अनुसंधान विशेषताएँ
RESEARCH HIGHLIGHTS
2011-12

केन्द्रीय रोपण फसल अनुसंधान संस्थान
(भारतीय कृषि अनुसंधान परिषद्)
कासरगोड़, केरल - 671124, भारत

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

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भाकृअनुप
ICAR

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(भारतीय कृषि अनुसंधान परिषद्)

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CPCRI

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KASARAGOD - 671 124, KERALA, INDIA

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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 2011-2012 की अवधि में अखिल भारतीय ताड़ अनुसंधान परियोजना के परिणामों को सारगर्भित रूप में इस प्रकाशन में प्रस्तुत किया है।

इस संस्थान द्वारा विकसित की तीन प्रजातियों, कल्पसमृद्धि, कल्पसंकरा और कल्पप्रतिभा के विमोचन और अधिसूचना के लिए केंद्रीय प्रजातीय विमोचन समिति ने अनुमोदन किया है। अनुसंधान और एकमात्र परीक्षण के संरक्षण के लिए एकमात्र नारियल वासप्ररूप को पहचानकर केरल में जननद्रव्य पर्यवेक्षण किया गया था। वर्तमान संग्रहणों के मूल्यांकन से कृषि के लिए तीन प्रजातियों जैसे आई एन डी 045 एस और आई एन डी 058 एस और सुपारि में वी टी एल 62 और वीटी एल 75 और कोको में दो वी टी एल सी - 1 और वी टी एल सी - 57 को पहचान लिया गया।

प्रशीत परिरक्षण अध्ययन में यह देखा गया कि नारियल पराग की अंकुरण क्षमता और वर्द्धन बनाए रखकर चार वर्ष तक उसका भण्डारण किया जा सकता है। ऑटोडॉक सर्वर का उपयोग कर नारियल तनू भ्रूणनिर्माण ग्राही के सजातीयता आधारित मॉडलिंग जैसे काइनेज़ (एस इ आर के) प्रोटिन नारियल एस इ आर के प्रोटिन के साथ होमो ब्रासिनोलिड को अनुकूलन परिस्थिति है। संपूर्ण प्रपित्रैक में माईक्रोसैटालाइट के गुणावगुणन और पहचान के लिए एम ए पी एस, जावा आधारित जैवसूचना सॉफ्टवेयर का विकास किया गया है। कोको में जैव संश्लेषण मार्ग को समझने के लिए जैव सूचना साधनों का उपयोग किया गया।

विभिन्न परिस्थितियों के अधीन फसलन पद्धति अनुसंधान द्वारा उच्च उत्पादन क्षमता और लाभदायकता पर एक अवलोकन प्रदान किया जाता है। उत्पादन क्षमता बनाए रखने के लिए जड़ मुर्झा रोग के लिए प्रचलित क्षेत्रों के अधीन नारियल बाग का प्रबंधन और पीला पत्ता रोग क्षेत्र के अधीन सुपारी में एक चुनौती है।

तमिलनाडु के कोलच्चल क्षेत्र में जड़ मुर्झा रोग प्रभावित नारियल बाग से संग्रहीत मृदा के नमूनों का संग्रहण किया गया। स्वस्थ नारियल पेड़ के बाग की तुलना में जैविक कार्बन मात्रा, संरध्रता और पादप नाईट्रोजन मात्रा (ऊपरी तल को छोड़कर) कम पायी गयी। यह रोगबाधित ताडों की उत्पादन क्षमता सुधारने में मृदा स्वास्थ्य की प्रमुखता दिखाते है।

नारियल राईज़ोस्पियर परीक्षण का उपयोग कर एन्टरोबाक्टर क्लोएसिए आर एन एफ, 267 स्यूडोमोनस प्लेकोग्लोस्सिसिडा Kn SF 227 और पी-पुटिडाबायोटाइव B HSF132 पहचान लिया गया, पृथक्करण किया गया। और बायोलोग सूक्ष्समाणुवीय पहचान पद्धित द्वारा पुष्टि की गई और 16 SrRNA जीन विश्लेषण द्वारा मान्य किया गया।

वायनाड, उडुपी, और कोयम्बत्तूर में कली सड़न कारक नारियल व्याधिजन पी, निकोटियाने के रूप में पहचान लिया गया। नारियल और कोको में फाइटोफ्थोरा पर प्रशन सेरोसेरा मृदु मन्थर पहचान लिया गया था और यह इस रोग के संक्रामण में प्रसारक के रूप में इस मृदु मन्थर के योगदान पर अध्ययन किया जा रहा है। गन्ना घास प्ररोह, नारियल जड़ मुर्झा, और 16 SrXI समूह के नेपियर घास वृद्धि रोध फाइटोप्लाज़्मा के सदृश पीला पत्ता रोग फाइटोप्लाज़्मा रहा। नारियल के लाल ताड़ घुन को पकड़ने में नानोमट्रिक्स भरित फेरोमोन ट्राप प्रभावी पाया गया। उत्थित ताप और 700 पी पी एम के उत्थित कारबन डायऑक्साइड गाढता के अधीन कोको और नारियल में सूखा की सुग्रहिता बढ जाता है। कटाई उपरांत प्रौद्योगिकी में कृषि कचड़ा ज्वलित वेरजिन नारियल तेल कुकर, गोल खोपड़ा बनाने के लिए सौर टनेल ड्रायर, नारियल पेड पर चढ़ने के लिए सुरक्षित साधन, नारियल मूल्य वर्द्धित उपजों की तैयारि के लिए नयाचार का विकास किया गया है।

सामाजिक विज्ञान अनुभाग द्वारा विस्तार कार्यक्रम और दो कृषि विज्ञान केंद्र की ओर से संस्थान से उपयोगकर्ताओं को प्रौद्योगिकी हस्तांतरण का प्रोत्साहन दिया जाता है। उद्देश्य के लिए अभिमुख कार्यक्रम, प्रदर्शनियाँ, विशेष प्रदर्शन या निरूपण, प्रक्षेत्र परीक्षण, साईबर विस्तार, रेडियो और दूररसंचार कार्यक्रम, प्रकाशन आदि प्रभावी उपायों का उपयोग किया गया है।

अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना, कासरगोड़ की द्विवार्षिक समूह बैठक केंद्रीय रोपण फसल अनुसंधान संस्थान, कासरगोड़ में 15 से 17 अकुतूबर, 2011 तक आयोजित की गई।

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

जी. वी. थॉमस

(डॉ जॉर्ज वी थॉमस)
निदेशक

4 फरवरी 2012

PREFACE

A glimpse of the achievements and progress made by the Institute on the research and transfer of technology programmes of the institute in the mandate crops and under AICRP (Palms) during the year 2011-12 is presented in this publication.

The Central Variety Release Committee has approved for notification and release of three coconut varieties developed by the Institute, Kalpa Samrudhi, Kalpa Sankara and Kalpasree. Germplasm explorations were conducted in Kerala for identifying unique coconut ecotypes for research and conservation of specific traits. Evaluation of existing collections resulted in identification of three selections in coconut for cultivation, *viz*., IND 048S, IND 045S, and IND 058S; two in arecanut viz., VTL 62 and VTL 75 and two in cocoa *viz*., VTLC-1 and VTLC-57.

In cryopreservation studies, it was found that coconut pollen could be stored up to four years maintaining germinability and vigour. Homology–based modeling of a coconut somatic embryogenesis receptor-like kinase (SERK) protein using AutoDock server revealed best docking orientation with homobrassinolide. MAPS, a java based bioinformatics software for identification and characterisation of microsatellites in entire genome has been developed. Bioinformatic tools were utilised to understand biosynthetic pathways in cocoa.

Cropping systems research provided further insight on higher productivity and profitability under different situations. Management of the coconut garden under root (wilt) disease prevalent tracts and arecanut under yellow leaf disease areas remain a challenge for maintaining productivity. The soil sample collected from root (wilt) affected coconut garden in Colachal area of Tamil Nadu had lesser organic carbon (except in the top layer), porosity and plant nitrogen content compared to gardens with healthy coconut palms, highlighting the importance of soil health management in improving productivity of diseased palms.

Microbiological studies in coconut rhizosphere, have resulted in isolation of potent phosphate solubilizers identified as *Enterobacter cloacae* RNF 267, *Pseudomonas plecoglossicida* KnSF 227 and *P. putida* Biotype B HSF 132 using conventional biochemical tests and BIOLOG microbial identification system.

Coconut bud rot causing pathogen in Wyanad, Udupi and Coimbatore was identified as *P. nicotianae*. *Derosera* slugs feeding on Phytophthora were identified in coconut and cocoa and the possible role of this slug as vector in transmission of this disease is being studied. The YLD phytoplasma resembled the sugarcane grassy shoot, coconut root (wilt) and napier grass stunt phytoplasma of 16SrXI group. Nanomatrix loaded pheromone trap was found to be effective in trapping red palm weevil of coconut.

Under elevated temperature and elevated carbon dioxide concentrations of 700 ppm, sensitivity to drought increases in coconut and cocoa. In post harvest technology front, an agricultural waste fired virgin coconut oil cooker, solar tunnel dryer for ball copra preparation, safety device for coconut palm climbing device as well as protocol for preparation of coconut value added products have been developed.

Extension programmes through Social Science Division as well as the two KVKs are providing a boost to technology transfer from the Institute to end users. Interface programmes, exhibitions, frontline demonstrations, on farm trials, cyber extension, radio and TV programmes and publications are the effective tools utilised for this purpose.

Biennial Group Meeting of All India Coordinated Research Project on Palms held at CPCRI, Kasaragod during 15-17 October, 2011, reviewed the progress and formulated the programmes for the next two years.

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

(Dr. George V. Thomas)
Director

4th February, 2012.

CROP IMPROVEMENT

Inheritance of horned trait in coconut

The horned coconut, a freak type, was collected from natural indigenous coconut populations of the country and conserved in the National Coconut Gene Bank. Evaluation of this accession has revealed that the trait is inherited to the next generation. The palms commenced flowering about 6 to 8 years after planting. Observation revealed that over 60 % of open pollinated progenies exhibited this trait. In the fruit bunches of these coconut palms, one of the ovaries located in the centre develops into a complete fruit with husk, shell, endosperm and embryo surrounded with multiple rudimentary ovarian structures. The unique heritable trait could be useful in studying the segregation pattern in coconut using it as a marker trait. This type could also be useful for ornamental purposes.

Enriching germplasm with unique traits

Horned coconuts were also identified in a farmer's garden in Kerala and seed nuts were collected for conservation. The number of horns varied from one to three, within the bunch. The horn-like appendage comprised mainly of fibrous tissue (husk) and the central fruit had normal husk, shell and endosperm.

