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FOUR DECADES OF CPCRI INTERVENTIONS ON COCONUT-BASED ISLAND ECOSYSTEM AT MINICOY, LAKSHADWEEP

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1. Back ground

1.1. History and Mandate

The Central Plantation Crops Research Institute (CPCRI), Regional Station, Minicoy previously known as 'ICAR Research Complex for Lakshadweep' was established at Minicoy Island during 1976 under the overall administrative control of CPCRI. Consequent upon the formation of the Island Zone under the ICAR system, the station was merged with the Central Agricultural Research Institute (CARI), Port Blair, Andamans during 1989. Subsequently, based on the repeated requests from the farming community and the Department of Agriculture, Union territory of Lakshadweep, the Station was brought again under the administrative control of CPCRI during 1994 and operated as one of the Regional Stations of CPCRI till 2011. The centre has also received the farm land and facilities of the erstwhile Research Centre of Central Marine Fisheries Research Institute (CMFRI) functioned at Minicoy during 2006. Since 2011, the station at Minicoy functions as a demonstration-cum-production centre for enhancing the production and availability of fruits and vegetables in the Island with a revised mandate.

The present activities at the centre are:

a. Introduction/evaluation of new improved/high yielding varieties of various vegetables and fruits suitable for cultivation under Island conditions.

b. Demonstration and popularization of production technology for fruits and vegetables among the Island community.

c. Development/refinement of location-specific technologies/planting materials for increasing productivity of coconut and other existing crops in Lakshadweep Islands

d. Demonstration and popularization of technologies among the Island community for area-wide adoption.

As per the present revised mandate, many improved varieties of different fruit and vegetables such as cucurbitaceous vegetables, tomato, brinjal, chillies, bhendi, cowpea, amaranth, cabbage, cauliflower, onion, coriander etc. and fruit crops such as banana, water melon, papaya, guava, custard apple *etc*. were introduced for cultivation under the Island conditions. These activities are being taken up with the technologies developed at CPCRI, Indian Institute of Horticulture Research, Bengaluru, National Research Centre for Banana, Trichy and State Agricultural Universities.

1.2. Location of the Centre

The Research Centre is located at South Bandaram, 1.5 km away from the main passenger jetty on the main road side towards Minicoy Light House. The Centre is situated at 8^0 17'N Latitude and 73^0 04'E Longitude. The Minicoy Centre has an experimental farm with an area of 5.2 ha comprising coconut germplasm, hybrids and mother palm blocks with various vegetables and fruit crops as inter/mixed crops. During the last four decades, the Centre has been engaged in research and developmental activities aimed at increasing the production and productivity of coconut palms in the Island ecosystem and evolving various technologies for the Island ecosystem.

1.3. Agro-ecology of Minicoy Island

The soil type is coral sandy in texture formed by the disintegration of coral limestone underlined with pebbles of different shapes and sizes. The soils are alkaline in nature with *p*H of 7.0 to 8.6 and deficient in macro and micronutrients essential for plant growth. Most of the soils being calcareous/sandy are well drained and can support good growth of plants and trees. It is generally poor in the level of nitrogen and potassium and fairly good with respect to phosphorus. The climate of the Minicoy Island is moderate, temperature ranges from 22^0C to 32^0C, and relative humidity from 70 to 76%. The average rainfall received is about 1500 to 1700 mm. The entire cultivable area of the Island is thickly planted with coconut trees forming a grove.

2. Achievements

The major achievements of the Centre in coconut-based research and developmental activities are given below.

2.1. Conservation and utilization of genetic resources from Lakshadweep

Coconut germplasm collection commenced as early as 1924 from the Lakshadweep Islands. Presently, about 40 distinct accessions have been collected from different Islands *viz*., Agatti, Kavaratti, Kalpeni, Androth and Minicoy and conserved at National Gene Bank at CPCRI, Kasaragod and CPCRI, Research Centre, Kidu. *In situ* and *ex situ* observations in the Lakshadweep coconut populations indicated wide variability for dwarfness, fruit size, copra yield and shape. Special types such as Micro Talls, Giant coconuts, Sweet husked coconuts, types with higher oil content, lines with putative drought tolerance, dwarf coconuts and Mini Micro nuts have been collected from these Islands by CPCRI which were subsequently conserved in the gene bank.

A survey on the natural coconut populations undertaken in the Minicoy Island revealed wide diversity for fruit size and sporadic occurrence of Mini Micro palms. Among the 2672 coconut trees observed, 81.47% Laccadive Ordinary (LCT) type, 3.26% Laccadive Micro (LMT) type, 1.05% Laccadive Mini Micro (LMMT) type, 14% Laccadive Giant type (LCGT) and 0.22 % male palms (which produce inflorescences with very few or no female flowers) were recorded. The nut component analysis also revealed wide variability for most fruit traits. The copra content ranged from 3 g in Mini Micro to 329 g in Giant types. The observations revealed wide variability for fruit characters and oil content in coconut populations of the Island and indicate scope for further collection and conservation.

Wide variability observed in Minicoy coconut populations for nut component traits.

Utilizing the germplasm lines collected from Lakshadweep, LCT selection was released as Chandrakalpa, suitable for growing under rainfed conditions in the coconut growing areas. The selection of LCT was used as a parent in hybridization

programmes considering its better performance and two hybrids *viz*., Chandralaksha and Lakshaganga were released from CPCRI and KAU, respectively utilizing the genetic resources of Lakshadweep. An early bearing green dwarf accession with round fruits from Minicoy was also added recently in the germplasm collection at CPCRI. Laccadive Orange Dwarf (LCOD) has been identified to be an ideal cultivar for tender coconut purpose with early-bearing palms, orange fruits with water content of over 300 ml.

