अनुसंधान विशेषताएँ

Research Highlights

2008-09

केंद्रीय रोपण फसल अनुसंधान संस्थान

(भारतीय कृषि अनुसंधान परिषद्)

कासरगोड़, केरल - 671 124

CENTRAL PLANTATION CROPS RESEARCH INSTITUTE

(Indian Council of Agricultural Research)

KASARAGOD - 671 124, KERALA, INDIA

CPCRI. 2008. Research Highlights 2008-09
Central Plantation Crops Research Institute
Kasaragod, Kerala, India. 32 p.

Published by

Dr. George V. Thomas
Director
Central Plantation Crops Research Institute
(Indian Council of Agricultural Research)
KASARAGOD - 671 124, KERALA, INDIA
Phone : 04994 – 232893, 232894, 232895 & 232996;
Fax: 04994-232322
E-mail: cpcri@nic.in, directorcpcri@gmail.com
Grams: 'RESEARCH' Kasaragod;
Website: http://www.cpcri.gov.in/

February 2009

Compiled and Edited by

Dr. D.V. Srinivasa Reddy
Mr. H. Muralikrishna

Photo Credits

K. Shyama Prasad
S.N. Mohana Gowda
E.R. Asokan

Hindi Translation

Dr. (Mrs.) Alka Gupta
Smt. K. Sreelatha

Printed at

Niseema Printers
SRM Road, Ernakulam North - 682 018
Phone: 0484 2403760

प्रस्तावना

इस संस्थान की मुख्य फसलें जैसे नारियल, सुपारी एवं कोको के अनुसंधान एवं प्रौद्योगिकी हस्तांतरण कार्यक्रमों पर इस संस्थान द्वारा प्राप्त की गई प्रगति एवं उपलब्धियाँ तथा वर्ष 2008-2009 की अवधि में अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना के परिणामों को सारगर्भित रूप में इस प्रकाशन में प्रस्तुत किया है।

इन दोनों ताड़ों के आनुवांशिक संसाधनों में भारत एक विश्व नेता बनकर जननद्रव्य संग्रहणों में नारियल की संख्या 370 तक, सुपारी की 158 तक और कोको की 230 तक बढ़ायी गयी हैं। इस वर्ष की अवधि में चार नारियल प्रजातियों जैसे कल्प धेनु, कल्प मित्रा, कल्प प्रतिभा और कल्प रक्षा का विमोचन केंद्रीय प्रजातीय विमोचन समिति द्वारा किया गया है तथा इसको भारत के राजपत्र में अधिसूचित भी किया गया है। गोलाकार खोपड़ा उत्पादन के लिए जननद्रव्यों का मूल्यांकन किया गया और आई एन डी 030 एस और आई एन डी 069 एस, कल्प मित्रा और आई एन डी 073 को उचित प्रजातियों के रूप में पहचान लिया गया।

86 माईक्रो सैटलाइट मार्केर्स का उपयोग कर नारियल ताड से अन्य ताड़ तक एस एस आर मार्केर्स का अपर संक्रमणीयता से संबंधित अध्ययन से यह देखा गया कि तेल ताड़, सुपारी, पॉमैरा, और खजूर ताड़ में क्रमशः 36.36%, 29.09%, 18.18% और 12.70% क्रास अैक्सा एम्प्लीकेशन पाया गया। एस एस आर विश्लेषण से उच्च स्तर की युग्मोभयगुणीयता (0.387 - 0.452) तीन नारियल समुदायों में बौनी प्रजाति की तुलना में (0.038 - 0.041) लंबी वासप्ररूप में पाया गया।

समुद्रतटीय बलुआर मृदा में 100% नाईट्रोजन फोसफोरस पोटाश के प्रयोग की अपेक्षा ड्रिप सिंचाई द्वारा उर्वरक का 50% का प्रयोग करने से उच्च नारियल उपयोग क्षमता और उपज प्राप्त किया गया। सुपारी बाग में औषधीय पौध जैसे शतावरी तथा सुरभि वर्ग पौध, पाल्मोरोज़ा आदि उचित अंतर फसल के रूप में पहचान लिया गया। उप हिमालयन उचल भूमि क्षेत्रों के अधीन फसल जैसे कचु प्रजाति, कंद मूल फसल, भिण्डी, बसेला और प्रवास्तुक प्रजाति आदि सुपारी बागों के लिए लाभकारी पहचान लिया गया।

अन्तारोही तथा वायुशिफ पी जी पी आर का कोको पर वृद्धि सुधारक प्रभाव दिखाया गया। नारियल में कम समय सम्बद्ध और यथार्थता के साथ पत्ता वितान क्षेत्रफल की गणना के लिए एक मॉडल का विकास किया गया। वर्तमान पौध संरक्षण विधियों के परिष्कार के रूप में नारियल का कली सड़न रोग के नियंत्रण में 300 मि ली पानी में 5 ग्रा मांकोज़ेब विलेय कर 5 ग्रा का मांकोज़ेब का 2 थैली तर्कु पत्ते का चारों ओर रखने से प्रभावी पाया गया। कोको में चेरेल्लो विल्ट कारक एक नया कीट के रूप में पीला पर्णजीवक को पहचान लिया गया।

नारियल टुकड़ा करने की मशीन और निधाय आयु बढ़ाने के लिए अतिलघु संसाधित मृदु नारियल आदि नारियल में मूल्य वर्द्धन सुकर बनाने में विकसित की गई लघु मशी हैं।

इस वर्ष में प्रभावी विस्तार गतिविधियाँ जैसे प्रशिक्षण, प्रौद्योगिकी विकास में कृषकों की भागीदारी और मुख्य फसलों की रोपाई सामग्रियों का वितरण, उत्पादन एवं प्रसार कर इस संस्थान के मुख्य फसलों को पर्याप्त रूप में प्रोन्नत करने का प्रयास किया गया है। जैविक बागवानी पर एक राष्ट्रीय सम्मेलन इस संस्थान में सफलता पूर्वक आयोजित किया है और बागवानी फसलों में जैविक कृषि के त्वरण के लिए रणनीतियों का रूपांकन किया गया है।

जैविक पहुंच द्वारा नारियल कचड़ा जैवभार का मूल्य वर्द्धन पर फसल उत्पादन टीम का कार्य बागवानी विज्ञान में अंतर अनुशासनिक टीम अनुसंधान उत्कृष्टता के लिए भ कृ अनु प का द्विवार्षिक 2005-06 का पुरस्कार जीतने का सौभाग्य प्राप्त हुआ।

मैं उन सभी का आभारी हूँ जिन्होंने विज्ञान की उन्नति और कृषक समुदाय के हित के लिए महत्वपूर्ण योगदान दिया है।

जी. वी. थॉमस

फ़रवरी, 2009

(जॉर्ज वी थॉमम)
निदेशक

PREFACE

The highlights of achievements and progress made by the Institute on research and transfer of technology programmes in the mandate crops *i.e.*, coconut, arecanut and cocoa and also the glimpses of the achievements of AICRP (Palms) during the year 2008-09 are summarized in this publication.

The germplasm collection have been enhanced to 370 in coconut, 158 in arecanut and 230 in cocoa making India a global leader in the genetic resources of the two palms. During the year, four coconut varieties *viz.*, Kalpa Dhenu, Kalpa Mitra, Kalpa Pratibha and Kalpa Raksha have been released by the Central Variety Release Committee and also notified in the Gazette of India. The evaluation of germplasm for ball copra led to identification of IND030S, IND069S, Kalpa Mitra and IND073 as suitable varieties for ball copra production.

Study relating to cross transferability of SSR markers from coconut to other palms using 86 microsatellite markers revealed cross taxa amplification in oil palm, arecanut, palmyrah and date palm at 36.36 %, 29.09 %, 18.18 % and 12.70 %, respectively. SSR analysis revealed high level of heterozygosity (0.387-0.452) in tall ecotypes compared to that of dwarfs (0.038 - 0.041) in three coconut communities.

In littoral sandy soil, 50 % of recommended NPK applied through drip irrigation recorded higher nutrient use efficiency and yield on par with 100 % NPK. In arecanut, medicinal plant such as asparagus and aromatic plant, palmarosa have been identified as suitable intercrops. Under sub-Himalayan Terai region, crops like colocasia, elephant foot yam, lady's finger, basella and amaranthus were found to be remunerative intercrops for areca garden.

Endophytic and rhizospheric PGPR from cocoa showed marked growth promoting effect on cocoa. A model was developed for calculation of canopy leaf area of coconut with accuracy and less time involvement. As a part of refinement of existing plant protection measures, pouring of 5 g mancozeb dissolved in 300 ml water coupled with placing of 2 nos. of mancozeb sachets (5 g each) around the spindle leaf was found effective in controlling bud rot of coconut. In cocoa, yellow thrips was identified as a new pest causing cherelle wilt.

Coconut slicing machine and the machine to produce minimally processed tender coconut are the new gadgets developed to facilitate value addition in coconut.

During the year, effective extension activities including trainings, farmer participatory approaches in technology development and dissemination, production and distribution of planting materials of mandate crops have been undertaken in order to adequately promote the mandate crops of the Institute. The Institute has successfully organized the National Conference on Organic Horticulture and formulated the strategies for accelerating organic farming in horticulture crops.