Horned coconut accession conserved at the National Genebank

Horned coconut collected from Kerala

Southern districts of Kerala were explored and four coconut ecotypes with good quality fibre better suited for coir industry, the mainstay of coastal districts of Kerala, were identified. Puvar ecotype is long-fruited, with longer fibres (>30cm) and has one and a half times more fibre than other types. Edawa Oblong and Edawa Round ecotypes bear large fruits with good endosperm content and yield long fibres. Kappil ecotype is large fruited with higher copra (200-250g) and oil content (70 %).

Edawa Oblong ecotype of coconut

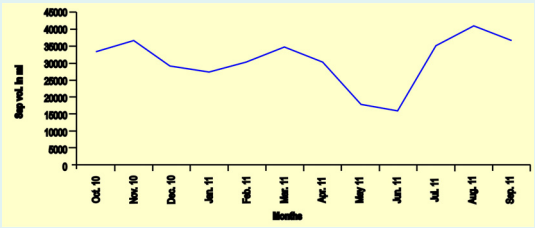
Edawa round ecotype of coconut

Puvar ecotype of coconut

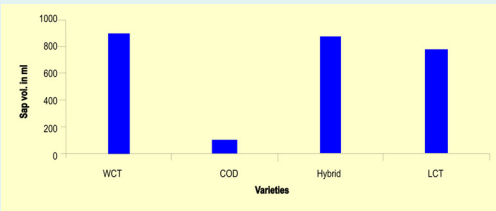
Kappil ecotype of coconut

Inflorescence sap production in coconut

A study on inflorescence sap production in coconut varieties *viz.* WCT, LCT, COD and Chandra Sankara (COD X WCT), indicated varietal difference for quantity of daily sap production. Highest production was recorded in WCT followed Chandra Sankara, LCT and COD, respectively. Average production per palm also showed seasonal variation, with lesser production in winter followed by an increase in post winter period before again showing reduction in summer months followed by increase in monsoon period. Further in WCT palms, sap production was observed to be comparatively higher in irrigated palms (811 ml) than in rain fed palms (459 ml). Sap collected during monsoon season showed no appreciable difference in total sugar content between irrigated and rain fed palms of WCT. However, reducing sugar and protein was more in sap of WCT under irrigation. Total sugar, reducing sugar and protein in inflorescence sap during monsoon season were more in WCT, followed by Chandra Sankara and LCT.



Seasonal variation in sap production



Varietal difference in sap production

Germplasm conservation and evaluation

A comparative evaluation trial of 17 dwarf accessions of coconut was laid out at Kasaragod during the current year to assess their performance for development of improved dwarf varieties. Further, to augument seed production in dwarf varieties, blocks of released/ promising dwarf varieties were planted at Kasaragod during September 2011.

In the coconut germplasm evaluation trials, accessions *viz.* IND045, IND001S, IND085S, IND013S, IND086S, IND027S, IND026S, IND071S, IND038S, IND002S, IND004S, IND059S, IND 042S, IND034S, IND031S were identified as promising for higher yield. In National Gene bank in Kidu, IND205 and IND215 appeared promising, with early flowering and high yield.

Around 3600 female flowers were pollinated in selected coconut accessions for production of seed nuts for experimental planting, germplasm conservation and gap filling in the field gene bank. Further, 617 *inter se* seed nuts of different accessions were sown for generation of planting material for experimental planting. From CARI, Andamans, 432 seed nuts of Pacific Ocean coconut accessions were received for generation of planting material for germplasm conservation.

Studies on floral biology in COD x WCT, ECT, WCT, and two of local tall coconut palms at Mohitnagar indicated overlapping of male and female phases for all the coconut palms for all the months. The inflorescence emerged during winter month (October-January) took maximum time to open. The inflorescence emerging during winter month also took maximum time for maturity. Fruit setting was less during winter and rainy season, indicating that low temperature and rain had negative effect on pollination and fruit setting in this region for these varieties/ hybrid.

In the alternate gene bank at Mohitnagar, a separate block of Nalbari variety of arecanut has been established with 335 *inter se* seedlings. *Inter se* seedlings of 18 NE accessions collected from Mohitnagar have been planted in the germplasm block at Kahikuchi during September 2011. Two more compact blocks of Shriwardhan and Mohitnagar planted with 250 and 200 *inter se* seedlings, respectively at Vittal. Eight dwarf hybrids developed using promising germplasm lines along with their parents have been planted at Vittal. Growth characters recorded in four dwarf hybrids planted in YLD endemic area showed no symptoms of disease for the past two years.

Varieties identified for release

Coconut

Three coconut varieties, IND 045S, IND 048S, IND 058S, respectively were identified from the Institute for release for commercial cultivation in the country. Variety release proposals of these three varieties were recommended for release in the XX Biennial Group Meeting of AICRP on Palms held during October 2011.

Variety IND058S of coconut

IND 058S: This dwarf variety with yellow fruits gives higher nut yield both at CPCRI Kasaragod (114 nuts/palm/year) and CPCRI RC Kidu. The tender nut water is organoleptically good with TSS-5.9 Brix and total sugars - 6.2g/100ml. Hence, the variety is proposed for release as a dwarf tender nut variety in the states of Kerala and Karnataka. The estimated copra yield is 16.24 kg/palm/year, which is 138% higher than the yield of the local control (COD).

IND 048S: This is a superior dwarf variety with orange fruits proposed for release considering its higher nut yield both at CPCRI Kasaragod (123 nuts/palm/year) and AICRPP Coconut Research Station, Arsikere (Karnataka) and Aliyarnagar (Tamil Nadu), coupled with good quality (TSS - 6.2 Brix, total sugars - 6.7 g/100 ml) of tender nut water. This variety is proposed for release as a dwarf tender nut variety for commercial cultivation in the states of Kerala, Karnataka and Tamil Nadu. The estimated copra yield is 23 kg/ palm/year, which is 149% higher than the yield of the local control (COD).

Variety IND048S of coconut

IND 045S: This variety is a superior tall selection proposed for release considering its superiority for nut and copra yield both at CPCRI Kasaragod and CPCRI RC Kidu and coupled with good quality (TSS-

Variety IND045S of coconut

5.85, total sugars – 4.55 g/100ml) and quantity of tender nut water (438 ml). The variety is proposed for release as a dual purpose variety, for copra as well as tender nut purpose, for commercial cultivation in the states of Kerala and Karnataka. The variety was observed to be having very less incidence of eriophyid mite infestation (8.87%), in comparison to 60.07% in the local control (WCT) under field conditions. This variety gives an average nut yield of 118 nuts/palm/year under rainfed conditions, The estimated copra yield is 25.54 kg / palm/year, which is 54.36% higher than the copra yield of the local control.

Arecanut

Two arecanut varieties viz., VTL 62 (Shriwardhan selection) and VTL-7 (Nalbari) have been recommended for release for commercial cultivation in the XX Biennial meeting of AICRP on Palms held during October 2011 at Kasaragod.

VTL 62 (Shriwardhan selection)

The yield performance of VTL 62 is higher than the earlier released varieties and suitable for both tendernut and ripe nut processing. The variety produces superior quality of nuts with marble appearance of the split nut, which fetches higher price in the market.

Variety VTL 62 of arecanut

The variety possesses high yielding nature, medium tall palms, regular bearing habit, orange to yellow colour, oval and round shaped nuts, high recovery (25.90%) of dry kernel from fresh nuts, higher content of polysaccharides and polyphenols, medium maturity group, comes to bearing by 4th year. The average yield is 3.54 kg dry kernel/palm/year and about 4500-5000 kg dry kernel/ ha/ year and 2.95 kg dry tender processed nuts/palm/year and about 3800-4500 kg dry tender processed kernel / ha/ year. The economic yield can be realized up to 30-40 years depending upon the management. The variety is recommended for commercial cultivation in Karnataka and Konkan region.

Variety VTL 75 of arecanut

VTL 75 (Nalbari)

The yield performance of VTL 75 is higher as compared to earlier released varieties and found suitable for ripe nut processing. The variety with tall type is a regular bearer, consistent in yield, round shaped yellow colour nuts, high recovery (25.18 %) of dry kernel from fresh nuts, comes to bearing by 5th year and economic yield can be realized up to 40-45 years. The average yield is 4.15 kg dry kernel / palm/ year and 5600 kg dry kernel/ha/year. The variety is recommended for release for Karnataka, North Bengal and NE region.

Cocoa

Two selections of cocoa based on their vigour, early, stable, high yielding potential, ability to withstand stress and performance under CPCRI, RS, Vittal, Karnataka and Kannara, Kerala were recommended for release as national varieties during AICRPP workshop.

VTLC 1

A selection from VTLC-1, this variety yields an average of 55 smooth red pods/ tree/ year at the age of 12 years as clones with medium canopy, both under Arecanut and Coconut as well as in farmer's gardens. Pods are of 360 g weight with 41 beans. With single bean dry weight of 1.13 grams this clone recorded a yield potential of 2.52 kg/ tree/ year and the yield/ha is 1700 kg. This is suitable for chocolate industry as well, with a shelling percentage of 11% and 52% fat content.

Variety VTLC 1 of cocoa

Variety VTLC 57 of cocoa

VTLC 57

A selection from VTLC-57, this variety produces an average of 54.5 green pods/ tree/ year with medium canopy. Pods are of 400 g weight with 41 beans. Beans are very bold and big with 1.21 g dry weight, 15% shell and 53% fat content. The yield recorded is 2.70 kg/ tree/ year and the yield/ ha is 1840 kg.

Breeding for high yield

The hybrid variety "Kalpa Samrudhi", a cross between IND058S x IND 069S, has been released by Central Sub Committee on Crop Standards, Notification and Release of Varieties. The variety is recommended for commercial cultivation in Kerala and Assam. In different hybrid evaluation trials, hybrids *viz*., COD x WAT, COD x LCT, COD x ADOT, MYD x TPT, LCT x COD, PHOT x GBGD, CGD x PHOT, CGD x LCT, LCT x CGD, CRD x WCT, MYD x CGD, COD x GBGD, MYD x NLGD were observed to show better performance for growth, flowering and bunch production. The hybrid PHOT x GBGD recorded higher copra. Nut analysis revealed the superiority of the hybrid MYD x TPT for copra yield. Tender nut studies conducted in hybrids MYD x Kenya Tall and MYD x TPT compared with COD showed that the hybrids are also suitable for tender nut purpose.

Around 4700 female flowers were pollinated for production of seed nuts of new Dwarf x Tall combinations involving promising dwarf accessions as female parents and Klapawangi, San Ramon, Cochin China and Philippines Lono as male parents for experimental planting and about 1130 seed nuts of different hybrids were produced and sown in nursery.

Breeding for resistance/ tolerance to coconut root (wilt) disease

Survey was carried out in Niranam and Kottayam areas and 20 CGD mother palms with bolder nuts were selected for the breeding programme. Observations on root (wilt) disease recorded two years after planting indicate that MOD and hybrids involving MYD are more susceptible to the disease, while the performance of MGD, CGD x MGD and MGD x WCT was encouraging.