A comparative study on ball copra revealed the superiority of LMT accession (IND030S) as a suitable cultivar considering the lowest spoilage (with its fruits apparently remain un-germinated under long storage during ball copra production) and yielded good quality, firm ball copra. The palms of LMT, LCOD, LCT are also conserved at Minicoy centre as well as in the National Gene Bank at mainland.

High yielding LCOD palm suitable for tender nuts

Crown of Laccadive Ordinary Tall

Laccadive Green Dwarf collected from Minicoy

Out of the conserved germplasm from Lakshadweep Islands, two accessions were registered with NBPGR for their unique traits. The details of the registered germplasm are as follows.

(i) Laccadive Micro Tall

The accession was first introduced from Lakshadweep Islands to Indian mainland during 1940 and conserved in field gene banks and evaluated in replicated trials. It is unique for its heavy bunches with large number of micro nuts and has scientific and commercial value as it has recorded the highest copra oil content (75%) among the conserved coconut accessions. The nuts are suitable for production of ball copra mainly due to small size having less nut water aiding in very low spoilage during storage as well as slow rate of germination resulting in lowest damage during storage, which are ideal characteristics required for ball copra production.

The palms of this selection are tall statured with clear bole on the stem. The palms start flowering after six to seven years of age, but profuse fruit production is generally observed after nine to ten years of planting. The mean annual bunch production is 11 with a range of 8 to 12. The average yield varies from 100 to 320 fruits per annum in Kasaragod, whereas, the yield is still higher in selected palms in some years. The palms are mostly alternate bearers, nuts are small, kernel is thick with average copra content of about 90g. The inflorescences are longer with strong peduncle with partial overlapping of male and female phases in alternate years during successive inflorescence production making the palms self-pollinated to some extent. The fruits are green or greenish-brown, oval to round-shaped. The dehusked nuts are also oval or round-shaped with a pointed tip. The palms of Laccadive Micro Tall selection can be grown with the regular recommended package of practices with irrigation for sustained yield of nuts. It can be grown in all coconut growing regions for conservation and further utilization. It has good potential for use in breeding programmes aiming for increasing the nut yield, oil content and more copra out turn.

Laccadive Micro Tall crown with cluster bearing bunches

Longitudinal section of fruit of Laccadive Micro Tall

(ii) Laccadive Mini Micro Tall

Laccadive Mini Micro Tall is a unique coconut type present in Minicoy Island of Lakshadweep, known for its smallest fruits. This type was collected through selection from the original coconut population of Minicoy Islands and conserved at National Gene Bank at CPCRI Research Centre, Kidu, Karnataka. The palms in the Gene Bank were developed through embryo culture of nuts collected from the original mother palms available at CPCRI Regional station, Minicoy. The trait of smallest nuts in all bunches of the palms is unique and not present in any other accession in the gene bank. The nuts of this type do not germinate under natural conditions. This is a tall coconut type with morphological traits similar to other coconut accessions but differ in the nut component traits. The female flowers develop into small fruits recording lower values for most of the nut component traits. The average fruit weight is about 31g with copra content of 5 g and has lowest husk content. The fruits of this accession are round in shape, green or greenish-brown colour. The kernel sometimes fills the entire cavity with the embryo completely embedded in the kernel. The cavity has very less water of about 1.1 ml and the copra recorded about 73% oil. As the Mini Micro nuts do not germinate under natural conditions owing to the less nut water and quick drying of nuts, they need to be multiplied through embryo culture. The vegetative growth of Mini Micro Tall palms is normal with similar morphological traits compared to other coconut accessions. This genotype has profound academic and scientific value besides the potential for ornamental planting. Despite the occurrence of this genotype in sporadic incidence from Minicoy, its prevalence was not reported from any other cocount-growing regions in the world.

Crown of Laccadive Mini Micro Tall

Longitudinal section of fruit of Mini Micro Tall

2.2. Coconut hybrids and germplasm trials

Evaluation of various hybrids produced by crossing the locally available Laccadive Ordinary Tall (LCT) and three dwarf cultivars *viz*., Laccadive Green Dwarf (LCGD), Laccadive Orange Dwarf (LCOD) and Laccadive Yellow Dwarf (LCYD) was initiated at the Research Centre during 1989-1990. All the hybrid progenies started flowering and yielding earlier than the local Tall variety. First flowering was observed in LCOD x LCT at 30 months after planting, whereas, the LCOD flowered only at 54 months after planting. The result indicates that all the hybrids are performing better (with a mean yield of 166 nuts/palm/year) than their parents. The highest mean yield of over 150 nuts/palm/year was recorded with hybrids involving Local dwarfs such as Laccadive Green Dwarf and Laccadive Yellow Dwarf and Laccadive Orange Dwarf as female parents and LCT as male parent. It would be rewarding to cultivate these hybrids to further enhance the productivity of coconut palms in Lakshadweep Islands as they have potential for better adaptability and higher yield. Based on the nut yield and copra out turn, two hybrids *viz*., LCGD x LCT, LCOD x LCT were identified and recommended by the Institute Research Committee of CPCRI for commercial exploitation under Lakshadweep conditions.

