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Coconut Research in India – A Review

1. History

Coconut research in India will complete 100 years in another decade. It was initiated in 1916 with the establishment of a Coconut Research Station at Kasargod by the then Govt. of Madras. Since then, there have been many changes in the name, administrative control, organizational structure and mandate crops of this station. However, one thing which has not changed is that coconut remains its primary mandate crop even to-day. ICAR took this station under its control in 1966 and designated it as Central Plantation Crops Research Institute in 1970. Since then, many research stations and sub stations in various parts have been attached to work under this institute. Besides Kasargod a center established in 1947 at Kayangulam (Kerala) with the specific objective of investigating coconut diseases with emphasis on root wilt also forms part of CPCRI. In 1972, a center at Kidu (Dakshina Kannada) was started to meet the increasing demand of high yielding hybrids and varieties of coconut and seeds of parental lines and quality planting material.

ICAR also launched an All India Co-ordinated Research Project on Palms in 1972, which has been promoting region specific research, primarily under the aegis of various State Agriculture Universities in A.P, Assam, Bihar, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Tamil Nadu and West Bengal.

2. Research Agenda

The research agenda in coconut has been by and large the same. Like any other crop, it concerns

improving productivity through identification of elite types and developing new varieties and hybrids, developing cost effective agro-techniques and solving pest and disease problems. While root (wilt) disease has been an age old problem, the problem of eriophyid mite has assumed serious proportions in the last few years. In recent years, emphasis has also been laid on issues like integrated nutrient management, drip irrigation, organic farming and effective post harvest management and value addition. A review of published literature emanating from the National Agricultural Research System institutions reveals that while significant advances have been made in several areas, much needs to be achieved in others.

3. Significant Achievements

3.1 Harnessing genetic potential

Collection of variability

Efforts have been made to collect indigenous and exotic germplasm of coconut. As a

result, India now has one of the largest gene banks in coconut. CPCRI has established a World Coconut Germplasm Collection centre at Andamans in A&N Islands comprising of 29 collections. The International Coconut Gene Bank with 55 accessions from South Asia is also located at Kidu. The total coconut collection with the Institute now numbers 355 comprising 223 indigenous and 132 exotic accessions. These include 24 exotic collections collected under a FAO/IBPGR funded expedition in 1981.

Coconut embryo culture

A protocol for zygotic embryo culture in coconut has been developed at CPCRI. It consists of direct field collection of 8 to 11 month old coconut embryos, short-term storage, *in vitro* retrieval and *ex vitro* establishment. It is characterized for short-term storage of embryos, reuse of mature embryos and higher rate of acclimatization of *in vitro* retrieved plantlets.

Release of high yielding varieties

Five high yielding varieties have been released for cultivation in different regions of the country. These include Philippines Ordinary, (Chandra Tara) Laccadive Ordinary (Chandra Kalpa) and Chowghat Dwarf (for tender coconut water) from CPCRI, other varieties include Banawli Green Round (Pratap) from KKV Dapoli, Arasampatty Tall from T.N. and Assam Green Tall (Kamrup) from Assam Agriculture University.

Exploiting hybrid vigour

Hybrid vigour was discovered in coconut at Kasargod and 11 hybrids have been released for commercial cultivation in different regions. These are:

Hybrid/variety	Parents	Institution from where released	Recommended States		
			Karnataka	Kerala	Tamil Nadu
Ananda-ganga	ADOT x GBGD	KAU	-	+	-
Chandra-laksha	LCT x COD	CPCRI	+	+	-
Chandra-sankara	COD x WCT	CPCRI	+	+	+
Kera-ganga	WCT x GBGD	KAU	-	+	-
Kera-sankara	WCT x COD	CPCRI	+	+	-
Kera-sowbagya	WCT x SS Apricot	KAU	-	+	-
Kera-sree	WCT x MYD	KAU	-	+	-
Laksha-ganga	LCT x GBGD	KAU	-	+	-
VHC-1	ECT x CGD	TNAU	-	-	+
VHC-2	ECT x MYD	TNAU	-	-	+
VHC-3		TNAU	-	-	+

The hybrids have potential to produce 49-77% more copra yield when compared to local tall besides being early bearer.