Studies on seed storage

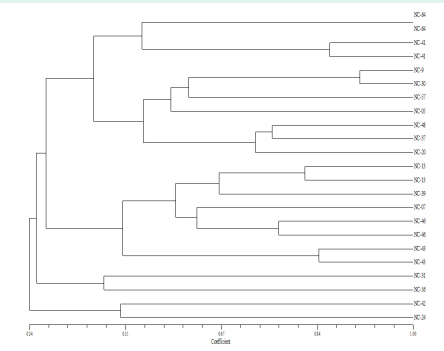
A study on germination in CGD variety of coconut, indicated that nuts stored in sand and saw dust for 15 days recorded more than 80% germination. The reduction in nut weight upon storage, even after 60 days, was comparatively less under sand and saw dust curing (10-12%), in comparison to 30-40% reduction in nut weight under normal storage. Studies on biochemical and physiological changes in coconut kernel (changes in total sugars, reducing sugars, total protein, oil content, amino acids, activities of amylase, invertase, lipase, protease and esterase) during storage indicated stability of enzyme activities upto 45 days of storage. Hence, sand and saw dust curing are good for prolonging storage without affecting germination.

Studies on vivipary

Observations on 10, 11 and 12 month old nuts during Oct-Nov revealed that the percentage of vivipary was highest in 12 month old nuts (MYD- 38%, MOD-30%, CGD-17%, MGD 10% and WCT-7%). However, the percentage of vivipary was comparatively less during Dec-Jan period which points out that vivipary is controlled by the prevailing weather conditions.

Pollination biology

Observations with regard to the insect fauna associated with coconut inflorescence on CGD and WCT revealed that insect diversity was higher during male phase and bees (*Apis cerana indica*, *Apis dorsata*, and *Trigona iridipennis*) were the predominant insects. However, in CGD the population of ants (different red and black ants) and the small pollen weevil (*Amorphoidea coimbatorensis*) were more and significant.



UPGMA Dendrogram for cocoa

Cocoa molecular characterization

DNA extraction protocol for cocoa using fully expanded but soft leaves was standardized with modified SDS method and 18 Nigerian cocoa accessions were studied with SSR markers. A total of 50 alleles were detected using 11 microsatellite primers with an average of 4.5 alleles per primer. DICE's coefficient showed maximum similarity between the clones NC-9 and NC-30 (0.91) and minimum (0.14) between NC-37 and NC-13. UPGMA dendrogram grouped the cocoa accessions into two major clusters.

Planting material production

A total of 90,000 seed nuts/ of coconut varieties/hybrids were produced and 43,000 seednuts were sold to farmers/ developmental agencies. In addition, 26,053 coconut seedlings including 10,524 hybrid seedlings were sold. About 4,21,244 areca seednuts were produced, 3,38,499 seed nuts of arecanut and 78,603 seedlings were sold. In cocoa, 57,901 seedlings/ grafts and17,618 cocoa seed pods were produced and sold to farmers, state developmental departments, CAMPCO and CADBURY. Another set of 50,000 cocoa seedlings were also raised. About 17,000 rooted seedlings of black pepper, 3,000 rooted air layers of cinnamom, 3,000 rooted cuttings of acid lime and 3,000 air layers of bay leaf were also produced for sale to farmers.

BIOTECHNOLOGY

Effect of different periods of pollen storage in liquid nitrogen on germinabitity and vigour

Pollen collected from WCT and COD palms during 2007 did not show any adverse effect of storage duration (4 years) on pollen germination and pollen tube growth. Pollen of both WCT and COD cultivars retained its viability and fertility even after a storage period of 4 years in liquid nitrogen.

Plant vitrification solution for coconut zygotic embryos

The composition of original plant vitrification solution (50% each of sucrose and glycerin) was modified by altering the ratio of sucrose and glycerin at 3 levels *viz.* 45% sucrose : 40% Glycerin; 40% sucrose : 45% glycerin and 40% sucrose : 40% glycerin. The preliminary results showed that PVS3 containing 45% sucrose and 40% glycerin performed better (56%) than other PVS3 solutions for germination.

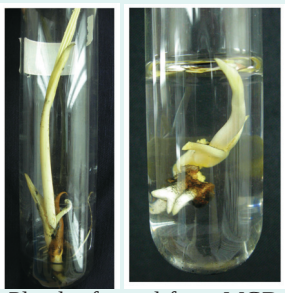
Arecanut tissue culture

Normal flowering and nut set was observed in tissue culture raised arecanut palms of the variety Sumangala.

Coconut plumule culture

A total of 18 somatic embryos were obtained from plumular calli in WCT. Palm to palm variation was observed for *in vitro* regeneration and palms for collection of explants for rapid somatic embryogenesis were identified. Incorporation of brassinosteriods (0.1 µM) in the initial plumule culture media was found to be effective for conversion of embryogenic calli to shoot conversion. Incorporation of 5 mg/l glutamine in the regeneration medium resulted in healthy normal shoot conversion. Plantlet were obtained from the plumular tissues of *inter se* mated MGD nuts from CDB farm at Neriamangalam.

Somatic embryo regeneration in response to brassinosteroid in WCT cultures

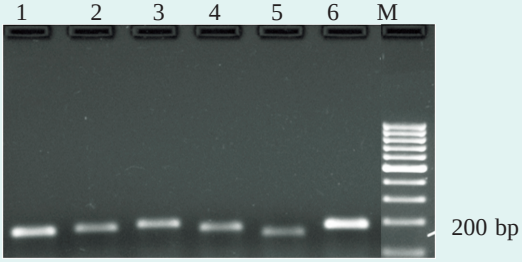


Plantlet formed from MGD *inter-se* nuts

Molecular aspects of somatic embryogenesis in coconut

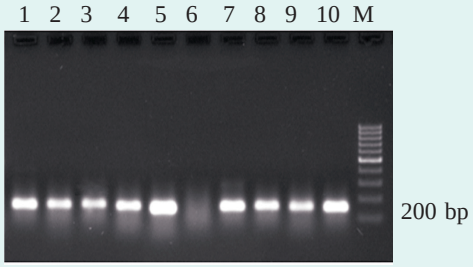
RNA isolation procedure was standardized from different types of callus *viz.* embryogenic, non-embryogenic, rhizogenic and nodular calli. Primers were designed for 11 housekeeping genes (*actin, rbcL, 18S rRNA, translation elongation factor, á-tubulin, elongation factor, alcohol dehydrogenase, cyclophilin, glyceraldehyde 3-phosphate dehydrogenase, ubiquitin* and *eukaryotic initiation factor*), genes known to be induced during somatic embryogenesis (*Leafy cotyledon, Agamous-like gene, Glutathione-S- transferase, Wuschel, Pickle, Germin-like proteins* and *Embryogenic Cell Protein*)

and transcription factors (*NAC, MAPK, WRKY, AP2,* and *CBF*). Reverse transcriptase-PCR (RT-PCR) was also carried out and amplicons of expected sizes were obtained. They were cloned and sequenced and positive sequences were identified.



Expression profiles of transcription factors analyzed by RT-PCR

Lanes: 1:NAC, 2:MAPK, 3:WRKY, 4:AP2, 5:CBF, 6:14-3-3, M: 100 bp ladder



Expression profiles of housekeeping genes analyzed by RT-PCR

Lanes:1: translation elongation factor; 2: elongation factor; 3: actin; 4: cyclophilin; 5: 18S rRNA; 6: glyceraldehyde 3-phosphate dehydrogenase; 7:GPD; 8: ubiquitin; 9:rbcL; 10. alcohol dehydrogenase; M: 100 bp ladder

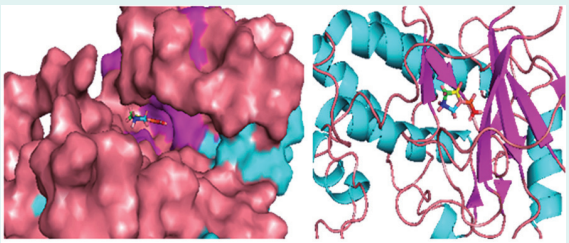
Molecular characterization of Annur and Bedakam ecotypes of coconut

Annur, Bedakam ecotypes (17 palms each) and West Coast Tall (WCT) cultivar (16 palms) were characterized using 30 SSR primers. The palms of Annur ecotype clustered at 70 % similarity, the palms of Bedakam at 58% and those of WCT at 61% similarity. Maximum similarity was observed between WCT and Annur palms, while the least similarity was between Annur and Bedakam ecotypes. Analysis of molecular variance (AMOVA) indicated that there was 68% variation within the population, while the variation between population was 32%.

BIOINFORMATICS

In silico studies on genes induced during somatic embryogenesis in coconut

Homology–based modeling of a coconut somatic embryogenesis receptor-like kinase (SERK) protein was carried out. 3-D model for coconut SERK was constructed using structure neighbours of the protein in MODELLER. The best model selected based on overall stereo-chemical quality (PROCHECK, PROSA, GROMACS) and minimum energy was used for active site characterization in Surface Racer Program. Twenty three ligands were docked with the target SERK protein using AutoDock server. Homobrassinolide gave the best docking orientation with coconut SERK protein.



Docked conformation of the polyvinylpolypyrrolidone (stick representation) in the binding site of SERK protein (surface representation)

Development of an algorithm for prediction of promoters in bacteria

The PROMIT tool developed for the Windows platform identifies promoters in the -10 and -35 regions of sequences from the *Pseudomonas* spp. Promoters were predicted using both SVM and HMM based approaches.

Microsatellite repeats localization in sequences of palms and annotation

Microsatellite repeats in sequences of coconut (390), arecanut (22), oil palm (41374) and date palm (250107) were mined and 38,083 microsatellites were localized. These repeats occurred at a frequency of 2.04 (coconut), 0.7 (arecanut), 0.22 (oil palm), 3.5 (date palm genome) and 0.62 (other palms) per kb of sequences. Protein coding potential prediction was performed, and majority of the sequences matched with gene of known function such as ribosomal proteins, ubiquitin conjugating enzyme, transcription factors and thus we have predicted and characterized.

The annotation of date palm SSR containing sequences were performed using the configured blast program and 33410 *Arabidopsis thaliana* gene models from TIGR were compared against the date palm SSR containing sequences. From 525214 annotated protein hits generated, 5174 protein regions were found to be spanning in <1kb portion of nearby SSR region. Apart from higher number of hypothetical/unknown proteins, cytochrome P protein was found to occur predominantly.

Development of a tool for detection of microsatellites in whole genome sequences

MAPS (Microsatellite Analysis and Prediction Software), a bio-Java based independent; stand alone platform was designed to allow the identification and characterization of microsatellites in entire genomes. The program can perform readings on FASTA, multi-FASTA files as well as GenBank files.