Among the 12 coconut genotypes planted during 2003 to evaluate under Island conditions, Fiji Tall, Gangabondam Green Dwarf, Java Tall, Philippines Ordinary Tall, Strait Settlement Apricot Tall and West Coast Tall were observed to be yielding on an average of more than 80 nuts/palm/year. Observations on varietal reaction of coconut to insect damage revealed that Benawali Green Round was highly susceptible to spiraling whitefly and Strait Settlement Apricot Tall was observed to have relatively less damage by rats under Minicoy conditions.

The following are the coconut Genetic resources being conserved at Minicoy centre of CPCRI and being observed for yield performance.

Details of coconut mother palms available at Minicoy Centre

Sl.No.	Mother palms
1	LCT Minicoy - 250 palms
2	LMT- Minicoy - 65 palms
3	LCOD - 60 palms
4	CGD - 12 palms
5	LCGD - 12 palms
6.	LCYD - 8 palms

Indigenous and exotic coconut germplasm conserved at Minicoy Centre

Sl. No.	Coconut accessions	Sl. No.	Coconut accessions
1	Cochin China Tall (CCNT)	10	Andaman Ordinary Tall (ADOT)
2	Malayan Yellow Dwarf (MYD)	11	West Coast Tall (WCT)
3	Benaulim Tall (BENT)	12	Chowghat Orange Dwarf (COD)
4	Java Tall (JVT)	13	Laccadive Green Dwarf (LCGD)
5	Malayan Green Dwarf (MGD)	14	Laccadive Yellow Dwarf (LCYD)
6	Fiji Tall (FJT)	15	Laccadive Orange Dwarf (LCOD)
7	SS Apricot Tall (SSAT)	16	Laccadive Ordinary Tall (LCT)
8	Gangabondam Green Dwarf (GBGD)	17	Laccadive Micro Tall (LMT)
9	Philippine Ordinary Tall (PHOT)	18	Laccadive Mini Micro Tall (LMMT)

Coconut hybrids evaluated at Minicoy Centre

Sl.No	Hybrid combinations	
1	LCGD x LCT	(D x T)
2	LCOD x LCT	(D x T)
3	LCYD x LCT	(D x T)
4	LCOT x LCGD	(T x D)
5	LCT x LCOD	(T x D)
6.	LCT x LCYD	(T x D)
7	LCT x GBGD	
8	LCOD x WCT	
9	WCT x COD	

2.3. Collection of Noni (*Morinda citrifolia*) and other genetic resources

Noni is a naturally occurring plant in Lakshadweep Islands which is valued for its fruits having medical properties. The plant is used for preparation of fruit juice valued for its nutrient content. A collaborative research effort to study the flora of Minicoy Island was carried out by CPCRI and NBPGR-RS Thrissur during Jan 2009 under which, 24 accessions of this medicinally important Noni was collected. Besides, sixty six important germplasm accessions of different plant species were recorded during the survey. Among them, 29 plants were of importance from the agri-horti, medicinal and tree crops point of view for the local inhabitants.


Noni – a naturally occurring medicinal plant under Lakshadweep conditions

2.4. Agro-management practices developed for Island ecosystem

2.4.1. Ideal spacing for coconut for improving the productivity

Owing to the rapid subdivision and fragmentation of holdings, the farmers practice very close planting and plant more seedlings on the boundaries or corners to mark their fields, thus creating overcrowding of palms in all the Islands. An average of 400-500 coconut palms of all ages is available in one hectare of land as against 175 normally recommended for optimum yield. Such overcrowding of palms without adoption of any proper spacing is the most important factor contributing to the low yield of coconut in all the Islands of Lakshadweep.


Dense coconut population in Minicoy Island forming a grove

Performance of palms planted at normal density (planted at 7.5 m x 7.5m) and double the normal density was evaluated from 1980 onwards. It has been consistently observed that the palms-planted at normal density gave significantly higher yield not

only on per palm basis but also on unit area basis. The average yield in the normal density during 1983-2001 was 129 nuts per palm per year as against 37 nuts per palm per year in double density of planting. This clearly indicates that removal of excess number of palms (thinning) is to be adopted for improving the yield of coconut palms per unit area in the Islands.

2.4.2. Recycling organic biomass from coconut garden by popularizing vermicomposting

Vermicomposting is the process of composting the waste biomass from agriculture into useful manure through naturally occurring earth worms. The technology for vermicomposting, using coconut leaves, which are available in plenty in the island territories of Lakshadweep, has been standardized using *Eudrilus* sp. of earth worms closely related to the African night crawler. Coconut leaf vermicompost is an ideal organic manure under Island conditions and its application increases fertility of soil. Fallen coconut leaves in the coconut garden can be effectively converted into nutrient-rich vermicompost using the earth worm Eudrilus sp. Vermicompost preparation can be done in cement tanks or in trenches made in the coconut garden. The weathered coconut leaves collected from the garden should be kept for two weeks after sprinkling with cow dung slurry. Cow dung should be used at the rate of one-tenth of the weight of the leaves. Afterwards, earth worms are to be introduced @ one kg for one tonne of the material. Care should be taken to provide sufficient moisture for the decomposing material by frequent sprinkling of water. Adequate shade also should be provided to avoid direct sunlight. Vermicompost will be ready in about 75 to 90 days. Watering should be stopped one week before collecting the compost. On an average, 70 per cent recovery of vermicompost is obtained. Multiplication technique for the local *Eudrilus* sp. of earthworm using 1:1 cow dung-decayed leaves mixture was standardized and the earthworms are being distributed to the farmers to initiate vermicomposting.

Vemicomposting in tanks at Minicoy

This technology has been demonstrated successfully in the centre as well as in farmers' fields not only at Minicoy but also at several places in other Islands of Lakshadweep.

