

Research Accomplishments of AICRP on Palms



Dr. H.P. Maheswarappa
Dr. Rajkumar



ALL INDIA CO-ORDINATED RESEARCH PROJECT ON PALMS

(Indian Council of Agricultural Research)

CPCRI, Kasaragod - 671 124, Kerala





◀ Address by DDG (HS) during 22nd AGM

QRT visit to Kahikuchi centre ▶



◀ QRT visit to Mulde centre

QRT Chairman Dr. S.P. Ghosh at Bhubaneswar ▶





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Phone: 04994-232333, Fax: 04994-232322

Website: <http://www.cpcri.gov.in/>

Compiled & Edited by

Dr. H.P. Maheswarappa

Dr. Rajkumar

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MAP SHOWING AICRP ON PALMS CENTRES





1. All India Co-ordinated Research Project on Palms, CPCRI, Kasaragod

1.1 Historical background

Plantation crops constitute an important segment of horticulture in Indian agriculture. Palms such as Coconut (*Cocos nucifera* L.), Oil palm (*Elaeis guineensis* Jacq.) and Palmyrah (*Borassus flabellifer* L.) have contributed significantly for the rural economy of our country. More than 20 million people in rural areas are engaged in the production, processing and marketing the products of these three crops. The long term nature of research on these crops, the prospects of higher returns from research investment and the likely distribution of research benefits to the small holders and economically disadvantaged sections of the society, make it imperative to strengthen the research programme on these crops.

The average coconut productivity in India is still at a low level (6869 nuts/ha/year) as compared to the production potential of 27300 nuts/ha/year. This indicates the scope for increasing the productivity by bridging the yield gap through the use of quality planting materials and adoption of better management practices. Though the coconut growing regions have substantially increased their total nut production during the past, still there is an urgent need to develop location specific agro-techniques for sustaining and improving the productivity levels.

Oil palm is one of the highest oil yielding crops under equatorial bioclimatic conditions that could help the country to minimize the edible oil imports with the cultivation of location-specific oil palm hybrids along with the required management practices. Under intensive management conditions providing recommended dose of fertilizer and weekly flood irrigation on good sandy loam soils, farmers may be able to realize an annual yield of around 20 tonnes of FFB; yielding about 4 tonnes of oil/ha.

Palmyrah palm, adorns the dry landscape of the semi arid regions of Tamil Nadu, Andhra Pradesh, Odisha, West Bengal, Bihar, Karnataka and Maharashtra. India has nearly 102 million palms and half of them are in Tamil Nadu. Out of 51.9 million palms in Tamil Nadu, more than 50% of palms are concentrated in the southern districts of Thoothukudi, Tirunelveli, Virudhunagar and Ramnad districts, while Thoothukudi district alone has a major share of 10 million palms. The palms offer opportunity for increasing the employment potential and provide a source of income to the poor in the rural areas.

1.2 Genesis

The All India Co-ordinated Coconut and Arecanut Improvement Project was sanctioned in the year 1970 by the Indian Council of Agricultural Research and the project started functioning in 1972. The time line of the Project over the years is presented here under:



- 1970 : All India Coordinated Coconut and Arecanut Improvement Project was sanctioned by the ICAR
- 1972 : The Project started functioning and 12 centres located in eight states were added to the project
- 1975 : Five more centres were added
- 1977 : Konark Centre (OUAT) was added
- 1980 : Experiments in Konark were shifted to Patha Farm
- 1980 : Mondouri (BCKV) Centre in West Bengal was added
- 1982 : Kahikuchi Centre (AAU) in Assam was sanctioned
- 1985 : Kahikuchi centre started functioning
- 1986 : Renamed as All India Coordinated Research Project on Palms
- 1987 : Jalalgarh Centre in Bihar was recommended for closure
- 1988 : Razole centre was merged with Ambajipeta centre
- 1989 : Four oil palm centres at Vijayarai (Andhra Pradesh), Mulde (Maharashtra), Gangavathi (Karnataka) and Aduthurai (Tamil Nadu) were added
- 1990 : Pilicode, Mahuva and Dapoli centres were closed
Coimbatore - Coconut programmes were shifted to Aliyarnagar
- 1990 : Arecanut centre at Coimbatore was closed
- 1992 : Research work on arecanut was phased out
- 1995 : Andaman Centre was closed
- 1995 : Two centres for Palmyrah research– Pandirimamidi in Andhra Pradesh and Killikulam in Tamil Nadu were sanctioned
- 2000 : Programmes of Konark centre were shifted to Bhubaneshwar due to the Super cyclone
- 2009 : Two centres for coconut research - Sabour (Bihar) and Navsari (Gujarat), Two oil palm centres - Madhopur (Bihar) and Pasighat (Arunchal Pradesh) were added
- 2010 : One centre for coconut research- Pilicode (Kerala) was started
- 2012 : Programmes of Aduthurai centre (TN) for oil palm research shifted to the Agricultural Res. Station, Pattukkottai in Tamil Nadu.



1.3 Profile of the AICRP on Palms Centres

Details of the 21 Coordinating centers functioning under the AICRP on Palms are presented below:

Sl. No.	Name of the Centre	Location of the centre	University/ICAR Institute
Coconut			
1.	Aliyarnagar	Coconut Research Station, Aliyarnagar - 642 101, Coimbatore District, Tamil Nadu	TNAU, Coimbatore, Tamil Nadu
2.	Ambajipeta	Horticultural Research Station, Ambajipeta - 533 214, East Godavari District, Andhra Pradesh	Dr. YSRHU, Venkataramannagudem, Andhra Pradesh
3.	Arsikere	Horticultural Research Station, Arsikere - 573 103, Hassan District, Karnataka	UHS, Bagalkot, Karnataka
4.	Bhubaneswar	Department of Horticulture, Bhubaneswar – 751 003, Odisha	OUAT, Bhubaneswar, Odisha
5.	Jagdalpur	Saheed Gundadhoor College of Agriculture & Research Station, Kumharawand Farm, Jagdalpur - 494 005, Chhattisgarh	IGKV, Raipur, Chhattisgarh
6.	Kahikuchi	Horticultural Research Station, Kahikuchi, Guwahati 781 017, Kamrup District	AAU, Jorhat, Assam
7.	Kasaragod*	Central Plantation Crops Research Institute, Kasaragod 671 124.	CPCRI, ICAR
8.	Mondouri	Directorate of Research, P.O. Kalyani – 741 235, Nadia District, West Bengal	BCKV, Mohanpur, West Bengal
9.	Navsari	ASPEE College of Horticulture & Forestry, Navsari Agricultural University, Navsari - 396 450, Gujarat	NAU, Navsari, Gujarat
10.	Pilicode*	Regional Agricultural Research Station, Pilicode P.O., Kasaragod – 670 353, Kerala	KAU, Thrissur, Kerala
11.	Ratnagiri	Regional Coconut Research Station, Bhatye - 421 612, Ratnagiri District, Maharashtra	Dr.BSKKV, Dapoli, Maharashtra
12.	Sabour	Bihar Agricultural College, Sabour, Bhagalpur District - 813 210, Bihar	BAU, Sabour, Bihar
13.	Veppankulam	Coconut Research Station, Veppankulam - 614 906, Thanjavur District, Tamil Nadu	TNAU, Coimbatore, Tamil Nadu



Oil Palm			
14.	Gangavathi	Agricultural Research Station, Gangavathi-583 227, Koppal District, Karanataka	UHS, Bagalkot, Karnataka
15.	Mulde	Agricultural Research Station, Mulde - 416 520, Kudal Taluk, Sindhudurg District, Maharashtra	Dr. BSKKV, Dapoli, Maharashtra
16.	Madhopur*	Regional Research Station, P.O. Madhopur - 845 454, Majhauria Via., West Champaran Dist., Bihar	RAU, Pusa Samastipur, Bihar
17.	Pasighat*	College of Horticulture & Forestry, Pasighat - 791 102, Arunachal Pradesh	CAU, Imphal
18.	Pattukkottai	Agricultural Research Station - Pattukkottai - 614 602, Thanjavur District, Tamil Nadu	TNAU, Coimbatore, Tamil Nadu
19.	Vijayarai	Horticultural Research Station, Vijayarai - 534 475, West Godavari District, Andhra Pradesh	Dr. YSRHU, Venkataramannagudem, Andhra Pradesh
Palmyrah			
20.	Killikulam	Agricultural College & Research Institute, Killikulam 628 252, Vallanad, Tuticorin Dist., Tamil Nadu	TNAU, Coimbatore, Tamil Nadu
21.	Pandirimamidi	Horticultural Research Station, Pandirimamidi, Ramapachodavaram P.O. 533 288, East Godavari Dist., Andhra Pradesh.	Dr. YSRHU, Venkataramannagudem, Andhra Pradesh

* Voluntary centres

1.4 Mandate

- To identify, conserve and utilize elite genetic resources for useful traits in palms from different agro-climatic regions and to evaluate performance of varieties/hybrids under different locations and to facilitate release of varieties/hybrids.
- To improve input use efficiency and develop location-specific palm based integrated farming systems to enhance the productivity per unit area, and organic cultivation packages for palms and palm based farming system.
- To evaluate bio-intensive insect pest and disease management strategies, modelling and forecasting of disease incidence and documentation of insect pest dynamics in changing scenario of palm ecosystem.
- Development of post-harvest technologies in palmyrah and to demonstrate and Transfer of technologies to the farmers.



2. Research Accomplishments of AICRP on Palms Centres

2.1 COCONUT

2.1.1 Aliyarnagar: Coconut Research Station, Tamil Nadu Agricultural Research Institute (TNAU), Coimbatore, Tamil Nadu

Year of start: 1990

General information

AICRP palms Aliyarnagar centre had its genesis in 1963 as agricultural research station to cater to the needs of the farming community of Parambikulam Aliyar Command Area. The initial mandate crops are groundnut and coconut. During 2002, the centre was renamed as coconut research station owing to the growing importance of research activities in coconut and its area expansion under coconut cultivation in the western zone of Tamil Nadu.



The centre is located at 10° 29'N latitude and 76° 58'E longitude at an elevation of 288 m above MSL. The research station is having a total area of 21.7 ha, out of which 18.7 ha is cultivable with tall coconut varieties in 12.53 ha and dwarf in 2.72 ha. Centre receives a mean annual rainfall of 858mm (47.1% during North-East Monsoon and 34% during South West Monsoon). The maximum and minimum temperature during summer is 35° C and 22.1° C. The maximum and minimum winter temperature is 31.9° C and 16.8° C. The soil are sandy loam and non-calcareous with neutral PH, low nitrogen, medium P₂O₅ and high K₂O.

Tamil Nadu is 3rd largest coconut growing area in India. The production shows a steady increase during the last three years (5,771 million nuts) with a productivity of 13,717 nuts/ha. The growth rate for coconut production during the last decade is 5.77.

Research Achievements

Crop Improvement

Germplasm evaluation

- A total of 43 germplasm lines comprising of 22 indigenous and 21 exotic accessions were received from CPCRI, Kasaragod in three sets during 1988, 1990 and 1994 and these were evaluated. Based on the evaluation, three varieties at state level and one variety at national level have been released.
- Under the "Collection, conservation and evaluation of local germplasm", a total of 12 local ecotypes have been collected from endemic coconut growing tracts



like Kanyakumari, Theni, Coimbatore and Dindigul districts of Tamil Nadu. Among the 12, five ecotypes viz., CRP 737 (ECT 18), CRP 742 (ECT 23), CRP 743 (ECT 25), CRP 744 (ECT 26) and CRP 745 (ECT 28) are under evaluation.