Kasargod is 500:320:1200 gm of N : P2O5 : K2O for adult coconut palm. However, multilocation trials conducted under All India

Andhra Pradesh		650 : 450 : 1200
Karnataka	Maidan Tract	650 : 450 : 900
Maharashtra	Konkan Coast	750 : 225 : 900
Tamil Nadu	Alluvial tract	650 : 450 : 1200

Drought tolerant hybrids

Coconut hybrids, viz, West Coast Tall x Gangabondam, West Coast Tall x Chowghat Orange Dwarf, Laccadive Ordinary x Chowghat Orange Dwarf and Talls like Laccadive Ordinary and West Coast Tall are relatively drought tolerant in comparison to other hybrids.

Critical water potential also varied between coconut genotypes. In general, Tall types were found to be more tolerant than dwarf types at Regional Agricultural Research Station, Pilicode KAU.

3.2 Improving productivity

Attempts made to standardize agro-techniques for improving productivity have also given good results as

Coordinated Project on Palms have indicated the levels of N, P2O5, K2O for optimum production in different states as given in the table above.

Experiments conducted at Coconut Research Station, Aliyarnagar in Tamil Nadu on variety Chandra-sankara have revealed that application of 500 : 250 : 1000 gm/palm/year of N,P,K resulted in higher copra yield per nut and per palm with a net income of Rs. 51,992/hectare.

Rock phosphate has been found to be the best source of P for coconut palms. Monitoring the plant phosphorus in soil over 14 years suggests 10-12 ppm of available P was sufficient for maintaining optimum P levels of coconut. Thus P application

discussed below:

Nutrient management through inorganic fertilizers

The general recommendation of chemical fertilizers from CPCRI



Philippines ordinary - Released cultivar



Chowghat Orange Dwarf - Released for tender coconut water



Kerasankara (WCT x COD) - A relatively drought tolerant hybrid
(Photo courtesy - CPCRI)

could be skipped if soil test values of P are more than 20 ppm.

Use of organics

A field experiment was conducted on nutrient management in coconut through organics at ARS Arsikere, UAS Bangalore. It revealed that application of organics can substitute chemical fertilizers as a source of nutrients. Organics used in this experiment were composted coir pith and neem cake in combination with bone meal and ash. The yield with organics was 93 nuts/palm/year compared to 78 nuts through chemical nutrient sources.

Green manuring

A low cost technology has also been developed for improving the organic matter and nutrient status of basins of coconut trees by growing leguminous crops such as *Calopogonium mucunoides*, *Puraria phaseoloides* and *Mimosa invisa*. This practice followed during June-October can yield 18-24 kg of organic matter per basin (10 m²) and substitute 50% N requirement of coconut palm.

Studies with *Gliricidia* loppings @ 30 kg/palm yield 2.3 t/ha of green matter which can meet 80% N, 23% P and 15% K requirement of palms.

Boron deficiency in coconut results in symptoms of crown choking and can be controlled by soil application of 50-75 g/palm of borax once a year in root wilt free zone and 300 gm borax in root wilt affected area.



Calapogonium - A good cover crop in coconut garden

Compost from waste

It has been estimated, that in coconut cultivation, around 11.2 million tonnes of recyclable biomass and 7.5 million tonnes of coir pith are generated, which are

equivalent to 0.79, 0.076 and 0.49 million tonnes of N, P₂O₅ and K₂O respectively. This can be recycled advantageously in coconut gardens by composting. CPCRI has perfected a technology for large scale production of vermicompost from coconut waste to eco-friendly organic manure with 70% recovery by using a local earthworm species. Optimum weather conditions for efficient vermicomposting of coconut leaves was observed to be 28-32°C temperature and R.H. of 90-95%. These conditions are available between June-November i.e. the monsoon and post monsoon period in Kasargod area. The yield of both compost and worms is also high at this time than during rest of the year.



