

Golden Jubilee Publication



Five Decades of the AICRP on Palms - The Tasks Accomplished

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Introduction

History of Establishment

Coconut Research in the country was initiated in 1916 at Kasaragod under the Department of Agriculture of the erstwhile composite Madras State. With the establishment of Central Coconut Committee in 1943, the Central Coconut Research Station at Kasaragod came under the administrative control of the committee. ICAR recognized the set up of plantation crop research in the country with the establishment of Central Plantation Crops Research Institute in 1970 and the Central Coconut Research Station, Kasaragod became the headquarters of CPCRI. Simultaneously the ICAR also sanctioned the All India Co-ordinated Coconut and Arecanut Improvement Project with the headquarters at CPCRI, Kasaragod. But the actual co-ordinated research could be initiated only in 1972 after the finalization of research programmes during the First Workshop held at Kasaragod during 1971.

Overview of All India Coordinated Research Project on Palms

All India Coordinated Research Project is a unique institutional mechanism for evaluating site-specific and need-based innovations pertaining to palms under different agro-climatic conditions across the country. The establishment of coordinated research at multi-locations based on a multi-disciplinary approach has enabled rapid strides in crop production in India. In India, plantation crops are grown in eight agro-climatic zones (Table 1). As of 2022-23, there are 28 AICRP centres with its headquarters at ICAR-CPCRI, Kasaragod. Currently, 15 centres are working on coconut, six on oil palm, four each on arecanut and palmyrah and seven on cocoa. These centres are located in different agro-climatic zones supporting improvement, production, protection and post-harvest processing in coconut, arecanut, oil palm, cocoa and palmyrah (Table 2). The coordinating centres are located in 14 states and one union territory covering 13 SAU's/SHU's, one Central Agricultural University and four ICAR Institutes. This technical bulletin articulates the outstanding achievements and future directions of coordinated research to meet the projected demand and diverse stakeholder interests.

Table 1. Selected agro-climatic features of sub-regions

Sl. No.	Zone/Sub-zone/Centres	Rainfall mm	Climate	Soils
1.	Zone-II: Eastern Himalayas 4. Lower Brahmaputra (Kahikuchi, Assam) 5. Upper Brahmaputra (Mondouri, W.B.) North East Hill Region (Pasighat)	1840 2809 3733	Per humid to humid Humid to perhumid	Alluvial, red, loamy, terai soils. Alluvial and red loamy
2.	Zone IV- Middle Gangetic Plains 2. North East Alluvial (Sabour, Bihar)	1470	Dry sub-humid to Moist sub-humid	Alluvial terai
3.	Zone VII – Eastern Plateau And Hills 5. Bastar plateau zone (Jagdalpur-Chhattisgarh)	1338	Moist-sub-humid to dry sub-humid	Red sandy soils and yellow red loamy Laterites.
4.	Zone XI- East Coast Plains and Hills 1. North Orissa Coast (Bhubaneswar) 3. South Coastal Andhra (Pedavegi, Ambajipet, Vijayarai & Pandirimamidi) 4. Cauvery Delta Zone (Veppankulam, Pattukkottai, T.N)	1287 996 1113	Moist Sub-humid Semi-arid Semi-arid to dry sub humid	Deltaic alluvial, Coastal alluvial, laterite & Red loamy Deltaic alluvium Deep black, red sandy Coastal alluvial Delta alluvium and red loamy

5.	Zone XIII –Gujarat Plains &Hill Region 1. South Gujarat (Navsari)	1883	Semi arid	Medium black
6.	Zone XII –Western Plains &Ghat Region 1. Coastal Hilly (Goa, Ratnagiri, Wakawali, Mulde) 2. Coastal Midland (Kasaragod, Pilicode, Thrissur)	3640 3127	Per humid to humid dry Sub-humid & per humid	Laterite red loamy,coastal alluvium Red loamy, cost alluvial, laterite
7.	Zone X-Southern Plateau &Hill Region 4. Southern transition zone (Bavikere and Shivamogga) 5. Sub Zone-5 (Arsikere – Hassan) 6. Sub Zone -6 (Aliyarnagar)	769 865 841	Semi arid & arid Semi arid Semi arid to dry sub humid	Medium black, laterite Deep black, red loamy Red loamy, red sandy Mixed red and black Red loamy, Deltaic alluvium
8.	Zone XV – The Island Region 1. Andamans	-	-	Forest soils

Out of the 15 agro-climatic regions identified, the Co-ordinated Research Centres on Palms are located in eight agro-climatic regions

Table 2. List of centres and crops handled under AICRPP

Sl.No.	State/UT	Centre	University/Institute	Crop
1.	Andhra Pradesh	Ambajipeta, Pandirimamidi Vijayarai Pedavegi	Dr. YSRHU IIOPR	Coconut, Palmyrah, Oil palm & cocoa

2.	Arunachala Pradesh	Pasighat	CAU	Oil Palm
3.	A&N Island	Andaman	CIARI	Coconut & Arecanut
4.	Assam	Kahikuchi	AAU	Coconut & cocoa
5.	Bihar	Sabour	BAU	Coconut & Palmyrah
6.	Chhattisgarh	Jagdapur	IGKV	coconut
7.	Goa	Goa	CCARI	Coconut & Arecanut
8.	Karnataka	Arsikere, Sirsi Bavikere	UHS (Bagalkot) UAHS (Shivamogga)	Coconut, Arecanut, Oil palm & Cocoa
9.	Kerala	Kasaragod Pilicode, Thrissur	CPCRI KAU	Coconut & Cocoa
10.	Maharashtra	Mulde Ratnagiri Wakawali	Dr. BSKKV	Oil palm Coconut & Arecanut
11.	Odisha	Bhubaneswar	OUAT	Coconut
12.	Tamil Nadu	Aliyarnagar Veppankulam Pattukkottai Killikulam	TNAU	Coconut Oil palm & Palmyrah
13.	Telangana	Konda Mallepally	SKLTSHU	Palmyrah
14.	West Bengal	Mondouri(Kalyani)	BCKVV	Coconut

Organisational Set Up

The All India Co-ordinated Research Project on Palms (AICRPP) is headed by the Project Co-ordinator (Palms) who is assisted by a Scientist (SPMA) in the Project Co-ordinator's Cell at Kasaragod. The major technical support for the project and planting materials required for centres are provided by ICAR - Central Plantation Crops Research Institute, Kasaragod and its Regional Stations and Research Centres and ICAR – Indian Institute of Oil Palm Research, Pedavegi. The Project Co-ordinator is under the administrative control of Director, CPCRI, Kasaragod while the technical control is directly under Deputy Director General (Hort.) ICAR. The funds for the centres are

released directly from the ICAR based on the recommendations of the Project Co-ordinator. The Project has 35 scientific, 20 technical, and 17 supporting staff.

Thrust Areas of the AICRP on Palms

- Varietal/hybrids evaluation through multi-location testing for different agro-ecological zones and specific target regions/areas. Germplasm enhancement and evaluation.
- Multi-location agronomic studies on integrated nutrient management and integrated farming system for optimization of input use.
- Multi-location screening of genotypes for disease and pest resistance, development and testing of different components of IDM and IPM and their integrated application.
- Coordinating and monitoring the quality planting material production.
- Dissemination of different technologies to the farmers through FLDs.

Annual Group Meeting

The Technical programmes were discussed thoroughly in biennial/Annual workshops held during every year at various Centres on rotation basis and, as per necessity, new projects were formulated and review of on-going projects were carried out. So far 30 Biennial/Annual workshops were conducted from 1971 to 2022 as detailed below. Besides these workshops, the group discussions were also held periodically to review the progress of research and also to make midterm corrections required, if any.

Details of workshop held under AICRP on Palms from 1972- 2022

Sl.No.	Date & Year	Place
I Biennial Workshop	20-21, October, 1971	ICAR- CPCRI Kasaragod
II Biennial Workshop	December, 1972	Trivandrum
III Biennial Workshop	15-20, December, 1975	TNAU, Coimbatore
IV Biennial Workshop	21-23, September, 1978	Goa
V Biennial Workshop	31 October – 3 November, 1981	KAU, Thrissur
VI Biennial Workshop	25- 28, October, 1983	Bangalore
VII Biennial Workshop	6-7, November, 1985	Trivandrum
VIII Biennial Workshop	24-27, October, 1987	OUAT, Bhubaneswar



IX Biennial Workshop	6-8, November, 1989	ICAR- CPCRI, Kasaragod
X Biennial workshop	16-28, September, 1991	ICAR- CPCRI, Kasaragod
XI Biennial Workshop	1-3, September, 1993	NIO, Panaji, Goa
XII Biennial Workshop	21-23, December, 1995	ICAR- CPCRI, Kasaragod
XIII Biennial Workshop	9-11, February, 1998	AAU, Jorhat, Assam
XIV Biennial Workshop	15-17, February, 2000	TNAU, Coimbatore
XV Biennial Workshop	19-21 November, 2001	BCKV, Kalyani, West Bengal
XVI Biennial Workshop	27-29, October , 2003	ICAR-CPCRI, Kasaragod, Kerala
XVII Biennial Workshop	9-11, December, 2005	BSKKV, Dapoli, Maharashtra
XVIII Biennial Workshop	27-29, November, 2007	ANGRAU, Hyderabad
XIX Biennial Workshop	12-14, October, 2009	NAU, Gujarat
XX Biennial Group Meeting	15-17, October, 2011	ICAR-CPCRI, Kasaragod, Kerala
XXI Annual Group Meeting	11 -13, July, 2012	AC & RI, Madurai , Tamil Nadu
XXII Annual Group Meeting	22-25, July, 2013	IGKV Raipur , Chhattisgarh
XXIII Annual Group Meeting	25 -28, July, 2014	DOR, Hyderabad
XXIV Annual Group Meeting	26 -29, May, 2015	ICAR- CCARI, Ela, Old Goa
XXV Annual Group Meeting	19-21, May, 2016	ICAR-CPCRI, Kasaragod, Kerala
XXVI Annual Group Meeting	26 – 29, July, 2017	UHS, Bagalkot, Karnataka
XXVII Annual Group Meeting	24 – 26, May, 2018	ICAR-IIOPR, Pedavegi, Andhra Pradesh
XXVIII Annual Group Meeting	6-7, June, 2019	TNAU, Coimbatore, Tamil Nadu
XXIX Annual Group Meeting	10-11, August, 2020	Virtual meeting through video conference at ICAR – CPCRI
XXX Annual Group Meeting	21-22, November, 2021	Virtual meeting through video conference at ICAR – CPCRI
XXXI Annual Group Meeting	16-18, September 2022	ICAR-CPCRI, Kasaragod, Kerala

Major Achievements

The research conducted over five decades has resulted in the release of different varieties and hybrids (Annexure I) suitable to different agro-climatic conditions, standardized techniques like inter-culture, manuring, irrigation, inter/mixed cropping and developed pest and disease management measures of coconut, oil palm arecanut, palmyrah and cocoa due to collaborative research among the AICRP (Palm) project, SAUs and ICAR. All the developed technologies were successfully transferred to extension agencies.

Planting materials produced

One of the significant contributions of the coordinating centers like Arsikere, Ambajipeta, Ratnagiri, Aliyarnagar and Veppankulam under the project has been the supply of planting material to farmers as well as developmental agencies. A total of 9.67 lakhs planting material of coconut were produced by different Centres and supplied to end users.

Planting materials Production (2014-15 to 2019-20)

S. No.	Centre	Produced (No's)	Area covered (ha)
1	Ambajipeta	326204	1864
2	Ratnagiri	312288	1784
3	Veppankulam	163171	932
4	Aliyarnagar	54927	300
5	Arsikere	55812	320
6	Navasari	25684	146
7	Kahikuchi	15700	90
8	Jagdapur	13300	76
	Total	9,67,086	5512

Revenue generated

- The project has generated revenue of Rs. 53.94 lakhs (25 % of ICAR share) primarily from sale of farm produce and planting materials at different Centres in last one decade as given below.

Revenue generated under AICRP on Palms in last one decade

Year	Amount (Rs.)
2011-12	231024
2012-13	196678
2013-14	270146
2014-15	638710
2015-16	642149
2016-17	605854
2017-18	510730
2018-19	491968
2019-20	664897
2020-21	534701
2021-22	607199
Total	5394056

Transfer of Technology**Demonstrations**

Field demonstrations were conducted for effective transfer of technologies on various aspects such as Integrated nutrient management, development of coconut based farming system, coconut production technologies, integrated management of pests and diseases, preparation of vermicompost and mass production of bioagents. ToT demonstrations have benefitted 5675 farmers (2014-2021).

