

Organic Farming Technology for Coconut

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Worldwide people realized that chemical farming undermines the natural biological mechanisms operating in the ecosystem and often leads to the soil degradation, pollution of ground water and eutrophication of water bodies with nitrates, phosphates and pesticides. Consequently, many farmers are seeking alternative practice of organic farming to make agriculture more sustainable. Several studies conducted elsewhere clearly indicate equal or higher profits from organic farming. With introduction of biofertilizers and other inputs of R and D, the situation is likely to improve further in favour of organic farming. Organic manures are important in sustaining soil productivity especially, for a perennial crop like coconut, which requires continuous supply of nutrients. According to Villiemain (1965), the nutrient balance in the palm could be improved by organic manuring. Any organic manure supplemented with the required quantity of inorganic fertilizers, is the best manurial combination for an adult bearing coconut palm (Thampan, 1972). Thus, the concentrated organic manures being rich in plant nutrients, could re-

place the inorganic fertilizers as on equivalent nutrient basis.

Perils of Chemical Fertilization

Green Revolution came to the rescue of our country for increased foodgrain production in 1960s relying heavily on the chemicals. This signaled a major shift towards the chemical farming, essentially to meet the demand by burgeoning population in a short time. Increasing use of chemicals brought with it, many ills plaguing the modern agriculture. The main emphasis on supply of macronutrients *viz.* N, P and K through high analysis fertilizers like urea, DAP, muriate of potash, etc. has led to severe nutrient imbalances over a wide tract in the country. Widespread deficiencies have been reported for N, P, K, S and Zn in the soil. However, pockets of deficiency exist for other nutrients also. It is very well accepted that larger gains from the application of fertilizers would be ensured, when deficiency of nutrients found limiting in the soil is corrected.

Long term fertilizer experiments have highlighted the impact of continuous use of chemicals on soil health. Accumulation of both zinc and phosphorus occurred with their continuous application (Biswas & Benbi, 1989). A build up of phosphorus can prove antagonistic to zinc and iron nutrition of crops. Similarly, high levels of zinc can cause iron chlorosis (Katyal & Randhawa, 1983). Regular use of physiologically acid or acid producing fertilizers like

ammonium phosphate over a period of 5 years to coconut palms lowered the soil pH compared to other P-carriers (Khan *et al.* 1985). Ammonium sulphate is a physiologically acid fertilizer, while, urea is an acid producing fertilizer. Regular use of such fertilizers would result in microsite drop in pH (Abrol & Katyal, 1990), whose impact will be more in poorly buffered acid soils. Heavy metal contamination in the soil is another problem which will affect the living beings adversely. Cadmium deserves a special mention because of its inadvertent additions through phosphatic fertilizers. In India, experiments on cadmium accumulation in soils are lacking. Nevertheless, long term Swedish field experiments indicated that cadmium accumulation in soil due to phosphatic fertilization over a period of 17 years vary from 20-87 g/ha depending upon the rate of phosphorous used (FAO, 1975). The cadmium content may reach levels which though not phytotoxic, may be harmful to the animals and human beings. Similarly, attention should be paid to other metals such as mercury, arsenic, lead etc.

Soil Nutrient Status and Nutrient Requirement of Coconut

Coconut is mainly grown in laterite and lateritic, coastal sand, red sandy loam, coral and alluvial soils. These soils are mainly acidic in nature with low fertility status. The soils suffer from varying degree of nutrient/moisture stress. The CEC of these soils is very low,

Table 3. Organic Carbon Content in the Mixed Cropping Experiment at CPCRI

Cropping System	Rhizosphere of	Org.C%
Coconut alone	Coconut	0.42
Coconut & Cocoa in single hedge	Coconut	0.48
	Cocoa	0.50
Coconut + Cocoa in double hedge	Coconut	0.53
	Cocoa	0.60
No crop	Non-rhizosphere	0.39

Source: Nair and Rao (1977).

tion of 100 kg FYM + 2.4 kg urea + 1.4 kg MOP/palm/year or 100 kg green manure/palm/year for coconut on the East coast of Tamil Nadu. In an ongoing experiment on coconut based mixed farming at CPCRI, in 1.2 ha coconut farm, involving coconut, grasses, dairy, poultry and rabbitry, 15 t of FYM, 2 t of poultry manure and 50000 litres of cow urine and cowshed washings are obtained annually, which if effectively recycled can supply 125 kg N, 78 kg P₂O₅ and 115 kg K₂O.