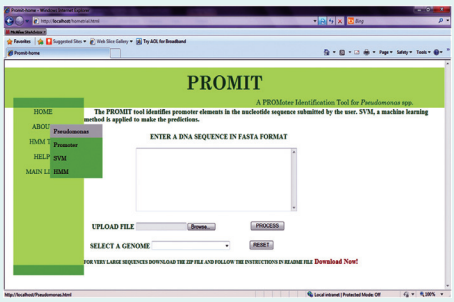
Genome-wide analysis of microsatellites in PGPR

Genomes of three plant growth promoting rhizobacterial strains of *Pseudomonas fluorescens viz.* Pf-5, Pf0-1 and SBW25 were analyzed for the distribution and abundance of microsatellite tracts. The percentage of microsatellite repeats found in *Pseudomonas fluorescens* Pf-5, Pf0-1 and SBW25 were 1.66, 1.67 and 1.88, respectively. In general, poly (C/G) tracts were more abundant than poly (A/T) sequences. The genomes show scarcity of long microsatellites. With respect to plant growth promotion, genes coding for TonB-dependent outer membrane receptor proteins, Acyl CoA dehyrogenase family protein, fecA-like outer membrane receptor, ACC-deaminase, D-cysteine desulfhydrase family protein, pyocin R2 PP, tail formation protein and 2,4- diacetylphloroglucinol biosynthesis were found to be rich in SSRs.

Bioinformatics applications for cocoa

Four libraries of cocoa ESTs derived from *Phytophthora megakarya* infected cocoa leaf and pod tissues were analysed and 6379 redundant sequences were retrieved and processed.Totally 272 enzymes corresponding to 114 metabolic pathways were identified.

Annotation of Carotenoid biosynthesis pathway genes in cocoa genome was done. The stand alone blast database was developed for comparative analysis using 25,912 cocoa genome short gun sequence retrieved from Genbank database.



Screenshot of PROMIT

Screenshot of MAPS

CROP PRODUCTION

Impact of intercropping on root proliferation of coconut under coastal sandy soil

In the coastal sandy soil, root studies indicated more number of new roots in the interspaces (22 m^2 area) with intercropping (85) compared to monocropping area (49), implying better absorption of water and nutrients in the system. Similarly in the interspaces, more proliferation of roots were observed in the shallow layer (12 cm depth onwards) with intercropping as compared to monocropping where root proliferation was observed from 30 cm depth onwards.

Root distribution in the intercropped area (more number of fresh roots seen)

Root distribution in moncropped area

Coconut based high density multi species cropping system with high value intercrops

Under coconut main crop, sweet corn, baby corn, brinjal and pumpkin crops were grown. Black pepper (Panniyur 1), banana (Njalipoovan and Grand Naine) also were cultivated. Economic analysis (based on annual variable cost) indicated that, the net return realized under fully organic with (vermicompost+biofertiliser application + green manuring + vermiwash application + husk burial + mulching coconut basin) was higher (Rs. 2,15,953/-per ha) followed by 1/3rd of recommended fertilizer NPK + vermicompost + biofertilizer application + green manuring + vermi wash application (Rs. 2,09,573/- per ha).

Intercropping brinjal and baby corn in coconut garden

Impact of intercropping and soil moisture conservation measures on soil temperature

The data on soil temperature for the period August 2011 to December 2011 indicated lower soil temperature both in the morning and afternoon under coconut and coconut based cropping system with soil moisture conservation measures compared to temperature recorded in the open place. Amongst the cropping systems tried, coconut + fodder grass had lower temperature (26.3 ^oC), followed

by pineapple intercropping (26.4 ºC), vegetable intercropping (26.7 ºC) and monocropping of coconut (27.6 ºC) compared to open conditions (28.4 ºC) Similar trend was observed in the afternoon but with higher differential temperature *viz.*, 6.5, 6.3, 5.8 and 4.6 ºC, respectively in pineapple intercropping (27.6 ºC), vegetable intercropping (27.8 º C), grass intercropping (28.3ºC) and monocropping (29.5ºC) as compared to open condition (34.1 ºC).

Nutritional requirement of dwarf varieties of coconut in root (wilt) affected area

Kalparaksha and Kalpasree varieties of dwarf coconut planted during August 2007 and maintained under different nutritional management practices have started flowering. About 26 and 36 percent of plants under Kalparaksha and Kalpasree varieties, respectively have flowered. Initial observations indicate that Kalparaksha responded more for inorganic fertilizer where as Kalpasree performed better under the integrated nutrient practices.

Kalaparakhsa variety of coconut in the experimental field

Kalpasree variety of coconut in the experimental field

Heliconia stricta as an intercrop in coconut garden

Iris Red *Heliconia* supplied with FYM @1kg/plant and bone meal @ 250g/plant as basal dose followed by vermicompost @ 200g/plant and neem cake @ 100g/plant at quarterly interval from three months after planting resulted in early flowering (7- 8 months after planting) as against normal flowering (10 - 11 months). These plants produced better quality flowers of >1 m length, 6-7 bracts and 8 cm peduncle girth. The flower quality was also significantly better under the nutrient management in intercropped area as compared to open condition.

Studies on predisposing factors of root (wilt) disease of coconut

The soil samples collected from Colachal area (Tamil Nadu) showed that organic carbon (exept in the top layer), porosity and plant nitrogen were less in the the root (wilt) affected garden than in the garden of apparently healthy palms. The coconut palms in less porous soils of disease prevalent tracts without air filled spaces showed severe foliar yellowing.

Coconut palms showing severe yellowing symptoms in leaves

Intercropping of seasonal vegetables under arecanut for NE condition

Four summer vegetables *viz*., ridge gourd, chilli, okra, amaranthus were tried with different fertilizer treatments under arecanut in North East condition. The results showed that among all the vegetables tried, okra performed well under fertigation with recommended dose of inorganics+arecanut husk placed in the sub-soil for reducing the loss of nutrients and water.

Soil nutrient limits for laterite soils in arecanut tract

At 0-30 cm soil depth, optimum nutrient concentration for P, K, Ca, Mg, Fe, Mn, Cu, Zn and B was established as 15, 192, 925, 179, 37, 88, 26, 5.5 and 1.4 mg kg^{-1}, respectively. Relation between soil fertility and arecanut yield was assessed in laterite soils. Optimum nutrient values were higher for laterite soils than generalized guidelines. Nutrient uptake explained the yield variability better than soil/leaf nutrients. Regression models also showed the positive impact of K, P and Ca on yield of arecanut.

The fitted model for soil and leaf nutrients is

$$Y = 5.8626 - 0.02225 \text{ leaf Cu} + 0.3759 \text{ soil B} + 3.819 \text{ leaf Ca} - 9.0968 \text{ leaf Mg} - 1.1869 \text{ leaf N} + 0.03189 \text{ soil Cu} - 0.1029 \text{ soil Zn} \quad (R^2 = 0.345)$$

The fitted model for nutrient removal (r) and yield is

$$Y = -1.999 + 0.00054\, Fe_r + 0.0185\, K_r + 0.0482\, P_r \quad (R^2 = 0.916)$$

The fitted model for total biomass and total uptake (tu) is

$$Y = 0.1838 + 0.0009\, Fe_{tu} + 0.05917\, K_{tu} + 0.05821\, Ca_{tu} + 0.10571\, P_{tu} + 0.00089\, Mn_{tu} \quad (R^2 = 0.986)$$

Organic matter recycling in arecanut

The long term study for 12 years revealed that the average kernel yield obtained with vermicompost produced from recyclable arecanut wastes was 2647 kg ha^{-1}. The advantage of organic matter recycling was found to be sustenance of uniform yield levels without any alternate bearing effect. However, application of K through other sources should be explored, as vermicompost cannot meet the K requirement.

Disorders in arecanut

Spatial and temporal variability in soil and leaf nutrient status of disorder affected plantations was used as a tool to find out the causes for disorders in arecanut. Zinc deficiency in 84 to 97 percentage of palms, indicate the reduction in Zn uptake despite sufficient to excess availability of nutrients in clay and laterite soils. Regression analysis between leaf Zn and soil fertility parameters indicated negative relation with soil Zn and Ca in clay and SOC, soil P and soil B in laterite soils. Multiple regression analysis indicated negative relation of DTPA-extractable Zn with nutrients like Ca, Mg, K and Fe in soil in different years. The results reveal that nutrient interactions in soil affect the uptake of nutrients despite sufficient nutrient availability.

Nutritional disorders in arecanut - crown bending, nut-splitting, crown choking and oblique nodes

Integrated nutrient management on four improved arecanut varieties at NE region

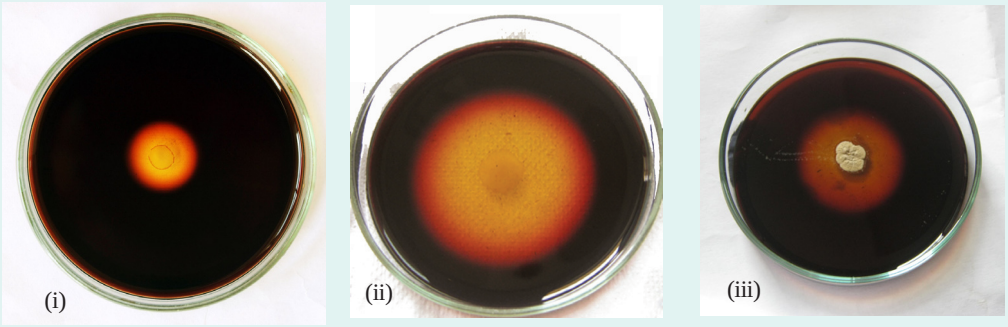
Maximum chali yield (4.19 kg) in Mohitnagar variety was recorded in the treatment where 50% N was substituted by vermicompost followed by (100% N substituted by vermicompost) (4.17 kg). In Sreemangala variety, maximum chali yield was recorded at recommended fertilizer dose.

Computational analysis of metagenome data on coconut leaf vermicomposting

QIIME (Quantitative Insights into Microbial Ecology) and MOTHUR based analysis of bacterial 16S rRNA of the genomic DNA extracted from four different stages of coconut leaf vermicomposting indicated that the diversity of the bacteria increased as the substrates were converted to vermicompost by the earthworms and then decreased in the finished product. The α- proteobacteria and Bacteroidetes were the dominant phyla followed by α- proteobacteria and Actinobacteria.

Estimation of cellulase, ligninase and xylanase activities of gut microflora

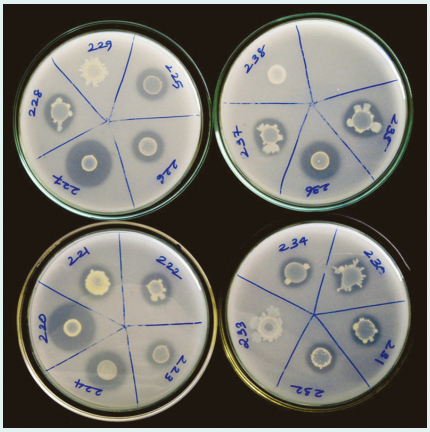
For the estimation of the three enzyme activities involved in degradation of cellulose, lignin and hemi-cellulose present in coconut leaves, bacteria, actinomycetes and fungi were isolated from the gut contents of active adult earthworms degrading the coconut leaves to compost and screened for their cellulose and lignin degrading capabilities. Presently, 31 bacteria and 13 actinomycetes with cellulose degrading capabilities were isolated.