Front line demonstrations

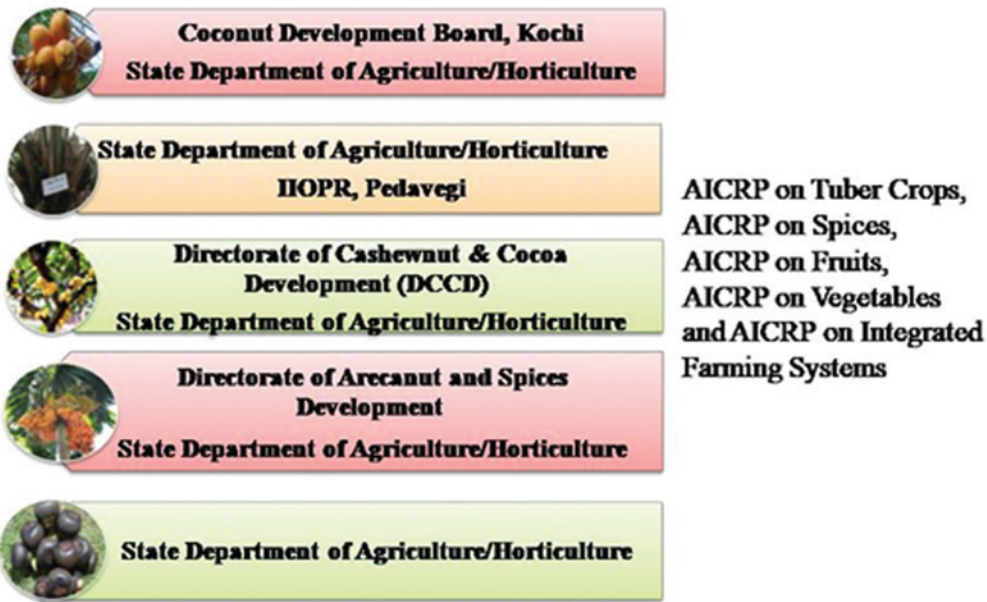
AICRP on Palms has conducted FLDs on production technologies and pest and disease management in coconut in collaboration with KVKs. Technologies recommended by the AICRP for palm have been effectively transferred to university KVKs in various states to benefit farming communities.

Collaboration and Linkages

Collaboration with other projects

Technical support was obtained/provided to other AICRPs eg., AICRP on Spices , Calicut and AICRP on Tuber Crops, Thiruvananthapuram, AICRP on Fruits and AICRP on Integrated Farming System with respect to implementation of the programmes on horticultural crops.

Linkages made by Coordinating Centres of AICRP on Palms



Linkages with farming communities and other stakeholders

The staff under the AICRP on Palms participated in transfer of technology programmes by organizing field days, participation in exhibitions, AIR and TV programmes etc., for effective transfer of technologies to farming community.

Awards and Recognition

ICAR- AICRP on Palms received ‘**Chaudhary Devi Lal Outstanding AICRP award-2014**’ for its contribution in developing many location specific technologies in mandate crops.



1970- 1982

Although research work on coconut was initiated during the second decade of the century by the Government of Madras by setting up a few research stations on the West Coast of India, research on arecanut was commenced only with the setting up of the Central Arecanut Research Station, Vittal in 1956. In coconut, work in the disciplines of Genetics, Agronomy and Soil Science was being carried out at Coconut Research Station, Kasaragod with the limited number of scientists available during the early years. Research in the disciplines of Pathology, Entomology and Physiology was being done at the Coconut Research Station, Kayankulam, which was set up in the year 1946. Except for these three major units no major research work was being carried out at any other place in the country. States like West Bengal and Gujarat did not have any research centre for coconut or arecanut. A few research Stations with limited facilities were set up by States like Tamil Nadu, Karnataka, Maharashtra, Andhra Pradesh, Orissa and Kerala. Having felt the lack of coordination among these various research units, the Indian Council of Agricultural Research sanctioned an “All India Coordinated Coconut and Arecanut Improvement Project” which commenced functioning from 1-10-1970. The *ad-hoc* schemes already functioning in some of the States *viz.* the Scheme on wilt in Tanjore, the Scheme on Thattipakka at Razole, Scheme on band disease of arecanut at Srivardhan and Schemes to set up the Regional Station at Veppankulam (Tamil Nadu) and Ratnagiri (Maharashtra) were already operating in

some States and funded by the I.C.A.R. These projects were also combined in a coordinated project in 1970.

In the same year the three Central Research Stations *viz.* those at Kasaragod, Kayankulam and Vittal with the Sub Centres were merged to form the Central Plantation Crops Research Institute with its headquarters at Kasaragod. One Regional Station each at Sipighat in the Andaman’s and the Laccadive was also sanctioned. The set up at the Central Plantation Crops Research Institute was also reorganized and strengthened to enable them to take up major problems connected with these crops in the disciplines of Genetics, Agronomy, Soil Science, Physiology, Nematology, Entomology, Biochemistry, Microbiology and Pathology. A strong extension unit was also created to disseminate results of research quickly to the cultivators.

In 1975, the scope of the project was extended to cover five more centres *viz.* Arsikere, Pilicode, Mahuva, Coimbatore and Ambajipet. In 1977, Konark centre was added and due to the paucity of land at Konark, the centre was shifted to Patha Farm (Cuttack) in 1980. The eleventh centre Mondouri (Kalyani) was also started during 1980.

Salient activities

- NPK experiments on major soil types in different agro climatic regions on Ordinary tall coconut cultivars started in Ratnagiri (1958); Coimbatore (1971), Kasaragod (1972); Veppankulam (1974); Ambajipeta (1976); Konark (1976); Pilicode (1976); Kalyani (1980); Mahuva (1981) with following fertilizers



- o N – 500: 1000: 1500 g /palm
- o P- 250: 500: 750 g/palm
- o K -750: 1250: 1750 g/palm
- The spacing cum fertilizer trails started in 1964 and continued at black soil of Arsikere with two spacing, 7.3 x 7.3 and 9.6 x 9.6 m and three levels of fertilizers, i.e. no fertilizer, 344: 225 : 450, 690: 400 :900 g N, P₂O₅, K₂O/palm/year. In Veppankulam center with three spacing 6.1 x6.1, 7.6 x 7.6, 9.1 x9.1 m with three levels of fertilizer i.e., no fertilizer, 340:227:454, 680:454:908 g of N, P₂O₅, K₂O/palm/year
- Before All India Coordinated Coconut and Arecanut Improvement Projects came into being, the Indian Council of Agricultural Research and the former Indian Central Coconut Committee had funded research in some states which generated some useful results. These include (1) Manurial and cultural experiment in Veppankulam, which clearly showed the positive response of coconut to higher dose of fertilization (2) Works on arecanut band disease from Srivardhan, Maharashtra, showing the close relationship between this disease and high water table, and works on Tanjore wilt at Muthupet, showing the complex nature of this disease.
- Although the All India Co-ordinated Coconut and Arecanut improvement Project was sanctioned with effect from 1-10-1970, the first workshop was held at Central Plantation Crops Research Institute, Kasaragod on 20th and 21st October, 1971 when the problems were identified and priorities of research were fixed for coconut and arecanut.
- Both coconut and arecanut are perennial crops requiring 5 to 8 years to commence flowering and another 4 to 6 years to attain stabilized yields. the immediate objective of the experiments taken up under the projects are to bring about improvement in coconut and arecanut by (1) evolving high yielding cultivars (2) standardising agro techniques for the crops under different agro climatic regions (3) evolving control measures for the serious pest and diseases. Forty four major experiments were formulated to be taken up immediately at the various participating centres.
- The second workshop was held at Trivandrum in December, 1972, the third workshop was held at the Tamil Nadu Agricultural University, Coimbatore in December, 1975; the fourth workshop was held in Goa in September, 1978 and fifth workshop was held at Kerala Agricultural University, Vellanikkara in November, 1981.
- During this decade, considerable research information on coconut and arecanut production technologies has been generated in the country with coordinated efforts. In coconut varietal improvement, the hybrids between Tall and Dwarf palms are well-known for their high yields. Under this Project, research was underway to determine which particular combinations of Tall and Dwarf palms can give the best performance under various agro climatic conditions of the country.

- In arecanut, the work completed under the project, has helped to release a promising variety 'Mangala' during the first workshop during 1971. This cultivar is semi-tall, early hearing, and high yielding. Now a series of multilocation trials have been laid out in the Co-ordinating Centres to study the relative performance of Mangala and 6-8 other accessions of this Institute, which have been found to be promising in the observation trial in the CPCRI.

Recommendations for development workers (Coconut)

- **Site selection:** The soil for new planting should be well drained and at least 1.5 m deep to have effective root zone.
- **Irrigation:** In early stages 45 liters of water/palm once in 4 days. Bearing stages – 45 liter of water twice in a week
- Laccadive ordinary gives good performances in Kerala and Tamil Nadu and suggested large scale multiplication of this variety
- A fertilizer dose of 750:225:990 g N, P₂O₅, K₂O/palm/year in two spit doses viz. half dose of N & P in February and other half dose of N and K and full dose of P₂O₅ during September for sandy soils of Konkan Coast (Maharashtra).
- A closer planting of 7.3 m x 7.3 m with a fertilizer dose of 680:450:900 of N, P₂O₅ and K₂O/palm/year. Applied in two split dose viz. 1/3 dose during May-June and 2/3 dose in September-October is recommended for black soils of maidan tract of Karnataka (Arasikere).
- Raising mulberry as mixed crop and also raising double cropping sequences of Potato-wheat, French bean-wheat, and ragi-wheat as inter crops in the existing coconut gardens with the wider spacing of 9.0 m x 9.0 m are highly remunerative and this may be popularized in the Arasikere tract of Karnataka state.
- Burying coconut husk and leaves in the basins of coconut palms may be recommended as soil moisture conservation practices for the sandy soils of Tanjore tract (Veppankulam).
- In the absence of a curative method, management practices for Tanjore wilt disease included application of neem cake @ 5 kg/palm/year and drenching 40 litres of 1% Bordeaux mixture or stem injection of Aureofungin sol 2 g + 1 g copper sulphate in 100 ml. of water thrice an year as recommendation to reduce the intensity of the disease. This is applicable only to the palms which are in the early disease conditions.
- Making a hole of 5 mm diameter to a depth of 10 cm at 45° angle just above the bleeding patch was recommended for stem injection for administering fungicides. After the chemical is absorbed the hole may be plugged with clay mixed with any fungicide and later by cement.
- Application of 5 kg neem cake/palm/year and drenching with 20 litres of 1% Bordeaux mixture solution once in a year and digging isolation trenches

to separate the healthy and diseased palms are recommended for management of *Ganoderm* wilt in Karnataka and Andhra Pradesh.

Recommendations for farmers

- The various coconut research stations in the country as well as private nurserymen have been distributing various planting materials including several hybrid combinations of coconut for several years. Until the time the trials in progress at the various research stations are able to identify one or more promising varieties for general cultivation, the Project endorses the following hybrids and variety for cultivation: (i) Chowghat Orange Dwarf as one of the parents and West Coast Tall/East Coast Tall as the other parent; (ii) Laccadive Ordinary.
- Saline water including sea water can be used for summer irrigation of coconut in Sandy loam soils in the West Coast.
- Entry of red palm weevil into coconut palm can be prevented by cutting green leaves when necessary at a distance of 120 cm from the base of leaves and avoiding making steps on the stems of coconut palms for climbing.
- Coconut bunches can be protected against bats (*Pteropuse dwardsii*) by covering them with thorny branches of the wild plant *Zizyphus* around them.
- The management practices for gardens affected by root (wilt) diseases will consist of: (i) application of (a) organic manures @ 25 kg; (b) fertilizers @ 0.34 kg N, 0.17 kg P₂O₅ and 0.68 kg K₂O; and

(c) dolomite @ 2 kg per palms annually; (ii) removal of highly diseased palms and replanting quality seedlings obtained from disease-free areas, possibly D x T hybrids; (iii) spraying 1.0% Bordeaux mixture or 0.3% Dithane M-45 twice annually in May or September.

Control of the new pest on coconut, *Paradasynus rostratus* Distant.

- Infestation by this coreid bug, recorded as new nut crinkler pest of coconut in Kerala, results in immature nut fall, production of barren nuts and malformation of nuts. This pest has been observed in all the coconut growing tracts of Kerala in different degrees of intensity. In a few pockets up to 80% infestation has been recorded. Chemical control trials have revealed that spraying BHC 0.1% or Carbaryl 0.05% on coconut bunches, inflorescences and leaf axils at bimonthly intervals is effective in controlling the pest. However, care should be taken not to spray just-opened flower bunches and buttons in the receptive stage.

1982-1992

The project, which started in 1972, underwent significant changes during different plan periods. During the seventh plan (1985-90) period three centres *viz.*, Pilicode, Mahuva and Dapoli were withdrawn from the project with effect from 1.4.1986. Further, the scope of the project was widened with the inclusion of oil palm and the project was renamed as **ALL INDIA CO-ORDINATED RESEARCH PROJECT ON PALMS**. Critical gaps in the overall coverage of the projects *viz.*, need for developing coconut production technologies for the non – traditional areas of Bihar and Madhya Pradesh, eradication of root (wilt) disease in Tamil Nadu and containing the spread of Thanjavur wilt disease in Kerala and also the feasibility studies of growing oil palm in the irrigation project areas were given priority. Seven new centres, three for coconut and four for oil palm, were added to the project. Two centres *viz.*, Jalalgrah (Bihar) and Jagadapur (Madhya Pradesh)

in the non-traditional coconut areas and one centre at Aliyarnagar (TN) for containing coconut root (wilt) and Thanjavur wilt disease were started. Of the four oil palm centres, three *viz.*, Vijayarai (A.P), Mulde (Maharashtra) and Gangavathi (Karnataka) started functioning during 1988 and Aduthurai centre (TN) started functioning during 1989.