The work of crop production team on value addition to coconut waste biomass through biological approaches could fetch ICAR Award for outstanding interdisciplinary team research in horticultural sciences for the biennium 2005-06.

I take this opportunity to congratulate all those involved in delivering these important contributions for the advancement of mandate crops of the Institute and to the benefit of the farming community.

(Dr. George V. Thomas)
Director

February, 2009

Crop Improvement

Utilisation of genetic resources

Four new coconut varieties, Kalpa Dhenu, Kalpa Mitra, Kalpa Pratibha and Kalpa Raksha was released by the Central Variety Release Committee and notified in the Gazette.

A germplasm collection trip was undertaken to Andhra Pradesh and five distinct coconut collections comprising Aromatic Green Dwarf, Yellow Spicata, Orange Spicata, Jonalarasi Tall and East Coast Tall ecotype of Andhra Pradesh were made. Another exploration trip was undertaken in the Western Ghat region of Madikeri in Karnataka for studying cold tolerance in coconut. This region located at an altitude of 936m MSL, experiences a minimum temperature of 5°C and maximum temperature of 31.5°C. Three high yielding palms were identified in the midst of severely cold affected palms for further studies. In another exploration trip, different coconut growing areas in North 24 Parganas district and Bansihari block of Dakshina Dinajpur district of West Bengal were surveyed and superior mother palms were identified.

The study on variation for fruit component traits and oil yield revealed fruit weight, husk percentage and nut yield as important characters influencing coconut oil output per hectare. Among the 71 accessions, including 58 tall accessions and 13 dwarf accessions, copra content ranged from 70.4 g (IND 089S) to 349 g (IND 034S). The accessions, IND 085S (306.9 g) and IND 023S (320.9 g) were found promising for copra content. Among dwarfs, IND 092S recorded copra content of 219.80 g, indicating possibility of exploiting this accession for crop improvement. The oil yield ranged from 0.4 t/ha (IND 089S) to 2.95 t/ha (IND 013S). IND 005S also gave high oil output of 2.94 t/ha. Among the dwarf accessions studied, IND 092S produced 2 t of oil/ha, further highlighting the superiority of this dwarf accession. Variability and association between floral traits and pollen yield has been worked out. Among the 16 accessions studied, IND030S, IND069S, Kalpa Mitra and IND073 were found better suited for ball copra production.

The nut component data on Minicoy coconut population explored during 2007, showed wide variability for most traits studied. The copra content ranged from 3 g in Mini Micro to 329 g in Giant types.

Bedakam ecotype showed more uniform germination and homogeneity for seedling traits as compared to Kuttiadi ecotype. Nut yield was observed to be significantly higher in Kuttiadi ecotype.

Sweet kernel coconut accession collected from Ratnagiri district of Maharashtra was planted in the National Gene Bank for conservation and evaluation.

Aromatic Green Dwarf

Orange Spicata

Jonalarasi Tall

Putative cold tolerant coconut palm

Diversity for coconut nut size and shape in Minicoy

Hybridisation in coconut

A total of 397 seed nuts of S1 progenies (43 WCT, 161 COD, 66 GBGD and 77 MYD) were produced to get S1 coconut seedlings for the production of inbred lines. Analysis of the 10 year yield data and fruit component traits in HET IV revealed IND 058S x IND 069S to be superior with average annual nut yield of 117 nuts/ palm and copra content of 219 g. Regular bearing commenced in the Dwarf x Dwarf hybrids and IND 058S x IND 029S, IND 058S x IND 003S and IND 003S x IND 112S showed early flowering and yield. Flowering commenced in mutant palm progenies.

Breeding for tolerance/ resistance

The putative *in situ* drought tolerant palms continued to show superior performance for yield and morphological traits when compared to the susceptible palms at the same location. Among the dwarf varieties planted at CDB farm Neriamangalam, CGD and MGD continued to show higher level of resistance to root (wilt) disease.

Evaluation of arecanut genetic resources

Survey was undertaken in North Bengal region and collected five distinctive ecotypes of arecanut and hence enhancing the total holding to 158 in the field gene bank at Vittal. Konkan accessions such as Daboli, Tamsula and Kurti recovered high percentage of first quality-processed nuts, when subjected for tendernut processing.

Seventy one accessions are being maintained as an alternate gene bank at RC Mohitnagar. Periodical data is being recorded on the parameters like number of inflorescences. Among the 14 accessions planted during 1988, maximum number of inflorescences (4.5) were produced by VTL-11 followed by VTL-9 (4.37). Of the 8 accessions planted during 1990, maximum number of inflorescences were produced by VTL-2 (18.88) followed by VTL-21 (16.00). Among the accession planted during 1991, VTL-27 produced maximum number of inflorescences (5.4) followed by VTL-26 (4.8). In the accessions planted during 1992, VTL-9 produced maximum number of inflorescences (4.8). Of the 19 accessions planted during 1994, maximum number of inflorescences production (5.2) was recorded in Nalbari followed by K & J Hills (5.0). In the 1997 batch planting, maximum number of inflorescences was produced in CAL-7 (3.9) followed by CAL-33 (3.30) and CAL-5 (3.30)

Dwarfs in arecanut

Production of Hybrids involving Hirehalli dwarf and released varieties/ cultivars continued and a total of 12,780 female flowers were pollinated in four promising combinations. New combinations involving Hirehalli dwarf with Thirthahalli tall and Shriwardhan evolved were being evaluated for yield and tendernut processing.

Cocoa

One cocoa hybrid MCB.C.3 x KKM.22 of Malaysian Cocoa Board, eighteen Trinidad, Ghana and UK clones and a related genera *Herrania nitida* were imported from Reading University, UK. With this the total cocoa germplasm holding enhanced to 230 in the Institute.

Eight year yield data after the yield stabilization compiled for forty four Nigerian cocoa clones showed that the clones NC-37, NC-23, NC-26, NC-50, NC-20, NC-51, NC-27 and NC-25 are heavy bearers with more than 50 pods/ tree/ year and dry bean yield of more than 1 kg/ tree/ year. They are precocious and efficient yielders with optimum canopy spread and recorded with single bean weight of more than 1 gram, 10-15 per cent shelling percentage and more than 50 per cent fat, which made them suitable for industries as well.

The details of cocoa clones and hybrids imported during the year

Accession No.	Clone Name
EC634091	COCA 3348/52
EC634092	CRU 100
EC634093	CRU 156
EC634094	CRIOLLO 22
EC634095	GHANA RED
EC634096	ICS 35
EC634097	ICS 40
EC634100	NA 26
EC634101	NA 670
EC634102	NA 756
EC634103	NA 916
EC634104	PA 70
EC634106	PA 137 (RUQ36)
EC634107	PA 137 (RUQ1081)
EC634108	PA 194
EC634109	PA 279
EC634110	PA 289
EC634111	SIAL 339
EC634112	*Herrania nitida*

BIOTECHNOLOGY

Isolation of genes induced during somatic embryogenesis in coconut

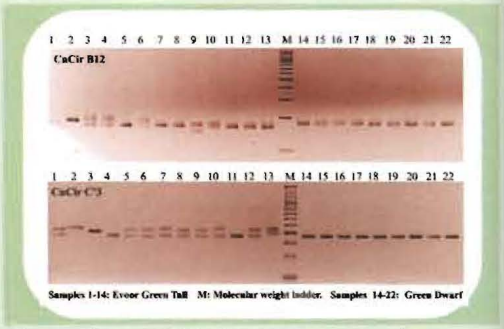
The nucleotide and protein sequences pertaining to genes induced during somatic embryogenesis viz. SERK (somatic embryogenesis receptor kinase) and BBM (BABY BOOM) were retrieved from the NCBI. Nucleotide sequences coding conserved domain amino acid was selected for oligomer designing. These degenerate primers were used to amplify, clone and sequence SERK and BBM genes in coconut.

Cross transferability of SSR markers from coconut to related palms

Study relating to the cross transferability of SSR markers from coconut to other palms, 86 microsatellite markers specific to coconut were screened, out of which, 55 primers gave strong, clear bands of expected size range (100-300bp). These primers were tested for their cross-taxa amplification in oil palm, arecanut, palmyrah and date palm. The percentage of cross-amplification of coconut SSR loci in other palms were 36.36% in oil palm, 29.09% in arecanut, 18.18% in palmyrah and 12.70% in date palm.

Molecular marker based characterization of coconut ecotypes

Simple Sequence Repeat (SSR) analysis was conducted to study the pattern of diversity in 90 selected coconut palms representing six coconut ecotypes (Evoor Green Tall, Evoor Brown Tall, Evoor Brick Red Tall, Jappanan, Green Dwarf and Orange Dwarf) from three coconut communities viz., Pathiyoor and Devikulangara (Alappuzha District) and Thodiyoor (Kollam District) in Kerala State. A total of 61 alleles were detected with an average of 4.35 alleles per SSR locus. The expected heterozygosity was much high in tall ecotypes (0.387-0.452) compared to the dwarf ecotypes (0.038-0.041). The overall degree of genetic differentiation was high (0.471) indicating a high level of genetic differentiation among the populations. Genetic similarity was calculated using UPGMA clustering analysis. Two major clusters were noticed, with tall and dwarf ecotypes clustering separately. Among the talls, 'Jappanan' clustered with 'Evoor Green Tall'.