Variety release at the state level

Since inception of AICRP program at CRS, Aliyarnagar, a total of three coconut varieties, viz., ALR (CN) 1, Kalpataru and TNAU ALR (CN) 3 have been released and popularized among the farming community of different coconut growing districts of Tamil Nadu. The salient features of the varieties are as follows.

ALR (CN) 1

- Year of release : 2002
- Pedigree : Selection from Arasampatti local (Tall)
- Time taken for first flowering : 48 months after planting
- Nut characters : Small to medium sized, Oblong shaped, Green coloured
- Average nut yield : 126 nuts / palm / year
- Copra content : 131 g / nut
- Copra yield : 16.5 kg / palm / year
- Oil content : 66.5 %
- Special attributes : Tall palms with high nut yield, Early bearing



Bearing palm of TNAU ALR (CN) 1



Bunch of TNAU ALR (CN) 1

TNAU ALR (CN) 3

- Year of release : 2012
- Pedigree : Selection from Kenthali Dwarf supplied by CPCRI through AICRP on Palms.
- Time taken for first flowering : 30 months after planting
- Nut characters : Oval shaped nuts with attractive orange colour
- Average nut yield : 121 nuts / palm / year
- Copra content : 192.5 g / nut
- Copra yield : 12.3 kg / palm / year



Bearing palm of TNAU ALR (CN) 3



- Oil content : 56.0 %
- Special attributes : Dwarf palms with attractive orange coloured nuts , suitable for tender nut purpose , Eriophyd mite tolerance
- Average tender nut water content : 420 ml / nut
- Tender nut water quality : TSS : 5.2 % ; Potassium : 190 mg / 100 g



Bunch of TNAU ALR (CN) 3

Contribution for variety release at the National level

- CRS , Aliyarnagar has contributed for the national release and notification of Kalpa Dhenu, Kalpa Pratibha - a tall varieties released by CPCRI, Kasaragod which are suitable for tender nut and copra yield. The varieties are recommended for cultivation in Tamil Nadu.

New hybrids under evaluation

- A total of 5 location - specific cross combinations (COD x ALR 1 , ALR 1 x MGD , MGD x ALR 1 , COD x WCT and ALR 3 x ALR 1) are being evaluated under the trial "Evaluation of new coconut hybrids for location - specific cross combinations."
- Evaluation of five Tall x Tall coconut hybrids (WCT x Tiptur Tall, LCOT x AO Tall , Benaulim Green Red x AO Tall , AO Tall x ECT , ECT x LCOT).

Establishment of Nucleus seed garden

- Under "Network project for establishment of nucleus seed gardens for production of quality planting materials of recently released cultivars", gardens of ALR 1 , COD , MYD and Kenthali have been established for mass multiplication and supply of genuine quality coconut seedlings to the farmers.

Crop Production

- Application of composted coir pith as organic manure saves 50% of nitrogen fertilizer requirement for coconut cultivation.
- Coconut based cropping system with banana, cocoa, elephant foot yam and pineapple has been developed.
- The medicinal plant, Sitharathai (*Alpinia galanga*) and the aromatic plant Lemon grass (*Cymbopogon flexuosus*) were found suitable and profitable subsidiary crops in adult coconut gardens.



Coconut based high density multispecies cropping system



- Fertilizer application through drip fertigation saves 50% of recommended dose of fertilizer requirement in the coconut cultivation.
- Application of NPK @ 1000: 250: 1000 g / palm / year in two splits with 50 % N substitution through vermicompost produced higher nut yield.



Alpinia galanga as intercrop in coconut garden

Entomology

Integrated Insect Pest Management

Rhinoceros beetle, *Oryctes rhinoceros*

- An IPM strategy involving removal and burning of dead coconut trees, collection and destruction of various biostages of the beetle from manure pits, examining the crowns of the tree frequently and hooking out the adults, placing 3 numbers of naphthalene balls / palm at the base of the inner most leaves once in 45 days, application of *Metarhizium anisopliae* fungus @ 5×10^{11} spores / m³ on manure heaps, setting up of Rhinolure @ one per 2 ha checks the incidence of rhinoceros beetle. Reduction in spindle, spathe and leaf damage was noticed in the gardens where IPM measures were practiced.
- Eco-friendly attractant pheromone lures (Rhinolure) developed by CPCRI were field tested for the monitoring and mass trapping of red palm weevils. The NPR CPCRI lures developed by CPCRI were also continuously evaluated for two years and were found superior to PCI lures available in the market both in terms of efficacy and longevity.
- Soak castor cake - 1 kg in 5 lit. of water in small mud pots and keep them in gardens to attract and kill the adults
- Field release of Baculovirus inoculated adult rhinoceros beetle @ 15/ha reduces the leaf and crown damage caused by this beetle.



Damage due to rhinoceros beetle



Pheromone trap (Pipe trap made of PVC) to attract adults

Black headed caterpillar, *Opisina arenosella*

- Remove and burn all affected leaves/leaflets.



- Spray Dichlorvos (2ml/lit) to cover the undersurface of the affected leaves thoroughly in case of severe incidence. Root feeding of monocrotophos 36 WSC (10 ml) + water (10 ml) in a 7 x 10 cm polythene bag is also recommended in heavily infested gardens. In such cases, a 45 days safe waiting period is essential before harvest of nuts.
- *Caridiostethus exiguus* is an efficient egg larval predator of *O. arenosella* and could effectively suppress the caterpillar population, when released alone @ 50 nos./palm at 15 days interval for six times consecutively.
- Spraying of Azadirachtin TS1% i.e. 10,000ppm @5ml+ Sandovit 1ml/litre of water followed by release of improved strains of two larval parasitoids Braconids, Bethyids and pupal parasitoid Chalcid @20:10:1 at 21 days interval for four times has shown significant effect on reduction of *Opisina arenosella* population. The parasitoids were released six times at 21 days interval which minimized the BHC population drastically.
- Olfactory stimulation of the larval parasitoids, *Bracon brevicornis* and *Goniozus nephantidis*, with the excreta/ faecal pellets of BHC, was also done under laboratory conditions 48-72 hours prior to release of the parasitoids which enhanced the parasitisation levels under field conditions.



Damage by Black-headed caterpillar in coconut gardens



Adults of *Bracon brevicornis* for sale at CRS, Aliyarnagar

Red palm weevil, *Rhynchophorus ferrugineus*

- Avoid injuries on stems of palms as the wounds may serve as oviposition sites for the weevil.
- For the monitoring and mass trapping of coconut red palm weevil, economically feasible and eco-friendly attractant pheromones lures (Ferrolure) developed by CPCRI were field tested. The NPR CPCRI lures developed by CPCRI were also continuously evaluated for two years and were found superior to PCI lures available in the market both in terms of efficacy and longevity.
- Setting up of attractant traps (mud pots) containing sugarcane molasses 2½ kg or toddy 2½ litres + acetic acid 5 ml + yeast 5 g + longitudinally split tender coconut stem/logs of green petiole of leaves @ 30 numbers in one acre to trap adult red palm weevils in large numbers.



Red palm weevil affected palm



Pheromone traps for attracting red palm weevil



Trapped adults of red palm weevil

- Root feeding with monocrotophos at 10 ml+ 10 ml water is an efficient practice to kill the different life stages of red palm weevil causing damage inside the trunk. When root feeding with monocrotophos is resorted to, a safe waiting period of 45 days is essential before harvesting the nuts.

Coconut Eriophyid mite, *Aceria guerreronis*

- Application of recommended doses of Urea and Super phosphate and an increased dose of Muriate of Potash to increase the plant resistance to the mite infestation (Urea – 1.3 kg; Super phosphate – 2.0 kg; Muriate of Potash – 3.5 kg/tree/year). Application of well decomposed Farm yard Manure @ 50 kg and neem cake @ 5 kg/tree/year besides soil application of micronutrients viz., Borax – 50 g/tree/year; Gypsum – 1.0 kg/tree/year; Magnesium sulphate – 0.5 kg/tree/year. Basin cultivation of green manures like sunnhemp, cowpea, etc. and incorporating *in situ* and judicious irrigation and mulching with coconut leaves and husk in the basin may also help in reducing the mite incidence.
- Spraying talc formulation of *Hirsutella thompsonii* (CPCRI isolate) during non rainy months @ 20g/palm – 3 sprays/year during October/ November, January/February and April/May reduces the incidence of eriophyid mite damage significantly.
- When severe eriophyid mite damage is noticed, root feeding with monocrotophos at 10 ml+ 10 ml water is resorted to. In case of root feeding with monocrotophos, a safe waiting period of 45 days is essential before harvesting the nuts.

Plant Pathology

Survey and Surveillance on coconut diseases

Survey on the occurrence of coconut diseases revealed that stem bleeding, basal stem rot, leaf blight, bud rot and root (wilt) diseases are the diseases recorded on coconut in Tamil Nadu.

Basal stem rot:

- Remove and destroy the severely affected and dead palm to avoid further spread.
- Split root inoculation method of *Ganoderma lucidum* showed early symptom



expression on 24 months after inoculation compared to the other methods of inoculation including stem block technique and planting of infected bole near the healthy palm.

- *In vitro* screening of several fungicides revealed that Tridemorph, Kitazin and Propiconazole were highly inhibitory to the mycelial growth of *G. lucidum* at 0.1% concentration.
- Application of neem cake 5 kg + drenching of 0.3 per cent Tridemorph around the affected palm significantly reduced the basal stem rot disease incidence.
- Similarly, application of neem cake 5 kg + root feeding of 2% Tridemorph @ 100ml/palm also significantly reduced the BSR disease incidence which was on par with application of neem cake 5kg and root feeding of Aureofungin-sol 2g + CuSO_4 2 g + 100ml water/palm thrice at quarterly intervals.
- Soil application of *Trichoderma viride* @ 250 g/palm/year along with neem cake @ 5 kg/palm/year followed by root feeding of 1 ml hexaconazole + 100 ml water/palm thrice at quarterly intervals was effective in managing the basal stem rot disease.



Basal stem rot affected palm-drooping of leaves



Fructification on basal stem rot affected palm

Studies on leaf blight disease management

- Leaf blight disease intensity increased with increase in temperature. Disease intensity was high during March-April and found at the low during October -December. A range of 42 to 66 percentage of similarity was observed among the *L. theobromae* isolates collected from various locations of Tamil Nadu.
- Remove and destroy the severely affected fronds to avoid further spread.
- Spraying of 1% Bordeaux mixture or 0.25% copper oxychloride for 2 to 3 times during summer months was effective against leaf blight incidence.
- Root feeding of Tridemorph 2 ml or Hexaconazole 2 ml or Carbendazim 2g +



Severely affected palm



100 ml of water/palm thrice at quarterly intervals was effective in reducing the leaf blight disease.

- Application of *Pseudomonas fluorescens* talc formulation @ 200g/palm/year was effective against leaf blight disease.
- Application of 1.5kg MOP in addition to the recommended dose is suggested to improve the palm health as well as disease tolerance/resistance against leaf blight disease.
- Root feeding of *P. fluorescens* culture suspension @ 25ml/palm at quarterly interval along with soil application of *P. fluorescens* talc formulation (50g/palm/yr) + Neem cake (5 Kg/palm/yr) was found to be the best against leaf blight disease.
- A microbial consortia containing the antagonists viz., *P. fluorescens* Pf1, *B. subtilis* (kambalapatti) and *T. viride* (TV1) was developed for the management of leaf blight disease of coconut.
- Several systemic liquid fungicides were screened against *L. theobromae*. Among the fungicides tested, 100% mycelial growth inhibition was observed in the plates amended with 0.1% of Tebuconazole, Tebuconazole + Trifloxystrobin, Kresoxim methyl and 0.2% of Carbendazim.