The yield gap of coconut production is staggering and it could be bridged by transfer of proven technology only. With increases in population and the land remaining a limiting factor, boosting the production per unit area is of utmost relevance. The high density multi species cropping system found beneficial by the research institution need to be encouraged among the framers. In 1984, a new experiment with an inter and mixed cropping model was attempted in Ambajipeta, Arsikere, Kahikuchi, Veppankulam and Ratnagiri with the following models

Models / center	Ambajipeta	Arsikere	Veppankulam	Kahikuchi	Ratnagiri
Model I	Coconut +pepper banana(Dwarf Cavendish)+pine apple+elephant foot yam papaya +coffee	Coconut +pepper+ subabul+ banana+ coffee +clove +nutmeg	Coconut +- banana +papaya +citrus +tapioca +turmeric	Coconut + coffee (var. San Ramon)+ pineapple (Var. Giant Kew)+banana (Var. Malghog)+citrus (assam lemon and mandarin orange)+ black pepper + Betel vine local	Coconut +nutmeg Coconut + clove Coconut +black pepper

Model II	Coconut +pepper +banana +pine apple +elephant foot yam +citrus +guava+subabul	Coconut +pepper + papaya+subabul, pineapple+ , mango+pomegranate	Banana +subabul +guava +sweet potato +soyabean	—	—
Model III	—	Coconut +banana +pineapple +elephant foot yam +citrus +guava	—	—	—

The broad objectives of the project are:

- Collection, conservation, cataloguing and evaluation of new hybrids and high yielding varieties;
- Standardisation of Argo – techniques for various agro climatic regions and developing suitable inter/mixed cropping systems and studying their effect on soil fertility managements;
- Development of effective and efficient disease and pest management systems and
- Feasibility studies on oil palm in different agro climatic conditions.

Within the period of ten years of the implementation of the programme it was possible to develop some technologies like suitable inter/mixed cropping to different states, fertilizer recommendation, soil moisture conservation methods and management of Thanjavur wilt and Ganoderma wilt diseases of coconut and these technologies could be transferred to the farmers. The availability of planting material which is the single most

constraint in coconut production was addressed through collective efforts of research and development agencies. Increasing the productivity of small holdings of coconut and arecanut is a matter of great concern to all researchers keeping in view the soil and climatic conditions, marketing possibilities and socio – economic conditions of the farmers.

- The Sixth workshop was held at Bangalore in October, 1983, the seventh workshop was held at the Trivandrum in November, 1985; the eighth workshop was held in Bhubaneswar in September, 1987 and ninth workshop was held at ICAR-CPCRI, Kasaragod in November, 1989 and the tenth workshop was also held at ICAR-CPCRI, Kasaragod in September, 1991.

The major recommendations emerged out during 1992 -2002

- During the seventh workshop held at Trivandrum in 1985, one local selection and three hybrids of coconut were recommended for release for the

first time in the history of coconut research and the same was also accepted by the Central Variety Release Committee.

- Based on the yield performances in the co-ordinating centres and CPCRI, Chandra Kalpa (Laccadive ordinary) was recommended for the states of Kerala, Tamil Nadu, Andhra Pradesh, Karnataka and Maharashtra.
- Tall hybrids *viz.*, Chandra Sankara (COD×WCT), Laksha Ganga (LCT×GBGD) and Chandra Laksha (LCT×COD) were also recommended for release in Kerala. The latter two hybrids can perform well even in drought conditions.
- Two varieties of arecanut, Sumangala (VTL 11) and Sreemangala (VLT -17) capable of yielding 62.89 and 47.59 per cent over the local cultivars were recommended for release in the South Kanara district of Karnataka and Kasaragod and Cannanore district of Kerala.
- Banawali Green Round cultivar under the name 'Pratap' and five hybrids, Banawali× COD, VHC-2 (ECT × MYD), Ananda Ganga (ADOT×GBGD), Kera Ganga (WCT×GBGD) and Laksha Ganga (LCT× GBGD) were recommended for commercial cultivation in Maharashtra, Tamil Nadu and Kerala (rainfed regions) during eighth biennial workshop held at OUAT Bhubaneswar in 1987.
- The hybrid Kera Sankara (WCT × COD) was recommended for release in Kerala, Coastal Karnataka, Goa and Coastal Andhra Pradesh during ninth workshop at ICAR-CPCRI, Kasaragod, in 1989.
- Pratap (Banawali Green Round) recorded a cumulative yield of 1208 nuts/palm over a period of eight years while WCT recorded only 746 nuts. The copra yield per ha in Pratap was 4 tonnes while in WCT it was 2.95 tonnes at Ratnagiri (Maharashtra).
- The hybrid VHC-2 (ECT ×MYD) was promising which recorded a mean annual yield of 96.6 nuts/palms/year over a continuous period of 10 years of bearing. The nut yield of VHC-1 and ECT were 91.1 and 61.2 nuts /palm/year. The copra content of both the hybrids was 159.0 g as compared to 125 g for East Coast Tall. VHC-2 (ECT ×MYD) hybrid has low degree of bulking of bunches and less susceptible to Pestalotia leaf spot at Veppankulam.
- For the first time, a coconut variety suitable for tender nut water, namely Chowghat Orange Dwarf, was approved for release in Kerala State. This variety was superior to all others in terms of total volume of water (350 ml), total sugars (7g/100 ml) and reducing sugars (4.7 g/100 ml). It also has two desirable attributes *viz.* optimum sodium and potassium content in the tender nut water.



- The hybrid, Godavari Ganga (ECT × Gangabondam), was recommended for release for cultivation in Andhra Pradesh and Tamil Nadu. This hybrid yields 128 nuts/palm/year while the local variety East Coast Tall gives only 80 nuts/palm/year.
- In arecanut, a new variety ‘Mohitnagar’ was recommended for release in northern part of West Bengal, Coastal Karnataka and Kerala. This variety gave 71% more yield than Mangala with a yield potential of 15 kg fresh nuts/palm/year. It also gave 16 and 17% higher yield than Sumangala and Sreemangala varieties, respectively. One additional advantage in this new variety is well-spaced bunches with nuts loosely arranged. This enables efficient plant protection against Mahali disease.
- Coconut based cropping systems for Kerala, Konkan Maidan tract of Karnataka State and North-eastern State of Assam have also been developed. Coconut mulberry mixed cropping coupled with rearing of silkworm, growing of chillies, potato as intercrops and double cropping of potato-wheat, French bean-wheat and chillies-wheat were profitable crops in coconut in maidan tract of Karnataka. Coconut based mixed farming and multi-tier cropping have not only increased coconut yield but also provided continuous income and employment opportunity.
- In coconut based cropping system models at Andhra Pradesh, the increase in yield of coconut was around 65%. Cocoa and banana were compatible component crops with good economic returns. In Tamil Nadu, Cropping system models with banana and turmeric were more profitable. In Assam, Black pepper, Mandarin, Lemon, Coffee and Pineapple were most remunerative when grown as intercrops in coconut garden.
- Experiments on the mixed cropping of cocoa in coconut conducted at Pilicode from 1971 had shown that cocoa did not affect the yield of coconut palms. Double hedge system of raising cocoa had given higher yield/ha and more returns compared to the single hedge systems.
- The crown chocking disease of coconut in Assam and West Bengal was causing anxiety among the farmers. Application of boron @ 50 g borax/palm/year was recommended for controlling crown choke disease in coconut and hook leaf in oil palm
- In arecanut, three varieties were released, technologies for production and protection were developed, areca based cropping systems with pepper and cocoa have been demonstrated successfully. The varieties and technologies developed have contributed greatly in increasing the production and productivity in the country.

Tatipaka Disease

The following chronology of symptom development for Tatipaka disease has been worked out based on the trial initiated during 1980.

- Appearance of translucent chlorotic spots, reduction of leaf size, twisting of fronds with slightly pale green foliage in early stages of disease development.
- Appearance of fasciation of leaflets, reduction in number of leaves, small round nuts admixed with atrophis nuts in bunches in later stages.
- The palms finally become barren /unproductive with few leaves and tapered in severely disease conditions
- Light microscopy studies established the presence of MLOs in Tatipaka disease affected palm.
- The presence of MLO in leaf tissues of Tatipaka affected palms and the success of eradication of root (wilt) disease (a similar MLO disease) in the mildly affected northern Kerala lead us to go in for survey and eradication of Tatipaka disease in Andhra Pradesh for containing the disease. Survey in the East Godavari District was completed in collaboration with the Department of Horticulture and 15788 palms affected by the disease were identified.
- Root feeding of tetracycline hydrochloride @ 3 and 6 g/ palm at monthly interval for one year reduced the numbers of atrophid nuts

Thanjavur wilt disease:

- The destructive sampling of Thanjavur wilt affected palms revealed that the bole and root portions were affected severely hindering the translocation of water and nutrients. The fungal cultures isolated from the disease affected palms were *Botryodiplodia theobromae*, *Fusarium solani*, *Acremonim spp* and *Schizophyllum commune*. The tapping of disease palm reduced the disease intensity compared to un tapped palms
- The destructive sampling of Ganoderma wilt affected palms at Razole indicated clear discolouration of tissues at bole region and roots similar to that of Thanjavur wilt.
- The ‘**Coconut Basal Stem Rot**’ commonly referred to as Ganoderma wilt in Andhra Pradesh and Thanjavur wilt in Tamil Nadu is confirmed to be caused by *Ganoderma lucidum*/*Ganoderma applanatum* by the work at Veppankulam and Ambajipet Centres.
- Ipomoea cutting planted in the basins of diseased palms as indicator plant did not yield any sporophores. Since the sporophores of *Ganoderma lucidum* were observed in *subabul* cuttings, this was tried as an indicator plant. Inoculation of *G. lucidum* to *subabul* seedlings in pits resulted in 80 percent of drying of terminal young shoots and leaves and also setting of fine roots within a month after inoculation. This indicates that *subabul* may be useful as indicator plant for Thanjavur wilt disease. EDTA and orthophenanthroline tests for early diagnosis of coconut palms affected by Thanjavur wilt were also developed. The physiological studies revealed that the rate of transpiration was slightly lower in diseased palms compared to healthy

palms. As the severity of the disease is increased the transpiration rate is reduced.

- A comprehensive management practices like digging isolation trenches, field sanitation, addition of organic matter, root feeding of 2 ml Tridemorph in 100 ml of water at quarterly intervals for one year along with 5kg of neemcake application per palm per year was recommended. Alternative to this, root feeding with 2 g of aureofungin sol+ 1 g of copper sulphate in 100 ml of water may be adopted at quarterly intervals for one year and the treatment has to be repeated once in two years. Drenching of 40 litres of 1% Bordeaux mixture thrice a year, providing adequate soil moisture etc. will help in managing the Thanjavur/Ganoderma wilt disease.
- The antagonist *Trichoderma harzianum* may be exploited for biocontrol of Ganoderma by adding as inoculum multiplied on wheat bran – saw dust medium
- Studies at Veppankulam revealed that there is high significant positive correlation with mean maximum soil temperature and numbers of bleeding palms and a negative correlation with soil moisture. In the disease affected palms more than 70 % root rotting was observed up to 60 cm depth.

Insect Pest

- Rhinoceros beetles collected and subjected to EM studies revealed the presence of Baculovirus.

The survey and screening studies at Aliyarnagar revealed that Baculovirus disease occurred in Tamil Nadu – Kerala border as well as in village around pollachi.

- Control of rhinoceros beetle in coconut and oil palm should be done with pathogens Baculovirus of *Oryctes* and *Metarhizium anisopliae*.
- The trapping methods developed at CPCRI using toddy plus yeast or fruits plus yeast or acetic acid or molasses should be taken up in all areas where the red palm weevil is a serious problem as this appears to be the best known control measure against free living adults.
- For controlling *Opisina arenosella*, the use of sampling methods developed at CPCRI and the use of improved breeding techniques for parasites should be popularised amongst extension agencies and emphasis should be placed on parasites that are specific, such as *Parasiero lenephandidis*, *Elasmus nephandidis* and *Brachymeria nosatoi*.
- A combined treatment of root feeding of monocrotophos 5 ml + 5 ml water, spraying of 0.2 % monocrotophos followed by the release of braconid parasitoids was found to give a good control against the coconut leaf eating caterpillars.
- After inundative release of larval parasitoids of coconut leaf eating caterpillar *Bracon hebetor* and *Goniozus nephandidis* in a pest affected coconut garden at Ambajipeta, the parasitisation increased from 0.1 % to 15.92 % and 0.6% to

7.96 % respectively. Steep fall in the mean pest population i.e. from 2381 to 235 insects per palm was recorded after release of parasitoids.

- *Brachymeria nosatoi* pupal parasite of coconut leaf eating caterpillar was mass multiplied in the laboratory and inoculated first time in the field. The parasite was well established in the field with 45 % recovery. Pest population was suppressed by 70 %.