Electrophoretic pattern of coconut palms using the primers CnCir B12 and C'3

Cloning of map kinase induced during water stress in coconut

Coconut plantlets *in vitro* were subjected to water stress with PEG treatment and RNA was isolated from the leaves. Degenerate primers, designed for amplification of MAP kinase, were used in single-step RT-PCR reactions with the isolated RNA as template. Bands of expected size were eluted, cloned and sequenced. One fragment showed homology to known MAP kinase from other plants.

BIOINFORMATICS

Creation of databases - Phytoplasma database

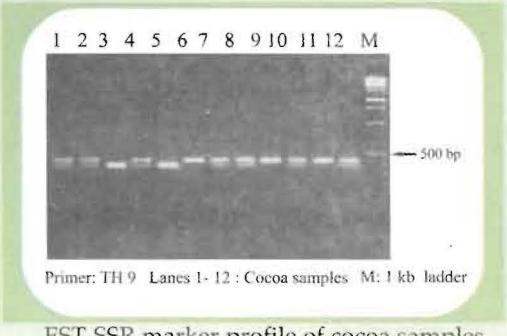
A database was developed incorporating all the available sequences of phytoplasma. The phylogenetic relationships of the sequences were done using multiple sequence alignment tool, ClustalX. The motif regions present in Phytoplasma associated with different phylogenetic groups (16Sr RNA groups) were determined using MEME. Sequence alignment of phytoplasmas revealed the sequences as much similar. Based on the consensus sequences, specific oligonucleotides were designed for the detection of specific phytoplasma using PCR. Database has phylogenetic relationships, motifs and oligonucleotides for its detection of phytoplasma in individual plant family using PCR. Based on the extensive analysis of various sequences, specific primers were designed for the detection of most of the phytoplasmas. The primers are tested in the lab for the detection of phytoplasma and shown to amplify the phytoplasma in coconut and arecanut and are characterized at sequence level.

A molecular database of plant growth promoting rhizobacteria (PGPR) has been developed. Forty PGPR isolates from coconut leaf vermicompost were characterized at the morphological, biochemical and molecular level. The PGPR identification system consists of biochemical and phenotypic identification, sequence level identification, biochemical and phenotypic data retrieval system and sequence retrieval tool. This user-friendly tool was built in PHP back end and HTML front end. The biochemical identification system was written in PHP and 41 tests can be accessed through this programme. A molecular database incorporating the data derived from microsatellite analysis of coconut accessions was also developed. The phytoplasma database was updated with new phytoplasmal sequences. The sequences were analyzed for motifs and signature sequences.

Validation of *in silico* designed EST-SSRs in cocoa

Validation of 11 EST-SSR primers in cocoa, designed using *in silico* tools, was carried out to observe their utility as molecular markers. The ideal annealing temperatures of these primers were deduced using gradient PCR. Out of the 11 primers tested, only nine markers produced amplification and only seven markers produced amplicons of expected size. The seven markers selected were used to screen a representative set of 12 cocoa accessions to test their level of polymorphism detection.

Phytoplasma database in http://bioinfcpcri.org



EST-SSR marker profile of cocoa samples

Crop Production

Fertilization in coconut under coastal sandy soil

Fertigation studies on coconut under coastal sandy soil revealed a significant difference among the different levels of fertilizer treatments. The treatment 100 per cent NPK applied through drip irrigation recorded higher coconut yield (91 nuts/palm/year). However, it was on a par with 50 and 75 per cent NPK applied through drip irrigation and 100 per cent NPK applied through soil. The treatment 100 per cent NPK applied through drip irrigation significantly differed from 25 per cent NPK applied through drip irrigation (72 nuts/palm/year).

Mixed cropping in coconut

Indian long pepper, indigenous to North-eastern and southern India and Sri Lanka, is a powerful stimulant for both the digestive and the respiratory systems and has been shown to have a rejuvenating effect on the lungs. Dried spikes are less aromatic and more acrid. Spikes are widely used in Siddha, Ayurveda and Unani particularly for diseases of the respiratory tract. Roots are used for bronchitis, stomachache and diseases of spleen and tumors.

Field experiment on evaluation of Indian long pepper under different organic treatments *viz.*, vermicompost alone, vermicompost+biofertiliser and vermicompost +vermiwash when grown as mixedcrop in coconut garden revealed that, the number of branches were almost similar in all the organic treatments. The dry spike yield obtained under VC+Vermiwash (123.1 kg/ha during the second year of planting) was higher compared to vermicompost alone (103.8 kg/ha) and VC+Biofertiliser (115.5 kg/ha) treatments.

View of Indian long pepper grown as mixed crop in coconut garden

Intercrops in coconut under coastal littoral sandy soils

Pineapple:

In coastal sandy soil management, pineapple was evaluated as intercrop in the coconut garden by adopting soil moistue conservation methods. The treatments were (T1) one layer dried coconut husk burial in the trenches and planting of pineapple, (T2) coir pith application in the trenches and planting of pineapple and

(T3) control (planting of pineapple with out any soil moisture conservation measures). Pineapple suckers grown under T1 and T2 treatments produced higher fruit yield. Further, the results showed that the husk and coir pith application as amendments had significant influence on fruit size and fruit weight. Higher fruit yield was obtained under husk application (16,241 kg from one hectare of coconut garden) and it was on par with coir pith application and significantly differed from the control treatment

Hybrid Bajra Napier grass CO-3:

The husk/ coir pith incorporation in the soil had significant influence on the fodder yield compared to that of control. The fourth year yield data (2007-2008) revealed that higher green fodder yield was obtained under husk application (74 t/ha/year) and it was on par with coir pith application and significantly differed from the control treatment.

Bhendi as rainfed intercrop:

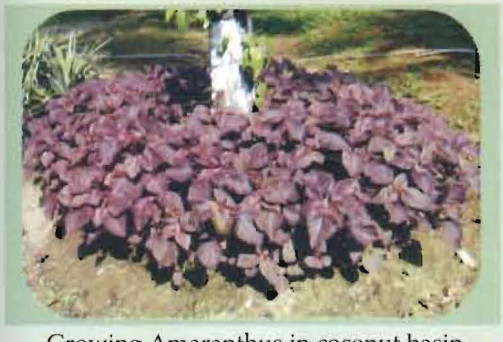
Bhendi was tried as rainfed intercrop with soil moisture conservation measures under coconut garden in coastal sandy soil. Results revealed that soil moisture conservation measures(husk burial/coir pith incorporation) led to higher bhendi yield compared to control (without soil moisture control measures).

Growing of amaranthus in the basin of coconut palms:

Amaranthus, Arun variety was tried as intercrop grown in the basin of coconut palms (1.8 m radius area). The yield ranged between 6 to 7.5 kg/basin (1.8 m radius area).

Impact of intercropping systems:

The impact of intercropping of fodder grass, vegetable and fruits crops in coconut revealed that intercropping of vegetables and pineapple increased the productivity of coconut. Among the different cropping systems tried, coconut + vegetable intercropping system (coconut + pumpkin/ash gourd/amaranthus/bhendi) recorded higher coconut productivity (148 nuts/tree/year) and was significantly superior to other cropping systems.



Growing Amaranthus in coconut basin

Pineapple and hybrid grass intercropping in coconut garden

Evaluation of organic cultivation of coconut in coastal agro-ecosystem

The field experiment on organic cultivation practices on West Coast Tall and D x T coconut palms resulted in significantly higher nut and copra yield in all the organic treatments when compared to control. The organic cultivation treatment, vermicomposting in the basin, application of bio fertilisers and cover cropping in the interspace, recorded higher nut yield (110 nuts/tree/year) for D x T, whereas the treatment, vermicomposting in the trenches, application of bio fertilisers and cover cropping in the basin, recorded higher nut yield (83 nuts/tree/year) in case of WCT variety.

Coconut based farming system for sustainable productivity under coastal ecosystem

The coconut based mixed farming system involving cultivation of fodder grass in the interspaces of coconut gardens and integration of animal enterprises involving dairy, poultry and pisiculture is in progress at CPCRI, Kasaragod. Average of four years of green foliage yield of Bajra Napier hybrid - CO 3 revealed that the fodder yield was significantly higher with the application of 50% NPK through vermicompost and farm yard manure + 50% NPK through chemical fertilizer and was comparable with fully organic treatments and significantly superior to chemical fertilizers alone. The impact of the treatment on soil physical and chemical properties in the coconut based farming system was studied. The results revealed the improved soil fertility status in organic treatments particularly with respect to organic carbon content and available nitrogen status. The improvement in physical properties of soil in the organic treatment was reflected in bulk density, water holding capacity and hydraulic conductivity.