Leaf blight management strategies

Root (wilt) disease

- Occurrence of root (wilt) disease in Theni, Kanyakumari, Tirunelveli, Dindigul, Coimbatore and Tirupur districts of Tamil Nadu were noticed and reported to prevent the further spread of the disease.
- Based on the survey over the period, it was observed that the root (wilt) incidence was noticed from 1 to 32.1 per cent in districts of Tamil Nadu bordering the Kerala state.
- In order to identify a indicator plant for root (wilt) disease, the annual crops including millets (sorghum, cumbu), pulses (blackgram, greengram, horsegram cowpea, chickpea), oilseeds (sesamum, sunflower, groundnut), vegetables (brinjal, tomato), fruits (banana), and fodder grasses (napier hybrid, fodder sorghum) and perennial crops like cocoa, nutmeg, arecanut grown as intercrop/ mixed crop in coconut gardens in the affected areas were periodically observed. Root (wilt) symptoms were not recorded in any of the crops.



Root (wilt) disease incidence in Tamil Nadu



Severely root (wilt) affected garden



Root (wilt) affected palm showing mammal's rib like symptom



Leaf rot symptoms

Validation of CPCRI recommended integrated root (wilt) management strategies evaluated at Gudalur, Theni district revealed that reduction in root (wilt) disease intensity ranges from 0.7 to 6.6 and the average reduction in root (wilt) disease intensity was 3.1. The nut yield per palm per year ranged from 76 to 118.

Post harvest studies

- Common mycoflora on copra during storage at room temperature were isolated and identified as *Aspergillus niger*, *A. flavus*, *Rhizopus*, *Penicillium* sp. and *Botryodiplodia* sp..
- Among the different mycoflora identified, *Aspergillus flavus* was found to be predominant.
- Potassium metabisulphite and Benzoic acid @ 500 ppm concentration were found to be effective against *A. flavus*.
- *Trichoderma viride* was found as an effective biocontrol agent against *Aspergillus flavus* *in vitro*.



2.1.2 Ambajipeta: Horticulture Research Station, Dr. YSR Horticultural University, Venkataramannagudem, West Godavari, Andhra Pradesh - 534 101

Year of start: 1972

General information

Agro-climatically AICRP palms, Ambajipeta of Andhra Pradesh falls under medium rainfall (900-1000 mm per annum) with dry spell during May. The maximum temperature is 35 to 39°C and minimum temperature is 19-31°C during winter. Soil pH found to be alkali (7.5 to 8.5) with medium soil fertility levels. The state of Andhra Pradesh covers about 1,03,967 ha under coconut cultivation, local tall varieties particularly green coconut varieties are predominant in the state. The major coconut produce is used for fresh kernel and tender nut water as refreshing drink. Value addition in coconut is not yet addressed economically as in traditional coconut growing neighboring states like Kerala and Tamil Nadu. Coconut is grown as monocrop on commercial scale for copra and tender nut purpose. To promote coconut cultivation in the state, Coconut Development Board (CDB) has launched its ambitious programme for providing coconut climbing machine along with training to the unemployed youth in rural areas to revive the farmers' interest to opt for coconut cultivation.



Research Achievements

Crop Improvement

Germplasm assembled and evolved

A total of 35 germplasm accessions were collected and maintained at AICRP on Palms, Ambajipeta centre. The germplasm lines which were collected from CPCRI, Kasaragod and selection of local elite palms are evaluated for their performance in terms of yield and adaptability to the agro-climatic condition to find out suitable variety to Andhra Pradesh. Based on the performance found during evaluation released following varieties in collaboration with CPCRI:

- 1) Kerachandra: A selection from 'Philippines Ordinary Tall' was released as a national variety by CPCRI considering the better performance at CPCRI, Kasaragod and AICRP palms Ambajipeta centre. The variety yielded 130 nuts/palm/year, with copra content of 200 g/nut and oil content 64 % has been recommended for Andhra Pradesh.
- 2) Kalpa Pratibha: A selection from 'Cochin China' released by CPCRI Kasaragod considering the better performance at CPCRI, Kasaragod and the performance at Ambajipeta. The variety was superior with nut yield of 106 nuts/palm/year, with Copra content of 228 g/nut and Oil content 65 % at Ambajipeta centre and



recommended for cultivation in the state.

- 3) Kera Bastar: A selection from 'Fiji Tall' supplied from CPCRI Kasaragod yielding 110 nuts/palm/year, with copra content of 170 g/nut and oil content of 67 %) has been released for cultivation in the state during 2007.
- 4) Gauthami Ganga: A selection from 'Ganga Bondam' was released during 2007 owing to its dwarf character, precocious bearing and for tender coconut water with an average nut yield of 80 nuts/palm/year, copra content 156 g/nut and oil content 68 %.

Hybrids released

Godavari Ganga: The T x D coconut hybrid a cross between East Coast Tall x Ganga Bondam was released as "Godavari Ganga" in the Andhra Pradesh state with 40 per cent increased nut yield over local cultivar East Coast Tall during 1991. It comes to bearing in four years with annual nut yield (140/palm). The hybrid contains high copra content (150 g/nut) and Oil content (68 %). It can also be used for tender nut purpose as it contains higher quantity of tender nut water.

New hybrids recommended for release

- The coconut hybrid GBGD x PHOT (Vasista Ganga) found promising and proposed for release in Andhra Pradesh and Karnataka states based on its precocity, higher nut yield (125 nuts/palm/year), copra output 21.9 kg/palm/year, oil content 69% and oil yield 15.1 kg/palm/year with good tender nut water content (395 ml) and TSS (6.2°Brix).
- The coconut hybrid GBGD x LCOT (Ananta Ganga) found performing better and proposed for release for commercial cultivation in Andhra Pradesh and Karnataka states. The hybrid is high yielding, precocious; having heavy bunches with average nut yield (128 nuts/palm/year), copra output 21.7 kg/



Gautami Ganga bearing palm



Godavari Ganga-bearing palm



Vasista Ganga bearing palm



Ananta Ganga bearing palm



palm/year, oil content 72 % and oil yield 15.5 g/palm/year).

Nucleus seed garden establishment

- Established seed gardens of Gautami Ganga, Kalpa Prathibha and Kera Chandra at Ambajipeta centre for mass multiplication and to supply genuine quality coconut seedlings to the farmers.
- Documented 1000 elite mother palms in each of major coconut growing districts of East & West Godavari and Visakhapatnam recorded yield and its specific characters for future utilization purpose.

Crop Production

Nutrient Management

- Fertilizer dose requirement for East Coast tall variety is @ 500 g N, 1250 g P and 1000 g K per bearing palm per year.
- Integrated nutrient management in coconut indicated that average nut yield/palm was higher (121 nuts/palm/year) with 50% composted coir pith (25 kg) + 50% recommended dose of chemical fertilizers.

Drip fertigation

- Studies on fertilizer application through micro-irrigation technique on coconut revealed that, application of 75% recommended dose of fertilizers (375 g N, 240 g P_2O_5 and 750 g K_2O per palm per year) is recommended through fertigation in eight splits from October to May. In terms of fertilizers viz., 91 g Urea, 74 g DAP and 178 g MOP are recommended for single dose per palm (Seven doses are to be applied from November to May).

Coconut Based Cropping System

- Among the five medicinal and aromatic crops evaluated, lemon grass recorded the highest fresh herbage yield (42.8 t/ha) followed by citronella (33.4 t/ha). The highest oil yield was registered in lemon grass (3.5 kg/t) followed by patchouli (3.4 kg/t). The crop combination of coconut + patchouli is more profitable with a B:C ration of 2.59 followed by coconut + citronella (2.13). Considering the performance of medicinal and aromatic plants and their economics, the crops viz., patchouli, citronella and lemon grass found promising as inter crops under coastal eco-system of Andhra Pradesh.
- Coconut based high density multispecies cropping system with cocoa, banana, pineapple, elephant



Citronella as intercrop



Patchouli as inter crop in coconut



foot yam and heliconia has been established which has produced higher net profit for the coconut farmer.

Plant Pathology

Integrated Disease Management Package for Basal stem rot disease

- The diseased part of the garden should be isolated from healthy area by digging isolation trench (1 m. deep and 0.5 m. width).
- Removal and burning of diseased and dead palms along with roots.
- The pit for replanting should be filled up with a mixture of soil and farmyard manure in equal quantities along with 50 g of *Trichoderma viride* talc powder + 1 kg neem cake
- Seedlings for new plantations should be raised in disease free fields.
- Injury or damage to roots and pruning or cutting of roots should be avoided prevent infection through injured roots.
- Since the disease is more severe in light soils with poor water holding capacity, raising of green manure crops like Sunnhemp and Sesbania and ploughing *in situ* is advised to increase soil organic matter and antagonistic microflora.
- Selection of seedlings for new garden from *Ganoderma* infected soil should be avoided.
- Frequent watering/irrigation should be done during summer months. While irrigating, care should be taken to avoid flow of water from diseased trees to others. Basin system of irrigation to individual palms should be adopted.
- Talc formulation of *T. viride* (50 g) in combination with 5 kg neem cake/palm/year should be applied to all palms in a garden.
- The biocontrol agent (*Trichoderma viride*) should not be applied in combination with fungicides.
- Application of fertilizers must be done as per recommendation.



Destruction of dead palm material



In situ green manuring



Application *Trichoderma viride* (50g) and neem cake (5 kg)

IDM technology for stem bleeding disease of coconut

- Injury or damage to the stem, especially while tractor ploughing should be avoided.



- Smearing of talc powder paste of *T.viride* / *T.harzianum* / *T.hamatum* on the bleeding patches on the stem (paste can be prepared by adding 5 ml of water to 10 g of talc powder).
- Soil application of 50 g of talc powder formulation of *Trichoderma viride* / *T. harzianum* / *T. hamatum* in combination with 5 kg neem cake /palm /year.
- Recommended dose of organic (50 kg FYM or green leaf manure or compost) and inorganic fertilizers (NPK 1 kg: 2 kg: 2½ kg) may be applied per palm/year.
- Frequent watering / irrigation should be done during summer months. While irrigating, care should be taken to avoid flow of water from diseased trees to others. Basin system of irrigation to individual palms should be adopted.
- Good drainage facilities may be provided in the garden.
- Raising and ploughing in situ of green manure crops like Sunhemp and Sesbania is advised to increase soil organic matter and antagonistic microflora.

Integrated Disease Management package for bud rot disease in coconut

- The garden should be kept clean.
- The trees died due to bud rot should be removed and burnt to avoid further spread of the disease.
- In the initial stages of bud rot, the rotten parts should be removed and destroyed.
- Application of talc powder formulation of *Pseudomonas fluorescence* or *Trichoderma viride* in crown region of coconut seedlings is recommended.
- The required quantity of talc formulation of *Pseudomonas fluorescens* or *Trichoderma viride* to be applied in the crown region of coconut seedlings is 5 g, 10 g, 50 g, 75 g, 100 g, 150 g and 200 g for 6 months, 1 year, 2 years, 3-5 years, 6-10 years, 11-20 years and above 20 years age of coconut seedlings respectively.
- Spraying of 10 to 15 day old culture filtrate of *Pseudomonas fluorescens* at 100% concentration twice at 30 days interval on crown region and on nuts of coconut.

Entomology

Integrated management practices for rhinoceros beetle, *Oryctes rhinoceros*

- a) **Sanitation** : Remove and destroy all possible decaying debris and dead palms from the plantation since these act as prolific breeding grounds for the beetle.



Treatment of FYM pits for rhinoceros beetle management



- b) **Mechanical** : The adult beetles can be extracted using curved beetle hooks from the palm crown particularly during the peak period of population build up. The holes made by the beetles are to be filled with a mixture of neem seed kernel powder 100g + 150g sand.
- c) **Prophylactic leaf axil filling** : To protect the young palms from rhinoceros beetle attack, the innermost 2-3 leaf axils are to be filled with a mixture of neem seed kernel powder 100g + fine sand (150g) per palm during May, September and December months.
- d) **Biological** :

Pathogens : Baculovirus of *Oryctes* and the green muscardine fungus cause diseases to the immature and adult stages of the beetle.