Planting material production

The development boards and directorate concerned with plantation crops should initiated programmes to generate adequate planting materials in elite types identified at the coordinating centres /institutes. The following criteria should be followed for mother palm selection of West Coast Tall

- The mother palms of known parentage should be regular bearers and consistency of yield for at least six consecutive annual initial harvests should have been ascertained
- dehusked nut weight should be 750 g and above
- copra per nut should be above 150 g
- out turn of copra /palm should be 12 kg and above or 80 nuts/palm

Strategy for the production of planting materials in coconut is based on (a) the area expansion in non traditional areas, (b) new planting in traditional areas , (c) regular under planting in traditional areas and (d) rehabilitation of root (wilt) affected areas under planting and replanting in Kerala

Oil Palm

- In oil palm, best *dura x pisifera* combinations were identified and 3.5 lakh hybrid Tenera seeds were produced. Germination and nursery techniques were standardised; Fertilizer schedule developed.
- Introduction of the pollinating weevil (*Eleidobius kamerunicus*) has also solved the problem of artificial pollination and in turn reduced labour cost substantially

Palmyrah

Palmyrah is an important economic species serving as a food item in several status and also as a raw material for production of gur in addition to production of toddy. At Present limited work is being done in a center established by TNAU. The workshop on palms at Bhubaneswar in October 1987 has recommended including research programme on palmyrah as one of the mandate of AICRP.

1992- 2002

In the course of time, the research priorities were changed and the AICRP and CPCRI had undergone some metamorphosis during the course of two decades. New centres in the non-traditional areas like Bihar (Jalalgarh) and Madhya Pradesh (Jagdalpur) for coconut were also added. Kerala wilt of coconut is the major instigation towards genesis of Aliyarnagar Centre. This project discontinued the research on arecanut during VII (1985-90) plan. It was proposed to start NRC for oil palm during VIII five year plans (1992-97) to give more thrust to oil palm research. Research on oil palm under irrigated conditions is practically a new start and the Indian Council of Agricultural Research established the National Research Centre for Oil Palm (later upgraded to Indian Institute of Oil Palm Research (IOPR) at Pedavegi in West Godavari district of Andhra Pradesh on February 19, 1995.

In India, the palmyrah palm is established to possess 60 million palms of which the major population is in Tamil Nadu. It is extensively seen in east and west coast. The palm has unlimited scope and the full fledged research for the fullest exploitation to obtain produces and products for National and International markets coupled with developing rural employment potential is yet to be started. Hence this crop has been taken up under the umbrella of this coordination research projects on palms. During VIII plan period palmyra was added and two new coordinating centres, one each in Andhra Pradesh and Tamil Nadu has also been Sanctioned.

Thus, the present mandate of the project is confined to three palms viz., coconut, oil palm and palmyrah. The objectives of the projects are:

- Collection, conservation, cataloguing and evaluation of germplasm and evaluation of new hybrids and high yielding cultivars.
- Standardization of agro- techniques for various agro climatic regions including development of suitable multi- cropping/inter cropping systems
- Adaptability studies for oil palm cultivation in different agro climatic conditions and
- Evaluation and hybridization of palmyrah.

Even though high yielding varieties /hybrids are available, and suitable technologies are also available there are a few hurdles in the adoption stages. The planting materials of released high yielding varieties are not available in sufficient quantities to reach the farmers. Hence it should be the endeavour of the coordinated centres of each region to produce enough planting materials of varieties released for the regions so that they are available for the local farmers. Another important aspect on which research thrust has to be given is developing varieties /hybrids tolerant /resistant to biotic and abiotic factors. Drought seems to be a chronic problem. It is more so in regions where even summer irrigation is difficult. Crops like coconut which is affected by drought will take at least three years to recoup.

The coconut based farming systems may be evolved to suit the requirements of the region, taking into consideration the farmers demand and also the need of the state. The agronomic management, fertilizer use efficiency, water management, management of micro

nutrients, integrated pest management etc should be standardised for each region to stabilise/increase productivity. In view of the escalation of input cost, technology has evolved to reduce the use of fertilizers, utilizing the principle of recycling of inorganic waste so that the soil health is improved and the resource is not exhausted. The low cost technologies and long term sustainability issues should be given important in our researches, extension and development activities. Since irrigation is an important factor, in the production of coconut and oil palm, emphasis must be laid on water harvesting and budgeting. In this connection suitable drip irrigation systems should be evolved.

The major recommendations emerged out during 1992 -2002

- Kera Chandra: an exotic coconut variety, selection from Philippines ordinary was recommended for release for cultivation in Kerala, Andhra Pradesh, Konkan Coast and West Bengal This has a yield potential of 100 nuts/palm/year, 3.6 tons of copra per ha and 2.4

tons of oil per ha. The additional advantages are that it is relatively resistant to root (wilt) disease, ranks 6th among the 23 cultivars evaluated for drought tolerance and less of pests problems and nematodes.

- In coconut Arasampatti tall was recommended to release in the XV biennial workshop in the name of Aliyarnagar – 1. 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
- Malayan Green Dwarf (156 nuts/palm) has shown promise and is in the pipeline for release.
- A coconut cultivar Assam Green Tall (112 nuts) as ‘Kamrupa’ was recommended for release for commercial cultivation in coconut growing tracts in Assam.
- NPK experiment on major soil types in different agro climatic regions on ordinary tall cultivar of coconut was studied and recommendation are mentioned below

S.No	Major soil types	Recommended dose of NPK (g/palm/year)
1	Maidan tract of Karnataka	680:450:900
2	Konkan Coast of Maharashtra	750:225:900
3	Sandy loam soils of Tamil Nadu	560: 320:1200
4	Sandy loam soils in East Coast of Andhra Pradesh	650:450:1200
5	Alluvial soil of West Bengal	500:250:750

- Irrigation schedules based on evaporative demand (E_o) has been standardized for the judicious use of water for irrigation to coconut

palms in Pollachi and Thanjavur regions of Tamil Nadu as give below:

a) Pollachi region (Coimbatore district, Tamil Nadu)

Months	Quantity of water to be applied (lit/day)		
	Adequate water available area	Moderate water available area	High water scarcity area
Feb-May	65	45	22
Jan, Aug and Sep.	55	35	18
June, July, Oct-Dec.	45	30	25

b) Thanjavur region (Thanjavur district, Tamil Nadu)

- The quantity of water to be applied per palm per day through drip irrigation will be 80 litres per day during March-September and 50 litres per day during October-February for Thanjavur region for sandy loam soil.
- The experiments on coconut based cropping models in different states enabled to identify suitable crop combination which gave 60 % additional benefit to the farmers.
- At Ambajipeta , Model I with pepper, banana, cocoa, pineapple and cinnamon yielded a net income of Rs. 35,035/ha and Model – II with pepper, banana, elephant foot yam and turmeric yielded a net income of Rs. 32,405/ha whereas the sole crop of coconut yielded a net income of Rs. 30,730/ha.

- At Kahikuchi, Model I (coconut+black pepper + banana + Assam lemon + pineapple +ginger) was fund most remunerative with net return of Rs. 15,348/ha and Model II (Rs. 14,058/ha) compared to Rs. 8147 /ha in the control.

Technology for soil moisture conservation by burying coconut husk and spreading coconut leaves were developed. The following methods are recommended for soil moisture conservation

- Mulching the basin with coir dust @50 kg/palm/ basin;
- the coconut husk can be buried in 2 or 3 layers in 0.5 m wide trenched opened at 1.8 m away from the bole, keeping the inner portion of the husk facing upwards ;
- Growing green manures crops like, sunnhemp, *Daincha*, *Pureria*, *Calpagonium*, *Mucuna Sp*, *Desmanthes*, *Desmodim*, *Sesbania rostrata* etc

in the basin and incorporation of the same along with fertilizers;

- d) Addition of tank silt to the light textured soil whenever it is easily available for increasing water holding capacity;
- e) Incorporation of cattle manures/composite/organic matter @50 kg/palm/year to increase water retaining capacity of the soil;
- f) Spreading common salt in the basin at 2 kg/palm to increase leaf turgidity;
- g) Deep planting of new seedlings can be adopted so that root system will be at deeper layer which can tap moisture from lower layers;
- h) Before planting coconut seedling, pits may be filled with 2 or 3 layers of coconut husk at the bottom which can help in conserving moisture;
- i) Micro irrigation and drip irrigation or sub surface watering through hollow bamboo pies buried under pots may be done to utilize limited water most effectively;
- j) In heavy soils, of Andhra Pradesh, deep ploughing has been found to conserve more water. However in light texture soils, inter culture may be avoided. Zero tillage has been found to conserve soils as well as moisture in slope terrain.

Basal Stem Rot

- An early diagnosis method has been developed for the basal stem rot (Thanjavur/*Ganoderma* wilt) disease of coconut.
- Studies on the antiserum developed at Ambajipeta indicated that it can be used in detecting

Ganoderma infection even in apparently healthy palms. The pathogenicity of *Ganoderma lucidum* has been established in 35 year old ECT palms at Veppankulam. Observations revealed that RWC (Relative water content) may be useful for early diagnosis of Thanjavur wilt.

- For the Management of Basal Stem Rot Disease of coconut, applying 50 kg FYM mixed with 500 g *Trichoderma harzianum* and 200 g Phosphobacteria once in a year to the base of palms in 2 m radius and root feeding 100 ml of 2% Calixin at quarterly intervals have been recommended.

Tatipaka disease

- The etiological studies of Tatipaka disease of coconut in Andhra Pradesh confirmed the presence of Mycoplasma like organism. Survey was conducted in East Godavari district of Andhra Pradesh to identify Tatipaka disease affected palms and the diseased palms were removed to reduce the inoculum potential and also to prevent further spread of the disease.
- Root regeneration in an infected palm by making rings of 3 cm width above the bole and heaping a mixture of river sand and farm yard manure and/or river silt around the rings checked further deterioration of the diseased palm. Application of zinc sulphate at the rate of 2 kg /palm twice in a year and subsequently at the rate of 1 kg/palm/year increased the zinc, iron, calcium and potash

contents in the leaves and reduced disease intensity of diseased palm.

Insect Pest

- Severe incidence of leaf eating caterpillar can be effectively controlled by IPM strategy including release of parasitoids and root feeding and spraying of monocrotophos. Spraying of 0.05 % monocrotophos or 0.05 % Endosulphan or 0.05 % phosalone or root feeding of 10 ml of monocrotophos with 10 ml of water were commended .
- *Brachymeri anosatoi*, an effective host specific pupal parasitoid of *Opisina* with higher parasitization is being successfully multiplied and supplied to farmers from Ambajipeta center for management of leaf eating caterpillar.
- *Metarhizium* spray in the breeding sites of *Oryctes* has completely eliminated the pest within six months in Ambajipeta.

Arecanut

- **Samrudhi (CAL-17):** This indigenous arecanut variety has been recommended for release in Andaman Islands. This variety has a yield potential of 18.89 kg ripe nuts per palm per year with a kernel (chali) weight of 4.34 kg per palm per year, amounting to 12 percent higher yield over Mangala.
- **Sirsi Arecanut Selection-1 (SAS-1)** this variety has been recommended for cultivation only in Sirsi area (Hilly area). This variety has a yield potential of 24.03 kg of ripe nuts per palm per year. It is a popular tender nut variety in Sirsi area.

Oil Palm

- Oil palm is one the very important mandate crops in this project. *Dura x Pisifera* combinations are being tried at Aduthurai, Gangavathi, Mulde and Vijayarai to assess their performance at different agro climatic conditions. The hybrids 128 d x 291 p performed well both at Vijayarai (AP) and Mulde (Maharashtra) yielding 11.35 ton FFB and 15.2 ton FFB per ha respectively.
- At Aduthurai, palms supplied with basin irrigation and the highest fertilizer dose (1200:600:2700 g NPK/palm) produced higher number of female inflorescence and yielded more FFB in the fourth year of planting.
- At Vijayarai, the fertilizer dose of 1200:600:2700 g NPK/palm/year with drip irrigation gave maximum FFB yield of 12.3 t/ha.

Palmyrah

Research on the Palmyrah crop is in its early stages and the main goal of the research centers will be to develop agronomic practices including spacing, planting depth, cultivation operation, fertilization needs and crop protection measures. The initiated germplasm collection and evaluation process should focus on the development of dwarf types. Among the economic uses, in addition to the edible part of the palmyrah, the extraction of neera and sugar ingredients are preferable.

- At Killikulam, 67 Accession and at Pandirimamidi 51 accessions were collected from neighboring areas considering important characters like neera yield and leaf production.

2002-2012

Coconut cultivation has undergone tremendous transformation during the past 60 to 70 years in the country. The traditional coconut areas were the coastal regions predominately west coast and some pockets in the east coast. The spread of coconut from the traditional states like Kerala, Tamil Nadu, Andhra Pradesh and West Bengal to non – traditional states of north and north eastern regions like Madhya Pradesh, Bihar, Assam, Tripura, and Arunachal Pradesh etc. has been very fast. Even in the traditional states, the cultivation has gone beyond the coastal belts to interior zones. Four new centres, two each for coconut and oil palm, were added to the project during 2009. Two centres viz., Sabour (Bihar) and Navsari (Gujarat) for coconut and two oil palm centers Madhopur (Bihar) and Pasighat (Arunachal Pradesh). The Eriophyid mite, a new coconut pest in India, has infested large areas in Kerala, Tamil Nadu and Karnataka. Probably no other pest has threatened the sustenance of yields in a perennial crop like coconut. The coconut farmers are demanding a specific recommendation that suits their agriculture. In particular, the coordination centers have the task of carrying out regional adaptation paths on the basis of the technologies developed at the research institutes and SAUs. Monitoring of the population dynamics of pests, with special attention to emerging pests, has been taken up by all centres. The nucleus culture of parasitoid of *Opisina arenosella* has to be maintained by the centres for supply to extension agencies /progressive farmers. The major thrust for the future will be *in suit*

conservation of local germplasm in the agro climatic regions. Shortage of elite planting materials is one of the major constraints in increasing the productivity. Since root wilt eradication is to be followed simultaneously by replanting programme, generating elite planting material become very important to augment the production. One of the significant contributions of the coordinating centers like Arsikere, Ambajipeta, Ratnagiri, and Veppankulam under the project has been the supply of planting material to farmers as well as developmental agencies.