Medicinal and aromatic plants as intercrops in arecanut plantation

Medicinal and aromatic plants *viz.*, asparagus (*Asparagus racemosus*), vetiver (*Vetiveria zizanoides*), long pepper (*Piper longum*), brahmi (*Bacopa monnieri*), *Nilagirianthus ciliatus*, periwinkle (*Catharanthus roseus*), aloe (*Aloe vera*), lemon grass (*Cymbopogon flexuous*), palmarosa (*Cymbopogon martinii*), basil (*Ocimum basilicum*), davana (*Artemisia pallens*) and patchouli (*Pogostemon patchouli*) performed well as intercrops in arecanut plantation, while senna (*Cassia anguistifolia*), safed musli (*Chlorophytum borivillianum*) and geranium (*Pelargonium* sp) did not come up well. Pooled analysis of 3-yr data (2004-2007) revealed that among all medicinal and aromatic plants, Shatavari produced fresh root yield of 10.7 t from one hectare of arecanut garden and contributed maximum kernel equivalent yield of 1524 kg ha^{-1}. *Nilagirianthus ciliatus* produced root yield of 1017 kg ha^{-1} and shoot yield of 7087 kg ha^{-1}, which was equivalent to kernel yield of 1429 kg ha^{-1}. Among aromatic plants, lemon grass, patchouli, davana, palmarosa and basil performed well with respect to kernel equivalent, varying between 398 kg ha^{-1} in case of basil to 1218 kg ha^{-1} in lemon grass. The kernel yield of arecanut was not affected adversely due to intercropping of medicinal and aromatic plants in all years.

Asparagus intercropping in areca garden

Lemongrass intercropping in areca garden

Nutritional disorders in arecanut

Analysis of 300 soil and leaf samples from Shimoga district revealed that availability of phosphorus, potassium and micronutrients was higher than the optimum in arecanut root zone. The analysis of about 150 soil and leaf samples collected from Kasaragod and Dakshina Kannada districts indicated imbalance in nutrient status both in soil and leaf samples. The results also indicated that the nutrient uptake pattern is disturbed in palms, which might be due to antagonistic nutrient interactions.

Management of yellow leaf disease in arecanut

The analysis of soil and leaf samples collected from YLD affected area in Sampaje (Karnataka) indicated very high level of micronutrients and low levels of P and K nutrients. In three plots selected for management trial, the intensity of disease remained same in one garden and reduced slightly in two gardens with improvement in yield after one year of treatment imposition.

INM in arecanut under Sub Himalayan Terai region

An experiment on integrated nutrient management (INM) involving four released varieties (Mangala, Sumangala, Sreemangala and Mohitnagar) and five different fertilizer treatments is in progress since 2007 at RC Mohitnagar. The data on number of inflorescences revealed that maximum number of inflorescences was produced by Mohitnagar (4.15) closely followed by Sumangala (4.18). Among the different fertilizer combinations tried, application of 2/3rd vermicompost and 1/3rd chemical fertilizer led to the production of maximum number of inflorescences.

Intercropping in coconut garden under Sub Himalayan Terai region

A total of five summer vegetables *viz.*, colocasia, elephant foot yam, lady's finger, basella and amaranthus were planted in rainy season under coconut garden as well as in open conditions. Among the crops studied, yield in open condition was more compared to coconut garden. However, the yield of lady's finger and basella was found almost at par in both conditions. During winter season, a total of nine vegetables such as tomato, french bean, raddish, carrot, knolkhol, cauliflower, cabbage, spinach and laffa sag have been successfully cultivated under coconut garden.

RAPD analysis of potassium - solubilizing bacteria from coconut rhizosphere

A total of 46 bacterial isolates showing potassium solubilizing potential were taken up for RAPD analysis. Out of 46 isolates, 17 were isolated from rhizosphere of coconut palms growing in red laterite soil (Manya, Kasaragod) and 29 were isolated from rhizosphere of coconut palms growing in sandy soil (CPCRI Farm, Kasaragod). DNA was isolated from these isolates and RAPD analysis was done. Eight primers of OPA and OPAF series were used for RAPD analysis. All the eight primers exhibited 100% polymorphism. A total of 187 RAPD markers were produced across the 46 bacterial isolates. The isolates showed only 6% similarity amongst themselves.

Molecular analysis of microbial communities in vermicomposts

The terminal random fragment length polymorphisms (T-RFLP) analysis of the microbial community structure (eubacteria, archaebacteria and fungi) present in 4

RAPD marker profile of rhizospheric K-solubilizing bacteria from laterite and sandy soils using the primer OPAF 04

different types of palm litter-based vermicomposts revealed that, all the four vermicomposts had distinctly different microbial community structures. Addition of these vermicomposts to the sandy loam soil greatly influenced the microbial community structure of the soil and their functions for first few weeks after their addition, but at later period, the structure normalized to that of the soil.

Vermicomposted coconut wastes on nutrition and productivity of coconut

To evaluate the effect of substitution of chemical fertilizers by vermicomposted coconut wastes, field experiment is in progress on WCT palms at CPCRI, RS, Vittal with 5 treatments viz. T1: NPK alone, T2: 25% VC + 75% NPK, T3: 50 % VC+50% NPK, T4: 75 % VC + 25 % NPK and T5: 100 % VC alone, replicated four times in RBD. The palms were irrigated with drip system from November onwards and basins were mulched with coconut leaves. During 2007-2008, it was observed that, application of 50 % VC+50% NPK (T3) recorded significantly higher nut yield (58.6 nuts/palm) compared to other treatments. Nut yield obtained with other treatments were on par (ranged from 43.5 nuts/palm to 49.4 nuts/palm).

Antagonistic activity of coconut PGPR

Nine endophytic bacilli from coconut roots and 12 coconut rhizospheric bacilli were found to inhibit both *Thielaviopsis paradoxa* and *Ganoderma* sp. Higher percentage of bacilli showed antagonism against both the fungal pathogens than fluorescent pseudomonads. The PGPR-mediated antagonism was found to be medium-dependent.

Green house studies on endophytic and rhizospheric PGPR from Cocoa

A total of 88 bacterial isolates from cocoa roots and rhizosphere, which performed well under environmental growth chamber conditions, were evaluated for growth promotion under non-sterile soil conditions on cowpea test crop in green house.

Coconut PGPR isolates showing antagonism against Ganoderma sp.

Out of 88, 33 cocoa isolates (7 rhizospheric fluorescent pseudomonads, 16 endophytic bacilli and 10 rhizospheric bacilli) showed increases in all the three parameters i.e., seedling length, fresh weight and dry weight of cowpea seedlings. A rhizospheric fluorescent pseudomonad -KDF 7, isolated from Kidu, showed 12%, 11% and 11% increase in seedling length, fresh weight and dry weight respectively. The same isolate had 100% increase in shoot length of cowpea seedlings in environmental growth chamber assay. Among endophytic bacilli, WEB 6, isolated from Wayanad, showed maximum increase in all the three growth parameters (13%, 38% and 36%, respectively). After seed inoculation with the fluorescent pseudomonads and *Bacillus* spp. in the green house assay, their population showed 3-8 fold increase in the rhizosphere soil of inoculated seedlings compared to uninoculated control.

Soil fertility management for root (wilt) disease affected area under high density multispecies cropping system

A high density multispecies cropping system experiment was conducted during 2004-08 at the Regional Station of Central Plantation Crops Research Institute, Kayamkulam, Kerala on root (wilt) disease affected palms of West Coast Tall variety with various component crops such as nutmeg, banana, pine apple, vegetables and elephant foot yam during different years. The entire field was divided into two parts and coconut palms were applied with 100% recommended dose of fertilizers

(500:300:1000 g NPK/palm/year) and with 50% fertilizers + organic manures as vermicompost produced *in situ* and incorporation of green manure cowpea (*Vigna unguiculata*) raised in the palm basin. All the coconut palms were indexed for the disease during December and May (2005 to 2008). The results indicated that there was an increase of 17% in yield in palms receiving both fertilizers and organic manures compared to 7% increase in palms receiving only fertilizers. Negative correlation existed between yield (2006- 2007) and disease index in the years 2005, 2006 and 2007 and was respectively -0.223, -0.268 and -0.284 ($P < 0.05$). In general, copra content was higher in palms applied with both fertilizers and organic manures and the overall percentage increase was 4.57 over palms applied with fertilizers alone. The results also indicated that through an integrated nutritional management, the health of palms could be improved over the years or maintained without further deterioration, thereby bringing more palms from the disease middle category (2-disease index of 36-50) to category (1) (1-disease index of 21-35) or from category(1) to disease early category(disease index of 0-20).

Increase in height of cowpea seedlings inoculated with fluorescent pseudomonads isolated from cocoa rhizosphere (Kidu) (Left to right- Control, fluorescent pseudomonads - KD7, KD8, KD5, KD4 and KD9)

The overall cost of cultivation of the cropping system for four years (2004-08) was Rs.1,17,405/- per ha with the gross return of Rs.2,10,311/- per ha. Intercropping recorded a share of 36% of the cost of cultivation with 39% of the gross returns. The BC ratio for different years ranged from 1.43 to 2.20 with a mean of 1.79. These results indicated that crop diversification could help the farmers to realize better returns even if the price of one commodity gets reduced in a particular year.