Actinomyctes (i) and bacteria (ii) from earthworm gut showing cellulose degrading capacity (clearing zone) in coconut leaf media and bacteria on CMC media (iii)

Phosphate solubilizing bacteria associated with coconut

Qualitative phosphate solubilization ability of 512 heterotrophic bacteria, isolated from rhizosphere and roots (endophytes) of coconut palms growing in various ecological zones of Kerala, Tamil Nadu, Karnataka, Andhra Pradesh and Maharashtra, was studied and 56% (284) isolates were able to solubilize phosphate in the Pikovskaya's agar medium. Six potent isolates including 3 fluorescent *Pseudomonas* spp., 2 *Bacillus* spp., and one unidentified bacterium were selected with phosphate solubilization efficiency ranging from 100% to 333%. These bacteria have potential applications in designing bioinoculants.



Phosphate solubilization showed by heterotrophic bacteria on Pikovskaya's Agar

AMF spore associated bacteria (SAB) in coconut and arecanut based cropping systems under organic management practices

Studies on spore associated bacteria (SAB) and their functional role in AMF-host interactions with respect to germination of spores and colonization of roots in coconut and arecanut based cropping systems under organic management practices revealed that AMF spore load of a particular cropping system increased with the number of intercrops. *Glomus* and *Gigaspora* spp. were abundant in coconut based cropping systems, while *Glomus* spp. predominated in arecanut based cropping systems.

Spore associated bacteria (SAB) were isolated from the cytoplasm of surface sterilized spores of *Glomus* and *Gigaspora* spp. Identification based on BIOLOG revealed the presence of bacteria - *Citrobacter amalonaticus Staphylococcus arlettae, Bacillus subtilis Bacillus amyloliquefaciens,* in association with spores of *Glomus* spp. *Corynebacterium coyleae, Bacillus cereus* and *Bacillus subtilis* were found to be associated with *Gigaspora* spp.

Production and supply of bioresources to end users

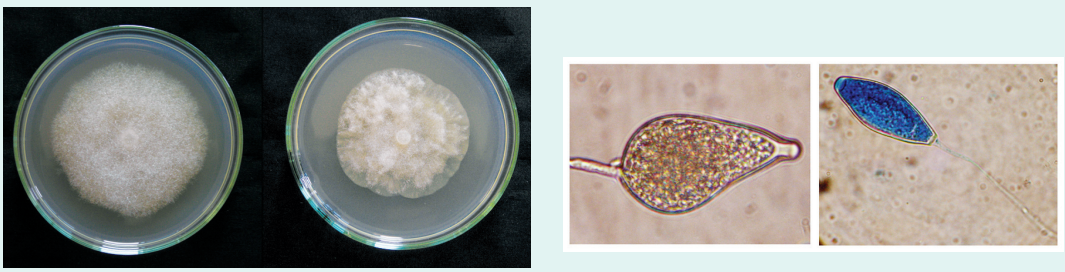
During the period March to Dec 2011, 4 lakh earthworms, 23 tonnes of vermicompost, 200 litres of vermiwash, 80 kg *Pleurotus* sp. mushroom spawn, 12 kg fresh mushrooms (*Pleurotus* sp.) were produced and part of it were supplied to farmers, women entrepreneurs and self employed youths. The majority of the vermicompost produced was supplied within the Institute and to KVK for carrying out various trials.

INTEGRATED MANAGEMENT OF DISEASES

Phytophthora nicotianae causing bud rot of coconut

Phytophthora sp. causing bud rot of coconut in Wyanad, Udupi and Coimbatore districts was identified as *P. nicotianae* and *Phytophthora* sp. isolated from fruit rot of coconut in Chikkamagalur district was identified as *P. capsici*, based on morphological and molecular tools. This is the first report of *P. nicotianae* causing bud rot and *P. capsici* causing fruit rot of coconut in India.

Artificial inoculation studies revealed that the lesion caused by *P. nicotianae* and *P. palmivora* did not vary, indicating that they are equally pathogenic.



Cultures and photo micrograph of *Phytophthora nicotianae*

Management of bud rot disease of coconut

Placing *Trichoderma* coir pith cake in the innermost leaf axils of coconut palm in disease endemic areas just before the onset of south-west monsoon (May end) and thereafter at two months interval was found to be very effective in the management of bud rot disease of coconut.

A new *Trichoderma* coir pith cake formulation

A new technology has been developed for the production of *Trichoderma* formulation using coir pith or vermicompost. This low-cost product has a long shelf life of 10 months and high population level of *Trichoderma*. Through a simple activation process of the dried cake, luxurious growth of *Trichoderma* covering the entire product could be obtained.

Trichoderma coir pith cake as a biocontrol formulation

Slow pesticide release product from coir pith

An organic and biodegradable slow pesticide release product (SPRP) was developed using coir pith. Shelf life of the pesticide incorporated in the slow release product is being evaluated. Field trial with this product containing mancozeb revealed that it is effective in the management of bud rot disease of coconut.

Management of stem canker disease of cocoa caused by *Phytophthora palmivora*

Stem canker disease of cocoa can be controlled by integrated disease management practices such as frequent removal and destruction of *Phytophthora* infected pods, proper pruning, removal of *Phytophthora* infected chuppons and twigs and treatment of canker lesions with either phosphorous acid or *Trichoderma* coir pith cake (TCPC). Application of TCPC in the soil around the base of the plant will be cheaper than phosphorous acid treatment with more advantages such as build up of *Trichoderma* population in the garden which in turn is expected to reduce incidence of *Phytophthora* diseases and also help in the long term management of the disease.

Treatment of canker lesion with *Trichoderma* coir pith cake

Role of the common slug, *Deroceras* sp. as dispersal vector of *Phytophthora*

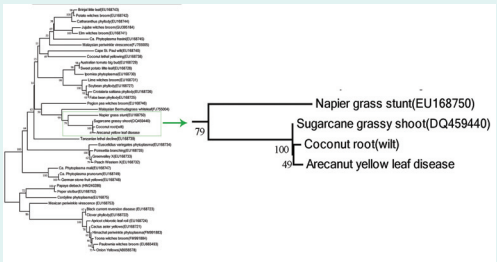
The common slug, *Deroceras* sp. found in abundance in coconut and cocoa gardens during rainy season play a major role in the spread of Phytophthora diseases of both the crops. These slugs were found feeding on the *Phytophthora* growth on cocoa pods and immature coconuts. Sporangia were observed in the feaces of slugs collected from coconut palms as well as cocoa plants.

Sporangia survived and remained infective after passing through the alimentary canal of the slugs. Artificial inoculation of healthy tissues of coconut and cocoa with feacal matter of the slug revealed that the *Phytophthora* propagules in the feaces form a major source of inoculum for primary infection as well as for secondary spread of the disease.

Slugs feeding on *Phytophthora* in the tender nuts of coconut and cocoa pods

SecA gene based phylogeny of arecanut yellow leaf phytoplasma

Partial *sec*A gene sequence of 425bp was amplified with semi nested primers cocsf/ cocsr-cocsnf/ cocsr designed from conserved regions. In the phylogenetic tree based on *sec*A gene, the YLD phytoplasma clustered with sugarcane grassy shoot, coconut root wilt and napier grass stunt phytoplasma, in the 16SrXI group. Hence YLD phytoplasma in India is placed in *Ca*. Phytoplasma oryzae.



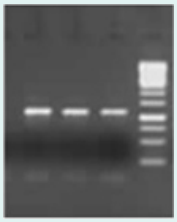
Phylogram showing phylogenetic relationships of partial secA gene of arecanut YLD phytoplasma and 41 other known phytoplasmas sequences. Bootstrap values are expressed as percentage of 1000 replications

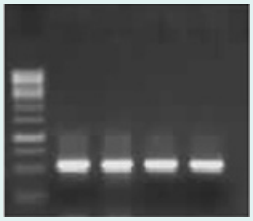
Isolation and characterization of ABC transporter system in coconut root (wilt) phytoplasma

The spermidine/putrescine transporter has 4 components: potA, potB, potC, and potD genes. Full length potC gene and partial sequence of potA and potB of ABC- transporter system of coconut phytoplasma were isolated. Pair wise alignment of these fragments showed 97% nucleotide identity with E value 0 and 100% query coverage of ABC spermidine/putrescine transporter of Coconut

RWD with *Ca. Phytoplasma mali*. Transmembrane prediction using TMHMM tool showed 6 transmembrane helixes. Two motifs, ABC transporter intergral membrane type-1 domain and binding-protein transport system inner membrane component are predicted using MotifScan tool.

PRIMERS: PUTF3-R3
DNA: Coconut RWD Phytoplasma





PRIMERS: PUTF4-R4
DNA: Sugarcane GS Phytoplasma

INTEGRATED MANAGEMENT OF PESTS

Investigations on entomophaga and entomopathogens of coconut pests

In the *Opisina arenosella* infested plot at Trivandrum, 50.20% reduction in leaf damage could be achieved in seven months period by constant monitoring and release of larval parasitoids *viz., Goniozus nephantidis* and *Bracon brevicornis.*

Prosena sp. nr. *siberita* (Fabricius) (Hymenoptera: Tachinidae) was found to be an endolarval parasitoid of coconut white grub, *Leucopholis coneophora* which completes larval stage inside the white grub. The last instar maggot comes out of the host and pupates in soil for about 12 days. Natural parasitism was observed up to 83%. This is the first report of parasitism by *Prosena* sp.nr. *siberita* on *L. coneophora*.

Refinement of IPM of palms and cocoa

Prophylactic management of rhinoceros beetle through leaf axil filling with Chlory dust (Chlorpyriphos 1.5% DP @ 6.0 g + 250 g sand), Ferterra granules (Chlorantraniliprole 0.4% W/W GR @ 6.0 g + 250 g sand) and botanicals (*Pongamia* cake + 250 g sand) were found to be effective in reducing leaf damage (47-66%) in coconut.

Laboratory evaluation of an insect growth regulator, Cigna 0.01% (Lufenuron 5.4% W/W EC) against grubs of red palm weevil, indicated 55-65% larval-pupal intermediates with retention of larval structures, blister formation on grubs and softening of cuticle. Field validation of spinosad 0.13% and imidacloprid 0.02% indicated recovery of red palm weevil infested palm to the tune of 60-80%, respectively.

A significant reduction in mite incidence (70-81%) on fresh bunches could be observed in palms treated with palm oil (200g)-sulphur (5g) emulsion.

