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# TOWARDS HELPING FARMING COMMUNITY



CENTRAL PLANTATION CROPS RESEARCH INSTITUTE  
Kasaragod 671 124, Kerala, India



# TOWARDS HELPING FARMING COMMUNITY

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**Back cover:**

- \* *Winner of Kerala State Award for coconut cultivation - in his hybrid coconut field.*
- \* *Women participants in the Poverty Reduction Project - with vermicompost produced by them.*

**Cover design & Book layout:**

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**July, 2003**

## FOREWORD

The Central Plantation Crops Research Institute (CPCRI), started in the year 1970 by the merger of the then Coconut Research Stations at Kasaragod and Kayangulam and Arecanut Research Stations at Vittal, Peechi, Palode, Hirehalli, Kahikuchi and Mohitnagar, has developed, over a period of time, a large number of technologies. The technologies are to benefit the farmers, farm women, entrepreneurs as well as agro industries. This compilation "*Towards helping farming community*" has been prepared to enable interface between CPCRI and Governmental and Private Sector as well as the farming community for the transfer of technologies to improve the economic and social well-being of the beneficiaries. This is a maiden attempt in providing user friendly details on CPCRI technologies covering the three mandate crops, viz; coconut, arecanut and cocoa at one place including the details on the users' feed back.

The publication presents information on each technology developed by the scientists of CPCRI in Crop Improvement, Crop Production, Crop Protection, Physiology, Biochemistry and Post Harvest Technology and Social Sciences Divisions. I sincerely hope that the document will create additional interest in the CPCRI technologies and will lead to effective linkage, transfer and adoption of technologies. Individuals or organizations interested to adopt and exploit any of the technologies may address their queries to the Director, CPCRI, Kasaragod – 671 124, Kerala.

I appreciate the efforts put in by Dr. V. Rajagopal, Director, CPCRI and Dr. S. Arulraj, Head of Division (Social Sciences), all the Heads of Divisions and Scientists who contributed towards the collection and collation of this valuable information.

I hope that the publication would be well received by the farming community, development personnel, research workers and policy managers as well as organizations interested in the commercialization of the field-worthy technologies for the benefit of farmers and consumers. I am sure that the present compendium would help us to increase productivity in these crops as well as to ensure additional income and employment through crop management, crop protection, value addition and agro processing enterprises. Comments and suggestions to improve the quality of the document are welcome.

New Delhi  
15.07.2003



G. Kalloo  
Deputy Director General  
(Horticulture & Crop Sciences)  
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## PREFACE

The Central Plantation Crops Research Institute (CPCRI) has been strengthening its interactive programmes with farmers, farm women and entrepreneurs for ensuring the rapid commercialization of the technologies evolved by the Institute during the past three decades. It was felt that there is a need to have a compendium that highlights the technologies developed under the aegis of the CPCRI to the farmers and other users for increasing the production and productivity of mandate crops, additional income and employment. The technologies evolved by the erstwhile Central Coconut Research Stations and Central Arecanut Research Stations as well as the findings recorded during the recent years have been compiled along with the details on the level of commercialization of each technology under the headings Economics – At Research Station, Economics – At Farmers' Fields, Technology Spread Status and Farmers' Perception.

Many of the technologies relevant to the farmers, farm women and entrepreneurs as well as industries are regularly being transferred by CPCRI. However, there are still a number of technologies that need to be transferred through the development organizations, in a technically feasible and economically viable manner. All these technologies are documented in this publication.

The technologies in this compendium have been contributed by the scientists from the five Divisions of CPCRI viz; Crop Improvement, Crop Production, Crop Protection, Physiology, Biochemistry and Post Harvest Technology and Social Sciences based on the research conducted by the scientists of these Divisions.

In addition to the recommendations that have been found successful in different locations, those technologies, which have been found field worthy at pilot level or found promising at bench scale and can be scaled up with beneficiary participation on participatory mode have also been included. Further clarifications, if any, required by the users would be readily offered by CPCRI. However, the ICAR rules and guidelines on training and consultancy will govern the consultancy charges for offering need based/location specific Institutional as well as peripatetic training programmes as well as detailed guidelines for starting/running the enterprises at different locations.

The Editors express their gratitude to Deputy Director General (ICAR) Dr. G. Kallou for his continued inspiration and all the Heads of Divisions of CPCRI and their colleagues especially the Authors of different components of the publication for providing valuable information on the technologies for compilation. It is our earnest hope that the publication will achieve its conceived objectives and reach the targeted users.

Kasaragod  
15.07.2003



V. Rajagopal  
Director

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# 1. CPCRI – AT A GLANCE

The *Central Plantation Crops Research Institute (CPCRI)*, is playing a pivotal role in research and extension activities of coconut, arecanut and cocoa. The mandate of the Institute are i) to develop appropriate production, protection and processing technologies for coconut, arecanut and cocoa through basic and applied research, ii) to act as a national repository for the genetic resources of these crops, iii) to produce parental lines and breeders' stock of plantation crops, iv) to develop improved palm-based farming systems through more effective use of natural resources to increase productivity and income from unit area, v) to collect, collate and disseminate information on the above crops to all concerned, vi) to coordinate research on these crops within the country and execute the research programmes under the All India Coordinated Research Project on Palms and vii) to transfer technologies developed at CPCRI to the farmers through the cooperation of Developmental Departments/Boards.

## Brief History

The Central Plantation Crops Research Institute was established in 1970 with its Headquarters at Kasaragod by merging the erstwhile Central Coconut Research Station, Kasaragod, Central Coconut Research Station, Kayangulam and the Central Arecanut Research Station, Vittal along with its five sub-stations at Palode and Peechi (Kerala), Hirehalli (Karnataka), Mohitnagar (West Bengal) and Kahikuchi (Assam).

In the initial years of establishment, the mandate of the Institute was limited to crop improvement in coconut, arecanut and cocoa through basic and applied research. Adaptive research on cashew and spices

was undertaken with effect from 1971 with the establishment of All India Coordinated Spices and Cashew nut Improvement Project. Subsequently, the All India Coordinated Coconut and Arecanut Improvement Project (AICCAIP) started functioning from 1972 with its headquarters at CPCRI, Kasaragod.

CPCRI was expanded with a Seed Farm for cashew at Shantigodu (Karnataka),



CPCRI Head Quarters at Kasaragod

acquiring the Research Centre at Appangala (Karnataka) for cardamom research in 1974, establishing a Regional Station at Calicut (Kerala) in 1975 for conducting research on spices, establishing a Field Station at Irinjalakkuda (Kerala) to monitor the northward spread of coconut root (wilt) disease, initiating research on oil palm at CPCRI Research Centre, Palode and taking over the administrative control of ICAR Research Complex at Goa and Lakshadweep Islands. To meet the added responsibility of research, the expansion of the Institute in scientific strength was also made. The period also witnessed many outstanding research achievements in terms of release of high yielding coconut cultivars and hybrids, standardizing coconut based

farming systems to increase the income of the farmer from an unit area, achieving self-sufficiency in arecanut, management of coconut pests and diseases, production of indigenous tenera hybrids in oil palm, standardizing input requirement for coconut, arecanut and spices and release of high yielding varieties in black pepper and turmeric.

The period from mid 80s was the years of development and reorganization of the Institute. During 1986 (VII Five Year Plan) research on spices and cashew was delinked from the Institute with the establishment of National Research Centres at Calicut and Puttur respectively, mostly by redeployment of scientists and staff from CPCRI. Simultaneously, the All India Coordinated Cashew nut & Spices Improvement Project was bifurcated and the Project on spices was transferred to Calicut and that of cashew to Puttur. Further, arecanut was excluded from the ambit of the AICCAIP and in its place oil palm was included and the project was renamed as All India Coordinated Research Project on Palms (AICRPP). Later, Palmyrah palm was also included in the project. During 1989, the ICAR Research Complex for Goa was upgraded as an independent Institute, delinking it from CPCRI. A Krishi Vigyan Kendra was established at Kasaragod during 1993 for effective transfer of technology to the farming community. A separate National Research Centre for Oil Palm started functioning at Pedavegi (Andhra Pradesh) from March, 1995. The Palode Centre was transferred to NRC for Oil Palm during 1999.

At present, the Institute deals with the research and extension aspects of coconut, arecanut and cocoa under five broad Divisions viz., Crop Improvement, Crop Production, Crop Protection, Physiology, Biochemistry and Post Harvest Technology and Social Sciences. The Institute has three Regional Stations at Kayangulam (Kerala), Vittal (Karnataka), Minicoy (Lakshadweep)

and four Research Centres at Kahikuchi (Assam), Mohitnagar (West Bengal), Kidu (Karnataka) and Kannara (Kerala). The Institute has sound infra-structural facilities like well established research farms, well equipped laboratories at Headquarters as well as Regional Stations and Research Centres and Library-cum-Documentation Centre. The Transfer of Technology of the Institute is carried out by adopting four faceted approaches in the form of the conventional extension programmes along with an Agricultural Technology Information Centre, Krishi Vigyan Kendras (one each at Kasaragod and Kayangulam) and the Institution Village Linkage Programme. The Research Centre at Kidu helps to cater to the needs of the farmers by supplying elite planting materials of the mandate crops, in addition to serving as the Centre for International Coconut Gene Bank.

### **Growth in production sector**

The overall scenario of general growth and development of coconut, arecanut and cocoa sectors in the country are presented here.

Area under coconut for the country increased nearly three fold from 622 thousand ha (1950-51) to 1778 thousand ha (1999-2000). There was a steady increase in area under coconut over the period. It was observed that Compound Growth Rates (CGR) during different decennial periods was positive except for the period 1970-71 to 1979-80 when it was found to be negative. However, during 80's, the trend was reversed as the growth rate was positive and high. This was because of the concerted efforts taken by CPCRI, Coconut Development Board and the State Agriculture Departments for the production of quality planting materials, introduction of different cropping systems and pest and disease management packages, replanting schemes and area expansion programmes. The trend in coconut production followed the same

pattern as that of area. The production during 1950-51 was 3582 million nuts which increased to 14925 million nuts in 1998-99. As in area, the CGR for production was negative during 1970's but during the later periods it picked up and the CGR for 1990's was high with 7.28 per cent. The productivity in India was 5759 nuts/ha during 1950-51. This increased to 7821 nuts/ha in 1998-99. The trend in the productivity was not uniform in different periods as during 60's and 70's there was a negative growth. However, the present growth rate projected is 4.92 per cent.

India is the largest producer of arecanut in the world and earns about Rs. 45 million annually by exporting arecanut in various forms. Karnataka, Kerala, Assam, Tamil Nadu and West Bengal are the important states growing arecanut. Area and production of arecanut in India showed an increasing trend during the past 40 years. It is observed that compared to 1960-61, the increase in area under arecanut is about two and a half times, production increase is about three and a half times and the productivity increase by one and a half times. The productivity of arecanut remained almost constant from 1957 to 1974. It was in the eighties an appreciable increase in productivity was noticed.

India produces about 7650 tonnes of cocoa from about 16.18 thousand hectares. Karnataka and Kerala are the important states growing cocoa accounting for more than 90% of the area under cocoa in the country. It is observed that though the productivity increased, the area and production decreased over the years. The main reason for this decline is the difficulty experienced by the farmers in selling the produce. Without proper marketing facility, cocoa was not able to attract the farmers. Though India exports a modest quantum of processed products from Cocoa, she imports huge quantity of cocoa beans from other

countries. To overcome this challenge and to become self sufficient in cocoa production, the country has to achieve an annual growth rate of 20% in production.

### **Special recognition**

Recognizing the contributions made by CPCRI towards the research and extension activities in plantation crops, the Institute was honoured with "Sardar Patel Award for Outstanding ICAR Institution" for the year 2002. The salient achievements highlighted in the citation for the award are as follows:

- The largest germplasm collections in the world on coconut, arecanut and cocoa are available in the Institute. The establishment of World Coconut Germplasm Centre, International Coconut Gene Bank for South Asia, release of coconut hybrids and a dwarf cultivar for tendernut purpose and high yielding arecanut varieties are the most significant achievements.
- The coconut and arecanut based cropping systems involving companion annual/perennial crops and mixed farming models developed by the Institute are acclaimed by the farmers due to economic benefits.
- The most useful technologies developed on water and nutrient management, identification of drought tolerant genotypes, integrated pest and disease management are popular among the growers.
- The concept of "wealth from waste" was highlighted through the vermicompost and mushroom cultivation technologies.
- The Institute has been attracting many farm entrepreneurs on processing technologies (like

coconut chips, snowball tendernut) and value added products. The Institute has thus shown convincingly the great potential for income augmentation by poor farmers.

- The visibility of the Institute has been enhanced through aggressive transfer of technology activities like Krishi Vigyan Kendra, Institution Village Linkage Programme and Agricultural Technology Information Centre.
- The innovative interface programmes (launched in collaboration with Kerala Government) involving scientists, farmers, extension workers and developmental agencies and special thrust given for women entrepreneurs and unemployed youth have been commended by distinguished visitors. Success stories documented are laudable, elevating the Institute to International standards.

- The Institute has to its credit many valuable publications and popular CD ROMs on mandate crops.
- With modernization in biotechnology, bioinformatics and information technology, CPCRI is poised for a leap in achieving greater goals to cater to the needs of plantation growers.

The strenuous and multi-faceted research and development efforts taken since seventies have paved the way for achieving remarkable progress in different sectors of coconut and arecanut in India and the country is aiming for the same as far as cocoa is concerned. Further improvement in these sectors is possible, only when the clients (farmers) exploit the production potential of the technologies identified by CPCRI through large-scale adoption. Technologies developed at CPCRI are described in the subsequent chapters to enable the readers to use them for adoption and improvement of returns from the cultivation of coconut, arecanut and cocoa.



Dr. V. Rajagopal, Director, CPCRI receiving Sardar Patel Award for outstanding ICAR Institution from the Honourable Union Minister for Agriculture

## 2. HIGH YIELDING COCONUT CULTIVARS

CPCRI is maintaining the world's largest germplasm in coconut with 301 cultivars. The coconut germplasm is evaluated nationally through systematic multilocation trials. This has led to the release of three cultivars namely Chandra Kalpa (Laccadive Ordinary), Philippines Ordinary and Chowghat Orange Dwarf (COD) for commercial cultivation (Table). Chowghat Orange Dwarf has been identified as the best cultivar for tender nut purposes.

Release of these cultivars was made possible due to the strenuous efforts made by the scientists of CPCRI under the research project on collection, conservation and cataloguing of the coconut germplasm, which has always been accorded the top priority under Crop Improvement programmes. Further, under the Coconut Genetic Resources Network (COGENT) programme (sponsored by IPGRI), CPCRI has been selected as the Centre for establishing an International Coconut Gene Bank for South Asia and the same has been established at CPCRI Research Centre, Kidu. At present, the Institute has the world's largest germplasm collection comprising of 301 accessions of coconut (173 indigenous and 128 exotic). The exotic collections are from 22 countries of South Asia, South-East Asia, Caribbean Islands, Indonesian Islands,



Philippines Ordinary – a high yielding coconut cultivar

Pacific Ocean Islands, African countries, Bangladesh and Sri Lanka.

Use of Biotechnology tools in germplasm programme: A protocol for aseptic collection of embryos in coconut, their storage and successful culturing to develop plantlets has been standardized. This is found to be useful in field collection of coconut germplasm from distant places. This technique has been successfully used in collection of 15 exotic accessions from the Indian Ocean Islands

### Economics

**At Research Station:** The cultivars released for commercial cultivation give an average yield of about 100 nuts/palm/year, thus increasing the net returns by 45% from Rs. 31340/ha to Rs. 45430/ha and the Benefit Cost Ratio from 2.27 to 2.85 based on cash flow analysis.

**At Farmers' Fields:** The released cultivars have increased coconut yield by 20%, thus resulting in an additional net returns of Rs. 14,000/ha.

In the case of Chowghat Orange Dwarf (the tendernut variety), though the yield improvement was only marginal, an additional net returns of Rs. 24,500/ha could be realized due to the better farm gate price.

## Yield performance of released cultivars

Sl. No.	Cultivar	Average nuts/palm/year	Copra yield		Oil (%)
			Mean/nut (g)	Mean/palm (kg)	
1.	Chandra Kalpa (Laccadive Ordinary)	98	176	17.3	70
2.	Philippines Ordinary	110	189	20.8	66
3.	Chowghat Orange Dwarf *	83	—	—	

\* Released as tender nut variety

(6 from Mauritius, 4 from Madagascar and 5 from Seychelles) for the first time in the World with a success rate of 96%. The methodology was also used for indigenous collections from World Coconut Germplasm Centre, Andamans and exotic collections

from Sri Lanka (4) and Bangladesh (11). Significant progress has also been made in the fields of tissue culture; *in vitro* conservation; cryopreservation of coconut zygotic embryos and use of molecular markers.

### Technology Spread Status

CPCRI is producing annually about 10000 - 20000 seedlings of released cultivars for sales to farmers. In addition, 10000 - 50000 seed nuts of these varieties are supplied to State Government Departments. The Seed Farms under State Agricultural Universities, Coconut Development Board as well as State Departments of Horticulture are also involved in the large scale production of planting materials of released coconut cultivars (including State Agricultural University selections) ranging from 5000 to 25000 seedlings/annum/state. It is estimated that the annual demand for coconut seedlings in India is 15.0 million and the present level of production of seedlings of released cultivars by Government Institutions is very low and extent of involvement of private agencies in this task is negligible. As a result, at present, the high yielding cultivars are estimated to occupy about 5.0% of total coconut area in the country.

### Farmers' Perception

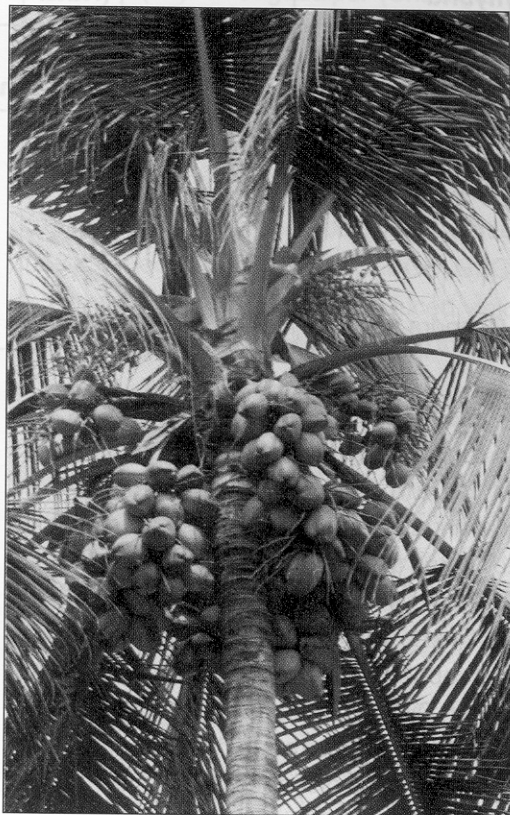
Under the Institution Village Linkage Programme at CPCRI, two released varieties, viz., Laccadive Ordinary and Philippines Ordinary were compared with the local West Coast Tall in 20 farmers' fields. The trials are in pre-bearing stage. Farmers felt that the two varieties are growing well despite the severe drought situation prevailing in the village. Farmers' experience elsewhere also highlights the better attributes of the released coconut varieties. Under comparable management conditions (in farmers' fields), the productivity of Laccadive Ordinary is reported to be better than that of West Coast Tall, the local tall variety.

Availability of planting materials was the major constraint perceived by the farmers in the adoption of the released varieties which needs immediate attention of all the coconut research and development organizations.

### 3. COCONUT HYBRIDS

Dr. J.S. Patel first exploited the hybrid vigour in coconut by crossing the local West Coast Tall with the Chowghat Green Dwarf and the hybrids were planted in 1934 for evaluation. The first hybrid coconut plantation in the world even today stands as a monument at the present Agricultural Research Station, Nileshwar. A number of hybrids involving Tall and Dwarf have been evaluated since that time. A total of eleven hybrids have been released nationally catering to the needs of various states and of these, three hybrids viz., Chandra Sankara (COD x WCT), Kera Sankara (WCT x COD) and Chandra Laksha (LO x COD) have been released by CPCRI (Table). These coconut hybrids give 49 to 77% more copra yield over local Talls and are not only early bearers but also give higher nut yield than either of the parent.

Apart from the breeding programmes for yield improvement, attempts are also being made to evolve high yielding cultivars/hybrids with tolerance to drought and root (wilt) disease. Physiologists and Biochemists have identified cultivars, which are drought tolerant, based on different physiological and biochemical parameters. West Coast Tall, Federated Malay States



Chandra Sankara – a hybrid coconut

(FMS), Java Giant, Fiji, Andaman Giant, LO x GB and LO x COD were identified as drought tolerant and are being used in breeding for drought tolerance.

#### Economics

**At Research Station:** The coconut hybrids could give an average yield of about 110 nuts/palm/year. Under similar management conditions, cultivation of coconut hybrids could give a gross income of Rs. 77,000/ha, as compared to Rs. 56,000/ha from West Coast Tall.

**At Farmers' Fields:** Case studies of farmers cultivating coconut hybrids on a commercial scale in Kerala, Karnataka, Tamil Nadu and Andhra Pradesh states revealed that the farmers could get an average yield of 150 nuts/palm/annum under irrigated conditions as compared to about 100 nuts from local cultivars resulting in an additional net return of Rs. 40,000/ha/annum.

### Performance of released coconut hybrids

Name of the hybrid	Parentage	Yield (Nuts/palm/year)	Copra yield		Oil (%)	State for which recommended
			per nut (g)	per palm (kg)		
Chandra Sankara	COD x WCT	116	215	24.9	68	Kerala
Kera Sankara	WCT x COD	108	187	20.2	68	Kerala, Coastal Maharashtra and Coastal Andhra Pradesh
Chandra Laksha	LO x COD	109	195	21.3	69	Kerala

Root (wilt) is a slow debilitating disease in coconut prevalent widely in eight districts of Kerala. CPCRI Regional Station, Kayangulam, has made considerable efforts to screen the available cultivars for tolerance to root (wilt) disease. However, all the cultivars/hybrids screened were found susceptible. Only the cultivar, Chowghat Green Dwarf (CGD), has been found to have field tolerance of over 90% to the disease. A survey of the disease affected areas (hot

spots) identified some high yielding, disease free WCT and CGD palms. Presently, phenotypically and serologically disease-free WCT and CGD palms are used in the breeding programme to produce different cross combinations - WCT x WCT, WCT x CGD, CGD x WCT, WCT self and CGD self. In addition, mixed pollen from all selected healthy palms in the diseased tract is also used for pollination to develop a gene pool of field tolerant palms. The relative tolerance/

### Technology Spread Status

As the cultivation of coconut hybrids is a well proven technology, all the Research and Development Institutions in the country, viz., Coconut Development Board, State Agricultural Universities, State Departments of Horticulture as well as CPCRI are giving major thrust for the production of hybrid coconut seedlings for commercial cultivation. Exclusive seed gardens have been established at different centres for strengthening this activity. Targets ranging from 2.00 lakhs to 10.00 lakhs for the production of hybrid coconut seedlings were fixed during different plan periods for different states and a generous funding was provided through Coconut Development Board for the production and distribution of hybrid coconut seedlings. In spite of the massive efforts taken by the Government Organisations, only a part of the demand for coconut seedlings (estimated at 15 million/annum) could be met from this programme and thus the area under coconut hybrids in the country remain low. Survey on the extent of adoption of coconut hybrids in different regions indicated that the use of hybrid seedlings for new planting was one of the lowest adopted recommendations and only 6% of the farmers adopted coconut hybrids.

resistance to the disease of the CGD x WCT hybrids, coupled with their high yield potential has highlighted the scope for developing this hybrid as a suitable planting material for the disease endemic areas. Seed gardens one each at CPCRI Research Centre, Kannara (Thrissur District) and Coconut Development Board Farm at Neriamangalam (Ernakulam District) have been established for large scale production of disease tolerant planting materials and their distribution to farmers in the diseased tract.

The research conducted at various Centres of All India Coordinated Research Project on Palms indicated that the performance of hybrids in different centres was good. The trial of promising seed material in coconut is in progress in seven centres. At Aliyarnagar (Tamil Nadu), the hybrids and cultivars planted during August 1988 have yielded on an average 133 nuts/palm. At Ambajipeta (Andhra Pradesh), the recovery of hybrid palms in the post cyclone period was better in terms of yield than other cultivars. The highest nut yield per palm per annum was recorded in COD x WCT (72

nuts) followed by Laccadive Micro (65), Laccadive Ordinary (57) and Andaman Ordinary (52). At Jagadapur (Chatisgarh), among three hybrids and six cultivars, COD x WCT and Andaman ordinary have shown promise as suitable cultivars for the tract. At Arsikere (Karnataka), all the combinations planted during 1994 in the red soil (representing major soil type of Maidan tract) have started yielding. WCT x GBGD, GBGD x Fiji, GBGD x LCO have produced yields between 61 and 75 nuts/palm during the year.

At Kahikuchi (Assam), where 10 cultivars are tried, MYD x WCT and Assam Tall performed better than others in regard to production of female flowers, spadices and bunches harvested. MYD x WCT yielded 97 nuts per annum and Assam Tall 97 nuts / palm when the average yield of five years was considered.

At Mondouri (West Bengal), Laccadive Micro produced 96 nuts/palm followed by COD x WCT (83 nuts), Laccadive Ordinary (81), WCT x COD ( 75) and Philippines Ordinary (72).

## **Farmers' Perception**

Availability of coconut hybrid seedlings from credible sources was the major constraint perceived by the farmers in the adoption of coconut hybrids. It is expected that the efforts being taken under the Technology Mission on Coconut would help to bridge this critical gap. In general, farmers perceive that coconut hybrids perform well under good management conditions. However, few farmers nurture disinclination to coconut hybrids because of the perceived attribute of lower economic life compared to the local Tall cultivar. Hence extension efforts to convince the coconut growers about the relative advantages of coconut hybrids are to be strengthened along with sustained efforts to ensure the supply of required quantity of planting materials from credible sources.

## 4. NURSERY MANAGEMENT

Coconut being a perennial and cross pollinated crop, the performance of the seedling will be known only after a long period of time and will continue to have its impact for years to come. The productivity of a garden depends right from the selection of seed garden, mother palm, seed nut and planting and maintenance of the nursery.



Management of poly bag nursery of coconut

### Selection of seed gardens

- i. Gardens should have palms with a high proportion of heavy bearers but it should be kept in mind that this must not be from very favourable conditions.
- ii. Garden should be free from the incidence of diseases and not prone to severe attack of pests.
- iii. Avoid palms located near cattle sheds and compost pits.

### Economics

**At Research Station:** Effect of various practices recommended for coconut nursery management could be measured in terms of higher yield obtained from planting the seedlings from properly managed nurseries. However, the additional cost involved in the adoption of nursery management practices is meagre ranging from Rs. 10 to 12 per seedling. The net returns per seedling could be Rs. 15 to 20 depending on the demand.

**At Farmers' Fields :** Farmers raising coconut plantations with seedlings raised in properly managed nurseries could get very high yields and additional returns as compared to the plantations raised with poor seedlings.

### Technology Spread Status

Majority of the coconut growers raised their own seedlings for planting. Medium to high level of adoption was recorded regarding selection of mother palms (89 to 100%), age of seed nuts (42 to 45%) and selection of seedlings (36 to 67%). However, a survey in the root (wilt) affected areas of Kerala State revealed that only 38% of the farmers

## Selection of mother palms

- i. Palms should be regular bearers with annual yield of more than 80 nuts/year (under irrigation-120 nuts/year) and copra content of not less than 150 g/nut under rainfed conditions.
- ii. Palms should have reached full bearing stage and have been giving consistently high yields for atleast four years.
- iii. Avoid very old palms of above 60 years age.
- iv. Seed nuts can be collected from the newly established seed gardens irrespective of the age of the palms as the performance of the parents is known and only high yielders are maintained.
- v. Mother palms should have atleast 30 fully opened leaves having leaf orientation in all directions i.e. umbrella shape crown is ideal.
- vi. The leaves should have short and strong petioles with wide leaf base firmly attached to the stem. Their arrangement would provide support to the bunches.

- vii. Each leaf axil should have one inflorescence with large number of spikes and one or two female flowers per spike.
- viii. Bunch stalk should be short, stout and strong and should not show any tendency to droop down or buckle.
- ix. Palms having medium sized nuts (about 1200 g when the husk is fully dried) with round and oblong shape. Husked nuts should be large (about 570 g) with thick kernel.
- x. Palms which produce barren nuts or those shedding large number of immature nuts should be discarded.

## Collection of seednuts

- i. Collect seed nuts from January to April in the West Coast region.
- ii. Only fully matured nuts i.e. about 12 months old nuts should be harvested.
- iii. Nuts should not be damaged while harvesting.
- iv. Discard nuts having irregular shape and size and improper development.

adopted the correct procedure of mother palm selection, while 45% adoption was recorded for the collection of seed nuts and 34% for seedling selection.

## Farmers' Perception

Farmers adopting the correct nursery management practices perceived that the recommended technology is simple to adopt with very high relative advantage. Lack of knowledge was identified as the major constraint resulting in the poor adoption of nursery management technologies. Coconut being a perennial crop, production and planting of quality seedlings, raised through the scientific nursery practices, is important to ensure a better performance of the crop in the subsequent years. Hence educational efforts to encourage the farmers to raise seedlings by adopting recommended nursery management practices assume much significance.

## Raising nursery

- i. Select well drained plot with coarse-textured soil near dependable water source for irrigation.
- ii. Prepare raised beds, if water stagnation is a problem during rainy season.
- iii. Soil may be treated with chlordane 5% dust @ 120 kg/ha in place where nursery is taken for the first time as a precaution against white grubs and termites.
- iv. Nursery can be raised either in the open space with artificial shade or in gardens where the palms are tall and the ground is not completely shaded.
- v. The seed nuts should be planted in long and narrow beds at a spacing of 40 x 30 cm during May-June, either vertically or horizontally in 20-25 cm deep trenches.

## Poly bag nursery

Germinated seeds are transplanted in poly bags of size 60 x 40 cm with 8-10 holes at the bottom. The potting mixture is in 2:1:1 ratio of top soil, sand and compost mixture. The advantage of poly bag seedlings is that there is no transplantation shock and the seedlings grow with better vigour.

## Care and management of nursery

- i. Light and frequent watering is to be done during dry season.
- ii. Mulching and shading should be done immediately after the monsoon, when the nursery is raised in the open space.
- iii. Keep nursery free of weeds.

- iv. Regular surveillance for any incidence of pests and diseases.
- v. Remove those nuts that have not sprouted even after five months of sowing.

Coconut seed nut contains endosperm which can supply food to growing seedling adequately upto 4<sup>th</sup> month only. Studies have revealed that young seedlings are in short supply of nutrients for a major part of their one year growth in the nursery. Hence it is recommended to apply NPK fertilizers in the months of December, February and April to supply 40 kg N, 20 kg P<sub>2</sub>O<sub>5</sub> and 40 kg K<sub>2</sub>O per application per ha in nurseries where seed nuts are planted in the month of May-June. This may ensure production of seedlings with favourable nutrient status, so as to facilitate better establishment, faster growth and early bearing in the main field.

Nursery requires light and frequent irrigation (once in 3 or 4 days). About 10 mm of water should be applied for every irrigation

## Selection of seedlings in the nursery

- i. Every coconut nursery contains some seedlings which are deformed or whose development is stunted, which must be eliminated.
- ii. Select seedlings, which have germinated early.
- iii. From the one-year-old nursery, select vigorous seedlings having minimum of six leaves and girth of 10 cm at the collar.
- iv. Early splitting of leaves is a good indicator of the rapid developers and early bearing.
- v. The recovery of good seedlings will be 60 to 65% of total seed nuts sown.

## 5. PLANTING SYSTEMS AND CARE OF YOUNG PLANTATIONS

Most of the existing coconut plantations are planted in the square system at a spacing of 7.5 m x 7.5 m. Adoption of hedge (rectangular) system of planting coconut with wider row spacing and rows oriented in east-west direction would increase light availability to intercrops (e.g. 9.0 m x 6.5 m with 170 palms/ha). This would facilitate growing annuals and perennials right from the time of planting coconut. Triangular system of planting (equilateral triangle) accommodates 30 palms more than the square system of planting, however it interferes with the cultural operations and cultivation of intercrops.

### Care of young plantations

- Mulching the base with coconut husks, dry leaves etc.
- Husk burial in planting pits.