Application of organic manures improves the soil physical properties with direct impact on moisture retention, root growth, nutrient conservation, etc. Studies conducted at CPCRI, Kasaragod, has demonstrated that all the organic sources viz. forest leaves, coconut shedding, cattle manure & coir pith in conjunction with inorganic improved significantly the soil physical conditions over inorganic in littoral sandy soil (Anonymous, 1981). Water retention at 0.2 and 1.0 bar was higher in soil samples collected from the basins of coconut palms receiving organic matter regularly for seven years, than in samples from the basins of palms not receiving any organic matter (Anonymous, 1978).

Long term experiments have conclusively proved the ability of the bulky organic manures to neutralize the rapid yield fall with the

continuous use of chemical fertilizers. Use of FYM prevented the occurrence of zinc (Katyal and Randhawa, 1983) and sulphur deficiencies (Nambiar and Abrol, 1989). Significant differences between the treatment means in the case of organic carbon, available N, Fe, Mn and exchangeable Ca and Mg. The absolute values were very low for the soils receiving NPK alone, compared to the plot receiving organic manures (Anonymous, 1982).

Crop residues are more important sources of potash as compared to nitrogen and phosphorus. In the case of coconut, it was observed that husk accounted for 67 per cent of the potassium and 85 per cent of chlorine. This indicates the considerable reduction in the fertilizer requirement which can be achieved by leaving the husk in the field where it is quickly broken down, releasing the locked up nutrients to be recycled (Ouvrier and de Taffin, 1985). One hundred husks will be able to provide 1 kg of potash apart from 270 g N and 150 g P₂O₅ in the same period (Jothimani, 1994). Effect of husk burial will be observed from 3rd year onwards and the beneficial effect lasts for 5-6 years.

Availability of Organic and its Recycling

Coconut produces huge amount of waste biomass which could be recycled, thereby improving the

soil fertility status. It has been estimated at CPCRI, Kasaragod that a well managed coconut garden with 175 trees/ha produces byproducts to the extent of 7 tonnes in the form of dried leaves and one ton as sheathes, spadices and inflorescence. Taking the total cropped area of 1.795 million ha (1995-96), 14.36 million tonnes of waste/byproduct is available in the country for recycling. The nutrient content of usefructs and the total nutrient supply is depicted in Table 4. Similarly, around 8 tonnes of husk is available from one hectare of coconut garden. However, the husk obtained is mainly used for extracting coir. But, the waste material viz. the pith is usually dumped without any use. During monsoon tannins oozing out of such heaps, creates environmental pollution problems. The studies conducted at various places have shown that coir pith can serve as important source of organic manure for agricultural crops (Savithri and Khan, 1994). In India, 7.5 million tonnes of coir pith is estimated to be produced annually (Kamaraj, 1994). In general, pith is acidic in nature, having low bulk density and high porosity. Thus, coir pith, with nutrient composition of 0.68 per cent N, 0.026 per cent P and 0.36 per cent K will supply approximately 51 thousand tonnes nitrogen, 9.5 thousand tonnes phosphorus and 27 thousand tonnes potash. Being highly lignocellulosic in nature, the nutrient release will be slow, thereby, minimizing nutrient loss from the profile.