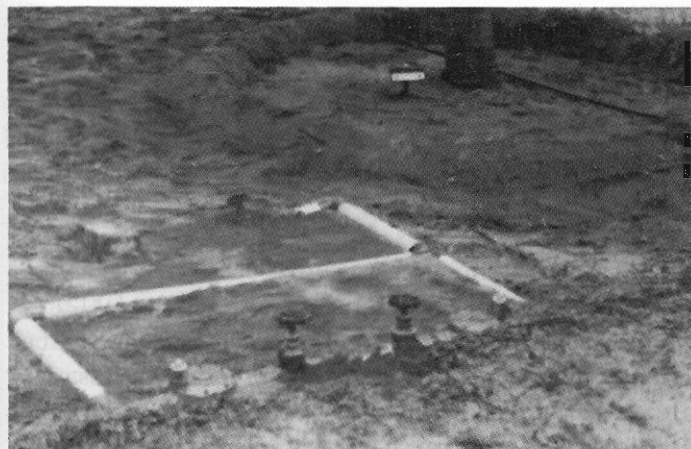
Vermi composting

Micro-irrigation

Experiments on different levels of drip irrigation at ARS Arsikera, Karnataka revealed that by drip irrigation, water can be saved to an extent of 8-10 per cent with irrigation at 100 per cent E₀ compared to surface



Drip irrigation system



Auto irrigation system

irrigation. Accordingly, drip irrigation at 100 per cent E0 on monthly basis is recommended for higher yields of coconut in Central Dry Zone of Karnataka.

Mulching

Mulching with coconut leaves during Oct-November was found to provide beneficial effects in reducing evaporation of soil moisture.

Coconut based farming system

Intercropping coconut gardens with suitable crops increases productivity as well as net returns/unit area. CPCRI Kasargod has also worked on identifying suitable



Inter cropping system

intercrops, palm based farming systems and cropping models with compatible crop combinations for effective utilization of interspaces and solar radiation available among the monocultured coconut gardens. High density multi-species cropping systems, involving a crop combination of pineapple, banana, clove and nutmeg

resulted in higher level of productivity than fertilizer doses. Mixed farming systems successfully demonstrated in coconut are dairy, poultry, rabbitry, sericulture and pisciculture.

3.3 Management of root (wilt) disease

Root wilt is an old and debilitating disorder of coconut now prevalent in almost all districts of Kerala. Electron microscopy studies conducted by CPCRI at its Regional Station at Kayangulam have revealed consistent presence of phytoplasma in the tissues of diseased palms and their total absence in the disease free palms. This has been further



substantiated by the successful transmission of the disease using lace bug vector (*Stephanytis typica*) under insect proof conditions.

Short range strategies

A strategy of uprooting and replanting of heavily infested trees and management of disease by adopting agro-techniques has been recommended by CPCRI which has demonstrated its success. Accordingly, the following integrated management practices are recommended in root (wilt) disease affected coconut gardens.

- Growing cowpea as a green manure crop in April-May and incorporating it in the basins during September-October.
- Application of organic manure during September-October.
- Application of inorganic fertilizer: N:P:K-@ 500:300:1000 g/palm/annum in 2 splits in the form of urea, rajphos, and muriate of potash (1/3rd during May-June and 2/3rd during September-October) along with MgSO₄-1.0 kg/palm/annum.
- Need based plant protection measures for leaf rot

control e.g., cutting and removal of rotten portions of the spindle and the adjacent two innermost fully opened leaves followed by application of 300 ml of fungicide solution containing 2 ml of contaf 5% EC or 3 g Dithane-M-45 around the spindle leaf.

- Mulching with coconut leaves during November to May months.
- Recycling the available biomass in the plantation through vermicomposting.
- Irrigation with hose during initial years and later perfo-irrigation to a depth of 20 mm.

Long range strategy

A long range management strategy being followed since 1987 at CPCRI is breeding for resistance to root wilt disease. Studies have revealed that Chowghat Green Dwarf (CGD) variety has higher level of resistance to root wilt when compared to other varieties.