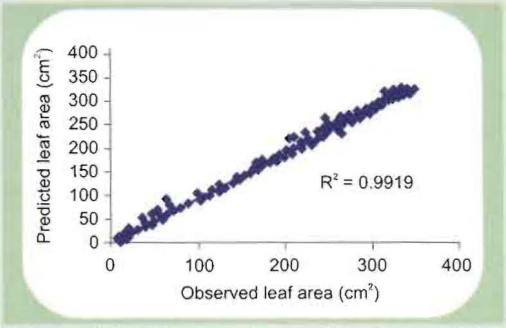
Performance of wilt tolerant pepper lines in areca garden under Sub-Himalayan Terai region

The data recorded on performance of 14 varieties indicated maximum vine length (625.3 cm) in case of P-24 followed by KS-14 (556.1cm). Maximum spike length (9.57 cm) was recorded in the variety Panniyur-I followed by C-1090 (8.96cm). Number of berries per spike was highest (55.65) in P-339 followed by Narayakodi (46.68 numbers). Yield of dry pepper per vine was found to be highest in Karimunda (1418.4 g) followed by KS-14 (1070.8 g). So far no disease incidence has been observed in any of the lines.

Modeling nutrient uptake of coconut for decision support system for input use efficiency

A simulation model to estimate the leaf area of the tall coconut palm (WCT) non-destructively has been developed in two stages. The first stage models were developed to estimate leaf area of individual leaflets and then in the second stage

simulation model was developed to simulate the leaf area of the frond with the leaflet length and the maximum breadth of the middle leaflet and number of leaflets present in the frond as the input data. The number of leaflet in the frond can be counted by Image Processing Lab Version 2.4.0. software using digital photograph of the frond. The developed simulation model predicted leaf area of the leaflets with the R value of 0.99 and RMSE of 11.19 cm^2 while validating with the observed value. The leaf area of the representative of three groups of fronds (flag leaf to 8th frond, 9th to 20th frond and 21st to last frond) of the crown *viz.*, 4th, 14th and last frond can be simulated by using the model and the leaf area of the representative group can be calculated by multiplying with no of fronds in that group. By summing up the leaf area of the three groups in the crown the leaf area of the entire crown can be simulated. The model can predict the canopy leaf area with minimum data requirement which can be collected accurately with less time.



Relationship between observed leaf area of the leaflets and the simulation model predicted leaf area.

Crop Protection

Molecular detection and characterization of phytoplasma of coconut root (wilt) disease from insect vectors

Survey conducted in newly emerging disease tracts of coconut root (wilt) disease *viz.*, Cumbum (Tamil Nadu), Sullia (Karnataka), Mavellai, Kannur district (Kerala), Colachel and Kulasekharam (Tamil Nadu) revealed the occurrence of insect vectors viz., lace bug, *Stephanitis typica* and erect winged plant hopper, *Proutista moesta* in higher population. Acid phosphatase activity, protein content and specific activity were found to be higher in field collected *P. moesta* than those insects that had completed acquisition access and incubation (A+I) period of 30 days. DNA extraction using CTAB buffer was standardized in *P. moesta.*

Integrated management of bud rot disease of coconut

A large scale field trial with treatments including bio-agents was conducted in a disease endemic area in Kasaragod district. Among the treatments, pouring of 5 g mancozeb in 300 ml water coupled with placing of 2 nos. of mancozeb sachets (5 g mancozeb / sachet) in the innermost leaf axils around spindle leaf was found to be very effective in controlling the bud rot disease.

Integrated management of coconut leaf rot disease with special reference to biocontrol and induced systemic resistance

Following the evidences of amelioration of leaf rot disease with biological control agents, *Bacillus subtilis* and *Pseudomonas fluorescens* especially in consortium formulation along with phytosanitation as accrued through field trials, a demonstration trial involving these biological agents and in comparison with treatment of fungicide (Contaf) for management of the disease has been laid out for technology popularization. Utility of various biological control agents through biotreatment of coconut seed nut / seedlings has also been established.

Surveillance and strategic management of emerging disease problems in coconut

Sporadic occurrence of pencil point problem in coconut gardens in Kerala and Tamil Nadu could be recorded and documented, and prevalence of the malady in diverse situations confirmed. Insights into categorization of the pencil point affected palms could be gained through field observation of affected palms and the malady ascribed as a disorder. Various other problems in coconut recorded were a petiole rot disease due to *Anthostomella fusispora*, another malady of dark lesions on lamina-petiole (no pathogenic organism involved), rare incidence of sudden wilt like symptoms among palms, and severe incidence / outbreak of grey leaf blight disease in seedlings due to *Pestalotiopsis palmarum.*

Digestive proteinases of major insect pests of coconut and their interaction with inhibitors

Peptidase activity revealed trypsin-like protease [(BApNA)-hydrolyzing ability] as one of the major luminal proteinases of *Rhynchophorus ferrugineus* as well as *Opisina arenosella*. In both the insects, more than 80% inhibition of peptidase activity was achieved *in vitro* by the addition of aprotinin, a bovine pancreatic trypsin inhibitor.

Refinement of IPM for major pests of coconut

Screening of new molecules against red palm weevil revealed 90-95% recovery of infested palms when treated with Spinosad 2.5% @ 0.013% and Indoxacarb 14.5% @ 0.04%. Shelf life of synthesized RPW pheromone was for more than 15 months when stored at 5°C. Dwarf varieties of coconut were more susceptible to red palm weevil infestation with higher susceptibility in CGD and Gangabondum in the field. Crown pouring of kerosene 150-250 ml per palm could effect total mortality of the residual RPW population in the dead palms.

Surveillance on possible invasive and emerging pests of coconut

Occurrence of spiraling whitefly, *Aleurodicus disperses* and scale insects *viz.*, pink wax scale, *Ceroplastes rubens* Maskell, mussel scale, *Lepidosaphes* sp. and soft scale, *Lecanium* sp. (Coccidae : Hemiptera) were recorded as emerging pests in Minicoy, Lakshadweep islands. Coconut whitefly (*A. areca*) and spiraling whitefly (*A. disperses*) were recorded in mild intensities in various tracts of Kerala, Karnataka and Tamil Nadu.

Entomophaga and Entomopathogens of coconut pests

Demonstration of IPM for *Oryctes rhinoceros* through integrated biocontrol methods showed 36.3% reduction in leaf damage over a period of 8 months. The acaropathogenic fungus *Hirsutella thompsonii* could be isolated from mite affected sample nuts collected from Sullia (Karnataka). The Entomopathogenic nematode, *Heterorhabditis bacteriphora* was found to infect the grubs of RPW in the lab. bioassay using filter paper technique. Entomopathogenic nematode resembling *H. indicus* could be isolated from soil sample from Kayamkulam.

Spiralling white fly *Aleurodicus dispersus*
Inset-spiralling mode of egg laying

Heterorhabditis bacteriophora infected RPW grub
inset: Wriggling EPN

Yellow thrips on cocoa

Yellow thrips, *Scirtothrips* sp is emerging as a new pest on cocoa. These infest the tender leaves, cherelles and pods. Injury on cherelles may lead to cherelle wilt.

Yellow thrips on cocoa

PHYSIOLOGY, BIOCHEMISTRY AND POST HARVEST TECHNOLOGY

PHYSIOLOGY & BIOCHEMISTRY

InfoCrop-coconut model has been developed, calibrated, validated and used to quantify potential yields in different agro climatic zones in India. The model is based on the generic crop model in InfoCrop that simulates various annual crops in tropical and subtropical regions. The InfoCrop-coconut model was calibrated and validated with data compiled from published studies comprising many physiological, agronomical and nutritional experiments conducted between 1978 and 2005 in diverse geographic location throughout India. The treatments included various water and nutrient regimes and varieties of coconut. Time to first flowering varied between 4 and 6 years, leaf production varied from 8 to 15 leaves $year^{-1}$ and nut yield ranged from 3000 to 27,000 nuts ha^{-1} $year^{-1}$. The genetic coefficients used for calibration and validation were generated from field experiments conducted during 1995-2005. Model efficiency and validation performance were analyzed statistically. Simulated trends in phenological development, total dry mass and its partitioning, and nut yield agreed closely with observed values, although a 15% error was observed in a few cases. Considering the fact that field measurements have an experimental error of 10-15% and wide variation existed within treatments, the model adequately simulated the effects of management practices and agro-climatic conditions over short periods. For a range of agro-climatic zones, simulated potential yields varied from 26 to 30 Mg ha^{-1} $year^{-1}$ and potential annual dry mass production varied from 52 to 62 mg ha^{-1}, depending on environment. The observations clearly revealed InfoCrop-coconut can be used to increase the efficiency of agronomic experiments designed to aid coconut crops management.

Principal component analysis of chlorophyll fluorescence transients along with leaf water potential for tolerance to drought stress in Dwarf x Tall coconut seedling combinations revealed a high level of genetic diversity for water stress tolerance in the combinations examined. The cross combinations with LCT as the pollen parent showed better adaptations to water stress condition followed by Fiji tall combinations. Based on the principal component loadings, the chlorophyll fluorescence transients *viz*; F0 and t ½ as well as leaf water potential are important traits which can be used to differentiate and screen coconut seedlings that can adopt to stress condition.

POST HARVEST TECHNOLOGY

Coconut Slicing machine

Sweet coconut chips using sugar/jaggery solution by osmotic dehydration has been developed by CPCRI and many entrepreneurs and self help groups were given training in the preparation of coconut chips. Slicing coconut kernel to produce chips of uniform thickness is the single most important operation in the coconut chips

making process. Presently, this is done manually and the process is very cumbersome and time consuming. Quality of chips, especially uniformity of thickness, depends on the skill of the operator. Inorder to make this operation simple and faster a manually operated coconut slicing machine has been developed. The machine could also be used to slice other products such as banana, potato, tapioca etc.

