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From the desk of Chairman

Dear Coconut farmers,

Coconut farmers are facing the challenge of prolonged drought in majority of the coconut growing regions due to climate change. Stiff competition from industrial use limits the water availability and irrigation. Ample opportunity exists for *in situ* moisture conservation and water harvesting in majority of the coconut growing areas. Proper management practices need to be adopted for judicious utilization of the harvested water in conjunction with the available ground water. Irrigation is one of the most important operations to increase the yield by providing a soil rhizosphere environment favorable for mineralization and continuous absorption of nutrients from the soil. One of the reasons for high productivity of coconut in Tamil Nadu and Andhra Pradesh is the adoption of suitable water saving irrigation in coconut gardens. Irrigation methods commonly adopted in coconut gardens are flooding, basin irrigation, sprinkler or perfo-sprays and drip irrigation. There is considerable wastage in conventional methods like flood irrigation, basin irrigation and irrigation through channels, loss of water due to deep percolation, seepage and evaporation.

Drip irrigation is ideal for widely spaced crops like coconut as it saves water, energy and labour. The water use efficiency is high and there is 34 per cent water saving in drip irrigation. Studies conducted by CPCRI reported that fifty percent of the recommended dose of fertilizer when applied through drip fertigation is sufficient to give yield equivalent to 100 % of the recommended dose of fertilizer. Sprinkler irrigation is most suited to inter or mixed cropping systems where the entire surface requires wetting. As a component of drip irrigation method in summer months, 45-65 litres of water/ palm/ day is recommended. Application of 200 litres of water once in four days is recommended for irrigating coconut palms through basin irrigation method. Irrigation plays a major role in deriving full benefits of organic farming. Though drip, sprinkler, basin or flood methods of irrigation can be adopted, drip irrigation is the most preferred method.

Moisture conservation methods such as mulching with coconut husk, coir dust, green leaves, dried coconut leaves, etc., addition of organic manures or green manures, husk burial, inter cultivation, bunding, terracing, etc. are recommended to reduce the effect of drought. In sloppy terrains, trench filled with coconut husk, half moon bund and staggered catch pit reinforced with pineapple across the slope are proved successful in soil and water conservation techniques. Drought management practices such as husk burial and composted coir pith application are also found to increase the nut yield under rain fed conditions.

Government of India is committed to accord high priority to water conservation and its efficient management. To this effect, Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) has been formulated with the vision of extending the coverage of irrigation 'Har Khet ko pani' and improving water use efficiency 'More crop per drop' in a focused manner with end to end solution on source creation, distribution, management, field application and extension activities. Government of India has been implementing Centrally Sponsored Scheme on Micro Irrigation with the objective to enhance water use efficiency in agriculture sector by promoting appropriate technological interventions like drip and sprinkler irrigation technologies and encouraging the farmers to use water saving and conservation technologies. The scheme is being implemented through the concerned state Agriculture/Horticulture Departments.

I sincerely request all coconut famers to utilize the financial and technical support extended by Gvernment of India under this scheme to adopt efficient drought management practices.

With warm regards,

A K Singh

Chairman

Turning Coconut Farmer to Entrepreneur

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1. Introduction

The Hon'ble Prime Minister of India has set the target to double farmers' income in the country by 2022. The most important approach to achieve this is product diversification of farm produce into high-value products with better price realization for farmers through competitive markets, value chains and improved linkage between field and fork. However, achieving the goal requires a clearly defined vision, a carefully crafted strategy, sufficient financial resources to support the efforts and above all a supportive government. Though coconut value addition is at its nascent stage in India, the recent innovations and the value chains developed in coconut can transform the farmers into entrepreneurs and can easily double their income. We have well established organizations for research (ICAR-Central Plantation Crops Research Institute), developmental agency (Coconut Development Board), financial sources (like central and state government schemes, NABARD) and to implement these value chains, Coconut Producer Companies are being established in each coconut producing states. Some of the value added products available in coconut which can be easily taken up as cottage or small scale industries are briefed below.

Coconut palm is widely acclaimed as Kalpavriksha or Tree of Heaven or Wonder tree where each and every part is useful. Based on the raw material used, the major products can be categorized as sap based, tender nut water based, meat/ kernel based, husk based, shell based and leaf craft based. The process of sap, tender nut water and meat/ kernel based preparation of consumable products, their nutritive value and use which are now considered as prime products in the market are described here.

2. Product diversification and value addition

2.1. Coconut sap based products

2.1.1. Kalparasa (Neera): Coconut sap, usually called as neera (Kalparasa) is the phloem sap from the unopened coconut spadix. It is a very good health drink, rich in sugars, protein amino acids, minerals, antioxidants and vitamins. ICAR-CPCRI has developed '*Coco-sap chiller'* to collect fresh, hygienic and unfermented sap.

Coco-sap chiller is a portable device characterized by a hollow PVC pipe of which one end is expanded into a box shape to house a sap collection container bound by ice cubes and the other end is wide enough to insert and remove a collection container of 2 to 3 1itre capacity. Each of the side-wall of the pipe from outside is covered with an insulating jacket excluding the portion of spadix holder which retains the internal cool temperature for a longer period. This coco-sap chiller is

lighter in weight, water proof, easy to connect to the spadix, requires less ice and retains low temperature for longer period as compared to commercially available ice boxes.

Kalparasa collected by coco-sap chiller under low temperature can be sold as fresh juice under local market with adherence to quality standards prescribed by ICAR-CPCRI. The pH of the fresh sap is between 7 to 7.5 and pH > 7.0 is ideal for promotion to health drink. Other quality parameters easily judged are brix (around 14); color (golden brown) and taste (sweet and delicious).

The collected sap can be stored for any length of time under subs zero temperature. Deep freezers are used for this purpose. The sap gets frozen and just before use, it is thawed to get the original liquid form. Dispensers are used to keep it cool in kiosks or neera hub for selling fresh sap.

The hygienic, zero alcoholic sap collected by ICAR-CPCRI method is easy to process in a natural way without the use of chemicals into various value added products which fetches premium price both in domestic and international markets. Very good quality coconut sugar, jaggery, nectar or syrup can be produced in double jacketed cookers with temperature regulation and stirring facility.

2.1.2. Coconut sugar: It is the best natural sweetner, has several health benefits and which has a high market potential.It contains all essential amino acids required for protein synthesis; contains considerable amount of minerals like calcium, magnesium, zinc, iron and copper; rich in electrolytes like sodium and potassium; abundant in dietary fibers which normalizes bowel movements and digestion and rich source of phenolics which are potent and important contributors in reducing oxidative stress due to their antioxidant activity. Moreover its glycemic index is low and is in the range of 35 to 54 GI. Eating a low glycemic index diet reduces the risk of chronic diseases such as Type 2 diabetes.

2.1.3. Kalpa bar: From the coconut sugar, product like `Kalpa Bar' a coconut sugar based chocolate purely from plant based ingredients without milk is prepared. It is a joint venture between ICAR-CPCRI and CAMPCO (Central Arecanut and Cocoa Marketing and Processing Cooperative Ltd.).

It contains cocoa powder, coconut sugar, natural vanilla extract and GMO free sunflower lecithin. It has low glycemic index and does not contain any added artificial ingredients. It is delicious dark chocolate for a healthy life and can be stored under room temperature and does not melt.

2.1.4. Kalpa drinking chocolate: It is an instantised blend of low GI coconut sugar, crafted from fine cocoa powder formulated to produce the delicious drinking chocolate. The product is soluble instantly in hot or cold

milk releasing the chocolate aroma.

Fresh Kalparasa based milk sweets are prepared in West Bengal. The advantage is that it is another way of transporting neera to long distance in the form of sweets. These sweets impart the minerals, vitamins and valuable fiber which will not be available in the normal cane sugar based milk sweets and their glycemic index is low and hence good for healthy life.

At ICAR-CPCRI, Kasaragod we have developed complete package of technologies and machineries for the production to consumption value chain either for Kalparasa (neera) to be sold as health drink or to be processed into value added products viz. coconut sugar, jaggery, concentrate, syrup etc. We have also developed on campus training module for a minimum period of two to three days for those entrepreneurs who wish to collect Kalparasa and market it as juice or process into value added products. (Coco-sap chiller) The manufacture and supply of has been entrusted to one of ICAR-CPCRI notified entrepreneur who supplies these boxes to those who signs an MOU with ICAR-CPCRI for technology transfer.

2.2. Coconut water based products

2.2.1. Tender coconut water processing: The water of tender coconut, technically the liquid endosperm, is the most nutritious wholesome beverage and has medicinal values. It has a calorific value of 17.4 per 100 g of water. It contains water (95.4%), protein (0.1%), fat (<0.1%), mineral matter (0.4%), carbohydrates (4.0%), calcium (0.02%), phosphorous (<0.01%) and iron (0.5mg/100g). At present, only 15% of the total coconut production is used for tender nut water. The price of tender nut in the market is more than double than that of mature nut and according a one survey, the demand for tender nut is increasing at a very fast rate of 135%. Thus, the existence of greater market demand and the higher price for tender nut should enable coconut growers to earn a better livelihood when there is poor price for mature nuts. However, the bulky nature of tender coconut and

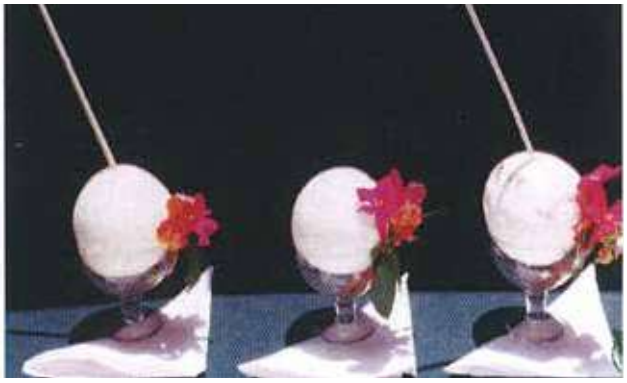
Packaged tender coconut water brands commercially available

its tendency to undergo biochemical change and spoilage within 2 to 3 days of its harvest are major constraints in marketing. Attempts are being made to minimally process tender nut for easy transport and extract the water and store it artificially with preservatives as described below.

2.2.1.1. Dressed tender nut/ minimally processed tender nuts: It is a partially dehusked cool tender coconut. Since husk constitutes major portion of the volume of tender coconut, partial portion of the husk is removed. The tender nuts are machine shaved to an attractive and uniform hexagonal shape, the smallest size possible that can retain the fluid safely inside. After removal of husk, tender coconut is dipped in anti browning agents (0.50% citric acid and 0.50% potassium metabisulphate), wrapped with food grade polyethylene for aesthetic and hygienic purpose. Product can be stored up to 24 days in refrigerated condition at 5-7 °C.

2.2.1.2. Preserved tender coconut water: The tender coconut water is highly susceptible to heating. Hence, it is subjected to mild heat, filter, sealed with or without carbonation and sodium citrate and citric acid is added. It is packed in flexible pouches and aluminium beverage containers. At a pH of 4.9-5.2 its acceptability is good. The product is found to be generally acceptable up to three months under ambient storage conditions.

2.2.1.3. Snow ball tender coconut: Snow ball tender coconut is the tender coconut without husk, shell and testa, which is white in color and in the shape of a ball. The ball contains tender coconut water, which can be consumed by just inserting a straw through the top white tender coconut kernel. Coconut of 8-month maturity is more suitable for making snow ball tender coconut. Since it is already devoid of husk and shell, there is no scope for littering of the premises. It is individually packaged and refrigerated to prolong the shelf life.



2.2.1.4. Tender coconut water jelly: Tender coconut water is a suitable option for the preparation of jelly as its delicate flavor can be well preserved in the form of jelly. The ingredients required are tender coconut water, sucrose and solidifying agent (china grass). The standardized quantity and concentration of tender coconut water is, sugar-250 g (20% of tender coconut water) and china grass- 20g (2% of tender coconut water).

2.2.1.5. Tender coconut water lemonade: Coconut water lemonade is a refreshing drink made of tender coconut water and lemon juice with addition of flavor ingredients. The formulation contains tender coconut water, tender coconut pieces, lemon juice, ginger juice, pepper powder and coconut sugar.

2.2.2. Products derived from matured coconut water

Matured coconut water is treated as a waste product of the coconut industries, as the sugar content goes up and rest of the nutrients are reduced. But various products can be derived from mature coconut water are as follows:

2.2.2.1) Nata-de-coco: Nata-de-coco is a very delicious dessert item served either mixed with other fruits or baked into a delicious cream pie or simply served with flavored syrup. It is a gelatinous dessert made from mature coconut water, sugar and bacterial culture (Acetobacter xylinium).

2.2.2.2. Coconut pulp ice cream: Tender coconut pulp also can be used in ice cream formulation to replace milk, fat, gums and emulsifier which are the common ingredients in this kind of food. The formulations included ingredients like coconut pulp, cocoa powder, sucrose, water, carrageenan gum, guar gum, hydrogenated vegetable fat etc.