Among the various insecticides evaluated against coconut root grub (*Leucopholis coneophora*) bifenthrin was extremely-toxic to first-instar grubs (LC_{50} 6.77 ppm) whereas imidacloprid was highly toxic to second-instar grubs (LC_{50} 22.53 ppm) and third-instar grubs (LC_{50} 53.10 ppm),

respectively. In addition, two green labeled insecticides *viz*., chlorantraniliprole and flubendiamide resulted in a median lethal concentration of 34.99 ppm and 32.30 ppm, respectively against second-instar grubs after 5 days of treatment.

Age related modulation of chymotrypsin (BT*p*NA-ase) activity, protein concentration and specific activity were observed for crude midgut homogenate of red palm weevil grubs (*Rhynchophorus ferrugineus*). Serine protease inhibitors such as aprotinin (50µg), phenyl methyl sulphonyl fluoride (1700 µg) and soybean trypsin inhibitor (30µg) marginally reduced (3.9-9.1%) chymotrypsin activity of *R. ferrugineus* at the highest concentration studied.

Integrated approaches for the management of Tea mosquito bug in cocoa

Helopeltis bradyi, H. theivora and *H. antonii* were recorded on cocoa. Among this *H. bradyi* is the most predominant one. Secondary infection on tea mosquito bug damaged pods showed presence of *Fusarium* spp.

Surveillance and pest monitoring

No incidence of invasive pest, *Brontispa longissima* was recorded so far from the areas surveyed in South India as well as in Lakshadweep Islands. *B. longissima* has caused economic setbacks in neighbouring countries including Maldives, China and Union of Myanmar.

Invasive pest *Brontispa longissima*

Bagworm infested leaf

The bag worm, *Pteroma plagiophelps* is a potential emerging pest of coconut / oil palm in West Godavari district of Andhra Pradesh and was also noticed on coconut and ornamental palms in Chemmanakary, Vaikkom, Kerala. Survey conducted in Cumbum and Tenkasi areas in Tamil Nadu revealed the presence of skipper butterfly (*Gangara thyrsis*) and stellate scale (*Vinsonia stellifera*) in young coconut palms.

Coconut seedling damaged by *O. rhinoceros*

Rhinoceros beetle damage was recorded on the collar region of newly planted coconut and oil palm seedlings in Alappuzha and Kollan districts, Kerala. Red palm weevil incidence on arecanut palms was reported from Assam, in palms infected with bud rot and basal stem rot and the average infestation ranged from 1-2%.

Occurrence of an invasive pest, buff coconut mealy bug, *Nipaecoccus nipae* (Maskell) (Pseudococcidae : Hemiptera) was recorded for the first time on feeder tender roots of a coconut seedling at Kayamkulam, Kerala, India. *N. nipae* was not observed on the foliage of coconut or other arboreal parts of the palm. This is the first distributional record of the alien pest in Kerala, India.

Assessment of coconut eriophyid mite damage in Andhra Pradesh

Survey conducted in East and West Godavari districts of Andhra Pradesh during November 2011 revealed low to medium mite incidence in the coconut gardens ranging from 18.3 to 54.2%. Well-maintained coconut gardens with adequate nutrition and irrigation had the least incidence of mite. In coconut gardens with flowering plants as intercrops the eriophyid mite was significantly low when compared to gardens with other inter / mixed crops. The acaropathogenic fungus, *Hirsutella thompsonii* could not be isolated from the coconut samples collected from these districts, however the major predatory mite, *Neoseuilus baraki* could be recorded in the nut samples. The present level of mite infestation in these two districts could be managed by adopting the current recommendation of integrated management consisting of plant protection and nutritional management.

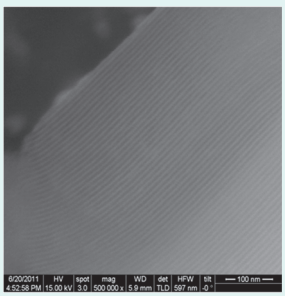
Nanomatrix for loading pheromone synergists of red palm weevil

Head space sampling of red palm weevil, *Rhychophorus ferrugineus* food baits had forty eight compounds. Neera fermented for four days had the maximum number of compounds followed by pineapple and banana. Iso amyl acetate and ethyl octonoate were present in all the food baits. Of the 48 compounds; ethyl acetate, iso amyl acetate, iso amyl alcohol benzaldehyde, benzyl alcohol caused the electrophysiological response in the red palm weevil's antennae.

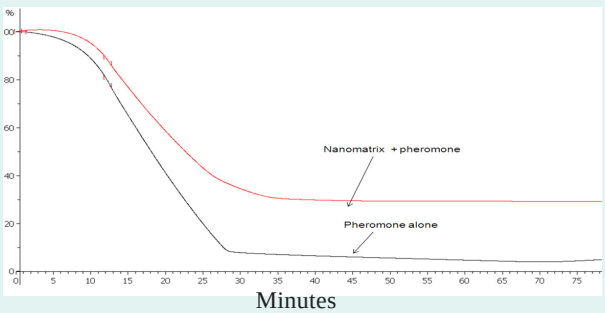
A novel nanomatrix with ordered pore channels was developed for loading the pheromone and kairomone. Characterization of the nanomatrix by Field Scanning Electron Microscopy (FESEM) and X - ray diffraction (XRD) confirmed the ordered structure of the pores on the nanomatrix.

Pheromone of red palm weevil when loaded in nanomatrix showed delayed dissipation as compared to pheromone alone when assayed by thermal gravity analysis (TGA). Fourier transform infrared (FT-IR) measurements confirmed the presence of pheromone in the nanomatrix. On the dissipation pattern the commercial lure lost all the compound in 80 days, whilst there was more than twenty percent pheromone remaining in the nanomatrix.

The behavioral assay of the red palm weevil adult to the pheromone being released from the nanomatrix was assessed using the high speed videography @ 1200 frames / sec. The flight initiation time on reception of the compound showed three phases of activity. The first was opening and spreading of hind wings prior to flapping took 0.42 seconds. The second was flapping of wings and wing beat frequency at a low amplitude of 80 Hz . The third phase was a high amplitude flapping and the frequency was 100 Hz.



FESEM image of ordered pores in the nanomatrix



Thermal gravity analysis of nanomatrix loaded with pheromone

Refinement of pheromone technology for rhinoceros beetle

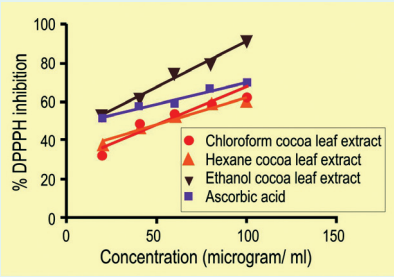
A nanomatrix and polymer composite was developed to load the rhinoceros beetle pheromone ethyl 4 methyl octonate. The pheromone loaded to nanomatrix showed extended duration of release when subjected to thermal gravity analysis.

Field evaluation revealed that nanomatrix loaded pheromone (240 mg) trapped around 17.7 beetles/ trap/ month followed by nanomatrix polymer composite that trapped 15.8 beetles / trap, while commercial lure trapped 12 beetles/ trap/ month. The commercial lure containing 800 mg pheromone was exhausted in three months whilst the nanomatrix having the pheromone was effective for six – eight months.

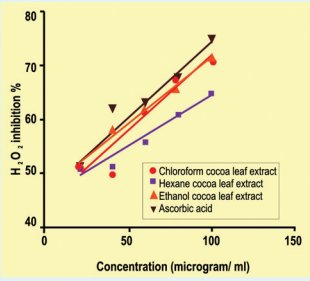
PHYSIOLOGY AND BIOCHEMISTRY

Adaptations potential in coconut and cocoa in relation to climate change

Preliminary data indicate wide variability in the response of coconut and cocoa to climate change variables, elevated CO_2 and elevated temperature. At higher CO_2 though the plants had grown taller but the photosynthesis and the chlorophyll fluorescence showed a declining trend. In case of cocoa jorquetting is delayed. There was interaction effect of elevated CO_2 and high temperature with drought. Plants were more sensitive to drought at ET and at 700 ppm CO_2. Coconut is more sensitive to interaction effect of climate change variables with drought compared to cocoa.



DPPH scavenging activities of cocoa leaf extract



H_2O_2 scavenging activities of cocoa leaf extracts

Genotype Dependent Protease and oxidative isozyme Response of Coconut under Elevated CO_2 and Temperature

The number of Mn-SOD isoforms are more in drought tolerant cultivars viz. WCT and FMST with four Mn-SOD isoforms, while dwarf cultivars *viz*. COD, MYD, MOD and MGD had single Mn-SOD isoform.

Drought tolerance in cocoa

Studies on photosynthesis, chlorophyll fluorescence and water potential under stress and non-stress conditions in 11 accessions from different geographical origins, indicated both seasonal and varietal differences. Transpirational water loss is reduced with increased stomatal closure, which is a favourable drought trait and based on rank sums, three accessions *viz.*, JA1/19, POU 16/A and SC 4 were found to be drought tolerant. In another trial, 52 accessions were compared for

physiological parameters and the clones, AM 1/8, AMZ 5, LP 1/41, LP 4/32, POU 4/B and POU 18 were identified to be adaptable to water limited conditions.

Antioxidant activity of cocoa leaves

Antioxidant activity of three solvent extracts (ethanol, hexane and chloroform) from cocoa leaves were assayed for DPPH radical scavenging activity and hydrogen peroxide scavenging activity, respectively. The ethanol extract showed the higher value of antioxidant activity IC_{50} 14.58±2.1 (µg/ml) based on DPPH radical scavenging assay and IC_{50} 12.08±2.8 (µg/ml) based on hydrogen peroxide scavenging assay (r^2=0.94). Hexane (IC_{50} 55.56±3.8 µg/ml in DPPH assay and IC_{50} 21.11±2.4 µg/ml on hydrogen peroxide assay) and chloroform extracts (IC_{50} 53.25.±4.1 µg/ml in DPPH assay and IC_{50} 22.14±3.2 µg/ml on hydrogen peroxide assay) showed moderate antioxidant activity in both assays as compared to synthetic antioxidant ascorbic acid.

POST HARVEST TECHNOLOGY

Agricultural waste fired Virgin Coconut Oil Cooker

An agricultural waste fired Virgin Coconut Oil Cooker has been developed to produce virgin coconut oil from coconut milk. It consists of a double jacketed vessel filled with thermic fluid. A furnace is provided at the bottom. An opening with a door is provided to feed fuel to the furnace. The cooker has capacity of 75 litres.

Performance evaluation showed that the cooker could process coconut milk of 25 kg coconut gratings in three and a half hours. It consumed 16 kg coconut shell as fuel for the process. Oil recovery was 23.54 %. When cream was separated from coconut milk and used for VCO production, processing time was reduced to two and a half hours. Fuel consumption also was reduced to 12 kg. However, oil recovery was reduced to 21.5%.