Planting of coconut seedling

- Irrigation during dry months @ 45 litres once in 4 days.
- Pitcher irrigation may be adopted in water scarcity areas.
- Shading during summer.
- Regular weed control.

### Economics

**At Research Station:** Adoption of recommended spacing and proper care of young plantations could give an average yield of about 150 nuts/palm/year, thus resulting in a gross return of Rs. 80,430/ha in well maintained coconut garden.

**At Farmers' Fields:** Adoption of correct spacing could provide good scope for inter and mixed cropping in coconut garden which would improve the net returns from the garden 3 to 5 times as compared to the monocrop of coconut.

### Technology Spread Status

Though, the practices like time of planting, depth of planting, pit size etc. recorded higher levels of adoption in various coconut growing regions (more than 60%), only 20 to 40% of the farmers adopted the recommended spacing for planting coconut.

### Farmers' Perception

Farmers are fully convinced about the importance of correct spacing and proper care of young plantations. Farmers' practice with regard to optimum spacing for coconut palms is evident from their traditional belief that leaves of two nearby palms should not overlap; instead they should just touch only. The traditional saying "Annan chadaruthu" in Malayalam means squirrels should not be able to jump easily from one palm to the adjacent one. To ensure this, farmers adopt a spacing of 7-7.5 m which is in line with the recommended spacing. However, the farmers who follow the homestead farming system with marginal size holdings could not adopt the correct spacing due to the desire for planting more number of crops/plants within the available limited area.

## 6. REPLANTING OR UNDER PLANTING

Replanting or under planting becomes necessary when the yield become very low due to old age, long-term neglect and continuous exposure to adverse conditions. Generally under planting is practiced where old palms are removed in stages over a period of three to four years. The following sequence of steps may be followed for carrying out the under planting in a coconut garden.

- i. Peg mark the area to be under planted.
- ii. Remove very poor yielders and those very close to the planting pits.
- iii. Plant the seedlings in the usual way.
- iv. Other palms are removed @ one-third each year during 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> year after planting.
- v. If the existing garden is irregularly



Underplanting in a coconut garden

- spaced, remove old palms within 1 m radial distance in first year, 2 m distance in second year, 3 m distance in third year and the rest in fourth year.
- vi. Generally flowering is delayed a little in under planted palms.

### Economics

**At Research Station:** Research efforts made by CPCRI indicated that under optimum management conditions, assuming a medium price range of Rs. 3.50/nut, the suggested time for removing the other palms is those periods, in which their annual yield is consistently falling below 40/nuts/palm.

### Technology Spread Status

The extent of adoption of the recommended practice of systematic replanting or under planting in coconut gardens is observed to be comparatively low. In the recent survey among coconut farmers in different regions in Kerala State, it was observed that, on an average, 10-15 seedlings per ha are planted every year in coconut gardens mainly as gap filling, in case of loss of palms due to natural calamities like lightning, disease incidence like bud rot and pest incidence such as red palm weevil.

### Farmers' Perception

The farmers are fully convinced about the need for under planting especially in gardens with a larger proportion of senile palms. However, it was observed that the removal of senile palms was not done at the correct time in many of the gardens, when the under planted seedlings are coming up resulting in their poor performance. The misconception that the over all returns would reduce drastically if the older palms (senile palms) are removed, was the major reason for the delayed removal. Appropriate extension efforts are needed to educate the farmers on the benefit of systematic under planting or replanting along with implementation of development programmes to restructure the existing gardens for optimum plant density and for systematic replanting/under planting to enhance coconut productivity.

## 7. INTEGRATED NUTRIENT MANAGEMENT

Coconut is a perennial crop that exports nutrients to the above ground parts continuously from a limited volume of soil throughout its existence. CPCRI recommends that one-tenth of the adult palm dosage of nutrients should be applied after three months, one third after two years of growth, two thirds after three years and full dosage from fourth year onwards (Table). General requirement of fertilizer elements for palms yielding an average of 50 nuts/palm/year is 500 g N, 320 g  $P_2O_5$  and 1200 g  $K_2O$  palm/year. The nutrients should be applied in the form of urea, rock phosphate and muriate of potash in acid soils and urea, single super phosphate and muriate of potash in neutral to alkaline soils. Adequate quantity of bulky organic manures (50 kg/palm/year) should also be applied. It provides some of the micronutrients needed by the palms and also improves the soil physical conditions including water holding capacity.



Manure application to coconut palm

Fertilizer application is usually recommended in two splits in a year, one third of the recommended dose must be spread around the palms within a radius of 1.8 to 2.0 m and forked in immediately after the pre monsoon showers. Remaining two third fertilizer dose should be applied in September when the monsoon rain recedes.

### Economics

**At Research Station:** The long term manurial experiments being maintained at CPCRI, Kasaragod indicated that by adopting the practices like fertilizer application along with organic manure application and intercultivation, the coconut yield could be increased to 101 nuts/palm/year as compared to 27 nuts/palm/year received from neglected plots. Recent studies on the economic analysis of integrated nutrient management in coconut based cropping system revealed that a total net return of Rs. 48,200/ha/year could be obtained by adopting one-fourth of the recommended fertilizer dose (along with organic recycling) with a Benefit Cost Ratio of 2.01.

**At Farmers' Fields:** Verification Trials conducted in 20 farmers' plots under the Institution Village Linkage Programme indicated that, under rainfed conditions, the farmers could get a net return of Rs. 14986/ha when they apply fertilizer based on soil test values as compared to Rs. 10300/ha by adopting the farmers' practice. The returns per rupee spent increased to 2.73 as a result of increase in the average coconut yield from 36 nuts/palm/year in plots with farmers' practice to 48 nuts/palm/year in plots where farmers applied fertilizers based on soil test values.

### Fertilizer schedule for coconut (g/palm)

Age of the palm	May-June			September-October		
	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
First year	—	—	—	50	40	135
Second year	50	40	135	110	80	270
Third year	110	80	270	220	160	540
Fourth year onwards	170	120	400	330	200	800

Boron deficiency causes characteristic malformation of leaves like hook leaves, nut cracking, drying of the female flowers etc. Soil application of Borax @ 50 g/palm twice at monthly intervals after the appearance of the first symptom corrects the deficiency. In the root (wilt) disease affected area, it is recommended to apply Borax @ 300 g/seedling and Borax @ 500 g/adult palm. Application of Magnesium @ 500 g MgO per palm is advantageous for the management of root (wilt) diseased palms to restore palm vigour and sustain the productivity.

Nutrient indexing of WCT, COD x WCT and WCT x COD palms indicated that hybrid palms do not require higher N, P and K inputs for higher productivity as compared to Tall cultivars.

Based on the experiments conducted nationally and internationally, it is well accepted that soils with 1% organic carbon status is ideal for coconut cultivation. Further, long-term observations led to conclude that 70 to 80 ppm of mineralizable nitrogen in soil and 10 to 12 ppm Bray

### Technology Spread Status

Lack of proper nutrient management is identified as a major constraint in enhancing coconut productivity. Various studies conducted in different coconut growing regions in the country indicated a high level of adoption of application of organic manures and low to medium level of adoption of practices like application of chemical fertilizers and green manuring. A survey conducted in Kannur District in North Kerala region showed that 89.20 per cent farmers applied organic manures to coconut palms, but application of chemical fertilizers to adult palms and seedlings were respectively adopted by 44.40 per cent and 28.57 per cent farmers only. A similar survey conducted in Alappuzha District in South Kerala region indicated that the farmers had medium level of knowledge (55 per cent) and adoption (25 per cent) on chemical fertilizer application to adult palms. The study also revealed that about 50 per cent farmers adopted the recommendation for magnesium sulphate application to coconut palms, though in incorrect doses. A recently concluded survey showed that only 19.60 per cent of farmers applied chemical fertilizers in the North Kerala region, while the figures were 34.85 per cent and 34.50 per cent for

extractable 'P' can sustain sufficient levels in coconut. Further work at CPCRI revealed that, if soil available P is less than 10 ppm, full recommended dose of 320 g P<sub>2</sub>O<sub>5</sub>/palm/year may be applied and for a soil test value of 10 to 20 ppm, 50 per cent of the same may be applied. For soil test values of more than 20 ppm, P application can be skipped.

The various data on leaf analysis and nutrient responses available in the country suggest the following critical levels (Fron, 14) for coconut:

N	-	1.7 - 1.8 per cent
P	-	0.11 - 0.12 per cent
K	-	0.8 - 1.0 per cent
Ca	-	0.3 per cent
Mg	-	0.2 per cent

The results of the experiments under taken in the All India Coordinated Research Project on Palms indicated that high yielding coconut varieties and hybrids have responded well to the integrated nutrient management practices. The salient findings of the trials in different centres are as follows.

At Aliyarnagar (Tamil Nadu), studies on nutritional requirement of COD xWCT indicated response to application of nitrogen increasing the number of functional leaves, number of bunches, female flowers and yield. Among the 27 treatment combinations, 500 :250:1000 g N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O/palm/year recorded a yield of 142 nuts/palm which also gave a B:C ratio of 1.91.

At Kahikuchi (Assam), a nutrient combination of 500 g N, 500 g P<sub>2</sub>O<sub>5</sub> and 2000 g K<sub>2</sub>O/palm/year resulted in consistently higher yields in COD x WCT palms (115 nuts/palm/annum over four years).

At Mondouri (West Bengal), COD x WCT palms exhibited positive response to NPK application with an average yield of 106 nuts/palms.

At Veppankulam (Tamil Nadu), the hybrid VHC-1 responded well to graded doses of NPK by corresponding increase in the growth, yield attributes, nut yield and cumulative mean nut yield. Hybrid palms receiving 1000 g N, 250 g P<sub>2</sub>O<sub>5</sub> and 2000 g K<sub>2</sub>O produced the highest yield of 196 nuts/palm/annum.

Central Kerala region and South Kerala region respectively. The survey results also showed that nearly half of the farmers who adopted chemical fertilizers were applying lower quantities than the recommended dose. In general, application of chemical fertilizers in correct doses was adopted by very few farmers only.

### **Farmers' Perception**

Studies have shown that in general, farmers are aware of the importance of integrated nutrient management practices for sustainable coconut production. But high cost of fertilizers, high wage rate and lack of availability of labour are some of the constraints experienced by them in the adoption of proper nutrient management in their coconut gardens. Lack of knowledge about the correct dose and frequency of application also limits the adoption of integrated nutrient management practices. Lack of capital, not convinced of the benefits, not aware of recommendations and high cost of fertilizers were the constraints perceived by the farmers resulting in low level of adoption of integrated nutrient management technologies.

## 8. IRRIGATION METHODS FOR COCONUT

Irrigation methods commonly adopted in coconut gardens are flooding, basin irrigation, sprinkler or perfo-sprays and drip irrigation. In certain areas of Tamil Nadu, East Godavari and West Godavari Districts of Andhra Pradesh where adequate supply of water is available, coconut gardens are flood irrigated, leading to considerable wastage of irrigation water. In basin irrigation, water is applied in the basins of 1.8 to 2.0 m which is the active root zone of coconut. Irrigation channels are provided in between two rows and each basin is connected with the channel. In this method, there will be some loss of water due to deep



Drip irrigation in a coconut garden

percolation, seepage and evaporation. However, the loss is reduced when basins are irrigated through hose pipes. This is

### Economics

**At Research Station:** Through the adoption of micro irrigation system, a net saving of 34% of irrigation water could be obtained. The water, thus saved, could be used for increasing the area under irrigation in the farm. Adoption of micro-irrigation system could help to save Rs.3000/ha due to reduction in total labour demand for irrigation.

**At Farmers' Fields:** Recent survey conducted by CPCRI revealed that in those gardens, where the micro-irrigation systems are adopted, the cost of cultivation is reduced by Rs.2500/ha, thereby increasing the realized gross returns and net returns from additional crop area irrigated.

### Technology Spread Status

Studies on the use of different methods of irrigation indicated that 34% of the respondents adopted basin irrigation while 9.5% adopted sprinkler irrigation and 2.85% of the respondents were using drip irrigation. Survey conducted by CPCRI in Kannur District indicated that nearly one-third of the farmers irrigate their coconut palms. Basin irrigation is the commonly adopted method. Water conserving irrigation methods such as drip irrigation is becoming popular among coconut growers. However, the extent of

being advocated to reduce water loss in transit. Still, there is loss due to deep percolation and surface evaporation. CPCRI recommends application of 200 litres of water per palm once in four days. For the palms in red sandy loam soils on the West Coast, perfo irrigation with 20 mm water, when cumulative pan evaporation was 20 mm, was found to be the best irrigation schedule.

Sprinkler irrigation or perfo irrigation are more suited to inter or mixed cropping systems, where the entire surface requires wetting. The quantity of water applied should be at least 75 per cent of open pan evaporation (E<sub>o</sub>). Drip irrigation is ideally suited for widely spaced crops like coconut

as it saves water, energy and labour and the Water Use Efficiency (WUE) is high. Based on a study conducted at CPCRI, it was concluded that yield of coconut with drip irrigation system daily at 66% of the evapo-transpiration from December to May was adequate and comparable to basin irrigation @ 200 litres/palm once in four days. Thus, there is 34 per cent saving of water in drip irrigation. This is applicable to all the cultivars and hybrids and also in different soil types. The number of dripping points per palm should be six for sandy soils and four for other soil types. The rate of water application should be 2-3 litres/hour/emitter. The quantity of water required in drip irrigation was 32 litres/palm/day under Kasaragod conditions.

adoption of microirrigation technologies is low (2.85 per cent). Another study conducted recently showed that 8.54 per cent of coconut holdings in the North Kerala region received irrigation, while the figures were 71.21 per cent and 25.00 per cent for Central Kerala region and South Kerala region respectively.

### **Farmers' Perception**

Farmers consider irrigation to coconut as important as other management aspects. They are well aware about the relative advantage in terms of higher productivity that could be achieved by providing irrigation to coconut palms. There is a proverbial phrase popular among the farmers "Nana kondu mathram nalikeramerum", meaning that the productivity of coconut palms can be increased considerably through irrigation. However farmers experience many constraints in adopting improved irrigation methods such as microirrigation. A study conducted by the Central Plantation Crops Research Institute revealed that clogging of the drip irrigation system, lack of timely service from the Dealers, poor technical guidance from the extension personnel, low level of awareness and inadequate knowledge about method of operation and maintenance of drip irrigation system were the important constraints faced by the coconut farmers for lesser adoption of micro irrigation systems. Considerable proportion of adopters of microirrigation technology in coconut farming do not possess the required level of know-why and know-how aspects, resulting in less effective field implementation of the technology. Hence adequate attention is to be paid to organize education programmes by extension agencies to enhance the knowledge level of farmers on the benefits of advanced irrigation methods for coconut farming.

## 9. INTERCULTIVATION

Intercultural operations increase the coconut yield not only through weed control per se, but also by providing a soil rhizosphere environment favourable for mineralization and soil moisture conservation. Cultivation alone, twice a year, one at pre monsoon and another at the post monsoon in the coconut gardens was found to increase the yield to 30-35 nuts/palm/year, compared to the neglected plots (27 nuts/palm/year). The response of West Coast Tall palms to management practices viz. Cultivation + Organic + Inorganic manuring has shown an increase in yield by four folds (101 nuts/palm/year) as compared to the



Intercultivation in coconut garden

neglected plots (27 nuts/palm/year) under rainfed conditions.

### Economics

**At Research Station:** In the “Permanent manurial experiment” being maintained at CPCRI, the realized gross returns and net returns (per hectare) from those plots in which cultivation + organic + inorganic manuring was followed was Rs. 81,000/- and Rs. 56,900/- respectively as compared to Rs. 18,900/- and Rs. 6,100/- in untreated plots.

**At Farmers’ Fields:** Under farmers’ field conditions, the average productivity is about 60 nuts/palm/year when cultivation + organic + inorganic manuring are carried out as compared to 20 nuts where no intercultural and no manuring was done. The gross returns and net returns from the treated plots (per hectare) were Rs. 42,000/- and Rs. 27,500/- per annum as compared to Rs. 14,000/- and Rs. 7,000/- in untreated plots.

### Technology Spread Status

Review of studies on the adoption of recommended practices of coconut cultivation, reveals that majority of the farmers (about 75 per cent) adopt systematically the cultural practices such as taking basins around the palms, ploughing or digging of inter spaces, providing field bunds etc.

### Farmers’ Perception

Interculture operations in coconut gardens are perceived as important by the farmers from the view point of weed management as well as soil and moisture conservation. Coconut farmers are also aware that digging of interspace and basin opening would aid in reducing pest infestation by exposing soil inhabiting grubs to predatory birds. However, shortage of farm labour and high wage rates are perceived by farmers as the major constraints for adoption of the recommended intercultural practices in coconut garden.

## 10. GREEN MANURING

The technique of utilization of leguminous cover crops as green manures to supply biologically fixed nitrogen and easily decomposable biomass to coconut is standardized at CPCRI. It involves cultivation of leguminous creepers such as *Pueraria phaseoloides*, *Mimosa invisa* and *Calopogonium mucunoides* in coconut basins during the monsoon period from June to October and incorporation of the legume biomass in respective basins. During a growth period of 140-150 days, the promising legumes



Green leaf manure application to coconut palm

generated 15-28 kg of biomass and 102-197 g of nitrogen in the basin of a coconut palm.

### Economics

**At Research Station:** The value of green manure obtained from one ha. of coconut garden @ 200 g of Nitrogen from 28 kg of biomass/basin is Rs. 5,600/-. To this extent, it is possible to substitute fertilizer nitrogen requirement, with the nitrogen contributed by leguminous green manures.

**At Farmers' Fields:** The on farm trials under the Institution Village Linkage Programme indicated that farmers could get an yield upto 38 kg of green matter from the cultivation of *Mimosa* or *Calopogonium*/palm basin with 2.0 m radius. Considering the fact that a few farmers in this area are purchasing green leaf manure from outside sources @ Re. 1 per kg, the total income obtained from the green manuring practice could be estimated as Rs. 38/palm basin and Rs. 6650/ha.

### Technology Spread Status

Application of organic manures to coconut palms in different forms is a widely adopted practice. The commonly used manures are farm yard manure, green manure, ash etc. These manures are applied either alone or in combination. Application of green leaf manure is a widely adopted practice in certain regions of the country. Recent survey in

A field experiment conducted in a coconut plantation in an acidic laterite soil type revealed the feasibility of substituting upto 50% of fertilizer nitrogen with the nitrogen contributed by leguminous green manures. *M. invisa* and *P. phaseoloides* are well nodulated by native *Rhizobia* in acidic coconut soils.

### Growing *Glyricidia* as a green manure crop

Generation of large quantities of nitrogen rich biomass is also possible through the cultivation of the fast growing leguminous tree crop, *Glyricidia* in the coconut plantations. It can also be grown in littoral sandy soils, where no other green manure crop can establish. The planting density and pruning frequency to obtain higher biomass yield from *Glyricidia sepium*, when grown as green manure crop in coconut plantation in littoral sandy soil was standardized. The treatment, three rows of *Glyricidia* in between two rows of coconut palms with three prunings per year (February, June and October) resulted in higher biomass yield of 7.9 t/ha/year. Application of *Glyricidia*

prunings from interspace of one hectare of coconut garden can meet a major portion of nitrogen (90%), as well as part of phosphorus (25%) and potassium (15%) requirement of coconut palm. Growing *Glyricidia* in the interspaces of coconut did not affect the growth characters of coconut.

In the experiment to study the effect of *Glyricidia* green manuring on production of coconut and to find out the possibility of substituting inorganic nitrogen source through *Glyricidia* green manure, it was observed that the treatment, where 50% N was substituted through green manure recorded highest nut yield and it was significantly superior to the treatments like 100% N supplied through chemical fertilizers, and 100% N substituted through green manure. The microbial load was higher in the treatments substituted with green manure. Green manuring had good impact on soil physico-chemical properties such as water holding capacity and bulk density etc., and treatments substituted with green manure recorded higher level of foliar NPK content.

different regions of Kerala State indicated that 70% of farmers in North Kerala region adopted green leaf manuring, while, 65% in Central Kerala region applied green leaf manure, farmers in South Kerala region adopted green leaf manuring comparatively at a lower level (60%). However, *in situ* cultivation of green manure crops and their incorporation in the palm basins is adopted only by a few number of farmers. Farmers in Karnataka, Tamil Nadu and Andhra Pradesh States also apply generously various forms of organic manures.

### Farmers' Perception

Coconut growers have traditionally been aware of the importance of green manuring to sustain productivity of coconut palms. Farmer participatory (On Farm Trials) studies conducted by Central Plantation Crops Research Institute indicated the following positive attributes of *in situ* green manuring in coconut garden viz., effectiveness in enhancing yield, easiness in adoption, providing higher biomass yield and survival during the summer and revival during the subsequent monsoon season. However, farmers were of the opinion that lack of availability of quality green manure seeds was the major constraint in the adoption of this technology.

# 11. VERMICOMPOSTING OF COCONUT PALM WASTES

Coconut palm wastes being very hard, they are decomposed rather slowly and vermicomposting has more relevance. Ligno-cellulosic waste materials from coconut plantation can be converted into brown, non-odorous, granular vermicastings using earthworms. At CPCRI, a local earthworm closely



Vermicompost using coconut leaves

related to the African night crawler (*Eudrilus* sp.) has been isolated and has been found to be effective in vermicomposting of coconut palm wastes. *Eudrilus* sp. can be multiplied in a mixture of cow dung and decayed leaves in 1:1 ratio taken in cement tub, wooden box or plastic bucket with drainage facilities. Worms should be introduced at the rate of 50 numbers per 10 kg of organic wastes. Within 2-3 months, the earthworm multiplies

300 times, which can be used for large scale composting. Organic wastes weathered in rains for 3-4 months can be directly used for vermicomposting. Composting can be done in pits of convenient size, with depth less than 1 metre dug in coconut plantation or in cement tanks. Cow dung may be added to the wastes at the rate of 10% by weight and the heap should be watered and allowed to undergo preliminary decomposition for 1-2

## Economics

**At Research Station:** Vermicomposting is proved to be a low cost-high returns technology. While, the cost of production of vermicompost using coconut leaves as base material and *Eudrilus* species of earth worms is less than Rs. 2/kg, an average market price of Rs. 7/kg is assured for the same. Thus, the farmers would be able to get high returns through the adoption of this technology.

**At Farmers' Fields:** Verification Trials on vermicomposting was taken up in 20 farmers' holdings under the Institution Village Linkage Programme. It was observed that for producing 100 kg vermicompost, the total cost involved was Rs. 170/- and value of vermicompost produced was Rs. 800/-, thus ensuring a net return of Rs. 630/- recording a return per rupee spent value of 3.71.

weeks. Then earthworms may be added at the rate of 1kg per tonne of organic wastes. The bed should be mulched and watered regularly to maintain sufficient moisture and the composting will be over in about 70 days. Watering should be avoided for one week before the removal of compost. Worms will move to deeper moist area and compost can be collected, sieved and dried. The recovery of compost could be as high as 70%. The waste material can be converted into brown, non-odourous, granular vermicastings. From one hectare coconut garden, one could get 4,000 kg of vermicompost from leaves alone. The final product will contain 1.2-1.8% Nitrogen, 0.1-0.2% Phosphorous and 0.2-0.4% Potassium.

The process of composting of organic matter using earthworms is vermicomposting and the end product is known as vermicompost.

The steps involved in vermicomposting are:

- i. multiplication of earthworms,
- ii. preparation of base materials for vermicomposting,
- iii. introduction of earthworm to the base material.
- iv. management of vermicomposting bed.

- v. separation of vermicompost from undecomposed materials.

The management of vermicomposting requires regular watering to keep the bed moist. Direct sunlight is harmful to worms and the bed should be mulched with dry grasses or moist gunny bags.

It takes nearly 60 days to compost most of the materials. Harvesting of vermicompost requires separation of worms (adult and juveniles) and cocoons by sieving from the compost. The granular vermicastings so obtained can be dried and stored for field application.

### **Composting of coir pith**

Coir pith which accumulates as a problematic waste in coir defibering units can be converted to organic manure by composting. Large scale composting of coir pith can be done either by the heap method in a shaded place or in cement tanks. Coir pith obtained from coir processing units are treated with lime (0.5%), urea (0.5%), rock phosphate (0.5%) and legume biomass (*Glyricidia* leaves) or cowdung or compost from previous batch (10%) and moistened. The treated coir pith is sprayed with 1% jaggery solution and mixed with fungal inoculum at 0.2% level, 15 days after the

## **Technology Spread Status**

Vermicomposting technology is becoming popular among the coconut growers in different states. CPCRI could sell 2.00 lakhs of earthworms to farmers for vermicomposting of coconut palm waste through its Agricultural Technology Information Centre Sales Counter in two years.

## **Farmers' Perception**

Coconut growers greatly appreciate the beneficial effects of vermicomposting technology, especially in the present context of lack of availability of sufficient quantity of organic manures. Relative advantages of the technology on vermicomposting of coconut leaves, as perceived by farmers, include; low cost, easy nature of technology, less labour

amendment. Regular watering is done to keep the heap moist. The raw coir pith with a C:N ratio of 108:1 would turn into compost having a C:N ratio 15:1 and high microbial population within a period of 40-50 days. *Marasmiellus troyanus*, an efficient producer of ligninolytic and cellulolytic enzymes, isolated from decomposing coconut waste was effective in composting of coir pith. A local isolate of *Trichoderma* species was also effective to compost coir pith. Microbial enrichment with nitrogen fixing bacteria and phosphate solubilisers enables production of good quality compost with better manurial value.

Coir pith can also be composted using earthworms. Coir pith treated with lime and rock phosphate @ 0.5% each and incubated for three weeks is to be mixed with cow dung @10%, fresh vermicompost @10%. This mixture is to be layered with uncut coconut leaves @20% to facilitate aeration in the bed. The earthworm *Eudrilus* spp. is to be introduced at the rate of 1000 numbers/tonne of organic materials and the bed should be mulched and protected from direct

sun light. Moisture level is to be maintained at 50% by regular irrigation. Earthworms form burrows in the bed and vermicastings appear as surface casts. A granular vermicompost with 1.2% nitrogen and C:N ratio of 16.7:1 can be obtained in two months.

### **Substitution of chemical fertilizers with composted coir pith**

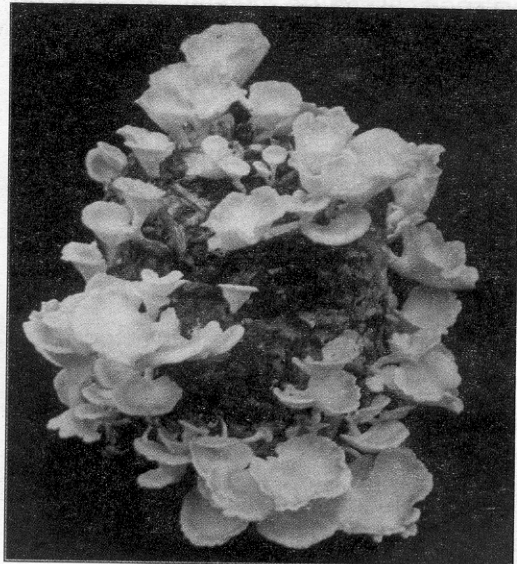
In the experiment on substitution of chemical fertilizers by composted coir pith in coconut, the treatment NPK (50%) + composted coir pith (50%) gave the highest yield of 104 nuts /palm /year followed by the treatment 100% NPK as inorganic fertilizer (82 nuts/palm/year). The lowest yield of 66 nuts/palm/ year was recorded in the control. Foliar analysis for N, P and K did not show significant differences. Organic carbon content of soil at 0-25 cm depth was found to be the highest in the treatment, 50% composted coir pith + 50% NPK. Available K content in the soil at 0-25 cm depth differed significantly and chemical fertilizer recorded significantly higher average K. The highest net returns of Rs. 18,124 /ha was obtained in the treatment NPK (50%) + composted coir pith (50%).

intensive, effectively use of family labour, vast potential to use locally available materials, simplicity and easy to adopt and high degree of observability of the impact of technology as evident from the early visible effects on growth traits of coconut palms due to the application of vermicompost.

However, the problem of higher incidence of ants affecting the survival of the earthworms and also higher incidence of rhinoceros beetle in the nearby coconut gardens were reported in a few areas. *In situ* vermicomposting of coconut leaves in the palm basin is also recommended. But farmers are apprehensive about this recommendation, as they perceive that application of chemical fertilizers in the basin would harm the earth worms.

## 12. MUSHROOM CULTIVATION FOR RECYCLING OF COCONUT WASTE

Research efforts of CPCRI concluded that coconut leaf stalk, bunch waste or a combination of leaflets + bunch waste are better substrates for oyster mushroom cultivation, which give a biological efficiency of conversion of 55-70%. The *Pleurotus* species found suitable for mushroom production on coconut waste were *P. florida*, *P.sajor caju*, *P.flabellatus* and *P.opuntia*. Mushroom produced using the coconut wastes had a protein content of 20-30% on dry weight basis. Low cost mushroom house, built exclusively of coconut materials inside coconut plantations provide ideal conditions for mushroom cultivation. The composted spent substrate has low C:N ratio and had N content of 1.00 to 1.29 % and P content of 0.08 to 0.13% compared to 0.45% N and 0.05% P in untreated substrate. The substrate also contain higher levels of micronutrients such as Fe, Zn, Cu and Mn



Oyster mushroom cultivation using coconut waste when compared to that of the untreated substrate.

### Economics

**At Research Station:** The trials at CPCRI indicate that mushroom cultivation on coconut waste in a profitable enterprise as the cost of production for one kg of mushroom is less than Rs. 18/- and the present market rate is around Rs. 40/kg and there is a good demand for the mushroom in the market.

**At Farmers' Fields:** Verification Trials in 18 farmers fields under Institution Village Linkage Programme indicated that for raising 6 beds of mushroom, farmers were to invest Rs.83/-. They got a total return of Rs. 158/- and net profit of Rs. 75/-, thus recording a value of 1.90 as the return per rupee spent on this venture.

### Technology Spread Status

The technology for mushroom cultivation on coconut waste is being adopted by a few Self Help Groups through the intervention of Krishi Vigyan Kendra at Kasaragod and Kayangulam. However, the spread of this technology in other areas is observed to be less.

### Farmers' Perception

Mushroom cultivation is a simple technique which could be practiced by farm women in their house holds without any additional land requirement utilizing the waste materials available in their coconut gardens. Farmers perceived that easiness in adoption of technology, availability of adequate quantity of farm waste and good yield of mushroom were the positive attributes of this technology.

## 13. COCONUT BASED CROPPING SYSTEMS

Coconut based cropping systems involving cultivation of compatible crops in the interspaces of coconut lead to considerable increase in production and productivity per unit area, by more efficient utilization of precious resources like sunlight, soil, water and labour. It has been estimated that upto 25% of the unit area in a coconut garden is utilized by the coconut, thereby leaving 75% of the area as unexploited. Further, it is estimated that as much as 56 per cent of the sunlight was transmitted through the canopy during the peak hours (10 - 16 hours) in palms aged around 25 years. The diffused sunlight facilitates cultivation of a number of shade tolerant crops in the interspaces. Depending upon the age of the palm, life span of coconut palm could be divided into three distinct phases, from the point of view of intercropping. They are



Coconut Based High Density Multi Species Cropping System

- i. Planting till full development of canopy (below 8 years): Good light transmission initially, but decreasing with age-suitable for growing annuals/biennials.
- ii. Young palms (8 to 25 yrs):

### Economics

**At Research Station:** Research Stations located at different regions of the country have identified ideal coconut based cropping systems suitable to the respective locations with the suggestion that farmers may adapt these models with certain modifications as per the home consumption requirements and market situations. At CPCRI, Kasaragod, High Density Multi Species Cropping System consisting of coconut, pepper, clove, nutmeg, banana, coffee and pineapple could give an annual net return of Rs. 88,000/- (2002-03 prices) as compared to the return obtained from the monocrop of coconut (Rs. 32,000/ha./annum). Summary of results obtained from various inter and mixed cropping trials is presented in the table:

Sl. No.	Crop Combination	Net Income (Rs./ha)
1	Coconut Monocrop	32,000
2	Coconut + Elephat Foot Yam	46,800
3.	Coconut + Ginger	67,500
4.	Coconut + Tapioca	65,700
5	Coconut + Clove	53,120
6	Coconut + Banana	70,470
7	Coconut + Bhendi	50,000

Maximum ground coverage and low canopy - poor light availability - not suitable for multiple cropping and

- iii. Mature trees (more than 25 years): Increase in trunk height; reduction in crown size - light transmission increasing with age - ideal for raising annual and/or perennial crops.