Coconut occupies land for a longer period of time. Being widely spaced crop a number of inter/mixed crops can be grown in the interspaces. Cocoa, as a component of multiple cropping system adds substantial quantity of organic matter to the soil, thus leading to annual internal recy-

Table 1: Soil Fertility Characteristics of Soils Under Plantation Crops

Item	Range	Remarks/method
pH	3.9 - 7.0	Varies with rainfall
EC (mmhos/cm)	0.01-03	No salt accumulation
CEC (meq/100g)	2.0-15.0	More than 50% CEC due to organic matter
Organic matter (%)	1.0 - 10.0	Varies with altitude, latitude & cultural practices
N(%)	0.01 - 0.05	Alkaline permanganate
P (ppm)	1 - 25	Bray & Kurtz - P2 modified
K (ppm)	30-250	Morgan's method

thereby, leading to low retention of cations like K, Ca, Mg etc. Tandon and Ranganathan (1988) have characterized the general fertility status of soils under plantation crops, which is to a great degree reflective of the conditions for coconut (Table 1).

Coconut being a perennial crop, requires continuous supply of nutrients from the limited soil volume throughout the year. The crop with a density of 175 palms/ha requires 353 kg/ha of N, P and K as per our recommendation. But, at present, consumptivity of fertilizer in coconut is approximately 36 kg/ha which is very low (Nair *et al.* 1996). The crop requirement based on nutrient export, in India is estimated to increase from 257.71 thousand tonnes (N + P₂O₅ + K₂O) at present, to 483.33 thousand tonnes by 2000 AD. However, the supply through fertilizers will meet only 15 per cent of the total

nutrient requirement by 2000 AD (Table 2). This calls for attention towards other sources of nutrients to meet the crop needs.

Importance of Organic on Crop and Soil health

The most important pool of nutrient reservoir in soil is organic matter. In tropical conditions due to higher rate of decomposition it is difficult to build up the organic matter status of the soil. However, possibilities exists for the maintenance of organic matter at a level possible under such climatic conditions. Investigations have revealed significant formation of soil organic matter during active root tissue without the intervention of soil microfauna (Martin, 1977). In addition to roots, the aerial portions of root and tuber crops grown as inter-crops and non harvestable portions of productivity of other crops (e.g. fallen leaves from cocoa) also

add to the organic matter in the soil. As a result, it has been observed that organic matter content of rhizosphere soils of coconut and cocoa has improved (Table 3). Enhanced microbial activity in the rhizosphere was also observed. *Beijerinckia* was observed as dominant N fixing bacteria in the rhizosphere. Twenty one isolates of bacteria, actinomycetes and fungi from the rhizosphere of coconut were found capable of solubilising tricalcium phosphate to varying extent (Nair and Rao, 1976a). Some of the bacteria and fungi isolated from the rhizosphere of coconut produced growth promoting substances. One isolate of *Escherichia* sp. was observed to produce IAA. Two isolates, one of *Aspergillus flavus* and other of *A. fumigatus* produced GLS (Gibberelin-like substances) in the culture media (Nair and Rao, 1976b).

The main factor limiting the application of chemical inputs is the cost of the inputs *per se* and constraints such as risk due to crop losses and fluctuating prices of the commodities. This discourages the small holders to apply chemical inputs. But, in integrated farming system/crop based farming system, recycling of organic wastes *viz.*, crop, animal dung, urine, etc. leads to a substantial saving in cost of fertilizer input thereby increasing the cost benefit ratio. In an integrated farming system comprising pasture, fodder and cattle in coconut small holding, it was observed that the cost of fertilizing of coconut palm was Rs.2.49/palm as compared to Rs.8.1/palm annually in coconut monoculture. This led to a saving of 69 per cent on the cost of inorganic fertilizer for coconut (Liyanage *et al.* 1989). Nallathambi *et al.* (1988) reported that maximum economic returns were obtained with the applica-

Table 2: Nutrient Requirement and its Supply to Coconut ('000t)

	Present			By 2000 AD		
	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
Requirement	66.54	28.40	162.77	161.80	78.76	242.77
Supply	14.27	9.13	34.25	18.02	11.53	43.26
Gap	51.27	19.27	128.52	142.78	67.23	199.51