Agricultural waste fired VCO cooker

Making ball copra using CPCRI Solar tunnel dryer

The time required for producing ball copra could be reduced considerably by giving heat treatment to partially dehusked coconuts in the CPCRI Solar tunnel dryer. The dryer could turn 77% of the coconuts to ball copra by nine months and 94% by the end of the year. The conversion was less than 50% and 70%, respectively for the same period.

Comparison of VCO with commercial coconut oil

Virgin coconut oil (VCO) differs from commercial grade coconut oil (RBD Oil) in the way it is processed. The latter is produced from copra or dried coconut meat and undergoes refining process to make the oil edible while the former is directly produced from fresh coconut meat by hot-processing, fermentation, extraction from dried dratings (EDG) and centrifuging. The chemical analysis of VCO prepared from coconut milk by hot processing and fermentation (VCOH and VCOF) and commercial grade coconut oil prepared from copra was done to find out the difference in quality between the oils. The analysis reveal that chemical parameters such as tocopherol, antioxidant activity, polyphenols and monoglycerides are three to four times higher in VCO than in copra oil. But there is no significant difference in the contents of fatty acids in both oils. Between the VCOs prepared by fermentation and hot processing, contents of antioxidant activity, polyphenols and monoglycerides are higher in the VCOH but tocopherol content is higher in VCOF.

Standardized the protocol for the preparation of coconut jaggery

Good jaggery can be prepared by keeping sap pH within 7.5 to 9. Time course measurement of biochemical quality of the sap was done in order to understand and improve the keeping quality of sap. Freshly produced sap has a pH of 8.0 and it starts declining and reaches a lower limit of 3 with fermentation. The rate of fermentation depends on temperature. At 40^{o}C fermentation starts after 2 hours. pH has a definite relation with sugar and protein content. As the pH decreases the total sugar decreases while reducing sugar increases.

Age of haustorium and its nutritional quality

Haustorium has two distinct portions. Outer yellow cover and inner white portion. Yellow portion contains more of oil while the inner white portion has carbohydrates and reducing sugars. With the age of haustorium the oil content of yellow portion increases and the total carbohydrate and reducing sugar decreases. On the other hand the change in white portion was only minimal.

A safety attachment to Chemberi model of coconut climbing device

The coconut climbing device developed by a farmer, Late Shri Chemberi Joseph, remains the only viable climbing device available in the market. A safety attachment to the climbing device has been developed involving a wire rope and a body harness.

SOCIAL SCIENCE

Enhancement in technology adoption

The level of knowledge and adoption of recommended technologies for coconut cultivation (except plant protection and soil/moisture conservation technologies) were observed to be enhanced by 30 to 40 % over a period of 10 years in Alappuzha district. The management of adult palms recorded fairly good adoption rates regarding basin opening (69%), basin management with cover crops (40%), and application of manures (30-60%). Farmers' knowledge and adoption indicated statistically significant relationship and are also significant with area under cultivation, training participation, membership in groups, frequent attendance in group meetings, and enterprise diversification. In case of coconut seedlings, chemical fertilizers (34 %) and organic manure application (82%) along with prophylactic measure against rhinoceros beetle attack (leaf axil filling) (34%) were adopted by the farmers.

Innovation system analysis on adoption of microirrigation technology

In a study conducted in the Kasaragod and Kannur districts with financial assistance from Kerala State Council for Science, Technology and Environment, it was observed that large number of farmers discontinued the drip irrigation technology in coconut gardens in the Northern Kerala (over 75%). Drip irrigation was discontinued after 5 years of its installation in majoirity of the cases. Even among the farmers who continued the adoption, the extent of adoption of recommended practices for drip irrigation technology was low which has resulted in low irrigation efficiency as reflected by the indicators of technical performance of the irrigation system. Emitter clogging was reported as one of the important problems for discontinuance. The training and technical support provided by the Departiment of Agriculture on installation and maintenance of drip irrigation system were indadequate. Majority of the officers (58 %) did not attend any specific training programme on drip irrigation technology and many of the officers opined this as a constraint in the proper monitoring and follow up of the field installation and maintenance of drip irrigation system in farmers' gardens.

Empowering CBOs in root (wilt) affected areas for sustaining the activities

In NABARD funded project on Integrated Model Coconut Clusters for improving livelihood security in root (wilt) affected areas, activities in two CBOs were integrated and technology interventions like production of bio-primed seedlings, intercropping, FFS on IPM of rhinoceros beetle and management of other pests and diseases were implemented. Yield and income from coconut and intercrops recorded an increasing trend due to integration of interventions. Significant increase was observed in the area under intercrops like tuber crops (four fold), vegetables (four fold), ginger and turmeric (81%) and banana (39%). The incidence of rhinoceros beetle was observed in 75 % and 48 % in the case of mild and severe cases, respectively, in case of red palm weevil, reduction in incidence was 89% and 30% and for leaf rot disease 54 % and 59 % respectively.

Community adoption of *Metarhizium anisopliae* as IPM component agaist rhinoceros beetle

Community adoption of green muscardine fungus (GMF) for treating the potential breeding sites of Edava panchayath as a participatory effort is accepted as a model wherein several farmers groups as well as extension officials visit the area and interact with the farmers enabling horizontal

Women master trainers imparting skills of farm level GMF production

farmer-to-farmer technology dissemination. Capacity building and participation of Women farmers made them skilled in the farm level production using a simple technique facilitated by CPCRI scientists which could be initiated with an investment of Rs. 10,000. The involvement and participation enabled them to make suitable refinements thus reducing the cost of production by 35 % and also the time involved. They serve as master trainers in farm production of GMF.

FPARP on soil and water conservation techniques

Technology interventions were implemented in 114 holdings in Kasaragod distrinct on various soil and water conservation techniques (water harvesing pits filled with coconut husk in the interspaces of coconut garden, making half-moon shaped basin reinforced with pineapple/grass), soil moisture conservation by mulching and construction of 15 water storage structures.

Stakeholders' interface programme facilitated through video conferencing

The mobile kodak was used for conducting 14 video conferencing programmes with various stakeholders including farmers, extension personnel, farm women, entrepreneurs, people's representatives and KVK personnel.

World Coconut Day

World Coconut Day was celebrated on 2nd September 2011 with various activities honouring best coconut cultivators from Kasaragod district, competition for coconut recipe preparation, essay writing competition for school children and quiz programme for the B.Sc.(Ag.) students facilitated through video conferencing. Sri. C. P. John, member, Kerala State Planning Board was the chief guest.

Mr. C. P. John inaugurating the World Coconut Day celebration at CPCRI, Kasaragod

Farm Innovators' Meet

A farm innovators' meet was conducted at CPCRI, Kasaragod on 28th February 2011 coinciding with the National Science Day. Mr. K. Abdul Rahiman, District Information Officer, Kasaragod inaugurated the meet. Dr. George V. Thomas, Director, CPCRI chaired the inaugural session. Sixteen farm innovators from Kerala, Tamil Nadu and Karnataka presented their innovations that include techniques on crop management, pest and disease control, cococnut/arecanut climibing, processing: Items displayed by the farmer innovators include arecanut tannin based soft drink, soap using arecanut tannin and hand operated coconut milk extraction device, milking machine etc. Following the presentations by the farmers, the scientific rationale, need for conducting further experiments/trials for refinement and validation, and scope for further scaling-up of the innovations were discussed.

'Kera Keralam' - an interface programme on coconut farming

In collaboration with Doordarshan Kendra, Thiruvannathapuram 'Kera Keralam', an interface programme on coconut farming with the focal theme on problems and prospects of coconut cultivation in Kerala state was conducted on 5 March 2011 at CPCRI Kasaragod and was serially broadcated in five episodes. The expert panel included Sri. R. Hali, veteran agriculture columinist, Shri K.N. Satheesh, IAS, District Collector, Kasaragod scientists from CPCRI and KAU, officials of Department of Agriculture, and award winning coconut farmers.

Agriculture Technology Information Centre

During the year various farm advisory activities were conducted through the ATIC at CPCRI, Kasaragod benefiting 2440 farmers, extension personnel and students. Technology inputs and products including planting materials, farm products, farm literature and CD ROMs worth Rs. 9,05,002/- were sold through ATIC.

Extension literature and mass media

Extension publications viz., 'Package of practices of coconut cultivation (Malayalam)' and 'Soil and Water Conservation and Water Harvesting in Coconut Gardens - Experiences Under Farmers Participatory Action Research Programme' and a video film on 'CPCRI-For farmers' prosperity' were brought out during the year. Scientists and technical personnel of the Institute published 42 popular articles on various aspects of the mandate crops.

Robust techniques for statistical data analysis

Kernel weighted frequency function of the errors is proposed for the identification of outliers or extreme observations present in the data generated through experimental designs and developed a robust technique for analysis of data from basic designs in the presence of outliers was developed.

Locally weighted robust regression models are used to explain the yielding pattern in arecanut. The yielding pattern in arecanut is better explained with the model based on cumulative yield. In the high yielding palms yield stabilization observed after 10 years of planting compared 13 to 17 years in low yielding groups.

Strengthening Statistical Computing for NARS

Organized a training programme on 'Data analysis using SAS' during 16-21 January 2012 in which 17 scientists form 8 NARS institutions participated. For analysis of plantation crops data in SAS, MACROS were developed on parameters such as, summary tables, frequency, t-test, ANOVA (CRD, RBD, split-plot), correlation, linear and non-linear regression, PCA, Factor analysis, generalized additive model, nonlinear regression models, and factor analysis using polychoric correlation matrix.

Training programme on SAS at CPCRI, Kasaragod

Price trend

Analysis of coconut market structure to understand the price fluctuaions of coconut oil indicated five major reasons viz., 1) the supply deficits, 2) price rise in substitute oils, 3) surging industrial demand 4) high volume of exports and 5) a global shortfall in edible oil supply.

Short term coconut oil price prediction was attempted using ARIMA (1, 1, 0)*(1, 0, 0) model and the predicted international coconut oil prices for January, February and March 2012 is USD 1422, 1401 and 1462 per MT, respectively.

The arecanut price series in Assam was observed to follow the model ARIMA (1,0,1) while or Meghalaya price series followed ARIMA (0,1,1) model with linear trend and point intervention during October 2011.

Cost of production

Cost of production of coconut in Kerala based on data from a well-managed coconut garden under rainfed condition is Rs 6.00 per nut and in the case of irrigated coconut it is Rs 5.00 per nut. Average cost of production of one kilogram of arecanut (chali) in a well-maintained garden was found to be Rs 104.20. The cost of production of cocoa grown in arecanut garden was found to be Rs 74.42/ kg of dry beans.

KRISHI VIGYAN KENDRAS

KVK, KASARAGOD

Krishi Vigyan Kendra, Kasaragod organised 93 training programmes during the period from January, 2011 to January 2012 with the participation of 2324 trainees.