2.3.Meat kernel based products

2.3.1. Fresh kernel based products

2.3.1.1. Desiccated coconut: Desiccated coconut is the white kernel of fresh mature coconuts, shredded and dried down to about 2.5% moisture content under strict hygienic conditions. It is rich in healthy medium

chain fatty acids with no cholesterol and an excellent source of dietary fibre. The main uses of desiccated coconut are for the confectionary industry, as a filling for chocolates and candies; the bakery industry for biscuits, cake and nut filling products; direct usage to decorate cakes, biscuits and ice cream and preparation of various snacks. India's export of desiccated coconut is only to the tune of less than one percent of the global demand. In comparison with the export figure of previous year, India achieved an increase to the tune of 60%, which indeed is a remarkable achievement. There exists an immense export potential the desiccated coconut across the world.

2.3.1.2. Coconut chips: Coconut chips is a ready-to-eat, snowy white crisp and healthy non fried snack food prepared from 8 to 9 month old fresh kernel through osmotic dehydration in a forced hot air electrical dryer at 70-80°C for 5-6 hours to less than 3% moisture content. Coconut kernels undergo paring, blanching, slicing and osmotic dehydration to prepare ready to eat chips. It contains 46% carbohydrate, 1.24% protein, 48% healthy fat, 6.13% fibre and 1.36% mineral content. Nutraceutical and medicated coconut chips can also be made by incorporating beet root, carrot, ginger and pepper.

2.3.1.3. Coconut milk and milk products: Coconut milk is an emulsion of coconut oil in water into which some of the soluble components of the fresh kernel have already been passed. Apart from household culinary uses, coconut milk is utilized as 'a substitute for dairy milk as evaporated and sweet condensed milk and in the preparation of white soft cheese, yoghurt, ice cream and many other foodstuffs. Coconut milk processing involves extraction of milk from coconut, straining the milk in a cheese cloth into an aluminum kettle with 0.1 percent benzoic acid before placing the kettle in an autoclave at 117°C for three minutes with steam injection. The temperature of the milk in the pot is then brought down to 80-85°C, by running tap water. The milk is then homogenized for about five minutes and bottled at 70°C to 80°C. The final product is as good as cow's milk and is highly nutritious.

2.3.1.4. Coconut cream: Coconut cream is a white, smooth, liquid cream with excellent coconut flavour and 20-30% fat. The product is easily pourable and ready for direct serving or can be used in other food preparations. Coconut cream is essentially used as a fat source for the reconstitution of the skimmed dairy milk and as a component of infant milk powder.

2.3.1.5. Dehydrated coconut milk: This product is produced on a commercial scale in the Philippines, Malaysia and India. In this, fresh coconut milk is blended with small amounts of additives such as maltodextrin or casein and is spray dried. The final product is marketed in laminated foil bags. The powder is easily dissolved in water to form a milky white liquid with the flavor and texture of coconut milk.

2.3.1.6. Virgin coconut oil (VCO): It is the oil obtained from fresh, mature endosperm (kernel-meat) of coconut by mechanical or natural means, with or without use of heat and no chemical refining, bleaching or de odorizing. It is called "virgin" because the oil obtained is pure, raw and pristine. Compared to the conventional coconut oil, VCO, contains high tocopherol (Vitamin E), polyphenols and antioxidants. Its nutraceutical properties make it a best oil for both consumption and cosmetics. It has a fresh coconut aroma ranging from mild to intense depending on extraction process. It is extracted directly from fresh coconut meat or from coconut milk or from coconut milk residue. The different

CMR based pasta, CMR based bread, CMR based extrudates, CMR based pasta, Low fat desiccated coconut flour



VCO cake based ladoo, VCO cake based mufffins, Pro- biotic product

methods involved are hot-processing method, natural fermentation method, centrifugation process and direct micro expelling method. The choice of technology to be adopted depends to a great extent on the scale of operation, the degree of mechanization, the amount of investment available and the market demand.

2.3.1.7. Edible coconut flour/ coconut milk residue flour: After, expelling the milk, the protein rich residue is dried and powdered to obtain a product called coconut flour. The flour so obtained typically contains 7-8 percent protein, 3-5 percent moisture and 17 percent oil. It can be used as an ingredient in weight control foods because of its high fibre content. A number of coconut flour based value added products have been standardized such as extrudates, pasta, sweets and ladoo, bread, porridge etc.

2.3.1.8. Virgin coconut oil cake: VCO cake obtained during the hot processing can be utilized for the preparation of cakes and ladoo.

2.3.1.9. Coconut delicacy: It is a non-dairy probiotic vegan product. Its ingredients are coconut milk/ cream, coconut sugar, tender coconut water, stabilizers with incorporation of air during freezing process.

2.3.2. Dried coconut products: Copra and the coconut oil as well as the cake derived from it are major source of foreign exchange for many coconut-growing countries in Asia, the Pacific and Africa.

The dried coconut endosperm is called copra. The copra and the oil it contains are the principal products of coconut palm. With oil content of 65-70 percent, copra is the richest source of fat. The essential requirement of copra drying is to bring down the moisture content of the wet fresh kernel from 45-55 percent to 5-6 percent. There are two types of copra: edible copra and milling copra. Edible copra is available in two forms: ball copra and cup copra. Copra (dried meat or kernel of coconut) may be made both in the forms of 'cups' or 'balls'. Copra in the form of balls is made from whole unsplit nuts. The process consists in storing coconuts with husk. Cup copra is made either by sun drying or kiln drying

to less than 6% moisture. Electrical, solar and electrical cum solar dryer technologies are optimized for effective drying.

3. Prospects of value addition in coconut

In the recent past, various value added products of coconut derived from sap, tender nut water and meat/ kernel have been developed and their adoption found to assure stable and lucrative income to the coconut farmer. For example, adoption of tapping for the collection of Kalparasa and its sale as fresh juice or production of value added products (e.g. coconut sugar) and sale has increased the revenue by at least 10 times than allowing it to produce nut. Similar kind of revenue advantages are seen in other enterprises like Virgin Coconut Oil, chips, desiccated coconut powder, coconut milk, tender coconut water etc. Thus, there is huge advantage for the farmer. These enterprises in addition to increasing the income also create lot of employment opportunities. Though the coconut value addition is at its nascent stage, the creation of Coconut Producer Companies, the financial support rendered by the government, the enhanced consumer preference towards coconut along with strong and supportive research back up is a right step in improving the economy of coconut sector. ■

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Coconut based High Density Multi Species Cropping System

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In India, Andhra Pradesh is one of the major coconut growing states after Kerala, Karnataka and Tamilnadu with 1.05 lakh hectares area and producing 1463 million nuts annually. Though, the state has the highest productivity of 13811 nuts per hectare (CDB statistics, 2014), the net returns per unit area is low and uncertain. In Andhra Pradesh, though coconut is being cultivated in almost all districts, majority area is confined to East and West Godavari districts. These two districts stand first in area, production and productivity in the state. However in the recent past, coconut farmers experienced considerable loss due to increased cost of cultivation and abiotic stresses like rising temperature and frequent cyclones. In coastal Andhra region, monocropping is predominant under irrigated conditions adopting spacing at 8.0 x 8.0 m, which does not fully utilize the natural resources like soil, space and solar radiation. Coconut being a widely spaced crop, provides sufficient scope for intercropping of different annual and perennial crops. Moreover, certain intercrops can successfully be grown because of its ability to tolerate coconut shade. Therefore, interspace could be profitably exploited for cultivation of intercrops suitable for the agro climatic condition and has good scope for increasing the net returns from existing coconut plantations.

Keeping in view the importance of High Density Multi Species Cropping System (HDMSCS) a trial was conducted at Horticultural Research Station, Ambajipeta during 2008-12 with cocoa, banana, pineapple, elephant foot yam and heliconia as intercrops in coconut. The mean data of four years revealed that nut yield recorded in coconut under cropping system was117.3 per palm whereas under monocropping it was 96.5 nuts per palm

.With respect to intercrops, cocoa recorded yield of 2.0 kg dry beans/tree, banana 22.7 kg/plant, pineapple 0.9 kg/plant, elephant foot yam yielded corm of weight 2.8 kg/plant and Heliconia 12 spikes/plant. With respect to biomass production, a total quantity of 34.5 t/ha/year on fresh weight basis was collected from the bio-system which was used for production of vermicompost. The economic analysis revealed that the highest net returns were obtained in coconut based cropping system (Rs.1,77,480/-compared to coconut monocrop (Rs.19255/-)

The coconut based high density multispecies cropping system was successfully demonstrated in farmer's fields to create awareness among farmers to adopt HDMSCS for sustained and higher economic returns.

Major Cropping systems being adopted by farmers of East and West Godavari districts of Andhra Pradesh

- Coconut+ Cocoa + Banana
- Coconut+ Cocoa

+Papaya + Fodder grasses ● Coconut + Papaya + Elephant Foot Yam + Dioscorea +Marigold ● Coconut + Arecanut + Cocoa+ Pepper +Banana ● Coconut + Arecanut + Cocoa+ Pepper +Banana+ Pineapple ● Coconut + Cocoa+ Guava ● Coconut +Papaya+Ginger ● Coconut + Turmeric

Success Story: Sri Khandavalli Nageswara Rao, Munganda, Ambajipeta, East Godavari District, Acerage:1.6 ha. Cropping system : Coconut + Arecanut + Cocoa+ Pepper +Banana

Mr. K. Nageswara Rao is a progressive farmer cultivating coconut with local cultivar *East Coast Tall* at a spacing of 8x8 m as monocrop since 1980. Due to wide interspace, there was luxuriant weed growth which lead to increased cost of cultivation with respect to weed management. The farmer applied higher dosage of nitrogen fertilizers with less usage of Phosphorus and Potassium fertilizers with no organic manures.

Cyclone impact and his new approach

During the year 1996, due to super cyclone in coastal region of Andhra Pradesh, the farmer's coconut garden was badly affected wherein more than 90 % trees were lodged and uprooted. Under this situation, the farmer approached the scientists of AICRP on Palms, Horticultural Research Station and replanted in 1997 with coconut hybrid Godavari Ganga in two acres and remaining two acres with East Coast Tall cultivar and Arecanut variety Mangala (600 nos) as intercrop duly adopting the scientific management practices as advised by the scientists. The hybrid started bearing within four years while the ECT cultivar started bearing from 6th year and Arecanut started bearing from 5th year onwards. He maintained the garden as such for 15 years. In 2011, the farmer was inspired by HDMSCS model grown in the research station and adopted HDMSCS in his garden by planting cocoa variety Forestero (600 nos), banana variety Tella Chakkerakeli (2000 nos), and pepper variety Panniyur-I (240 nos) as inter crops.

Increased returns and additional benefits

After adopting HDMSCS for four years, he obtained increased yields of 100 and 150 nuts/palm in ECT and Godavari Ganga respectively in HDMSCS compared to mono cropping. Further he reaped on an average of 1.5 kg dry beans /tree in cocoa, 0.8 kg chali /plant in arecanut and 1.25 kg/vine in pepper. By adopting high density multispecies cropping system in his four acres, he obtained an annual net income of Rs.2,44,600/- Coconut – Rs.63,600/-, Cocoa – Rs.54,000/-, Arecanut – Rs.50,000/-, Banana – Rs. 46,000/- and Pepper – Rs.38,000/-). Further he opined that HDMSCS improved soil fertility and nutritional status of his garden which helped in reduced inorganic fertilizer usage.

The farmer is satisfied with HDMSCS model in getting higher returns compared to coconut monocrop and also noticed low incidence of pest and diseases with sustained and assured net returns from different intercrops . He expressed his gratitude to AICRP on Palms, HRS, Ambajipeta for developing HDMSCS model. ■

Drip irrigation for coconut in Kerala

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Though Kerala is known as the land of coconuts, the production and productivity of palm is low compared to other coconut growing states, particularly Tamil Nadu and Karnataka. Several reasons are attributed to the low productivity of the crop in the state. Rain fed nature of the crop with low adoption of irrigation practices, low fertility status of the soil due to continuous cultivation of this crop without regular application of manures and incidence of diseases are the major reasons attributed to this. Coconut gardens in Kerala are subjected to drought in summer months in every year due to climate change. Even though farmers were aware that coconut palms respond well to irrigation during summer months, they are not taking up irrigation. In Kerala, only less than 10% of the total area is under irrigated condition, whereas in Tamilnadu and Andhra Pradesh it is purely an irrigated crop. However there is a trend growing among the coconut growers of Kerala to start irrigation in areas where sufficient water is available in summer months.

One of the major reasons for the low adoption of irrigation in coconut gardens is lack of availability of sufficient quantity of water during summer months. Since most of the farmers are not aware of the modern techniques in irrigation they follow traditional surface irrigation methods and thus a large quantity of water is wasted. Besides, irrigation through conventional methods is laborious.

Drip irrigation technology is the ladder of modern irrigation and is a shift from the conventional wasteful system of irrigation. Studies conducted at Centre for Water Resource Development and Management (CWRDM), Kozhikode and Central Plantation Crop Research Institute (CPCRI), Kerala showed that this method of irrigation is highly suitable for plantation crops, especially coconut, which is extensively cultivated in the state. Adoption of this system of irrigation is an option for efficient use of water and nutrients for improvement in the productivity of this crop.

Drip irrigation in coconut gardens

Drip irrigation is the frequent slow application of water to the soil at the plant root-zone through a series of entry points in the delivery line. It is the process intended to deliver water at the active root zone of coconut palm in quantities approaching its evapotranspiration requirements and at a rate close to what the soil will absorb. The objective is to maintain the moisture content of the soil close to field capacity so that roots will have constant supply of water.