### Intercropping systems

The following crops were found suitable for cultivation under irrigated and rainfed conditions in coconut gardens.

**Tuber crops:** Tapioca, sweet potato, elephant foot yam, colocasia, greater yam and lesser yam.

**Spice crops:** Ginger and turmeric

**Floriculture:** *Heliconia*, *Anthurium*, *Jasminum pubescence* and marigold

**Medicinal and Aromatic Plants:** Long pepper, kacholam, arrow root and patchouli.

**Vegetable crops:** Snake gourd, bottle gourd, amaranthus, coccinia, brinjal and bitter gourd.

**Mixed cropping:** A number of perennials like black pepper, cinnamon, banana, cocoa, clove, nutmeg, coffee, pepper and mulberry can be grown in association with coconut.

**Multistoreyed cropping:** This refers to the cultivation of three or more crops having different morphological characters in the interspaces of coconut so as to intercept solar radiation at different levels and exploit different soil zones. The multistoreyed cropping system was conceived and put to practice at CPCRI in 1970-71. The ideal crop combination in multistoreyed cropping was coconut -black pepper-cocoa-pineapple. However, pineapple could be grown only in the initial 5 or 6 years, until cocoa develops its full canopy.

**High-density multispecies cropping system:** High-density multispecies cropping system (HDMSCS) involve growing a large number of crops, maintaining an optimum

**At Farmers' Fields:** A series of Verification Trials were taken under the Institution Village Linkage Programme on the inter cropping of various crops in adult coconut gardens and the summary table is given below:

Crop	Total returns Rs./ha.	Net returns Rs./ha.
Coconut + Tapioca	107925	77925
Coconut + Ginger	150148	91448
Coconut + Turmeric	70624	39724
Coconut + Elephant foot yam	55625	17625
Coconut + Amaranthus	45500	24300
Coconut + Bhendi	52900	38150

level of plant density for each crop per unit area to meet the diverse needs of the farmer such as food, fuel, timber, fodder and cash. They are ideally suited for smaller units of land and aim at maximum production per unit area of land, time and inputs with no deterioration of land. The salient features of the system are as follows:

- HDMSCS model consists of a large number of crop species with optimum plant density.
- It includes annuals, biennials and perennials.
- The crops selected include cash crops, food crops and fodder crops.
- It includes large, medium and small canopy crops arranged in a

systematic way.

- The soil disturbance should be kept minimum - only slash weeding is done.
- The biomass (other than the economic parts) is recycled within the system.
- The annual crops are removed as the canopy size of perennial crops increases.

A HDMSCS model was established at Kasaragod in 1.2 ha of an 18-year old coconut plantation spaced 8 m x 8 m during 1983 by interplanting 17 additional crops. The crops included in the model were: tapioca, elephant foot yam, colocasia, banana, pineapple, mango, bread fruit, jack,

### Technology Spread Status

Varied levels of adoption were recorded in different coconut growing states as indicated in CPCRI survey of Coconut Community in India (a project sponsored by IPGRI).

Sl. No.	Location of the Community	State	% of farmers adopting inter and mixed cropping
1.	Siula	Orissa	0.00
2.	Mukkamala	Andhra Pradesh	62.00
3.	Batim	Goa	10.00
4.	Kepu	Karnataka	56.00
5.	G. Hosahalli	Karnataka	27.00
6.	Ariyankuppam	Pondicherry	22.00
7.	Kasangad	Tamil Nadu	0.00
8.	Pathiyoor	Kerala	88.00
9.	Edacherry	Kerala	15.00
10.	Pallikkara	Kerala	5.00

nutmeg, clove, sapota, acid lime, guava, pepper, papaya, San Ramon coffee and subabul. The annual crops (except banana) were withdrawn from the system in stages as the perennials grew and utilised more and more space and sunlight. Some perennials like lime, sapota, mango, guava, pepper, papaya and coffee were also withdrawn from the system, as their performance was not satisfactory. Finally, the system comprised of coconut, clove, pineapple and banana. The economics of the system was calculated based on 1999 prices. The net income was maximum with two-third of fertilizers (Rs. 75,375/ha ). The nut yield did not vary between two-third and full dose of fertilizers and it ranged between 147 to 152 nuts/palm/year. The performance of component crops was better under two third and full dose of the fertilizers. Further, biomass recycling in the system has also been taken up and it is expected that the main crop can be maintained at still lower levels of fertilizers.

The studies on removable biomass generated in the system showed that highest removable biomass production was at two-third of the fertilizer level (27.55 t/ha). Among the crops, maximum contribution to the removable biomass to the tune of approximately 85% was from coconut. The annual nutrient export (in terms of harvested produce and removable waste from the system) in case of coconut on per hectare basis ranged from 92.37 to 149.31 kg, 12.94 to 20.79 kg and 119.09 to 183.62 kg of N, P and K respectively whereas it ranged from 5.90 to 11.95 kg, 0.31 to 0.59 kg and 7.56 to 15.72 kg in terms of N, P and K respectively for clove, 3.55 to 16.14 kg, 0.96 to 1.90 kg and 19.03 to 85.65 kg in terms of N, P and K respectively for banana and 2.63 to 5.52 kg, 0.66 to 1.09 kg and 9.73 to 19.74 kg in terms of N, P and K respectively for pineapple under different fertilizer levels. Presently, the system comprises coconut, clove, banana, pineapple, coffee and pepper.

### **Farmers' Perception**

In general, farmers perceived the practice of inter and mixed cropping in coconut garden as necessary for improving the income from the coconut garden and for ensuring the sustainability of the entire farming system. However, the availability of planting materials of improved varieties of the component crops is perceived as a major constraint for adoption of this technology.

In a farmer participatory study conducted in Kerala, the participants identified that the lack of marketing facilities for the multiple produce that may become available from the system as another constraint in the systematic adoption of inter/mixed cropping in coconut garden. Since many of the small and marginal coconut holdings are not properly laid out and optimum plant density could not be maintained, farmers experience difficulty in adopting inter/mixed cropping in a systematic manner. Hence, there is vast scope for restructuring such coconut holdings to enable the adoption of systematic multiple cropping practices. Development departments and extension agencies are thus required to strengthen their activities to assist the small and marginal farmers to adopt systematic inter/mixed cropping.

## 14. MIXED FARMING IN COCONUT GARDEN

Mixed farming in coconut refers to the integration of other enterprises such as dairying, poultry and sericulture with coconut cultivation by raising fodder crops, mulberry etc., in the interspaces. Coconut based mixed farming with dairying involves establishment of pastures in the interspaces of coconut, maintenance of milch animals on the fodder produced and recycling the cattle manure, urine etc to the fodder crops and coconut. Studies have shown that some of the fodder grasses like Hybrid Napier grass (*Pennisetum typhoides* P. *purpureum*), Sudan grass (*Sorghum sudanense*), Guinea



Mixed farming in coconut garden

### Economics

**At Research Station:** Various research stations in the country are able to demonstrate effectively the profitability of management of coconut based farming system for sustainable productivity. Economics of the coconut based farming system being maintained at CPCRI, Kasaragod is presented below:

	Component	Rs./annum
1.	Feed cost	127894
2.	Cost of purchasing birds	6365
3.	Veterinary medicine	4290
4.	Fertilizer cost	9000
5.	Labour cost	20000
6.	Miscellaneous	3500
	Total Variable Cost	171049
	Annuity value	10000
	Total cost	181050

### Output and total receipts from the system

	Component	Output	Receipts (Rs./annum)
1.	Coconut	21830	98235
2.	Milk (in litres)	10850	135618
3.	Broiler birds (in kg)	687	27480
4.	Quail eggs(no.)	2476	990
5.	Fish (kg)	127	3162
6.	Banana (kg)	70	490
	Total receipts		265975

grass (*Panicum maximum*), Setaria, Rhodes grass (*Chloris gayana*) and legumes like lucerne (*Medicago sativa*) and Berseem (*Trifolium alexandrinum*) come up very well in the partially shaded conditions of coconut plantations in humid tropics.

Mixed farming provides additional employment to the tune of 900 man days per ha and ensures good returns without any yield decline in coconut. In the mixed farming in 1.04 ha. coconut garden at Kasaragod, comprising coconut, grass, dairy, poultry, sericulture and pisci-culture, sale of coconut,

milk and broilers accounted for 97% of the revenue generated from the system. The Total Variable Cost involved in maintaining the system was Rs. 1,83,169/-. The net returns obtained were Rs. 73,142/- per annum (Year 2000). About 64 tonnes of cow dung, 53.2 kg silkworm waste and 487 kg of poultry and quail manure obtained from the system were recycled in the coconut and grass plot, thereby improving the soil physico-chemical and biological properties. A total of 30 tonnes of fodder grass obtained from the grass plot was fed to the milch animals.

**At Farmers' Fields:** Field survey conducted in different coconut growing states indicated that the realized net returns from mixed farming varied from Rs. 23,750/ha to Rs. 39,750/ha.

In a farmer participatory survey conducted in Kerala, the participants observed that an unit of 0.4 ha when devoted to intensive integrated farming will absorb full family labour and sustain the livelihood security of the dependent family of 5-6 members. Likewise, an unit of over one ha can provide employment to outside labour as well.

### Technology Spread Status

The extent of adoption of mixed farming in coconut garden varies widely in different regions as indicated in CPCRI survey of Coconut Community in India (a project sponsored by IPGRI).

Sl. No.	Location of the Community	State	% of farmers adopting mixed farming
1.	Siula	Orissa	89
2.	Mukkamala	Andhra Pradesh	35
3.	Batim	Goa	33
4.	Kepu	Karnataka	45
5.	G. Hosahalli	Karnataka	93
6.	Ariyankuppam	Pondicherry	23
7.	Kasangad	Tamil Nadu	87
8.	Pathiyoor	Kerala	53
9.	Edacherry	Kerala	40
10.	Pallikkara	Kerala	63

### Farmers' Perception

The recommendations on mixed farming system in coconut gardens goes in line with the tradition of Indian farmers to include animal husbandry component as an integral part of agriculture. This cultural compatibility ensures fairly higher levels of adoption of this practice. However, constraints like non-availability of family labour, lack of irrigation facilities to grow fodder crops, high cost of labour and less proportion of time being allotted to farming play a major role in reducing the levels of adoption among different coconut communities.

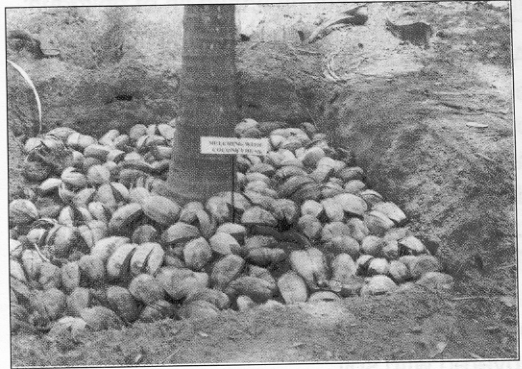
# 15. DROUGHT MANAGEMENT

Drought characterization and soil moisture conservation studies conducted in different agro-climatic zones viz., Western coastal area – hot sub-humid (Kasaragod – Kerala; Ratnagiri – Maharashtra), hot semi-arid (Arisikere – Karnataka) and Eastern coastal plains- hot sub-humid (Veppankulam – Tamil Nadu; Ambajipeta- Andhra Pradesh), which represent the major coconut growing areas in India, indicated the differences in duration, frequency and intensity of drought occurrence in these areas. The experiments indicated that by conserving soil moisture, higher yields can be obtained in rainfed plantations. Several soil moisture conservation practices were tested and recommended based on their suitability depending on soil type, location, raw material availability etc.

## Soil moisture conservation practices

### Basin opening

Coconut basin (1.0 to 1.5 m radius from bole) can be opened to a depth of around 20 to 30 cm. Basin opening can be done from



Mulching with coconut husk for moisture conservation

base or trunk, if sub-surface planting is done and no roots are visible near base or 30 cm away from the base of trunk, if roots are exposed near base of palm. In opened basins, materials like coconut husk or farm waste or green manure or composted coir pith etc., can be placed and covered with soil.

### Husk burial

The coconut husks (half pieces) can be buried in opened basin. Half splits of dry coconut husk should be placed in this trench

## Economics

**At Research Station:** The recently concluded trials under ICAR Cess Fund Scheme on “Drought Management Technologies” conducted at different centres in Andhra Pradesh, Karnataka, Tamil Nadu and Kerala States have conclusively proved the economic benefit of adopting the drought management technologies, the net profit ranging from Rs. 15,000 to Rs. 28,000/ha. Further, these techniques save the life of palms in case of severe drought.

**At Farmers’ Fields:** Adoption of drought management strategies is being given importance in the drought prone states like Karnataka, Tamil Nadu and Andhra Pradesh. The estimated economic benefit of adoption of these technologies is Rs. 12,000 to Rs. 17,300/ha.

## Technology Spread Status

The extent of adoption of various soil and water conservation measures as a part of drought management technology package varied in different regions. The survey in South

with convex side facing up. Husks should be placed closely so as to cover the entire area as a mulch. This can be done in 1 or 2 layers. Husk layers should be covered with soil. About 1000 husk pieces are required per palm for this treatment. This method of conservation is very effective and buried husks can remain intact for 2 to 4 years depending on soil type.

### **Composted coir pith**

Composted coir pith (50 kg/palm) can be buried in the entire area of opened basin and covered with soil.

### **Potassium application**

Potassium can be applied at double the recommended dose as per regular fertilizer application schedule.

### **Burial of farm waste**

Farm waste (fresh and dry material) can be put in opened basin and covered with soil. Material such as leaves and small twigs of *Casuarina*, *Glyricidia*, coconut bunch waste, and other farm waste can be used for burial. This is also a durable treatment. In palm

basins, farmyard manure (25 kg/palm) and *Glyricidia* (25 kg/palm) leaves can be placed as a layer.

### **Surface mulching**

Mulching can be done by placing dried coconut leaves or any other leaf material in entire basin area in 3 to 4 layers. Coconut leaves can be cut into 2 to 3 pieces before used for mulching.

Apart from these, addition of tank silt at 100 to 200 kg/palm basin to improve soil organic matter and water holding capacity will help to reduce the water stress during dry periods.

Further, water management in coconut gardens may include

- i) Bury 2 or 3 earthen pots/hollow bamboos and fill with water (sub-soil moistening).
- ii) Drip irrigation: Drip irrigation is shown to increase not only field Water Use Efficiency (WUE) but also the physiological WUE of plant.

Kerala region indicated that while 38% of the farmers adopted the practice of mulching, 9.6% of the farmers practised husk burial. A study taken at Karnataka State indicated that none of the farmers adopted husk burial practice or other drought management technologies. Another study carried out in Karnataka State indicated that the extent of adoption of husk burial and other moisture conservation practices in coconut gardens was only meagre.

### **Farmers' Perception**

Lack of conviction about the effectiveness of drought management technologies, in conserving soil moisture in coconut basins, as a measure for improving coconut productivity in drought prone areas, is the major constraint affecting coconut gardens. The observability of the impact of soil and moisture conservation measures in general, is less and takes considerable time for visible improvement in the crop performance. Hence, farmer participatory technology transfer programmes with emphasis on demonstrating the feasibility and impact of drought management practices in coconut gardens are to be designed and implemented.

- iii) If adequate water is available, irrigate with 200 litres water/palm once in 4 days and mulch with dry leaves.
- iv) Avoid flooding the basins. If water resources are good, save them for facing prolonged drought.
- v) Effective recycling of used water from backyards.

At large scale, some of the following are desirable to conserve soil and water.

- i) In slopy lands, terracing the palm basins may be undertaken (intercepts run off water and enhance soil moisture conservation),
- ii) Water harvesting devices in mild sloped area to enable water to collect in between rows of coconut.
- iii) Prepare bunds dividing the field into plots to prevent run off water.

These measures would help to increase the ground water table and soil water availability.

Crop management also offers scope to reduce drought impact on crop, mainly by the removal of senescent leaves to reduce transpiration loss. If late rains occur, pulses or fodder crops can be sown in between coconut rows. After harvest, these plant residues can be used as mulches. So also green manure crops can be raised in the plantations.

Drought can be managed by soil moisture conservation practices, which should be imposed just after first spell of monsoon showers. Depending on the availability of material, suitable practice can be adopted

as recommended. It is also advisable to conserve the summer rainfall water in similar way. Apart from this, available water may be supplied to all palms so that yield/palm can be maintained even during drought years.

Coconut hybrids such as Kera Ganga, Chandra Laksha, Kera Sankara and Talls like Chandra Kalpa and West Coast Tall have been identified as relatively drought tolerant. The drought tolerant palms accumulate more organic solutes in the leaf to cope up with the adverse situations and maintain higher harvest index during stress period.

*In situ* drought tolerant palms exhibited higher net photosynthetic rates, instantaneous water use efficiency apart from having more number of leaves in the crown, number of bunches and nuts per bunch compared to other palms in the vicinity.

### **Soil moisture conservation**

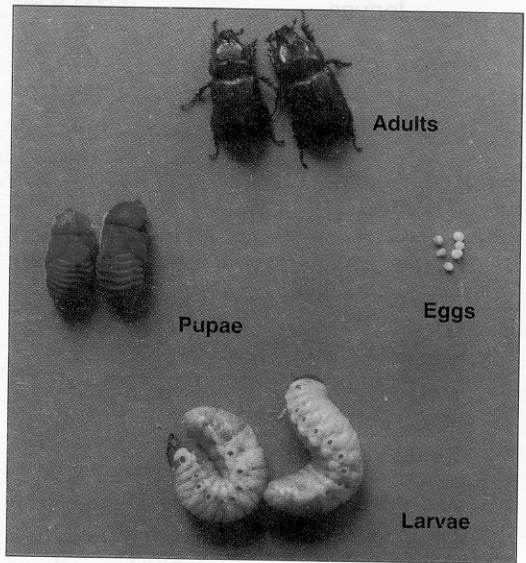
Coconut is mainly grown under rainfed conditions in most coconut growing regions. For reducing surface evaporation and improving water retention under rainfed conditions and to reduce the erosion hazard the various conservation methods described above are suggested.

Soil moisture conservation practices increased the nut yield under rainfed conditions. In a multi location trial, burial of coconut husk in basins gave good soil moisture conservation. Local practices for soil moisture conservation such as application of FYM + *Glyricidia* at Arsikere (Karnataka) and heaping of weeds in the basins of the palms at Ratnagiri (Maharashtra) showed an increase in the nut yield (20-30%) over control.

## 16. INTEGRATED PEST MANAGEMENT- RHINOCEROS BEETLE (*Oryctes rhinoceros*)

Rhinoceros beetle is one of the major insect pests of coconut palm. The adult beetle damages the palm by boring through the unopened spindle, inflorescence and petiole. The damage of spindle, on unfolding, presents the typical 'V' shaped geometric cut pattern. The Integrated Pest Management package for rhinoceros beetle includes:

- i) Extraction of the adult beetles using a beetle hook during the peak period of pest abundance (June-Sept.) from crown of all the palms. Holes to be filled with Dithane M-45 – 3g mixed in 1 kg fine sand.
- ii) Treatment of all possible breeding sites (farm yard manure dump, fallen coconut logs etc.) of the insect with 0.01% Carbaryl (50% WP) on w/w basis.
- iii) Maintenance of sanitation in coconut garden by prompt disposal of decaying organic debris.
- iv) Biological suppression of the pest by releasing 10-15 beetles inoculated with



Life cycle of rhinoceros beetle

*Oryctes virus* in one ha of garden and application of  $5 \times 10^{11}$  spores of *Metarhizium anisopliae* fungus/m<sup>3</sup> in the area of the breeding site of the pest, during monsoon period.

### Economics

**At Research Station:** Incidence level (as per the survey in different parts of the country): 20%

The recent survey conducted by CPCRI at Kollam, Alappuzha and Pathanamthitta Districts in South Kerala region indicated that 36.5% of the coconut palms were affected by rhinoceros beetle.

Extent of yield loss : 6%

Loss per ha due to the pest : Rs. 672/annum

Cost of adoption of management technologies : Rs. 350/ha.

Gain due to adoption : Rs. 322/ha.

Benefit Cost Ratio : 1.92

**At Farmers' Fields:** Verification Trials taken under the Institution Village Linkage Programme indicated that filling the leaf axils with Phorate could reduce the pest damage level from 17.56% to 6.56% while the leaf axil filling with Naphthalene balls could reduce the damage level from 18.86% to 9.31%.

Similarly, the adoption of recommended package of technologies in the 25 ha. demonstration plot being maintained by CPCRI Regional Station, Kayangulam could bring down the pest damage level from 45% to 20% within a period of two years.

- v) Leaf axil filling with Naphthalene balls @ 12 g/palm mixed with sand at 45 days interval.
- vi) Setting up breeding traps using decaying organic debris treated with 0.1% Carbaryl 3-4 times a year.

### **Maintenance and mass multiplication of pathogens of rhinoceros beetle**

The two established microbial pathogens of rhinoceros beetle are *Oryctes* virus and the fungus *Metarhizium anisopliae*. Their maintenance and mass multiplication have been standardized.

### **Technology Spread Status**

Survey conducted in North Kerala region indicated that 34.22% of the farmers adopted the control measures for rhinoceros beetle.

CPCRI survey in Alappuzha District in South Kerala region indicated that all the respondents (100%) were aware of the control measures for the management of rhinoceros beetle viz; leaf axil filling with sand and chemicals. However, only 11% of the farmers were aware of the practice on leaf axil filling with sand and Naphthalene balls. It was further observed that 81% of the respondents were having correct knowledge on the recommendation on leaf axil filling with sand and chemicals, while 2% of the farmers were having correct knowledge on leaf axil filling with sand and Naphthalene balls. Consequently, 36% of the farmers were adopting the practice on leaf axil filling with sand and chemicals as the management practice for the control of rhinoceros beetle, while none of the farmers were adopting leaf axil filling with sand and Naphthalene balls. Similarly, 18% of the respondents were aware of the technology on *Metarhizium* fungi treatment of manure pits and 3% of the respondents were aware of the practice on *Baculovirus* infestation of adult beetles. It was further observed that 3% of the respondents were having correct knowledge on the recommendation of *Metarhizium* fungi treatment of manure pits and none of the farmers were having correct knowledge on the practice of *Baculovirus* infestation of adult beetles. Consequently, none of the farmers were adopting the biocontrol measures recommended for the control of rhinoceros beetle.

### **Farmers' Perception**

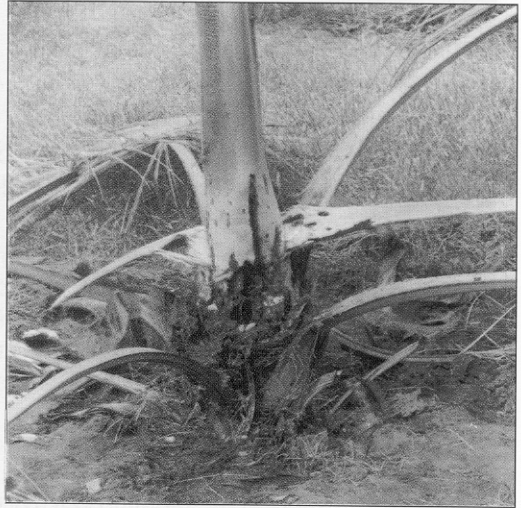
Hooking out beetles from the leaf axils mechanically and destroying them is one of the components of integrated management of rhinoceros beetle, which is traditionally adopted by the coconut farmers. But farmers, now a days, experience difficulty in getting skilled labour for climbing trees and hence adoption of regular crown cleaning and hooking out beetles is on the decline. However, when the availability of palm climbers is ensured, farmers adopt the above practice and also the recommended practice of leaf axil filling with sand and Naphthalene balls. Farmers' perceive that the leaf axil filling method is advantageous as the critical inputs required are easily available and also the method is quite easy to adopt. Though the farmers are convinced about the effectiveness of biological control measures using *Baculovirus* of *Oryctes* and *Metarhizium anisopliae* as an ecofriendly practice for controlling rhinoceros beetle, they experience difficulty in procuring the required cultures of the same and hence the adoption of biological control measures remains low. In view of the easy availability of critical inputs and easiness in adoption, farmers preferred to adopt the practice of leaf axil filling with Naphthalene balls as could be seen by the spread of the technology from IVLP trial plots to the nearby areas. The multiplier effect of the adoption of the leaf axil filling practice against rhinoceros beetle from the IVLP project area to the neighbouring areas is a testimony to the perceived benefits of the recommended technology.

## 17. INTEGRATED PEST MANAGEMENT - RED PALM WEEVIL (*Rhynchophorus ferrugineus*)

Red palm weevil is a serious tissue borer pest of the coconut, capable of causing damage to the crown and bole regions of the palm. Infestation, if undetected, kills the palm outright by toppling the crown. All the stages of the insect are completely hidden inside the palm. The apodous grubs are the damage inflicting stage.

### Integrated Pest Management package for red palm weevil

- i) Cleaning of palm crown periodically to avoid decaying of organic debris, proper cutting, splitting and burning of red palm weevil infested palms.
- ii) Treating of any wound on the palm with coal tar + 1% Carbaryl or 0.1% Endosulfan.
- iii) Treatment of bud rot and leaf rot diseases and rhinoceros beetle with appropriate fungicides and insecticides. While cutting the leaves, 120 cm long
- iv) Prophylactic leaf axil filling with 20 g Phorate 10G in 200 g of fine sand during May, September and December or with 250 g Marotti Oil cake + 200 g of fine



Symptom of attack by red palm weevil

petiole is to be left.

### Economics

**At Research Station:** Incidence level (as per survey) : 5.7% of the palms are infested in the West Coast region of India

CPCRI survey at Kollam, Alappuzha and Pathanamthitta Districts in South Kerala region indicated that 1.0% of the coconut palms only were affected by red palm weevil.

Extent of yield loss - upto 60%

Average loss due to the pest – Rs. 1920/ha.

Cost of adoption of management technologies – Rs. 300/ha.

Gain due to adoption – Rs.1620 / ha.

Benefit Cost Ratio – 6.40

### Technology Spread Status

Though, the red palm weevil infestation causes severe loss, the extent of adoption of recommended control measures is not at a satisfactory level owing to various techno-socio-economic reasons. A survey conducted in North Kerala region indicated that 13.63 per cent of the farmers adopted control measures against red palm weevil.

The recent survey conducted by CPCRI in Alappuzha District in South Kerala region indicated that 32% of the respondents were aware of the identification and management

sand in leaf axils around spindle during same period as above.

v) Curative treatment of infested palms with 0.1% Endosulfan/Dichlorvos or 1% Carbaryl. The chemical can be introduced into the palm by using a funnel inserted into a hole drilled slantingly downward on the stem at about 15 cm above the infested portion. A waiting period of 45 days must be given for harvest, after the chemical application.

vi) Trapping of floating population of the weevil using coconut logs treated with fermented toddy (@ 10 traps/ha) or with mud pots containing sugarcane molasses 2.5 kg or toddy 2.5 lit + acetic acid 5 ml + yeast 5 g + longitudinally split tender coconut stem/logs of green petiole at the rate of 75 numbers/ha. The traps are to be kept in the evening. Trapped weevils must be killed next day morning.

vii) Setting up of pheromone traps was also found to be effective. For this purpose, five litre plastic bucket should be taken.

Four windows (2.5 x 5.0 cm) are to be cut equidistantly just below the upper rim of the bucket. Stick jute cloth (gunny) on the outside of the bucket to provide better grip for the attracted weevils to get into the bucket. Hang the pheromone lure on the inner side of the lid using a metal wire. Provide a food bait of pineapple 100 g or 100 ml of toddy, yeast 2 g or jaggery and carbaryl 5 g mixed in 1 lit. of water in the bucket. Traps are hung on the palms 1-1.5 m above the ground level. Servicing of the traps and replacing it with fresh food bait is to be done once in a week. One trap/ha is recommended and the trap should be shifted from place to place. Placement of the traps on young palms (less than 10 year old) should be avoided.

#### **Pheromone synthesis at CPCRI**

Synthesis of Ferrugineol, the aggregation pheromone used in trapping the red palm weevil has been standardized in CPCRI. This indigenous product is undergoing field evaluation for ascertaining its efficacy in trapping the weevil.

of red palm weevil. It was further observed that only 11% of the respondents were having correct knowledge on the recommended chemicals/root feeding/stem injection for the management of red palm weevil. Consequently, only 8% of the farmers were adopting the recommended management technologies for red palm weevil.

#### **Farmers' Perception**

Studies have shown that, in most cases of red palm weevil infestation, owing to the nature of damage in which the grubs tunnel inside the tree trunk and feed on the palm internally, farmers take note of the pest incidence only at the advanced stages after the palm succumbs to the pest. Hence, it is imperative that efforts are made to fabricate a device for early detection of pest attack by the coconut farmers. Farmers still have certain misconceptions about the pheromone technology recommended against red palm weevil, especially the belief that the infestation will be made more severe by attracting more weevils from the neighbouring gardens, if pheromone traps are placed in their coconut gardens. Further, improper adoption of the pheromone technology also reduces the effectiveness of pest management measures. It is observed that farmers seldom take care to replace the pheromone sachet as per the recommendation. To be effective, utilization of pheromone against red palm weevil requires a community approach, wherein the coconut growers of a locality take organized efforts on a campaign mode for the field implementation of recommended practices.

## 18. INTEGRATED PEST MANAGEMENT- LEAF EATING CATERPILLAR (*Opisina arenosella*)

Leaf eating caterpillar is a major endemic pest of the coconut in certain regions. The larvae of this insect feed on the undersurface of the leaflets within silken galleries resulting in considerable reduction of photosynthetic area.

### Integrated Pest Management for leaf eating caterpillar

The leaf-eating caterpillar can be managed by biological control



Coconut palms infested by leaf eating caterpillar

### Economics

**At Research Station:** Incidence level (as per survey) : Survey in the interior Karnataka region during winter season, recorded 45 per cent infestation by *Opisina arenosella*. In pure and mixed coconut plantations, infestations recorded were 82 and 30 per cent respectively. In another survey, it was recorded that in coastal Karnataka region, infestation by *Opisina arenosella* ranged from 46.7-90.5% during the summer season. In interior Karnataka region, the infestation ranged from 60 to 95 per cent during the winter season.

Extent of yield loss – upto 65%

Loss due to the pest – Rs. 7280 /ha/annum

Cost of adoption of management technologies – Rs. 750/ha

Gain due to adoption – Rs. 6530/ha.

Benefit cost Ratio – 9.70

**At Farmers' Fields:** 94% reduction in pest population was recorded in South Kerala by releasing stage specific parasitoids.

methods. However, an IPM package is to be adopted in an epidemic outbreak. The package includes

- i) Cutting and burning of badly infested outer leaves/leaflets
- ii) Spraying of less toxic insecticides like 0.02% Dichlorvos, if pest is in active

larval stage.

- iii) Release of larval parasitoids *Goniozus nephantidis* @ 20.5%, pre-pupal parasitoids like *Elasmus nephantidis* @ 49.4% and *Brachymeria nosatoi* @ 31.9% respectively at fortnightly intervals depending on the larvae, pre-pupal and pupal population of *Opisina*.

### Mass multiplication of larval parasitoids *Apanteles targamae* and *Goniozus nephantidis*

Particulars	Parasitoid	
	<i>A. targamae</i> (Braconidae)	<i>G. nephantidis</i> (Bethyidae)
Rearing cages	Cylindrical specimen tube glass jar (10x5 cm) mouth covered with cloth	Specimen tube (7.5x2.5 cm) with cotton plug
Host/Range	<i>Opisina</i> or <i>Corcyra</i> larva (second instar) 15-20 Nos. on leafbit with gallery <i>in situ</i>	<i>Opisina</i> or <i>Corcyra</i> larva (4 <sup>th</sup> to 7 <sup>th</sup> instar) 1-2 Nos.
Number of parasitoids to be used	Male and female one each (newly emerged)	One or two mated females (2-3 days old)
Days of adult emergence	10-25	10-14
Progeny	Female biased	Female biased
Remarks	Parasitised larvae to be removed after 12 h to fresh leaflet (for <i>Opisina</i> ) and to 'semolina' (for <i>Corcyra</i> ) feeding and development	Parasitoid stings and paralyzes third instar host larvae, but egg laying occurs from fourth to further instar

### Technology Spread Status

Survey conducted in North Kerala region indicated that 18.75% of the farmers adopted the control measures for leaf eating caterpillar.