Frontline Demonstrations

The frontline demonstrations undertaken were coconut based mixed farming system (ongoing), farmer participatory management of bud rot disease in coconut (ongoing), Introducing bio control agent, *Metarhizium anisopliae*, for the management of coconut rhinoceros beetle (ongoing), integrating bee colonies in coconut based cropping systems and moisture conservation practices and intercropping in coconut garden of sandy soils (ongoing). In arecanut, Arecanut based mixed farming system (ongoing) was undertaken. Pepper production through bush pepper technology (ongoing) and management of foot rot disease in pepper were demonstrated to pepper farmers. High yielding variety of rice 'Prathyasa' and improved variety of guinea grass COGG-3 (ongoing) were introduced. Among poultry, backyard poultry rearing as an enterprise for women was initiated and among veterinary aspects oestrous detectors were introduced to identify ovulation period for successful artificial insemination.

On Farm Trials

On Farm Trial for the management of stem bleeding disease by smearing 5% tridemorph along with coal tar application and soil drench with 0.1% tridemorph @ 25ml in 25 l of water was found to give best results.

Performance assessment of different models of coconut climbing devices as an alternative to conventional climbing in terms of ease of operation, safety etc. was undertaken. Chemberi model was found to be more suitable for harvesting coconuts. TNAU model was found to be more women friendly but suitable for small trees only.

On farm testing of upland rice varieties in 3 locations at Panayal village showed that Vaisakh performed better (3200 kg/ha) followed by Samyuktha (2800 kg/ha) in comparison to the local var. (2100 kg/ha). The net returns obtained from the varieties were Rs.11250, Rs.7050 and Rs.1250 per ha respectively. B:C ratio were 1.6, 1.4 and 1, respectively.

Coconut climbing - Training programmes gained popularity

Friends of coconut tree, a collaborative programme of KVK, Kasaragod and CDB, Kochi was organised and eight batches of training programmes completed successfully. Also the first exclusive ladies' batch ever in Kerala including 17 women trainees completed their training out of which 11 women have taken up this profession.

Woman trainee pollinating coconut inflorescence

Krishiyidam – 24 episodes completed

Krishiyidam, the serial documentary by KVK, Kasaragod in collaboration with Kasaragod Vision Channel is gaining wide appeal among the farming community of Kasaragod. Till date 24 episodes have been completed successfully. The programme of 30 minutes duration is telecast every Sunday at 5.30 pm through Kasaraogod Vision channel.

Agro Clinics Organised in villages

KVK, Kasaragod conducted its monthly Agro Clinic at Madikkai and Vorkady panchayats of Kasaraogod district on 16th of July and 27th of December, 2011 respectively. Many farmers participated and benefitted from these programmes by bringing specimens with symptoms of pest and disease attack for diagnosis and consultation of remedy with the team of experts from KVK.

Farmers Monthly interface series with NABARD

The KVK-NABARD partnership Farmers' Monthly Interface series launched on 26th of April, 2011 receieved wide support among the farming community of Kasaragod. Eight monthly interface programmes were organized in which the farm innovators have demonstrated their inventions.

Training on Farm mechanisation

A training programme on Farm mechanisation under 'State Food Security Programme, 2010-11 – Wadackancherry model' sponsored by Dept of Agricuture, Manjeshwar block was conducted on 12th July, 2011. A total of 100 men were trained during the five days training programme in five batches on the operation and maintenance of power tiller, paddy reaper and power operated thresher cum winnower, paddy drum seeder and cono weeder.

Demonstration of paddy thresher in farmers field

Participatory seed production programme

Participatory Seed Production programme in association with NABARD and CRD, Nileswar was inaugurated at KVK on 18th May, 2011. The programme aims at enhancing the food security of Kasaragod district through production of quality vegetable seed production. Various training programmes were organized as part of this programme.

Celebrated Technology Week

Technology week of KVK was organised from 17-11-2011 to 21-11-2011 at Pullur Periya panchayath jointly by KVK and Department of Soil Conservation, Kasaragod district. As a part of the technology week, farmers were appraised of the latest developments in the field of agriculture.

Revolving fund of KVK

KVK has raised and sold 12650 cabbage, 8462 cauliflower, 167 brinjal, 98 tomato seedlings, 500 rooted pepper cuttings and 862 banana suckers under this activity.

KVK, ALLEPPEY

Training programmes

The KVK, Alleppey organized 87 training programmes during the period for a total number of 2264 participants out.

Frontline Demonstrations (FLDs)

Completed FLD on 16 different technologies *viz*., better practices of stingless bee keeping in homesteads, cultivation of tomato in rain shelter, wilt management in cowpea, introduction of high yielding sesamum variety- Thilarani for Onattukara region, soil test based nutrient management in sesamum, , use of pole harvester for coconut harvesting, introduction of high yielding chilly variety Samrudhi as intercrop in coconut gardens, management of blast disease in paddy, demonstration on white elm (CO-2) cultivation, demonstration on duck rearing in cages for homesteads, management of white eye disease (Vit A deficiency) in indigenous ducks, introduction of Gramapriya layer breeds for backyard poultry rearing, introduction of milk pail in neo natal calves, introduction of rumen by-pass fat as energy supplement in dairy cows, feeding of enriched straw in ruminants under scarcity conditions, and use of portable incubator in different parts of the district. Nine technology demonstrations are in progress during the period.

On Farm Testing (OFTs)

Assessment was done in farmers' fields on 11 technologies to find their suitability to local needs. The technologies tested were, use of division boards to overcome wax moth attack, Pseudostem weevil management in banana using bio agents, oral pellet vaccine against Raniket disease in backyard poultry, performance of different rice hybrids under scientific management, effectiveness of IIHR neem soap in cowpea, improved screw press for drudgery reduction in small scale coconut processing units, effect of application of IIHR vegetable special in cowpea, effect of potassium sulphate spray for yield improvement in nendran banana, performance of Hybrid brinjal CoBH-2, performance of soft wood saw dust as substrate for oyster mushroom cultivation, and productive performance of Gramasree and Cauveri. Assessments of five different technologies are progressing in field.

Demonstration of effective use of foliar nutrients in banana cultivation under coconut

Extension activities

Extension activities like help line service (1142 calls), field visits for diagnosis and problem solving (66), agro clinic services (821), farmers group visit (241), students group visit (493 in 5 batches), seminar (3 with 250 participants), animal health campaign/ vaccination (1), method demonstrations (4), radio talks/ programmes (3), participation in exhibition (2), field days (3), group meeting (2), lectures delivered (8), exposure visits (two - 61 participants), radio/ news paper coverage (28), PRA (1) were conducted during the period of report.

Revolving fund activities

Production and supply of ME traps, seeds and seedlings, mushroom spawn, bee keeping accessories, azolla, worms for composting, layer chicks, processed products etc. were undertaken using the revolving fund.

External funded programmes

Under 'Friends of Coconut tree' training programme – sponsored by Coconut Development Board, Kochi. 91 persons were trained in six batches of one week duration.

Conducted training programme on coconut product diversification and scientific vegetable farming in two batches, sponsored by Muthukulam Block panchayath in May, 2011.

Technology demonstration component of the National Initiative on Climate Resilient Agriculture (NICRA) funded by ICAR and coordinated by CRIDA, Hyderabad is implemented in Muttar village of Veliyanad block in Kuttanadu taluk by KVK-Alleppey with an outlay of 30.35 lakhs. The project was officially launched on 8.7.2011. Demonstrations of different climate resilient technologies are in progress at the village.

Demonstration of mechanised paddy cultivation

State-wide network project on 'Soil based plant nutrient management for agro-ecological systems of Kerala'- funded by State dept. of Agriculture and co-ordinated by State Planning Board with an outlay of Rs.5 lakhs is under progress. Analysis of 3645 soil samples from 24 panchayaths and one municipality of Alleppey district and data uploading are in progress.

ALL INDIA COORDINATED RESEARCH PROJECT ON PALMS

Coconut, oil palm and palmyrah occupy a predominant place in Indian rural economy. To improve the productivity in these crops and thus the income level of farmers, the All India Coordinated Research Project on Palms was started in 1972. At present, the Project is implemented in 21 Centres including its headquarters at Kasaragod and Pilicode (Kerala); Aliyarnagar, Aduthurai, Killikulam, Veppankulam (Tamil Nadu); Arsikere, Gangavathi (Karnataka); Ambajipeta, Pandirimamidi, Vijayarai (Andhra Pradesh); Bhubaneshwar (Orissa); Navsari (Gujarat); Madhopur, Sabour (Bihar); Pasighat (Arunachal Pradesh); Kahikuchi (Assam); Mondouri (West Bengal); Jagadalpur (Chhatisgarh); Ratnagiri and Mulde (Maharashtra). Out of the 21 Centres, 13 Centres are conducting research on coconut, six on oil palm and two on palmyrah.

Salient achievement during 2011-12

At Arsikere centre, the trial was initiated to assess the performance of indigenous and exotic crosses (consisting of nine hybrids) along with the local cultivar for their yield. The trial was laid during 1987 in RBD with 3 replications. The nut yield (Average of 4 years) was higher in the GBGD x LCOT (132) and GBGD x PHOT (131) compared to Kalpatharu (90). Hence, these combinations can be released for cultivation in the maidan tract of Karnataka.

Considering the performance of different medicinal crops as a intercrop and market demand, the Arrowroot and Lemongrass have been recommended as intercrops in coconut plantation for Konkan region of Maharashtra.

TNAU Coconut ALR (CN) 3, a selection from Kenthali dwarf is an exclusive tender nut variety which has been accepted and recommended for release in Tamil Nadu region by the State Variety Release Committee.

A joint survey was undertaken to explore the collection of palmyrah at Prakasam and Guntur districts of Andhra Pradesh. A total of 15 accessions were assembled and the present palmyrah germplasm collection at Killikulam centre stands as 238.

Germplasm block of palmyrah palms

Observation on bunch and fruit production in the female palmyrah palms indicated that the trees which were defoliated to the level of 30 % continued to consistently record more number of inflorescences (11) and fruits per tree (100) followed by 50 % defoliation.

The evidence of cropping system research experiments under coconut proved that micro climate of coconut orchards favours cultivation of greenhouse crops like carnation in interspace of coconut garden at low cost and increases the profitability of coconut cultivation. Other than carnation, Bottle gourd, colocasia, brinjal are profitable intercrops under coconut at Jagdalpur centre.

Etiology and epidemiology of basal stem rot disease of coconut is being studied at Ambajipeta and PCR amplification of the 16 newly collected isolates with RAPD primers, Rfu1, Rfu2, Rfu3, Rfu4, Rfu5 and Rfu 7 was carried out and grouping of the isolates is being made.

At AICRP on Palms, Jagdalpur Centre, studies on germination of seeds of Sulphi palms (*Caryota urens*) indicated that the seed treatment with cowdung slurry minimizing seed germination time from 360 days to 90 days.

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