For coconut, generally, three to four drippers are given per palm. Open four pits of size of 30 x 30 x 30 cm opposite to each other at one meter distance from the trunk. Place 40 cm long PVC pipe (16 mm) in a slanting position in each pit and place the drippers inside the tube and allow the water to drip 30 cm below the soil surface. Fill the pits with coir pith to prevent evaporation. The cost of drip system including installation will be Rs. 130 to 150 per palm (exclusive of pump) which works out to Rs. 23000 to 26000/- approximately per hectare of coconut garden with four emitter per palm.

Fertigation: Fertilizers also can be applied through drip system. Application of 50% of the recommended dose of fertilizer through drip fertigation produces a yield equivalent to 100% of the recommended dose of fertilizer applied through conventional methods. The fertilizers are applied through bypass tank to the palms. 70g Urea, 60g DAP and 170g Murate of potash are recommended for single dose per palm.Similarly six doses are to be given to the palms which are to be applied from December – May at monthly intervals for Kerala condition. For phosphorus application commercial phosphoric acid can also be used.

Advantages of Drip irrigation

Adoption of drip irrigation along with application of fertilizers (fertigation) increases productivity of coconut, besides ensuring higher efficiency of water and nutrients in coconut. In drip irrigation system use of 30 to 50% less water is required than conventional methods. Labour and fuel are also saved by adopting this method. It is suitable on undulating lands, weeds can be controlled and fertilizer efficiency can be increased due to localized application and reduced leaching. Drip irrigation is highly suitable to sandy tracts and there will be low incidence of pest & disease.

Disadvantages of Drip irrigation

Drip irrigation is susceptible to clogging problems. It is economically viable for only widely spaced crops

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Health Mixes with Coconut Milk Powder

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Introduction

Coconut milk is the liquid obtained by manual or mechanical extraction of grated coconut meat. Approximately 50% of the fatty acids in coconut fat is lauric acid. Coconut milk powder is an excellent substitute for fresh coconut milk as it is rich in proteins, vitamins and minerals.

Malnutrition in children and women remains as one of the greatest challenges in India. Malnutrition remains as a major threat to the survival, growth and development of children. It may occur due to lack of available food sources and inability to absorb nutrients or poor feeding. This necessitates the search for low cost, readily available, easy-to-prepare alternatives to cater for the nutritional needs of children.

A food supplement provides nutrients that may be lacking in the diet. The nutrient density must be sufficient to permit adequate protein, vitamin and mineral intake to meet the nutrient intake of children. Formulation of health mix with coconut milk powder provides a nutritious and cost effective alternative commercial health mixes. This value addition further increases the use of coconut and benefit the farmer.

Selection of ingredients for Health Mix

Coconut milk powder, millets namely ragi, bajra, and jowar, pulses namely roasted Bengal gram, sprouted green gram and nuts namely peanuts, almonds and cashew nuts were selected for formulation of health mix. All the food samples were cleaned and dried .Millets and nuts were roasted and finely ground in a mill. Cane sugar and cardamom(for flavor) were procured from reputed departmental stores.

Formulation of Health Mixes

Five different variants A1, A2, A3, A4, and A5 (Table: I) were formulated by adding 10- 50 % of coconut milk powder in the mix.

The ingredients were mixed together as per the proportion given in Table-I and packed in HDPE packages, sealed, labelled and stored at room temperature.

Table: I. Composition of Health Mix

Ingredients	Quantity (gm/100g)					
	Standard	AV1	AV2	AV3	AV4	AV5
Coconut Milk Powder	-	10	20	30	40	50
Ragi	20	20	20	15	10	10
Bajra	20	20	20	15	10	10
Jowar	20	20	20	15	10	10
Roasted Bengal gram	15	10	5	7.5	10	5
Sprouted Green gram	15	10	5	7.5	10	5
Peanuts	5	5	5	5	5	5
Almond	2.5	2.5	2.5	2.5	2.5	2.5
Cashew nut	2.5	2.5	2.5	2.5	2.5	2.5
Cardamom	1	1	1	1	1	1

Preparation of Porridge

Porridge was prepared by dissolving 50 g formulated health mix with 150 ml boiling water. It was cooked for five minutes in a low flame and served warm. Sugar was added for taste.Organoleptic evaluation of the prepared porridge was carried out by 10 semi trained panel members using a 9 point scorecard.

Nutrient Composition

Nutrients namely carbohydrate, protein, fat, fiber and energy were calculated using nutritive value for Indian Foods (ICMR, 2012).

Shelf life study of the formulated health mix

The formulated health mixes were stored at room temperature for three months. The samples were drawn at regular intervals of 7 days for microbial analysis. Organoleptic evaluation of the porridge was carried out every 15 days to find out its acceptability.

In vivo analysis of the formulated health mix

Twenty one days old weanling rats were selected for carrying out Protein Efficiency Ratio (PER) of the health mix.PER is defined as unit weight gain per unit protein intake.

The weanling rats (Sprague Dawley) were procured

from PSG IMSR Animal Facility and housed in polypropylene cages, maintained on standard pellet diet and water ad libitum. The rats were acclimatized for a period of seven days to laboratory conditions (temperature 25 ± 2°C) and 12 h light/dark cycle. The rats were then divided into 5 groups and housed separately. The formulated food was fed to the weanling rats as per Table-II.

Table-II Composition of Rat Food Plate-3
Grouping and Feeding of rats

Groups	Diet administrated
Control	100 % standard food (20 g protein)
Group- 1	75 % Standard food + 25% Formulated food (19 g of protein)
Group- 2	50 % Standard food + 50% Formulated food (19.3 g of protein)
Group- 3	25%Standard food + 75% Formulated food (18.3 g of protein)
Group- 4	100% Formulated food (18.7 g of protein)

The rats were weighed every alternate day to measure the weight gained at the end of the feeding period. The amount of food served and the leftover food were weighed every day to find out the amount of the food consumed.Protein intake was calculated on the basis of protein in the consumed diet by the rats.From the above data, PER was found out.

PER is based on the weight gain of a test subject divided by its intake of a particular food protein during the test period.

$$PER = \frac{\text{Gain in body weight (g)}}{\text{Protein intake(g)}}$$

The obtained results were analysed by relevant statistical tools namely general linear model, t- test, post hoc test and ANOVA.

Results

Nutrient Content of Health Mix

Table-III - Nutrient Content

Health mix	Nutrients/100g				
	Energy (kcal)	Carbohy-drate (g)	Protein (g)	Fat (g)	Fibre (g)
Standard	378.0	65.0	17.0	3.0	6.0
AV4	534.68	44.45	14.74	30.1	1.38

The carbohydrate and protein content (Table - III) of AV4 was 44.45g% and 14.74g% respectively which was lesser than the standard. AV4 is low in protein content, yet the quality of protein is good as it comes chiefly from coconut milk powder. Therefore it can be recommended for children. The fat content of the AV4 was 30.1g% which is much greater than standard and this fat is chiefly constituted by medium chain triglycerides (MCT's) and the major fatty acid is lauric acid.Organoleptic Scores of Health Mix

The mean score obtained for colour by AV4 was maximum (8.75±0.43) which was greater than the other variants and standard (8.4 ±0.48).The mean scores obtained for texture by both standard and AV4 were the same (8.8±0.4). AV4 had got maximum score (8.8±0.35) for taste and overall acceptability (8.8±0.4) compared to standard and other variants which is due to the addition of coconut milk powder. The variant AV3 had got the maximum score (8.8±0.35) for flavour. The results of one way ANOVA showed that there was a significant difference observed between groups for all the criteria except for the texture.

Thus it is clear that AV4 containing 40% of coconut milk powder had obtained maximum scores in the sensory attributes namely colour, texture, taste and overall acceptability. Therefore AV4 was selected to evaluate the shelf life, nutrient content and determine the PER in rats.

Shelf Life Study of AV4 and Standard

The mean organoleptic scores of the standard and AV4 gradually decreased over the storage period and were the least on 90th day with 3.6±0.48 and 3.9±0.53 respectively. The mean scores for texture of the standard and AV4which were 8.5 and 8.6 on 0th day respectively, gradually decreased to 3.5 and 3.8 on 60th day respectively. The scores started decreasing gradually and was least for the standard (2.9±0.7) compared to AV4 (3.5±0.67) on the 90^{th} day. The decrease in the mean organoleptic scores was marginal on the 15^{th} day (8.6±0.48), thereafter the decrease was sharp every 15th day and was 5 points lesser on the 60^{th} day compared to the 0^{th} day. The mean scores gradually declined over the storage period and were 3.8±0.74 and 4.1±0.53 on the 90^{th} day.

Microbial Analysis

The results of microbial analysis revealed that the growth of microorganisms till 70th day was within the permissible limit according to BIS standards (IS 11536:2006).The results also depicted that there was not much contamination till 14^{th} day of storage as the colony count was less than 1 CFU/ g. The maximum range of permissible limit of microorganisms was reached only after 77^{th} day (1.1 × 104 CFU/ g). Therefore, it is recommended that the product could be consumed till 70 days of storage if stored at appropriate conditions.

Results of PER

Table – IV Mean scores of PER

Group	Average protein intake	Average total weight gain	PER
Control	40.65	139.62	3.43
Group 1	39.08	123.5	3.15
Group2	37.45	107.5	2.86
Group 3	34.5	109.5	3.17
Group 4	32.35	108.37	3.34

Rats of control group (Table-IV) showed the highest protein intake followed by the rats of Group 1. The protein intake was the least in Group 4, yet the PER value was only marginally lower than control. This shows the high quality of protein in the formulated food that has helped in the growth and development of rats of Group 4. The PER of Group 4 which was fed with 100% of coconut milk powder was the highest (3.34) among the experimental groups. This indicates that the incorporation of coconut milk powder at 100% level had promoted substantial growth. This also confirms that coconut milk powder can be added to the health mix of children as it has such enormous growth potential.

Conclusion

Health mix prepared with coconut milk powder is a power packed supplement which is good for health. The proteins present in coconut will promote the growth of the growing children to attain their growth for age. The formulated health mixes are a combination of conventional foods and no artificial additives or supplements have been added to enhance its nutritional quality. The health mixes thus prepared with coconut milk powder can be promoted as a nutritious health drink for children.

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Continued from page 12

and for high value crops. High level of management is needed and drip irrigation is suitable in arid/ drought hit areas where sufficient water is not available in summer months for irrigation.

Drip feasibility in coconut gardens of Kerala

Field level observations reveal that drip system of irrigation has not become popular amoung coconut farmers in Kerala. A careful consideration of the drip irrigation and nature of coconut gardens in Kerala show that the advantages of drip irrigation can be well utilised and its disadvantages can be minimised by the selective adoption of this system of irrigation in chosen areas. The major justifications for adoption of drip irrigation in coconut gardens of Kerala are briefed below:

The coconut palms of Kerala during every year faces moisture stress from November to May and respond well to irrigation during this period. Spacing of this crop is wide enough to make the cost of the system to be lowest. Since it is a cash crop additional return can pay back the system cost quickly. The labour cost is high in the state. The saving in labour costs will be an added incentive. Generally, soils of Kerala are highly infiltrative and the surface system will waste water. Drip can avoid this. In coastal areas saline water can be effectively used for irrigation through drip system since salt accumulation near root zone is prevented by the continuous application of water near root zone through drip. In most of homestead farms irrigation is well-based where the quality of water ensures less clogging. More homestead farms in existence are with intensive cropping systems. So the intercrops also can be irrigated. With the fragmentation of holdings, part time cultivators are more in the state. They can well adopt such labour saving irrigation system. Certain areas of the state like Kollam,Pathanamthitta and Palakkad districts can very well adopt this system as water is very scarce there.

There is ample scope for wide adoption of this system of irrigation in coconut gardens of Kerala. Institutional agencies finance drip irrigation especially in areas of scanty rainfall and water scarcity. The Government of India has been implementing centrally sponsored scheme through the state government promoting adoption of micro irrigation with the objective to enhance water use efficiency in agriculture section by promoting appropriate technology interventions like drip irrigation technology thereby encouraging farmers for adoption by extending financial and technical support. It is necessary to-educate the coconut growers on the viability of drip irrigation system and motivate them to adopt the same in their coconut gardens. However, today, many progressive farmers have shown keen interest and are adopting drip irrigation system in their coconut gardens. Large scale adoption of this technology will make a break through in the production of coconut in the state.

Farm conservation and utilisation of coconut diversity

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Coconut, cocos nucifera L., is a mono-typic genus and an important crop of tropical world. Evolved and adapted along the coastal ecosystem in tropical world, coconut spread to other regions subsequently with human assistance and became part of human culture. Various uses of coconut to mankind and the long history of cultivation obliterate the marks of its origin and diversification. Dispersal of coconut has been aided by both nature and man, through ocean currents and human movements in prehistoric times. Its spread in coastal regions and islands can be attributed to ocean currents while the dissemination hinterland definitely required human interventions. Along its spread to various geographical situations and adaptation to the conditions, there was a gradual accumulation of phenotypic diversity. Origin of coconut is still a debated matter. It is generally accepted that coconut originated either in Central American region or in islands of Indian or Pacific Ocean.