2.4.3. Cultivating green manure crops for improving soil fertility

Considering the fragile nature of the island ecosystems, the use of chemical fertilizers and other inorganic inputs are not advocated in the Island. Hence, to enhance soil organic matter and microbial communities, cultivating various green manure crops and their incorporation was tested and found to be beneficial. Sunnhemp (*Crotolaria juncea*) was introduced as a green manure crop and its growth under Island conditions was excellent and the yield obtained was 11.5 t/ha. The NPK content was 0.75%, 0.12 % and 0.51% and the percentage of contribution was estimated to be 98 for N and 28 each for P and K.

2.4.4. Intercropping vegetables /fruit crops

Coconut is the only crop grown extensively in Lakshadweep group of Islands. The Islanders quite often depend fully on mainland supply chain for their fruits and vegetable requirements as the cultivation of these are not their traditional practice. In the rainy season when the sea is rough, the timely arrivals from mainland through ships are also affected resulting in non-availability of fruits and vegetables.

High-yielding varieties of various vegetables/fruit crops were introduced and evaluated as intercrop in coconut garden. It was found that inclusion of such crops in the coconut-based cropping system could ensure regular supply of good quality fruits and vegetables in Island and also increase the income per unit area. Screening of improved varieties from National Agricultural Research System and scaling up production through the Tribal Sub Plan Project of ICAR contributed to the increased availability of fruits and vegetables.

Intensified efforts taken up by CPCRI in the recent years have yielded rich dividends in identifying the most suitable varieties of fruit crops *viz*., banana, papaya, sapota and vegetables crops *viz*., tomato, brinjal, chilli, bhendi, amaranth, cabbage, cauliflower, cucurbits, moringa for Island conditions of Minicoy. Large-scale production of vegetables and fruits has become the most important activity of the CPCRI centre at Minicoy Island to cater to the needs of island community in meeting the food and nutritional security. The institute has successfully demonstrated organic fruits and vegetable production at the centre with optimum utilization of available resources through organic methods under coconut gardens and made available fruits and vegetables to the Islanders throughout the year.

2.4.4.1. Fruit crops

Among the various fruit crops evaluated, banana, papaya and sapota are the most ideal crops that can be successfully cultivated in various Islands.

From the earlier studies, it was found that the banana var. *Nendran* flowered in five months after planting and the first bunch was ready for harvest in seven months. Two to three ratoon crops were also possible under the Island conditions in contrast to the mainland where '*Nendran*' is mostly replanted after each crop. In the recent studies on the evaluation of different varieties of banana under organic cultivation, '*Saba*' recorded higher bunch weight ranging from 18 kg to 23 kg followed by '*Udayam*' and '*Robusta*' varieties with average bunch weight of 16 kg and 18 kg, respectively. The suckers of these varieties are distributed to the Islanders for growing under coconut gardens.

Among the papaya varieties evaluated during the year 2000, the variety Pusa Nanha gave the maximum fruit weight of 15.7 kg/plant followed by Tainung1 with an yield of 9.8 kg. Two other varieties *viz*., Arka Prabhath and Arka Surya were introduced during 2012 and are being successfully grown under Island conditions. The varieties Co2, Co3 and Co 5 were also performing well under Island conditions. Sapota is

Performance of papaya under island conditions

'Saba' variety of banana at Minicoy

one of the important fruit tree crops that have been performing well under Island conditions. Among the sapota varieties grown as mixed crop in coconut gardens, PKM 2 performed better with higher fruit yield of over 35 kg per tree per year with medium sized canopy making it suitable for growing under coconut gardens. Watermelon was well established and yielding fairly-well in the Island.

Performance of Sapota in the interspaces of coconut at Minicoy

Grafts of fruit crops *viz*., Annona (Arka Sahan and Balanagar), Guava (Arka Kiran and Arka Mridula), and Mango (Kacha-Mitta) were planted for evaluation at Minicoy farm.

2.4.4.2. Vegetable crops

The vegetable crops such as green chilli, brinjal, tomato, bhendi, snake gourd, bitter gourd, amaranth, annual moringa, and pumpkin were found to perform well under Island ecosystem. Cool season vegetables such as cabbage and cauliflower could also be successfully cultivated as intercrops.

Growing of improved varieties of tomato (Arka Meghali, Arka Alok, Co 3), brinjal (Arka Anand and Co 2), chilli (Arka Lohit, Arka Harita, and Co 4), bhendi (Arka Anamika), amaranth (Arka Arunima, Arka Samraksha), cabbage (Ankura manas), cauliflower (F 1 Hybrid white), bitter gourd (Ventura), pumpkin (Arka Chandan and Arka Suryamukhi), cowpea (Arka Garima) and moringa (PKM 1) were successfully demonstrated at the Centre in an area of about 35 cents of coconut garden using different organic inputs such as poultry manure, cowdung, coconut leaf vermicompost, neem cake and *Pongamia* cake.

The successful cultivation of green chillies, brinjal, cabbage and cauliflower under Island soil; and climatic conditions enhanced enthusiasm among the Islanders for cultivation of such vegetables in their homesteads. Under the demonstration trials, the average head weight of cabbage recorded was 1.4 kg, while the average flower weight of cauliflower was 0.9 kg. The average yield of chilli was over 1.5 kg per plant.