The major recommendations emerged out during 2002– 2012

The decade saw release of number of varieties/ hybrids of coconut from different centers in collaboration with CPCRI. High yielding hybrids in oil palm was also identified as potential candidate for release in coming years.

Kalyani Coconut-1

- A selection from Jamaican Tall, comes to bearing by 72 months. It gives 14066 nuts/ha/year with an average yield of 80 nuts/palm/year. The copra content is 154 g/nut with copra yield of 12.3 kg/palm/year. Tender nut quality of the variety is good with 350 ml of water, 4.9 % of total sugar content and high potassium (2347 ppm) content.
- Recommended for West Bengal

Gauthami Ganga

- It is a selection from the local early bearing germplasm accession, Gangabondam, with an average yield of 80 to 90 nuts/palm/year. Dwarf



palm with semi circular canopy with oblong shaped green colour fruits. Yields 12813 nuts/ hectare per annum with copra content of 156.68g/ nut and an oil content of 68 %.

- Recommended for Chhattisgarh, Andhra Pradesh, Maharashtra and Tamil Nadu states

Kera Keralam

- It is a selection from the popular local accession of west coast region of India, viz., West Coast Tall. It is a tall coconut variety. It is found to be promising and adaptive to wide ranging cultivation zones; comes to flowering in 58 months. Yields 147 nuts/ palm/year with irrigation. In east coast region of Tamil Nadu, it recorded higher nut yield by 19 to 48 % over the previously released varieties. It comes up well in varied types of soil including sandy, sandy loam and red sandy loam with pH ranging from 6.0 to 8.0.
- Recommended for states of Kerala, Tamil Nadu & West Bengal

Konkan Bhatye Coconut Hybrid-1

- It is a cross between GBGD ×ECT and released in the year 2007, tall palm with semi- circular bearing at 66 months with green colour oval shaped fruit. It is a high yielder with better copra quality than West Coast Tall and Pratap and with better oil content than ECT (67.10%). This hybrid yields 122 nuts/ palm/year (20300 nuts/ha/year) with copra yield of 22.08 kg/palm/year i.e. 3.43 tonnes/ha/year. It is resistance to stem bleeding diseases and moderately resistance to leaf blight and bud rot.

- Recommended for Maharashtra

Kera Bastar

- It is selection from Fiji Tall and excellent coconut variety with wide adaptability. The nut yield ranges from 110 to 117 nuts/palm/year with a copra yield of 2.5 to 3.1 tonnes/ ha. Widely adapted to different agro- climatic zones. Quantity of tender nut water is 332ml and total sugar content in tender nut is 6.2 g/ 100 ml.
- Recommended for Chhattisgarh, Andhra Pradesh, Maharashtra and Tamil Nadu

Kalpa Dhenu

- It is selection from Andaman Giant Tall and it is a regular bearer, relatively tolerant to drought. The palms are tall, robust and bear large, green nuts. The tender nut water of this variety contains 4.92g total sugars/100 ml, 1.3 mg free amino acids/100 ml, 2650 ppm potassium and 24.6 ppm sodium. It commences flowering in 67 months after planting. The quantity of tender nut water is 290 ml/nut. The average yield 15012 nuts/ha, copra yield 3.66 ton/ ha
- Recommended for Kerala, Karnataka, Maharashtra, Tamil Nadu and Andaman & Nicobar Islands

Kalpa Pratibha

- It is selection from Cochin China Tall and suitable for tender nut and copra. The variety is a regular bearer, relatively tolerant to drought. The nuts are large, round in shape and predominantly green in colour. The quality of tender nut water is good with

5.5 g total sugars/100ml, 1.1 mg free amino acids/100 ml, 2150 ppm potassium and 21.7 ppm sodium. The quantity of tender nut water is 448 ml/nut. The average yield 15874 nuts/ha, copra yield 41 q/ha and oil 27 q/ha.

- Recommended for Kerala, Karnataka, Maharashtra and Tamil Nadu

Kalpa Mitra

- It is selection from Java Tall and a regular bearer, relatively tolerant to drought and produces large, yellowish green, oval shaped nuts. The variety is suited for west coast region of the country and West Bengal. Suitable for ball copra. The tender nut water of this variety contains 5.7g total sugars/100 ml, 1.3 mg free amino acids/100ml, 2150 ppm potassium and 23.5 ppm sodium. The quantity of tender nut water is 495 ml. The average yield 13973 nuts/ha, copra yield 34 q/ha and oil 22 q/ha.
- Recommended for Kerala, Karnataka, Maharashtra, Tamil Nadu and West Bengal

Kalpataru

- It is a selection from Tiptur Tall accession, suitable for ball copra production. The average yield 20300 nuts/ha, copra yield 35 q/ha and oil 25 q/h.
- Recommended for rain fed and irrigated regions of Karnataka, Tamil Nadu and Kerala

Kalpa Samrudhi

- A cross between MYD×WCT is a high yielder (104 nuts/palm/year) with higher copra out turn (3.1 t/ha) and oil content (68.0%). It was recommended

for release for the North East region by AICRP on Palms, Kahikuchi centre in collaboration with CPCRI, Kasaragod. The hybrid is semi-tall, precocious bearing (comes to bearing at 5 years) moderately tolerant to stem bleeding, red palm weevil and crown choking disorder.

- Recommended for Kerala and Assam

Kalpa Jyothi

- Dwarf variety (selection from Malayan Yellow Dwarf) with yellow fruits, yielding on an average 114 nuts per palm per year under rainfed conditions with estimated copra yield of over 16 kg per palm per year.
- Recommended for cultivation in Kerala and Karnataka for tender nut purpose.

Kalpa Surya

- Dwarf variety (selection from Malayan Orange Dwarf) with Orange fruits for tender nut purpose. The average yield is 123 nuts per palm per year under irrigated conditions with estimated copra out turn of 23 kg per palm per year.
- Recommended for recommended for cultivation in Kerala, Karnataka and Tamil Nadu.

Kalpa Sreshta

- A cross between MYD×TPT with a mean yield is 167 nuts/palm/year and high copra out turn of 35.9 kg/palm/year or 6.28t/ha copra. The hybrid is suitable for tender nut and ball copra also.


Kalpa Sreshta

Kalpa Jyothi

Kalpa Surya

Germplasm conservation

Germplasm collection and conservation plays a prime role in crop breeding as the very objective of the activity is to preserve the genetic diversity of a particular plant or genetic stock for its use at any time in future. Research efforts were undertaken to conserve and evaluate coconut germplasms; collect, conserve and

evaluate local germplasm collections and evaluate elite genotypes from germplasms in multi-location trials.

A total of 112 ecotypes of coconut have been collected from Assam, Chhattisgarh, Odisha, West Bengal, Karnataka, Tamil Nadu, Andhra Pradesh and Maharashtra for desired traits and conserved for further evaluation and deposited in National Active Germplasm Site, ICAR-CPCRI, Kasaragod.

Genetic resources maintained at AICRP on Palms centres:

Name of the centre	Number of accessions maintained	Number registered with NBPGR (ICNos.)
Aliyarnagar	12	610368-79
Ambajipeta	13	610306-18
Arsikere	20	610333-52
Bhubaneswar	11	612457-67
Jagdapur	10	610323-32
Kahikuchi	15	610353-67
Mondouri	10	612447-56
Navsari	4	610319-22
Ratnagiri	12	599111-16599994-9
Veppankulam	7	599263-69

Crop Production

Water management in coconut:

Drip irrigation: Region specific drip irrigation schedule was recommended for improved water use efficiency

Region	Months	Quantity of water (lit/palm/day)
Western Region of Tamil Nadu	February-May	65
	January, August -September	55
	June-July, October– December	45
Eastern region of Tamil Nadu	March-September	80
	October – February	50
Maiden tracts of Karnataka	February-May	65-75
	Oct-January	40-50
Konkan region	February to May	40
	October to January	30

Increasing input use efficiency through Drip fertigation

Based on the studies taken up on fertigation in coconut at different Centres of AICRP on Palms from 2007-08 to 2012-13, Results from the study suggest that there is a potential for higher coconut production with efficient use of water and nutrients through drip irrigation and fertigation in comparison to conventional system of irrigation and fertilizer application. Drip fertigation of N, P and K (i.e., fertilizers applied through drip irrigation) results in higher coconut yield than soil application of N, P and K through conventional ring basin irrigation.

- Aliyarnagar, Veppankulam, Mandouri and Kasaragod Centres: The nut and copra yield per palm per year in fertigation of 50% recommended dose of fertilizer (RDF).
- Ambajipeta, Ratnagiri, and Arsikere Centres: Application of 75% RDF through fertigation recorded significantly higher nut and copra yield per palm per year compared to soil application.
- By improving the water and nutrients utilization, which can reduce the cost of production by 15 to 20 %, increase the productivity of the system by 25 to 30 % and resulted in maximum utilization of available natural resources.

Nutrient management

Integrated nutrient management packages were recommended for the cultivation of coconut in different regions.

S.No	States	INM packages (g NPK/palm/ year)	Remarks
1	Tamil Nadu	1000:250:1000	50 % of the recommended nitrogen dose could be applied as organic manures (Vermicompost) and the balance NPK could be applied as inorganic fertilizers for Dwarf × Tall
2	Assam	500:500:2000	
3	West Bengal	1000:500:1000	
4	Konkan region	1000:500:2000	
5	Karnataka	1000:250:1000	

By adopting integrated nutrient management packages, there was increase in the productivity of the system by 30 to 40 % and there was improvement in the soil properties.

Evolving location-specific coconut based cropping systems:

Popularisation of coconut based cropping system opened new vista for growth and rural economy

in the country. These labour intensive cropping system models provide added employment opportunities and also additional income by effective utilization of horizontal and vertical land, air and sunlight. The cropping models in coconut tried in different states enable to identify crop combination which gave 60 % additional benefit to the farmers.



Coconut based cropping system

Location specific coconut based cropping system with different crops:

Sl. No.	Region	Component crops
1	Tamil Nadu	<ul style="list-style-type: none"> • Coconut + banana + turmeric + EFY + pineapple+ tapioca + bhendi • Coconut + black pepper + banana + elephant foot yam + coriander • Coconut + galanga + lemon grass + patchouli • Coconut + aloe + galangal + tulsi • Coconut + marigold + gomphrena + chrysanthemum
2	West Bengal	<ul style="list-style-type: none"> • Coconut + black pepper + pineapple • Coconut + sarpagandha + aswagandha +arrowroot • Coconut + gladiolus + tuberose + gerbera
3	Odisha	<ul style="list-style-type: none"> • Coconut + banana + tube rose (in young coconut garden) • Coconut + stevia + artensia
4	Chhattisgarh	<ul style="list-style-type: none"> • Coconut + black pepper + carnation +chrysanthemum • Coconut + stevia + amahaldi + sarpagandha + tikhur + patchouli
5	Assam	<ul style="list-style-type: none"> • Coconut + black pepper + turmeric • Coconut + pipali + patchouli + citronella + sarpagandha • Coconut + gerbera + tuberose + gladiolus
6	Maharashtra	<ul style="list-style-type: none"> • Coconut + turmeric + banana + pineapple + tapioca • Coconut + sathavari + adulsa + arrow root + lemon grass + citronella • Coconut + lily + jasmine + heliconia
7	Karnataka	<ul style="list-style-type: none"> • Coconut+ banana + drumstick + French bean+ ladies finger + red gram • Coconut + banana (High water requirement) • Coconut + annual drumstick (Medium water requirement) • Coconut + red gram (low water requirement) • Coconut + lemon grass + garden rue + tulsi +kalmegh + arrow root + makoi • Coconut + chrysanthemum + crossandra + jasmine
8	Gujarat	<ul style="list-style-type: none"> • Coconut + turmeric + amorphophallus
9	Andhra Pradesh	<ul style="list-style-type: none"> • Coconut + palmarosa + mango ginger + patchouli + citronella • Coconut + Cocoa + Banana + Pine apple + Tomato

Disease Management

Identification of Indicator Plants for Basal Stem rots:

Indicator plant studies were carried out both in pot conditions and natural sick soil conditions. In pot experiments, sterile soil was inoculated with the pure culture of *Ganoderma* and seedlings were transferred to the pots. Under, natural conditions, seeds of red gram and bengal gram were sown in the disease sick soil. Red gram and Bengal gram plants were identified as

indicator plants for basal stem rot disease of coconut. Red gram plants showed the symptoms of bark splitting at the base of the stem within three months period. The results were consistent in all the plants that were grown in *Ganoderma* sick soil. Bengal gram plants showed withering and yellowing of the lower set of leaves followed by upper leaves and complete death of the seedlings within one month. Pure culture of *Ganoderma* was re isolated from the infected bengal gram plants



Indicator plants for BSR: Red gram and Bengal gram

Early detection by PCR techniques: *Ganoderma* specific primer: Primers were designed from ITS 1 region of ribosomal DNA of *G. boninense* Accession number: X78749 which would amplify an expected band size of 167 bp. The sequence of forward and reverse primers was as follows. GAN1: 5' – TTG ACT GGG TTG TAG CTG-3' and GAN2: 5' – GCG TTA CAT CGC AAT ACA-3'. DNA was isolated from the *Ganoderma* isolates and the PCR reaction using the

above said primers was carried out with the following steps. It included an initial denaturation at 95 °C for 10 min followed by 35 cycle reaction of 94°C for 1 min, 58°C for 1 min and 72°C for 1 min. The final extension step included 72°C for 10 min. Preliminary results showed that all the isolates showed expected band size of 167bp and also showed some non specific amplification.