Two major forms of coconut developed during the evolutionary process are tall types and dwarf types based on the plant height (Narayana and John 1949, Menon and Pandalai 1958). Tall is the commonly cultivated type for copra and oil. Dwarf types are generally used for tender nut water, avenue planting or ornamental purposes. Other two major types identified in coconut are the niu vai and niu kafa types based on fruit morphology. Niu kafa type, considered as wild, has triangular fruit with high husk content and small nut inside. Niu vai types, with round fruits with low husk content and large nut inside containing large quantity of liquid endosperm are considered as advanced cultivars developed under human selection (Harries 1978; Samsudeen et al 2006). Both niu vai and niu kafa types are identified in tall population. Dwarf types are known to produce niu vai type fruits but not niu kafa type fruits.

Major products of coconut, beside copra and oil, are desiccated coconut, tender nut water and coir. Other

products include copra meal, shell charcoal, activated carbon, cocochemicals (fatty acids, fatty alcohol, methyl ether), coconut wood, fibre products, coconut cream, coconut milk, coconut powder, coconut chips and nata de coco. The inflorescence sap, known popularly as 'neera', has been creating a lot of interest among farmers and consumers recently and emerging as a health cum sports drink of natural origin. Coconut today is being positioned as a food, nutraceutical and industrial crop rather than oil crop.

Today, coconut is cultivated in 12.3 million hectares in 94 countries producing 62.5 million tons of nuts equivalent of 10 million tons in copra or six million tons in oil (FAOSTAT 2014). Approximately 96% of coconut area is cultivated by 10 million smallholder farmers with farm holdings less than four hectare and more than 80 million people depend on coconut for their livelihood (FAO 2001). In India, coconut is cultivated in 18 states and three Union Territories under 2.16 million ha for the production of 15.08 million tons (Indiastat database 2015). The four southern states of Kerala, Karnataka, Tamil Nadu and Andhra Pradesh account for 90% of area under coconut and 93% of production. Rest of the production comes from Maharashtra, Orissa, Pondicherry, Andaman & Nicobar, Lakshadweep, Gujarat, Goa, West Bengal and non-traditional states like Bihar, Assam, Tripura, Nagaland, Manipur, Meghalaya, Arunachal Pradesh and Chhattisgarh.

Evidences suggest that coconut reached the Indian subcontinent early in history. Recent discovery of 65 million year old fossil fruit resembling coconut (world's oldest fossil record of coconut) from Ghansor in Seoni district of Madhya Pradesh suggests origin of coconut in the Indian subcontinent (Srivastava and Srivastava 2014). Diversity in tall as well as dwarf populations found in India along the west and east coast supports the theory of coconut origin from India. Andaman Nicobar Islands and Lakshadweep Islands are rich resources of coconut genetic diversity. Kerala is the traditional coconut growing state where coconut is closely associated with social and religious life. Diverse ecological conditions prevailing in Kerala resulted in adaptation of suitable coconut population in those conditions. Ecologically adapted coconut populations (ecotypes) are found throughout Kerala, many of which have been documented. However, the ecotype diversity has been obscured by the human interference (movement of genetic material in and out of ecological niches) and delineating these ecotypes has become extremely difficult.

The ecotypes described from Kerala include both tall and dwarf types. Generally, ecotypes are named based on the geographical locations where they are located. Major tall forms reported from Kerala are Bedakam, Annur, Kuttiyadi, Jappanam, Komadan, Neduvarayan and Kappadam. Major dwarf forms reported from Kerala includes Chowghat Orange Dwarf, Chowghat Green Dwarf and Chowghat Yellow Dwarf. These ecotypes are developed as a result of continuous farming activity and selection by man and nature. Coconut is found only as a cultivated form and has no wild relatives. Long juvenile period and long productive life makes coconut genetic resource management unique. Generation time (average time between two consecutive generations in the lineages

of a population) in coconut is 15 – 20 years. It takes many years for a coconut population adapt to a particular geographical location. Many generations of farmers are involved in one coconut population getting adapted to a location. Conservation of coconut genetic diversity is farmer driven. Most of the ecotypes are identified and named by farmers. In situ characterization, cataloguing and on farm conservation with farmer participation is most appropriate model for management of coconut genetic resources. Inventories of coconut ecotypes are the prerequisite in this model. A few ecotypes from Kerala are described here.

West Coast Tall (WCT)

WCT is the coconut population adapted to west coast of India especially the Kerala coast. It is a very sturdy palm adapted well to the coastal ecosystem yielding beyond 100 years. The palms flowers in 6-7 years in open condition.

Kuttiyadi ecotype

This variety of coconut population is adapted to hilly region in Kozhikode district of Kerala. It is a very sturdy palm adapted well to the midland ecosystem yielding beyond 100 years. The palm flowers in 6-7 years in

open condition. Seeds of this cultivar germinate in 120 – 180 days. Kuttiyadi ecotype has longer inflorescences compared to WCT. Length and number of spikelets, number of female flowers and number of nuts/year are more in WCT compared to Kuttiyadi ecotype. Husk content and oil percentage in copra are higher in Kuttiyadi compared to WCT.

Bedakam ecotype

This ecotype is found on the eastern part of Kasaragod district. Bedakam ecotype can be described as intermediate in height having spherical crown, slender trunk, close leaf scars, less than 28 leaves on the crown, spaciously arranged leaflets, spaciously arranged spikelets, more than 46% husk, fruit length to breadth ratio 1.2, thick shell and thin endosperm.

Annur ecotype

This variety of coconut population is adapted to coastal area of Kannur district. It is adapted well to the coastal sandy soil yielding beyond 100 years. The palm flowers in 6-7 years in open condition. Seeds of this cultivar germinate in 120 – 180 days.

Jappanam ecotype

Jappanam ecotype is located in Alleppey district of Kerala state. The ecotype has large fruits, large nuts, thick shell and thick endosperm. Farmers are of the opinion that the palms are not susceptible to root (wilt).

Kappadam Tall

Kappadam Tall, an ecotype from coast of Kerala, is also known as 'Chappadan' in some parts of Kerala. Compared to the other varieties from west coast populations, this cultivar produces heavier larger fruits with thinner husk. The fruits of this selection are predominantly green, oblong to round in shape. The palms shows clear bole on the stem. The leaves are longer with broader and longer leaflets. The palm starts flowering between the 6th to 7th year after planting and produces large inflorescences. The average fruit weight is around 1200 g, with husked fruit weight of about 800 g. The kernel weight ranges from 400 to 550g with 215 to 280g of copra per nut.

Puvar ecotype

The Puvar ecotype is long fruited,with long fibre. They yield one and a half times more fibre than other types. The fibre is more than 30cm in length. The ecotype has large endosperm content. It gives 200 to 250 gram copra per nut. Oil percentage is about 70.

Chowghat Orange Dwarf

Chowghat Orange Dwarf is the most common dwarf coconut cultivated in India. Found sparsely cultivated throughout the west coast region of India, particularly in the Chavakkad area of Thrissur district of Kerala. The palm has a thin stem with closely arranged leaf scars, a small compact crown with characteristic orange colour on leaf petioles, inflorescences and fruits. This is an early

flowering cultivar and takes about 3-4 years for initial flowering. This is largely a self-pollinating cultivar. The palms of this variety are sensitive to moisture stress and also show alternate bearing habit. The fruits are small with an average weight of 634 g per fruit and average copra content of 128 g/nut and 66 % oil. The variety Chowghat Orange Dwarf was found to have the highest total sugar content in tender nut water. The tender nut water of fruit of 7th month is sweet with a total sugar content of 7.0 g/100 ml and sodium and potassium contents of 20 ppm and 2000 ppm, respectively and organoleptically graded as 'very good'.

Chowghat Green Dwarf

Chowghat Green Dwarf gets its name from the green coloured fruit and it was first identified from Chavakkad

region in Kerala. The palms are early flowering and take about 2.5 to 3 years for flowering. The leaf petioles, leaves and nuts are dark green in colour. The fruits are oblong in shape and have a characteristic 'beak' when fully mature. The palm attains a height of around 4 m at 20 years of age. It is generally grown for tender nut purpose as it contains very sweet nut water. The tender nut water has total sugars about 4.80 g/ml, average potassium content of 2150 ppm and average sodium content of 22.40 ppm. The palms are very sensitive to biotic stress and need plant protection measures against major pests particularly red palm weevil when large scale commercial plantings are adopted.

Chowghat Yellow Dwarf

Chowghat Yellow Dwarf is another variant of dwarf coconut from Chavakkad area in Kerala. The palms are scarcely distributed among the coconut populations in the area. The Chowghat Yellow Dwarf has erect leaves, large sized nuts with higher tender nut water and higher nut yields. The number of fruits per bunch range from 12 to 20. The palms are characterized by stem girth of 55 cm at 1 m from ground and an average leaf length of 3.45 m at the age of 30. The bunch production is regular and ranges from 9 to 13 bunch per year. The colour of the fruit is yellow, oval shape with an average fruit length of 37 cm and average fruit breadth of 16.5 cm. Tender nuts of this cultivar contain more sweet water ranging from 250 to 340 ml per nut with average TSS of about 6.7o Brix.

Farmer participatory characterisation of coconut diversity

Genetic diversity is very important to sustain the productivity of a crop. In coconut, diversity provides characters for yield, adaptation, disease resistance, high value uses and characters. Rich diversity of coconut varieties is observed in farmers' fields, which have not been reached by the traditional research methods employed for crop improvement in coconut. Farmer participatory approaches are important to characterize and to utilize the coconut genetic diversity for the sustainable production of coconut and enhancing income of farmers.

An initiative for the participatory analysis of coconut situation by the local coconut growers conducted under COGENT/IPGRI sponsored project implemented by Central Plantation Crops Research Institute (CPCRI) on "Developing coconut based income generating technologies in poor rural communities" in Pallikkara village in Kasaragod District, Kerala State and Ariyankuppam village in Pondichery. Farmer participatory methods were employed to understand the coconut cultivation scenario and to analyse the coconut diversity in farmers' gardens. PRA tools such as transect walk, resource mapping and seasonal calendar were employed to analyse the land use, local agro-ecology, problems and opportunities in the coconut community. Through matrix ranking farmers were facilitated to characterize and evaluate the coconut varieties found in their community. Coconut Diversity Fair was organised in the communities to facilitate the coconut growers to gather together in a common place, exhibit the different varieties of coconut grown in their gardens, study their preferences for varieties and analyse various criteria for characterizing and evaluating the varieties.

Altogether 12 diverse coconut types, six in Pallikkara and six in Ariyankuppam coconut communities were identified and their significant characteristics were documented. 'Sevvelanir' was one special coconut ecotype documented in Ariyamkuppam coconut community. 'Sevvelanir' in Tamil language means red tender nut. This is a special ecotype present in the locality, the tender nut of which when cut open the husk at the top portion shows a unique pink colour and hence the local people call it sevvelanir. The tender nut water is very sweet and local people believe that the tender nut water has the medicinal property to cure jaundice and asthma. The palms are tall and produce medium sized light green nuts. Only very few palms of sevvelanir tall are present in the locality.

The farmer participatory characterisation of coconut varieties in two coconut communities, one in the west coast and the other in the east coast in India, revealed the genetic diversity of coconut present in farmers' gardens. Further, the analysis also yielded information on the preference of farmers about the desirable traits of coconut varieties. (Thamban et al 2007). In the farmer participatory survey and study of varietal diversity and profitability of coconut in Kerala by IPGRI/COGENT

funded by IFAD it was revealed that farmers value hybrids for the traits of early bearing and high production potential in terms of nuts when facilities for better management are available whereas under average and below average management level preference is for local tall variety (Thampan, 1999). It is important that coconut breeders take into account the performance of coconut varieties in farmers' field and also the varietal preference of coconut growers while formulating coconut breeding programmes.

Management and utilisation of coconut diversity

Conservation of biodiversity is essential to the sustainable development and human survival. Coconut (Cocos nucifera L.) is an integral part of agricultural biodiversity in its natural home for many centuries and has been closely associated with human culture as food, medicine, cosmetics, in construction, in rituals and in social life. Development activities and non-profitability of coconut cultivation are driving the coconut out of cultivation leading to erosion of coconut genetic resources and indigenous knowledge associated with it. It is imperative that such resources and knowledge associated with are documented and protected for the benefit of future generations.

As a result of many uses and preferences by local people, different ecotypes have emerged through the selection both by man and nature. West coast of Kerala is a natural home to coconut. It is a narrow strip of land between the Western Ghats and the Arabian Sea and ranges from 50 to 100 km in width. The region with numerous rivers and backwaters inundating the land sustains unique ecosystems. Selection coupled with adaptation lead to the development of many local ecotypes in coconut along the region. Identification, characterization, documentation and conservation of this genetic diversity are crucial for future breeding programs.

Supporting the maintenance of diversity on farm is one strategy for crop genetic diversity conservation. On farm conservation is viewed as a complementary strategy to ex situ conservation strategies. Through on farm conservation not only the materials, but also the processes of evolution, adaptation of crops to their environment and traditional knowledge associated with the crop are conserved by studying traditional identification and nomenclature processes one can understand the way in which coconut diversity is perceived and understood by indigenous people. Documentation of diversity and its association with people is prerequisite to develop on farm conservation programs.