Tomato in the interspaces of coconut at Minicoy

Brinjal in the interspaces of coconut

Chillies in the interspaces of coconut

Cultivation of cabbage

Demonstration in farmer's garden

A total of 8.0 t and 1.6 t of different vegetables and fruits, respectively were produced from the centre during 2012-14 period and distributed among the islanders. The successive vegetable production in the demonstration area (of about 35 cents) resulted in revenue generation of over Rs.2.30 lakhs over a period of two years.

To showcase the success and scope of fruit and vegetable cultivation with organic inputs as intercrops in coconut gardens, CPCRI is taking up demonstration trials in farmers' gardens in Minicoy Island. The seeds and planting material of the improved varieties are being supplied to the needy farmers in the Island territory. The efforts by CPCRI have made a positive impact on the utilization of scarce resources for the benefit of livelihood through horticulture and making available the fruits and vegetables in the Island areas, thus ensuring nutritional security to the Island dwellers.

2.4.4.3. Protected cultivation of vegetables

As chemicals are not advocated for plant protection in the Islands, there was increased infestation by insect pests. Hence, a demonstration of protected cultivation of vegetables such as brinjal, chilli, bhendi and amaranth using insect proof cage is taken up at the Research Centre, Minicoy. Initial attempts showed the success of crops under screen houses owing to the lesser incidence of pests. The seeds of various vegetables are sourced from TNAU, Coimbatore, IIHR, Bengaluru and KAU, Vellayani. Protected cultivation of vegetables such as tomato, chilli and brinjal were initiated at the centre. Besides, protected cultivation using low-cost poly house for cultivation of tomato, brinjal and amaranthus are also established in the homestead farms of Sri.U. Muhamad, Uday village and Sri. Ismail, Aoumagu village two farmers of Minicoy Island for demonstration.

Vegetable production in low-cost poly house under farmers' garden

2.4.5. Mixed farming through rearing poultry birds

Rearing poultry birds (both White Leghorn and Gramalakshmi breeds) under backyard system has been found to be ideal under Island conditions for enhancing farm family income and improving nutritional security. The Gramalakshmi breed of poultry has a potential of laying 180 eggs/bird/year.

Poultry – a promising venture demonstrated under island conditions

2.5. Pest management

A natural biotic balance is well maintained in the Island environment. Though no upsurge of pests is reported in the recent past, rat damage, infestation by coconut eriophyid mite, and papaya mealy bugs as well as hairy caterpillars causing allergic reaction in humans are some of the concerns among the Island farmers.

2.5.1. Rat

Rat (*Rattus rattus*) is the major mammalian pest of coconut found to cause about 33-44% damage to coconut palms in Minicoy. In general, palms that yield sweet nut water and pulp are highly preferred by rats. All stages of the nuts are attacked by the rats making a typical circular hole by gnawing and feeding on the inner contents. Laccadive Orange Dwarf is highly preferred by rats followed by Laccadive Green Dwarf and Laccadive Yellow Dwarf. The rats make nests over the coconut crowns using the cut leaflets, and moving on the crowns of adjoining palms through the touching fronds. The severely affected palms exhibit damaged leaves, young inflorescences and

Rat nest on coconut crown with cut leaflets

Irregular cut leaves by rat damage

tender fruits. Hence, placement of rat cake over the crown is essential to efficiently check the rat population. A device for placing the trap over the coconut crown was designed and tested which was found effective. Some of the major reasons attributed for the increased rat damage in the Island are higher density of coconut palms per unit area, inadequate crown clearing and delayed harvest of nuts, heaping fallen fronds and husks in the farm, absence of predators like snakes, owls *etc*. in the Island, and improper care provided to the coconut palms.

Rat damaged tender nuts

Rat damage on young inflorescence

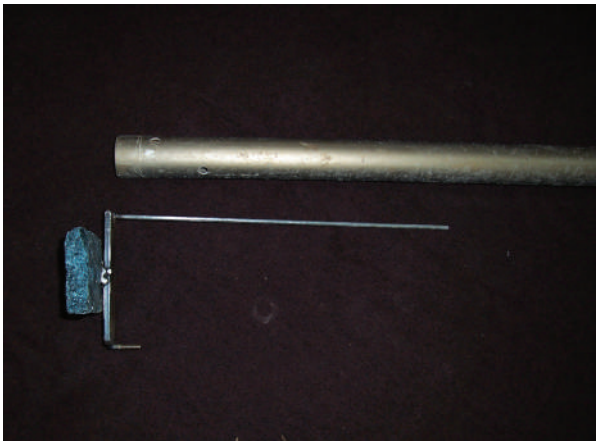
Wrapping the trunk of coconut trees using polythene sheets was found to reduce the damage by rats significantly.

2.5.1.1CPCRI device to place rat poison cake on the petiole/ crown of coconut

Placement of rat poison cake on the crown of those rat-preferred palms is practiced by the Island people to contain the rat population. Sri. Moosa of Funhilol village, Minicoy has developed a low-cost method for effective placement of rat poison cakes on the crown of coconut where the rat movement is at the maximum. Rat poison cake was affixed on the terminal portion of a long coconut petiole and using a screw the petiole affixed with cake was hanged on the way of rats so that the moving rats get sight of the cake and consume the poison.

CPCRI has developed a device by which any number of rat cakes can be placed in the coconut crown from the ground. The device consists of a small metal platform of 12 cm length and 5 cm width on which a clip is fixed. A small metal rod of 30 cm length is joined to one end of the platform and another rod of 5 cm length is joined at the

opposite end by welding. The long arm is to place the cake with the platform on the petiole and the short arm prevents it from accidental falling. Rat cake is placed between the claws of the clip. The long arm is then entered in to a light weight aluminium pipe. The platform on which the rat cake is fixed can be placed on the coconut petiole by raising the aluminium pipe. The aluminium pipe after placing the rat cake can now be lowered. Fabrication cost of such a device would be only Rs.10/- other than the cost of the light weight aluminium pole. The aluminium pole though costly, only one is required. Aluminium poles can go up to a height of about 15m.