### Farmers' Perception

Farmers are convinced about the effectiveness of Integrated Pest Management measures recommended against the leaf eating caterpillar of coconut. However, non-availability of critical inputs in time, improper field implementation of the recommended practices and difficulty for the survival of parasites used in the biological control during summer season are observed to be the factors for the comparatively low extent of adoption of IPM measures recommended against the leaf eating caterpillar.

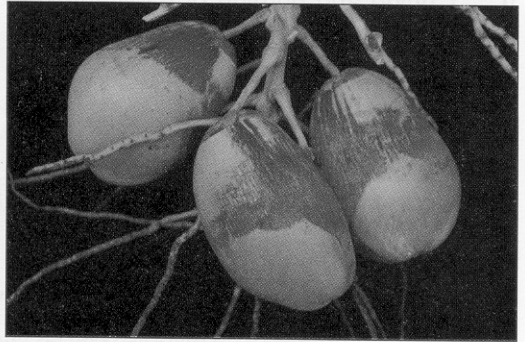
## 19. INTEGRATED PEST MANAGEMENT- ERIOPHYID MITE (*Aceria guerreronis*)

The large scale presence of the Eriophyid mite, acarine pest was detected in 1998 at Ernakulam by CPCRI. The mites are about 250 microns in size; they are harboured on the tender meristematic regions of the nuts underneath the perianth. The mites suck the sap from the tender nuts resulting in the appearance of elongated triangular white patch below the perianth, which in turn becomes pale yellow, then brown with the advancement of the mite infestation. Severe infestation results in poor development of the nuts with reduced kernel weight and poor quality fibre.

### Management of the mite

#### i) Chemical pesticides

Spraying of micronised Wettable Sulphur



Eriophyid mite infestation on coconut

at 0.4% concentration or 0.2% Triazophos or 0.1% of either Endosulfan or Dicofol or 0.05% Carbosulfan has been found to give effective management.

#### ii) Botanical pesticides

Spraying of 2% neem oil, garlic and soap

### Economics

**At Research Station:** Incidence level (as per survey in the affected areas): 30 - 40%

Extent of yield loss: upto 40%

Loss due to the pest : upto Rs. 8960/ha

CPCRI survey at Kollam, Alappuzha and Pathanamthitta Districts in South Kerala region indicated that 81.5% of the coconut palms were affected by eriophyid mite.

Based on another detailed survey in Alappuzha District, the level of incidence of mite in the District was estimated as 82.4% of the bearing palms. Out of the forecasted production of 366.31 million nuts in Alappuzha district, only 164.25 million nuts would be of normal quality. One quarter of the nuts produced (90.25 million) would be severely damaged and have no practical use and another 52.83 million moderately damaged nuts would not have any buyers in the market. The loss in terms of copra was estimated to be 19062 tonnes (30.94%) and loss of husk was 41.74%.

Cost of adoption of management technologies – Rs. 1050/ha

Gain due to adoption – Rs. 7910/ha

Benefit Cost Ratio – 8.53

**At Farmers' Fields:** Frontline Demonstrations on the effect of integrated pest management technology on eriophyid mite management indicated that the recommended technologies could lead to 35% reduction in fresh infestation of eriophyid mite.

mixture or 0.004% Azadirachtin is also good for the mite management.

Preparation of neem oil, garlic and soap mixture

*Ingredients:*

Neem oil	-	20 ml
Cleaned garlic pearls	-	20 g
Washing soap	-	5 g
Water	-	1 lit

Dissolve the soap in 500 ml of water, add neem oil to this solution and mix it well until emulsification. In another 500 ml of water, mix the well ground garlic and add this to the soap-neem oil by sieving through a cloth. Stir the whole contents well. Spray it on the same day.

### iii) Mode of application

The mite colonies are harboured on the inner soft tissues of the developing nuts covered by the perianth. Therefore, pesticide spray should be focussed on the perianth region from the top, so as to provide the maximum possible accessibility to the perianth lobes through capillary action.

The droplet size of the spray should be fine and about 250-500 ml/palm of spray solution is sufficient. Nuts of 2-7 months alone need to be sprayed. Mature bunches should be harvested before the pesticide application. Unpollinated bunches should not be sprayed.

Spraying should be done during April-May, Oct.-Nov. and Dec.-Jan., in such a way that all mite infested palms in an area should be covered at the shortest possible interval.

## Technology Spread Status

Though eriophyid mite has emerged as a major pest of coconut causing considerable economic loss to farmers, the extent of adoption of recommended remedial measures is comparatively low. The recent survey taken by Scientists of the CPCRI Regional Station, Kayangulam indicated that 100% of the respondents were aware of the methods of identification and management of eriophyid mite. It was further observed that 84% of the respondents were having correct knowledge on the recommendation for the management of eriophyid mite. Though, at the time of survey, 84% of the respondents have adopted the recommendations for the management of eriophyid mite (due to the efforts taken by the State Government under the mass spraying programme), it was observed that only 14% of the farmers were adopting the technology during the next season.

## Farmers' Perception

Farmers are convinced about the effectiveness of the eco-friendly botanical pesticides recommended against the eriophyid mite in coconut. However, they experience difficulty in adopting spraying of the same three times a year, due to the lack of availability of skilled labourers for climbing trees, high wage rate for palm climbers and also high cost of insecticides. However, wherever the grama panchayat level Kera Vikasana Samithies (Coconut Development Committees) are actively functioning, spraying campaigns have been effectively organized following a group management approach. Inability of the control measures to prevent the fresh incidence of eriophyid mite in gardens, where the control measures were adopted was the major constraint in the spread of the recommended technologies. Farmers perceived that effective biological control measures alone would be the viable strategy to contain the eriophyid mite damage in coconut gardens, in the long run.

## 20. INTEGRATED PEST MANAGEMENT- OTHER PESTS

### i. White grub (*Leucopholis coneophora*)

White grubs are one of the major pests of coconut palm in the sandy loam tracts of Kerala and Karnataka. The grubs mainly damage the roots of palms and also tunnels into the bole and collar region of seedlings. It results in drying up of the spindle leaf and death of seedlings.



White grub - feeding on coconut root

### Integrated Pest Management strategy

- Deep ploughing and digging of soil during pre and post monsoon period.
- Collection and destruction of adult beetles during peak emergence period in May-June.
- Setting up of the light traps to attract adult beetles and killing them.
- Insecticidal application with Phorate 10G

@ 100 g/palm during May-June and Sept.-Oct.

### ii. Coreid bug (*Paradasynus rostratus*)

Coreid bug is currently emerging as a serious pest problem in association with the eriophyid mite. The adults and nymphs suck the sap from buttons and developing nuts, resulting in nutfall and malformation of the nuts. The coreid bug can be managed by

### Economics

**At Research Station:** CPCRI survey at Kollam, Alappuzha and Pathanamthitta Districts in South Kerala region indicated that 4.75% of the coconut palms affected by coreid bug.

**At Farmers' Fields:** Frontline Demonstrations on the effect of integrated pest management technology indicated that through the adoption of recommended technologies, 57% of the palms recovered from coreid bug infestation.

### Technology Spread Status

Studies showed that the extent of adoption of recommended control measures against other pests of coconut varies with pests and regions. Survey conducted in North Kerala region indicated that the extent of adoption of recommended control measures against white grub was 14.28 per cent and against rodents 39.33 per cent adoption was recorded.

spraying the bunches and leaf axils with 0.1% Carbaryl/Endosulfan. Spraying, if necessary, should be repeated after an interval of 45 days. It should be done during the afternoon with caution as not to fall on inflorescence, which have just opened and on buttons in the receptive stage.

### iii. Rodents

The rodents feed on the contents of tender nuts (3-6 months) by making small holes near the perianth region resulting in nut drop. They also attack the unopened spathes, female flowers and leaf stalks. They also damage the seedlings and eat away the cabbage portion.

### Integrated Management technologies

- a. Farm sanitation – removal of weeds, dried leaves, spathes and other wastes.
- b. Mechanical barriers – banding the trunk with GI sheet 25 to 30 cm wide at a height of 2 m from ground level.
- c. Trapping the rodents with different trapping systems
- d. Placing of single dose anticoagulant like Bromodiolone (0.005%) – 10 g of Bromodiolone wax blocks, 2 times at an

interval of 12 days on the palm crown of one tree out of every 5 trees, can control the arboreal black rat.

- e. For the bandicoots and gerbils, poison baits can be prepared by mixing 95 parts of raw rice, 3 parts of coconut oil and 2 parts of Zinc Phosphide (acute poison) and placed in 'active' burrows. Before putting the Zinc Phosphide laced bait, the rats are to be lured by using plain baits to overcome their bait shyness.

### iv. Termites (*Odontotermes obesus*)

Termites cause serious damage to nursery seedlings by feeding on the husk portion of the nut and collar region resulting in wilting of central shoot. They also cause damage to older palms by feeding on the bark and crown region.

To manage termites in coconut gardens:

- a. Maintenance of adequate soil-moisture is a pre-requisite.
- b. Drenching the nursery with 0.05% Chlorpyrifos twice at 20-25 days interval is recommended.
- c. The trunk can also be swabbed with above chemical.

The recent survey conducted by CPCRI in Alappuzha District in South Kerala region indicated that, while only 12% of the respondents were aware of the methods of identification and management of coreid bug, all the respondents were aware of the identification and management practices for rodents. It was further observed that, while 8% of the farmers were having correct knowledge on the recommendations on the management of coreid bug, all the respondents were possessing correct knowledge on rodent management. However, none of the respondents were adopting the recommended technologies for the management of coreid bug. In contrast, all the (100%) respondents were adopting the technology recommended for the management of rodents.

### Farmers' Perception

Farmers opined that the traditional practice of digging interspace of coconut garden commonly adopted by farmers reduce the incidence of white grub. Similarly, they felt that indigenous rodent control measures are also effective. The farmers are highly appreciative of the recommended practice of putting Bromadiolone cakes in the crown of palms for rodent control as they perceive the technology as simple and easy to adopt.

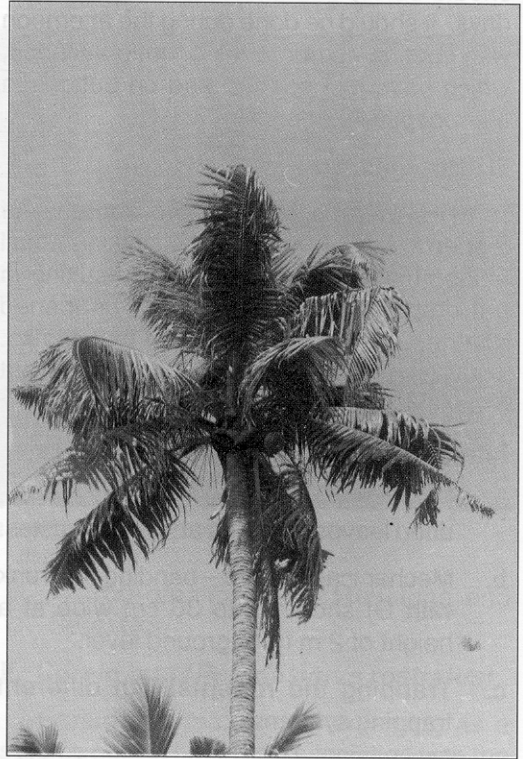
## 21. COCONUT ROOT (WILT) DISEASE MANAGEMENT

The coconut root (wilt) disease is a non-lethal debilitating malady that reduces the production potential of the palm. The disease is caused by *Phytoplasma*. It is prevalent in all the eight southern districts of Kerala. It has also been reported in isolated pockets in northern Districts of Kerala and in Theni and Dindigul Districts of Tamil Nadu and in Goa. The loss is to the tune of 986 million nuts annually in Kerala alone, due to this problem. The root (wilt) diseased palms can be identified by the characteristic bending of the leaflets termed “flaccidity”, along with foliar yellowing and marginal necrosis.

### Coconut root (wilt) disease management -Integrated Approach Technology

#### A. Nutrition Management

- i) Application of organic manures like farm yard manure or green leaves or composted coir pith or vermicompost at the rate of 25 kg/palm during Sept.-



Root (wilt) affected coconut palm

### Economics

Per cent incidence (as per survey in the Southern districts in Kerala State) – 32.3%.

CPCRI survey at Kollam, Alappuzha and Pathanamthitta Districts in South Kerala region indicated that among the root (wilt) affected palms, disease intensity varied widely as indicated below:

Apparently healthy	-	12.50%
Disease early	-	24.75%
Disease middle	-	41.25%
Disease advanced	-	21.05%
Leaf rot affected	-	21.00%
Extent of yield loss	-	upto 50%
Average loss due to the disease	-	Rs. 9280/ha

- Oct. improves the soil health. The manures should be applied by opening a basin to a depth of 30 cm in a radius of 1.8 m from the bole along with the chemical fertilizers.
- ii) Nitrogen, Phosphorus and Potassium is to be supplied to each palm @ 500 g: 300 g: 1000 g through application of 1.1 kg urea, 1.5 kg mussorie rock phosphate, 1.7 kg of muriate of potash and 500 g of MgO in the form of 1 kg MgSO<sub>4</sub> (3 kg of MgSO<sub>4</sub> for Onattukara region). This dosage is to be applied in two splits, 1/3<sup>rd</sup> during April-May and 2/3<sup>rd</sup> during Sept.-Oct. under rainfed condition and in 4 splits during Jan., Apr., July and Oct. under irrigated conditions.
- iii) Palms having boron deficiency should be treated with 300 g borax/seedling and 500 g borax/adult palm in 2 equal splits.
- iv) Growing of green manure crops like cowpea, sunnhemp (*Crotalaria juncea*) or Mimosa (*Mimosa invisa*) or *Calapogonium mucunoides* or *Pueraria phaseoloides* in coconut basin (1.8 m radius) during April-May (after applying first dose of fertilizer) and incorporating the green manure during Sept.-Oct. (at the time of applying second dose of fertilizer) helps in the addition of N rich organic manure. It also acts as cover crop suppressing the weed growth and preventing soil erosion.
- v) Mulching of the basin of the palm with coconut leaves during Oct.-Nov. and retained till April-May helps to conserve soil moisture during the

Cost of adoption of management technologies	–	Rs. 6000/-
Gain due to adoption	–	Rs. 3280/ha.
Benefit Cost Ratio	–	1.55

**At Farmers' Fields:** Adoption of recommended package of technologies in the 25 ha. demonstration plot being maintained by CPCRI Regional Station, Kayangulam could bring down the disease intensity considerably while improving the coconut yield levels as indicated in the Table.

#### Effect of root (wilt) disease management technologies

(Area covered under demonstration: 25.0 ha.)

Parameter	Pre treatment period	After two years of treatment
Disease Intensity (Severe) %	23.5	7.8
Incidence of leaf rot (%)	47.9	1.5
Eriyophid mite infestation (%)	34.3	15.3
Nut yield per palm	25	46
Benefit Cost Ratio	1.02	1.77

summer. Introduction of epigeic earthworms (*Eudrillus* spp.) will effectively convert the coconut leaf mulch to vermicompost.

### **B. Cropping/Farming System**

The interspaces in the coconut field can be effectively used for additional income by growing appropriate inter/mixed crops.

### **C. Water management**

The coconut gardens can be watered through basin irrigation or drip system or by perfo/sprinkler irrigation.

### **D. Quality seedlings**

In root (wilt) disease endemic areas, seednuts collected from high yielding disease escape palms of WCT x CGD should be raised as quality seedlings for future planting. Hybrids like CGD x WCT can also be planted

in diseased area.

### **E. Leaf rot management**

Integrated control measures for leaf rot disease should be adopted as per requirements.

### **F. Pest management**

Management of the major insect/acarine pests by the recommended Integrated Pest Management practices to be adopted.

### **G. Removal of disease advanced palms**

Coconut palms having advanced stage of the disease, yielding less than 10 nuts/palm and diseased palms in the pre-bearing stage should be cut and burnt.

Adoption of integrated approach can improve the yield by 25 to 83% depending upon the severity of the disease.

## **Technology Spread Status**

CPCRI survey in Alappuzha District in South Kerala region indicated that 17% of the farmers were aware of the technologies for the integrated management of root (wilt) disease in coconut. It was further observed that 11% of the farmers were having correct knowledge on this technology. Consequently, only 5% of the farmers were adopting the recommended technologies for the integrated management of root (wilt) disease in coconut.

## **Farmers' Perception**

In view of the easy availability of critical inputs and less difficulty in adoption, farmers felt that the recommended technology could be adopted on a larger scale. However, lack of awareness and lack of conviction about the impact of technologies were the constraints inhibiting the widespread adoption of root (wilt) disease management technologies. Farmers involved in the participatory technology transfer programme organized by the Central Plantation Crops Research Institute Regional Station, Kayangulam are convinced about the feasibility of adopting the integrated management practices in root (wilt) disease affected coconut gardens. Sustained efforts through participatory extension approach coupled with appropriate development programmes, would result in better utilization of root (wilt) disease management technologies for sustainable production of coconut.

## 22. LEAF ROT DISEASE MANAGEMENT

Leaf rot disease in coconut is caused by many fungal pathogens, chiefly *Colletotrichum gloeosporioides*, *Exserohilum rostratum* and *Fusarium solani*. This foliar disease gets superimposed in 65% of root (wilt) affected palms. The symptoms are seen as presence of tiny spots of various shapes and shades of different colours on the soft white leaflets of the unopened spindle, which enlarge and coalesce to cause extensive rotting. The distal end of the leaves are generally diseased severely. The disease results in reduction in photosynthesis and subsequent loss in yield.

### Integrated Leaf Rot Disease Management

- i. Cutting the rotten portions of the spindle and the adjacent two innermost fully opened leaves.
- ii. Pouring either Contaf-5EC 2 ml or



Coconut palm affected by leaf rot disease

### Economics

**At Research Station:** Per cent incidence in South Kerala region (as per survey) – 30%

The recent survey conducted by CPCRI at Kollam, Alappuzha and Pathanamthitta Districts in South Kerala region indicated that 21% of the coconut palms were affected by leaf rot disease.

Extent of yield loss: upto 60%

**At Farmers' Fields:** Frontline Demonstrations on the effect of leaf rot disease management technologies indicated that the recommended technologies could lead to 60% reduction in leaf rot disease incidence.

### Technology Spread Status

CPCRI survey in Alappuzha District in South Kerala region indicated that 23% of the farmers were aware of the chemical control method of leaf rot management and 18% of the farmers were aware of the correct time of application. However, only 5% of the farmers were having correct knowledge on the recommended technologies for the leaf rot disease management leading to only 5% adoption of the recommended technologies.

- Dithane M-45/Indofil M-45 3 g dissolved in 300 ml of water in the cavity around the base of the spindle leaf.
- iii. Application of Furadan 3G 30 g or Folidol Dust (Methyl Parathion) 50 g or Marotti/Neem oil cake 100 g mixed in 200 g sand around the base of the spindle leaf.
  - iv. Treatment of all the palms to be carried out twice in a year during April-May and Oct.-Nov.
  - v. The cost of Contaf pouring comes to Rs. 8.00/palm when carried out along with harvesting and for Dithane M-45/Indofil M-45, it is Rs.7.50 per application.



Removal of rotten portion in the crown region

## Farmers' Perception

Farmers are convinced about the effectiveness of the recommended practices for leaf rot disease control in coconut. The visible improvement due to the adoption of recommended practices (as manifested by the healthy leaves in the crown in place of rotten leaves) has been so prominent that the technology is gradually being accepted by the coconut growers in the root (wilt) disease track in South Kerala. The demonstration programmes conducted by CPCRI both inside campus as well as in farmers' fields have been quite successful in proving the feasibility of the leaf rot disease management technologies.

## 23. BUD ROT DISEASE MANAGEMENT

The disease is caused by *Phytophthora palmivora*. The first visible symptom of the disease is withering of the spindle, as a result of which it turns first pale and then brown and droops down. Subsequently, one or two young leaves surrounding the spindle also show similar symptom. Rotting of soft tissues of crown sets in and emits foul odour. Subsequently, inner leaves fall away and spindle dies.

### Management of bud rot

- i. Palms in the advanced stage of the disease should be cut and burnt.
- ii. As a prophylactic measure, all the healthy palms surrounding the diseased one should be sprayed with 1% Bordeaux mixture on the spindle and the base of 2-3 innermost leaves.



Bud rot affected coconut palm

### Economics

**At Research Station:** Level of incidence (as per survey) – 0.1 to 6.5%

Extent of yield loss – upto 100% at advanced stage

Average loss due to the disease in endemic areas – Rs. 3840/ha

Cost of adoption of management technologies – Rs. 250/ha

Gain due to adoption – Rs. 3590/ha

Benefit Cost Ratio – 15.36

### Technology Spread Status

A survey conducted in Kannur District in North Kerala region indicated that 42.85% of farmers adopted some of the recommended control measures against bud rot disease in coconut. But another study on farmers' receptivity to recommended practices of coconut

- ii. Root feeding and stem injection of Akomin (16.8 ml) and Calixin (21 ml) is effective in protecting the palms for a period of 8 weeks.
- iv. In the early stage of disease incidence, application of 10% Bordeaux paste on affected portion can check the disease. Bordeaux paste should be applied after thorough cleaning and removal of infected material. The treated portion should be covered with polythene sheet or mud pot.
- v. Regular spraying with copper fungicides at 40 days interval especially before and after monsoon is an effective preventive measure.
- vi. Perforated sachets containing Dithane M-45 should be kept in leaf axils of copper sensitive palms during rainy season.

### **Preparation of 1% Bordeaux mixture**

Dissolve 1 kg of powdered copper sulphate crystals in 50 litres of water. In another 50 litres of water, prepare milk of lime with 1 kg of quick lime. Pour the copper sulphate solution into the milk of lime slowly, stirring the mixture all the while. Test the mixture before use for the presence of free copper, which is harmful to the palms, by dipping a polished knife in it. If the blade shows a reddish colour, add more lime till the blade is not stained on dipping. Always use plastic, cement, earthen or copper vessels for the preparation of Bordeaux mixture.

### **Bordeaux paste preparation**

Dissolve 100 g of copper sulphate and 100 g of quick lime each in 500 ml of water separately. Mix together to make one litre of Bordeaux paste 10%.

cultivation revealed that the extent of adoption of bud rot disease management was 2.5 per cent in Northern Kerala region, 7.1 per cent in Central Kerala region and 3.0 per cent in South Kerala region.

### **Farmers' Perception**

Farmers are convinced about the effectiveness of the control measures suggested against bud rot disease in coconut. They perceive that, whenever early detection of the disease incidence could be made, the control measures were very effective. But, when the farmers take note of the yellowing of leaves and falling of spindle in the advanced stages, recovery of the palm was difficult. Hence educational programmes to motivate coconut farmers for adopting regular monitoring of coconut palms for disease incidence as well as prophylactic measures including phyto-sanitary measures, are to be organized for the effective field implementation of bud rot disease management practices.

## 24. STEM BLEEDING DISEASE OF COCONUT

The stem bleeding disease is caused by *Thielaviopsis paradoxa* and is characterized by dark brown patches at the base of the trunk of the palm which grow into longitudinal irregular streaks with dark reddish brown liquid exuding from them. Streaks coalesce to form larger patches and bark tissues decay. Leaves of outer whorl in the crown show premature yellowing followed by drooping and drying.

### Stem bleeding disease management

- i. Avoid wounding of coconut palm trunk.
- ii. Provide regular basin irrigation during summer month.
- iii. Apply neem cake @ 5 kg/palm/year in the basin during Sept.-Oct.
- iv. Root feeding of 5% Calixin or 5% Bavistin at quarterly intervals is effective in initial stage of the disease.



Stem bleeding disease of coconut

### Economics

**At Research Station:** Per cent incidence (as per survey) – upto 10% in parts of Kerala

Extent of yield loss – upto 30%

Average loss due to the disease in endemic areas – Rs. 1728/ha

Cost of adoption of management technologies – Rs. 1000/ha

Gain due to adoption – Rs. 728/ha

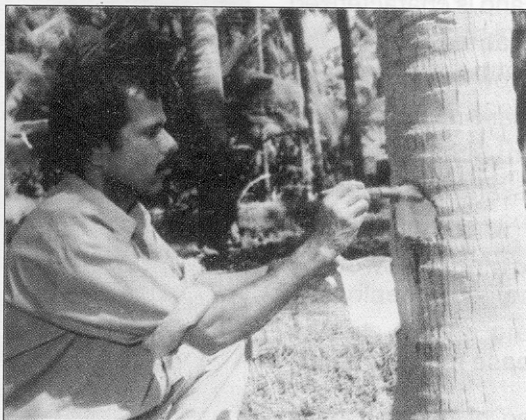
Benefit Cost Ratio – 1.73

### Technology Spread Status

A study on the utilization of coconut production technologies by farmers conducted in

- v. The affected bark should be chipped off till the healthy tissue is exposed and painted with 5% Calixin (5 ml Calixin in 95 ml water). The painted

wound should be left to dry for one day and then covered with hot coal tar to prevent further infection by the fungus.



Treatment with calyxin in the chiselled area

Kannur District in North Kerala region indicated that 29.59 per cent of farmers adopted the recommended technologies for stem bleeding disease in coconut. But another survey conducted by CPCRI recently has shown that the extent of adoption of control measures for stem bleeding disease in different regions in Kerala State is only meagre (1.01 per cent in North Kerala region, 0% in Central Kerala and South Kerala regions).

CPCRI survey in Alappuzha District in South Kerala region indicated that 12% of the respondents were aware of the stem bleeding disease management technology, while only 9% of the farmers were having correct knowledge on the stem bleeding disease management package. However, 12% of the respondents were adopting the recommended technology (partially or fully) for the management of stem bleeding disease in coconut.

### Farmers' Perception

The experience of CPCRI in organizing On Farm Trials on the control of stem bleeding disease in coconut has indicated that farmers perceived the recommended technologies as effective. The positive attributes of the recommended control measures as perceived by the farmers were; easiness in adoption, easy availability of critical inputs required and lesser cost of application. They also felt that the control measures would be more effective when the disease index is low to medium. In the advanced stages, the treatments do not yield results to the desired level. Hence, intensive educational efforts are required to motivate farmers for the timely adoption of the integrated management practices against stem bleeding disease in coconut.

## 25. INTEGRATED DISEASE MANAGEMENT- OTHER DISEASES

### i. Crown choking disorder

Boron is an essential micronutrient and its deficiency causes malformations of leaves and nuts in coconut leading to stunted growth and also low productivity. This is also known as Crown choking disorder.

#### Management strategies

- In palms upto 5 years of age, apply 300 g borax or Sodium Tetraborate per palm per year in two split doses of 150 g each at 3 months interval.
- In adult palms, apply 500 g borax per palm per year in two equal split doses.
- In summer, irrigate the palms after borax application.
- Stop borax application once the palm recovered.

### ii. Immature nutfall of coconut

This disease is caused by fungus *Lasiodiplodia theobromae*. In this disease, dark grey to brown lesions with undulating margins appear on the apex region of the nuts and progressively cover the entire nut. The affected nuts are desiccated, shrunk and deformed. In some cases, nuts split and the contents leak. This disease can be controlled by spraying 1% Bordeaux mixture or 0.3% Dithane M-45 on nuts. Unpollinated buttons are to be avoided.



Crown choke symptom in coconut

### iii. Basal stem rot of coconut

The disease is also called as 'Ganoderma wilt'/'Anabe Roga'/'Thanjavur wilt'. *Ganoderma lucidum* and *G. aplanatum* are involved in the disease. In this disease, outer whorl of leaves turn brown and droop to form a skirt around the trunk apex, which shows tapering in later stages. Bleeding symptoms appear on base of the stem, where the inside tissue decays. In the advanced disease condition, fruiting bodies appear at the base of the palm.

An early detection technology based on immunofluorescence microscopy has been developed.

### Economics

CPCRI survey at Kollam, Alappuzha and Pathanamthitta Districts in South Kerala region indicated that 4.75% of the palms are showing the Boron deficiency symptom.

### Technology Spread Status

The recent survey conducted by the Scientists of CPCRI Regional Station, Kayangulam covering the coconut farmers in Alappuzha district in South Kerala region revealed that subject to the incidence of the disease, the rate of adoption of this technology is very low.

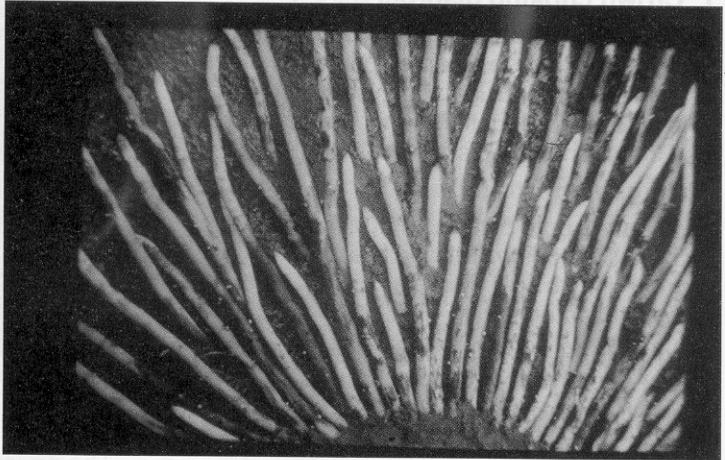
### Farmers' Perception

Farmers perceived that the remedial measures recommended against boron deficiency induced crown choke disease in coconut are very effective. They felt that the technology recommended is very simple, easy to adopt, involve low cost and the impact of adoption is easily observable and comparatively quick. Farmers' experience difficulty in adopting those disease management technologies, which involve treatment of crown portion of palms due to the lack of availability of skilled palm climbers and their high wage rate.

## 26. NEMATODE MANAGEMENT

### Burrowing nematode (*Radopholus similis*)

The burrowing nematode infests coconut particularly the seedlings. The infested palms exhibit general decline symptoms like yellowing, button shedding, reduction in leaf size and yield. *R. similis* infestation on root produces isolated elongate orange-coloured lesions on tender and semi-hard roots. These lesions further coalesce to cause extensive rotting of roots.



Root lesions due to nematode attack

### Management technologies

#### Cultural practices

Application of oil cake, farm yard manure and growing of sunnhemp in the coconut basin and interspaces, incorporation of green manure, inhibits nematode multiplication.

#### Chemical control

- i) Dipping coconut seedlings in 100 ppm DBCP for 15 minutes ensures nematode-free coconut seedlings.
- ii) Soil application of Phenamiphos or Phorate @ 25 kg ai/ha during Sept., Dec. and May completely eliminates *R. similis* in coconut nurseries.

- iii) Application of Phorate @ 10 g ai/palm in June-July and in Oct.-Nov. increases the yield by 30% in *R. similis* infested palms.

#### Agronomic practices

- i) Avoid growing banana as shade crop in coconut nurseries.
- ii) Cultivation of less susceptible/tolerant cultivars of coconut like Kenthali and Klappawangi dwarfs and hybrids like Java Giant x Kulasekharam Dwarf Yellow and Java x Malayan Dwarf Yellow.

### Technology Spread Status

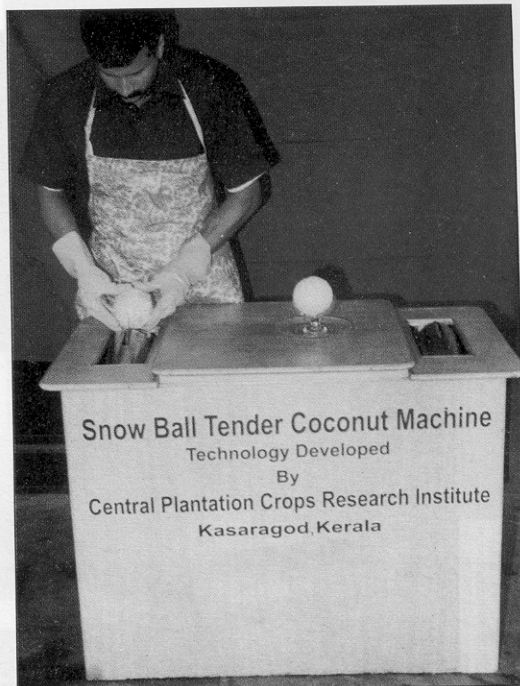
Studies conducted in different regions in Kerala State indicated that none of the coconut growers adopt any of the specific nematode management practices.

### Farmers' Perception

Absence of specific and observable symptoms of nematode incidence and lack of conviction about the effectiveness of management measures were the major constraints affecting the adoption of nematode management practices.