Ethno botanical approach aim to document, describe and explain complex relationships between cultures and uses of plants. This field of study analyzes the results of indigenous manipulations of plant material together with the cultural context in which plants are used. Coconut has a long history of human association. Man had used coconut in many ways resulting in a large number of products and knowledge associated with it. Most of these products and knowledge are location or region specific linked to the culture of the land. Documentation of these products and knowledge help in the sustainable use of coconut genetic diversity and promoting coconut as a food for nutrition, health care and environmental services to safeguard the interest of millions of people and their livelihoods.

Conclusion

There is tremendous scope for utilizing the genetic diversity of coconut available in farmers' fields for providing various options and opportunities while formulating strategies for solving the problems of coconut farmers. A thorough understanding about the coconut diversity available in farmers' gardens would enable the stakeholders to utilize the germplasm for sustainable production of coconut and enhancing income of farmers.

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Innovative Uses of Coconut

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Coconut - The prodigy among the fruits is well known for its wide field of application from food to cosmetics. Almost everything of the coconut palm is useful in various applications. Not only the kernel of coconut, but even its stem and leaves are having various usage. The hard shell is used as a fuel, the husk and fiber are wonderful insulation materials for constructing eco-friendly houses. According to Dr. Bruce Fife, a renowned certified nutritionist and naturopathic physician, coconut oil is good in preventing Alzheimer's disease, cancer and other diseases. The uses and benefits of coconuts are kind infinite, as new ways of application of coconut products are discovered day by day.

Coconut oil is rich in fatty acids that are found to be having powerful medicinal properties. It contain Medium Chain Triglycerides (MCTs) that are sent straight to the liver from the digestive tract and are used as a quick source of energy or are turned in to ketones which are said to have therapeutic effects on brain disorders like epilepsy and Alzheimers. Research has proved that people who consume more coconut products are healthy. Coconut oil is helpful in burning more fat and can kill harmful microorganisms. Coconut oil can be used to reduce appetite; can improve the blood cholesterol levels as the saturated fats in coconut oil may increase HDL cholesterol levels and transform the LDL

cholesterol to a less harmful form and hence decrease the risk of heart diseases. The fatty acids in coconut oil are said to boost brain functions in Alzheimer's patients.

Coconut Oil

One of the recent and pioneer innovations is the use of coconut oil is as a Metal Working Fluid (MWF) used in the process of industrial machining. Most of the MWFs used in the industry are mineral oil-based fluids. MWFs are used to cool and lubricate during metal cutting and machining process. Certain studies were held to assess the potential stability of coconut oil in the production of cutting fluid by processing test composites of various mixtures. The research was done for the adequate interpretation of the facts gathered. Since coconut oil does not mix with water without the addition of proper emulsifiers, various emulsifiers were tried and the test results were analysed. Preliminary experiments were done to find the best emulsifiers to use. The first one to test was acacia powder and coco midrib ash and the outcome of the experiment was that their physical and chemical properties were comparable with those of mineral based cutting fluid or MWF available in the market. Coconut oil is found to have long shelf life in contrary to its counterparts. Certain researchers compared it with other vegetable oils like soybean, sunflower and rapeseed oils. It is found that the usage of raw white coconut oil in the form of an emulsion as MWF is better on mild steel in comparison with AISI 304 steel. The use of coconut oil as an MWF has great advantages as it can be used as MWF which is exponentially better in terms of the pollution it creates in the environment in comparison with the petroleum alternatives. It doesn't create any respiratory issues and skin disorders to the workers. The usage of coconut oil also contributes to slower exhaustion of the fossil fuels. Coconut oil is non toxic, renewable, biodegradable and posses high viscosity and flash point which equates to a very low vapor pressure and volatily which in turn eliminates potential hazards during use.

Comparative Information on cutting fluid					
Material Compo-nent	Type	Efficien-cy	Effect to Human skin	Effect on Disposal	Cost
Mineral Oil	Emulsifi-able	Highly Efficient	Irritant	Negative	High
Coconut Oil	Emulsifi-able	Efficient	Non-Irri-tant	Eco Friendly	Low

Coconut oil can be used in diesel engines in its raw form, but the direct use of coconut oil possess certain issues with the normal diesel engine due to its high viscosity and high melting point and the tendency to remain solid in colder temperature. In order to solve this situation, bio diesel is produced by a process called trans-esterification. This process converts the coconut oil to biodiesel which very much resembles its petroleum counterpart. The emission from coconut oil engine are far less harmful than the normal diesel engine.

Coconut Oil has a wide variety of uses in cosmetic products. It can be used as a mild sunscreen (SPF 4) which isn't much in comparison with the commercial sunscreens but is far better than bare skin. It is used to manufacture soap due to its fat content. It is also used as moisturizing skin cream, and can be used as diaper cream for babies to avoid symptoms of diaper rash as an alternative to products with Zinc Oxide. Coconut oil is also having the added advantage of washability with regular detergent.

Coconut oil does wonders to hair. When applied at room temperature it acts as a conditioner and makes hair healthier due to its rich content of vitamin E, vitamin K and iron. It gives a natural shine to hair, acts as a cleaning agent for scalp due to its antifungal/antibacterial properties, and also acts as an ideal solution for reducing dandruff. It is also used as flea repellent to avoid bug bites.

Coconut Water

Coconut water with full of nutrients induces lots of health benefits. Mature coconut water consists of electrolytes and is a perfect sports drink. It aids in weight loss and also helps in reducing appetite. Oral consumption and topical application of coconut water helps in maintaining the skin healthy and reduces acne and other blemishes. Its high concentration of fiber facilitates good digestion. Coconut water reduces blood pressure as the electrolytes in it act as a balancing mechanism. Coconut water is fermented to make jellies and other sweet food products. Fresh coconut water can be used as an emergency alternative for saline in IV fluids due to its highly sterile nature and high content of electrolytes. It is also used as a natural diuretic.

Coconut Shell

Coconut shells are used for making activated carbon for filtration purposes. Coconut shells are of high density and are full of micropores. Coconut shells are used to make shell charcoal which is used as domestic and industrial fuel source. The shell is carbonized using various methods like pit method, drum method and destructive distillation methods to produce shell charcoal. Shell charcoal is the raw material for activated carbon and is used by blacksmiths, goldsmiths and in laundries. Coconut shell powder is manufactured from coconut shell which is a by-product of coconut oil industries, and this powder can be used as a filler in synthetic resin glues, filler, bituminous powder, mastic adhesives and mosquito repellents. Coconut shells are used to produce various vintage musical instruments and percussions and are widely used in the music industry for its wide variety of sound effects that it can produce. Coconut shells are also used to manufacture various artifacts and handicrafts which are having a huge market share.

Coconut husk

The husk of fresh coconut is made up of very strong fibers. The medium between the fiber is having a high lignin content which act as a natural glue. These properties can be exploited to produce hard products like Medium Density Fiber (MDF) boards. The fiber is compressed in a mold and then is heated to a certain temperature which produces strong solid board which is similar to MDF boards. These coconut boards are said to be in consideration to use it as floor board in cars. Coconut husk can be used along with latex and formed into furniture of various forms which are self-cushioned and still doesn't lose their shape. Coconut husk is used for the manufacture of hydroponic planting medium. This substance is good for growing orchids, mushrooms and other plants, has excellent moisture retaining capacity, balances the mineral content, maintains good temperature and pH value for plant, is 100 percent natural and can be completely replace soil. It is getting more popular in terrace farming application as well as in normal gardening. Coconut husk is used to produce ropes, floor mats, rags, brushes and other household items. These products are eco-friendly, cheap and long lasting.

Coconut Meat

Coconut meat, the rich white substance inside coconut shell is juicy, tender, thick and crunchy or strong and fibrous according to the age of the kernel. Coconut meat contains high amount of protein and consists of all the essential amino acids required for the human body. Protein supplements are made with coconut meat by pressing the oil from it which leaves a powder with low fat and high protein. This powder can be added to other protein supplements and is a natural source for complete proteins. The powder after extraction of oil is used as an alternative for flour in various forms of cooking. Coconut meat is sliced, shredded or shaved to thin pieces of coconut and can be microwaved and can be consumed as chips. It doesn't require oil for frying as the oil content in itself is sufficient for the purpose.

Coconut Milk

Coconut milk is the mixture of coconut meat and coconut water. It can be used as a dairy alternative. It is sometimes called a miracle liquid because of its nutritional values and its wonderful ability to increase our body's immunization power which in turn prevent diseases. It lowers the blood pressure, lowers the cholesterol and improves the heart health. The Medium Chain Triglyceride (MCT) fatty acids present in coconut milk increases the energy consumption and increases the physical performance. It helps build muscles and to lose fat. Since it is high in healthy fats it helps avoid overeating.

Coconut tree sap

The sap of the coconut tree can be used to make coconut sugar or nectar and coconut vinegar. Sugar made from coconut sap is said to have unique flavor and can be used as an alternative to cane sugar. Coconut sap sugar is a low glycemic index food which denotes that it is a healthy alternative to other sugars with high glycemic. The Coconut sap sugar consists of sixteen essential amino acids which are very vital for various bodily processes. It includes glutamine which is used to produce glutamic acid which is involved in heart health and brain function. It also contains high levels of essential minerals like Zinc, Magnesium and Potassium and is a rich source of Vitamin B and nutrients like inositol.

Conclusion

Coconut has a wide variety of uses and is a natural replacement to many chemicals. Recent studies even shows that it is an effective alternative in industrial machining processes. Thus coconut help serve the mankind by providing 100 percent natural and quality products. ■

Extension approaches for reaching the farmers and other stakeholders

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1. Introduction

India is one of the major producers of coconut in the world and about 12 million people are dependent on coconut farming and its allied activities. The average productivity of coconut from the importnat producting states viz.,Kerala, Tamil Nadu, Karnataka and Andhra Pradesh is 11,775 nuts/ha which is lower in comparison to research station yield of 3,0625 nuts/ha. In the recent past, coconut sector suffered from problems such as price flucutations, pests and diseases, moisture stress, lack of value addition etc. Hence, technological innovations and diffusion of new technologies are the key drivers to enhance the productivity and profitability of coconut farming. Through the systematic research conducted at Central Plantation Crops Research Institute (ICAR-CPCRI) and State Agricultural Universities (SAUs) during the last few decades, a substantial number of viable technologies related to crop improvement, production, protection and processing have been evolved for enhancing coconut production. Various programmes are being implemented by R & D agencies on a regular basis as part of the efforts to disseminate the research results among the coconut cultivators. Front line extension activities are also being organized by ICAR-CPCRI and SAUs. On farm testing of these technologies and front line demonstration and extension activities are carried out by Krishi Vigyan Kendras (KVKs). Mainstream extension programmes in coconut are mostly organized by Coconut Development Board (CDB), State Department of Agriculture/Horticulture and farmers organizations.

In spite of the efforts made by coconut R & D/ extension agencies, farmers are not able to exploit the production potential from the improved technologies to the extent desirable. The extent of adoption of technologies recommended for higher yield and income from coconut farming is comparatively low due to various constraints including socio-economic, technological, management or infrastructure. Low and fluctuating price of coconut is the most important

problem faced by coconut growers. Lack of sufficient labour for climbing palms and high wage rate also create much problem to farmers. Incidence of pests and diseases is another important problem experienced by coconut farmers. Predominance of senile and unproductive palms, high cost of inputs, lack of availability of quality planting materials, low availability and utilization of organic manure due to reduced adoption of livestock integrated farming, lack of irrigation/drainage facilities etc. are also often reported as constraints in adopting the recommended practices of coconut cultivation. Majority of the coconut growers belong to small and marginal holding categories and the uneconomic holding size limits the adoption of recommended technologies for higher productivity and income from coconut farming.

The low level of technology utilization at farmers' fields calls for formulating effective extension strategies suitable to the heterogeneous farming situations in coconut cultivation. The important technology dissemination activities in coconut implemented by ICAR-CPCRI include training programmes, front line demonstrations, information communication through mass media like radio, television, newspapers and farm magazines, extension pamphlets, CD ROMs, video cassettes etc., arranging exhibitions, seminars, Krishi Melas and group meetings, providing consultancy through field visits and replying postal, e-mail queries etc. Besides, a few innovative extension approaches have also been pilot tested through action research with farmers' participation by ICAR-CPCRI for improving technology utilization by coconut farmers.

2.Training Programmes

On campus/off-campus training programmes for farmers and extension personnel on specific topics on coconut such as agrotechniques, integrated pest and disease management, nursery management, organic farming technologies for coconut based cropping systems and post harvest technology form an important component of TOT programmes to enhance their knowledge and skill for better technology utilization. The study conducted among extension personnel who had participated in the Model Training Course (MTC) programmes conducted at ICAR-CPCRI indicated that the efforts for organizing such training programmes were highly successful in achieving the objectives as reflected by the high Training Effectiveness Index (TEI) values.

Impact analysis of capacity building programme among SMSs of KVKs during 2016 revealed that training had significant impact on enhancing the knowledge level of the respondents in all subjects of coconut technologies. Average gain in knowledge was estimated to be 18.36 per cent. There was a difference in knowledge levels in pre- evaluation and in knowledge gain among age groups wherein, youngsters were having high knowledge gain. Similarly, knowledge gain was higher among respondents who had undergone training earlier. Majority (79 %) of the respondents were highly satisfied with the course contents and training delivery methods. Sixty one per cent of the respondents graded training course as excellent. After the training, about 38 per cent of KVKs initiated OFTs and FLDs on coconut technologies for better technology integration.