Minimally processed tender coconut

Transportation of tender coconut could be made easy by reducing its size by dehusking. However, complete removal of husk reduces the shelf life of tender nut to a great extent. To overcome this and to provide the tender nut a uniform and appealing appearance many small scale entrepreneurs started producing the minimally processed tender coconut. Partial dehusking is done manually by a skilled person using a sharp knife. Many tender nut parlours already started selling this product. In order to make the dehusking process simpler and to avoid the risk involved, a minimal processing machine has been fabricated to partially dehusk tender coconut. Using the two cutting blades specially fabricated for this purpose tender coconuts could be dehusked to any required shape.

Coconut slicing machine

Minimally processed tender coconut

Social Sciences

Model Training Course

Model Training Course (MTC) sponsored by Directorate of Extension, Ministry of Agriculture, Govt. of India, for extension personnel on 'Crop Management Technologies for coconut, arecanut and cocoa cultivation' was conducted at CPCRI, Kasaragod during September 23-30, 2008. Extension personnel from Assam, Goa, Kerala, Karnataka and Tamil Nadu participated in the MTC. As a unique part of the MTC, Interface programmes through video conferencing were arranged between the participants at CPCRI Kasaragod and scientists at IIHR Bangalore and CTCRI Trivandrum on topics *viz.*, 'Intercropping of vegetable crops in coconut and arecanut gardens' and 'Intercropping of tuber crops in coconut and arecanut gardens' respectively. Besides, video conferencing was also arranged with officials of Coconut Development Board, at Kochi on development programmes for coconut.

Participants of Model Training Course

Cyber Extension Programmes

Research-Extension-Farmer Interface programmes through video conferencing were conducted under Cyber Extension Project to strengthen the technology transfer efforts of the Institute. Seven programmes were organized during the year involving extension personnel participating in the training programmes at CPCRI, Kasaragod, scientists at IIHR, Bangalore, scientists at CTCRI, Thiruvananthapuram, Officials at CDB, Kochi, farmers and entrepreneurs at CDB

Research-Extension-Farmer Interface programmes facilitated through video conferencing

State Center at Hyderabad and scientists of CPCRI at Kasaragod. The thematic areas covered in the interface programmes include agrotechniques, crop protection and product diversification in coconut, arecanut and cocoa, inter/mixed cropping and mixed farming in coconut and arecanut gardens and schemes for coconut, arecanut and cocoa development implemented by different agencies.

Farmer Participatory Action Research Programme (FPARP)

Central Plantation Crops Research Institute (CPCRI) was selected as one of the Institutes for implementing the Farmer Participatory Action Research Programme (FPARP) sponsored by the Ministry of Water Resources, Government of India. The 'FPARP on soil and water conservation and water harvesting in the west coast region of Kerala' is being implemented in 20 selected villages in Kasaragod District of Kerala state. Participatory analysis of field situation in respect of moisture conservation and water harvesting in farmers' plots was done. The technologies demonstrated in farmers' plots during the year under the project include soil and water conservation measures such as mulching coconut basins with dried leaves, coir pith etc. in 38 gardens, coconut husk burial in the interspaces of coconut/ arecanut in 26 gardens, half-moon bund around coconut basin reinforced with pineapple in 41 gardens, trench filled with coconut husk in 20 gardens, catch pits with pineapple border in 23 gardens and cover crops as green manure and to reduce soil erosion in seven gardens and low cost water harvesting structures *viz.*, roof water harvesting in storage tanks using ferro-cement technology and recharging wells in five gardens each. Farmers who visited the demonstration plots have shown keen interest to adopt the technologies. Awareness programmes on the importance of water conservation were organized for farmers at Bedadka and Periya, two of the project locations, in collaboration with local gramapanchayats and Department of Agriculture.

Demonstration plot under FPARP on trench filled with coconut husk

Inauguration of roof water harvesting storage tank using ferro-cement technology under FPARP

Shri K.V.Kunhiraman, M.L.A. inaugurating Farmers Training Programme under FPARP at Bedadka

Forecasting of coconut production

Production forecasting of coconut in the country for the year 2008-09 was made available during October 2008 as a part of the project sponsored by Coconut Development Board, Kochi. Results indicated a reduction in yield in most of the districts in Kerala, while increased yield in the districts of Tamil Nadu. Loss of palms due to bud rot disease was very high in Kannur, Kozhikode, Trichur, Kasaragod and Malappuram districts during the year 2007 (on an average 4 to 8.5 palms/ha). Considerable number of palms were lost due to red palm weevil infestation in Alappuzha and Kollam districts as well with an average loss of 6.82 and 3.06 palms/ha in the year 2007.

Institute web site

Structure and pages of CPCRI website www.cpcri.ernet.in. were modified with new information. This new website has three themes. One is mandate crops details and cultivation practice for farmer point of view. Second one is details about commercial technologies for entrepreneurs. Third one is highlighting the Division-wise research activities of the Institute. About this institute, training details, video conferencing activities, consultancy details, ATIC, RTI, tenders and opportunities were also provided in this website.

Crop production model for decision support system in arecanut

Semiparametric regression technique is proposed to study the input-response relationship in arecanut based on the field survey data collected from Kasaragod district. In this approach, both qualitative (discrete) and quantitative (continuous) input variables can be included in the crop production model. The analysis of quantitative variables such as N, P and K indicated that the estimated optimum levels of N, P and K per palm in the study area are 100 g, 50 g and 120 g respectively, which are very close to the recommended doses. The yield differences in arecanut under monocrop and mixed cropping systems were not significant and therefore it is better to maintain arecanut gardens under mixed cropping system for enhanced returns.

Coconut based micro enterprises among rural women

Participatory programmes were organised among rural women in Thekkekara panchayath in Alleppey district, Kerala State. The initial survey, field visits and interaction programmes among the women farming community indicated scope for group based micro entrepreneurship in coconut product diversification, backyard poultry, intercropping banana/vegetables/tapioca in coconut gardens, oyster mushroom cultivation and beekeeping. Ten self help groups were formed and activities started. They were given trainings and follow up sessions in the respective areas.

Gender dimensions of training need in coconut cultivation

Training need analysis was done among 120 coconut farmers (60 men and 60 women farmers) of Thekkekara panchayath of Mavelikkara block in Alleppey

district. The highest training need was recorded in integrated management of coconut pests by men farmers followed by organic cultivation practices and integrated disease management, whereas the women farmers recorded highest training need in the subject matter area of intercropping in coconut gardens followed by identification of nutritional deficiencies and post harvest technologies. The data indicates that the training needs of men and women farmers in coconut cultivation varies and while designing training programmes these factors could be taken into consideration for improving the effectiveness and utility of training programme. The correlation of training need score of farmers with the socio economic variables indicated positive and significant relation with time spent and involvement in farming, both in the case of men and women farmers.

IFAD funded project

The project coconut genetic resources for sustainable livelihoods in India was funded by IFAD/COGENT. Community Based Organizations (CBOs) served as ideal vehicle for carrying out the project interventions in the project sites. In three project areas, CBOs were established with 75-100 active members. Microcredits @ Rs.1, 41,500/-, Rs.1, 40,000/- and Rs.1,30,000/- were disbursed to Pathiyoor, Thodiyoor and Devikulangara CBOs respectively and enrolled members were supported through appropriate technologies, village level equipments, training and capacity building and access to markets. Effective linkages were established with other agencies for technological support, input supply and credit facilities. The micro credits were mainly utilized for intercropping, nursery establishment, livestock rearing and local cattle feed production, production of high value products, mushroom production and azolla cultivation by more than 90% of the members.

Almost all members participated in one or more of the project interventions, with more than 90% of them utilizing micro credit for implementation. Majority of them (42%) utilized the micro credit for livestock integration, followed by intercropping (36%) and production of high value products (10%).

The capacity development efforts coupled with other support mechanisms could boost the adoption of interventions. A total of 1761 participants were trained in various fields through 57 training programmes, of which 72% were women. Forty eight per cent of the CBO members acquired special skills related to farming and of this 22% of them have been utilizing it.

The project revealed significant impact in the project areas. The income from coconut increased by 50% and the area under intercrops doubled over the pre-project period.

Other conspicuous benefits to be pointed out are the organized marketing attempt at the community level and food and nutritional security of the family members, preferably children. Significant change was recorded in the poverty status before and after the project, in terms of the number of holdings below the poverty threshold

level, which reduced from 95 to 56%. Highest reduction in poverty incidence was recorded in Pathiyoor CBO (48%), followed by Devikulangara (36%) and Thodiyoor (34%). Regarding food security, there was an increase in the completely secure category from 67-96%, whereas in the nutritional security, it was from 8 - 72% after the project period. The totally insecure category was completely wiped off. The coping mechanisms to improve the food and nutritional security revealed backyard / homestead gardening (87%), livestock / fish / poultry rearing (64%) and food processing (85%) as the important means followed by the CBO members.