## 27. SNOW BALL TENDER NUT

At CPCRI, a technology for making Snow Ball Tender Nut (SBTN) has been developed. SBTN is the tender coconut without husk, shell and testa, which is in ball shape and white in colour. This white ball will contain tender coconut water, which can be consumed by just inserting a straw through the top white tender coconut kernel. In this process, coconut of 8 month maturity is more suitable for making SBTN. Making groove in the shell before scooping out the tender kernel with water is the one of the important unit operations. For this, a suitable machine has been developed. After making the groove, the globular kernel without breakage can be scooped out by using a special knife. The machine for extracting SBTN costs Rs. 22,500/- and by avoiding the side and top cover of the machine and the additional frame support, the cost of the machine can be further reduced to Rs. 12,000/-. The



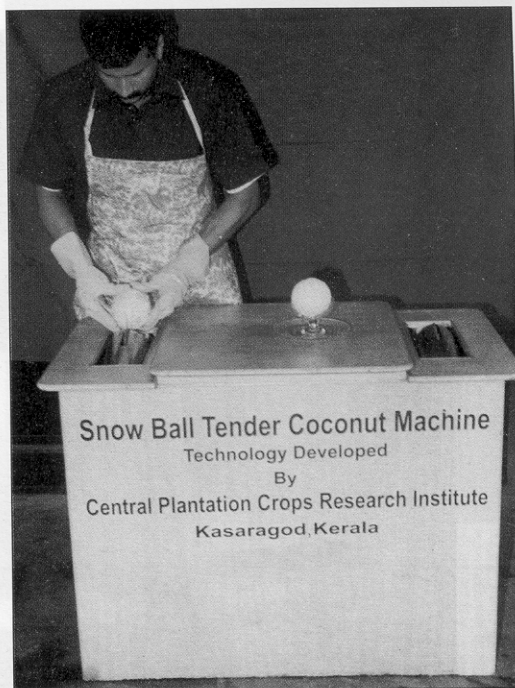
Snow Ball Tender Coconut Machine

### Economics

• Capacity/day	-	500 Tender Nuts
• Land requirement	-	50 sq.m.
• Cost of building	-	Rs. 0.25 lakh
• Cost of machinery	-	Rs. 0.25 lakh
• Working capital	-	Rs. 0.10 lakh
• Sales turn over/annum	-	Rs. 7.50 lakh
• Net profit/annum	-	Rs. 1.50 lakh
• Return on investment	-	40%
• Technology available with	-	CPCRI, Kasaragod

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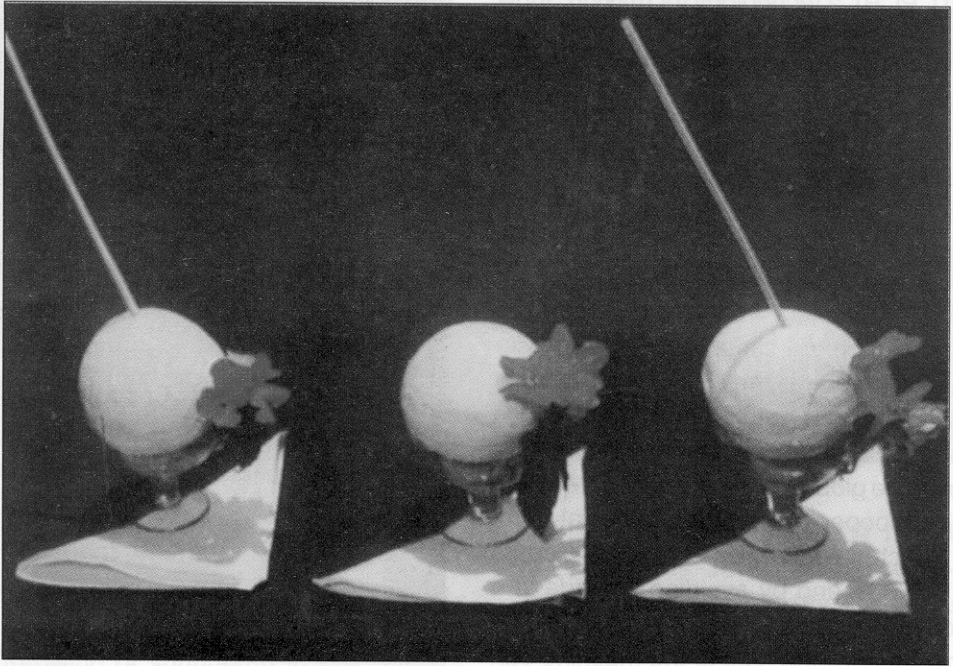
Snow Ball Tender Coconut Machine

### Economics

- |                             |   |                  |
|-----------------------------|---|------------------|
| ● Capacity/day              | - | 500 Tender Nuts  |
| ● Land requirement          | - | 50 sq.m.         |
| ● Cost of building          | - | Rs. 0.25 lakh    |
| ● Cost of machinery         | - | Rs. 0.25 lakh    |
| ● Working capital           | - | Rs. 0.10 lakh    |
| ● Sales turn over/annum     | - | Rs. 7.50 lakh    |
| ● Net profit/annum          | - | Rs. 1.50 lakh    |
| ● Return on investment      | - | 40%              |
| ● Technology available with | - | CPCRI, Kasaragod |

SBTN can be packed in LDPE film of 200 G and stored for 15 days at about 15° C and

one day at ambient temperature without affecting the quality.



Snow Ball Tender Nut

### **Technology Spread Status**

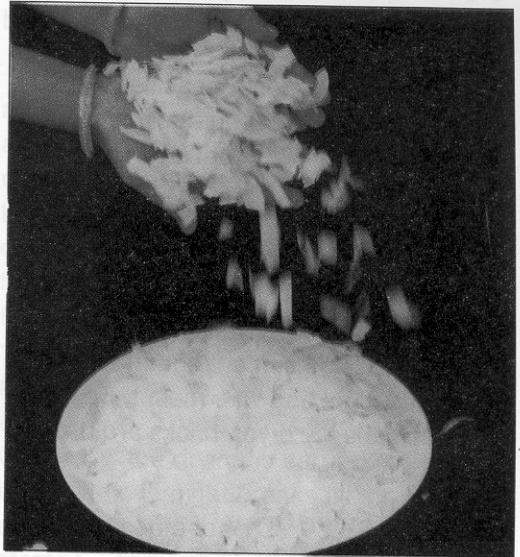
The SBTN machine is available for sales at the Agricultural Technology Information Centre of CPCRI, Kasaragod. A few units have already been supplied to entrepreneurs from Kerala, Maharashtra, Pondicherry and Karnataka States as well as Lakshadweep Islands. The Coconut Growers Association in Ariyankuppam village near Pondicherry Town is producing Snow Ball Tender Nut on a commercial basis and market them with a special stall available in the town. Instead of the farm gate tendernut price of Rs. 3.50 per nut, the farmers are able to sell the Snow Ball Tender Nut for Rs. 12 per nut.

### **Users Reaction**

The consumer response studies on the acceptance of Snow Ball Tender Nut indicated the highly encouraging market potential available for the product. The Lakshadweep Administration is proposing to introduce the Snow Ball Tender Nut as the "Welcome Drink" for the tourists visiting the Islands instead of providing bottled aerated cool drinks. A few users of the technology expressed the opinion that, if the technology is further refined with greater scope for longer periods of storage, it would be a boon to the coconut community.

## 28. COCONUT CHIPS

Coconut kernel with intermediate moisture is obtained from the mature coconut kernel after removing the moisture content of the kernel partially by osmotic dehydration by using osmotic medium like sugar syrup. This osmotically dehydrated coconut slice is named as "Sweet Coconut Chips". A technology for the production of sweet coconut chips has been developed at CPCRI. Sweet Coconut Chips is crispy and can be packed and marketed in laminated aluminium pouches, which will ensure a shelf life of 6 months. Since it is in ready-to-eat form, it could be used as snack at any time. Process for the production of coconut chips with different flavours, medicated, spicy as well as instant coconut chips by microwave oven has also been standardized.



Coconut chips

### Economics

Capacity/day	-	225 kg (1500 coconut)
Land requirement	-	200 sq. m.
Cost of building	-	Rs. 1.50 lakh (60 sq. m.)
Cost of machinery	-	Rs. 0.75 lakh
Pre operative expenses	-	Rs. 0.50 lakh
Contingencies	-	Rs. 0.10 lakh
Working capital	-	Rs. 1.00 lakh
Sales turn over/annum	-	Rs. 50.00 lakh
Net profit/annum	-	Rs. 6.00 lakh
Return on investment	-	50%
Technology available with	-	CPCRI, Kasaragod

### Technology Spread Status

A number of Self Help Groups and entrepreneurs in Kerala, Tamil Nadu, Pondicherry and Karnataka states have already started producing coconut chips on a commercial scale and market the products under various brand names. The technology is made available by CPCRI at a nominal cost of Rs. 1000/- as the Technology Fee. Necessary institutional training is provided by the scientists of CPCRI for the entrepreneurs as well as the members of the Self Help Groups and further guidance at the project site is offered on consultancy basis.

### Users Reaction

Consumer preference studies were conducted at Kerala, Karnataka, Tamil Nadu, Pondicherry, Delhi and Rajasthan states. The results indicated that the consumers preferred coconut chips as a supplement/substitute for other similar items like potato chips and Tapioca chips. Entrepreneurs who are running the chips production units expressed the opinion that the technology could give good returns to the investment made on the venture.

## 29. SMALL HOLDERS COPRA DRYER

### Description

The dryers of various capacities viz., 100, 400, 1000 and 3000 coconuts per batch using agricultural waste as fuel are available. These dryers comprise of (a) drying chamber (b) plenum chamber (c) burning-cum-heat exchange unit and (d) chimney with regulators. These dryers are constructed from locally available materials such as asbestos cement sheet, GI sheet, MS angles, flats and wire mesh. For 3000 coconuts capacity dryer, bricks are used to construct sidewalls.

### Operation of the Dryer

The produce to be dried is kept in the drying chamber. As the fuel is burnt in the burning chamber, the flue gases heat the GI



Small holders copra dryer

### Economics

**At Farmers' level:** Verification Trials conducted under the Institution Village Linkage Programme indicated that the copra dryer could be used profitably in the rural areas of North Kerala region. The data recorded on economic indicators are as follows.

Sl. No.	Particulars	Conventional method	Copra Dryer
1.	Cost of coconut (400 nos.) @ Rs. 5.50/nut	2200	2200
2.	Total labour charges (dehusking, breaking, removing shell, cleaning of copra after complete drying)	223	88
3.	Total cost (Rs.)	2423	2288
4.	Returns from sale of copra (Rs.)	2370 (79 kg @ Rs. 30/ kg)	2560 (80 kg @ Rs. 32/kg)
5.	Returns from sale of shell and husk (Rs.)	120	60
6.	Total Returns (Rs.)	2490	2620
7.	Total Profit (Rs.)	67	332
8.	Returns per rupee spent	1.02	1.15

sheet surface by conduction. The heat from GI sheet is transferred by radiation and convection to the surrounding fresh air entering from the bottom, generating a convection air current. The hot air moves up through the wet produce in the drying chamber and the hot air laden with moisture escapes through the top of the drying chamber. A dial thermometer fixed just below the drying platform will help to monitor the drying air temperature.

The split cups are loaded into the drying chamber. The first two or three bottom layers are kept with cups facing up and the rest of the cups are kept facing down in brick fashion. The fuel comprising both husk and shell is kept in the weldmesh tray and fired. The tray is kept in the centre of the cylinder and the damper is closed. Fuel is fed as

and when required to keep the fire burning. The drying air temperature is kept at 70°C by adjusting the valves in the chimney.

After 8-10 hrs. of drying, the shells are removed. The drying may be continued after a few hours of tempering, as the migration of internal moisture to the surface of the kernel is slower. The cups, from which shell could not be removed, are kept at bottom layers facing upwards and the kernels freed from shells are kept over that. At the end of 15 hrs, shells from all the cups could be removed. The copra cups are to be raked every two hours for uniform drying. Generally, the drying is carried out for four days with overnight breaks till the moisture content of copra reaches 6 per cent for safe storage. The actual, time taken for drying will be about 36 hrs.

### Performance of the dryers

Dryer type	Capacity (No. of nuts)	Drying time (Hr.)	Source of heat energy	Quantity of fuel (kg)	Cost of dryer (Rs.)	Drying cost (Rs. / nut)	Drying cost (Rs. / kg of copra)
Mini size	100	34-36	Coconut husk	16	2900	1.20	7.60
Small size	400	34-36	Coconut husk	28	6000	0.97	6.05
Medium size	1000	34-36	Coconut husk	110	12500	0.66	4.15
Large size	3000	34-36	Coconut husk	250	20000	0.49	3.05
Smoke free dryer	1000	24	Coconut shell	70	12000	0.39	2.42

### Farmers' Reaction

Under the Institution Village Linkage Programme of CPCRI, farmers' reaction on the use of copra dryer was assessed through Matrix Scoring Procedure and the results are as follows.

## Advantages

- Any dry agricultural waste material can be used as fuel.
- Controlled combustion ensures economic use of fuel.
- The dryer is versatile as the produce of many of the plantation crops like coconut, arecanut, cardamom, cocoa and pepper can be dried.
- It is useful during the monsoon season when sun drying is not possible.
- Quality of dried produce is good, as smoke does not come in contact with the produce
- Temperature control ensures uniform and perfect drying
- It is simple in design and safe to operate
- It requires only 2 m<sup>2</sup> area for housing and a temporary shed of 4 m x 4 m area is sufficient for keeping the dryer (400 nuts capacity dryer)
- It is portable (except large capacity dryer) - to move short distances, three to four persons can lift and transport the dryer
- It can be fabricated locally.

Sl. No.	Characters/Items	Scores	
		Conventional method	Copra Dryer
1.	Better copra quality	5	10
2.	Higher value for copra in local market	5	10
3.	Easy marketability of copra	5	10
4.	Less time taken for drying coconut	4	10
5.	Less skill required for use of method	10	6
6.	More easy to use method	5	10
7.	Low risk and injury hazard	10	5
8.	Higher need for repair and maintenance	0	10
9.	Less drudgery involved	4	10
10.	More scope of use in local households	10	7

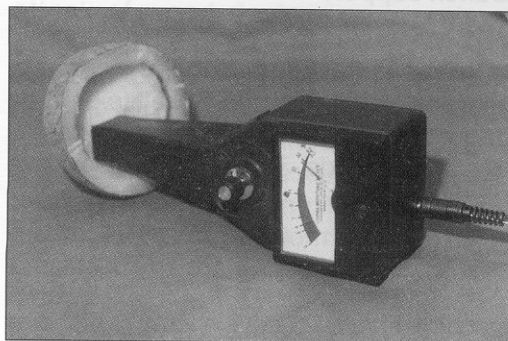
With the increasing consumer preference for good quality products, it is expected that the demand for copra dryers would go up considerably for ensuring the production of good quality coconut oil.

## 30. COPRA MOISTURE METER

The copra is graded in the order of its market value. The grading is mainly based on moisture content, the foreign matter and black copra. The maximum limits for them are 10 per cent, 2 per cent and 5 per cent respectively. However, the good quality copra should have the following requirements:

Moisture	:	6 per cent
Oil content	:	71 per cent
Acid value	:	2.5 per cent
Foreign matter	:	0.5 per cent
Mouldy cups	:	5 per cent
Wrinkled cup	:	5 per cent (free)
Black copra	:	1 per cent (free)

A copra moisture meter has been developed to determine both rapidly and



Copra Moisture Meter

accurately moisture content of copra. The equipment is based on the principle of electrical conductivity. It can read moisture content between 5% and 40%. The instrument is handy and useful to the copra processors and copra marketing societies.

### Economics

**At Research Station:** The instrument has been fabricated at CPCRI, Kasaragod based on a series of trials and modifications and the user survey indicated that the unit could be used profitably for ensuring good quality copra production.

### Technology Spread Status

The technology has been transferred to Kerala State Industries Development Cooperation who is manufacturing the instrument on a commercial scale. They could market a total number of 450 units so far and the buyers are mainly cooperative societies and Whole-sale marchants who are involved in copra trade.

### Users Reaction

The instrument is handy, accurate and cost effective in determining the quality of copra, thus helping in the production of good quality copra after ensuring the required level of drying. It is to be noted that the instrument helps the copra producers from under drying or over drying, thus leading to better profit.

## 31. OTHER PRE AND POST HARVEST TECHNOLOGIES

### Bunch support

Coconut bunch support was developed to prevent buckling of heavy coconut bunches. It consists of a GI belt to be fixed on the trunk and telescopic supports having GI pipes and rods. The cost of the device is Rs. 150/-.

### Dehusker

A manually operated coconut-husking machine has been developed. The device can be easily operated by any unskilled person. It requires less effort to dehusk the coconut using this device when compared with the conventional method. It can be fabricated locally. It is simple in design and safe to operate. The out turn of this machine is 110 nuts/hr.

### Semi Automatic Dehusker

A power operated semi automatic coconut dehusking machine has also been developed. The machine can dehusk 600 nuts/hour much higher than the traditional spike method. Two unskilled labourers are required to operate this machine. It is economical and financially beneficial to farmers and copra manufacturers. The time required to dehusk one nut is six seconds.

### Ball copra preparation

The conventional method of preparing ball copra is by storing the fully matured coconuts on a raised platform inside a shed or attic for a period of nine to twelve months.



Coconut bunch support

In order to reduce this incubation period to the minimum, a new processing method was developed. Coconut is partially dehusked and heated in the CPCRI Small holders copra dryer at 55 - 60°C for eight hours daily for three days and stored in gunny bags for 10 days. This intermittent heating was repeated till all the nuts became ball copra. All the nuts under heat treatment became ball copra within six months and the quality of the ball copra was also very good.

### Copra storage

The caterpillar of Almond moth, Ham beetle, Saw Toothed Grain beetle, Foreign Grain Beetle and Coffee Berry Borer are common pests infesting the copra. Coconut kernel is a favourable substrate for the growth of microorganisms. Since drying is done under open conditions, copra spoilage due to fungal infection is very common. Usually bacterial action starts during the initial stages of drying and later mould infection

### Technology Spread Status

A few of the technologies listed above were introduced on a pilot scale in different states and they are perceived to be highly effective. However, intensive efforts in the form of multi location trial/Verification Trials are needed to refine these technologies and make them as viable technologies. Such refinement could be followed by an intensive transfer of technology programme for ensuring better technology spread.

occurs. It was recommended from the study on storage of copra on various storage containers with various fumigants and gases that copra could be stored for more than 6 months, by exposing it either to bio-gas for 1 to 3 days or to neem leaf gas for 15 days immediately after splitting, prior to storage in any air-tight container.

### **Storage of coconut oil**

The study on the storage of coconut oil in various containers with various anti oxidants/preservatives revealed that the storage of oil in air-tight brown coloured containers along with either sodium meta bisulphate, citric acid or common salt will increase the shelf life of the oil for more than six months.

### **Coconut wood as timber**

Coconut wood belongs to the non-durable group of timbers. When used in situations favourable for attack by decay fungi and wood boring insects, the hard dermal portion of the trunk will last only for a period of one to two years. The soft inner portion will

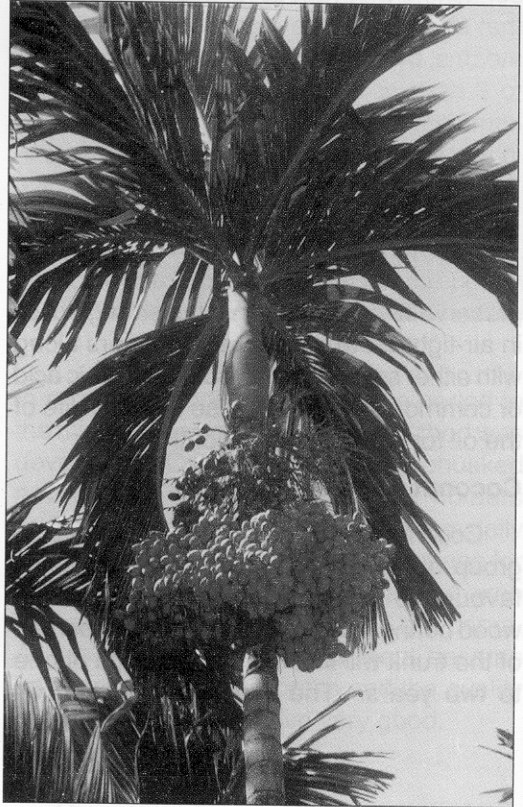
deteriorate in a few months when left exposed to the weather. Coconut wood should be properly treated to protect it against attack of wood destroying organisms especially when used in ground contact and exposed to the weather. An attempt was made to find the most suitable preservation technique and to select the best preservative with respect to the various end use of the treated wood. Among the preserving methods, dipping performed better than brushing. For the end use exposed with ground contact, treatment with chemical creosote was found to be very effective. All the treated as well as control samples were found to be intact for the end use interior without ground contact.

### **Fuel briquette**

Process for the production of the fuel briquette with different proportions of pith and shell powder of tender coconut husk has been developed. Fuel briquettes were produced in the commercially available briquette machine. Piston with cylinder type briquette machine was found suitable.

## 32. HIGH YIELDING ARECANUT VARIETIES

Based on the trials conducted at CPCRI Regional Station, Vittal, four high yielding arecanut varieties have been released so far, for commercial cultivation. Mangala was released in 1972. It was found to have a number of desirable characters such as earliness in bearing, more number of female flowers per inflorescence, higher nutset, initial and cumulative higher yield, quicker stabilization of production and lesser height in comparison with local variety. Average yield of this variety is 3.00 kg chali/palm. Similarly, Sumangala and Sreemangala, which were released in 1985, had a higher number of desirable characters as compared to local South Kanara variety. There was an increase in yield by 63 per cent and 48 per cent, respectively over the local control. Mohitnagar, an indigenous arecanut variety with a high yield potential has been released during 1991. The important feature of this variety is its greater uniformity. The bunches are well placed and nuts are loosely arranged on spikes which help in their uniform development and also enable efficient plant protection measures. Early stabilization of yield as compared to Sumangala and Sreemangala was also noticed. The variety is consistently high yielding with an average



Mohitnagar – a high yielding arecanut variety

### Economics

**At Research Station:** The four arecanut varieties released for commercial cultivation viz; Mangala, Sumangala, Sreemangala and Mohitnagar give an average yield of about 3.25 kg chali/palm/year as compared to the yield level obtained from the local varieties of about 2.5 kg chali/palm/year. Thus the released varieties are having the potential for increasing the net returns from one ha. of arecanut farm from Rs. 0.90 lakh to Rs. 1.35 lakh per annum and the Benefit Cost Ratio from 2.65 to 3.46.

**At Farmers' Fields:** Verification Trials conducted under the Institution Village Linkage Programme indicated that the Mohitnagar variety could yield 2.3 kg chali/palm/year as against 1.5 kg from local variety. The average profit/palm/year was Rs. 50/- in the case of Mohitnagar as against Rs. 20/- from the local variety.

### Technology Spread Status

High yielding varieties of arecanut released from CPCRI are very well received by the cultivators. CPCRI continues to be the major source of good quality planting materials of arecanut. About 3-5 lakh seed nuts of high yielding areca varieties are distributed to cultivators every year from CPCRI. It is estimated that about 10,000 ha of areca gardens

yield of 3.67 kg chali per palm per year. This variety was released for cultivation in West Bengal and Coastal areas of Karnataka and Kerala. The characters of the released arecanut varieties are given in the Table.

Release of these varieties was made possible on the successful implementation of the project on collection, conservation and cataloguing of arecanut germplasm. The Central Arecanut Research Station, Vittal (Presently the Central Plantation Crops Research Institute Regional Station, Vittal) has embarked on the collection and maintenance of world arecanut germplasm since its inception in 1957. At present, the

germplasm bank of arecanut consists of 140 types, which include 23 exotic types belonging to six species of *Areca* obtained from important areca growing countries such as Sri Lanka, Philippines, Indonesia, Singapore, Malaysia, Thailand, Soloman Islands, Fiji, South China and Mauritius. The variability in this collection includes genes for high yield, dwarfness, early bearing, suckering habit and high fruit set. In evaluation trials, superior varieties with high yield potential over the local cultivar were identified and used for commercial cultivation/ breeding programmes.

### Characteristics of arecanut varieties

Variety	Growth habit	Shape and size of nut	Dry nut yield (kg/plant/ annum)	Recommended for
Mangala	Semi tall	Round, Small	3.00	Coastal Karnataka and Kerala
Sumangala	Tall	Oval, Medium	3.20	Karnataka and Kerala
Sreemangala	Tall	Round, Bold	3.18	Karnataka and Kerala
Mohitnagar	Tall	Round, Medium	3.67	West Bengal, Kerala and Karnataka

in the major arecanut growing states are covered with high yielding varieties, thus accounting for 4.00 per cent of the total area under arecanut cultivation in the country. Nurseries managed by State Agriculture/Horticulture Departments and private firms also produce areca seedlings for distribution among growers. During certain years, especially when the arecanut prices are very high, CPCRI is unable to meet the demand for seed nuts. However, as India has already achieved self sufficiency in the production of arecanut, expansion of arecanut cultivation to newer areas is being discouraged as a policy measure and hence production and distribution of planting materials of high yielding varieties of arecanut is to be restricted to meet the requirements for underplanting and replanting.

### Farmers' perception

Farmers are convinced about the better performance of released varieties of arecanut as compared to the local varieties, as is evident from the heavy demand for the planting materials of the high yielding varieties. Lack of availability of quality planting materials is often perceived by the farmers as a major constraint in the adoption of high yielding varieties of arecanut. However, few farmers also perceived that short life span, unsuitable for underplanting, alternate bearing tendency and higher requirement of chemical fertilizers as the undesirable traits of the released varieties. Few farmers believe that local variety will perform better under moisture stress situation than the high yielding varieties.

### 33. ARECANUT NURSERY MANAGEMENT

Arecanut is propagated only by seeds. Being a perennial crop, adequate care should be taken in selecting the planting material. There are four steps in selection and raising of arecanut seedlings viz., selection of mother palms, selection of seed nuts, germination and raising the seedlings and selection of seedlings.



Arecanut nursery

**Selection of mother palms:** The selection should be based on characters with high heritability and which are also correlated with

yield. Some of the characters thus identified for the selection of mother palm are; early bearing, regular bearing habit, large number of leaves on the crown, shorter internodes and high fruit set.

#### Economics

**At Research Station:** Effect of various recommended practices for arecanut nursery management could be measured in terms of higher yield obtained from planting the seedlings from properly managed nurseries. However, the additional cost involved in the adoption of nursery management practices is very meagre.

#### Technology Spread Status

From the field visits to arecanut gardens in different regions, it is observed that majority of areca growers who raise own seedlings adopt the correct procedure for selecting mother palms. They generally follow the criteria for selecting seed nuts. However, some farmers do not raise primary and secondary nurseries, instead, retain the seedlings in single nursery, in which seed nuts are sown until transplantation in the main field. This practice results in lanky growth of seedlings as they do not get sufficient space for proper growth in the nursery. Further, the extent of adoption of the recommended practices for

**Selection of seed nut:** Fully ripened nuts having a weight of above 35 g should be selected. The nuts selected should float vertically with calyx-end pointing upwards, when allowed to float on water. These nuts produce seedlings with greater vigour.

**Primary and secondary nurseries:** For obtaining good germination, the seed nuts should be sown as whole fruits. Under Vittal conditions, the mean number of days required for the commencement and completion of germination are 53 and 94 days respectively. The number of days required for germination increases with the altitude. The nuts should be sown immediately after the harvest in soil or sand and watered daily to get early and good germination. The nuts should be sown at 15 cm distance in vertical position with calyx end just covered. The beds may be mulched lightly using areca leaf or paddy straw. After six months in primary nursery, the seedlings are transplanted to secondary nursery beds of 150 cm width, 15 cm height and convenient length. The results of the experiments conducted to find out the optimum spacing in nursery indicated that 35 to 45 cm spacing was optimum for a growth period of one year in the nursery. Polythene bags (25 cmx15 cm, 150 gauge)

filled with potting mixture (top soil:FYM:sand = 7:3:2) can also be used to raise secondary nursery. Sprouts of 3 months old should be used. The secondary nursery should be given a basal dose of farm yard manure @ about 5 tonnes per ha.

Areca sprouts and seedlings are very delicate and do not withstand exposure to direct sunlight. Hence, proper shade should be provided to the nursery. The shade may be either of coconut or arecanut leaves spread over a pandal or by planting some fast growing green manures or banana. The nursery should be watered regularly in the summer and proper drainage should be provided in rainy season. The nursery should be kept clean by periodical weeding.

**Selection of seedlings:** The research has shown that the seedlings having more than 26 cm girth after one year and more than 5 nodes after two years are the best seedlings to achieve higher yield. Twelve to eighteen-month-old seedlings are transplanted in the main field. In general, seedlings with maximum number of leaves (five or more), minimum height and maximum girth are to be selected for planting. The selected seedlings should be removed with a ball of earth adhering to the roots for planting.

seedling selection also is only at medium level. Many a times, farmers use all the seedlings in the nursery for planting without resorting to any selection procedure.

### **Farmers' Perception**

The recommended practices of arecanut nursery management are perceived by farmers as simple and also mostly in tune with the traditionally advocated practices, especially for the selection of mother palms and seed nuts. Lack of knowledge about the importance of adopting recommended procedure for seedling selection results in lower adoption of such practices.

## 34. ESTABLISHMENT OF AN ARECANUT GARDEN

### Selection of site and layout

The crop thrives better in humid areas protected well against hot sunburn and heavy wind. Since the areca palm does not withstand drought, the site selected should have adequate facility of water for irrigation.

The soil should have proper drainage facilities. Arecanut

palm cannot withstand extremes of temperature and exposure to direct sun. Hence, the site selected should have



Planting an arecanut seedling

protection from southern and western sides. The soil depth and the depth of water table are other two parameters to be considered

### Economics

**At Research Station:** Adoption of recommended spacing and proper care of young plantations could give an average yield of about 3 kg chali/palm/year, thus resulting in a gross return of Rs. 1.80 lakhs/annum from one ha. of well maintained arecanut garden.

**At Farmers' Fields:** Adoption of correct spacing could provide good scope for inter and mixed cropping in arecanut garden, which could improve the net returns from the garden 3 to 4 times as compared to the monocrop of arecanut alone.

### Technology Spread Status

The extent of adoption of recommended practices related to season of planting, size of pit and depth of planting is observed to be high (above 75 per cent). However, adoption of recommended spacing for planting arecanut is not at a satisfactory level. Further, the recommended criteria for selecting suitable site for planting is not given adequate attention by the farmers. This is more obvious in the case of areca gardens established in recent years, during which farmers get highly attractive market rates for arecanut. A large number

while selecting the site. The soil should be deep (preferably not less than two metres) and water table should be sufficiently low for better root development. Aligning the rows in north-south direction with a deviation of 35° towards South-West lowers the incidence of sun-scorch.

### **Spacing**

The spacing adopted in arecanut growing tracts varies from 1.25 m x 1.25 m to 3.6 m x 3.6 m. The spacing trials conducted at different centres of CPCRI indicated that the spacing of 2.7 m x 2.7 m was optimum for better yield of the crop. The root studies also indicated that this spacing is optimum for root development and there will not be root competition.

### **Depth of planting**

In well-drained soils and in the fields where proper drainage can be provided, deep planting is preferred. Thus in well-drained soils, planting at a depth of 90 cm is recommended and in heavy soils planting at a depth of 60 cm is recommended.

### **Season of planting**

In areas where South-West monsoon is severe, planting in the months of September-

October is recommended. In other areas, planting can also be done in the months of May-June.

### **Drainage**

For better growth and development of the plants, proper drainage is essential. The number of drainage channels depends upon the soil type. In light soils, the number of channels may be less and in heavy soils, the channels should be dug in each row space to ensure proper draining of the excess water. The channels should be at least 15 – 30 cm deeper than the depth at which the seedlings are planted.

### **Shade**

Arecanut palms are highly susceptible for sun scorching. The seedlings should be given protection against the direct exposure to sun. This may be done either by covering the plants with areca or coconut leaves or by raising crops like banana in between two rows of arecanut. Sun scorch is mostly seen during October – January. During this period, even the stems of young palms have to be protected. For this, a quick growing shade plant can be planted on Southern and Western sides of the garden.

of farmers planted arecanut even in ill-drained paddy fields without providing adequate drainage facilities.