The viral pathogen Baculovirus of *Oryctes*: The adult beetles can be inoculated either by feeding the viral inoculum or by allowing the insect to crawl over the viral suspension. Release of such baculovirus inoculated beetles has to be done @ 10-15 beetles/ha of the plantation periodically.

The entomo pathogen *Metarrhizium anisopliae* (Metch.) Sorokin : This fungus can be mass cultured in rhinoceros grubs or broken maize grain or coconut water or on cassava chips and rice bran supplemented with a nitrogen source. Periodical spraying of fungus on manure heaps is to be done during monsoon season. The fungus should be inoculated @ 5×10^{11} spores / m³ of the breeding material.

- e) **Periodical spraying of insecticide**: Carbaryl 50 per cent W.P @ 3gms / 1 lt. of water on the farmyard manure heaps may be done for the control of immature stages of the pest.
- f) **Traps for attraction**: Establishment of rhinolure traps @1 trap/ ha will help in effective trapping of adult beetles.



Pipe trap technique for trapping adult rhinoceros beetles using rhinolure

Integrated management practices for red palm weevil *Rhynchophorus ferrugineus*

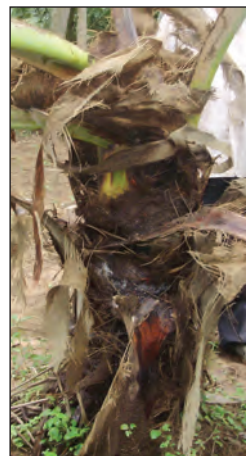
For the management of red palm weevil an integrated approach involving all proven methods of control is very effective. This includes:

- I. **Sanitation and Cultural methods**
 - a. The palm crown has to be cleaned periodically to avoid decaying of organic debris in leaf axils. Dead palms which lodge various stages of the weevil



should be removed, cut open and burnt so as to destroy all stages of the pest there by preventing spread of the weevil to neighbouring healthy palms.

- b. As far as possible avoiding making any cuts causing injuries to the palm through agricultural tools and implements as these will attract weevil for egg laying. The cuts or injuries if any, may be treated with coal tar and carbaryl.
- c. When fronds are to be removed from the palm, it should be cut leaving a petiole length of 120 cm. This will avoid entry of the pest into the trunk portion.
- d. Palms affected by bud rot and leaf rot disease and rhinoceros beetle may be properly treated with respective fungicides and insecticides.



Red palm weevil damaged palm

II. Insecticidal treatment

a. Prophylactic method :

- Treat wounds with a slurry of mud and insecticide to prevent egg laying by weevil.
- Fill leaf axils and holes made by rhinoceros beetle with neem seed kernel powder 100g + fine sand (150g)
- Treat bud rot infected palms with copper oxy chloride fungicides (3g/litre of water)



Ferrolure trap for trapping red palm weevil adults

- b. **Curative treatment :** The affected palms in early stages of infestation could be saved by root feeding with monocrotophos@ 10ml+ 10ml water. Chisel out affected trunk region and burn it and smear the wounded portion with coal tar. After cleaning fill the tunnelled portion of trunk with cement and sand mixture to give strength to the palm.

III. **Pheromone trapping:** The commercially available pheromone lure is hung inside from the lid of the bucket which is filled with 100 g pineapple/sugarcane, 2 gm yeast and 2 gm carbaryl in one litre of water as food bait which is necessary to orient the weevil into the trap. The trap is hung in the gardens at a height of 1 to 1.5 m above the ground level in the field @1 trap per hectare.

Integrated management practices for black headed caterpillar, *Opisina arenosella*

- I. **Mechanical :** Early to mild stages of infestation can be reduced by cutting and



burning the badly infested leaves/ leaflets.

II. **Biological** : Among the parasitoids, the larval parasitoids, *Bracon hebetor*, *Goniozus nephantidis* and pupal parasitoid, *Brachymeria nosatoi* are the most promising ones. These parasitoids can be mass multiplied and released in *Opisina arenosella* affected coconut plantations.

III. **Insecticidal** : In severely infested gardens spray the palms once with dichlorvos 0.02 per cent. Spray the under surface of the leaves to give a thorough coverage to the galleries of the pest. Root feeding with monocrotophos 10 ml and 10 ml water. No harvest should be made (either mature or tender nuts) at least for 45 days after treatment.

IV. Under Epidemic populations :

- Removal and burning of one or two badly infested leaves in the outermost whorl.
- Spray dichlorvos 0.02 per cent initially, if the pest is in its active larval stage.
- Give root feeding with monocrotophos @ 10 ml + 10 ml water when the pest is in larval stage after harvesting the matured nuts. A safety period of 45 days should be observed.
- Release of larval parasitoids after safety period and pupal parasitoids after root feeding.
- Combined with the management techniques, adequate manuring (recommended dose of fertilizers: 1 kg urea, 2 kg single super phosphate and 2 ½ kg muriate of potash / palm) and irrigations are to be resorted for rejuvenating the very severely affected palms.



Coconut garden severely affected by Black headed caterpillar



Release of bio agents by farmer Sri M. Krishna Murthy, Dwarapudi

Integrated management practices for eriophyid mite, *Aceria guerreronis*

- Based on the results obtained from the field surveys and experiments, the following package was developed for the management of coconut eriophyid mite.
- Phytosanitary measures are to be taken up in the gardens regularly. Root feeding of Azadirachtin 10,000 ppm @ 10 ml + 10 ml water given three times in a year i.e., December - February, April - June and September - October



- Recycling of organic waste, Raising of green manure crops in the basin, Application of recommended dose of fertilizers, Recommended level of irrigation, Husk burial in basin.

Integrated management practices for slug caterpillar, *Macroleptra nararia*

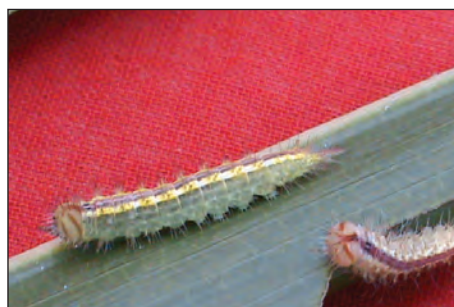
- Monitor the crop in the summer months for pest incidence by installing light traps.
- Cutting and burning of severely infested and dried leaves will reduce the pest population to a greater extent.
- Spraying of carbaryl 50% w.p. @ 3 g/1 lit. of water in the young gardens will check the pest.
- Root feeding of monocrotophos 36% WSL @ 10 ml + 10 ml water/palm by observing 45 days safety period will control the caterpillar stage of the pest.
- Immediate application of recommended dose of fertilizers (1 kg Urea, 2 kg Single super phosphate and 2 ½ kg Muriate of potash) and irrigation will boost the palms to recover early.
- Checking the pest incidence on other inter crops also helps to keep the pest under check.



Slug caterpillar larvae



Light traps for trapping slug caterpillar moths



Coconut leaf feeder *Phalacra* sp

Integrated Management Practices for coconut defoliator, *Phalacra* sp.

- Installation of light traps [200 w bulb] for mass trapping and destruction of adult moths
- Cutting and burning of severely infested and dried leaves will reduce the pest population to a greater extent.
- Spraying of carbaryl 50% W.P. @ 3 g/1 lit. of water in the young gardens will check the pest spread.



Defoliation due to *Phalacra* sp caterpillar feeding



- Root feeding of monocrotophos 36% WSL @ 10 ml + 10 ml water/palm by observing 45 days safety period will control the caterpillar stage of the pest.

Integrated management practices for Rodents

- Regular cleaning of the crown, expose the breeding places of the pest to avian predators and thus reduce population build up. Clean cultivation reduces the harbourage spots for ground dwelling rodents to the minimum.
- Wooden rat traps baited with ripe coconut kernal set at the rate of 30 traps / ha on the crown of palms are found to be the best for trapping black rats
- The more effective and economic way of controlling this pest is by use single dose anti coagulant rodenticide bromadiolone (0.005%) in wax cake formulation. In coconut plantations application of bromadiolone wax cakes @ 2 nos./ palm on the crown of infested palms, two times at monthly interval is recommended for effective control of black rat.
- The burrowing rodents such as bandicoots and gerbils which can damage seedling in nursery can be effectively controlled by zinc phosphide baiting. The baits can be prepared by mixing 95 parts of rice three parts of coconut oil and two parts of zinc phosphide.
- In case of coconut nurseries frequent irrigations along with cleaning of bunds and fields keeps away the rats in the nursery.
- Smoking of rat burrows with help of smoke generators helps in checking rat population.
- Indiscriminate killing of predators such as owls, vultures, rat-snakes, mangoose, etc. should be discouraged as these are the potential enemies to rodents.



2.1.3 Arsikere: Horticulture Research Station, University of Horticulture Science (UHS), Bagalkot, Karnataka-

Year of start: May 1976

General information

The Horticulture Research Station, Arsikere is situated at 76° 15' E longitude and 13° 15' N latitude with an altitude of 808 m MSL. The soils are red sandy loam to medium black clay soils. The soils having alkali Ph range between (7– 8). The soils are low in available nitrogen (254.1 kg N/ha) and phosphorous (19.0 kg P₂O₅/ha) and medium in available potassium (246.0 kg K₂O/ha). The average annual rainfall of the region is 815 mm which distributed mainly during April to October. There are two peaks in rainfall distribution, one in May and the other during October. The mean minimum temperature ranges from 11.0°C (January) to 19.3°C (June) and the maximum temperature ranges from 27.9°C (December) to 35.4°C (March). The mean relative humidity ranges from 49.1% (March) to 75.0% (August).



Research Achievements

Crop Improvement

Coconut varieties

1. **Kalpataru:** Coconut variety selection from local cultivar 'Tiptur Tall' grown in Thumkur and Hassan district of Karnataka. The palms take about 6-7 years for flowering. The average yield of nuts per palm is 90 (15750 nuts/ha and 80-120 nuts/palm and tender nut contains 270 ml of fresh water of good taste). The variety is suitable for both rainfed and irrigated regions of Karnataka, Tamil Nadu and Kerala states.



Kalpataru variety of coconut

Coconut hybrids

Three coconut hybrids with cross combination of Gangabondam green dwarf x Laccadive ordinary Tall (GBGD x LCOT), Gangabondam green dwarf x Philippines ordinary tall (GBGD x



Bunch - Kalpataru



PHOT) and Gangabondam green dwarf x Fiji Tall (GBGD x FJT) were found suitable for cultivation in Karnataka state. The performance of these hybrids in terms of yield was higher than the local cultivar (Tiptur Tall).

- GBGD x LCOT (133 nuts/palm/year and 21.3 kg copra/palm/year)
- GBGD x PHOT (130 nuts/palm/year and 20.6 kg copra/palm/year)
- GBGD x FJT (120 nuts/palm/year and 19.1 kg copra/palm/year)



Ananta Ganga



Vasista Ganga



Kalpa Ganga

Crop Production

Intercrops: Intercropping of banana, drumstick, french bean-ladies finger and redgram in adult coconut palms is found productive and remunerative. The crops are selected depending on the availability of irrigation water. When there is a good source of irrigation water, high water requirement crop like banana, drumstick, french bean and ladies finger can be grown. Under limited source of irrigation water, redgram can be grown with need based protective irrigation.