Training Programmes for farmers

- Twenty farmers from Srivilliputtur along with Deputy Director of Agriculture were oriented to the latest coconut technologies on 11-03-08.
- Twenty farmers from Virudhunagar along with Agricultural Officer were oriented to the latest coconut technologies on 25-03-08.
- One day training was organized to 121 farmers of Krishnapuram Farmers Club on 16-05-08 in collaboration with Syndicate Bank and NABARD.
- A batch of 44 farmers under the Attappady Hill Area Development Society (AHADS) was trained on Coconut Based Farming Systems on 21-05-08.
- Off-campus training was given for 52 farmers at Chavara in collaboration with Krishi Bhavan on Scientific Management of Coconut Gardens on 01-09-08.
- One day trainings were given to two batches of 47 farmers under the CDB coconut clusters of Bharanickavu Panchayat on Scientific Management of Coconut on 2nd and 5th of December, 2008.
- A batch of 32 farmers from AHADS, Attappady was given one day training on recent advances in coconut cultivation on 11-12-08.
- Demonstration on Integrated Management of Root (wilt) Disease of Coconut: Selected 7 ha. area with 47 stakeholders in Cheppad Panchayat of Alappuzha district for the demonstrations. A detailed base line survey on the number of palms in the different disease categories and all other information like farmer characteristics, yield data and other pests and disease incidence was conducted.
- The scientists of Regional Station, Kayamkulam participated in the district level interface programmes at Pathanamthitta, Alappuzha and Kottayam.

Production of planting material

About 72,144 seed nuts and 17,846 hybrid coconuts were produced. This year hybrid seed production in coconut was doubled when compared to previous year. In arecanut, 1,82,929 seed nuts and 1,02,091 cocoa grafts were produced. Nearly 31,609 coconut seed nuts and 16,417 coconut seedlings were sold. In arecanut,

1,82,920 seed nuts and 24,320 seedlings were sold. About 38,000 cocoa grafts were also sold during the year.

Supply of bioresources to end users

1,65,000 *Eudrilus* sp. earthworms, 22 tonnes of coconut leaf vermicompost, 100 kg of *Pleurotus* sp. mushroom spawn and 27 kg of fresh mushrooms (*Pleurotus* sp.) were produced and sold to farmers, women entrepreneurs and self employed youth during the year.

KRISHI VIGYAN KENDRAS

Krishi Vigyan Kendra, Kasaragod

Training programmes

Organized a total of 99 training courses on various aspects of agriculture and allied enterprises wherein trained 2,628 participants (673 men and 1955 women) comprising farmers, farm women, rural youth, extension personnel and others. Out of these courses, 37 were on-campus and 62 were off-campus with the participation of 890 (277 men and 613 women) and 1738 (396 men and 1342 women) trainees, respectively. Further, conducted 6 vocational training programmes on the topics *viz.*, Vegetable cultivation, Nutrimix, Food processing, Food catering management, Management of coconut bio-waste and Fruits and vegetables processing wherein trained 101 personnel (11 men and 90 women). Apart from these courses, 15 sponsored training programmes were organized wherein 660 (489 men and 171 women) participants have been benefitted.

Front line demonstrations

Organized a total of 99 demonstrations in the farmers fields and successfully introduced the high yielding varieties of various crops as well as production technologies *viz.*, Tissue culture banana as intercrop in coconut gardens, Fodder grass and pineapple as intercrop in coconut gardens in coastal sandy soils, Management of inflorescence die-back in arecanut, Cocoa as intercrop in coconut and arecanut gardens, Management of budrot disease in coconut, *In-situ* green manuring of coconut using grain cowpea, Hybrid napier (CO-3) in palm based mixed farming, Introduction of high yielding varieties of coconut and Introduction of low cost modified aluminium cooker among WSHGs.

On-farm testing of technologies

(a) Effectiveness of vermiwash against leaf spot of amaranthus: An experiment was conducted in eight farmers fields at Mogral and Kudlu villages of Mogral Puttur Panchayath on effectiveness of vermicompost and vermiwash against leaf spot of amaranthus. It was laid out with six treatments *viz.*, T1 - sparying of vermiwash @ 1:5, T2 - sparying of vermiwash @ 1:10, T3 - drenching of vermiwash @ 1:5, T4 - drenching of vermiwash @ 1:10, T5 - spraying of mancozeb (Dithane M-45) @ 3g/lit and T6 - farmers practice (control). Results indicated that no incidence of leaf spot was found in all vermiwash as well as fungicide treatments. Where as the crop was severly affected with leaf spot disease in control treatment. Further, farmers opined that the vegetative growth was better in vermiwash treatments as compared to mancozeb treatment. Thus, it clearly indicate that the sparying of vermiwash could effectively prevent the occurence of leaf spot disease in amaranthus.

Amaranthus grown with vermiwash treatment (left) and without treatment (right)

(b) Evaluation of high yielding varieties of sweet potato as mono crop in Kasaragod district : Generally farmers are growing local type (Kanhangad local) in sweet potato growing areas in Kanhangad block of Kasaragod district. Hence, an experiment was taken up with high yielding varieties of sweet potato namely, Sree Arun, Sree Varun, Sree Badra and local variety to find out its performance for increasing income of the sweet potato growers. Results indicated that Sree Badra gave highest yield of 18.3 t/ha and found superior to other varieties in the area.

Field growth and tuber yield of high yielding variety of sweet potato Sree Badra

(c) Evaluation of high yielding varieties of tapioca as crop rotation in rice fallows: Rice cultivation is being uneconomical due to high labour wages and other socio economic factors. Farmers generally cultivate only Kharif crop and the rest of the seasons the paddy field is left fallow. Due to high cost of cultivation and market fluctuation, growing vegetables in the paddy field during rabi and summer is found to be less remunerative. In this direction, KVK had conducted an OFT on "Evaluation of high yielding short duration varieties of Tapioca as crop rotation in rice fallows" at Perumbala

Farmers with a bumper production of Tapioca

village. In this trial, three short duration varieties *viz.* Sree Prabha, Sree Jaya and Sree Vijaya were evaluated. Results indicated that Sree Jaya gave highest yield (36.2 t/ha) followed by Sree Vijaya (31.3 t/ha.) and Sree Prabha (23.8 t/ha.). Net return obtained was Rs.15970 - 90370 / hectare. Through this study, the cultivation of short duration varieties of Tapioca as crop rotation in rice fallows was found to be highly remunerative.

Womens' Cell activities

A total of 38 training courses were conducted on various topics *viz.*, Coconut products, Food processing, Food preservation, Jasmine cultivation, Paper bag making, Mushroom processing, Nutritional security among mother and child, Fruit preservation, Nutrimix, Cashew apple preservation, Nutrition education to women, Nutrition garden, Processing of grapes, Pineapple preservation, Masala powder preparation, Balanced diet through fruits and vegetables, Balanced diet for adolescents, Cashew apple preservation, etc. under Womens Cell of KVK and trained 737 women participants of various categories. Out of which, 10 were on-campus and 18 were off-campus training programmes with 220 and 517 participants, respectively.

Extension activities/ services : A total of 1360 activities comprising of field days, kisan gosthi, kisan melas, exhibitions, film show/video CD, advisory services, agricultural seminars, farmers visit to KVK, awareness campaigns, field visits, demonstrations, etc. were conducted, where in 12618 farmers (8575 men and 4043 women) and 893 extension personnel (514 men and 379 women) were appraised of modern production technologies of various crops and allied enterprises. Further, faculty participated in seven radio talks, published three popular articles and 13 activities covered in news papers/TV.

Krishi Vigyan Kendra, Alleppey

Trainings

KVK Allepey conducted 170 trainings on various subjects in which 4513 farmers/ rural youths/students were participated as detailed below:

Trainings	No. of batches	Participants Men	Women	Total
On Campus	52	410	788	1198
Off Campus	79	802	1487	2289
Total	**131**	**1212**	**2275**	**3487**
Vocational trainings	07	24	132	156
Sponsored trainings	32	686	184	870

Gender wise analysis showed that 65.24% of the participants were farm women in these trainings. Vocational trainings on various enterprises like coconut product

diversification, scientific mushroom cultivation, goat rearing, bee keeping, layer chick rearing were organized for seven batches in which a total of 156 rural youths were participated. Apart from these programmes, KVK also conducted training programmes sponsored by different government agencies such as Dept. of Agriculture, Dept. of Fisheries, NGOs, DBT, etc. A total of twenty four sponsored training programmes were conducted during the period for 870 participants.

On farm trials (OFT)

A total of seven technologies were assessed through 53 on farm trials with farmer participation.

Frontline demonstrations (FLDs)

A total of nine technologies were demonstrated in 102 demonstrations comprising of 28 ha in the district.

Supply of Quality inputs to farmers

Produced / procured quality seed/planting materials, mushroom spawn, ME traps, azolla, layer/broiler chicks, fodder grass cuttings, fresh vegetables/fruits etc are distributed to farming community for increased adoption. KVK distributed seeds/ planting materials of improved varieties of vegetables, spices, plantation crops, fodder grass, ornamental plants, medicinal plants, azolla, and ME traps, earth worms, mushroom spawn, bio agents, layer breed chicks etc. valued Rs. 47136/- to 4993 farmers during the reporting period.

Participatory Rural Appraisal (PRA)

Problems identification, prioritization and training need analysis were done through PRA at Cheriyanad, Chunakkara, Chennithala and Thekkekara panchayaths.

