polythene cover for 48 hours against root-knot nematode infestation.*

Oil palm

1. *A fertiliser dose of 1200 g N, 600 g P_2O_5 and 1200 g K_2O/palm/ year in two splits is recommended for oil palm.*

Fisheries

1. *Rice cum fresh water fish culture with Catla and Rohu is recommended for the low-lying paddy fields of S. Kerala where water stagnates for 8 - 10 months. A pond should be dug in one-tenth of the total area, for fishes to get collected during summer.*