### **Farmers' Perception**

Farmers are fully convinced about the importance of correct spacing and proper care of young plantations. However, the farmers who follow the homestead farming system with marginal size holding could not adopt the correct spacing due to the desire for planting more number of plants within the available limited area.

Lack of sufficient knowledge regarding arecanut production technology also acted as an inhibiting factor in the adoption of the recommended technologies.

## 35. CULTURAL OPERATIONS IN ARECANUT GARDEN

The cultural operations for arecanut vary across the region. In *Malnad* tract, the main purpose of cultural operation is to loosen the soil and to rebuild the soil fertility after the heavy rains during monsoon. In *Maidan* tract, where the soils are heavy, the purpose of cultivation is to conserve the soil moisture and prevent the hardening of the soil. In general, the cultivation has been found to increase the yield by 10-20%. In light soils, digging can be done once in two years. But in heavy soils, digging has to be done every year. Clean cultivation was found to give better yield. When planting is done on hill slopes, contour planting gave higher yields. Mulching is another operation being followed in the arecanut gardens. This checks evaporation during summer, erosion during



Intercultivation in arecanut garden

rainy season and keeps the weeds under check. Chopped areca leaves, grass cut and spread, arecanut husk and dry leaves collected from the forests can be used as mulch in areca gardens.

### Economics

**At Research Station:** Experiments conducted at CPCRI Regional Station, Vittal have conclusively proved that through cultural operations, it was possible to improve the arecanut yield by 15%, thus resulting in an additional yield of 450 kg chali per ha.

### Technology Spread Status

Majority of areca growers adopt the recommended practice related to digging the interspace in arecanut garden, Similarly, digging the ground at the base of areca palms and opening the basin for the application of organic manures is also widely adopted by farmers in all the major areca growing areas. It is observed that many of the areca growers in Northern Kerala do not cover with soil after the application of organic manures in the basin.

### Farmers' Perception

Areca growers are convinced about the importance of adopting the recommended cultural operations. But high wage rate and scarcity of labour is often cited as the constraints by arecanut growers, especially in Kerala State, for lesser adoption of the recommended cultural operations.

## 36. INTEGRATED NUTRIENT MANAGEMENT

### Fertilizer management

Studies conducted at various centres of CPCRI revealed that, in arecanut the maximum response was observed to the green leaf application in almost all the centres. Application of lime did not show any advantage. Annual application of 100 g N, 40 g  $P_2O_5$  and 140 g  $K_2O$  in addition to 12 kg each of green leaf and compost per palm is recommended except in areas of heavy soils like Hirehalli. In these soils, application of 50 g N, 40 g  $P_2O_5$  and 70 g  $K_2O$  with 14 kg green leaves appears to be optimum. The fertilizers are to be applied in two split doses. One third of the fertilizer is applied in May - June and two third along with the organics is applied during September-October. Fertilizers are applied in basin around the palm dug to a depth of 15-20 cm and 50-100 cm radius leaving 20 cm from the base of the palm. After application, the fertilizers are covered with organic matter and soil.



Fertilizer application to arecanut palm

### Organic matter recycling

As chemical fertilizers alone are not in a position to meet the nutrient demand, extensive use of organic wastes is advisable. Available arecanut wastes have a potential to supply 5260, 1337 and 6230 tonnes of nitrogen, phosphorous and potassium respectively to the agricultural system annually. These wastes are not put into

### Economics

**At Research Station:** Recent studies on the economic analysis of integrated nutrient management (inorganic fertilizers along with organic recycling) in arecanut based cropping system revealed that a total net return of Rs. 1.50 lakhs/ha/annum could be obtained with a Benefit Cost Ratio of 3.5.

**At Farmers' Fields:** Verification Trials conducted in 20 farmers fields under Institution Village Linkage Programme indicated that the farmers could improve the arecanut yield to 2.9 kg chali/palm/annum, when they adopt balanced and timely application of fertilizer nutrients.

### Technology Spread Status

In a study conducted in Kasaragod District in Northern Kerala, it was observed that majority of arecanut cultivators (more than 90 per cent) adopt application of organic manures in the form of farm yard manure and green leaves. It was observed that, on an average, 20 kg of farm yard manure and 30 kg of green leaves are applied per palm per year. However, it was found that only one-fourth of the farmers apply chemical fertilizers to areca palms. Further, majority of farmers who apply chemical fertilizers to arecanut palms apply the same only once in a year instead of the recommendation for split application.

### Suitable fertilizer doses for different agro-climatic conditions

Region	Fertilizer rate (N:P <sub>2</sub> O <sub>5</sub> :K <sub>2</sub> O g/palm/year)	Green leaf or compost /palm /year
Vittal (Coastal Karnataka)	100:40:140	12 kg each of green leaf and compost
Mohitnagar (West Bengal)	100:40:140	12 kg each of green leaf and compost
Peechi (Kerala)	No response to fertilizers	14 kg green leaf or compost
Hirehalli (Karnataka)	50:40:70	14 kg green leaf or compost
Kahikuchi (Assam)	50:40:140	14 kg green leaf or compost

proper use. Direct application of these organic wastes do not meet the crop nutrient demand immediately.

Areca nut wastes are efficiently converted into vermicompost with a recovery of 87.75% in a composting period of 3 months by using African night crawler (*Eudrilus eugeniae*). Major nutrient (NPK) and micronutrient (Cu, Zn, Fe and Mn) contents are slightly higher in the vermicompost than in normal compost. Reduced C:N ratio in vermicompost (23.98) and in normal compost (33.36) as compared to C:N ratio in dried areca leaves (62.25) ensures immediate release of nutrients to the crop. In case of recycling, vermicompost produced from organic wastes of one hectare of areca nut plantation meet 50% of N, 32.5% of P and 26% of K requirement besides supplying considerable organic matter and micronutrients.

To prepare vermicompost, areca wastes are chopped into small pieces of 10 cm and heaped. The heap is mixed with cow dung slurry @ 10 kg / 100 kg of waste. Water is sprinkled daily and the heap is kept for two weeks. Then the chopped material is arranged in beds of one-metre width and convenient length. Cement tanks or trenches can be used for this purpose. A layer of 10-15 cm waste material is alternated with 2 cm layer of cow dung over which earthworms are released at the rate of 1000 numbers per square metre. The wastes are converted into fine granular, odourless vermicompost within 60 days. During this period, the earthworm population is doubled. About 8 kg /palm/year of vermicompost meets the crop nutrient demand.

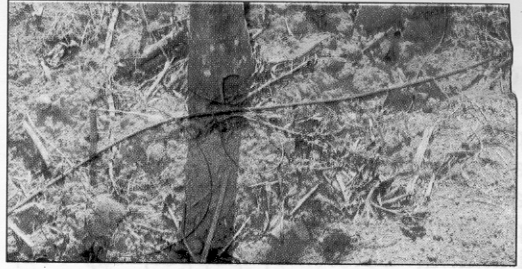
### Farmers' Perception

Even though application of organic manures is adopted by most of the areca growers, they perceive constraints with regard to availability of organic manures, especially green leaves. They felt that the hill slopes in the nearby areas from where they used to collect green leaves have been now cultivated with other crops and hence there is sharp decline in the availability of green leaves for manuring areca palms. High cost of chemical fertilizers and also lack of knowledge about the recommended practices of integrated nutrient management were also perceived to be the constraints for proper adoption of recommended technologies related to integrated nutrient management in areca nut.

## 37. IRRIGATION MANAGEMENT

Areca nut crop cannot withstand drought for a long time. Being a perennial crop, once affected by water stress, it may require two-three years to regain the normal vigour and yield. The death of palms due to moisture stress is also not uncommon.

In West Coast of India, where more than 50 per cent of areca nut is cultivated, rainfall is mostly confined to June-November months. Monsoon is followed by a prolonged dry spell normally extending from November to May. Therefore optimizing the irrigation requirements and also economizing the irrigation water assumes major importance in areca nut cultivation. At Vittal conditions, irrigation intervals of 5 and 10 days were found superior throughout the season. When irrigation treatments were based on IW/CPE ratio, irrigation of 30 mm of water when the CPE is 30 mm is optimum. This works out to an irrigation frequency of once in 7-8 days during November-December, once in 6 days during January-February and once in 4-5 days during March-May. The quantity of water to be applied is about 200 litres per palm/irrigation for Vittal conditions.



Drip irrigation in areca nut garden

During the summer, majority of the farmers face scarcity of water and it will be difficult to supply the required quantity of water to the palms. To overcome this problem, new irrigation methods were tried which can save water without affecting the yield of areca nut. They are sprinklers and drip irrigation methods. Adoption of sprinkler and drip irrigation methods can save 20 and 44 per cent of water respectively, under Vittal conditions for an Eo of 66% as compared to conventional method of irrigation (flooding and splashing). About 20 litres of water per day per palm is to be given through drip irrigation. Three drippers/ microtubes should be placed in the basin at 50 - 60 cm away from the trunk.

### Economics

**At Research Station:** For areca nut, the recommended level of irrigation is 200 litres of water per palm once in 6 days with hose irrigation. In the case of drip irrigation, it is 20 litres/palm/day. Since areca nut is basically an irrigated crop, palms receiving optimum level of irrigation and other management could yield 3.5 kg of chali/palm/year.

**At Farmers' Fields:** Farmers irrigate through hose method once in four to six days. Areca nut growers adopting sprinkler/drip irrigation systems get an average yield of 2.5 kg chali/palm/year.

### Technology Spread Status

Areca nut is grown predominantly as an irrigated crop. However, in a few areas, it is cultivated under rainfed situation. Majority (more than 90 per cent) of areca nut farmers adopt the conventional basin method of irrigation. Micro irrigation technologies such as drip irrigation is slowly gaining popularity among areca growers. Yet the spread of the drip method is only to a limited extent of less than 5 per cent.

### Farmers' Perception

Erratic power supply is the most important constraint faced by the farmers in adopting the recommended irrigation schedule. Repeated occurrence of drought followed by fast depletion of ground water resources is another constraint. Perceived complexity of the technology of micro irrigation could be overcome through appropriate transfer of technology efforts.

## 38. ARECANUT BASED CROPPING SYSTEM

The long pre-bearing period, low returns during the initial bearing stage, fluctuations in market prices, unexpected loss due to pests and diseases and natural calamities are some of the problems associated with arecanut cultivation. To overcome these problems, farmers started growing crops like banana, betelvine, pepper, tapioca, colocasia, pineapple and even coconut and jack to realise more income from arecanut gardens. Central Plantation Crops Research Institute started a scientific study of inter/mixed cropping during 1970s and High Density Multi Species Cropping System during 1980s with the objective of increasing productivity per unit area and maximising the economic returns from arecanut gardens.



Arecanut based High Density  
Multi Species Cropping System

### Scope for inter and mixed cropping

Approximately 60 per cent of the light is intercepted by an adult areca palm. By

### Economics

**At Research Station:** Research Stations located at different regions of the country have identified ideal arecanut based cropping systems suitable to the respective locations with the suggestion that farmers may adapt these models with certain modifications as per the home consumption requirements and market situations. At CPCRI Regional Station, Vittal, High Density Multi Species Cropping System consisting of arecanut, pepper, clove, nutmeg, banana, coffee and pineapple could give an annual net return of Rs. 2.8 lakhs as compared to the return obtained from the monocrop of arecanut (Rs. 1.5 lakhs/ha/annum).

Summary of results obtained from various inter and mixed cropping trials at Mohitnagar (West Bengal) and Kahikuchi (Assam) are presented below.

Sl. No.	Crop Combination	Net Income * (Rs./ha)
01.	Arecanut + Black Pepper + Banana + Lemon + Pineapple + Ginger	43,700
02.	Arecanut + Betelvine + Banana + Lemon + Colocasia + Turmeric	22,760
03.	Arecanut Monocrop	10,680

\* Average for 1991-92 to 2000-01

**At Farmers' Fields:** Survey in North Kerala region indicated that a crop combination of arecanut with banana, could give a net return of Rs. 1.01 lakhs/ha/annum with a Benefit Cost Ratio of 2.12. Similar survey conducted in Jalpaiguri District in West Bengal revealed that betelvine was the most profitable intercrop in arecanut gardens followed by pineapple, ginger, banana and turmeric.

growing intercrop, the level of light interception could be increased to about 95 per cent. The root distribution studies in arecanut have revealed that at the recommended spacing, arecanut uses only about 35 per cent of the space. Remaining 65 per cent of the space is not effectively used and this can be used for raising mixed/intercrops. Intercropping also leads to increased availability of organic matter for recycling. In arecanut and cocoa mixed cropping, the higher litter fall and prunings of cocoa improves the organic matter content, soil fertility and increased microbial activity.

A large number of annuals, biennials and perennial crops have been tried in areca gardens to evolve suitable crop combinations at CPCRI Regional Station and the Research Centres spread over the states of Karnataka, Kerala, Assam and West Bengal. Crops like banana, pepper, cocoa, elephant foot yam, citrus, betelvine, pineapple etc. were found suitable for mixed cropping in arecanut.

Some of the intercrops and the summary of their crop husbandry are given in the Table.

### **High Density Multi Species Cropping System**

Research revealed that by growing only one mixed crop in arecanut gardens, one would not utilize the resources to the full extent. This gives scope for taking more than one crop in the arecanut gardens as mixed crops. The system of growing more number of crops of different species mixed with main crop to meet food, fuel and timber needs is called High Density Multi Species Cropping System (HDMSCS). Research efforts at CPCRI centres revealed that banana, cocoa, pepper, lemon, betelvine, elephant foot yam and tapioca can be grown with arecanut in HDMSCS. At Vittal, cultivation of cocoa, banana and pepper was found profitable with arecanut. At Hirehalli, cocoa, pepper, banana and lemon were found profitable, where as at Mohitnagar, a combination of arecanut, banana and pepper increased the

### **Technology Spread Status**

Arecanut is mostly grown as a monocrop in Karnataka and Tamil Nadu, while in Kerala where homestead farming is a traditional practice, farmers adopt inter/mixed cropping practices in their arecanut gardens.

In a study conducted in Kasaragod District of Kerala State, it was observed that more than 60 per cent of farmers adopt inter/mixed cropping in their areca gardens. The most widely adopted intercrop and mixed crop in arecanut gardens were banana and pepper respectively. Mixed cropping of cocoa is also adopted in some of the areca gardens.

### **Farmers' Perception**

Arecanut farmers, in general, are convinced about the techno-economic benefits of arecanut based cropping system. They perceive that the recommended technologies related to arecanut based cropping system can be better adopted in areca gardens systematically planted with proper spacing. The feasibility of adoption of cropping/farming system in old areca gardens with high palm density and irregular planting is very limited. Fluctuation in the price of produce of inter/mixed crop grown in areca garden is also a constraint in adopting arecanut based cropping system. The widespread discontinuance of mixed cropping of cocoa in areca garden a few years ago due to the price crash for cocoa in market, is a typical example in hand. Some farmers perceive that trailing of pepper on arecanut palm as a mixed crop create difficulty in harvesting and plant protection operation in arecanut. Further, mortality of pepper vines grown in arecanut garden due to quick wilt disease is also perceived as a constraint by farmers in the wider adoption of mixed cropping of pepper in arecanut gardens.

### Crop husbandry for mixed crops in arecanut garden

Crop	Spacing (m x m)	Popula tion/ha	Fertilizer (g/ plant/ year)			FYM (kg/ palm)	Age of arecanut at which dose mixed crop can be planted
			N (Urea)	P <sub>2</sub> O <sub>5</sub> (RP)*	K <sub>2</sub> O (MOP)§		
Arecanut	2.7 x 2.7	1300	100 (220)	40 (200)	140 (235)	10	-
Black Pepper*	2.7 x 2.7	1300	100 (220)	40 (200)	140 (235)	..	6-8 years
Banana†	2.7 x 5.4	650	160 (350)	160 (800)	320 (535)	20	Before or with planting
Cocoa†	2.7 x 5.4	650	100 (220)	40 (200)	140 (235)	..	4 years
Lemon†	2.7 x 5.4	650	300 (655)	250 (1250)	500 (835)	20	4 years
Betelvine*	2.7 x 2.7	1300	100 (220)	40 (200)	140 (235)	10	6-8 years

\* Planted at the base of the palms; † Planted at the centre of four palms.

\* RP – Rock phosphate; § MOP – Muriate of potash

net profits. By following HDMSCS, one can increase the net returns by 2 to 2.5 times over arecanut monocrop. Efficient cropping

systems models for different regions are given in the Table .

### Efficient cropping system models for different regions

Sl. No.	Region	Cropping System Model	Net income (Rs./ha)
1.	Maidan parts of Karnataka	Arecanut + pepper + cocoa	1,98,000
2.	Maidan parts of Karnataka	Arecanut + banana + acid lime	1,78,000
3.	Coastal Karnataka and Kerala	Arecanut + pepper + cocoa + banana	2,69,000
4.	Northern region of West Bengal	Arecanut + pepper + banana (or) Arecanut + pepper + acid lime	1,95,000
5.	Wynad of Kerala and Uttara Kannada Dist. of Karnataka	Arecanut + cardamom	3,05,000

(The rates are as per the year 1999)

## 39. ARECANUT WASTE UTILIZATION

Studies at CPCRI Regional Station, Vittal have revealed that mushroom and vermicompost production using arecanut wastes such as leaves, leaf sheaths and husk are the promising technologies in terms of waste recycling and employment generation. Production of oyster mushroom (*Pleurotus sajor-caju*), which are edible and rich in protein content, generates Rs. 17,000/ha/year. The same wastes can be reused for vermicompost production. On an average, one net income of Rs. 28,000/ ha /



Vermicomposting from arecanut waste year is realized with mushroom and vermicompost production using wastes from one hectare of arecanut plantation.

### Economics

**At Research Station:** Vermicomposting technology is proved to be a low cost-high return technology. While, the cost of production of vermicompost using arecanut leaves as base material and *Eudrilus* sp. of earth worms is less than Rs. 1.50/kg, the market price of Rs. 7/kg on an average is assured. Thus, the farmers would be able to get high returns through the adoption of this technology. The trials at CPCRI Regional Station, Vittal indicated that mushroom cultivation on arecanut waste is a profitable enterprise as the cost of production for one kg of mushroom was less than Rs. 15/- and the present market rate is around Rs. 40/kg.

**At Farmers' Fields:** Verification Trials on vermicomposting was taken up in 20 farmers holdings under the Institution Village Linkage Programme. It was observed that for producing 100 kg of vermicompost, total cost involved was Rs. 170/- and value of vermicompost produced was Rs. 800/- thus ensuring a total return of Rs. 630/- recording a return per rupee spent value of 3.71. Similar Trials in 18 farmers fields under the Institution Village Linkage Programme indicated that for raising 6 beds of mushroom, farmers were to invest Rs. 83/-. They could get a total return of Rs. 158/- and net profit of Rs. 75/-, thus recording a value of 1.90 as the return per rupee spent on this venture.

### Technology Spread Status

Vermicomposting technology is spreading fast among the farming community in different States. CPCRI could sell more than 2.00 lakhs of earthworms (for vermicomposting) during the last two years. The technology for mushroom cultivation on arecanut waste is being adopted by a few Self Help Groups through the intervention of CPCRI. However, the spread of technology to other areas is observed to be negligible.

### Farmers' Perception

Farmers perceived vermicomposting practice to be a low cost technology requiring less labour and with high potential for using locally available materials as well as with easiness in adoption and with high observability in terms of earliness in the beneficial effect of compost when applied to plants. However, the problem of higher incidence of ants affecting the survival of the earthworms was reported in a few areas. Mushroom cultivation is a simple technique which could be practiced by farm women in their house holds without any additional land requirement, utilizing the waste materials available in their arecanut gardens. Farmers perceived that easiness in adoption of the technology, availability of adequate quantity of farm waste and good yield of mushroom were the positive attributes in this technology.

## 40. INTEGRATED DISEASE MANAGEMENT IN ARECANUT

### Fruit rot

It is one of the major diseases seen in heavy rainfall areas of arecanut tract. The disease, caused by the fungus *Phytophthora meadii*, is seasonal and occurs during South-West monsoon season. The loss due to this disease is reported to vary between 10 - 90 per cent. The first visual symptom is the formation of water soaked lesions near the perianth end on the nut surface. The infected nuts loose their natural colour and become dark green. The lesions spread gradually covering the entire surface of the nut before or after shedding. A felt of white mycelial mass develops on the lesion of the shed nut and it eventually envelope the entire nut surface. In severe cases, fruit stalks of the inflorescence are also affected. Usually the disease makes its appearance 15 - 20 days after the onset of monsoon (May - June) and persists till the end of monsoon (Aug. - Sept.).

The disease is controlled effectively by spraying with Bordeaux mixture (1%) twice. First spraying should be given immediately after the first monsoon showers and the second 40 - 45 days thereafter. Recent



Polythene covering against Fruit rot disease of arecanut

studies have shown that polythene covering of bunches is very effective in checking the disease.

### Economics

**At Research Station:** Due to the incidence of fruit rot disease of arecanut (Mahali), an annual loss of 10 to 75% was recorded in parts of Karnataka, Kerala and Maharashtra States or total destruction of crops in individual gardens have been recorded.

Comprehensive survey in the disease affected areas of Kerala and Karnataka States revealed that the yellow leaf disease is prevalent in almost all the districts of Kerala and in parts of Karnataka State. Area affected by yellow leaf disease in different Districts of Kerala State varied from 2.0% to 70%. Survey on the yellow leaf disease affected palms revealed a reduction in yield to the extent of 50% causing an economic loss of Rs. 73000/ha over a period of three years immediately following the disease incidence.

**At Farmers' Fields:** Verification Trials conducted under the Institution Village Linkage Programme on the technology for covering arecanut inflorescence with polythene covers as compared to two to three times spraying of Bordeaux mixture for the control of fruit rot disease revealed that the percentage of disease incidence was nil in polythene covered

## Bud rot

This fatal disease caused by the fungus *Phytophthora meadii*, is seen during South-West monsoon as well as in the subsequent winter months (Oct.- Feb.). First visual symptom of the disease is the yellowing of spindle leaf. As a result of infection, spindle turns to yellow or brown. Infection spreads to the outer whorl of leaves leading to yellowing, dropping and shedding. The infected palm emits a disagreeable odour. Early detection of the disease and prompt removal of the infected tissues will help in the recovery of the palms and also prevent further spread of the disease. Infected tissues are scooped off by making longitudinal side slit and treated with Bordeaux paste (10 %). Removal and destruction of areca palms dead or affected due to bud rot and fruit rot affected areca bunches and drenching the crowns of surrounding palms with Bordeaux mixture (1%) minimize the disease incidence.

## Foot rot

This disease, caused by the fungus

*Ganoderma lucidum*, is a major problem in the Malnad and Maidan areas of Karnataka, parts of Tamil Nadu, Kerala and Assam. Poor drainage and high water table are the factors favouring occurrence of the disease. The initial visible symptom is yellowing of outer whorl of leaves, which gradually extends to the inner whorls. The development of inflorescence and nuts is arrested and nuts already formed are shed. In advanced stage of the disease, the leaves droop and drop off one by one leaving a tuft of one or two leaves along with the spindle at the centre. The affected palm initially exhibits a dull brownish patch at the base of the trunk, which later enlarges in size and a brownish exudate oozes out from the ground level. The fruting bodies of the fungus are formed at the base of the trunk immediately after the death of the palm or occasionally in advanced stages of the disease or at times on the stumps, after felling the affected palm.

The diseased palms are to be isolated by digging trenches of 30 cm wide and 60 cm deep all around the affected palms. The palm in the early stages of disease are root

inflorescence. No immature nut drop was noticed in the polythene covering treatment, while, 2.30% nut drop was noticed in Bordeaux mixture sprayed palms. The arecanut yield in polythene covering treatment palms could be increased to 3.08kg chali/palm, thus recording a net profit of Rs. 96443/ha/annum with the return per rupee spent value of 2.08.

## Technology Spread Status

The recommendation on Bordeaux mixture spraying for fruit rot control is recording very high level of adoption with more than 90% of the farmers in West Coast region of the Karnataka and Kerala States adopting this practice. But the extent of adoption of the package for integrated management of yellow leaf disease and the recommended control measures against minor diseases of arecanut like inflorescence die-back is not to the desired level. Though, intensive efforts are being taken by CPCRI for the spread of integrated management technology package for yellow leaf disease, less than 1% of the farmers only are adopting this practice.

## Farmers' Perception

Farmers are fully convinced about the advantages of spraying 1% Bordeaux mixture against fruit rot disease in arecanut and hence the high level of adoption is recorded. The fact that fungicidal solution can be prepared by themselves adds to the relative advantage of the technological recommendation. However non-availability of skilled labour and high wage rate are perceived to be major constraints in adopting the spraying schedule against

fed with 125 ml of 1.5 per cent calixin solution at quarterly interval *i.e.*, during March, July, October and January. The basins of affected palms are to be treated with 1.5 per cent calixin by drenching. Bordeaux mixture (2%) as soil drench at monthly intervals throughout the monsoon season also proved superior in controlling the disease. Besides, all the palms in the Infected garden are applied with neem cake @ 1.5-2.0 kg along with recommended dose of organic and inorganic fertilizers.

### **Inflorescence die-back and button shedding**

The disease is seen throughout the year but becomes severe during summer months. Symptoms are yellowing and drying of the rachis from the tip towards the base followed by shedding of female flowers or buttons. Several factors such as lack of pollination, insufficient nutrients, water stress, high temperature and physiological reasons are associated with the disease. A fungus, *Colletotrichum gloeosporioides* is also associated with this disease. The disease due to the fungus can be controlled by spraying with Dithane Z 78 @ 4 g/lit. or Dithane M 45 @ 2 g/lit. of water or a mixture of Aureofungin-sol and Copper Sulphate both at 50 ppm. The first spraying is to be given at the time of opening of female flowers and

the second 20-25 days thereafter. Removal and destruction of dried inflorescence is very much helpful in reducing the build up of the fungus and its further spread.

### **Yellow leaf disease**

This is a fatal disease and is prevalent in parts of Karnataka, Kerala, Maharashtra and Tamil Nadu. Phytoplasma is found to be constantly associated with the disease. The plant hopper, *Proutista moesta* acts as a vector in the spread of the disease. Symptoms appear as yellowing of leaves. The yellowing starts from the tips of the leaflets of the outer leaves gradually extending along the margin interspersed with green stripes. In later stages, necrosis of lamina becomes prominent. Besides, the developing feeder roots show different degrees of blackening and will be brittle. Since the disease is not amenable to control by conventional plant protection measures, proper management of the garden is the only suggested method to prevent the loss due to this malady. Application of NPK fertilizers, and additional dose of super phosphate in combination with lime (1 kg/palm), improvement of drainage etc. will minimize the disease incidence. Besides, the spread of the disease is minimized by uprooting and destroying the mildly affected palms.

fruit rot. Farmers also perceive that continuous rainfall creates difficulty in taking up spraying operations thus reducing the efficiency of plant protection measures. More than 75% of the farmers in the Shimoga region in Karnataka State adopt polythene covering of arecanut bunches against fruit rot disease. But in Northern Kerala, areca growers perceive that the feasibility of the practice of polythene covering is very limited due to the lack of availability skilled palm climbers as well as their high wage rate.

Lack of knowledge about the recommended package of integrated management practices against yellow leaf disease is perceived as a major constraint in the adoption of the recommended package against YLD. Hence it is imperative that large-scale Demonstrations to convince the arecanut farmers about the technical feasibility and economic viability of the integrated disease management practices recommended against yellow leaf disease are to be organised. Intensive educational programmes are also needed to be organised for imparting the required knowledge and skill to the farmers to adopt the recommended plant protection measures in arecanut.

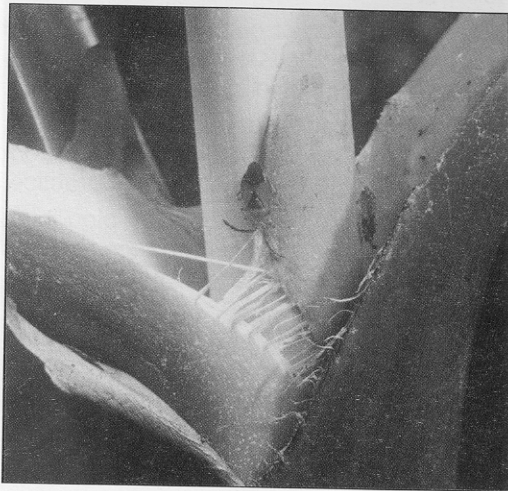
## 41. INTEGRATED PEST MANAGEMENT IN ARECANUT

**Mites:** Mainly two species of phytophagous mites viz. White mite (*Oligonychus indicus* Hirst) and Palm or red mite (*Raoiella indica* Hirst) colonize on the lower surface of leaves. Infestation of mites is seen after the monsoon rains and reaches its maximum in April - May. Neglected and poorly irrigated gardens particularly those in exposed conditions are prone to severe infestation. Infestation of mites start declining with the onset of rains in June. These mites suck sap from the lower surface of leaves and this results in yellowish speckles on the leaf. Mortality of seedlings can occur due to severe infestation of mites.

A number of indigenous natural enemies like coccinellid beetles, predaceous mites, staphylinid beetles, predaceous thrips etc. are observed on both the species of mites and they exert a good check on the population. Spraying the lower surface of leaves with Dicofol 2% or Dimethoate 1.5 % gives effective check of these mites.

**Spindle bug (*Carvalhoia arecae* Miller) :** It is a chronic problem in arecanut plantations of Kerala, Karnataka and parts of Tamil Nadu. The peak period of infestation occurs during March-April to November-December. Bugs suck sap from the emerging spindle and tender leaflets. As a result, the spindle often dries and fails to open. Complete decay and death of the spindle during rainy season is also noted.

Application of 2 g of Phorate granules in sachets of 3 cm wide is effective. Fine pinhole perforations are made on the topside



Spindle bug infesting arecanut palm

of the sachet. One such sachet each is tied on to the topmost two leaf axils before the premonsoon showers. Plantations with initial infestation may be sprayed with Dimethoate 0.05 per cent (15 ml in 10 litres of water) in and around the spindle and inner whorl of leaves.

**Root grub (*Leucopholis burmeisteri* Brenske and *L. lepidophora* Blan):** Root grub infestation is seen in low lying and clayey soils where the water table is high. The pest is serious in the arecanut tracts of Kerala and Karnataka. Grubs of these beetles feed on tender and mature roots of the palm. In arecanut seedlings, infestation results in dropping and drying of leaves. Palms with few years of infestation show a sickly appearance, with yellowing of leaves,

### Economics

**At Research Station:** The four pests which cause considerable economic loss to the arecanut crop are mites, spindle bug, inflorescence caterpillar and root grubs. They are either seasonal or persistent on the arecanut crop. Though, not highly host specific, they always infest the crop and assume serious proportions under ideal conditions.

**At Farmers' Fields:** Verification Trials on the root grub management conducted in a series of gardens in Shimoga area, where the grub was causing more than 50% yield loss in arecanut revealed that the pest could be effectively controlled and the original yield level could be restored through the recommended technologies.

tapering of stem and reduction in yield.

Management practices for this pest are as follows:

- An integration of cultural, chemical and biological methods of management of this pest is essential for getting good results.
- Collection and destruction of beetles during the period of their emergence from soil is an effective management practice.
- Exposing the pest stages by ploughing or digging the soil for predation by birds and other animals is found effective.
- Proper drainage is another cultural practice to be adopted.
- Application of Phorate 15 g per palm twice a year in May-June and September-October for a period of minimum three years will reduce the infestation.
- Natural enemies like scoliid wasps and entomophilic nematodes exert some control.

#### **Inflorescence caterpillar (*Tirathaba mundella*)**

This pest causes damage to areca inflorescence. Affected spadices may be opened and if all the female flowers have been damaged, the inflorescence should be

removed and burnt. If damage is partial, remove affected portion and spray Malathion (0.125%).

#### **Pentatomid bug (*Halymorpha marmorea*):**

This bug causes tendernut drop in arecanut. Infestation of this bug is seen from March/April to July/August. The bugs pierce the tendernuts of different maturity and suck the kernel sap. As a result, the kernel dries up and the tendernuts drop. Spraying the bunches with Endosulfan at 0.05 per cent twice (March-April and 45 days after) is effective.