Lack of availability of labour, especially skilled labour for coconut climbing, and high wage rate are important problems faced by growers in adopting timely crop management practices. To tackle this problem, the Coconut Development Board has initiated an innovative training programme, 'Friends of Coconut Trees (FoCT)' to develop a professional group of youth for harvesting and plant protection operations in coconut. The training targeted the group of unemployed youth in developing technical skills, entrepreneurship capacity, leadership qualities and communication skills to address the needs of the coconut growers.

Training on Friends of Coconut Trees (FoCT)

Activities taken up in different FLD programmes

FLD on Soil and water conservation

FLD on cocoa as an intercrop in coconut

FLD on Soil and water conservation

FLD on management of coconut root (wilt) disease

3. Front Line Demonstrations (FLD)

ICAR-CPCRI has been organizing front line demonstrations in farmers' fields on different coconut cultivation technologies such as coconut based farming systems, soil and water conservation, management of root (wilt) affected coconut gardens, cocoa as a profitable intercrop in coconut gardens etc. Such demonstration programmes have proved to be effective in convincing the farmers about the technical feasibility and economic viability of the technologies. The adoption of the integrated root (wilt) management practice was effective in improving the average yield of root (wilt) affected palms in farmers' fields from about 24 to 46 nuts/palm/year after three years, recording an improvement of around 92 per cent. Observations on yield of coconut revealed an increase in productivity of palms from a pre-demonstration yield of 95 nuts per palm per year under mono crop situation to 122 nuts per palm per year in coconut based high density multi species cropping system. Farmers' participatory research-cum-demonstration plots on cocoa as an intercrop in coconut gardens in five districts of Andhra Pradesh have been initiated to know the technical feasibility and economic viability of the technology. Farmers have taken up this programme whole heartedly. Some of the activities taken up in FLDs are depicted in above.

4. Paradigm Shift in Reaching out to Stakeholders

Refinement of extension approaches pave way for reaching out to the relevant stakeholders more efficiently and effectively. Farming is not an isolated activity by any means and it has the foundations in culture, heritage, experiences, tacit knowledge, knowledge innovations, innovation systems and social process.

• Participatory Technology Transfer Approach (PTTA) for coconut root (wilt) disease management • Clustering coconut farmers – A successful extension approach for enhancing adoption and income from marginal and small holdings of root (wilt) disease affected areas • Area Wide Community Extension Approaches (AWCA) in Bio-management of Rhinoceros Beetle of coconut • Farmer Field Schools (FFS) in coconut • Participatory community approaches in area wide management of red palm weevil • Information communication technologies (ICT) as interactive platform for technology transfer and field problem solving for farming community

Special features of the extension approaches evolved are:

1. Interactive and participatory involving relevant stakeholders
2. Paradigm shift from individual farmers to farm family approach with gender concerns
3. Inclusiveness incorporated for reaching out to all sections of society

FFS for IPM of coconut

4. Area wide interventions to overcome the challenges of fragmented holdings and resource base variability of farming community

5. Appropriate integration of extension techniques and methods for awareness building, knowledge dissemination and skill upgradation

6. Technology specific and problem specific approaches for focused technology interventions and improving the impact of research

7. Utilizing the digital literacy and advances in taking technologies and information to different strata of the society.

4.1. Community Based Organizations (CBOs) for sustainable income enhancement

Livelihood of a substantial number of families in rural poor communities in India depends on coconut farming. Technology options for enhancing income from coconut farming in such poor rural communities do exist, but not fully realized in field situation. To augment the production and productivity of such small and marginal holdings, which are also fragmented, group management of resources to overcome the inherent weaknesses of such holdings was taken up through Community Based Organizations (CBO) by ICAR-CPCRI in selected localities. Such an approach helped efficient management of farmers' resources to reduce cost of cultivation and to increase productivity through integration of technologies.

4.1.1. A project sponsored by International Plant Genetic Resources Institute (IPGRI) for developing sustainable coconut based income generating technologies in poor rural communities was successfully implemented by the ICAR-CPCRI in two selected coconut communities, at Pallikkara in West Coast region and Ariyankuppam in East Coast region. The strategies for the project included i) growing suitable inter/mixed crops in coconut gardens and integrating animal husbandry and other subsidiary enterprises with coconut farming, ii) cultivating high yielding cultivars of coconut to enhance the yield and income and, iii) promoting diversification of coconut products. The implementation of the strategies envisaged in the project was routed through Community Based Organization of coconut growers in the selected communities. Micro-credit for introducing the interventions envisaged under the project was routed through the CBO.

4.1.2. Under the project on 'Cluster approach among coconut farming community' for improving productivity and income from small and marginal coconut based homesteads in the root (wilt) affected coconut area, the farm family members of 25 ha area clustered together for deciding the farm strategies; both individual and group ventures for improving productivity and income. The average yield of coconut was doubled after technology package implementation for three years. The cluster approach has been scaled up by other agencies like Coconut Development Board (CDB) among coconut farming communities through their development schemes. The Board has initiated the formation of Coconut Producer Societies (CPS) by associating 40-100 coconut growers in a contiguous area with a consolidated minimum of 4,000-5,000 palms.

4.1.3. Under the National Agricultural Innovation Project (NAIP) project on 'Value Chain in Coconut', implemented by ICAR-CPCRI, the methodology involved facilitating CBOs of farmers and women SHGs for effective integration of production and processing technologies in coconut holdings for higher income. Ten CBOs comprising of 534 farmers in clusters of 25 ha each were formed and technological interventions on soil and water conservation, soil health management, integrated nutrient management, inter/mixed cropping and integrated pest and disease management were implemented in farmers' gardens. Four women SHGs were facilitated to take up microenterprises on production and marketing of coconut value added products like coconut chips. The group approach in coconut farming for income enhancement in small holdings is being scaled up by other agencies like Coconut Development Board, State Department of Agriculture and Local Self Governments.

4.1.4. Farm families of manageable contiguous area (50-100 ha) affected by coconut root (wilt) disease will be joining the Participatory Technology Transfer (PTT) approach wherein multidisciplinary team of scientists, extension officials, farmer representatives, local village representatives, women, youth etc. forms the stakeholders. The awareness, knowledge, attitude and adoption of farmers towards the technology package for the integrated root (wilt) disease management technologies were improved by 40-85 per cent over the pre-implementation level. The monitoring, appraisal and evaluation of the technology implementation and impact were done with the stakeholder participation and documented in 'farmer-scientist-extension dialogue session' for further scaling up by other agencies.

4.1.5.Farmer Field Schools (FFS) for IPM of coconut: The innovative concept of FFS was implemented by ICAR-CPCRI Regional Station, Kayamkulam for the IPM of rhinoceros beetle in coconut in 15 locations. The awareness and knowledge of farmers were improved by 100 per cent over pre- FFS level.

4.1.6.Promotion of Women's Self Help Groups: Entrepreneurship Development Programmes are organized for women to train them on the opportunities for value addition in coconut. Various topics including the concept and practices of Entrepreneurship Development, group approach for micro level interventions and product diversification in coconut are included in the programme. The experiences and impact of organizing such programmes clearly indicated the scope and importance for enhancing the income of resource-poor coconut farmers and socio-economically disadvantaged rural women through product diversification in coconut.

4.1.7.Farmers' Participation in Coconut Research: This approach invariably enhances the extent of technology utilization at farm level. ICAR-CPCRI was one of the selected centres to implement the Institution-Village Linkage Programme (IVLP) under National Agricultural Technology Project (NATP). The TAR-IVLP project was implemented in three villages, viz., Pady, Edneer and Nekraje of Kasaragod, Kerala with coconut as one of the important crops in the production system of the villages. Implementation of the project revealed the effectiveness of participatory approach in the performance assessment of various technologies related to high yielding varieties, intercropping, nutrient management and crop protection in coconut.

5. Strengthening Research-Extension-Farmer Linkage in Coconut Sector

Various agencies both from research and extension systems strive for the development of coconut sector and for better impact, such extension activities are to be coordinated at different levels. Research-Farmer-Extension interface programme is an approach for strengthening the ToT efforts for the development of coconut sector and the experiences of ICAR-CPCRI in implementing such programme indicate the relevance of strengthening linkages at different levels. Researchers, extension personnel and farmers are brought together on a common platform and the activities for the sustainable development of coconut are streamlined. ICAR- CPCRI had organized research-farmer-extension interface programmes on coconut in 12 districts of Kerala during 2002-03 and 13 districts of Karnataka during August 2013-October 2013 as a collaborative effort with SAHUs, KVKs and Department of Horticulture.

The interface programmes could enhance the awareness and knowledge about the technologies for improving coconut productivity and income of farmers. The experiences gained from interface programmes revealed that the concept of research-extension-farmer interface is sure to enhance the adoption of technologies ultimately leading to coconut growers' own benefit.

6. Area Wide Community Extension Approach (AWCA) for management of coconut pests

Adoption of plant protection technologies in coconut was reported to be very low (below 5%). Alternative extension mechanisms for managing pest/disease problems of coconut needs special emphasis because coconut, a perennial plantation crop, is cultivated in

Activities under AWCA

Identification of coconut pests (area wide community approach)

Interface with beneficiaries of AWCA

Research-Farmer-Extension interface programmes organized by ICAR-CPCRI

Interface programme at East Godavari, Andhra Pradesh

Interface programme at Kannur, Kerala

Interface programme at Coimbatore, Tamil Nadu

contiguous area in small and marginal land holdings (average holding size of 0.2 ha) provides congenial conditions for pest and disease incidences throughout the year and it is a challenge for technology delivery among farming community with varied resource base, socio personal and psychological variables. Hence, extension approaches/ mechanisms need paradigm shift from individual farmers to area wide or groups/community based for improving efficiency.

ICAR - CPCRI took the initiative to evolve area wide community extension approach (AWCA) for management of coconut pests which was scaled up in several districts subsequently. The model community extension approach underscores the role of linkages with peoples' representatives, farmer organizations, farmer leaders, co-operative societies of farmers and co-ordination with various extension departments and research institutions. The critical component of the extension approach was the decentralized option for technology facilitation viz. capacity building of women farmer groups as master trainers and farm level producers of Green Muscardine Fungus (GMF) and targeting the 'potential and critical adopters' of the bio control technology against rhinoceros beetle, the major pest of coconut. Through this approach, more than 90 % of the potential adopters were reached within two months and post intervention data indicated 75.8% reduction of fresh pest infestation.

7. Participatory Technology Assessment and Refinement for Evolving Climate–Smart Adaptations in the Management of Coconut Based Farming Systems under Coastal Sandy Soil Conditions of South Kerala

Climate-smart adaptations evolved during the course of participatory demonstration coupled with assessment and refinement of technologies for management of Coconut Based Farming Systems (CBFS) in the Southern coastal tracts of Kerala during 2012-14 resulted in reducing crop loss due to climate vagaries, improvements in soil properties, identification of ideal crops and their varieties and income enhancement from coconut and intercrops. Pine apple was found to be the most ideal crop withstanding water logging, followed by fodder grass and Nendran variety of banana. Climate resilient refinements by farmers viz., modified method of husk burial for pine apple, shifting of planting time, planting of 4-5 months old suckers and earthing up with silt and coconut husk, green manure, coir pith compost and husk for banana, planting of short duration varieties and shifting of planting time for tuber crops were proved to be successful.

8. IFAD project on Overcoming Poverty in Coconut Growing Communities: Coconut Genetic Resources for Sustaining Livelihoods in India

Participatory planning and implementation of diverse interventions notably intercropping and off-farm activities in small and marginal coconut homesteads in Pathiyoor, Thodiyoor and Devikulangara panchayats through registered Community Based Organizations (CBOs) along with nutrition education brought out significant improvements in the food and nutritional security as well as the income of the family members. The project efforts could bring in tremendous increase in income from intercrops, livestock and household level

Demonstration on management of coastal sandy soil

processing and the total annual income per homestead enhanced from Rs.25,617 to Rs.59,017 over the project period.

9.Integrated Model Coconut Clusters for Improving Livelihood Security in Root (wilt) affected areas

Integrated model coconut cluster at the panchayat level by linking the ward level coconut clusters through a common support centre with continued government support for input use and marketing for effective functioning and sustenance was developed and tested in 25 ha area in Thekkekkara panchayat of Alappuzha District sponsored by NABARD. Technologies related to production, protection and processing of coconut were effectively transferred to the farmers which resulted in an increase in knowledge index to the tune of 153%. One coconut processing unit and a bio agent production unit were established under the project. The income from coconut recorded 2.4 folds improvement, while the area under intercrops increased to double than that of the pre-project period and the income from intercrops increased by 3.9 folds. The project efforts could also bring in increase in income from household level processing by 2.7 folds. The average farm income increased by 2.7 folds over the project period, thereby resulting in an increased in household level income by 26%.