Placing the rat cake using the pole method

2.5.2. Rhinoceros beetle or black beetle (*Oryctes rhinoceros*)

The damage caused by black beetle in the Island is less than 5%. Black beetle damage was 4.3% in Laccadive Green Dwarf, 2.6% in Laccadive Ordinary Tall and 3.7% in Laccadive Yellow Dwarf.

Oryctes rhinoceros nudivirus was released in Lakshadweep Island for the first time during 1990's and it was very effective in the bio-suppression of black beetle. Re-isolation of *Oryctes rhinoceros* nudivirus could be made during 2012 (even after two decades of its first release during 1990's) indicated the sustained establishment of the entomopathogen in the Island. The emerging adult black beetles are smaller in size than those recorded from the main land.

Though black beetle damage was recorded in Minicoy, no incidence of red palm weevil was reported from the Island. High calcium content in the soil could be one of the reasons for the non-establishment of the pest, as calcium is found to infuse tolerance to coconut palms for the attack by red palm weevil.

2.5.3. Coconut eriophyid mite (*Aceria guerreronis*)

One of the constraints emerged during 2008 in the production of coconuts by the Islanders was the damage caused by coconut eriophyid mite. All varieties of coconut including the coloured genotypes were infested by the mite. Size of the mite infested nuts was highly reduced and thereafter a significant decline in the copra yield was noticed. The cultivars, COD, LCOD and LCYD were observed with lesser incidence of mite.

2.5.4. Scale insects

Four different types of scale insects *viz.*, coconut scale, *Aspidiotus destructor* Signoret (Diaspididae: Hemiptera), pink wax scale, *Ceroplastes rubens* Maskell (Coccidae: Hemiptera), mussel scale, *Lepidosaphes* sp. (Diaspididae : Hemiptera) and a soft scale, *Lecanium* sp. (Coccidae : Hemiptera) were recorded feeding on coconut leaflets / nuts. A mealy bug belonging to the genus *Dysmicoccus* sp. (Pseudococcidae: Hemiptera) was also found feeding on the under surface of the coconut leaflets. Among the scale insects recorded, coconut scale, *A. destructor* was found to be very severe on coconut palms of Minicoy.

Though normally 6-8 colonies of any of the aforesaid species of scale insects are present in a coconut leaflet at Minicoy, the occurrence of these scale insects in such a higher population is not causing any economic damage to coconut. This is mainly attributed to the natural presence of effective bio-suppression agents in the Island ecosystem due to practices of organic farming and complete ban on use of pesticides.

Two different species of lady beetles *Chilocorus subindicus* Booth (Coccinellidae : Coleoptera) and *Scymnomorphus* sp. (Coccinellidae : Coleoptera) were predatory on coconut scale insects. Another effective predator on scale insects is *Cybocephalus* sp. (Cybocephalidae/ Nitidulidae: Coleoptera) identified by its hump-backed appearance. These natural predators are to be effectively conserved in the Minicoy Island.

2.5.5. Bio-suppression of papaya mealy bug (*Paracoccus marginatus* Williams and Granarade Willink (Pseudococcidae : Hemiptera)

Papaya mealy bug (*Paracoccus marginatus*), an invasive pest, was found to severely infest papaya leaves and fruits in the Minicoy Island bringing down the production quite significantly. Affected plants fail to flower and bear fruits and get dried up in severe infestation.

Papaya tree damaged by mealybug

Rejuvenated trees after release of parasitoid

Introduction and releases of the exotic parasitoid, *Acerophagus papaya* Noyes and Schauff (Encyrtidae: Hymenoptera) obtained from NBAII, Bengaluru during December 2011 and April 2012 has reduced the population and resulted in successful establishment of the parasitoid and brought down incidence of mealy bug to <5%, thereby resulting in rejuvenation of papaya plants in the Island.

Inspection for presence of Predators and parasitoids on papaya trees

Predators and parasitoids established on papaya leaves

The lepidopteran predator, *Spalgius epius* was also observed from the mealy bug infested papaya plants. The caterpillar of *S. epius* was found feeding on the mealy bug colonies. The population of *A. papaya* was so high that the parasitoids could be collected and released in other areas.

2.5.6. Use of semiochemicals in fruit fly management of cucurbits

Installation of cue lure traps @ 5 traps / ha in the bitter gourd as well as snake gourd fields was successful in the management of fruit flies. The percentage of damage was very low after the introduction of these traps and wrapping of the fruits. About 2-3 fold increase in the yield could be realized after the installation of cue lure traps.

Cue lure traps found effective in checking fruit flies

2.5.7. Pest surveillance in Minicoy

Minicoy Island being close to Maldives and adjoining international sea route, is considered to be prone to entry of new diseases and pests. CPCRI is making surveillance of invasive pests like coconut leaf beetle, *Brontispa longissima* (Chrysomelidae : Coleoptera) in all coconut growing regions of the country. The surveillance is being made in the Minicoy Island also periodically in order to prevent any possible entry of such pests.