Disease free palms of West Coast Tall and Chowghat Green Dwarf (CGD) identified from farmers fields among heavily disease affected palms have been used in the breeding programme. Nearly 2725 progenies of various crosses, planted since 1991 are being evaluated at CPCRI for yield and disease resistance. This hybrid combination has shown significant resistance to root-wilt disease. Four seed gardens comprising of 6472 artificially pollinated seedlings of these varieties have been established for large scale production of root wilt resistant/tolerant planting material.

3.4 Managing diseases and pests

Work carried out on control of leaf rot, stem bleeding and crown choking among diseases and leaf eating caterpillar, rhinoceros beetle and eriophyid mite among pests, has resulted in the following recommendations:

Disease management

Besides root (wilt) diseases other diseases are not many and are much less serious and control measures for these are available. For instance, fungal disease caused by *Theilaviopsis paradoxa* can be effectively controlled through phytosanitation by removing the infected bark and application of calaxin 5% followed by coal tar and root feeding with calaxin 5%. Other recommendations include irrigation in summer, drainage in rains and application of neem cake @ 5 kg/palm.

In recent times, there has been resurgence of bud rot disease of coconut almost in all coconut growing zones. While it does not assume epiphytotic proportions except in some years, a management strategy has been worked out by CPCRI for its control.

Bio-control of major pathogens of coconut e.g., basal stem rot, stem bleeding and bud rot has been tried at Ambajipat in AP successfully.

Pest Management

Plant and field sanitation treatment with 1% carbaryl or use of pheromone traps and attractants are recommended as IPM technology against red palm weevil of coconut.



Palms infested by leaf eating caterpillar

Opisina arenosella of coconut can be controlled by spraying of foliage with dichlorvos (0.02%) after removing one or two severely affected fronds and subsequent release of parasitoids 15 days after spraying.

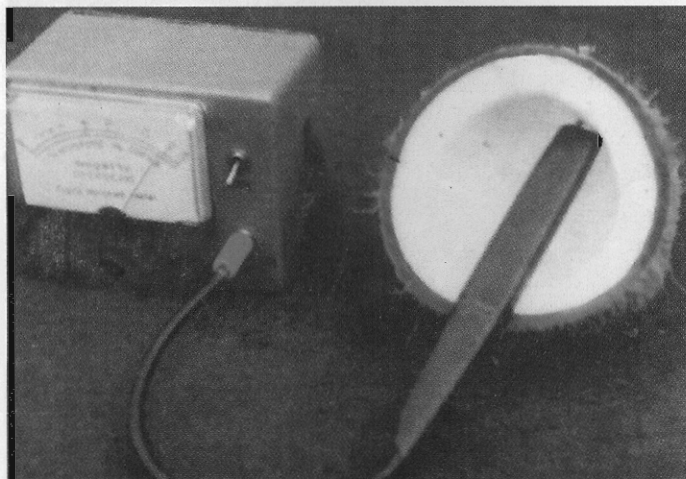
IPM technologies have been found useful in control of rhinoceros beetle. Steps include hooking the beetle, filling of leaf axial with sevidol (25 g) and fine sand (200 g) or naphthalene balls @ 12 g/palms and releasing baculo-virus infected beetles. The field evaluation of this control revealed that damage due to rhinoceros was reduced significantly. Therefore release of 12-15 baculo-virus infected beetles/acre in coconut plantation is recommended. *Metarrhizium anisopilae*, a fungus was identified as an effective bio-control agent against rhinoceros beetle.

Incidence of Eriophyid mite (*Aceria guerreronis* Keifer) has been reported on almost all cultivated varieties

of coconut in all important coconut growing states. The intensity of attack has caused an alarm in coconut growing states and has resulted in huge losses to growers in Kerala, Karnataka and Tamil Nadu. Feeding injury results in brown patches leading to warting and longitudinal fissures on the nut surface. A low incidence has, however, been reported in Kenthale and Chowghat Orange Dwarf varieties. Management strategy for the mite has been developed by CPCRI. Azadirachtin based pesticides and neem oil-garlic soap emulsion were found to be effective against eriophyid mite attack.