Stem Bleeding disease

Integrated disease management package was developed for stem bleeding disease which involves avoiding injury or damage to the stem, especially while tractor ploughing, 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) and soil application of 50 g of talc powder formulation of *T. viride* / *T. harzianum* / *T. hamatum* in combination with 5 kg neem cake /palm /year.

Bud Rot

Integrated disease management package developed for bud rot disease, which comprised clean cultivation, removal of dead and decomposed trees, cleaning of the effected regions and application of talc powder formulation of *P. fluorescence* or *T. viride* in crown region of coconut seedlings. The required quantity of talc formulation of *P. fluorescence* or *T. viride* to be applied in the crown region of coconut seedlings was standardized and recommended as 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.

Leaf Blight Disease

- Microbial consortia consisting of *Pseudomonas fluorescens*, *Trichoderma viride* and *Bacillus subtilis* have also been developed for the biological management of leaf blight disease of coconut.
- Root feeding of *Pseudomonas 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.

Insect Pest Management

Coconut black headed caterpillar

- Regular incidence of coconut black headed caterpillar *Opisina arenosella* was observed in coastal districts of Andhra Pradesh. This pest was successfully managed through biological control. A total number of 62.21 lakh parasitoids were supplied during the last 10 years and an area of 10,678 ha of coconut black headed caterpillar affected gardens were covered (2013-14).
- A very severe outbreak of this caterpillar was recorded in 2011 and 2013 in East Godavari, West Godavari and Visakhapatnam districts and by release of bio agents *Bracon hebetor* and *Goniozus nephantidis* (7.00 lakhs), the pest was successfully managed. The farmers are very much impressed and convinced with the technology demonstrated in their fields.

Coconut black headed caterpillar infested and recovered gardens after biological control intervention

- Root feeding of bio pesticide Azadiractin F5% @ 10 ml + 10 ml water and inundative release of larval parasitoids *Bracon brevicornis*, *Goniozus nephantidis* and pupal parasitoid, *Trichospilus pupivora* at recommended dose at 21 days interval for each treatment in two phases significantly reduced

Coconut Black headed caterpillar. A technology for the management of coconut black headed caterpillar involving release of *Bracon brevicornis* @ 30 no./ tree or *Goniozus nephantidis* @ 20 no./ tree was standardized.

- Studies conducted at all three centres viz., Ambajipeta, Aliyarnagar and Ratnagiri on olfactory conditioning of parasitoids of coconut black headed caterpillar, *O. arenosella* by exposing them to the

odor of larval frass and larval damaged leaves revealed that parasitisation levels of *O. arenosella* was found to be significantly more in conditioned parasitoid release treatment than in the unconditioned parasitoids release treatments . Hence, while releasing paraitoids against *O. arenosella* they should be invariably conditioned for 72 hours by exposing them to the odor of larval frass and larval damaged leaves of *O. arenosella*

Laboratory for mass production of coconut parasitoids

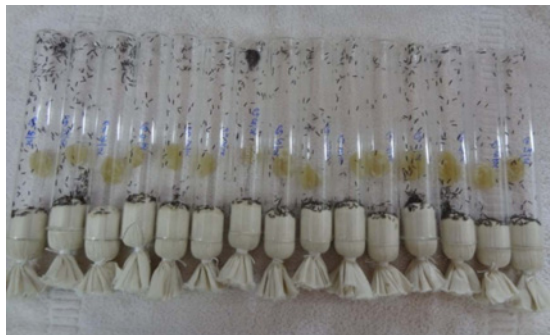
Mass multiplication and distribution of *Bracon brevicornis* and *Goniozus nephantidis* is being taken up in the AICRP labs for management of Black Headed Caterpillar



Mass rearing of parasitoids at Aliyarnagar centre



Mass rearing of parasitoids at Ambajipeta centre



Goniozus nephantidis culture



Bracon brevicornis culture

Rhinoceros beetle and Red palm weevil:

- Placement of aggregation synthetic pheromone traps viz., Rhino lure (without feeding stimulant) @ one / ha; Ferro lure @ one / ha with feeding attractant (Sugarcane molasses 2.5kg + 5 ml acetic acid +5gm yeast) attracted and captured more numbers of black beetles and red weevils of both sexes. Setting up of attractant traps (mud pots containing sugarcane molasses 2.5kg/toddy 2.5 l + acetic acid 5 ml + yeast 5 g + longitudinally split tender coconut stem/logs of green petiole of leaves of 30 numbers in one acre to trap adult red palm weevils in large numbers. Mud pots containing castor cake suspension (2.5 kg) + 5 ml acetic acid 5 gm yeast + longitudinally split tender green petioles of leaves of 30 numbers/acre to trap adult rhinoceros beetles in more numbers.
- An IPM technology involving setting of Rhinolure trap @ 1/ha, leaf axil placement of phorate granules or naphthalene balls, release of Baculovirus infected adults @ 15/ha and application of *Metarhizium anisopliae* to manure pits has been standardized for the management of coconut rhinoceros beetle.
- Validation of integrated pest management strategies for Rhinoceros beetle was carried in farmer's field (10 ha) and the technology was found effective and successful in the managing these pests.
- Pipe trap technique for rhinoceros beetle using rhinolure was tested and popularized
- Pheromone trapping of red palm weevil, rhinoceros beetle was popularized and was effectively taken up in the pests affected gardens in coastal districts of Andhra Pradesh.



Pipe trap technique for rhinoceros beetle



Bucket trap for rhinoceros beetle

Oil Palm

Evaluation of oil palm genotypes for drought tolerance

- Evaluation of oil palm genotypes for drought tolerance revealed that, five African dura genotypes viz., ZS-3, ZS-1, ZS-6, ZS-3 and TS-5 were drought tolerant based on physiological and yield characters based on 10 years data. Further they were selected as mother palms for crossing programme to improve the dura types and dura x pisifera crosses.

Crop Production

On the basis of 18 years study (1989 -2007) on fertilizer and irrigation requirements for oil palm under Tungabhadra command area (Karnataka); West



ZS 1 genotype

Godavari (Andhra Pradesh) and Konkan regions (Maharashtra) and Cauvery delta regions of Tamil Nadu following recommendation was given.

- Water requirement for adult Oil palm worked out and is as follows:

Months	Water requirement (day/palm)	
	Basin irrigation	Drip irrigation
Gangavathi		
July - October	110-140	55-70
November - February	90-130	45-65
March - June	150 - 220	75 - 110
Mulde		
October - January	50	100
February - March	80	120- 150

• Fertigation

S.No	States	Fertigation Schedule
1	Tungabhadra command area (Karnataka)	1200:600:1200 N,P ₂ O ₅ and K ₂ O/palm/year through drip in 6 equal
2	West Godavari (Andhra Pradesh)	
3	Konkan regions (Maharashtra)	1200; 600; 1800 g N,P ₂ O ₅ and K ₂ O/palm/year through drip in 6 equal
4	Cauvery delta regions of Tamil Nadu	

Nucleus seed gardens for released varieties of coconut

The successful establishment of coconut plantations begins with producing good-quality planting material. Hence, selecting appropriate planting material before field planting ensures higher productivity in the long run. Direct field planting of coconut seed nuts is not recommended. Utmost care is recommended while selecting seedlings as quality planting materials is

advantageous to enhance productivity and improve the coconut palm's economic life. Nucleus seed gardens were set up to produce high-quality planting material for released coconut varieties at AICRP on Palms centres with funding from Coconut Development Board (48.lakhs). This mechanism has provided 9.67 lakh coconut seedlings of released variety/hybrids to coconut farmers, contributing significantly to acreage expansion.



Fig 1. Nucleus Seed Gardens of released varieties established in AICRPP centres



Nucleus seed garden at Aliyarnagar (Tamil Nadu)

2012- 2022

The overall mandate of All India Coordinated Research Project on Palms is to identify location specific technologies for coconut, oil palm, arecanut, cocoa and palmyrah, that can be recommended for commercial adoption in the respective agro-climatic region and to develop the technical capability in the National Agricultural Research System in conducting research on palms. During the XII plan period, AICRP on Palms was expanded to include arecanut as one of the mandate crops, and to six more new centres were added. The success of cocoa as a mixed crop under coconut and arecanut has been proved beyond doubt and this crop has a very vast potential in this country. There is also urgent need for increasing the production of cocoa to meet the demands of the process factories. The palms projects should encompass cocoa also and evaluate suitable varieties under different agro climatic regions and develop management practices for increasing the production and productivity and improvement in quality and processing. In the 2017-18 to 2019-20 period, the EFC approval was issued to open four more voluntary centres for cocoa and Palmyra. As of 2021-22, there are 28 AICRP centres with its headquarters at ICAR-CPCRI, Kasaragod. Currently 15 centres are working on coconut, six on oil palm, four on arecanut, four on palmyrah and seven on cocoa located in different agro-climatic zones supporting improvement, production, protection and post harvest processing in coconut, arecanut, oil palm, cocoa and palmyrah. The coordinating centres are located in 14 states and one

union territory covering 13 SAU's/SHU's, one Central Agricultural University and four ICAR Institutes. The AICRP on Palms contributed to the development of horticulture in the country through testing and release of the varieties and technologies besides the supply of quality planting materials. This, in turn, has contributed to an increase in the area under new varieties and technologies of plantation crops in several states.

The major recommendations emerged out during 2012 – 2022

Coconut varieties notified by CVRC

- Kalpatharu
- Kalpa Samrudhi
- Kalpa Surya
- Kalpa Sreshta
- Kalpa Jyothi
- Kalpa Shatabdi
- Kalpa Ratna

Varieties recommended for release

- **Kalpa Ganga:** The hybrid, GBGD x FJT with a mean yield of 121 nuts/palm/year has been recommended for cultivation in Karnataka.
- **VHC-4:** The Tall x Tall hybrid (LCOT x CCNT), which gives a mean nut yield of 161 nuts/palm/year was recommended for cultivation in Tamil Nadu.
- **Kalpa Shatabdi:** A high yielding Tall coconut selection from San Ramon is recommended for cultivation in Tamil Nadu, Karnataka and Kerala.

It records an average yield of 105 nuts / palm/year and has large nuts with a copra content of 272.9g/nut with an estimated copra yield of 28.65 kg/palm.

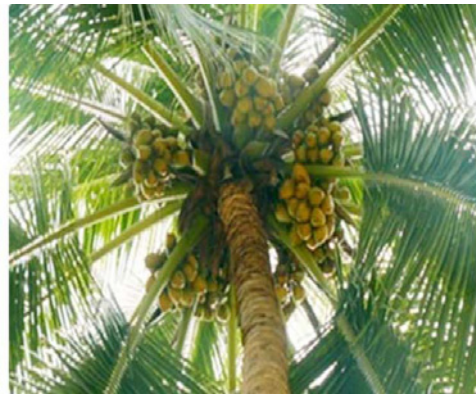
- **Abhaya Ganga** hybrid (GBGD x LCOT) with an average yield of 136 nuts/palm/year, copra output of 21.7 kg and oil yield of 15.5 kg/palm/year was released for commercial cultivation in Andhra Pradesh State.
- **Vasista Ganga** hybrid (GBGD x PHOT), with an average yield of 125 nuts/palm/year, copra content of 158 g/nut and oil yield of 15.35 kg/

palm/year was released for commercial cultivation in Andhra Pradesh State.

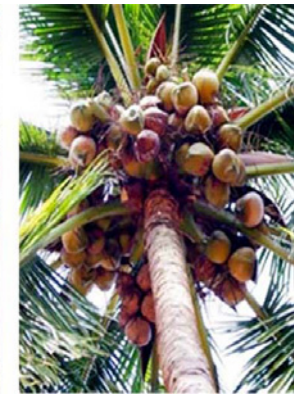
- **Gauthami Ganga** - a selection from GBGD for tender nut purpose, with an average nut yield of 85 - 94 nuts/palm/year and tender nut water content of 446-450 ml/nut was released for commercial cultivation in Andhra Pradesh State.
- **Kalpa Ratna** - a tall coconut variety selected from Federated Malay States (IND 010 S) was recommended for release for cultivation in the coconut growing regions of Karnataka, Kerala and Tamil Nadu states with copra content of 162 g/nut and a copra yield of 12.7 kg/ palm/ year.