Surveillance surveys conducted in Lakshadweep Islands could not locate the presence of the invasive pest, *B. longissima* though the pest is reported from Maldives group of Islands, which are only a few nautical miles away from Minicoy Island. *B. longissima* is a leaf beetle that feeds on young leaves and damages seedlings and mature coconut palms. It has become an increasingly serious pest of coconuts throughout various growing regions in the Pacific, especially over the last 3 decades. The farmers are made aware of the importance of preparedness in the management of the serious pest of coconut. Presence of another invasive pest, inflorescence moth, *Batrachedra nuciferae* in a few palms with dried and intact male flowers and few feeding lesions on the developing buttons was noticed. Coconut varieties such as Laccadive Ordinary Tall and Laccadive Orange Dwarf were found infested by the pest.

2.6. Value addition in coconut

Coconut is used for copra making and oil production in the Islands. The Islanders have number of recipes using fresh matured kernel, half matured kernel and tender kernel. Besides, sap production and utilization of the sap for fresh consumption and

sugar production is also followed by the Islanders. The sugar production using the sap is documented. In this method, the fresh sap is collected during morning and evening from the tapped trees and collected in plastic cans. The accumulated coconut sap is then filtered to remove the fallen insects and debris. In a wide mouthed vessel, few bits of bleached coral is placed with about 100 ml of water and boiled. Then the coconut sap is slowly added to the water and boiled. Frequent stirring is done during boiling to avoid clotting. The coral bits are removed and boiling continued till the entire content turns into golden yellow coloured sugar. Some farmers exhibited skill in getting the sugar with white colour by removing it from the pan at appropriate time. The sugar fetched good price locally as it is preferred for making number of ethnic sweet preparations in Island culture. Considering the chemical free cultivation of coconuts, the fresh and processed coconut products from Islands are considered organic and healthy.

Filtering fresh coconut sap

Boiling pan with coral bits

The coconut sugar product at Minicoy

Among the coconut growing regions of the country, the productivity of coconut is reported to be the highest in Lakshadweep Islands. However, at present, very little efforts are being made for value addition of coconut other than making copra and taking to main land for marketing. Thus, there is immense scope for value addition of coconut in a higher scale to profitably utilize the coconut produced in the Island to enhance income of the coconut farming community and to ensure livelihood security.

The following are suggested in this regard:

- Vinegar- a permanent natural preservative, ingredient for pickles, salads, soups, curry, *etc*. The Islanders prefer coconut vinegar for making fish pickles which is a common delicacy among Islanders
- Jaggery- a colloidal sugary substance made out of coconut inflorescence sap used for making a variety of snacks and sweet preparations.
- Desiccated coconut powder- Powder made out of fresh coconut by mechanical processing. Used mainly for confectionery items, many other variety dishes, curries, *etc*.
- Snowball tender coconut- Eight to nine months old tender coconut is dehusked and shells removed using a machine without damaging the kernel content, kernel ball is fixed in an ice cream bowl and served with a straw fixed in the eye of the kernel ball.
- Ball copra- It is a conversion of raw coconut into copra without breaking it into two pieces, nuts allowed to dry till shell is separated from the kernel and dried ball copra is comparatively clean, fetches good value in the market and posseses enhanced shelf life.
- Coconut milk- Coconut cream is the processed milk extracted from fresh matured coconut.
- Coconut fibre products- curled coir fibre, coir rope, yarn, coir mats and matting, pressed board, fibre bush, geo-jute to prevent soil erosion.
- Extraction of coconut oil and virgin coconut oil.
- Converting waste coconut pith into usable manure, briquettes.
- Coconut shell for Handicrafts, activated carbon, shell powder, *etc*.
- Coconut tree stem- construction material, quality furniture, boat making, *etc*.
- Midrib of coconut leaf-broom and handicrafts.

Various programmes for promoting value addition of products and by product utilization are being organized, wherein facilities for extraction of coconut oil, coir

fibre *etc*. will be created and demonstrated to the farming community, which would create improved scenario of market for Island produces.

2.7. Transfer of technology activities

In order to disseminate the technologies generated at the Research Centre for improving the agricultural productivity in the Islands and to increase the standard of living, various extension activities have been undertaken during the last four decades. These include:

- ❒ Farmers' study visit to experimental farm
- ❒ Organizing training programmes for farmers
- ❒ Frontline demonstrations in farmer's gardens
- ❒ Diagnostic field visits and suggesting suitable remedial measures for field problems
- ❒ Production and supply of quality planting materials of coconut, various vegetables and fruit crops

2.7.1. Training programmes

Various training programmes are being organized at Minicoy centre as well as at different Islands on need basis for the benefit of Islanders. Following thematic areas are covered in the training programmes.

1. Organic vegetable and fruit production under island conditions
2. Coconut-based cropping and farming systems
3. Scope of mixed farming in coconut gardens under Lakshadweep ecosystem
4. Azolla production under Island conditions
5. Biological control and treatment of stem bleeding disease of coconut using *Trichoderma harzianum*
6. Biological control of rhinoceros beetle
7. Popularization of vermicomposting technology under Island condition
8. Coconut climbing using paddle type coconut climbing machine
9. Management of rat menace in coconut gardens

Training to farmers on use of coconut climbing device and its distribution

Training on coconut and vegetable cultivation and field demonstration of package of practices