Coconut + Banana



Coconut + Drum stick



Coconut + French bean

Medicinal and aromatic crops for coconut gardens: Lemon grass (*Cymbopogon flexuosus*), garden rue (*Ruta graveolens*), tulsi (*Ocimum sanctum*), Kalmegh (*Andrographis paniculata*), arrow root (*Maranta arundinacea*), and makoi (*Solanum nigrum*) are the promising medicinal and aromatic plants for intercropping in coconut gardens of *maidan* tract of Karnataka.



Coconut + Redgram



High density multispecies cropping system (HDMSCS) for rain fed regions of Karnataka

The HDMSCS model was being developed for rainfed region of Karnataka and it was successfully demonstrated to the growers. The medium height subsidiary crops like cocoa, lime and drumstick were planted in 40 year old coconut garden (Tiptur Tall cultivar). The generated coconut waste was recycled by vermicomposting. The green manure crop like sunhemp/ cowpea was grown in the basins of coconut, cocoa, lime and drumstick and same was incorporated into the soil every year during *Kharif* season. The coconut could be leaves used as mulching the basins of coconut and its intercrops to conserve moisture during winter and summer months.

Drip irrigation: Drip irrigation at 100% Eo is ideal for coconut in rainfed tract of Karnataka. The irrigation water requirement during summer months (February-May) is 65-75 while for winter and rainy months (June-January) are 40-50 palm/day.

Drip fertigation: The 25% of recommended dose of fertilizer can be saved through drip fertigation in coconut cultivation in rainfed region of Karnataka. 75% of recommended NPK ap in eight split was found to be.

Use of coir pith as a organic manure and source of nitrogen: Raw coir pith can be convert as good manure by using ligno-cellulolytic fungi, *Pleurotus sajorajyu*. The composted coir pith (CCP) can be applied to coconut palm to supplement 50-100% of the recommended dose of N (25-50 kg CCP).

Fertilizer dosage for hybrid coconut: A fertilizer level of 1000:250:1000 g N, P_2O_5 , K_2O per palm per year is optimum and recommended for hybrid coconut (COD x WCT) in the *maidan* tract of Karnataka.

C. Crop Protection

Management of basal stem rot: The combined application of hexaconazole @ 1% (100ml) root feeding at quarterly interval along with soil application of neem cake (@ 5 kg/palm/year and *Trichoderma viride* (@ 50g/palm/half year is effective in the management of basal stem rot disease of coconut.



2.1.4 Bhubaneswar: Department of Horticulture, OUAT, Bhubaneswar, Odisha

General Information

- The centre “All India Coordinated Research Project on Palms” functioning under O.U.A.T was continued at Konark, Puri during 1984 to 2002.
- But the poor soil condition (littoral sand) of the centre at Konark as well as the super cyclonic hit resulting severe damage to the experimental palms during October 1999 paved the way for shifting of research centre of AICRP on Palms from Konark to Bhubaneswar.
- The centre again **restarted at Bhubaneswar** in the year **2003** and continuing till date.
- The total area of the present research station is about 17.5 Acres (7.0 ha).
- The soil status of the centre at Bhubaneswar :Loamy sand (textural class), pH (5.83), low in available nitrogen. Phosphorus and potassium.

Research achievements

Crop Improvement

- Coconut cultivars like Gangabondam (63 nuts/palms), MGD (50.8 nuts/ palm), were found more suitable for coastal sandy soil of Odisha.
- The cultivars like GBD, COD, MOD, MYD, Laccadive Ordinary, Sakhigopal local evaluated for tender nut types were found to be more suitable for tender nut purpose because of high volume of water and mineral content at seventh month of development.
- Among different promising coconut varieties and hybrid studied, - WCT x GBD (68 nuts/palms), Laccadive Ordinary (52 nuts /palm) performed well in the littoral sandy soil.

Crop Production

- Sixteen local strains of Sakhigopal Local have been identified Viz. Jahaji. Jahaji yellow, Bana, Suryabana, Tinisira, Dhila, Local Brown, Gol, Chaka, Goja, Narangi, Local giant, Dhanei, Tinisira, Khila and Bangera.
- Root distribution pattern of coconut hybrids were studied. Effective root zone was found within 0-60cm depth and 0-200cm laterally from the trunk and found suitable for irrigation and fertilizer application in sandy soils. The NPK content of root was higher in good bearer than poor bearer.
- Application of coir dust at the rate of 40 kg in the palm basin increased the water holding capacity and resulted in increased growth and development of palms in sandy soils.



- Recovery pattern of cyclonic damaged palms were studied. Basing on the intensity of damage the palm takes 2 to 4 years to recovered fully.
- A fertilizer dose of NPK 1500: 750: 1250 g along with Ca: 150g and Mg: 30g per palm per year in three equal splits was found to increase the growth and yield of local tall palms in sandy soils as against NPK 500: 320: 1200.
- Application of 50% of recommended chemical fertilizers and rest 50% NPK supplemented by Organic sources particularly composted coir pith was found more effective for better growth and yield of palms under Odisha condition.
- Among various combinations of coconut based cropping system models tried, the combination of coconut+ banana+ tuberose in young coconut garden was considered more profitable and recommended for commercial adoption in the state.
- Medicinal and aromatic plants like stevia (*Stevia rebudiana*) and Artensia (*Artensia pallens*) were found more promising for cultivation as intercrops in coconut gardens under Odisha condition.



2.1.5 Jagdalpur: SG College of Agriculture & Research Station, Kumharawand, IGKV, Raipur, Chhattisgarh

Year of start: 1988

General Information

All India Coordinated Research Project on Palms Jagdalpur centre comes under Zone VII eastern ghat and plateau zone of Indian Agro climatic Zone. This Zone includes *Dandakaranya* region, plains of *Mahanadi*, *Indravati* and *Sabri* rivers tract and is a part of continuous tribal belt and known for special tribal culture and whole region is known as unique name “Bastar Plateau Zone” comprises of seven districts; Jagdalpur, Kanker, Dantewada, Bijapur, Narayanpur, Kondagaon and Sukma. The longitude of the centre 20° 34' N and latitude 82° 15'E with mean sea level of 850m. The zone receives high rainfall couple with comparatively lower temperature and high humidity. The average annual rainfall (mean of 50 year) ranges from 1200 to 1600mm mostly received from June to September with its peak in July and August. The maximum and minimum temperature during peak summer and winter touches 42 °C and 4 °C, respectively.

The soils are silty loam to clay-loam, rich in silicon, prone to excessive cementing nature with low contents of organic matter, zinc, nitrogen, phosphorus, potash and boron. PH ranging from 5.5 to 6.1.

Research Achievements

Crop Improvement:

- Germplasm accession IND 004 S of CPCRI - Kasaragod was evaluated evolved in bastar region and for release in the name of *Kera Bastar* suitable to rainfed condition in the Maharashtra and irrigated condition of coastal Andhra Pradesh and Tamil Nadu also.
- Verrikobari and Gonthebilli were also found to be promising varieties for tender nut purpose.
- Ten local germplasms were identified and characterized for cold tolerance and collected for further evaluation.



Coconut variety - Kera bastar

Crop Production

- Tikhur, (*Curcuma angustifolia*) Amahaldi (mango ginger), colocasia, elephant foot yam and sanone are profitable intercrops under coconut garden.
- Coconut + Bottle gourd + Cowpea are profitable intercrops under coconut.
- The evidence of cropping system research experiments under coconut proves



Intercrop in Kharif season
(Elephant foot yam)



Intercrop in Rabi season (Bottle guard and cowpea)



that micro climate of coconut orchards favours cultivation of greenhouse crops like carnation in interspaces' of coconut garden which is of low cost and increase the profitability of coconut cultivation.

- Local elite coconut palm yielded more than 150 nut/palm/ year were identified in entire Bastar zone and around 71 elite palms have been identified as mother palms for seednut collection and seedling production.



2.1.6 Kahikuchi: Assam Agricultural University (AAU), Jorhat, Assam

Year of start: 1985

General information

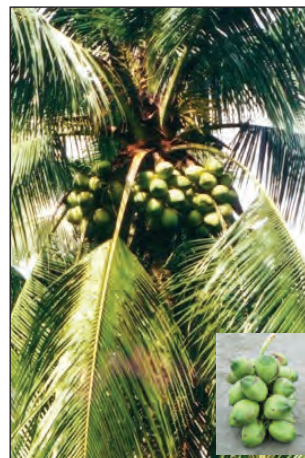
The Centre is located near Lakapriya Gopinath Bordoloi Airport (Borjhar) and about 17 km away from Guwahati city. Geographically, Kahikuchi is situated on the 26.3° N latitude, 91.7°E longitude and 64 m above the mean sea level. The soil of the centre is mainly alluvial clay-loam with pH ranges - 4.5 -5.5. The area receive an annual rainfall of about 1200- 1800 mm and hot-humid during summer Periodic dry spell generally occurs from November to March. The maximum and minimum temperature ranges from 19°-35° C and 5°-26° C, respectively. The soil fertility status of the centre is in the medium range having N= 264.8 kg/ha, P₂O₅ = 20.6 kg/ha and K₂O = 126.1 kg/ha.



Research Achievements

Crop Improvement

1. **Variety released:** A high yielding coconut variety "Assam Green Tall" (KAMRUPA) has been selected and released under the trial 'Trial of promising seed materials' and recommended for this region. The variety recorded more than 100 nuts/palm/year, tolerant to low temperature and semi-waterlogged condition, tolerant to stem bleeding, red palm weevil, crown choking and grey leaf spot. Better nut quality with 253 ml of tender nut water, copra yield: 2.86 tonnes/ha, oil content: 64.5 %. Adaptable to wide range of soil and highly accepted by the farmers.



Kamrupa variety

Crop Production:

Coconut based high density multispecies cropping system: A suitable model of coconut based high density multispecies cropping system has been established. The model comprised of coconut (16 adult palms) + black pepper (var. panniyur-1) + ginger (var. nadia) + assam lemon + banana (var. chenichampa) + pineapple (var. Kew). The model was found to be profitable and highly sustainable.

Coconut based medicinal and aromatic cropping system: Out of five five MAPs tried under coconut, the intercropping system of coconut + patchouli proved to be the best with net return of Rs. 1,78,089/ha and benefit cost ratio of 3.26 as against Rs. 52,750/



Coconut based cropping system with M & AP'S

ha and B:C ratio of 1.85 under coconut alone.

Nutritional requirement of high yielding/hybrid coconut: For the hybrid COD x WCT, a fertilizer dose of 500 g N: 500 g P_2O_5 : 2000g K_2O has been proved to be the best by recording the highest yield of 114.8 nuts/palm/year and benefit cost ratio of 3.45.

By adopting integrated nutrient practice, (50% N by urea + 50% N by vermicompost), P_2O_5 = 500 g/palm/year and K_2O = 2000 g/palm/year. The total nitrogen can be supplied through vermicompost (50%) and organic fertiliser.

Fertilizer application through micro-irrigation technique for coconut: Application of 75 % RDF through drip irrigation recorded the highest nut yield (82.8 nuts/palm/year) and net return of Rs. 96,185.00/ha with B:C ratio of 2.01.



2.1.7 Mondouri (Kalyani): Bidhan Chandra Krishi Viswa Vidyalaya (BCKV), Nadia, West Bengal

Year of Start: 1980

General Information

The centre of All India Co-ordinated Research Project on Palms was sanctioned to Bidhan Chandra Krishi Viswavidyalaya (BCKV) in 1980-81. The project was started functioning at Mondouri centre, BCKV from 1981. The centre is located at the New Alluvial Zone, situated centrally between 21.5°- 24.5° North latitude and 86°-89° East longitude. Average temperature is 35-37 °C throughout the summer months. The winter is mild with average temperature being 8 to 12 °C. The natural precipitation ranges between 1600 mm and 1800 mm, average annual rainfall being 1700mm. The soil of the experimental plot was Gangetic alluvial, sandy loam in texture, well drained with medium fertility status.