Kalpa Ganga



VHC 4



Kalpa Shatabdi

Palm Based cropping systems

Popularisation of coconut based cropping system will be open new vista for growth and rural economy in the state. In this context research focus is needed as economics aspects specially in relation to size of holdings, plants species and livestock component

- **HDMSCS:** Coconut Based High Density Multi Species Cropping System involving crops like Black Pepper, Cocoa, Banana, Drumstick, Nutmeg, Cinnamon, Pineapple, Turmeric, Elephant Foot Yam, Tapioca, Bhendi and Coriander were recommended with suitable combinations for different regions, which

enhanced the net income to the tune of Rs. 1.75 lakhs to Rs. 3.25 lakhs/ha as compared to coconut monocrop (Rs. 70,000 to Rs. 90,000/ha).

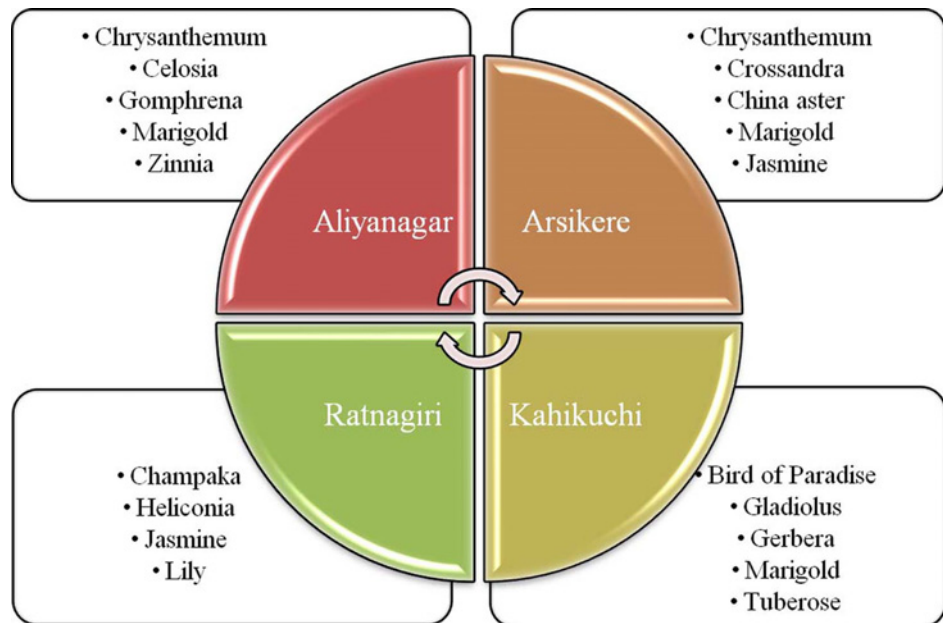
• **Intercropping with medicinal and aromatic crops:**

Crops such as Galangal, Lemon grass, Patchouli, Pipali, Citronella, Aloevera, Tulsi, Palmarosa, Sarpagandha, Aswagandha, Arrow root, Amahaldi, Sathavari, Garden rue, Mango ginger, Makoi and Kalmegh were recommended for cultivation in coconut garden in different regions - resulted in an additional net income to the tune of Rs. 1.20 lakhs to Rs.1.75 lakhs/ha.

• **Intercropping of flower crops in coconut garden:**

All India Coordinated Research Project on Palms (AICRPP), has been an important contributor to the region's specific coconut research and development effort. One of the priority areas of research within the AICRP on Palms; is to assess the influence of intercropping flower crops in coconut on productivity per unit area and system economics in different agro-climatic regions. As coconut based intercropping with flower crops requires short period of planting time, smaller area (unutilised spaces between coconuts), provides additional income to coconut farmers. From 2012 - 2016, field experiments were conducted at Aliyanagar (Tamil Nadu), Kahikuchi (Assam),

Arsikere (Karnataka), and Ratnagiri (Maharashtra) in a randomised block design with four replications each taking four coconut palms per treatment. The flower crops were grown in 84 of the area in the interspaces of coconut leaving 16 in the coconut basins. Marigold, chrysanthemum, celosia, zinnia, gomphrena, crossandra, china aster and gladiolus were planted every year while jasmine, lily, heliconia, tuberose, gerbera and bird of paradise which are perennial in nature were planted during first year and maintained during subsequent years. Vermicompost and FYM were used as organic manure applied basally, and inorganic fertilisers were used as top dressing in split dosages. The recommended package of practices was followed as per the regular schedule. The following figure lists the flower crops grown in each centre.



This technology has received wide acceptance/adoption among the coconut growers of Kanyakumari district, a coastal district located in the southern tip of Tamil Nadu which is very often prone to weather extremities like cyclonic depressions and thunder storms. Flowers viz. Marigold, chrysanthemum, tuberose and gomphrena are cultivated by the farmers for use in garland making. Elsewhere in Tamil Nadu, Karnataka and Maharashtra flowers viz. marigold and chrysanthemum are intercropped in coconut gardens sporadically by the farmers targeting Dussera / Vijayadasami festivals when there is a huge demand for flowers.

• **Integrated Nutrient management under coconut based cropping system:** Application of 50% of RDF (NPK) + 50% N through organic recycling with vermicompost + vermiwash + biofertilizer and *in situ* green manuring recorded higher system productivity followed by 75% of recommended NPK + 25% through organic recycling with vermicompost or fully organic - recommended from Aliyarnagar, Ambajipeta, Arsikere, Bhubaneswar, Jagdalpur, Kahikuchi, Mondouri, Navsari, Ratnagiri, Sabour and Veppankulam centres for adoption by farmers.

Integrated farming system: Integration of coconut with pasture crops (*Cumbu Napier hybrid + Desmanthus*), fodder trees (*Sesbania grandiflora + Leucaena leucocephala + Glyricidia*) and Tellicherry breed of goats recorded net income of Rs. 2,54,206/- per ha with BC ratio of 3.16 as compared to Rs. 1,51,312/- per ha with BC ratio of 2.25 in the monocrop of coconut at Aliyarnagar centre.

Impact of Integrated farming system: During COVID-19 pandemic, when many industries and textile mills in the cities are closed, there was reverse migration of workers back home and everyone could not be absorbed in agricultural operations as the agricultural marketing channels also got disrupted. There were emotional setbacks among the rural unemployed youth but they synthesised confidence from the Goat Shed based Goat farming advocated by AICRP Centre at Aliyarnagar and ventured into goat rearing on a small scale to meet their family needs. Frequent enquiries being received from diverse stake holders, more specifically from the software professionals in the recent days, on establishing goat shed, underline the importance of this trial in the region.



Coconut based cropping systems



Intercropping of flower crops in coconut garden

Integrated nutrient management for tender nut

- Site Specific Nutrient Management with secondary ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ – 1 kg and MgSO_4 – 500 g per palm per year) + Micronutrient mixture (FeSO_4 , MnSO_4 , CuSO_4 , ZnSO_4 , Borax and ammonium molybdate) @ 1 kg per palm per year + Coconut frond mulching + *Azospirillum* – 100 g + *Phosphobacteria* -100 g + VAM -100 g per palm per year enhanced productivity by 32 % over farmers' practice in Tender nut variety Chowghat Orange Dwarf at Aliyarnagar. Net Returns and Benefit cost ratio were Rs. 4.38 lakhs per ha and 2.99 in INM package as against Rs. 3.10 lakhs per ha and 2.66 in farmer's practice respectively.

Disease Management

Leaf blight

- Molecular characterization of *Lasiodiplodia theobromae* isolates was carried out at Aliyarnagar Centre. Through PCR amplification of ITS region of *L. theobromae* isolates, an expected amplicon of 550 bp was obtained and the sequences were deposited in Gen Bank (Accession numbers; MG685854, MG685855 and MG 697234).

- At Aliyarnagar Centre, in the field evaluation trial, sequential root feeding of carbendazim @ 5 g/ 100 ml of water during January and July followed by propiconazole @ 5 ml/ 100 ml of water during April and October was found to be effective in controlling the disease.

Stem bleeding

- The new fungicide molecules with combi product (carbendazim 25% + Mancozeb 50% WS) was tested against mycelial growth of *Thielaviopsis paradoxa* under *in vitro* conditions. Cent percent inhibition of pathogen at lower concentration i.e. 100 ppm indicated its strong action against the test pathogen.
- Application of neem cake based formulation of "*Trichoderma harzianum*" cakes (one cake / bleeding patch/year) was found effective for the management of stem bleeding disease in coconut in Andhra Pradesh.

Bud rot

- Talc based formulation of *Trichoderma reesei* @ 5 g/coconut seedling at spindle region is

recommended for application during pre monsoon period in Andhra Pradesh State.

Basal stem rot

- Soil application of talc based formulation @ 125g each of *Trichoderma reesei* and *Pseudomonas fluorescens* + 5 kg of neem cake per palm at yearly interval have been recommended for the management of basalstem rot disease in coconut.

Insect-Pest Management

- **Management of rhinoceros beetle:** Application of CPCRI Botanical cake @ 15 g/palm + paste@ 15g/palm is recommended against rhinoceros beetle in juvenile palms as it was found effective in reducing spindle damage and leaf damage in coconut.
- **Management of Eriophyid mite:** Effective INM and IPM package involving (i) application of recommended dose of fertilizers with 20 kg

vermicompost and 5 kg neem cake/palm (ii) growing of green manure crops viz., cowpea / sunnhemp in the inter rows and ploughing *in situ* at flowering stage (iii) application of Keraprobio (100 g/palm) (iv) root feeding with fenpyroximate 5% EC @ 10 ml (in the month of March) and (v) spraying of palm oil-sulphur emulsion (during December) is an effective package for reducing infestation of eriophyid mite in coconut.

- **Management of Rugose Spiraling Whitefly:** Installation of *Yellow Sticky Traps* in coconut garden is recommended for effective attraction of RSW in coconut in order to mitigate their incidence.
- **Black headed caterpillar:** Black headed caterpillar management in coconut was carried out byproduction and release of parasitoids like *Goniozus nephantidis* and *Bracon sp.* in farmers' fields of different regions.



Release of parasitoid by a farmer

Supply of parasitoids to farmers (In lakhs) in the management of Black headed caterpillar(2014-2020)		
Centre	<i>Bracon hebetor/ B. brevicornis</i>	<i>Goniozus nephantidis</i>
Ambajipeta (AP.)	43.22	18.69
Aliyarnagar (TN.)	7.33	0.61
Arsikere (Karnataka)	21.41	38.07
Ratnagiri (Maharashtra)	0.86	0.90
Total	72.82	58.27

- Integrated management of Slug Caterpillar:**
 The IPM packages comprising mechanical removal and destruction of larval and pupal stages, installation of light traps @ 5/ha, application of recommended dose of fertilizers, spraying of insecticide chlorantraniliprole 18.5 % SC @ 0.3 ml/litre and release of potential parasitoid *Pediobius imbreus* @ 60/palm is recommended for effectively managing the incidence of slug caterpillar in coconut.

Oil Palm

Intensive evaluation of African germplasm D x D and D x P by ICAR-IIOPR, Pedavegi resulted in the identification of a few remarkably high- yielding accessions. As a result of planting *dura x pisifera* progenies, oil palm yield has increased substantially and the majority of hybrid evaluation studies carried out in

India (MLT) involve *dura x pisifera* in different agro climatic regions viz., Tungabhadra command area (Karnataka); West Godavari (Andhra Pradesh) and Konkan regions (Maharashtra) and Cauvery delta regions of Tamil Nadu. Based on the long term experiment (for 12 years) following hybrid cross combination were released for cultivation.

Oil Palm hybrids

- NRCOP-2:** NRCOP-2 is recommended for release as Godavari Ratna with the FFB yield potential of 22.69 t/ha for Maharashtra.
- NRCOP-4:** NRCOP-4 is recommended for release as Godavari Swarna with the FFB yield of 30.11 t/ha for Andhra Pradesh.
- NRCOP-17:** NRCOP-17 is recommended for release as Godavari Gold with the FFB yield of 28.37 t/ha for Tamil Nadu.



NRCOP 17



NRCOP 4



NRCOP 2

Intercropping in juvenile phase oil palm garden :

The vegetable okra intercropped with oil palm recorded higher fruit yield and net returns followed by tomato and brinjal in juvenile oil palm garden under Tungabhadra command area of Karnataka.

Bio- converting the biomass of oil palm - Vermicomposting

The increasing global demand for edible oils has resulted in the increase of oil palm cultivation but there are concerns over the large amount of (biomass) that are being generated in the field. The ability of vermicomposting process to utilize organic waste and bio-convert them into higher value added products like vermicompost makes it an attractive technology.



1.Heap of leaves



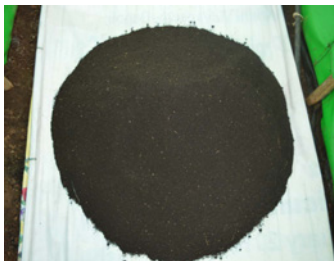
2. Chopping of leaves with tractor operated chopper



3. Vermicomposting in Readymade plastic bed



4. Eudrillus eugeniae



5. Vermicompost

Preparation of compost bed

Step 1

- Partial green and dried oil palm leaves and fronds were chopped into pieces with the tractor driven mechanical shredder

Step 2

- Chopped material was spread in a single vermicompost unit alternating with fresh cow dung slurry at 25% of biomass
- Final layer covered with thick slurry of cow dung

Step 3

- Beds were incubated for 4-5 weeks and moistening was done through the two foggers

Step 4

- Moisture content was maintained at 60–80% by periodic sprinkling of adequate quantity water on the bed turning of waste at weekly interval after 2-3 weeks

Step 5

- Earthworm species *Eudrillus eugeniae* were introduced at a rate of 1,000 worms/bed after 5 weeks when material started decomposing

Step 6

- Watering was stopped one month prior to harvesting of bed. The product was air-dried and collected in polythene bags

Step 7

- Decomposition and final vermicomposting was ready after 7 months (chopped) and 12 months (unchopped)

The experiment was performed in compost beds of plastic, Kaddappa and lateritic stones in open condition of the shaded yard. Readymade plastic unit (Fig. 3) having dimensions of 3" × 3" × 10" were used

for preparation of vermicompost. Dimensions, cost of construction, quantity of chapped fronds and quantity of vermicompost are given in table 1.