Adapted from Nair *et al.* 1996

cling of nutrients in the system . It has been observed that 8.2 and 19.8 t/ha/year (oven dry basis) of cocoa litterfall was obtained from single and double hedge systems of planting respectively (Varghese *et al.* 1978). Taking nutrient concentration of cocoa leaves to be 2.84 per cent N, 0.26 per cent P and 1.73 per cent K on dry weight basis (Ernstman, 1968), it could be assumed that about 50 kg N, 11 kg P₂O₅ and 35 kg K₂O could be returned to the soil every year through leaf fall of cocoa under double hedge system of mixed cropping. Similarly, weed infestation is very high. In high rainfall areas, weeds are allowed to grow in the field and then ploughed after rainfall, thereby recycling nutrients in the system.

Growing green manure crops in coconut garden is a common practice in certain parts of the country. The common green manure crops are *Mimosa invisa*, *Calpagonium*, *Puereria javanica*, etc. The rooting system and canopy characteristics are conducive for raising a number of green manure crops either in basin or in interspaces. If grown in basins of coconut palms, 15-20 kg green matter per basin will be added, supplementing about 100-150g nitrogen per palm. In interspaces about 3-4 tonnes of green matter could be added, which will be equivalent to 20-111 kg N, 4-21 kg P₂O₅ and 15-67 kg K₂O per hectare . Further studies carried out in Sri Lanka, revealed that when *Gliricidia* topping applied @ 30 kg/palm provides total requirement of nitrogen and at least part of phosphorus and potassium requirements, thus, reducing the cost of fertilizer by about 40 per cent (Liyanage and Jayasundera, 1988). Incorporation of organic manures in basin of plantation crops leads to proliferation of microbes, thereby, increasing effi-

Table 4: Quantity of nutrients supplied by coconut leaves, shedding and coir pith

Bye-products	Quantity available (million tonnes)	Chemical composition %			Total nutrient supply (million tonnes)		
		N	P	K	N	P	K
Dried leaves*	12.57	0.89	0.06	0.45	112000	8000	57000
Shedding	1.80	0.66	0.10	0.50	12000	2000	9000
Coir pith**	7.50	0.68	0.026	0.36	51000	9500	27000

* Source - Chemical composition of leaves and shedding - Anonymous (1994)

** Source - Chemical composition of coir pith - Ravichandran (1988)

ciency in the nutrient release.

Waste Management through Composting

Composting is one of the most important methods of recycling the residues back to the soil. In broad terms, compost is biologically decayed refuse like leaves, twigs, roots, stubble, crop residue etc. It leads to the production of brown and dark coloured humified material which is valuable for replenishment of plant nutrients in the soil organic matter, thereby, improving the soil health. The process of composting depends upon C/N ratio, blending/shredding, moisture, temperature, microbes involved and aeration. The most important is C/N ratio. C/N ratio of 30 in raw materials could be most desirable for efficient composting (Gaur *et al.* 1984). For materials with higher C/N ratio, an external nitrogen source must be added, for efficient composting. The C/N ratio of coir pith ranges from 80 - 120 :1. Thus, it requires a starter dose of nitrogen to narrow down the C/N ratio for microbes to act.

Various techniques have been developed for the preparation of

organic fertilizers from the crop wastes. The techniques primarily involves chemical and biological processes to break down the complex organic molecules to the simpler form. The various techniques used are hot fermentation, cold digestion, chemical digestion, microbial and vermicomposting. Studies carried out on coir pith in CPCRI revealed that chemical technique involving urea and mussoorie rock phosphate in anaerobic conditions gave highest recovery and good quality of compost.

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Down memory lane

Orissa proposes planting coconut on canal banks

According to a report received from the Government of Orissa, 10,030 coconut seedlings have been planted on the banks of the irrigation canals in the Puri District as the first step of a comprehensive scheme to plant 5 lacs of coconut seedlings along the banks of the existing canals and the new canals under construction.

This scheme has been started in pursuance of a suggestion made by the Indian Central Coconut Committee to extend coconut cultivation to new areas including the banks of irrigation canals.

Coconut Bulletin, July, 1960