10.Community based Bio-resource Management for Sustaining Production and Livelihood security under Coconut Based Farming Systems

Community based bioresource management through production and utilization of organic inputs ensured quality bio-inputs to the farmers along with efficient use of resources, thereby contributing to sustainable production and productivity. Awareness programmes, training- cum-demonstrations, small group discussions, farmer field schools and household level trainings resulted in an increase in knowledge level of 117% in case of bioresource management and 76% in case of integrated nutrient management. Soil test based site specific integrated nutrient management with emphasis to bioresource management was recommended to farmers through soil health cards. Significant improvement in income from coconut and other intercrops resulted in 89.7% improvement in farm income.

11. Mera Gaon Mera Gaurav

The innovative initiative 'Mera Gaon Mera Gaurav' by Ministry of Agriculture and Farmers' Welfare, Govt. of India has been planned to promote the direct interface of agricultural scientists with the farmers to hasten the lab to land process. ICAR- CPCRI, Kasaragod and its Regional Stations and Research Centres have started implementing the programme in 69 villages from

Community based bioresource management

Mera Gaon Mera Gaurav initiatives

Videoconferencing facility at ICAR-CPCRI

October, 2015 as per the guidelines (Fig.9). Training programmes, demonstration on improved practices, farm advisory visits and mobile advisory services are organized in the selected villages for the benefit of farming community. Cutting across all disciplines, farm problems are diagnosed and effective solutions are delivered and showcased in farmer's fields. National priorities such as secondary agriculture, climate change, good agricultural practices and soil and health management of crops are envisaged in this programme.

12. Cyber Extension Programmes

Cyber Extension includes effective use of information and communication technology (ICT), national and international information networks, internet expert systems, multimedia learning systems and computer based training systems to improve information access to the farmers, extension workers, researchers and extension managers. ICAR-CPCRI has been implementing various cyber extension activities as part of strengthening the technology transfer programmes of the institute in mandate crops viz., coconut, arecanut and cocoa. As part of the cyber extension activities, a group video conferencing system through ISDN was installed at the ATIC, ICAR-CPCRI, Kasaragod to facilitate interaction between various stakeholders for enhancing technology utilization in coconut. In the year 2010, the videoconferencing facility for organizing interface programmes was strengthened by procuring a mobile CODEC.

13. Conclusion

Coconut is one of the important plantation crops in India which support millions of farmers. Though large number of technologies has been generated for the improvement of coconut at various research institutes, they have not reached the beneficiaries to the desired level. The present scenario of technology adoption in coconut calls for the technology generation and dissemination programmes based on a viable extension strategy with the active participation of stakeholders. Further, effective linkage is to be established among different research, and extension agencies and coconut farming community through well co-ordinated participatory research/ extension programmes for ensuring a meaningful technology generation and transfer in coconut. ■

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Foundation stone laid for the Farmers Training Centre and Regional Office Building

Shri. Radha Mohan Singh, Hon'ble Union Agriculture Minister, Govt of India laid the foundation stone for the Farmer's Training Centre and Regional Office building of Coconut Development Board at Bihar Agricultural Management & Extension Training Institute, Patna, Bihar on 12th January 2017. The minister in his inaugural address stated that the Central Government is bound to promote the coconut cultivation and related activities in Bihar. He told that since 2014 a total amount of Rs 409.06 lakhs has been sanctioned for implementing the schemes on coconut cultivation in Bihar. The Regional Office of the Coconut Development Board was shifted to Guwahati, Assam from Patna, Bihar on the basis of recommendations of a committee constituted under ICAR in 2009. A central team was constituted by the Modi Government for focussing on coconut productivity in Bihar. This team has recommended to open a new and fourth Regional Office of the Board at Patna in place of the State Centre Patna.








The minister further told that India is the global leader in coconut production and productivity. Coconut is cultivated in 16 states and three union territories in an extent of 2.14 million ha. The crop sustains more than one crore farmer families of the country through cultivation, processing, marketing and trade related activities. In Bihar state coconut is grown in 14,900 hectares producing 141.38 million nuts.

Agriculture Minister said that Kosi region in North Bihar which comprises places on either sides of the Kosi river is ideal for coconut cultivation. It is estimated that nearly 50,000 hectares of potential area in Bihar is available for coconut cultivation, mainly in North Bihar under irrigated condition.

The Minister concluded that CDB aims to equip the coconut farmers in production, processing, marketing and export of coconut and its value added products thus making India the world leader in production, productivity, processing for value addition and export of coconut. Bihar belongs to nontraditional coconut cultivated area and special focus is given for the development of coconut sector in the state. The establishment of a Farmers Training Centre, attached to the Regional Office, Patna is expected to impart skills to farmers. The centre will strengthen the coconut cultivation and industry in the state.

Dr. Sanjeev Chaurasia, MLA, Digha Constituency presided over the programme. Smt.Asha Sinha, MLA, Dhanapur Constituency spoke during the occasion. Dr.A.K.Singh, Chairman Coconut Development Board delivered the welcome address and Shri. Saradindu Das, Chief Coconut Development Officer proposed vote of thanks. Members of Coconut Development Board and around 300 coconut farmers, entrepreneurs and officials from the state of Bihar participated in the programme.

49th PAC approved 38 Projects worth Rs 60.20 Crores

49th meeting of the Project Approval Committee (PAC) on Technology Mission on Coconut (TMOC) held at Kochi on 23rd January 2017 under the Chairmanship of Dr. A.K. Singh, Chairman, CDB approved 38 projects with an outlay of Rs. 60.20 crores and financial assistance of Rs. 9.086 crores. These units are having annual processing capacity of 1912.70 lakh coconuts, 18,000 MT production of coconut shell charcoal and 1500 MT production of coconut shell based activated carbon. Out of 38 projects, three are research projects, 32 projects on processing and product diversification and three projects on market promotion.

Under processing and product diversification, seven desiccated coconut powder units with annual processing capacity of 795 lakh nuts, eight virgin coconut oil units with annual processing capacity of 787 lakh nuts per year, two neera processing unit with processing capacity of 39.6 lakh liters neera per year, two coconut oil units with capacity to process 76.50 lakh nuts per year, five copra dryer units with processing capacity of 150 lakh coconuts per year, four ball copra units with processing capacity of 29 lakh coconuts per year, three shell charcoal units with annual processing capacity to produce 18000 MT shell charcoal per year and one activated carbon unit with capacity to produce 1500 MT activated carbon per year were sanctioned.

In Kerala, five virgin coconut oil processing units with capacity to process 77400 nuts per day, one coconut oil unit for processing 5500 coconut per day, one desiccated coconut powder making units with capacity to process 30,000 nuts per day and one copra dryer unit with capacity to process 10,000 coconuts per day, one neera processing units to process 3,200 litre neera per day, two integrated processing units; one for processing 25,000 coconuts per day for desiccated coconut powder and virgin coconut oil and a coconut oil unit with capacity to process 20,000 coconuts per day and neera processing with a capacity to process 10,000 litre neera per day; two shell charcoal unit to produce 30 MT charcoal per day and one activated carbon unit to produce 5 MT activated carbon per day were sanctioned.

In Karnataka, two desiccated coconut powder processing units with capacity to process 65,000 nuts per day and one shell charcoal unit to produce 30 MT Charcoal per day were sanctioned. In Tamil Nadu, four desiccated coconut powder processing unit with a capacity to process 1,70,000 nuts per day and three virgin coconut oil units for processing 1,85,000 coconut per day were sanctioned. In Andhra Pradesh, four milling copra making units with capacity to process 40,000 coconuts per day and four ball copra making units with a capacity to process 29 lakh coconuts per year were sanctioned.

Dr. P. Chowdappa, Director, CPCRI, Kasaragod; Mr. Venkatesh N Hubballi, Director, Directorate of Cashew and Cocoa Development, Kochi; Shiri B.A.R. Patro, Chief Regional Manager, Indian Overseas Bank, R.O, Kochi; Smt Usha K, DGM, NABARD, RO, Thriuvananthapuram; Dr. P. Vijayaraj, Scientist, CFTRI, Mysore; Dr. Anil Kumar R., Asst. Agricultural Marketing Advisor, Directorate of Marketing and Inspection, Kochi; Shri. Ramesh T., Deputy Secretary, Department of Agriculture, Government of Kerala; Shri Saradindu Das, Chief Coconut Development Officer, Dr. A.K. Nandi, Secretary, Shri R. Jnanadevan, Deputy Director, and Shri Sardar Singh Choyal, Deputy Director, CDB, Kochi attended the meeting.

4th Assam International Agri-Horti Show 2017

Assam International Agri Show

Coconut Development Board Regional Office, Guwahati participated in the 4th Assam International Agri Horti Show organized by the Department of Agriculture, Government of Assam in association with Indian Chamber of Commerce (ICC) and Assam Agricultural University(AAU) held from 6th to 9th January 2017 at College of Veterinary Science Playground, Khanapara, Guwahati. Assam International Agri-Horticultural Show is an annual event held in Assam which showcases the advanced technologies and new opportunities available in agriculture, horticulture, food processing, floriculture and allied sectors. Chief Minister, Assam, Shri. Sarbananda Sonowal inaugurated the 4th Assam International Agri-Horticultural Show on 6th January 2017.The chief Minister in his inaugural address told that the Government is committed to strengthen the agriculture sector to attract the new generation and assured the farmers that soon the Government would ensure Minimum Support Price for their production. The State Agriculture Minister Shri Atul Bora in his address mentioned that the Agri-Horticultural Show would help in the growth of export and investment in agriculture sector in Assam. He also stressed that the farmers of the State would be highly benefited from the show as the same would give them an exposure of advanced farming technologies. State Water Resources Minister Keshav Mahanta, MLA Suren Phukan, Chief Secretary to the Government of Assam VK Pipersenia, Additional Chief Secretary (Agriculture) Dr KK Mittal, Commissioner and Secretary (Agriculture) Amlan Baruah were present during the occasion. The Chief Minister also inaugurated the exhibition which was attended by 350 organisations including 10 foreign delegates from China, Italy, Canada, Nepal, Bhutan, Bangladesh, Uganda, Myanmar, Thailand & Sweden.

Coconut Board displayed various varieties of nuts, coconut convenience foods, value added products from coconut kernel, coconut shell & coconut water, coconut shell/wood based handicrafts and various leaflets, books & publications on coconut and postures on the nutritional and health benefits of coconut and its products.

Shri Tarun Gogoi Ex Chief Minister Govt Of Assam visiting CDB Stall

A view of CDB Stall in the Assam Agri International Horti Show 2017

M/s. Kovai Agro Foods, Tirupur and M/s. Yogic foods, Pollachi had their display cum sales counters in the CDB stall. Shri Tarun Gogoi, Ex Chief Minister of Assam, Shri Atul Bora, Agriculture Minister, Govt. of Assam and Shri Prithibi Majee, MLA, Govt. of Assam visited the Board's stall. An international seminar on Make in North East: Agriculture & Allied Sectors was also held as part of the programme. Board participated in the seminar and a paper on entrepreneurship development on coconut was presented by Shri. Sree Kumar Poduval, Processing Engineer, CDB during the session on Agriculture Productivity & Innovation.

Market review – December 2016

Domestic price

Coconut Oil

During December 2016 the price of coconut oil opened at Rs. 10700 per quintal at Kochi market, Rs.10700 per quintal at Alappuzha market and Rs.10800 per quintal at Kozhikode market and remained almost stable during the first week. During the second week and the third week onwards prices in all markets picked up and depicted a positive trend. During the fourth week a slight decline in prices was observed. But by the end of the month prices closed with an upward trend.

The price of coconut oil closed at Rs.11500 per quintal at Kochi and Alappuzha market and Rs.11900 per quintal at Kozhikode market with a gain of Rs.800 per quintal at Kochi and Alappuzha market and Rs.1100 per quintal at Kozhikode market.

Compared to the prices prevailed during the month of November which was Rs.10700 per quintal at Kochi and Alappuzha and Rs.10800 per quintal at Kozhikode market, the prices indicated an upward trend during December.

The price of coconut oil at Kangayam market in Tamilnadu, which opened at Rs.9667 per quintal expressed a increasing trend in the first three weeks and declined slightly during the fourth week. By the end of the month prices expressed an upward trend and closed at Rs. 10867 per quintal with a gain of Rs 1200 per quintal.

Table1: Weekly of price of coconut oil at major markets Rs/Quintal)

	Kochi	Alappuzha	Kozhikode	Kangayam
	Kochi	Alappuzha	Kozhikode	Kangayam
04.12.2016	10800	10700	10800	9400
11.12.2016	11300	11200	11500	10400
18.12.2016	11700	11700	12000	10867
25.12.2016	11300	11300	11900	10267
31.12.2016	11500	11500	11900	10867

Milling copra

The price of milling copra at major markets moved in tune with the prices of coconut oil. During the month the price opened at Rs.6950 per quintal at Kochi, Rs.6750 per quintal at Alappuzha and Rs.6950 per quintal at Kozhikode market expressed an upward movement during the first three weeks. During the fourth week the price declined slightly at all markets. By the end of the month prices at all markets expressed an upward trend and closed at Rs.7500 at Kochi, Rs.7450 at Alappuzha and Rs.7650 at Kozhikode market with a gain of Rs.550 per quintal at Kochi and Rs.700 per quintal at Alappuzha market and Kozhikode market.