#### **Scale insects (*Aonidiella orientalis*):**

Scale insects colonise the leaves, spathes, leaf sheaths and bunches and suck sap from the tissues. Continuous feeding on nuts results in pre-mature yellowing of nuts and the kernel may not develop and may turn black and shrivel up in case of severe infestation. The scale insects are present throughout the year, but are more serious during October to February. Natural enemies like coccinellid beetles (mainly *Chilocorus spp.*), thrips and mites keep the scale population at a low level. Spraying of insecticides like Malathion 0.1 per cent or Fenthion 0.1 per cent is found effective.

### **Technology Spread Status**

Arecanut farmers rarely venture into the pest management practices in their arecanut gardens. Less than 5% of the arecanut farmers only are estimated to adopt the integrated pest management technologies. In a study conducted in Northern Kerala region indicated that the level of knowledge on chemical control of root grub was recorded as 6.67%, while none of the farmers were having the required knowledge about the chemical control of spindle bug.

It is observed that many farmers do not possess the required level of knowledge to distinguish the symptom and nature of damage caused by the pests like mites, spindle bug and root grubs. Lack of knowledge about the recommended control measures and non-availability of labour and high wage rate are also perceived to be the constraints in adopting the integrated pest management technologies in arecanut.

### **Farmers' Reaction**

Farmers are not fully aware of the extent of damage caused by the arecanut pests and the impact of the recommended integrated pest management technologies for reducing the yield loss due to these pests. Hence need based training programmes and field demonstrations on IPM in arecanut are to be organized as a part of Transfer of Technology strategy.

## 42. HIGH YIELDING COCOA ACCESSIONS

The cocoa improvement programme was started at Vittal Research Station in the early 60's with the mandate of introduction, selection, hybridization and evaluation of cocoa germplasm. The germplasm at CPCRI, at present, consists of 137 accessions, which includes collections from Nigeria, Ghana and Malaysia. The efforts of crop improvement aimed at identifying different cocoa lines with high dry bean yield and better bean quality parameters. The major objectives of breeding are high yield, bean size of more than one gram, drought tolerance and resistance to black pod disease.

An experiment with 14 accessions for the clonal evaluation programme revealed that the accession Na 242 recorded the highest dry bean yield (0.827 kg/plant/year). In the four progeny trials under the hybrid evaluation programme, the progenies belonging to Na33 x ICS, I-56 x II-67, ICS6 x



An high yielding cocoa accession

Sca6 and II-67 x NC42/94 performed better in terms of dry bean yield.

### Economics

**At Research Station:** Studies at the CPCRI Regional Station, Vittal as well as the bulk plots at CPCRI Research Centre, Kidu indicated that the selected accessions could give an average yield of about 0.8 kg of dry bean/plant/year.

**At Farmers' Fields:** At the demonstration plots sponsored by the Directorate of Cashew and Cocoa Development in different locations, the high yielding accessions could record an yield of 0.4kg of dry bean/plant/year. The farmers thus could earn a gross return of Rs. 7200/ha from cocoa as a mixed crop in arecanut garden after incurring an amount of Rs. 3000 towards the cost of cultivation. The Benefit Cost Ratio for the cultivation of the high yielding accessions of cocoa worked out to 2.4.

### Technology Spread Status

In order to produce good quality hybrid seeds, biconal seed gardens with self incompatible parents with high specific combining ability have been raised at CPCRI Research Centre, Kidu, CPCRI Regional Station, Vittal as well as Kerala Agricultural University campus. The pods from these gardens can produce around 5.0 to 10.0 lakhs seedlings/year. The seedlings are distributed among the farmers as per their request.

### Farmers' Perception

The selected accessions are perceived to be performing well as compared to the seedlings from local types as indicated by the heavy demand for the planting materials of these accessions.

## 43. NURSERY TECHNIQUES FOR COCOA

Cocoa can be raised by seeds as well as through vegetative propagation. Fresh beans should be used for sowing as cocoa seeds, lose their viability soon after they are taken out of pods. Cocoa beans from ripe pods within fifteen days of becoming ripe can be used for raising seedlings. The seeds should be rubbed with dry sand or wood ash to remove the mucilage and are planted not more than 1 cm below the surface with their pointed ends upwards. Seeds may be sown in polythene bags (25 x 15 cm size, 150 gauge thickness). Normally germination will be at least 90 per cent and will be complete in 15 days. The nursery requires watering, which is commonly done every two or three days although daily watering is sometimes recommended especially during summer months. The seedlings will be ready for transplantation to the main field after three to four months.

**Grafts:** Softwood grafting is found successful and suitable in cocoa. The method consists of cleft grafting of scions to seedlings of 45 days old raised in polybags. The scions are collected by prior defoliation of shoots of comparative thickness. The selected scions are inserted into the cleft portions of the rootstocks so that they fit in tightly and the grafted site is tied with polythene strips. These grafts are kept in



Cocoa nursery

shade and watered daily. Graft union will take place within one month. All the shoots emerging from the rootstocks are to be removed periodically. The grafts are planted in the pits as in the case of seedlings after three to four months of hardening. About 80 per cent success is expected, if grafting is done in October month.

**Shade in nursery:** Cocoa, whose natural environment is the lower storey of the forest, requires shade particularly when they are in nursery. Coconut or arecanut fronds are used for providing shade as they are easily available and have the advantage of allowing the shade to be adjusted easily. Alternatively, shade trees like Rubber tree, *Glyricidia*, Silver Oak or *Erythrina* can also be used. Initial shade requirement is quite heavy—exceeding 50 per cent, but decreases as the seedlings grow.

### Economics

**At Research Station:** Planting materials obtained through soft wood grafting are performing well as compared to the seedlings. The soft wood graft materials could give an average yield of 1kg of dry bean/plant/year, thus ensuring a gross return of Rs. 18,000/ha from cocoa cultivation as a mixed crop in arecanut gardens.

### Technology Spread Status

CPCRI Regional Station, Vittal is producing about 1.0 to 2.0 lakhs of soft wood graft materials/annum for supply to farmers as well as the State Governments. It is estimated that more than 10.0 lakhs of cocoa plants with soft wood graft materials as the source of planting materials are available in the field at present.

### Farmers' Perception

The soft wood graft materials are perceived to be performing well as compared to the seedlings as indicated by the heavy demand for these planting materials. However, inadequate availability of soft wood graft materials is perceived to be the major constraint inhibiting the spread of this technology. Hence, more number of decentralised regional nurseries to produce quality soft wood grafts are to be established, to ensure the supply of the required quantity of good quality planting materials of cocoa to farmers.

## 44. ESTABLISHING A COCOA PLANTATION

**Planting time:** Cocoa can be planted as a mixed crop in both arecanut and coconut gardens. Planting time in both crops is May - June in low rainfall areas and September in heavy rainfall areas to avoid water logging in the initial stages.

**Spacing and alignment:** Cocoa seedlings are planted in pits of 60 cm<sup>3</sup> filled with compost. As a mixed crop, it can be grown in arecanut and coconut gardens. The mixed plantation of arecanut and cocoa can be raised by adopting normal spacing of 2.7 m x 2.7 m for arecanut and 2.7 m x 5.4 m for cocoa. Root studies also indicated that the above spacing is optimum for the crop. Both areca and cocoa need shade for the first two hot seasons. Later on, the shade provided by the areca is sufficient for cocoa.

When cocoa is to be raised as a mixed crop with coconut, either single hedge or double hedge system of planting may be adopted. In single hedge system, cocoa can be planted 2.7 m apart in a single row in between two rows of coconut, while in double hedge system, it can be planted 2.5 m apart



Establishing cocoa as a mixed crop in an arecanut garden

in double rows in between two rows of coconut palms.

**Shade in main garden:** Cocoa, whose natural environment is the lower storey of the forest, requires shade when young and also to a lesser extent when grown up. Young cocoa plants grow best with 50 per cent sunlight. It grows very well in the partially shaded conditions prevailing in the arecanut and coconut gardens in our country. As the tree matures, its shade requirements are reduced.

### Economics

**At Research Station:** The mixed plantation of arecanut and cocoa raised by adopting the normal spacing of 2.7 m x 2.7 m for arecanut and 2.7 m x 5.4 m for cocoa could give an average yield of 3.5 kg chali/palm/year from arecanut and 0.8 kg dry bean/plant/year from cocoa, thus ensuring an annual gross income of Rs. 2.24 lakhs/ha from this garden.

**At Farmers' Fields:** Under farmers field conditions, the average yield of arecanut is 2.5 kg chali/palm/year and 0.5 kg dry bean/plant/year from cocoa, thus ensuring an annual gross income of Rs. 1.59 lakhs/ha/annum.

### Technology Spread Status

It is estimated that more than 90% of the farmers adopt the correct planting time where as around 50% of the farmers adopt the recommended spacing for planting cocoa in arecanut/coconut gardens.

### Farmers' Perception

The farmers are fully convinced that cocoa crop planted during the recommended months alone could establish well and give a good performance. Similarly, farmers are convinced about the importance of adopting the recommended spacing. However, improper spacing already given to the main crop of coconut/arecanut influence the spacing to be adopted for cocoa, thus leading to improper adoption.

## 45. MANURING AND IRRIGATION IN COCOA

For obtaining good yield from cocoa crop, an annual application of 100 g N, 40 g P<sub>2</sub>O<sub>5</sub> and 140 g K<sub>2</sub>O per tree in two equal split doses is recommended. During the first year of planting, the plants may be given one third of the above dose, while in the second and third year, two thirds and full dose of fertilizers are to be applied respectively. The first dose should be applied in February - March and the second in September - October. Fertilizers are to be applied uniformly around the base of the tree up to a radius of 75 cm

and forked and incorporated in the soil. Summer irrigation is one of the important aspects in the cocoa cultivation. Cocoa plants require continuous supply of moisture for optimum growth and yield. During summer, the plants will have to be irrigated at weekly intervals. A weekly irrigation with 150 – 200 litres of water per tree is needed for cocoa. Where there is scarcity of water, drip irrigation can be adopted with great advantage. Through drip, about 20 litres of water per day per tree is required for good growth and yield of cocoa.

### Economics

**At Research Station:** Trials at CPCRI Regional Station, Vittal indicated that with a recommended level of fertilizers and irrigation schedule, the dry bean yield of 872 kg/ha could be obtained, thus resulting in a net return of Rs. 20,000/ha (as a mixed crop in arecanut garden).

**At Farmers' Fields:** Under farmers' field conditions, organic manures are mostly applied to the cocoa plants with under dosage of chemical fertilizers. They realize an yield of 300 kg/ha, thus resulting in a net return of Rs. 4000/ha.

### Technology Spread Status

Though the extent of adoption of recommended fertilizer schedule for cocoa cultivation is very low, the adoption level for the irrigation schedule is estimated to be more than 60%. It is observed that farmers seldom give the same level of importance for manuring cocoa plants as they take care to the main crop, either arecanut or coconut.

Only, less than 1% of the farmers are adopting the micro-irrigation system for cocoa crop. However, some farmers follow the sprinkler system especially when cocoa is grown as a mixed crop in arecanut gardens.

### Farmers' Perception

Farmers possess low level of awareness and knowledge about the relevance and importance of integrated nutrient management in cocoa, grown as a mixed crop in arecanut or coconut gardens. Hence intensive educational efforts, through training, field demonstration etc. are to be made for enhancing their level of knowledge about nutrient management in cocoa. Farmers perceive that the major reasons for low level of adoption of water conserving irrigation methods such as drip irrigation are the high initial investment required and clogging of pipelines.

## 46. PRUNING AND COCOA CANOPY MANAGEMENT

Cocoa plant requires fairly large canopy and leaf area to sustain high productivity because of its very low photosynthesis and net assimilation rate. When cultivated as a mixed crop under palms, a maximum of two-storey canopy architecture may be maintained. The plants require minimum of pruning, which is restricted to removal of the highly shaded and non-fruiting branches. The main stem may be kept to 1-1.5 m height before allowing the first jorquette. When budded-clonal planting material is used, it is advisable to keep 2-3 strong upright stems for good pod yields.

In cocoa, the nitrogen supply to the tree will determine the amount of vegetative growth, while photosynthesis will determine the carbohydrate reserve. The ratio between the nitrogen supply to the tree and the carbohydrate reserve within the tree will determine the quantity of fruit, which reaches maturity. Only the branches on the outside part of the canopy of the tree will produce



Pruning of cocoa for canopy management

### Economics

**At Research Station:** Spacing cum pruning trials conducted at CPCRI Regional Station, Vittal indicated that the highest yield of cocoa beans (650 kg/ha) could be obtained with a spacing of 2.7 m x 2.7 m and with a larger canopy of cocoa, thus resulting in a gross income of Rs. 19500/ha/annum from cocoa alone when cocoa is grown as a mixed crop in arecanut gardens.

**At Farmers' Fields:** Pruning is not done scientifically under farmers' field conditions. Thus the average yield realised is about 300 kg/ha of dry beans which fetches a gross income of Rs. 9000/ha/annum.

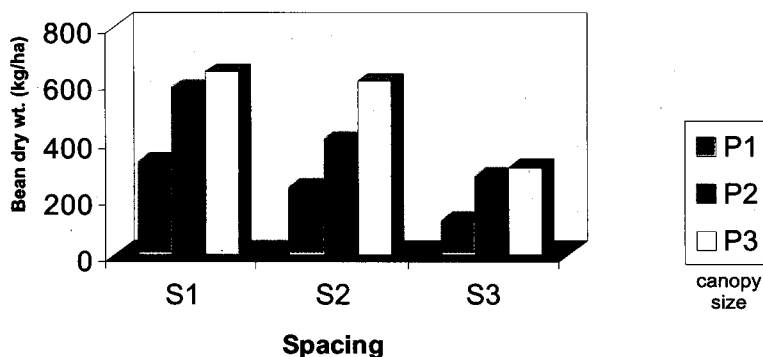
### Technology Spread Status

Though, more than 75% of the cocoa growers are adopting the practice of pruning, the extent of adoption of the recommended level of pruning among the cocoa growers was observed to be low.

photosynthates and thus make a real contribution to the carbohydrate reserves of the tree. All branches without leaves, but within the canopy could therefore be considered as parasites because they consume more nutrients than they produce. The maximum photosynthetic activity will occur when the maximum surface area of cocoa leaf per unit ground area is exposed to light.

In studies on canopy architecture and yield where five different types of canopy architecture were maintained in cocoa, it was found that big canopy with spreading nature seems to be ideal for cocoa. In order to understand and elucidate optimum canopy shape and structure of cocoa, different spacing and canopy sizes were studied. Cocoa was grown as mixed crop with arecanut. There were three spacing (S1, S2 and S3: narrow, medium and large spacing) and three canopy size treatments (P1, P2 and P3: small, medium and large) in a split plot

design. The results showed that there was significant difference in growth and canopy architecture with reference to treatment. Light interception varied among different treatments. The net photosynthesis, transpiration, stomatal conductance and internal CO<sub>2</sub> did not vary significantly among the treatments. Chlorophyll fluorescence parameters showed variations at different spacing. The dry bean yield showed significant variations, highest yield being obtained in S1P3 and S2P3 treatment (2.7 m x 2.7m spacing and large canopy; 2.7 m x 5.4m spacing and large canopy). Based on this experiment it was concluded that cocoa requires comparatively big and spreading canopy for high yield.



Dry bean yield (kg/ha) as influenced by spacing and pruning levels.

### Farmers' Perception

Lack of knowledge about the recommended practice of pruning and canopy management is perceived to be a major factor for its low level of adoption. Since the recommended technology involves certain amount of skill, it is necessary that adequate emphasis is given for the demonstration of the recommended pruning and canopy management practice to convince the farmers about the utility of this technology and also to guide them in carrying out this practice in the correct manner.

## 47. DISEASE MANAGEMENT IN COCOA

### Black pod disease

The disease was reported for the first time on criollo variety at Kallar in Tamil Nadu and later it was identified as a major problem on forastero variety. Black pod disease of cocoa occurs in the rainy season (June-September) when the humidity is high with a constant optimum temperature. Pods of all ages are susceptible to the disease. Presence of water soaked lesions is the first indication, which become necrotic and enlarge into circular or elliptical shape. The entire pod including beans turns into black colour within 15 days. In addition to *P. palmivora*, *P. capsici* and *P. citrophthora* also cause black pod disease in certain localities of Kerala State. Fungicides such as Captaf (0.1%), Ridomil MZ 72 (0.2%) and Foltaf (0.3%) were found to be highly effective in completely inhibiting the pod infection.

Field trials conducted in Karnataka suggested that spraying of Bordeaux mixture (1%) in 15 days intervals or Copper Oxylchloride at monthly (0.3%) or bimonthly (0.6%) intervals to the pods along with removal and destruction of diseased pods during June-September were found to be highly effective in black pod disease management. The spray should be mainly directed at the pods and bearing branches.



Black pod disease in cocoa

### Cherelle rot

The infection of younger pods by *Colletotrichum* is referred as cherelle rot. The mature pods are free from this disease. The symptoms of cherelle rot mostly start from the stalk end and infection proceeds towards the tip of the pod as a dark brown sunken region with a diffused yellow halo. As the

### Economics

A detailed survey of cocoa gardens in Kerala, Karnataka and Tamil Nadu States revealed that the diseases caused by *Phytophthora* and *Colletotrichum* and cocoa wilt could be considered as the major problems in India based on the extent of damage and nature of disease. Series of surveys conducted by various organizations indicated that the incidence of black pod disease has been found to vary from 12.93 to 29.78%. Severe incidence of cocoa wilt disease was noticed in parts of Karnataka (near Mysore) State and Kerala (near Thrissur) State in selected gardens, thus causing losses upto Rs. 5850/ha.

infection progresses, the internal tissue of the pod also becomes discoloured. The infection also starts from anywhere on the pod surface other than stalk region as a dark brown sunken region. Finally the pod turns dark brown to black and remains on the tree as mummified fruit. Spraying of Bavistin WP (Carbendazim) 0.05-0.1 per cent and Indofil M-45 (Mancozeb) 0.2-0.3 per cent were reported as promising fungicide for the control of cherville rot disease in cocoa.

### **Stem Canker**

Stem canker was first reported in 1978 from Dakshina Kannada in Karnataka. Later, a detailed survey conducted during 1980 reported the occurrence of canker disease in 22 per cent of the gardens in Kerala, Karnataka and Tamil Nadu States. Canker disease is identified by the appearance of greyish-brown, water soaked lesions with broad, dark brown to black margin anywhere on the main trunk, jorquette or fan branches. When the cankers girdle the trunk or branches, discolouration, wilting and ultimately defoliation take place. Such plants/branches show symptoms of dieback and eventually the portion above the point of attack dies. The canker disease often develops from the pods infected by *P. palmivora*. The infection from the pods spreads to the peduncle and then to the

cushion and bark causing canker. Hence, such infected pods should be removed and destroyed. This disease can be controlled in the early stages by the excision of diseased bark followed by wound sealing with Bordeaux paste.

### **Cocoa wilt**

Cocoa wilt was first noticed in 1998 in Hunsur (Karnataka). The disease has now reached an epidemic proportion and at present the disease is prevalent in Mysore, Mandya, Chamarajanagar and Bangalore Rural Districts of Karnataka. The cocoa plants of 2-5 years old were found to be more susceptible. The disease appears in September after South-West monsoon period and reaches maximum during October-March and then declines. The symptoms of the diseased plants are yellowing or browning of leaves, wilting of branches and finally death of the plants. The pods on the affected trees remain green for several days and slowly shrivel. These symptoms are invariably associated with borings of the branches that are about 1mm in diameter and are inhabited by *Xyleborus* beetles. For the control of the disease, phytosanitation measures such as removal and burning of infected trees and spraying of Propiconazole to adjacent plants are recommended.

## **Technology Spread Status**

Except for the adoption of fungicide spray for black pod disease on a trial basis, none of the cocoa farmers are adopting the disease management technologies especially with reference to application of chemical for the control of disease. However, other cultural and mechanical methods of disease management are being adopted by a large number of farmers.

## **Farmers' Perception**

Farmers feel that the diseases in cocoa would be managed by the adoption of cultural and mechanical methods of control and the spraying of fungicide for controlling diseases may not be effective in their plots.

## 48. PEST MANAGEMENT IN COCOA

### Mealy bugs (*Planococcus lilacinus* Ckll. and *P. citri* Risso)

Most important insect pest of cocoa in India is mealy bug. The mealy bugs infest all tender parts of the plant such as tender shoots, flower cushions, flower buds, cherelles and pods. The infestation of the growing tip suppresses the growth of the shoot and the tender leaves deform into hairy structures giving the shoot tip a brush-like appearance. When flower cushions are repeatedly infested, the growth of the flower buds is suppressed and in severe cases the flower cushions dry up. When cherelles are attacked, they wilt because the mealy bugs mainly colonize on the pedicel of the fruits. Population of mealy bugs is at its peak during summer months. Caterpillars of the lycaenid butterfly *Spalgis epius* are predaceous on the mealy bugs. Spot application of Monocrotophos 125 ml in 100 litres of water or Fenthion 50 ml in 100 litres of water would maintain the mealy bug population at a low level.



Rat damaged pod

### Mirids (*Helopeltis antonii* Sig.)

Incidence of *Helopeltis* on cocoa has become prominent in recent years. This mirid attacks cherelles, shoots and pods of cocoa. The feeding lesions on cherelles and pods are circular in shape. The pods with a heavy load of feeding may develop fissures on the surface and the beans become warty. Due to severe feeding on shoots, dieback symptoms will be seen on the canopy.

### Economics

**At Research Station:** Through the adoption of mechanical and chemical methods for controlling the rodents, it is possible to control rats as well as squirrels with minimum damage to the cocoa pods. As the incidence of insect pests in cocoa crop is below the threshold level in most of the gardens, it might not be necessary to opt for chemical methods for controlling these insects. However, when the intensity of the insect attack is high, chemical control could help the farmer in containing the losses.

**At Farmers' Fields:** Rodent management if not scientifically practiced in cocoa plantations, could incur economic loss up to Rs. 2000/ha.

## **Aphids (*Toxoptera aurantii* B de F.)**

The aphids colonize on the under side of tender leaves, succulent stem, flower buds and small cherelles. Heavy infestation brings about premature shedding of flowers and curling of leaves. The natural enemies associated with the aphid effect better control normally. In severe cases of infestation, spraying with Dimethoate 160 ml in 100 litres of water is suggested.

## **Stem borer (*Zeuzera coffeae* Nietn.)**

The red borer of coffee bore into the branches and trunks of cocoa trees. The portion of branch above the point of entry of the pest dries up. Control of the pest is best achieved by pruning off and destroying the attacked branches and by local application of Carbaryl paste.

## **Stem girdler (*Glenea* sp)**

The larvae of this beetle tunnel the bark first and penetrate deeper making galleries. On younger trees, the pest attack occurs at the jorquette, which normally results in the drying or breaking of the portion above. Mechanical extraction of the larvae and topical treatment with Carbaryl paste are suggested as control measures.

## **Rodent Management**

Rats (*Rattus rattus*) and squirrels (*Funambulus tristriatus* and *F. palmarum*) are the major rodent pests of cocoa. They cause serious damage to the pods. The rats usually gnaw the pods near the stalk portion whereas squirrels gnaw the pods in the centre. The rats are known to damage the mature as well as immature cocoa pods whereas the squirrels damage only the mature ones. They gnaw the pods and feed on the mucilage covering of the beans. The rats can be controlled by keeping 10 g Bromadiolone (0.005%) wax cakes on the branches of cocoa trees twice at an interval of 10-12 days.

Trapping with wooden or wiremesh single catch 'live' trap with ripe coconut kernel as the bait controls squirrels. The success is more if trapping is carried out during the lean periods of the crop (September-November) and when the alternate food such as paddy, cashew apples and jackfruit are not available. The traps are inspected daily and the trapped animals are killed to minimize the chances of communication with other animals. Timely harvest of the pods will help in increasing the efficiency of poison baiting as well as trapping.

## **Technology Spread Status**

More than 75% of the farmers are adopting the mechanical and chemical methods of controlling the rats and squirrels in cocoa gardens to keep the losses due to these vertebrate pests at the minimum. However, the level of adoption of control measures for other pests is almost nil except for the periodical removal of affected plant parts.

## **Farmers' Perception**

Farmers feel that the rats and squirrels are the major pests of cocoa causing heavy losses to the cocoa growers. Hence, research on the management of rodent in cocoa gardens is to be strengthened. Farmers are of the opinion that the losses due to other insect pests to cocoa is negligible.

## 49. INSTITUTIONAL TRAINING PROGRAMMES

CPCRI is organizing a series of short term Institutional training programmes as well as off-campus training programmes for the benefit of research workers, extension personnel, farmers, farm women and entrepreneurs. The “Annual Calendar” indicating the training programmes to be organized during the year is brought out at the beginning of every year under the title “Training Sched-

ule”. This publication includes information on the list of training programmes to be or-



A training programme on “Plantation crops production technology” for extension personnel

ganized during the year, Key contents (Syllabus), Duration, Schedule, Venue, Number

### Impact analysis – a case study

On the receipt of the “Training schedule – 2000” publication from CPCRI, Govt. of Maharashtra approached CPCRI to offer a need based training programme on “Post Harvest Technologies for Horticultural Crops in Konkan Region” covering the mandate crops of CPCRI viz., coconut, arecanut and cocoa as well as crops of sister institutions like cashew, spices and mango. The programme was to be offered in 9 batches @ 20 officials per batch. Duration of each course was seven days. Thus, seven days training programme on “Post Harvest Technology of Horticultural Crops of Konkan Region” was held in nine batches during 2000 – 01. A total number of 179 Horticultural Officers from the Maharashtra State participated in the training programmes. The course was designed to impart latest knowledge and skill on various aspects of harvest and post-harvest operations and allied techniques of horticultural crops such as coconut, arecanut, cocoa, cashew, spices and mango. List of topics covered for each batch of the training programme is indicated here:

- i. Plantation crop processing industry in India with special reference to the Konkan region of Maharashtra State
- ii. Post Harvest Technology of edible coconut products and by-products.

of seats, Course fee, Course Director, Last date for receipt of nomination as well as the proforma for nominating candidates. Similarly, details on the International training programmes to be organized by the Institute

during the year are also included. CPCRI is highly encouraged by the response shown by the user organizations for the training programmes being offered at the Institute.

- iii. Products of coconut timber, husk and shell
- iv. Post-harvest technology of arecanut
- v. Post-harvest processing technology of Cocoa
- vi. Quality and post-harvest processing of Cashew
- vii. Post-harvest processing of Spices
- viii. Post harvest technology of Mango
- xi. Keeping quality of products and by-products of Horticultural crops of Konkan Region
- x. Agro-techniques for getting good quality products in coconut, arecanut, cocoa, cashew, mango and spices
- xi. Farmer participation in agri-process sector – a tool for transfer of technology
- xii. Mango based products – canning and bottling of fruit products
- xiii. Primary and secondary processing of cashew
- xiv. Cocoa based products
- xv. Selection of varieties with respect to agro-climatic region for getting good quality products
- xvi. Coconut shell based products
- xvii. Utilization of wastes of coconut industry

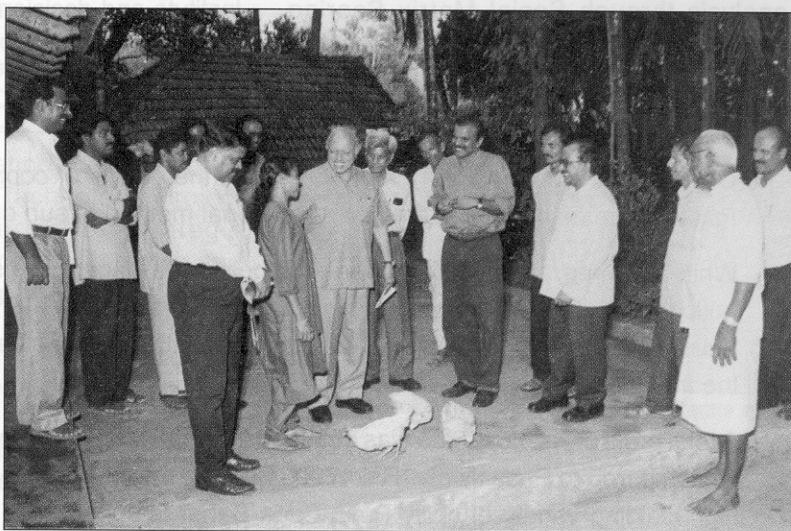
In addition to the class room lectures, visit to nine processing industries of coconut, cocoa, arecanut, cashew and mango was arranged. The course fee for the training was Rs. 1000/- per trainee.

A book on 'Post harvest technology of horticultural crops of Konkan Region' published at the commencement of the programme, served as the course material. The book covers about post harvest handling of the major horticultural crops of Konkan Region like coconut, arecanut, cocoa, cashew, mango and spices.

Follow up study on the impact of the training programme showed that the participants could immensely benefit from this programme and introduce a Member of post-harvest technologies in the Maharashtra State.

## 50. INSTITUTION VILLAGE LINKAGE PROGRAMME

The Institution Village Linkage Programme for Technology Assessment and Refinement was started in the year 1996 as an ICAR Cess Fund Scheme. The project was continued under National Agricultural Technology Project from 1999 onwards. The project was utilized for conducting multi-locational trials on emerging CPCRI



Dr. M.S. Swaminathan, a world renowned scientist visiting a village under IVLP

technologies in farmers' fields under participatory mode. Every year 15 to 20 technologies are chosen and each

technology is tested for its performance in about 20-50 farmers holdings. The performance of technologies is assessed by

### Salient Achievements

- i. The medium duration, rice variety Aishwarya obtained a higher profit of Rs. 10,951/ha as compared to the local variety (Rs. 5,571/ha) during the Viruppu (Kharif) season. The high yielding medium duration variety of rice, Aishwarya has been accepted as a suitable variety for Kharif by 90% of the farmers in the study area as well as in the adjoining villages.
- ii. The bhendi variety, Arka Anamika (6.60 t/ha) could give higher per day productivity than the local variety, Arka Abhay and CO-3. In the case of Arka Anamika, yield equal to local variety was obtained within 45 days as against 135 days taken by the local variety. The result indicate that Arka Anamika variety is suitable for cultivation as an intercrop in coconut gardens during kharif season. 60% of the farmers have expressed satisfaction in this regard.
- iii. Green manure crops like *Mimosa invisa*, *Calopogonium mucanoides* and *Peuraria phaseliodes* are suitable for cultivation in coconut basins during kharif season.

various technical parameters, economic indicators as well as farmers' perception analysis through Social Matrix Scoring Procedure. The feed back obtained from this

assessment is discussed in detail in the Scientific Research Council meetings of the Institute and decisions on commercialization or further refinement of technologies are taken.

- iv. Use of small holders copra dryer increases the quality of copra and fetches higher market price as compared to the conventional method of sun drying.
- v. While covering arecanut bunches with polythene bags, no disease incidence was noticed as compared to the spraying of Bordeaux mixture (13.99% disease incidence). This indicate that covering of arecanut bunches with polythene bags effectively controls the fruit rot disease in arecanut.
- vi. A total profit of Rs. 26725/ha was obtained from Pusa Sada Bahar (a new chilly variety) as compared to Pusa Jwala (Rs. 17923/ha) and the local variety (Rs. 12150/ha). The high yielding variety of chilly Pusa Sada Bahar is suitable for cultivation in the rice fallows during rabi season in North Kerala region.
- vii. The returns per rupee spent in the sweet potato variety, Selection 56/2 – a pre-release variety from CTCRI was 2.45 as compared to the local variety (1.96) and the other variety Selection RS/III-3 (1.31). This proves that Selection 56/2, a pre-release sweet potato variety is suitable for cultivation in the region.
- viii. The Gramalakshmi birds were found to be excellent layers, with better feed- efficiency, having an average clutch size of 22 and comparatively lesser inter clutch interval, while the weight of the birds (1.35 kg) was more or less on par with the local breed. This Verification Trial indicated that Gramalaxmi is a suitable poultry breed for rearing in the backyards of homesteads.
- ix In addition, the following long term trials being conducted in the study area are showing encouraging results on the field performance of new technologies in plantation crops.
  - Assessing the performance of improved coconut varieties under rainfed conditions.
  - Assessing the performance of coconut hybrids under irrigated conditions.
  - Assessing the performance of new pepper cultivars as mixed crop in adult coconut gardens under rainfed conditions.
  - Assessing the performance of improved varieties of arecanut.
  - Assessing the performance of new pepper varieties as mixed crop in arecanut gardens.
  - Assessing the performance of new cashew varieties.