3.5 Post harvest technology

In recent years emphasis is being laid on studies on post-harvest technology and value addition in coconut. A number of tools and machinery items have been developed at CPCRI. These include, copra moisture meter



Copra moisture meter

to determine moisture content; Electronic Tensiometer and automatic irrigation system to optimize irrigation in coconut gardens, and copra dryers of various capacities (for 400, 3500 to 4000 nuts). The above technologies have been transferred to Kerala Agro Industries Corporation.

4. Impact of Available Technologies

Despite concerted progress by CPCRI, State Agricultural Universities and Coconut Development Board, studies by CPCRI have shown that the extent of adoption of available technologies in coconut is not at a satisfactory level. As a result, there exists a wide gap, between the productivity achieved at Research Station and in the field. CPCRI developed package of integrated management of root wilt disease has been tested over 25 ha of contiguous area with participation of 208 farm

families for 3 years. The impact of technology indicated 91.4% improvement in the average yield and reduction in root wilt disease intensity besides significant improvement in awareness, knowledge and adoption of technology package.

5. Future Research Thrusts

No doubt research efforts by ICAR institutes, AICRP and SAU's have made substantial contribution in developing varieties/hybrids, production technologies, including pest and disease management, and to a limited extent post harvest technologies, there are still areas which need positive and long lasting solutions.

1. There is considerable scope for increasing the productivity through crop improvement.
2. There is need to identify and breed dwarf palms as harvesting is likely to emerge as a major problem due to non availability of skilled climbers for tall palms.
3. Existing World Coconut Germplasm collection in the International Coconut Gene Bank needs to be screened for identification of root wilt resistance.
4. Standardization of micro-propagation techniques need priority to ensure faster multiplication of superior cultivars/hybrids and large quantity of uniform, disease free planting material is required in the replanting programme. In vitro culture techniques also need to be standardized for conservation of germplasm.
5. There is scope to promote integrated farming in coconut holdings with emphasis on resource conservation.
6. Need based promotion of organic production of coconut is required after estimating the cost benefit ratio and market implementation of this technology.
7. More value added products need to be developed to ensure that coconut cultivation continues to be remunerative.
8. Continuous efforts need to be made to improve farmers awareness about latest coconut technologies and their adoption rate.

It is hoped that concerted effects by ICAR, SAU's, CDB and other organizations involved in R&D in coconut will help in achieving the above objectives.