At Kangayam market in Tamilnadu, the prices opened at Rs.6500 and closed at Rs. 7300 per quintal with a gain of Rs.800 per quintal.The prices expressed a similar trend as that of the prices quoted in Kerala markets. Prices expressed a slight upward trend during the month compared to the previous month price which was closed at Rs.6231 per quintal.

Table2: Weekly price of Milling Copra at major markets (Rs/Quintal)

	Kochi	Alappuzha (Rasi Copra)	Kozhikode	Kan-gayam
04.12.2016	7000	6750	6950	6500
11.12.2016	7350	7100	7350	6950
18.12.2016	7700	7500	7700	7100
25.12.2016	7300	7350	7500	6900
31.12.2016	7500	7450	7650	7300

Edible copra

The price of Rajapur copra at Kozhikode market which opened at Rs.7750 per quintal expressed an increasing trend during the first fortnight and declined slightly during the fourth week. The price closed at Rs.7600 with a loss of Rs.150 per quintal.

Table3 :Weekly of price of edible copra at Kozhikode market (Rs/Quintal)

04.12.2016	7600
11.12.2016	7900
18.12.2016	8000
25.12.2016	7500
31.12.2016	7600

Ball copra

The price of ball copra at Tiptur market opened at Rs.6400 per quintal, expressed an erratic trend during the month. During the last week the prices expressed a slight upward trend and closed at Rs.6666 with a gain of Rs.266 per quintal.

Table 4 : Weekly of price of Ball copra at major markets in Karnataka (Rs/Quintal)	
	Tiptur
04.12.2016	6200
11.12.2016	6511
18.12.2016	6600
25.12.2016	6511
31.12.2016	6666

Dry coconut

At Kozhikode market the price of dry coconut opened at Rs.6900. The price remained steady during the first fortnight and in the fourth week price expressed a slight downward trend, but increased by the end the month. The price closed at Rs.7300 with a gain of Rs.400 per thousand nuts.

Table5 : Weekly of price of Dry Coconut at Kozhikode market (Rs/1000 coconuts)	
04.12.2016	6900
11.12.2016	6900
18.12.2016	7100
25.12.2016	7000
31.12.2016	7300

Coconut

At Nedumangad market price opened at Rs. 10000 and closed at Rs.11000 per thousand nuts with a gain of Rs.1000. At Bangalore APMC, price opened at Rs.8000 per thousand nuts and ruled at same price during the first fortnight and improved during the fourth week. The price closed at Rs.8500 per thousand nuts with a gain of Rs.500 .At Manglore APMC market the price of partially dehusked coconut opened at Rs.14500 per thousand nuts was ruled steady throughout the month.

Table 6: Weekly of price of coconut at major markets (Rs /1000 coconuts)			
	Nedumangad	Banglore	Mangalore (Grade-1)
04.12.2016	10000	8000	14500
11.12.2016	10000	8000	14500
18.12.2016	10000	8500	14500
25.12.2016	11000	8500	14500
31.12.2016	NR	8500	14500

Tender coconut

The price of tender coconut at Maddur APMC market in Karnataka opened at Rs.10100 per thousand nuts. The price expressed an upward trend during the first week, declined slightly during the second week and reached at Rs.10000 per thousand nuts and ruled at same price throughout the month. The prices closed at Rs.10000 with a loss of Rs.100 per thousand nuts

Table7 : Weekly of price of tender coconut at Maddur market (Rs/1000 coconuts)	
04.12.2016	10200
11.12.2016	10000
18.12.2016	10000
25.12.2016	10000
31.12.2016	10000

International price

Coconut oil

The international (CIF Rotterdam) and domestic price of coconut oil at Indonesia, Philippines expressed an upward trend during the month. The domestic price of coconut oil in India expressed a slight upward trend during the first three weeks and declined by the end of the month. The domestic price of coconut oil in India opened at US$ 1570 and closed at 1665 per MT. The price of coconut oil quoted at different international/ domestic markets is given below.

Table 8: Weekly Price coconut oil in major coconut oil producing countries October 2016

	International Price(US$/MT)	Domestic Price(US$/MT)		
	Philippines/ Indonesia (CIF Europe)	Philippines	Indonesia Indonesia	India*
02.12.2016	1630	1523	1604	1570
09.12.2016	1675	1568	1646	1656
16.12.2016	1705	1625	1687	1731
23.12.2016	1800	1680	1758	1665

* Kochi Market

Copra

A surge in price of copra was observed at Philippines and Indonesia market during the month. The price of copra in India expressed a slight upward trend during the first three weeks and declined by the end of the month. Price of copra in Srilanka expressed a fluctuating trend and was the highest among all the major copra producing countries

Table 9: Weekly Price of copra in major copra producing countries October 2016

	Domestic Price(US$/MT)			
	Philippines	Indonesia	Srilanka	India*
02.12.2016	877	887	n.q.	1020
09.12.2016	941	897	1135	1079
16.12.2016	961	919	1016	1139
23.12.2016	993	964	1133	1076

* Kochi Market

Desiccated coconut

The FOB price of desiccated coconut in India during the month of November was very competitive compared to the prices of major DC exporting countries.

Table 10: Weekly price of desiccated coconut in October 2016

	Domestic Price (US$/MT)			
	Philippines	Indonesia	Srilanka	India*
02.12.2016	2420	2085	n.q.	1704
09.12.2016	2453	2075	2264	1575
16.12.2016	2453	2075	2136	1672
23.12.2016	2453	2110	2301	1652

*FOB

Coconut

In major coconut producing countries, only minute fluctuation in the prices of dehusked coconut was observed during the month. The domestic price of dehusked coconut in India was slightly higher compared to other major coconut producing countries.

Table 11: Weekly price of dehusked coconut with water during October 2016

Date	Domestic Price (US$/MT)			
	Philippines	Indonesia	Srilanka	India*
02.12.2016	215	224	n.q.	279
09.12.2016	216	224	205	303
16.12.2016	218	232	238	318
23.12.2016	218	223	208	295

*Pollachi market

Coconut shell charcoal

The FOB price of coconut shell charcoal in India remained stable during the month and was competitive compared to the prices quoted by major coconut producing countries. Indonesia's price was the highest among major coconut shell charcoal exporting countries.

Table 12: Weekly price of coconut shell charcoal during October 2016

Date	Domestic Price(US$/MT)			
	Philippines	Indonesia	Srilanka	India
02.12.2016	340	390	n.q.	325
09.12.2016	340	380	350	325
16.12.2016	340	380	350	325
23.12.2016	340	380	350	325

*FOB

Monthly operations- February

Andaman & Nicobar Islands: Continue watering the nursery. Start collection of seednuts from the mother palms. Store them for about one month before sowing. Prepare land for new plantation by removing weeds and cutting down unwanted plants.

Andhra Pradesh: Search for rhinoceros beetles on the crowns of the palms with beetle hook and kill the beetles. Fill the top three leaf axils of the palm with a mixture of 25g sevidol 8G with 250g fine sand. Spray the manure pits with 0.01 per cent carbaryl. Continue irrigation. Collect seednuts from selected mother palms. Release parasitoids if the attack of black headed cater pillar is noticed, particularly in coastal belt. If the palms are infected by scale insects, spray the palms with 0.01 per cent malathion or fenthion.

Assam: Dig isolation trenches of one metre depth and 30 cm width two metres away from the base of the Ganoderma affected palms. Cut down and destroy the affected trunk of dead palms in the garden. If planting pits have not been dug in January or February dig them during this month and fill up with top soil+sand+cow dung manure mixture up to 60 cm for transplanting. After one or two showers, bring the soil to a fine tilth around the palms. Start preparing the nursery beds for sowing of seednuts.

Bihar/Jharkhand: Irrigate the palms. Apply plant protection chemicals to avoid attack of pests and diseases. Repair the irrigation channels. Prepare the land and dig pits of 1m x 1m x 1m size at a spacing of 8m x 8m. Replant/transplant the seedlings in low-lying areas where flood water is a problem. Adopt surface planting if water table is high. Check for the incidence of termite attack, especially in young palms. For the management of termite, adequate soil moisture is a prerequisite. Drench the nursery with 0.05 per cent chlorpyriphos twice at 20-25 days interval. Fill the top three leaf axils of the palms with 25g Sevidol 8G mixed with 250g fine sand to prevent rhinoceros beetle/red palm weevil attack.

Chattisgarh: Irrigate the palms, nursery and inter crops in the garden. Remove weeds from the garden. Plough the land and mulch the basins. Plant summer vegetables and other intercrops. Apply vermi compost to coconut palms.

Karnataka: Irrigate the garden. Give 70-80 litres of water per palm per day under drip irrigation. Plant suitable intercrops under irrigated conditions. Check the attack of rhinoceros beetle. Clean the crowns of the palm and fill top three leaf axils of the palms with a mixture of 25g sevidol with 200 gm fine sand. Fill the leaf axils with two naphthalene balls covered with fine sand at 45 days interval. Treat manure pits and other possible breeding sites of rhinoceros beetle with carbaryl (0.1 per cent) which is to be repeated in every three months. Spray 1 per cent bordeaux mixture against leaf spot. Adopt integrated control measures against the attack of leaf eating caterpillar. Release parasitoids of suitable stage immediately after noticing the infestation and subsequently three times at fortnightly intervals. For tall plants and large orchards a combination of biological and chemical methods are suggested. If the attack of mite is noticed, spray neem oil formulation containing 0.1 per cent Azadirachtin / Neemazal@ 4 ml/ litre of water. The spray droplets are to be directed towards the second to fifth immature bunches. In order to improve the nutrient

status of the soil grow green manure crops like daincha in the basins of the palms and incorporate into the soil within 45 days. Apply organic manure @ 25 kg/ tree/year. Provide neem cake @5 kg / tree/year.

Kerala/Lakshadweep:

Continue irrigation. Continuecollection of seednuts from selected mother palms and store them in a cool dry place. Apply one fourth of the fertilizers in irrigated gardens. If the attack of mite is noticed, spray neem oil formulation containing 0.1 per cent Azadirachtin / Neemazal@ 4 ml/ litre of water. The spray droplets are to be directed towards the second to fifth immature bunches.

Maharashtra/Goa/Gujarat:

Undertake hoeing in the garden. Remove the grasses and shrubs and burn them. Check for attack of pests/diseases and take appropriate steps to control them. Ensure irrigation. Start collection of seednuts for raising seedlings.

Odisha: Irrigate the palms. Remove weeds from the garden. Mulch with dry coconut leaves and coirpith for moisture conservation. Collect seednuts from selected mother palms and store them in cool and dry place. Spray the palms affected by leaf eating black-headed caterpillar with 0.02% dichlorvos or malathion 0.05 per cent. Repeat the spraying after an interval of 15 days if the attack is severe. Before spraying, cut down the affected leaves and burn them to prevent further infestation. Alternatively liberate parasites of black-headed caterpillar on the affected palms after 15 days of spraying. Palms on which the parasites have been released should not be sprayed with insecticides as it will kill the parasites also. If the attack of mite is noticed, spray neem oil formulation containing 0.1 per cent Azadirachtin / Neemazal@ 4 ml/ litre of water. The spray droplets are to be directed towards the second to fifth immature bunches.

Tamil Nadu/Puducherry: If the attack of mite is noticed, spray neem oil formulation containing 0.1 per cent Azadirachtin / Neemazal@ 4 ml/ litre of water. The spray droplets are to be directed towards the second to fifth immature bunches. Spraying has to be done especially on the perianth region of buttons and affected nuts. Wherever spraying is difficult root feeding may be done with Azadiractin 50% formulation 7.5 ml in 7.5 ml water. Continue irrigation. Treat manure pits and other possible breeding sites of Rhinoceros beetle with 0.01 per cent carbaryl to control grubs. Continue collection of seednuts from selected mother palms and store them in a cool dry place.

Tripura: Irrigation should be continued and the frequency of irrigation should be based on the quantum of rainfall received. Regular irrigation will improve the production of bearing plants.

West Bengal: Continue irrigation. Apply 200 litres of water in basin twice a week depending upon moisture retention capacity of the soil. If drip irrigation is adopted give 70 to 80 litres of water per palm per day. Provide proper shade to newly young seedlings. Mulch the basins with coconut husk, green leaves, dried coconut leaves in 3 to 4 layers or spread coir pith in six-inch layer for moisture conservation. Harvest mature nuts. Collect the seednuts from the selected mother palms, which are regular bearers and have an annual yield of hundred nuts and above. Store the collected seednuts in shade. Check for the attack of rhinoceros beetle (triangular cuttings in new spindle leaves). Hook out the beetles from affected palms.

Clean the crowns of the palms and fill the top most axils of the palms with 25g sevidol 8G with 250g fine sand at 45 days interval. Treat manure pits once in every three months with carbaryl (0.1 %). If bud rot is noticed remove all the affected portions. Treat the wound with Bordeaux paste or paste of Blitox. Spray the crown with Blitox @ 5g per litre of water or Dithane M 45 @ 2 g per litre of water. To manage eriophyid mite infestation, spray the crowns with 0.1 per cent Azadiractin (Neemazal) @ 4.0 ml per litre of water.

The spray droplets are to be directed towards the second to fifth immature bunches. Alternately, root feeding with 7.5 ml of Neemazal (5%) dissolved in 7.5 ml of water can also be done. Plough the interspaces and destroy weeds. Grow summer vegetables and flowers like marigold as intercrop. ■