10. Production of coconut vinegar

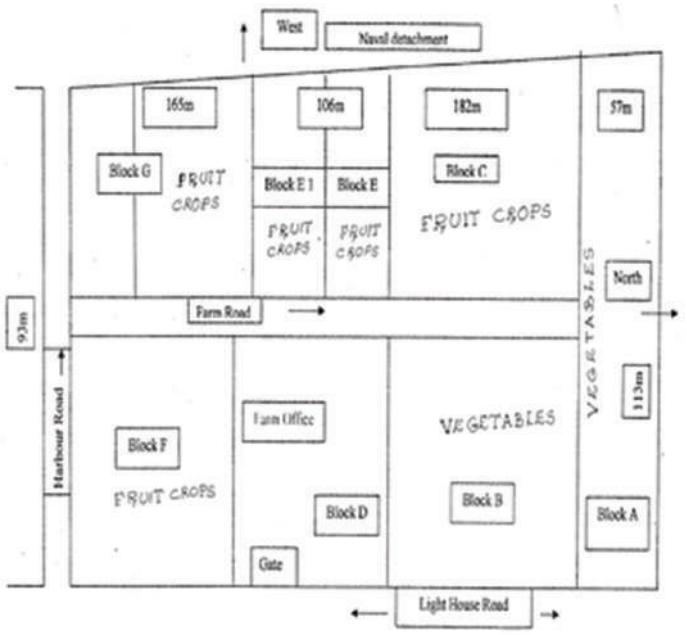
11. Preparation of snow ball tender coconut, coconut chips

12. Coconut inflorescence sap tapping using CPCRI technology

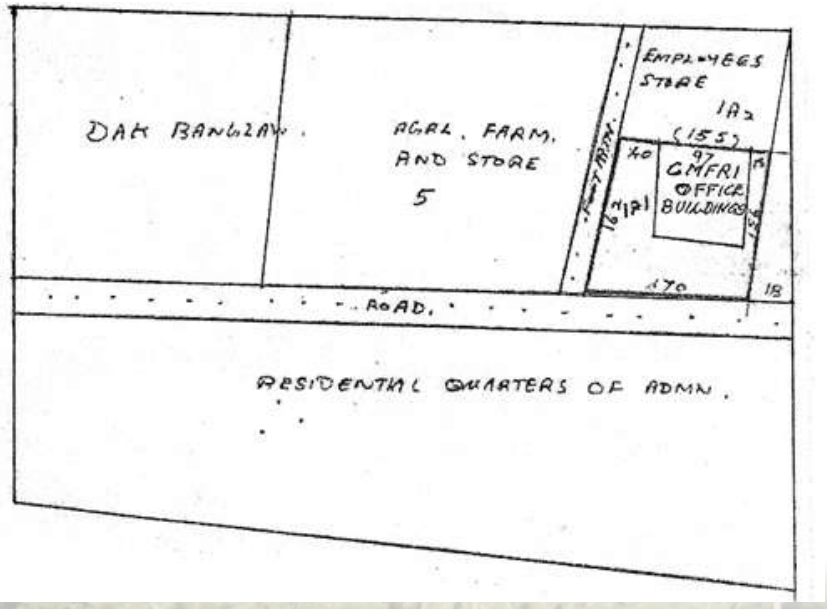
3. Way forward

Four decades of CPCRI interventions on managing coconut-based Island ecosystem at Minicoy, Lakshadweep have been successful in evolving appropriate technologies for enhancing productivity and income from coconut farming and also for disseminating the same to farming community for large scale adoption. The future thrust for the centre is focused on introduction/evaluation of new improved/high yielding varieties of various vegetables and fruits suitable for cultivation under Island conditions, demonstration and popularization of production technologies for fruits and vegetables among the Island community, development/refinement of location-specific technologies/ planting materials for increasing productivity of coconut and other existing crops in Lakshadweep Islands and demonstration and popularization of technologies among the Island community for wider adoption.

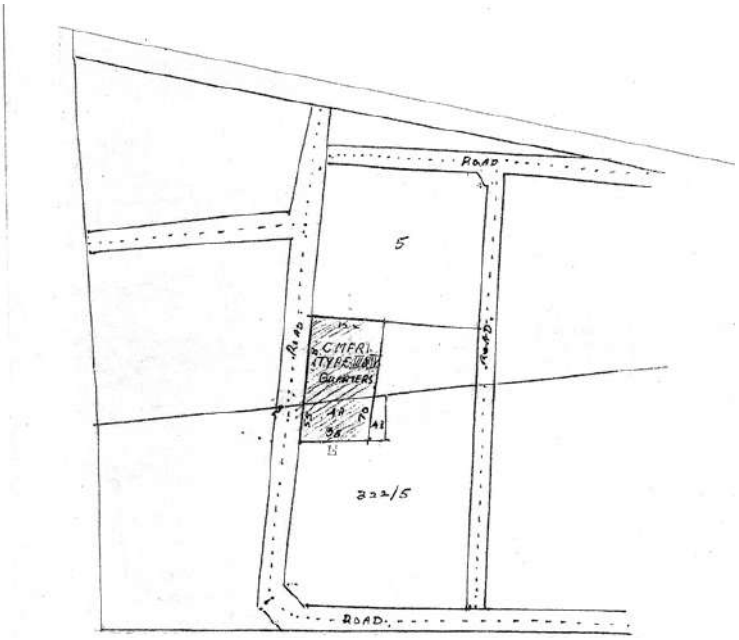
Central Plantation Crops Research Institute, Minicoy Centre – main farm area plan – South Bandaram



Central Plantation Crops Research Institute, Minicoy Centre – plan for the office area(Acquired from the then CMFRI Centre) - Field No.333



Central Plantation Crops Research Institute, Minicoy Centre – plan for the quarters area (Acquired from the then CMFRI Centre)- Field No.323



Central Plantation Crops Research Institute, Minicoy Centre – plan for the quarters area (Acquired from the then CMFRI Centre)- Field No.341W