Research Achievements

Crop Improvement

Kalyani Coconut -1 – A selection from Jamaican tall supplied from CPCRI, Kasaragod has been released for cultivation in the state with average nut yield of 110 nuts/palm/year.

Crop Production

Intercropping system

Coconut (East Coast Tall) + Ginger (Annual)
+Okra (Seasonal)

Coconut (Tall) +Black pepper + pineapple
(Biennial)

Coconut + Black pepper+Tuberose
+Heliconia



Visit of QRT team to HDMSCS model

Nutrient management

For East Coast Tall variety – Nitrogen 500g+P₂O₅ 250g+K₂O 750g/palm/year recommended.

For Tall HYV and Hybrids – 1000g N+500g P₂O₅+1000g K₂O per palm/year with 50% N from organic sources recommended.

Fertigation at 75% of recommended NPK in eight split found to be optimum.



2.1.8 Navasari: Horticultural Research Station, ASPEE College of Horticulture & Forestry, Navasari, Agricultural University, Navsari, Gujarat

Year of start: 2009

General Information

The regional horticultural research station is situated at 20° 57' North latitude and 72° 57' East longitudes with an altitude of 12 m above MSL. The AICRP centre belongs to South Gujarat Heavy Rainfall Zone – I, AES– III. The weather is tropical and monsoon period begins from June to September. The average rainfall recorded range between 1500-1700mm. The weather is humid with an average RH is above 68.27% throughout the year. The average maximum (20°-30°C) and minimum temperature (12.0°C-28.1°C).

The soils are deep and moderately drained clay soil with an medium fertility classified as deep black soil with soil pH 7.5 - 8.5. The major area is under coconut cultivation in the state is occupied tall varieties and it is mainly used for the tender nut and dry nut purpose. The maximum area under coconut grown as boarder crop in South Gujarat and whereas in Saurashtra of Junagadh, the coconut is grown as commercial mono-cropping. Refech achievement in improving overall coconut yield and its productivity of the state by encouraging the farmers to use quality planting material and advocating farmers for adoption of scientific improved technologies for coconut production.

Crop Improvement

Germplasm assembled and evaluation: The four local germplasm were collected and being evaluated.

Demonstration of released varieties of coconut: The coconut varieties Kera Bastar, Kalyani Coconut-1, Kalpa Mitra, Kalpa Dhenu, Gautami Ganga and Kalpa Prathibha were found suited to the local agro-climatic regions of the state.

Evaluation of cocoa clones for their performance as mixed crop in coconut gardens: The clone VTLC-1 had performed better with respect to growth, yield and quality of cocoa.

Crop Production

Development of coconut based integrated cropping system model: The combinations of coconut + banana+ turmeric + cinnamon + black pepper was showing showing in coconut gardens.

Noni, (*Morinda citrifolia*) promising mixed crop in coconut: The seedling plants were found better suited compared to tissue culture plants of noni under old coconut orchard.



Turmeric as intercrop



2.1.9 Ratnagiri: (Bhatye) Regional Coconut Research Station, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli - 415712

Year of start : 1972

General information

The Research Station is situated on the coast of the Arabian sea of village Bhatye. The centre is closer to the Ratnagiri town and is located at 17.00 ° N Latitude and 73.40 ° E Longitude with 3M above mean sea level of 3M. The regional coconut research station, Bhatye was established on 1st July, 1955 by the Indian Central Coconut Committee and administratively controlled by the State Department of Agriculture. The centre was under Mahatma Phule Krishi Vidyapeeth, Rahuri, up to 1969 and presenting with the Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth.



Research Achievements

Crop Improvement

Coconut varieties/hybrids released

- **Pratap:** The pratap variety of coconut was released in year 1987, which produces 140-145 nuts/palm, with copra content of 120-160g per nut and 68% oil.



Pratap

Konkan Bhatye Coconut Hybrid 1 (GBGD x ECT): The hybrid was released in year 2007, with yielding of 120-122 nuts/palm, copra content 160-169 g/ nut and 67.10% oil.

Nucleus seed gardens for released varieties

Nucleus seed gardens for newly released varieties were established ECT, GBGD (Gautami Ganga) and Kera Bastar for quality seed production.



GBGD x ECT

Crop Production

Fertilizer dose requirement: A fertilizer dose of 1 kg Nitrogen, 1000:500:1000 g NPK/Palm in three splits (June, October and February) was recommended for coconut in sandy soils of Konkan region of Maharashtra. The dose should be applied in three splits i.e. 1/3 N and full dose of P₂O₅ along with FYM in June and remaining 2/3 N and K₂O in splits in October & February.



Drip irrigation: The water requirement through drip irrigation in coconut for the region forever to be 30 liters/palm/day during October to January and 40 liters during Feb to May with six drippers placed at a distance of 1.25 meters away from coconut bole in the sandy loam soils.

Drip fertigation: Application of through drip irrigation in eight splits from October to May forced to be optimum.

Mixed cropping system of spices in coconut: Recommended to inter plant nutmeg, cinnamon and clove in well spaced coconut garden.

Intercropping of fruits & spices in coconut: Four intercrops were recommended in the region, turmeric; banana, pineapple and tapioca were recommended in coconut plantation.

Medicinal plants as Intercrops in coconut: Recommended by considering the performance of different medicinal crops as intercrops are arrow root, lemon grass, shatawari, adulsa and citronella are profitable in coconut growing regions.



Coconut based cropping system

Crop Protection

- Identified and documented occurrence of insect pests in different coconut growing regions of Maharashtra. The hotspot areas for black headed caterpillar were earmarked in Ratnagiri, Thane, Kolhapur, Solapur and Pune districts and managed by releasing *Goniozus nephantidis* parasites.
- Validated of pheromone lures developed by PCI, Brookland, CPCRI and Chemtica for the management of rhinoceros beetle and red palm weevil and results found the significant reduction in the number of palms affected by above said insect pests by adopting the pheromone traps.



Release of parasites in the field



2.1.10 Veppankulam: Coconut Research Station, Tamil Nadu Agricultural University, Thanjavur district

Year of Establishment : 1973

General information

The coconut research station, Veppankulam was established in 1958 to carry out research on coconut to cater the needs of the coconut farmers in Tamil Nadu. It was later brought under Tamil Nadu Agricultural University during 1973. It acts as a Co-ordinating Research Centre for palms in Tamil Nadu under ICAR-AICRP on Palms from 1973. The centre is situated at 10°29'N altitude and 79° 23'E longitude at an altitude of 20.0 m above MSL. The soil sandy in nature with the pH 7.1 to 7.7. Region receives an annual rainfall of 112.5mm.



Research Achievements

Crop Improvement

- ✓ The centre has now the coconut germplasm collection comprising of 53 accessions including 24 exotic and 29 indigenous accessions.
- ✓ A total of six accessions (indigenous) have been included during 1997-2002
- ✓ Screening of germplasm for tendernut water quality attributes resulted in the identification of COD as the best tendernut variety.
- ✓ Screening of germplasm for eriophyid mite resistance has resulted in the identification of COD, Siam, Spicata, BSI and Ayiramkachi as moderately tolerant to eriophyid mite attack.

Heterosis breeding involving East Coast Tall as the female parent and other dwarf varieties as male parents has resulted in the development of three high yielding coconut hybrids and they have been released for cultivation in Tamil Nadu. The details of the hybrids/varieties released by this centre has been presented below.

Coconut hybrids/varieties released by CRS, Veppankulam

S. No.	Variety/ hybrid	Parentage	Year of release	Annual nut yield/palm	Special feature
1.	VHC 1	East Coast Tall x Malayan Green Dwarf	1982	115	Medium tall, Medium thick trunk, Circular crown, 40 months for first, flowering, Oblong nuts, Oil content (68.6%), Copra content 142g/nut



2.	VHC 2	East Coast Tall x Malayan Yellow Dwarf	1988	142	Medium tall, Thick trunk, Semi circular to circular crown, 43 months for first flowering, Medium to big oblong nuts, Oil content 70.2%, Copra content 146g/nut
3.	VPM 3	Selection from Andaman Ordinary	1994	92	Tall, Circular crowns, thick trunk, 63 months for first flowering, Big oblong nuts, Oil content 70%, Copra content 176g/nut, Drought tolerant
4.	VHC 3	East Coast tall x Malayan Orange Dwarf	2000	156	Medium tall, Thick trunk, Semi-circular to circular crown, 46 months for first flowering, Medium to big oblong nuts, Oil content 70.2%, Copra content 162 g/nut.
5.	Kera keralam (VPM4)	Selection from WCT	2011	152	Comes to flowering in 58 months, Average annual nut yield – 152.4 nuts/palm, Oil outturn 2.44 t/ha, Oil content 67.8 %

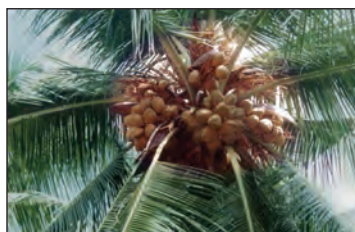
- Hybrids LCOT x CCNT, ECT x GBGD, Siam x MYD, MYD x Siam, AY x WCT and CGD x MYD are other promising hybrids with high nut and copra yield.
- The genotype WCT recorded 152 nuts / palm / year which was released as Kera Keralam.



VHC-1 Hybrid Coconut



VHC-2 Hybrid Coconut



VHC-3 Hybrid Coconut



VPM-3 Tall Coconut Variety



Kera Keralam Tall Coconut Variety



- Among the 14 hybrids planted during 1986, the hybrid COD x WCT recorded highest cumulative mean yield of 133 nuts per palm per year over a period of 15 years compared to other hybrids.

Crop Production

Water management

- In basin irrigation, apply 410 litres of water once in 5 days during March to September and Once in 8 days during October to February.
- In drip irrigation, 80 litres / day / palm during March to September and 50 litres / day / palm during October to February is sufficient.

Manuring

- 2nd, 3rd and 4th year - 1/4th, 1/2 and 3/4th of the recommended dose of fertilizers (RDF).
- 5th year - Tall varieties: 560 g N, 320 g P_2O_5 , 1200 g K_2O & 50 kg FYM/palm/year
- 5th year - T X D hybrids: 1000 g N, 250 g P_2O_5 , 2000 g K_2O & 60 kg FYM/ palm/year
- Root feeding with TNAU coconut tonic @ 200 ml / palm twice in a year
- Sowing sunnhemp @ 50 g/palm & *in situ* incorporation.

Intercropping in coconut

Coconut based cropping system with Black pepper + banana + turmeric/greens and Coconut + black pepper + banana + Elephant Foot Yam/ greens were found to be economical cropping systems as they recorded the higher B:C ratios and nut equivalent yield.



Coconut + Turmeric +
Banana



Coconut + Bhendi



Coconut + Yam + Banana



Coconut + Banana



Inter Crop in Coconut



Coconut + Pepper + Banana
+ Pineapple



Coconut + Tapioca



Coconut + Banana + Pepper
+ Mango Ginger

Crop Physiology

Management strategies for button shedding

- ❖ 20 ppm planofix spray at 30 days after opening of spathe
- ❖ Application of 2 kg potash & 500 g borax
- ❖ Root feeding of 2000 ppm Zinc sulphate at quarterly interval (0.4 g / 200 ml / palm)

Management of barren nuts

Additional dose of 2 kg potash combined with 500 g of borax/palm/year for 3 years over & above the recommended dose of NPK + FYM.