References

- Anithakumari, P. and Manoj, S. 2004. Technology transfer of integrated root (wilt) management package-Experiences from the participatory programme on coconut. *Journal of Plantation Crops* 32(Suppl.), December 2004: 474-79.
- Arulraj, S. and Ravikumar, N. 2004. Cyber extension for transfer of technology in India. *Journal of Plantation Crops*, 32(Suppl.), December 2004: 445-53.
- Chadha, K.L. and Rethinam, P. 1994. History of plantation and spice crop research in India. In: *Advances in Hort. Vol. 9: Plantation and spice crops Part 1*. Malhotra Publishing House, pp. 1-49.
- CPCRI, 1997. Vision 2002-CPCRI Perspective Plan, Indian Council of Agricultural Research.
- Desai, V.S., Narangalkar, A.L., Nagwekar, D.D., Shivpuje, P.R. and Jmbhale, N.D. 2004. Occurrence and impact of baculovirus on coconut rhinoceros beetle, *Oryctes rhinoceros* L. in Konkan region of Maharashtra. *Journal of Plantation Crops*, 32(Suppl.), December 2004: 318-20.
- Gopal, M., Gupta, A. and Thomas, G.V. 2004. Optimum weather conditions for efficient vermicomposting of coconut leaves by *Eudrilus* sp. In coastal tract of Kerala. *Journal of Plantation Crops*, 32(Suppl.), December 2004: 486-90.
- Gunasekaran, M., Moosa, H., Rasmi, A.R., Iyer, Rohini, Sheena Kumari, T.K. 2004. Emerging trends in the management of bud rot disease of coconut. *Journal of Plantation Crops*, 32(Suppl.), December 2004: 269-279.
- Hanumanthappa, M., Girijesh, G.K., Kusagur, N., Basavaraj, T.B. and Naik, T. Basavaraj. 2004b. Nutrient management through organics in coconut. *Journal of Plantation Crops*, 32(Suppl.), December: 236-39.
- Hanumanthappa, M., Girijesh, G.K., Kusagur, N., Basavaraj, T.B., and Naik, T.B. 2004a. Effect of different levels of drip irrigation on growth and yield of coconut under maindan tract of Karnataka. *Journal of Plantation Crops*, 32(Suppl.), December 2004: 232-35.
- Karun, A., Sajini, K.K., Radha, E. and Parthasarathy, V.A. 2004. Effect of CPCRI protocol of coconut embryo culture in germplasm expedition. *Journal of Plantation Crops*, 32(Suppl.), December 2004: 139-43.
- Khan H. Hameed, 2004. Initiatives towards improving coconut productivity. *Journal of Plantation Crops*, 32(Suppl.), December 2004: 173-85.
- Madhavan K. and Bosco, S.J.D. 2004. Development of a solar tunnel dryer for plantation crops. *Journal of Plantation Crops*, 32(Suppl.), December 2004: 428-32.
- Maheshwarappa, H.P. and Anithakumari, P. 2005. Agronomic strategies for managing root (wilt) affected coconut gardens. *Tech. Bull. CPCRI Regional Station, Kayamkulam*, pp. 1-17.
- Nagwekar, D.D., Sawant, V.S., Magdum, M.B., Joshi, G.D., Khan, H.H. and Jambhale, N.D. 2004. Effect of NPK fertilizers on yield of COD x WCT hybrid of coconut under Konkan condition of Maharashtra (India). *Journal of Plantation Crops*, 32(Suppl.), December 2004: 186-89.
- Naik, R.G. and Khan, A.N.A. 2004. Integrated management of basal stem rot disease of coconut. *Journal of Plantation Crops*, 32(Suppl.), December: 340-43.
- Nair, R.V., Jacob, P.M., Thomas, R.J. and Sasikala, M. 2004. Development of varieties of coconut (*Cocos nucifera* L.) resistant/tolerant to root (wilt) disease. *Journal of Plantation Crops*, 32(Suppl.), December 2004: 33-38.
- Paul, A. and Mathew, T.B. 2004. Population dynamics of coconut eriophyid mite, *Aceria guerreronis* Keifer and the influence of weather parameters. *Journal of Plantation Crops*, 32(Suppl.), December 2004: 335-39.
- Rajamanickam, K. 2004. Bio-efficacy of herbal pesticide phytopalm against coconut eriophyid mite, *Aceria guerreronis*. *Journal of Plantation Crops*, 32(Suppl.), December 2004: 330-32.
- Rao, D.V.R., Kalpana, M., Srinivasulu, B. and Khan, H.H. 2004. Performance of coconut based cropping systems for sustainable productivity under coastal ecosystem of Andhra Pradesh. *Journal of Plantation Crops*, 32(Suppl.), December 2004: 240-44.
- Romila, P.P., Karun, A., Sajini, K.K. and Jayadev, K. 2004. In vitro active conservation of immature zygotic embryos of coconut (*Cocos nucifera* L.) for germplasm collection. *Journal of Plantation Crops*, 32(Suppl.), December 2004: 134-38.
- Sairam, C.V., Arulraj, S. and Bosco, S.J.D. 2004. Technology prioritization for improving coconut productivity in India. *Journal of Plantation Crops*, 32(Suppl.), December 2004: 465-473.
- Srinivasulu, K., Kumar, V.K, Aruna, K. and Rao D.V.R. 2004. Biocontrol of major pathogens of coconut. *Journal of Plantation Crops*, 32(Suppl.), December 2004: 309-13.
- Thamban, C., Arulraj, S. and Sairam, C.V. 2004. Farmer participatory technology assessment and refinement in coconut through institution-village linkage programme-experiences of CPCRI in India. *Journal of Plantation Crops*, 32(Suppl.), December 2004: 459-464.
- Venkitaswamy, R. 2004. Effect of NPK levels on dwarf x tall hybrid coconut (COD x WCT) in Tamil Nadu. *Journal of Plantation Crops*, 32(Suppl.), December 2004: 169-72.