Other extension services

A total of four field days in connection with Front Line Demonstrations, Film shows (25 no.)on various topics such as poultry rearing, bee keeping, vegetable seed production, clean milk production etc. were conducted benefitting more than 475 farmers. Sixteen seminars on different topics were organized during the period for 1256 participants. Five radio talks including agri quiz to school students were broadcasted. Diagnostic visits to farmers plots was (179 no.) carried out to solve farm problems in various parts of the district.

Publications

A technical report on on-farm testing for location specific farm oriented technologies a technical bulletin on Krishi Vigyan Kendra, Alleppey - Activities and Achievements, extension literatures - Hand book on banana cultivation, Profitable self employment through rabbit rearing, Small holders copra dryer, Preparation of virgin coconut oil, Coconut water products, Krishi Vigyan Kendra, Alleppey as well as extension pamphlets on FFS in paddy, Value added products of paddy, and Bio-agents in plant protection of rice were published.

Success stories

Farming sector/ enterprise	Name	Production	Average Income (Rs.)
Vegetable farming under IPDM system	Sivadasan Pillai Anjali, Chunakkara	Seasonal vegetables Amaranthus, cowpea Snake gourd, Bitter gourd	3,000/- per month
Mushroom cultivation	Swadija, Bindu, Nisha, Veerantharayil valanja nadakkavu	Oyster mushroom and milky mushroom	5000/- per month
Bee keeping	Georgekuuty, Jose Vihar, Pallickal	Honey-5-7kg/hive Bee colonies / combs	150/3 combs Rs. 5000-7000 from honey
Banana Vegetable, tuber intercropping	Gramajyothi SHG, Karuvatta	Banana 150 nos. Cucumber, bhindi, amaranthus	150-300/ per day
Coconut vinegar	Girija, Chaithram, Chunakkara North Sreekala,	300litres of coconut	4500/- per month
Quail rearing	Kunnathu, Kochumuri, Krishnapuram	600 quail per batch	Rs.7000/- 8000 /- per month

All India Coordinated Research Project on Palms

The All India Coordinated Research Project on Palms was started in 1972, is being implemented in 16 centres including its headquarters at Kasaragod (Kerala); Aliyarnagar, Aduthurai, Killikulam, Veppankulam (Tamil Nadu); Arsikere, Gangavathi (Karnataka); Ambajipeta, Pandirimamidi, Vijayarai (Andhra Pradesh); Bhubaneshwar (Orissa); Kahikuchi (Assam); Mondouri (West Bengal); Jagadalpur (Chhatisgarh); Ratnagiri and Mulde (Maharashtra). Out of the 16 centres, 10 centres are conducting research on coconut, four on oil palm and two on palmyrah.

Establishment of new Centres under AICRP on Palms

Approval has been received for the establishment of four new Centres under AICRP on Palms during the XIth Five Year Plan Period. The Centres at Navsari (Gujarat) and Sabour (Bihar) are meant for the identification of region specific coconut varieties and coconut crop management technologies. The two Centres at Madhopur (Bihar) and Pasighat (Arunachal Pradesh) would initiate trials on oil palm during the year 2009 for the identification of region specific technologies for Eastern and North-East regions of the country.

Major highlights of research findings in the three mandate crops under AICRP (Palms) are presented here:

Coconut

Approval of the Central Varietal Release Committee has been received for the large-scale promotion of four new coconut varieties, *viz.*, Kalpa Dhenu, Kalpa Pratibha, Kalpa Mitra and Kalpa Raksha.

Among the 11 tall genotypes evaluated at Veppankulam Centre in east-coast region of Tamil Nadu, Andaman Ordinary recorded the highest annual nut yield of 114.0 nuts/ palm followed by ECT (Marungapallam ecotype) with 103.8 nuts/palm. The annual yield ranged from 36.5 to 114.0 nuts/palm. Andaman Ordinary also recorded the highest cumulative mean yield of 78.2 nuts/palm/year followed by Andaman Giant Tall (74.9 nuts/palm/year).

Collection of a new set of local germplasm of coconut in Assam has been initiated at the Kahikuchi Centre to collect the germplasm in areas not covered in the previous collection programme. Six new local germplasm types of coconut were collected from Nowgaon, Marigaon, Mangaldoi and Kamrup districts of Assam and seed nuts of these collections were sown in the nursery.

Similarly, ten local types of germplasm from different districts of West Bengal were identified and field survey for other local types is in progress. The superior five types of germplasm have been planted in the main field from the nursery bed

in RBD maintaining 7.5 x 7.5 m spacing. Another 5 types collected from different districts in West Bengal State were planted in a row trial.

In the coconut hybrid evaluation trial planted in 1985 at Ambajipeta in Andhra Pradesh, highest copra content was registered in the cross combination GBGD x PHOT (24.77 kg/palm/year) followed by GBGD x LCOT (22.76 kg/palm/year) and GBGD x Fiji Tall (21.88 kg/palm/year) respectively as compared to 19.90 kg/palm/year in the check i.e., ECT x GBGD.

The experiment on the nutritional requirement of hybrid coconut was laid out at Arsikere Centre In Karnataka State during 1987 to assess the performance of D x T palms (COD x WCT) under graded levels of NPK. Considering the nut yield, net returns and B:C ratio, it was inferred that the fertilizer level of 500:250:1000 g N, P_2O_5, K_2O per palm per year is optimum for higher nut production for hybrid coconut in the maidan tract of Karnataka.

Among the coconut based cropping system models, involving medicinal and aromatic plants as intercrops in coconut gardens, tried at Kahikuchi Centre in Assam State, the crop combination of patchouli with coconut recorded the highest net return of Rs. 65,914 ha and benefit cost ratio of 1.21, while treatment with madhushaleng + coconut gave the lowest net return (Rs. 22,566 /ha) and benefit cost ratio of 0.46.

The integrated Nutrient Management trial at Arsikere Centre in Karnataka State indicated that the raw coir pith can be made into compost of good manurial value by using ligno-cellulolytic fungus, *Pleurotus sojarcaju* and used as a source of nutrients to coconut. The composted coir pith (CCP) can be applied to coconut palm to supplement 50%-100% of the recommended dose of N (about 25-50 kg CCP).

Survey on the occurrence of root (wilt) disease of coconut was conducted in Theni, Tirunelveli, Kanyakumari and Coimbatore districts of Tamil Nadu. In Theni District, an average root (wilt) disease incidence of 21.2%, 31.3% and 33.6% respectively was observed in three villages. In Tirunelveli District, root (wilt) disease was observed in ten villages.

Field experiments on the control of stem bleeding disease in coconut indicated that *Trichoderma* spp was effective against stem bleeding disease. Of different treatments, the maximum decrease in bleeding (exudation) patch (perimeter) was obtained when *T. harzianum* was applied as a paste on the bleeding patch coupled with basal application of the same bioagent (50g) in combination with 5 kg neem cake (10.6 cm decrease), followed by *T.viride* (9.8 cm decrease) and *T. hamatum* (8.3 cm decrease) when applied as a smearing paste in combination with soil treatment (50g) by mixing in 5 kg neem cake.

Oil Palm

Evaluation on the performance of *tenera* hybrid combinations of oil palm in different agro-climatic regions, since 1991, could result in the identification of an high yielding hybrid 124D x 266P yielding 24.06 tonnes FFB/ ha at Mulde Centre in

Maharashtra State. Similarly, the hybrid 115D x 291P is performing well both at Vijayarai Centre in Andhra Pradesh State and Mulde Centre in Maharashtra State. The hybrid is yielding 13.80 tonnes FFB/ha at Vijayarai Centre and 20.32 tonnes FFB/ha at Mulde Centre.

Studies on the nutritional requirements of oil palm at Aduthrai Centre in Tamil Nadu State indicated that fertilizer application had positive response in increasing the FFB yield. Application of fertilizer @ 1200:600:2700 g NPK / palm/ year recorded significantly superior FFB yield of 14.17 t/ha/year and the increase was 58 per cent over the control. Application of 800:400:1800 and 400:200:900 g NPK/ palm/year also increased FFB yield to the tune of 38 and 15 per cent over control (no fertilizer).

Palmyrah

Under the AICRP on Palms, palmyrah germplasm, representing the variability available in the crop in different regions of the country, are being collected and maintained at the two palmyrah Centres. At present, 187 types are maintained at Killikulam Centre (Tamil Nadu) while 176 accessions are maintained at Pandirimamidi Centre (Andhra Pradesh).

Survey carried out for palmyrah tuber rot disease in Rajanagaram Mandal in Andhra Pradesh indicated that the disease incidence ranged from 2.0 to 17.0 per cent. Survey at Nidadavolu and Chagallu Mandals of West Godavari district in Andhra Pradesh revealed that the incidence of tuber rot ranged from 0.5 to 3.0 per cent.

Leaf blight disease in palmyrah was observed in South Tamil Nadu region with the PDI ranging from 3.00 to 37.00. Leaf spot disease was observed with PDI ranging from 6.00 to 25.30.

In order to meet the immediate research needs of the millions of palmyrah farmers and farm workers, approval has been received to initiate research programmes for evolving new value addition technologies in palmyrah that offers vast scope for improving income, employment opportunities as well as large scale private investment.