Plant Pathology

Management strategies for basal stem rot

- Root feeding of 1.3 g aureofungin-sol + 0.5 g copper sulphate (or) 2 ml of Hexaconazole in 100 ml of water combined with soil drenching of 40 litres of 1% Bordeaux mixture at quarterly interval
- Application of 50 g *Trichoderma harzianum*, 50 g *Pseudomonas fluorescens* 50 kg FYM and 5 kg neem cake / palm / year
- Soil application of 500 g each of CaSO_4 + MgSO_4 .
- Application of 500 g inoculum of *Trichoderma harzianum* in 50 kg FYM.
- Application of 200 g Azotobacter or phosphobacteria in 10 kg FYM reduces the BSR disease.
- Chemodiagnostic methods EDTA and TTC tests are useful for early detection of Basal stem rot disease of coconut.
- Combined application of 50g each of *Trichoderma viride* and *Pseudomonas fluorescens* reduced the severity of Basal stem rot disease of coconut.



2.2 OIL PALM

2.2.1 Gangavathi: University of Horticulture Sciences, Bagalkot, Karnataka

Year of Establishment: 1989

General information

The All India Co-ordinated Research Project on Palms (Oil palm), Agricultural Research Station Gangavathi belong to Koppal district of Karnataka state comes under the purview of University of Horticultural Sciences, Bagalkot and was established in 1988-89. The centre is situated at 15°27" N latitude and 76°31" E longitude and at an altitude of 428 m above MSL. The centre is situated in the heart of Tungabhadra command and is fed by left bank canal where water is available for a period of 9 months from August to April.



The soil of the centre is medium deep black clay belonging to order vertisol. The pH of the soil is neutral to slightly alkaline (8.2-8.4). The soil is low in available N (247 kg/ha), medium in available P (23.8 kg P_2O_5 /ha) and high in available K (455 kg K_2O /ha). The mean rain fall of the station for a period of 25 years was about 520 mm distributed over 35-36 rainy days. Peak rainfall was observed during the month of September and October (118.5 mm & 108.5 mm). Higher mean monthly maximum temperature was observed in the month of April & May (36.9°C & 38.0 °C). While mean minimum temperature was the lowest in the months of December (12.2 °C) & November (14.7 °C). The mean relative humidity was higher in the month of July (73.45%) followed by the month of June (73.0%). While it was lowest in the month of March (44.45%) followed by the month of April (49.4).

Research Achievements

Crop Improvement

- Under Evaluation of oil palm genotypes for drought tolerance, it was observed that, based on last 10 years data analysis, five African dura genotypes viz., ZS-3, ZS-1, ZS-6, ZS-3 and TS-5 were identified as drought tolerance based on physiological and yield characters and are further selected as mother palms for crossing programme to improve the dura types and dura x pisifera crosses.
- Ten new oil palm hybrids developed from DOPR, Regional Station, Palode planted



General view of drought tolerance plot at Gangavathi



during 2007 are being evaluated for their yield potential. During, 2013-14, the hybrid NRCOP-4 recorded the significantly higher mean FFB yield (10.6 t/ha) and was on par with NRCOP 1 (10.1 t/ha) and NRCOP 2 (10 t/ha) and differed significantly over hybrids like NRCOP-3 (5.9 t/ha) and NRCOP-6 (7.3 t/ha).



ZS 1 genotype



Yield of NRCOP1 and 4 at Gangavathi

Crop Production

- A fertilizer dose of 1200:600:1200 N,P₂O₅ and K₂O/palm/year was found optimum for oil palm under irrigated condition of Tungabhadra command area.
- Water requirement for adult Oil palm worked out and is as follows;

Months	Water requirement (day/palm)	
	Basin irrigation	Drip irrigation
July - October	110-140	55-70
November - February	90-130	45-65
March - June	150 - 220	75 - 110

- Fertigation of 1200:600:1200 N,P₂O₅ and K₂O/palm/year through drip in 6 equal splits was found optimum for oil palm under irrigated condition of Tungabhadra Command Area



2.2.2 Mulde: College of Horticulture, Dr. Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, (BSKKV), Dapoli, Maharashtra

Year of start: 1989

General Information

The experimental station is located at 16°2' latitude, 73°42' longitude and at an altitude of 17 m above mean sea level in Konkan region of Maharashtra. The Konkan region (Coastal part) has a characteristic feature of assured and high annual rainfall (3000 – 3500 mm) restricted between the months from June to September, high humidity and modest climate with the temperature ranging from 15°C to 35°C. The soils are sandy loam with a pH around 6.01, EC 0.082 ds/m. The organic carbon in the soil is 1.23%, available N: 364 kg/ha, available P: 423 kg/ha and available K: 181.3 kg/ha. The soils are well drained with 10 to 15 per cent slope. At the field capacity, the moisture content was 28 to 30 per cent and at permanent wilting point was 16 to 18 per cent.



Research Achievements

Crop Improvement

- Hybrid combination 148 D X 98 P (V9) recorded significantly higher yield of FFB (96.2 kg/palm and 13.7 t/ha).
- Hybrid combination 124 D X 266P (V4) recorded 154.9 kg/palm and 22.2 t/ha yield of FFB. Considering the performance of both the hybrids for last 10 years these hybrids identified as a promising hybrids.
- Among the African Dura type's, ZS-2, ZS- 6, ZS-8, TS- 2, TS- 10 and TS -11 found to be drought resistant.

Crop Production

- Validated the irrigation requirement during winter (Oct- Jan) is @ 50 lit. / day / palm and during summer (Feb- May) irrigation requirement is @ 80 lit. / day/ palm
- Fertilizer dose recommendation @ 1200, 600, 2700 g NPK per palm per year respectively



ZS 6 genotype



NRCOP 9 hybrid



General view of hybrid evaluation trial



2.2.3 Pattukkottai: Agricultural Research Station, Tamil Nadu Agricultural University

1. Year of Establishment : From 01.01.1989 at TRRI, Aduthurai From 10.12.2012 at ARS, Pattukkottai

General Information

The All India Coordinated Research Project on Palms (oil palm), Agricultural Research Station, Pattukkottai is 1.5 km from Pattukkottai town. The station is situated at 10°25' N latitude and 79°20'E longitude and at an altitude of 20m above mean sea level. The station having 11.40 ha and is situated in Cauvery meltat project under the command of Grand Anecut Canal.



Soil characteristics

The soil of experimental site is clay loam in texture with a water holding capacity of 52.5 per cent and soil pH is 7.5. The soil is low in available nitrogen (262 kg/ha), medium in available phosphorus (41 kg/ha) and high in available potassium (272 kg/ha). The mean annual rainfall was 1158.6 mm distributed over 53.9 rainy days.

Research Achievements

Crop improvement

- Of 10 hybrids (NRCOP 1 – NRCOP 10) studied for growth and yield parameters, data on yield attributes revealed that the highest FFB yield (81.8 kg/tree) was recorded in the hybrid NRCOP 5.
- Among the hybrids, data on yield attributes revealed that the highest FFB yield (135.5 kg/tree) and yield / ha (19.4 t) was registered in the hybrid NRCOP 17 at the age of 7 years in the farmers field.



Performance of hybrids in the farmer field

Crop production

Fertilizer application through micro-irrigation technique in oil palm: The results revealed that application of 1200:600: 1800 g of NPK through fertigation recorded more stem girth, number of leaves / palm and FFB yield.



2.2.4 Vijayarai: Horticultural Research Station, Dr. YSRHU, Venkataramannagudem, Andhra Pradesh

Year of start: 1989

General Information

Horticultural Research Station, Vijayarai located in West Godavari District, Andhra Pradesh (formerly Agricultural Research Station) was established during December, 1983. Research work on Oil Palm was initiated for the first time in Andhra Pradesh in the year 1989 to study the adaptability and performance of Oil Palm with different levels of irrigation and fertilizers.



Soil and Weather

The entire farm area has a typical red sandy loam soil. The bulk density varied from 1.68 g/cc to 1.45g/cc in general, which decreased with increasing in depth. The soils are classified under alfisols with slight acidic to neutral in reaction, devoid of free calcium carbonate, low in available nitrogen, phosphorus and medium to high available potassium. The weather experienced during the period from 2008 to 2013 indicated that the average annual rainfall of the region was 1,000–1,200 mm.

Research Achievements

Crop improvement

- Out of 11 cross combinations tried at Vijayarai centre, 115DX291P recorded maximum FFB yield of 22.6 t/ha from the varietal trial, which was recommended to the farmers for adoption.
- The Costa Rica hybrid developed at Palode centre performed well with an FFB yield of 15.5 T/ha among other cultivars (Papua New Guinea, IRHO & Costa Rica) like exotic Tenera hybrids at Vijayarai centre.
- The hybrid NRCOP-4 produced highest yield of fresh fruit bunches (18.33 t/ha) and lowest in NRCOP-7 (8.24 t/ha) at the age of 7 years.



NRCOP 4 hybrid

Crop Production

- Basin irrigation recorded maximum FFB yield of 18 t/ha over flood irrigation.
- The water use efficiency was higher in drip irrigation treatment with 682.3 kg-ha/cm.
- The FFB yield was increased by 18.7 t/ha at higher dose of 1200+600+2700 g NPK/palm/year which was recommended to the farmers as technology.
- The fertilizer dosage 1200:600:1200 g NPK through fertigation recorded maximum FFB yield of 124.7 kg/palm/year



2.3 PALMYRAH

2.3.1 Killikulam: Agricultural College and Research Institute, Tamil Nadu Agricultural University (TNAU), Coimbatore, Tamil Nadu

Year of establishment: 1995

General information

The palmyrah centre is located in south-eastern corner of Tamil Nadu State, between 8° and 22' to 9° and 22' North Latitude and 77°40' and 78° East Longitude. The soils of the region sandy and red sandy soils are predominant. This region enjoys a tropical type of climate and the major area in orchard is under dry land horticultural crops and is mostly rainfed. Rainfall is received both during S.W. and N.E monsoon. The average rainfall is around 640 mm and a sizeable quantum of rain is also received during summer months, The maximum temperature shoots up to 39°C coinciding with the months of June to August and the minimum temperature is around 20-22°C experienced during the months of November – December. The coolest month is January and the hottest months are from May to June. The city has a very high humidity being in the coastal sector.



Research Achievements

Genetic Resources

Collection of elite germplasm of palmyrah is being done since from 1995. Dwarf, early bearing and high neera yielding genotypes alone are selected through surveys conducted both in Tamil Nadu and Andhra Pradesh. So far eight joint surveys have been undertaken by both the centre since from the year 2002. The districts viz; Nalgonda in 2002, Sagallu in 2003, East Godavari and Nallampalli in 2006 and Srikakulam in 2009 were targeted in Andhra Pradesh. Similarly, the districts viz; Thoothukudi, Ramanad and Pudukottai in 2004, Tirunelveli and Virudhunagar in 2007, Salem in 2008, Srikakulam district of A.P during 2009 and Baghalpur & Banka districts of Bihar during 2010 and Prakasam and Guntur districts of A.P during 2011 and Nellore district of A.P during 2012, Southern districts of Karnataka were surveyed jointly. It is mandatory for the scientists to survey



Germplasm block



Germplasm block



Germplasm collection from Karnataka

both Tamil Nadu and Andhra Pradesh in alternate years. As a result, 254 accessions have been collected and are being maintained at Killikulam centre since from the inception of the project. The accessions are being evaluated regularly for the parameters such as plant height, stem girth, number of leaves and leaf length every year.

Crop Production

- In palmyrah, simple removal of mesocarp enhanced the percentage of germination by 15 percent and the percentage of germination of seed nut ranged from 35.8 to 96.62.
- Storing of palmyrah seed nuts for a period of 30 days in shade improved the germination (79%) while, the seeds sown immediately after harvest had recorded the lower germination percentage (51 %).
- 50 Kg FYM + 500 g of NPK improved the neera production and fruit production.
- Among 8 accessions continuously evaluated for padaneer yield for 10 years from 1995 – 2004, the accession BF34 (female) yielded the maximum of 287.8 liters in a tapping duration of 85 days with a mean of 176.9 lit followed by BF.36 (male) recording a maximum of 237.7 litter with an average of 113.8 litter and the yield was consistent even in drought years.
- The neera yield from individual inflorescence ranged from 21.7 lit. to 69.4 lit. in a tapping duration ranging from 57.5 to 65.0 days. It is also evident that the neera yield may be high when the total number of inflorescences produced per tree is low.