Table 1. Dimensions, cost of fixing, quantity of chapped fronds and vermicompost

Sl. No.	Particulars	Dimensions/ bed (cm)	Cost of Construction/bed (Rs.)	Quantity of dry material with cow dung (25 %) (kg)	Quantity of Vermicompost (kg)
1	Readymade plastic bed	300 x 120 x 60	1200/-	600	210
2	Kaddappa	420 x 75 x 90	9800/-	400	150
3	Lateritic stones	420 x 75 x 90	9100/-	400	140

Nutrient value of vermicompost

After 7 months of vermicomposting process using *E. eugeniae* the final produce of vermicompost was analyzed. The colour of vermicompost was also darker with granular grain size of 1 to 1.5 mm with black colour, pH 6.6, organic carbon (13.50%), nitrogen (0.75%), phosphorus (0.39%) and potassium (0.89%). In short, this study suggests that the chopped oil palm wastes which were mixed with an appropriate ratio of cow dung could be easily vermicomposted by *E. eugeniae* when compared to dried un-chopped oil palm fronds and the vermicompost produced could be utilized as an efficient organic fertilizer for sustainable land restoration practices.

Cocoa

Cocoa genotypes are under evaluation in seven AICRP (Palms) centres covering west coast, east coast

and NE regions and different cropping systems including arecanut, coconut and oil palm gardens. From the 12 year old trial at Kasaragod (Kerala), Ambajipeta (Andhra Pradesh) and Veppankulam (Tamil Nadu), VTLCH-2 and VTLCH-1 were identified as best performers respectively in the regions under coconut. From the initial years of evaluation, it was observed that among 8 year old trees of Aliyarnagar (Tamil Nadu), Ratnagiri (Maharashtra) and Kahikuchi (Assam), VTLC-16, VTLC-17 and VTLC-20 were best performing respectively, whereas VTLC-57 was high yielding at Vijayarai (Andhra Pradesh) under oil palm.

Palmyrah

Evaluation of germplasm: 265 (Killikulam) and 272 (Pandirimamidi) germplasm accessions were maintained and evaluated for yield and quality. Survey

was conducted at Dakshina Kannada district of Karnataka, Midnapur district of West Bengal, Puri and Khorda districts of Odisha. 27 germplasm types were collected with distinct characters and conserved at palmyrah centres.

- Composting of palmyrah leaf/base/pith with the following technology resulted in production of suitable organic manure in duration of 100 to 105 days with sufficient nutrient content. Palmyrah pith (100 kg) mixed with poultry manure (10 kg), urea (1kg) treated with *Pleurotus* fungus 2 bottles (1kg) + Ligno Cellulolytic fungi (1kg) + *Trichoderma viride* (1 kg) (turning at 15 days interval up to 45 days). Application of *Trichoderma viride* on 46th day and again turning at 15 days interval.

Post harvest technology in palmyrah

- Preservation of neera using chemical processing- could be stored under refrigerated condition up to

7 days with heating for 5 min. under 90oC followed by 0.1% KMS or 0.1% sodium benzoate and with membrane processing, neera could be stored under refrigerated condition for 60 days by heating for 5 min under 90oC followed by micro filtration under 1kg/cm² pressure for 10 min.

- Storage study of Ready To Serve sap collected following CPCRI method- had a storage life of 10 h without any preservative. The study suggested that the RTS beverages maintained under refrigerated condition, showed minimum deviation in quality from their initial value. These beverages remained in acceptable condition for one day (24 hours).
- Palmyrah jaggery prepared from inflorescence sap is collected by adopting CPCRI method having a shelf life of six months was recommended for commercial release.



Palmyrah jaggery

Arecanut

Establishment of mother blocks and production of quality planting materials in arecanut

Centre	Varieties
Wakawali	Shriwardhani, Swarnamangala, Sumangala, Sreemangala, Mohitnagar, Mangala and Madhuramangala
Shivamogga	Mangala, Sumangala, Sreemangala, Mohitnagar, Swarnamangala, Madhuramangala and Shriwardhani

- Burmese coriander is a popular herb grown in the Andaman and Nicobar Islands. The herb was grown as an intercrop in bearing arecanut palms of variety Samrudhi to study the profitability of this herb as an intercrop in the warm humid tropical conditions of South Andaman Island. Results suggested that introduction of Burmese coriander in the interspaces could give higher net returns of Rs. 13,03,065/- as against Rs. 9,59,600/- in the arecanut sole crop. The B:C ratio of this treatment was found to be 3.19 and hence, it could be recommended for the island farmers.

Management of koleroga disease in arecanut: (i)

Alternate management practice in the place of Bordeaux mixture (1%) is recommended for Malnad region of Karnataka. This practice involves application of Fenamidone 10% + Mancozeb 50% (w/w) (sectin) (@ 0.3% spray) + adhesive (ii) application of *Trichoderma harzianum* (IMI 304056) + *Pseudomonas fluorescens* (NCIB 9046) + *Bacillus megatarium* (NCTC 9848) @ 20 ml (105×10⁷ cfu/ml stock solution/1 water) + soil application of microbial consortia (talc

formulation) containing all the three isolates @ 100 g/plant (*Pseudomonas fluorescens* + *Bacillus megatarium* @ 25 g each and *Trichoderma harzianum* @ 50 g) along with 1 kg of FYM/ decomposed compost to the soil per year.

Entomopathogenic nematodes (EPN) for the management of arecanut white grubs

- Application of EPN (*Steinernema carpocapsae*) (@ 0.75 billion IJs/ha) alone during June-July and combined application of EPN @ 0.75 billion IJs/ha + Imidacloprid 17.8 SL (0.5 ml/ 2 l water) during September- October to the root zone are found to be effective against white grubs.

Impact on Tribal Communities

Programmes under Tribal Sub Plan (TSP) were implemented under AICRP on Palms from 2013–14 onwards. Under the Tribal Sub Plan programme in Gujarat, Maharashtra and Odisha, quality planting materials were distributed to tribal families resulting in area expansion in 20 villages. These programmes focused on training of farmers in using climbing machine.



- Skill development programmes were arranged for tribal youth for profitable farming.
- 110 farmers of Ghatkawali village, Bastar Block in Chhattisgarh State were benefitted from the training programme on ‘Coconut cultivation and its importance in Bastar Region’. Vegetable seeds, fertilizers, insecticides and fungicides were also distributed to 157 tribal farmers.
- Coconut seedlings (Banavali- 2325 Nos) and Nutmeg grafts (1393 Nos) were distributed from Ratnagiri Centre to tribal families from Dehare Taluka, Palghar District in Maharashtra State. Two training programmes were conducted for 115 TSP Farmers in Dehare Village.
- Workshop was organized for demonstrating “planting technique” and after care to 65 TSP farmers.
- 4800 coconut seedlings were planted in the backyard of tribal houses at Keonjhar, Sundargarh and Rayagada villages of Odisha. Farmers were encouraged to grow intercrops in coconut plantations. Different vegetable seeds/seedlings, fertilizers and other inputs were distributed to the tribal farmers.

Annexure 1
Improved varieties of plantation crops developed through selection and hybridization under the aegis of AICRP on palms

Sl.No	Variety	Important traits	Nut Yield (ha ⁻¹ year ⁻¹)	Copra yield (t ha ⁻¹ year ⁻¹)	Recommended states	Agency responsible for the release
COCONUT						
1.	Pratap	High yield	20826	3.60	Maharashtra	Dr. BSKKV Maharashtra
2.	Kamrupa	High yield	17877	2.90	Assam	AAU Assam
3.	ALR (CN)-1	High yield	22302	3.50	Tamil Nadu	TNAU, Tamil Nadu
4.	Gautami Ganga	Dwarf, Green fruits	13260	3.60	Andhra Pradesh	ANGRAU, Andhra Pradesh
5.	Kera Bastar	High yield	19740	3.18	Chhattisgarh, Maharashtra, Tamil Nadu & Andhra Pradesh	AICRPP, IGAU, Chhattisgarh
6.	Kalyani Coconut -1	High yield	14240	3.9	West Bengal	BCKV, West Bengal
7.	Kera Keralam	High yield	26019	3.53	Tamil Nadu, West Bengal & Kerala	AICRPP
8.	Kalpa Dhenu	High nut and oil yield, drought tolerant	14160	3.4	Kerala, Tamil Nadu & Andaman & Nicobar Islands	ICAR-CPCRI, Kasaragod
9.	Kalpa Pratibha	High nut, oil yield, tender nut	16107	4.12	Kerala, Andhra Pradesh & Tamil Nadu	ICAR-CPCRI, Kasaragod
10.	Kalpa Mitra	High nut and oil yield, drought tolerant	15222	3.68	Kerala & West Bengal	ICAR-CPCRI, Kasaragod

11.	Kalpatharu	Drought tolerant, ball copra and High yield	20709	3.64	Kerala, Karnataka & Tamil Nadu	AICRPP, UHS Bagalkot
12.	Kalpa Jyothi	Dwarf, Yellow colour fruit, tender nut purpose	19935	—	Kerala, Karnataka & Assam	ICAR-CPCRI, Kasaragod
13.	Kalpa Surya	Dwarf, orange colour fruit, tender nut purpose	21593	—	Kerala, Karnataka & Assam	ICAR-CPCRI, Kasaragod
14.	Kalpa Shatabdi	High copra out turn and tender nut quality	18375	5.01	Kerala, Karnataka & Tamil Nadu	ICAR-CPCRI, Kasaragod
15.	Kalpa Ratna	Suitable for tender nut, for tapping inflorescence sap. It is also tolerant of drought conditions.	17482	2.61	Kerala, Karnataka & Tamil Nadu	ICAR-CPCRI, Kasaragod
Coconut Hybrids						
16.	Godavari Ganga (ECT x GBGD)	High yield	18585	2.79	Andhra Pradesh	ANGRAU, Andhra Pradesh
17.	Konkan Bhatya Coconut Hybrid I (GBGD x ECT)	High yield	20532	3.47	Maharashtra	Dr. BSKKV Maharashtra
18.	Vasista Ganga (GBGD x PHOT)	High yield	22125	3.88	Andhra Pradesh & Karnataka	Dr. YSRHU, Andhra Pradesh
19.	Kalpa Ganga (GBGD x FJT)	High yield, suitable for ball copra production	21417	3.38	Karnataka	USH, Bagalkot
20.	Abhaya Ganga (GBGD x LCT)	High yield	22400	3.79	Andhra Pradesh	Dr. YSRHU, Andhra Pradesh



21.	VHC 4 (LCT x CCNT)	High yield	28497	4.27	Tamil Nadu	TNAU, Tamil Nadu
22.	Kalpa Samrudhi (MYD x WCT)	Dual Purpose variety, drought tolerant, higher nutrient use efficiency	20744	4.35	Kerala & Assam	ICAR-CPCRI, Kasaragod
23.	Kalpa Sreshta (MYD x TPT)	Dual purpose variety, high yield	29227	6.28	Kerala & Karnataka	ICAR-CPCRI, Kasaragod

OIL PALM

S.No	Hybrids	Important traits	FFB yield (t ha ⁻¹)	Oil to bunch (%)	Recommended states	Agency responsible for the release
1	Godavari Swarna	High yield	30.11	21.25	West Godavari (Andhra Pradesh) & Tungabhadra command area (Karnataka)	ICAR-IIOPR, Pedavegi
2	Godavari Ratna	High yield	22.69	26.5	Konkan region of Maharashtra	ICAR-IIOPR, Pedavegi
3	Godavari Gold	High yield	28.37	21.28	Cauvery delta zone of Tamil Nadu	ICAR-IIOPR, Pedavegi

ARECANUT

S.No	Variety	Important traits	Mean dry kernel yield (ha ⁻¹ year ⁻¹)	Potential dry kernel yield (ha ⁻¹ year ⁻¹)	Recommended states	Agency responsible for the release
1	Sumangala	High kernel yield and high recovery of chali	3900-4350	7400-7700	Karnataka & Kerala	ICAR-CPCRI, Kasaragod

2	Sreemangala	High dry kernel and bold nuts	4240-4500	7100-7300	Karnataka & Kerala	ICAR-CPCRI, Kasaragod
3	Mohitnagar	High dry kernel yield	5030	7540	Karnataka, Kerala & North Bengal (West Bengal)	ICAR-CPCRI, Kasaragod
4	Samrudhi	High dry kernel yield with bold nuts	5987	—	Areca growing areas of Andaman and Nicobar Islands	ICAR-CPCRI, Kasaragod
5	SAS-1	High dry kernel yield & Better storage of dried nuts	7193	—	Sirsi region (Hill zone) of Karnataka	UHS, Bagalkot



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