## 51. AGRICULTURAL TECHNOLOGY INFORMATION CENTRE

For serving the interests of the farming community, the Indian Council of Agricultural Research, under the “Innovation in Technology Dissemination” component of National Agricultural Technology Project (NATP), made a series of strategic investments to introduce programmes and institutional adjustment at national, state, district, block and village level and operational changes in the methodology in which the extension workers are trained, interact with farmers and communities, communicate information and coordinate with the private sector.

As a part of this strategy, Agricultural Technology Information Centres (ATIC) are established in 40 centres located in ICAR Institutes and State Agricultural Universities for serving the farming community on a ‘Single Window System’ concept. The ATIC at Central Plantation Crops Research Institute was sanctioned during November, 1999.

### Infrastructural Facilities

The ATIC is functioning in a well-designed building constructed under NATP. The building has facilities like Reception Room, Sales Counter for planting materials



Agricultural Technology Information Centre at CPCRI, Kasaragod

Communication Hall, Audio-Production Centre, Technology Information Gallery, Public Relations Cell, Sales Counter for Technology Products and Plant Clinic. In addition, the Tendernut Parlour and the “Coconut House” are also functioning as the components of ATIC.

### ATIC – Objectives

The objectives for the establishment of ATIC at CPCRI as a Single Window System are as follows:

- To provide a ‘Single Window’ delivery system for the products available from CPCRI to the farmers and other interested groups as a process of

### Impact

ATIC services were formally initiated on February 2, 2000. Upto the date of this publication, a total number of 1,34,172 farmers and other clients visited, utilized services at the ATIC primarily for the purchase of quality planting materials and other technological inputs and products in addition to availing guidance on the establishment of coconut and arecanut gardens and to obtain information on the achievements and activities of CPCRI. Crop management technology and crop protection were the major areas of interest evinced by the farmers. In addition, a large number of farmers showed interest in understanding the comparative performance of different varieties of coconut and arecanut and measures for ensuring better establishment of coconut and arecanut while they purchase seedlings of these crops. A special feature of the ATIC activity is the sale of 725 numbers of CD ROM on coconut, arecanut and cocoa cultivation.

Innovation in Technology Dissemination at the Institute level.

- To facilitate direct access to the farmers to the institutional resources available in terms of technology inputs, advice, technology products etc.
- To provide mechanism for feedback from the users to the Institute.

### **Services offered at ATIC**

#### **Technology inputs**

- West Coast Tall – coconut seedlings
- Other varieties of coconut seedlings
- Hybrid – coconut seedlings
- Poly bag coconut seedlings
- Arecanut seedlings
- Arecanut seed nuts – Mohitnagar, Mangala, Sumangala and Sreemangala varieties
- Mushroom spawn (Pleurotus)
- Earthworms
- Vermicompost

#### **Technology products and processed products**

- Arecanut dehusker
- Snow Ball Tender Nut Machine

- Coconut chips
- Snow Ball Tender Nut
- Mushroom
- Tendernut
- Coconut

#### **Priced publications**

- Coconut cultivars & Hybrids
- Cocoa Crop Management
- Copra Dryers
- Organic Farming Technology in coconut
- Arecanut Crop Management
- Coconut crop scientific Management (Malayalam)
- Improved varieties and promising traditional cultivars of Arecanut
- Management of coconut gardens
- Mixed cropping of black pepper in coconut and arecanut gardens
- Cashew production technology
- Coconut Embryo culture
- Treatise on palmyrah
- Plant Pathology Research at CPCRI
- Annotated Bibliography on coconut in

CPCRI web site ([www.cpcri.nic.in](http://www.cpcri.nic.in)) is well visited by the users. Approximately 15000 users are visiting the web site per annum. Innovative activities initiated by the ATIC to fulfill its objectives include “Ask the Expert” facility, “Frequently Asked Questions” and the facility for on-line registration for planting materials available in the web site; production and distribution of large numbers of CD ROM on the cultivation practices for coconut, arecanut and cocoa and publication of ATIC Newsletter utilizing the in-house facilities available at CPCRI. The popularity of CPCRI among the stake holders has gone up tremendously. Due to heavy demand from visitors, most of the priced publications at CPCRI were exhausted and printing of a series of Technical Bulletins (priced publications) is in progress. Sale of post-harvest technology machineries (first time in the history of CPCRI) could be made possible because of the promotional efforts taken by ATIC. The total value of sale of technological services, products and publications during the first three years of establishment of ATIC was Rs. 19.55/- lakhs.

India 1977-1990

- Coconut Descriptor Part-I
- Cocoa

#### **CD ROM**

- eManual on Coconut Cultivation
- Integrated Pest Management in Coconut
- Arecanut Cultivation
- Cocoa Crop Management
- CPCRI – An Overview
- Coconut Descriptor Part – II

#### **Video Films**

- Integrated pest and disease

management in coconut

- CPCRI – at a glance
- Coconut Cultivars and Hybrids
- Root (wilt) disease Management
- Eriophyid Mite Management
- Coconut Production Technology
- Arecanut Production Technology

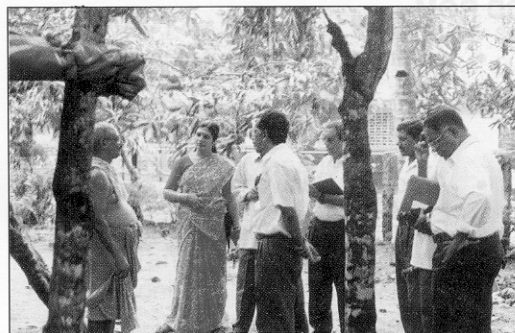
#### **Audio-cassettes**

- Coconut cultivation technology
- Arecanut cultivation technology
- Cocoa cultivation technology
- Integrated pest and disease management in arecanut

## 52. PARTICIPATORY TECHNOLOGY TRANSFER PROGRAMME

Convincing the farmers about the new technologies in perennial crops is often felt to be a great task especially due to low observability of the impact of technology and less immediacy of returns. Hence, it is essential that new extension strategies are adopted to popularize the perennial crop based technologies.

CPCRI tried the Participatory Technology Transfer (PTT) methodology as the process for demonstrating the impact of root (wilt) management technologies. For this purpose, 25 hectares of coconut gardens owned by 208 farmers on both the sides of the road was selected near the CPCRI Regional Station, Kayangulam as the participants of the programme. The project



Participatory Technology Transfer programme for Integrated Management of root (wilt) affected coconut gardens

was implemented under NATP. The participatory technology transfer approach is being implemented among the farmers to improve the awareness, knowledge, skill and

### Impact of the programme

**Behavioural impact:** The improvement in awareness, knowledge, attitude and adoption scores of the farmers before and after Participatory Technology Transfer recorded significant changes indicating the utility of extension interventions (Table).

#### Impact of the programme on the behaviour of participants

Variables	Average scores		't' value
	Before PTT	After PTT	
Awareness	14.11	32.53	14.3452**
Knowledge	18.84	59.47	08.0527**
Attitude	22.56	36.48	04.3811**
Adoption	16.32	45.58	06.8981**

\*\* Significant at 0.01 level

Further analysis of the impact data revealed the following:

- ❖ The categorization of the farmers indicated significant shift to the high level of awareness from 63.00 to 92.00 % after three years of PTT efforts in root(wilt) affected area.

the adoption of technologies recommended by CPCRI. The methodology includes utilization of personal, mass and group extension techniques with the participation of the farmers, farm women/household as an unit of transfer of technology and the

extension officials and the scientists of the research stations as facilitators. To study the feasibility and impact of the approach, the initial socio-economic details, farm and coconut palm profile were recorded in detail.

- ❖ The improvement in the high level of knowledge category was from 14.00 to 74.50 % after PTT regarding integrated management practices.
- ❖ The overall adoption categories indicated that only a quarter of the respondents (27.50%) were in the high adoption level before PTT. But more than half of the respondents (57.00%) were in the high adoption category after PTT.

**Physical impact:** The impact of the programme in terms of improvement in coconut yield and changes in the pattern of incidence of pests and diseases are given below:

The project covered about 25 ha area with about 5000 adult coconut palms and 2000 seedlings. The average yield recorded during the initial period was about 24 nuts per palm per year. After 1½ years of implementation of the project, a sample survey was conducted and the average yield recorded was 33 nuts per palm per year (34.3% increase). However, at the end of three years, the average yield went up to 46 nuts per palm per year showing an increase of 91.4%.

About 23.5% of the palms were in the 'disease advanced' category in the initial period and their proportion got reduced to 7.8% after the implementation of the project. 'Apparently healthy' palms increased to 18.8% from 12.6%. Similarly proportion in 'disease early' category and 'disease middle' category were increased to 37.7% from 31.7% and 35.7% from 32.0% respectively.

Leaf rot disease incidence was noticed in 47.9% palms during the initial periods of the programme. But after the application of leaf rot management practices, only 1.5% of the palms are showing mild symptoms while none of the palms was having severe infestation.

At the beginning of the programme, 68% of the yielding palms were having severe Eriophyid mite infestation. After three years of implementation of the project, 34.3% of the palms are fully free from mite attack, whereas only 15.3% of the palms are severely infected. Rhinoceros beetle attack got reduced from 25.5% to a mere 1.8% after the programme.

The study indicated that the rapid spread of perennial crops based technologies could be ensured by utilizing novel extension methodologies like Participatory Technology Transfer Programme.

## 53. REMANDATED ZONAL RESEARCH STATION

A Krishi Vigyan Kendra was established at CPCRI Regional Station, Kayangulam campus during the year 2000 under the NATP on Remandated Zonal Agricultural Research Stations for taking up additional responsibilities of Krishi Vigyan Kendra with the following objectives.



A training programme on food processing organised by the KVK at Kayangulam for the Women's Self Help Group

- i. To organize vocational training programmes in agriculture and other allied enterprises.
- ii. To conduct on farm testing for identifying technology in terms of location specific sustainable land use systems.
- iii. To organize frontline demonstrations on major cereal crops, oilseeds and pulses and other enterprises related to agriculture.
- iv. To arrange in-service training for field level extension officials on emerging trends in agricultural research.

The activities are mainly concentrated in the Alappuzha District, which is very unique with its paddy area and specific agricultural areas like Kuttanad Padasekharams, Kari lands and water bodies. Highlights of the activities and achievements made under the project are presented in this chapter.

### On Campus training programmes

Sl. No.	Category	Male	Female	Total
1.	Practicing Farmers	793	293	1086
2.	Farm Women	-	1136	1136
3.	Rural Youth	632	470	1102
4.	Students	21	88	109
5.	Extension Officials	153	147	300
	<b>TOTAL</b>	<b>1599</b>	<b>2134</b>	<b>3733</b>

### Off Campus training programmes

Sl. No.	Category	Male	Female	Total
1.	Practicing Farmers	302	89	391
2.	Farm Women	-	1201	1201
3.	Rural Youth	55	34	89
4.	Students	13	133	146
5.	Extension Officials	64	57	121
	<b>TOTAL</b>	<b>434</b>	<b>1514</b>	<b>1948</b>

## Details of Frontline Demonstrations and on-farm trials conducted by RZARS-KVK

Sl.No.	Title of FLD/OFT	Results
1.	Frontline demonstration on utilization of organic wastes using earth worms	It is a low input, clean, better utilization technology by which additional income can be generated. A total of Rs. 2000/- was generated/pit/harvest. B:C ratio was 2.37.
2.	Frontline demonstration on Solarization as a prophylactic measure against pests and diseases	Disease incidence and weed growth was very much reduced and hence the yield was increased. B:C ratio was found higher in case of solarized (1.6) than unsolarized (1.07) beds.
3.	Integrated root (wilt) disease management practices in coconut gardens	An average increase of 92% over the initial yield was noticed in the treated palms, with a B:C ratio of 2.79.
4.	Frontline demonstration on the establishment of nutrition garden for year round vegetable production	Better utilization of time by farm women and production of farm fresh vegetables were the main advantages.
5.	Frontline demonstration on different varieties of banana including tissue culture banana as intercrop in coconut gardens.	An increase in yield of 37.09% was obtained over the local check with a B:C ratio of 1.62
6.	Management of rhinoceros beetle in coconut	Leaf axil filling with Naphthalene balls @ 12 g/palm, 4 times in a year recorded 84% reduction in pest infestation and found superior to other treatments tested.
7.	Comparison of different management practices for the control of leaf spot of Amaranthus	Avoiding splash irrigation +removal of affected leaves+spraying Mancozeb 0.4% in cow dung supernatant solution at weekly intervals registered the lowest disease intensity (6%) and maximum yield (23.75 tonnes/ha). The farmers' practice using baking soda and turmeric powder also gave an yield of 21 tonnes/ha with 14% disease intensity.
8.	Evaluation of feasibility of low cost supplementary food among pre- schoolers	Ragi based pre school snack considerably improved the nutritional status of the children.

## **Publications**

The Krishi Vigyan Kendra has published 17 Training Manuals to improve the quality of training programmes and to make the participants gain maximum from such programmes.

- i. A guide for banana farmers
- ii. Ginger, turmeric – scientific cultivation practices
- iii. Oyster mushroom cultivation and its preparations
- iv. Scientific pepper cultivation
- v. Kitchen gardening
- vi. Apiculture
- vii. Vahilla cultivation
- viii. Different types of composts
- ix. Nursery management and plant propagation techniques

- x. Food processing
- xi. Medicinal plant cultivation
- xii. Lawn making and management
- xiii. Bio pesticides
- xiv. Banana products
- xv. Cashew apple products
- xvi. Growing layer birds as a profitable vocation
- xvii. Soap making

## **Impact**

The Krishi Vigyan Kendra could act as a catalyst in initiating a number of micro-enterprises as well as farm based activities especially among the Women Self Help Groups. The project was appreciated as the best in the series by the reviewing authorities.

## 54. INTERFACE PROGRAMMES

CPCRI is organising a novel effort of conducting “Interface programme for coconut development” at District Headquarters in Kerala and Karnataka States primarily to convince the farmers and field level extension workers regarding the utility of the recommended coconut crop management and value addition technologies.

### Objectives

- i) To organize a comprehensive interface among all those associated with coconut cultivation and development
- ii) To explain the farmers the details of the technologies developed, including the necessity for their timely adoption
- iii) To demonstrate the technologies in the fields of farmers through participatory methodology
- iv) To arrange an exhibition on all aspects of coconut highlighting the success of technologies
- v) To elicit the response of farmers and to clarify their doubts
- vi) To evaluate the level of acceptability of technologies and their adoption pattern
- vii) To assess the constraints in the adoption of technologies
- viii) To suggest corrective measures for ensuring appropriate application of technologies
- ix) To demonstrate the potentiality of technologies towards increasing the economic returns.

### Scope

A number of coconut production technologies have been developed by



Interface programme organized at CPCRI, Kasaragod.

various organizations including ICAR Institutes and State Agricultural Universities over the last few decades. The package of practices for coconut cultivation as recommended by different states are the outcome of research efforts taken by scientists for the benefit of farmers. However, the acceptance and utilization of these technologies by the farmers depend on various factors. Survey conducted by the Central Plantation Crops Research Institute and Kerala Agricultural University in different Districts in Kerala State have indicated that the major factor for non-adoption is the lack of knowledge on technologies. In addition to this, perception among the farmers that the recommended technology may be effective at research stations or at a given situation only, but the same may not be economical in their own farming conditions may also hinder in the acceptance of technologies. The extension system in the State comprising officers of the Department of Agriculture and Scientists from KAU, CPCRI etc., take intensive efforts to spread the information on coconut cultivation technologies among the farming community through the use of various communication channels. However, the problems of misconception about the coconut

technologies continue to exist in majority of the minds of the farming community. This situation leads us to think that only through an holistic approach by bringing the scientists, development personnel and end users (farmers and entrepreneurs) to a common platform for a meaningful and dispassionate dialogue, one could bring remedy to the situation. The ultimate goal is

to remove all the doubts from the minds of growers. Hence, the proposal for organizing interface programmes in different Districts of Kerala, Karnataka, Tamil Nadu and Andhra Pradesh States was mooted. This interface programme is bound to enhance the adoption of technologies ultimately leading to coconut growers' benefit.

#### List of interface programmes conducted

Sl. No.	District	Date	Thematic areas discussed
1.	Kollam	28.5.2002	a. Eriophyid mite management b. Root (wilt) disease management c. Coconut crop management d. Post harvest technology
2.	Thiruvananthapuram	31.5.2002	a. Coconut crop management b. Integrated pest and disease management c. Post harvest technology
3.	Pathanamthitta	10.6.2002	a. Eriophyid mite management b. Root (wilt) disease management c. Post harvest technology
4.	Alappuzha	28.6.2002	a. Eriophyid mite management b. Root (wilt) disease management c. Post harvest technology
5.	Malappuram	05.7.2002	a. Eriophyid mite management b. Coconut crop management c. Integrated pest and disease management d. Post harvest technology
6.	Kozhikode	06.7.2002	a. Eriophyid mite management b. Coconut crop management c. Integrated pest and disease management d. Post harvest technology
7.	Kasaragod	08.7.2002	a. Eriophyid mite management b. Coconut crop management

			c. Integrated pest and disease management d. Post harvest technology
8.	Palakkad	17.7.2002	a. Eriophyid mite management b. Coconut crop management c. Integrated pest and disease management d. Post harvest technology
9.	Kottayam	10.8.2002	a. Eriophyid mite management b. Root (wilt) disease management c. Coconut crop management d. Post harvest technology
10.	Ernakulam	28.9.2002	a. Eriophyid mite management b. Root (wilt) disease management c. Post harvest technology
11.	Kannur	17.2. 2003	a. Eriophyid mite management b. Coconut crop management c. Integrated pest and disease management d. Post harvest technology
12.	Trichur	10.04.2003	a. Eriophyid mite management b. Coconut crop management c. Integrated pest and disease management d. Post harvest technology
13.	Tumkur	05.6.2003	a. Eriophyid mite management b. Coconut crop management c. Post harvest technology

### Impact

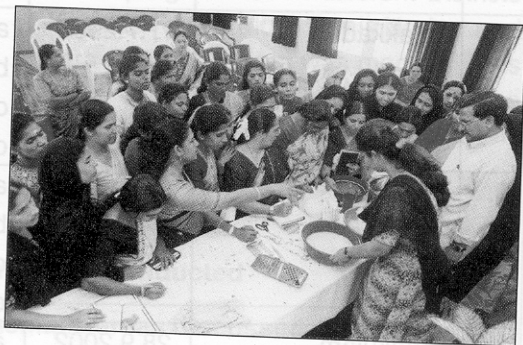
Through the Interface programmes in different District headquarters, we could create a mass awareness among the farming community and extension personnel about the viability of recommended technologies. As the survey among the field level extension personnel in different Districts indicated, the interface programmes acted as a catalyst for initiating a few Coconut Processing Industries through the Self Help Groups. In addition, the negative perception about the

performance of the technologies especially with reference to root (wilt) disease management, considerably and eriophyid mite control was reduced to a great extent among the extension personnel and policy makers as well as the farming community. Frequent follow-up contacts between the extension personnel/farmers and CPCRI, subsequent to the interface meetings, is an encouraging sign for the Institute to take up similar programmes.

## 55. EMPOWERMENT OF WOMEN

Women are the pioneers of farming activity in India. It was women who first domesticated the crop plants and thereby the art and science of farming. "Women-thy name is creation of all greens around us". Nearly 84% of all economically active women in India are engaged in agriculture. They constitute 1/3<sup>rd</sup> of the agricultural labour force and 48% of self employed farmers. Agriculture is the main stay of Indian economy as over 70% of India's population depend upon agriculture and allied occupations for their livelihood. Despite their crucial role in agricultural development, the farm-women remain as 'invisible workers' suffering severe discrimination due to gender biased society. Though the law does not permit any prejudice on the ground of gender, the daily wages of women labourers are much less when compared to male counterparts. Gender disparity reduces the participation of women not only in employment, but also in the process of economic development. The effect is so severe that even educated women are oppressed.

In India, there is an increasing trend towards feminization of agriculture. One of its main causes is the rural-urban migration



Training programme on production of value added coconut products for women

of men in search of employment. To meet the changing socio-economic realities, the improvement of technical competence of women in agriculture is a must. For an economically and ecologically sustainable agriculture, the involvement of farm-women is absolutely essential. Keeping in view the past and continued role of women in this sector, efforts must be streamlined towards reduction of drudgery, improved productivity and diversified opportunity, productive and remunerative employment. Today, technological empowerment and education of women are the key issues before the society for saving them from drudgery. In order to improve their physical and human

### Training highlights

Since its inception in 1993, the KVK at Kasaragod has organized a total of 489 training courses consisting of 283 on-campus and 206 off-campus training programmes. A total of 10,064 trainees have been benefited from these training courses, out of which 3,939 are women beneficiaries. Among the above courses, 59 were conducted exclusively for women self-help groups under women cell activities, which was attended by 1,112 ladies.

### Impact

The Krishi Vigyan Kendra of CPCRI, Kasaragod has been instrumental in motivating the rural women in acquiring professional skills and capabilities in the fields of Home Science, Agriculture and allied aspects through trainings and women cell activities in empowering them. Food processing is one area which helps in reducing wastage and adds value to the produce. Among the women of Kasaragod District, small scale food

capital, their access to resources, technology and information has to be enhanced. The Government of India has been making concrete efforts by initiating several schemes and interventions to protect and improve the status of women.

Krishi Vigyan Kendra (KVK) are district level organizations established by the ICAR mainly for speedy transfer of technologies with a minimum time lag between technology generation and its utilization. The KVK also caters to the needs of broadening the range of agricultural training programmes and extension activities to support women's role in agricultural production, processing, preservation and marketing and in non-formal activities such as health care, upbringing of children and nutrition.

The KVK of CPCRI, Kasaragod is functioning since 1993 for the over-all development of farming community in the District with much emphasis on the technological empowerment of rural women. It has been organizing need based training programmes in different disciplines such as Home Science, Horticulture, Agriculture, Agricultural Engineering and allied

enterprises for the benefit of practicing farmers, rural youth, farm women and extension functionaries. Krishi Vigyan Kendra at CPCRI, Kasaragod Campus has been instrumental in motivating the rural women of Kasaragod District in acquiring professional skills and capabilities in the field of Home Science, Agriculture and allied aspects through different training modules with emphasis on "learning by doing" for higher production on farms and generating self-employment. This mandate of the KVK could be implemented effectively through the active and wholehearted co-operation of all the District level Development Departments such as Agriculture/Horticulture/Fisheries/Animal Husbandry/Sericulture/Khadi and Village Industries Board and other non-government organizations. The Scientific Advisory Committee of KVK has also played a key role in offering valuable guidance for undertaking the programmes. The KVK activities are further strengthened by the establishment of a Women Cell with effect from March, 1998. The women participation in KVK training programmes is significant with a sex ratio of 100(M):64(F).

processing is a popular activity which is very well accepted. It plays a significant role in controlling post harvest losses thereby enhancing the income level. Activities like establishment of kitchen garden, ornamental crops orchard, bee keeping, vermicomposting, mushroom cultivation, poultry, silk worm rearing etc., which require intensive and tender care are efficiently and successfully taken up and handled by several women self help groups. Women are the best teachers and managers in the family. Rural women now are on par with their urban counter parts and play a greater role in all development programmes. They have been sensitized by various activities of the KVK towards better management of their resources especially through self help groups to eradicate poverty and create happy, healthy families and communities and there by a strong nation. The KVK is also extending suitable technical help by way of imparting need based training programmes as per the request of various self-help groups functioning in Kasaragod District with the financial assistance of local bodies and voluntary organizations. About 80 self help groups have been identified and motivated to start income generating enterprises.

Thus, the popular concept of 'reaching' the 'unreached' women in awakening and realizing their innate potentials to improve their own families and serve as models to others has come to stay in the Kasaragod District, which other Districts in Kerala State might emulate and enhance the economic benefits to the farming community.

## 56. POVERTY REDUCTION PROGRAMMES

The coconut tree popularly known as "Kalpa Vriksha" is offering unlimited scope for the production of a wide range of products and by-products. If a coconut farmer uses all the parts of the coconut palms effectively, he would definitely be able to improve his standard of living substantially. The SWOT analysis undertaken by the Institute on the coconut production scenario revealed the following:

### STRENGTH

- ❖ Perennial crop with continuous production of nuts and other marketable products.
- ❖ Wider adaptability to ecosystems
- ❖ Established management practices for sustained yield levels
- ❖ Time tested and proven technologies for adoption at farmers' level with scope for inter/multiple/mixed crops.
- ❖ Innumerable products/byproducts of high economic value
- ❖ High employment opportunities for women, deprived and youth
- ❖ High potential for export of products and earnings in international markets.
- ❖ Health promoting food products and eco-friendly non-food items
- ❖ Great stake for agro-industries and community development.

### WEAKNESS

- ❑ Predominance of small and marginal holdings
- ❑ Less marketable surplus
- ❑ Fluctuations in productivity
- ❑ Prone to attack by abiotic and biotic factors
- ❑ Inadequate knowledge and poor adoption of technologies



High yielding coconut - a source of additional income to poor rural communities

- ❑ Market process based on one or two products only
- ❑ Lack of infrastructure for marketing
- ❑ Insufficiency in agro-based industries
- ❑ Unexploited potential of human resources for small/medium scale industries.

### OPPORTUNITIES

- Evaluation of the largest number of germplasm for a given purpose/ utilization
- Enhancement of knowledge through intensive training programmes
- Greater scope for adoption of technologies with refinement
- Involvement of community level approach for augmenting farm income

- Potential source for women empowerment through self-help groups
- Restructuring the market base linkages with agro-corporations/industries
- Excellent scope for product diversification and value addition.

### THREATS

- Decline in farm income imposed due to various factors — market price, infestation by pests/diseases, adverse weather
- Neglect of the garden leading to poor yield levels
- Increase in unemployment of youth and women
- Non-competitiveness at global level
- Depression in coconut community

Keeping the theme “ a coconut farmer need not be a poor farmer” as the basic concept, an IPGRI sponsored project on “Poverty Reduction” among coconut communities has been initiated at CPCRI.

CPCRI received the approval and sanction in the year 2002 for the implementation of IPGRI funded project on “Developing sustainable coconut-based income generating technologies in poor rural communities in India” in two sites with coconut communities representing East-Coast and West-Coast regions of India. The project envisaged the implementation of the following activities for improving the returns from coconut cultivation.

- Bench mark survey and situation analysis through PRA
- Development of a production plan
- Formation of a Community Based Organization (CBO) involving all the coconut farmers in the selected area as stake holders (A nominal entry fee of Rs. 50/- per member was collected).
- Implementation of a Micro-Credit system by which part of the funds provided under the project would be placed at the disposal of the Community

Based Organization as the seed money.

- The CBO would provide micro credit to its members (in kind) for the purchase of critical inputs. The loan is to be paid back by the farmers at the end of the crop season.
- A few group activities for the maintenance of community nurseries as well as undertaking post harvest processing/value addition enterprises are to be initiated by the members of the CBO and a portion of the profit will be paid back to the CBO to strengthen its seed money.
- All the members of the CBO would be encouraged to cultivate appropriate inter and mixed crops in their coconut farms
- Similarly, all the members would be encouraged to undertake various organic recycling activities to build up their soil fertility level.
- A few micro enterprises like “Production of coconut chips”, “Production of quality coconut oil”, “Production of quality coconut fibre” (without retting process), “Production of vermicompost”, “Production of mushroom”, “Production of shell based products’ etc. have been started in the two communities under the direct technical guidance from the scientists of CPCRI.

### Impact

Implementation of poverty reduction programmes in the two communities has already created great awareness about the production potential of the recommended technologies among the participants as well as among the farmers, extension personnel and policy makers in the two regions. It is optimistically expected that the activities undertaken in **this project would lead to an increase in the income of the farmers from coconut cultivation by 3-5 times.** The project is expected to serve as a model project for similar ventures among the coconut communities in different coconut growing States in the country.

## 57. CPCRI – MARCHING AHEAD

The Agreement on Agriculture (AoA) of the World Trade Organization (WTO) is posing serious challenges to the Indian agriculture. Depending upon the nature and degree of the impact, it is indispensable to formulate and implement certain medium and long term policies in agricultural research and development. Effective implementation of these reforms would be a Herculean task for the planners, policy makers and researchers involved in perennial crops like tea, coffee, rubber, coconut, arecanut, cashew etc., since the inherent problems of these crops would not permit short-term adjustments as foreseen in the AoA. Hence scientists and development personnel in the field of plantation crops need to give additional emphasis through strategic measures to protect the farmers and planters cultivating plantation crops.

The major theme stressed by the researchers, planners and policy makers to overcome the issues arising out of AoA of WTO is "Competitiveness through higher productivity in the production, processing and marketing sectors". To achieve higher level of productivity, the role of scientific technologies is vital. Realizing this fact, the research programmes of CPCRI are formulated carefully with long term perspective and are being implemented effectively.

The major research perspectives of the Institute include resistance breeding, Molecular Biology and Biotechnology, Integrated Nutrient Management in Perennial Crop Based Farming Systems, Precision Farming, Stress and Drought Physiology, Integrated Pest and Disease Management, Post Harvest Technology and Value addition, Cyber Extension, Data Base Management and Marketing. The specific crop-wise medium and short term research priorities include the following aspects:

### Coconut

- Strengthening the germplasm collection and evaluation.
- Breeding for higher productivity and drought tolerance.
- Strengthening the resistance breeding for root (wilt) disease.
- Tackling the root (wilt) disease problem through DNA finger printing and marker genes.
- Disease indexing through Remote Sensing and GIS.
- More thrust to research on farm diversification/intensification in coconut based farming systems using the concept of precision farming.
- Developing location specific low cost/no cost technologies to reduce the cost of production in the long run.
- Resource recycling and organic farming.
- Soil conservation and water management on watershed basis .
- Integrated Pest Management against all major and minor pests of coconut.
- Sustained pest and disease monitoring through state level monitoring cells.
- Integrated Disease Management against all major and minor diseases of coconut.
- Strengthening the studies on residual toxicity of pest management.
- Research on drought management.
- Stress physiology of coconut.
- Quality parameters of coconut and its products under different levels of management.
- Development of labour saving spraying and harvesting equipments for coconut based farming systems.

- Strengthening research on product diversification and by-product utilization.

### **Arecanut**

- Strengthening the germplasm collection and conservation programme.
- Encouraging adoption of managerial practices to improve the productivity through farming system approach.
- Integrated disease management for fruit rot and Yellow Leaf Disease.
- Product diversification and value addition.

### **Cocoa**

- Strengthening the germplasm collection and conservation programme.
- Encouraging adoption of managerial practices to improve the productivity.
- Stress physiology of cocoa.
- Integrated disease management against black pod and wilt diseases.
- Integrated rodent management.

### **Social Sciences**

- Multi-dimensional approaches in Transfer of Technology.
- Cyber Extension.
- Technology assessment and refinement.
- Market intelligence studies based on International Trade Theory.
- Integrated Agricultural Resources Information System.

### **Client oriented technology development**

Agricultural research, organized traditionally along disciplinary or commodity lines and without adequate involvement of the clients lacked the farming system perspective as they are mostly conducted in research stations under conditions that are not representative of farmers' fields. They often focus on increasing the productivity of the farms by generating new technologies without a proper understanding of the

existing farming systems, resulting in low adoption rate of the evolved technologies.

Traditionally the agricultural researchers, having a good idea of the constraints pertaining to their field of specialization use them for research problem definition. By this, they often fail to observe that any change caused by the introduction of a new technology will not only affect the component being studied, but the entire farming system within which the component is embedded. Agricultural research in India, often aims to increase the productivity of crops without paying much attention to the economic viability and social acceptability of those technologies under farmer's field conditions. In contrast, farmers are more interested in raising profits, which need not be necessarily through increase in productivity. Hence for better adoption of research results by the farmers, in addition to productivity, more attention is required on the socio-economic aspects of the evolved technologies. To summarize, for increasing the rate of adoption of various technologies, their technical feasibility, economic viability and social acceptability need to be proved under farmer's field conditions.

Considering these facts, CPCRI has formulated a multi-dimensional approach for Transfer of Technology (TOT), through which technology dissemination takes place in the most efficient manner. The Extension Section, Agricultural Technology Information Centre, Krishi Vigyan Kendra and the Institution Village Linkage Programme are the four pillars of Transfer of Technology at CPCRI, through which technologies are assessed and refined and taken to the clientele for commercialization.

It is expected that through increased adoption of these technologies, farmers and processors would be able to increase the productivity and profitability in production and processing sectors of coconut, arecanut and cocoa in the country.