Crop Protection

- ❖ To control the tuber rot disease caused by *Rhizoctonia solani*, the seed nuts have to be soaked in carbendazim 0.1 % for 24 hours, besides reducing the tuber rot, enhanced the germination up to 20.1 %. This was followed by the application of *Trichoderma viride* (CF) at 10 g / sq. m .area.
- ❖ Two foliar diseases, a leaf blight caused by *Pestolotiopsis palmarum* and a leaf spot caused by *Sligmia palmivora* were recorded. Leaf feeding caterpillar *Opisina arenosella* was also recorded. These do not affect the palm to the Economic threshold level.



2.3.2 Pandirimamidi: Horticultural Research Station, Dr. YSRHU, Venkataramannagudem, Andhra Pradesh

Year of start: 1995

General information

Horticultural Research Station, Pandirimamidi is situated in East Godavari district of Andhra Pradesh. The station is located at an elevation of 250m MSL with 17° 25' East latitude and 81° 45' North longitude. The research for AICRP on palms-Palmyrah was started in 1995. The research station is situated in the tribal area comprising 7 tribal mandals of East Godavari District.



Brief background of the project and mandate:

Palmyrah is an important sugar palm contributing to the up lifting of poor, the economic attributes of the palm come into account right from the day of germination of the seed nuts till the palm survives in the field. The useful end products of the palm include right from the tuber through the culm, leaf lamina, petiole and ultimately the neera content. Palmyrah is a total palm as each and every part of the plant is being utilized for one or the other purpose. Among all, neera is the top most important economic produce exploited from the palm. In order to strengthen the location specific research on palmyrah, the centre was started with the objective to study the germplasm collection, evaluation and Post harvest technology.



Dwarf statured palm collected from Nellore (Andhra Pradesh) during 2012

Research Achievements

Genetic resources

➤ Collection of dwarf, early bearing and high neera yielding genotypes were carried out through intensive surveys conducted in Tamil Nadu, Andhra Pradesh, Bihar and Karnataka from 1991 to 2013. So far, 260 accessions have been collected and planted for evaluation.

Variabilities observed in palmyrah during germplasm surveys

Stoneless fruits:- During survey in Nellore district during 2001, a palm was identified producing stone less fruits. It is high fruit yielder and having a unique character of producing fruits round the year. This feature will be very useful in sectors



Fruit colour variation among the germplasm collected from Guntur and Prakasam districts (Andhra Pradesh) during 2011



where fruit is the main economic for making value added products.

Monoecious palm:- During the 2003 survey, a palm was identified producing both male and female spadices in addition with modified male spikes. These spike are swollen (24cm) and enlarged (80cm) and have small seed less fruits numbering 80 to 300 all along. The fruits are embedded and the modified spikes in the manner the seeds arranged in maize cob. Fruits in the normal bunches are mostly 2 to 3 seeded and are black in colour.



Germplasm from Tamil Nadu

➤ In the year 2005-06, flowering was observed in the 1991 planted germplasm block. Subsequently the germplasm blocks of 1993, 1994 and 1995 came to flowering during the later years and particulars of the inflorescences growth parameters have been recorded. Tapping was initiated on the palms and in the first year of flowering neera out flow was very poor and negligible and in the subsequent years the neera out flow was increased. Studies are under progress for identification of dwarf and high neera yielding palms among the existing germplasm which came to flowering.



Monoecious palm

Growth & development

In the Juvenile palms, rate of petiole growth ranged from 2.6 cm/15 days (Older leaves) to 15.2 cm/ 15days (younger leaves). The lamina growth (length) was slowest (0.7 cm) in older leaves and it was faster (11.2 cm) in younger leaves in the crown. Mean time taken for the emergence of successive leaf varied from 28.3 days to 30.7 days.

In the adult palms (18 years old), data on growth parameters indicated that, in both male and female palms rate of petiole growth varied from 6.1 cm to 17.7 cm in male palms and from 3.9 cm to 22.2 cm in female plants. Growth is slower in older leaves and faster in younger leaves. Time taken for opening of successive leaf varied from 25.7 to 27.2 days in male and 25.2 to 28 days in female palms. Mean height of inner most unopened crown leaf at which petiole emerges was 98 cm in male palms and 95 cm in female palms.



Germplasm block planted during 1998



Male palms started giving out the inflorescences early in the months of November and December compared to female palms where emergence of inflorescences has taken place in the months of December to January. Time lapse between emergences of first inflorescence to last inflorescence on the palm was 149 days in male palms and 123 days in female palms. Mean growth rate of the inflorescence was 9.2 cm/ fortnight in male palms and 8.1 cm in female palms. Mean length of inflorescence was 1.0 m in male palms and 0.8 m in female palms.

Flowering and fruiting data has been recorded in germplasm blocks of 1991, 1993, 1994 and 1995. Variations in time of flowering, number of fruit bunches/palm, fruit weight, number of fruits/ bunch, bunch weight and nungu yield/ bunch have been observed across the accessions. Number of bunches produced per palm varied from 1 to 14. Mean number of fruits per bunch varied from 5 to 25 among the accessions. Weight of the bunch varied from 3.9 kg to 19.5 kg and mean fruit weight from 0.35 kg to 1.16 kg. Yield of the nungu per bunch also varied from 0.2 kg to 1.9 kg/ bunch among the accessions.



Germplasm block planted during 1995



Germplasm block planted during 1991-93

Crop production

➤ For studying the germination pattern in palmyrah, seeds were collected from three different agro climatic regions in the district namely i.e., from dry tracts, wetland grown trees and from trees growing in the coastal areas and planted in beds. Beds have been pot watered initially for fifteen days. Time taken for emergence of plumule from stone varied from 10 to 15 days among different stones irrespective to the collection origin. Further, it was observed that, time taken for maximum tuber development also varied among the seeds from 99 to 104 days. Mean length of apocolon and tuber and width of tuber at full maturity was 46.7, 26.5 and 9.4 cm, respectively.

➤ Defoliation studies were carried out to know the effect of different levels of defoliation on neera yield of palmyrah. Self-sown, on farm palms aged between 25 - 35 years were utilized for the study. From the tapping results, it has been found that



Defoliation of Palmyrah



highest neera yields have been recorded with 30% defoliation treatment which was followed by control. The lowest yield of neera was recorded with 90% defoliated palms. Among the three months tapping the highest neera yields was recorded during February followed by January months.

Post Harvest Technology

➤ Flow of inflorescence sap (neera) by different type of cut for spathe i.e control, cross, V channel and central hole in various spathe of same palm was studied and it showed that V type cut yields more as compared to others for particular time. It was also observed that, yield increases with increase in surface area of the cut portion of spathe. Studies conducted for improving the yield of neera by applying anti oxidant (Ethopan, EDTA, BHT, CaOH, Citric Acid) to the sliced portion of the spathe indicated that, yield increases more in ethopan followed by citric acid.



Palmyrah sap

➤ Preservation of neera by using ultra filtration technology was studied and it can be stored under refrigerated condition for 28 days by heating for 5 min under 90°C followed by ultra filtration under 1 kg/cm² pressure for 10 min without affecting of quality of the neera.

➤ Jaggery preparation from neera was standardized and it was found that Optimized parameters for jaggery found from the analysis was lime of 0.9%, temperature of 117°C and time of 174 min with maximum total sugar content (> 90%), moisture <10% and Ash <6%.



Jaggery from Palmyrah

➤ Tubers (Apocolon) were analysed at age of 3, 4, 5 and 6 months and results showed that 4 and 5th month tubers had higher nutritive values. The optimum age of harvesting tuber for high nutritive values was found at the age of 4 months i.e 120 days. Flour and Rava was prepared and was found superior quality in the method of steam cooked (in auto clave) followed by drying as compared to other traditional methods i.e open fired, fired in iron tin and directly dried. Biscuits and bread were prepared with tuber flours of 5, 10 and 15%, results showed that bitterness was increasing with increase in the tuber flour content.

➤ Tender fruit endosperm has the (nungu) superior quality at the age of 70 days followed by 60 days after fruit initiation. The dehydrated samples treated with sugar syrup concentration of 50 and 60 Brix was found to be acceptable in sensory qualities except slight colour change on storage. Nungu blanched and packed in 100 gauge



polythene film with sugar syrup of 30 brix and stored at -5°C was given good results.

Pathology

➤ Survey was taken up for the incidence of diseases in palmyrah in Krishna District of A.P. Twenty six mandals covering 89 villages were surveyed. Data indicated that the mean incidence of leaf blight, leaf spot and bud rot were 3.85, 1.53 and 0.33 per cent, respectively. The maximum severity of leaf spot, leaf blight and bud rot were recorded in Gudlavalleru (3.66%), Penuganchiprolu (6.47%) and Ghantasala (4.29%) mandals, respectively.



Nungu - delicious kernel from Palmyrah fruit

➤ Surveys were taken up in East Godavari, Visakhapatnam, Vizianagaram and Nalgonda district of Andhra Pradesh to record the prevalence of diseases and their severity. Leaf spot and leaf blight severity ranged from 0-9% and 0-7%, respectively in Nalgonda district. Highest percentage of bud rot [3.95%] was recorded in Nalgonda district. Incidence of leaf blight and leaf spot in Krishna district was recorded. Five isolates of *Pestotiopsis palmarum* were from infected leaf blight samples. Observations were recorded on colony growth characters of *Pestotiopsis palmarum*. Experiment on management of leaf spots *in vivo* by fungicides indicated that five fungicides viz., Mancozeb @ 0.3%, Carbendazim @ 0.1%, Companion @ 0.1%, Copper oxy chloride @ 0.3% and Propiconazole @ 0.1% were found effective for management leaf spots.

➤ Survey carried out for tuber rot disease in Rajanagaram mandal East Godavari district indicated that the incidence was ranged from 2.0 to 17.0 per cent. Survey at Nidadavolu and Chagallu mandals of West Godavari district revealed that the incidence of tuber rot was ranged from 0.5 to 3.0 per cent.

3. Conclusion

AICRP on Palms has made significant achievements since inception in the following areas:

- **Genetic resources:** 120 indigenous coconut and 254 palmrah accessions collected for conservation and evaluation.
- **Varietal development:** 14 improved coconut varieties (11 varieties and 3 hybrids) developed and released.
- **Ensuring Quality planting material:** Nucleus seed gardens established for released varieties in different agro-climatic region.
- **Enhancing productivity and profitability:**
 - Profitable coconut based cropping system with annuals, biennials and perennials developed.



- Integrated nutrient management packages for coconut, oil palm have been standardized.
- **Plantation health management:** Developed and demonstrated - Integrated Insect-Pest and disease management technologies
- **Value addition:** Developed and demonstrated different value added products in coconut and palmyrah.

In view of challenges faced in different locations, following thrust areas have been identified for the project: Evolving varieties for desirable traits and high yield, establishment of nucleus seed garden for dwarfs for increased availability of quality planting material, site specific production technologies with higher input use efficiency and integrated farming systems for sustainable profitability, validating IPM and IDM technologies for existing and emerging insect pest and diseases, processing technologies for palm products and demonstration and transfer of technology.



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◀ QRT at Pandirimamidi centre



QRT at Ambajipeta ▶



◀ QRT at Aliyarnagar centre



QRT at Ratnagiri Centre ▶



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