Prospectus

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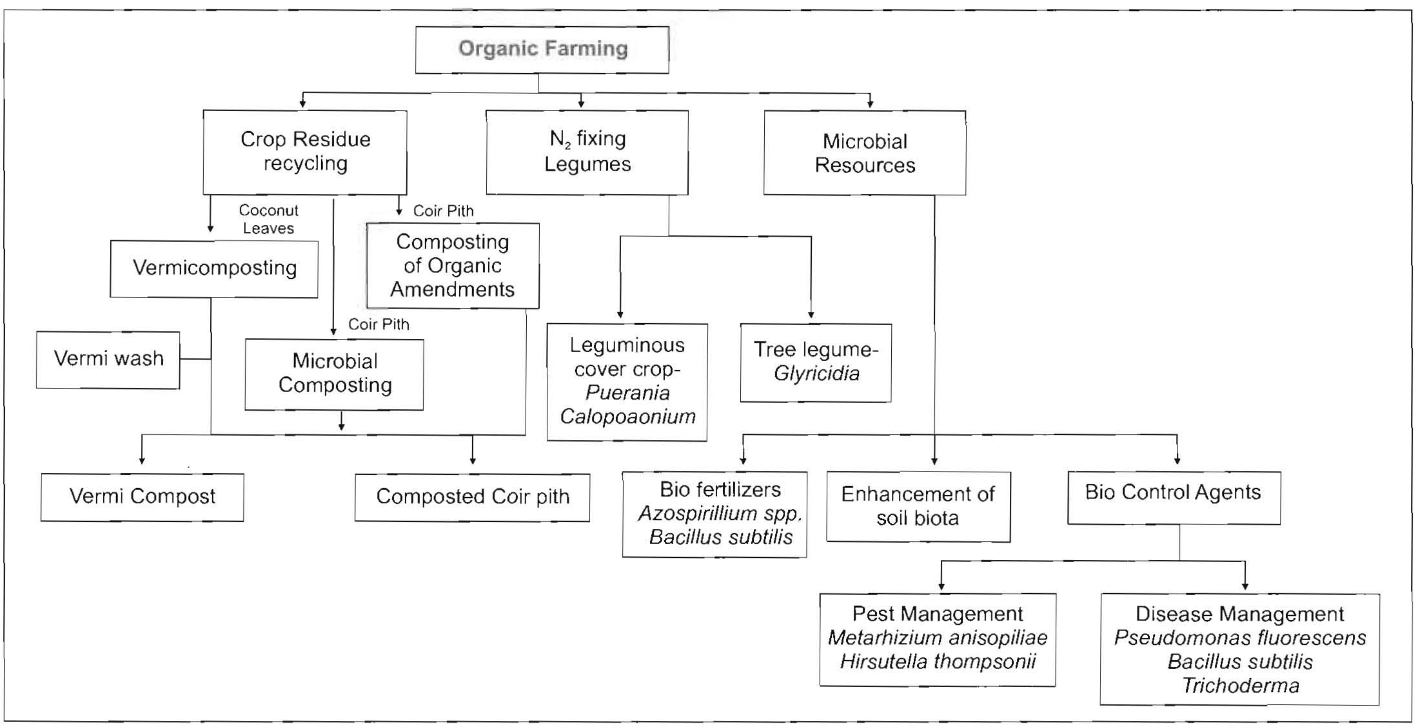
Producing coconut the environment-friendly way

The growth habit and planting methods of coconut make it highly suitable for managing through organic farming. About 74 per cent of the roots produced do not go beyond 2 m from the bole and most of the roots also confine to 30-120 cm depth, thus utilizing only limited extent of land area for growth of palms and leaving considerable area for inclusion of other crops to maintain crop diversity, an important requirement for organic farming. Coconut plantations are ideally suitable for organic farming as they produce large quantities of waste biomass which, if recycled, can meet the nutrient demand of the crop. The total availability of waste biomass from 1.93 million ha of coconut plantation in the country has been estimated as 14.36 million tonnes annually.

COCONUT plays a significant role in the agrarian economy of India, which is one of the largest coconut-growing and-producing countries in the world. The area under coconut cultivation in India during 2008-09 was 1.895 million ha with the production of 15.729 million nuts. This important plantation crop contributes around six per cent to the national vegetable oil pool and about ten million farm families depend on it for their livelihood. In India most of the production comes from small and marginal farms and more than 90% of the holdings are below one hectare with the average size being 0.22 ha. In the west coast of India, the palm is an essential component in homestead system of farming, where it is mostly grown as a rainfed crop.

Organic Coconut Production



Nitrogen-Fixing Leguminous Crops

Nitrogen fixed symbiotically by legume-rhizobium association can form an important source of nutrients and organic manure for coconut palms. It involves cultivation of leguminous creepers such as *Pueraria phaseoloides, Mimosa invisa* and *Calopogonium mucunoides* in coconut basins from June to October and incorporation of legume biomass in respective basins. During a growth period of 140-150 days, promising legumes generate 15-28 kg of biomass and 102-197 g of nitrogen in the basin of a coconut palm. Besides, there is a significant increase in population of specific group of beneficial microorganisms and enzymatic activity modifies soil environment for the benefit of palm growth.

Vermicompost production unit

Generation of large quantity of nitrogen rich biomass is also possible through the cultivation of *Glyricidia* in coconut plantation. This can be very well grown along the borders of coconut plantation and can generate adequate amount of nitrogen rich green leaves. It can also be raised in littoral sandy soils where no other green manure can establish. The best growth and biomass of leaves could be obtained with planting of three rows of *Glyricidia* (at 1 m × m spacing between two rows of coconut) and pruning of leaves during February, June and October. This could produce around 8 tonnes of biomass in one hectare of coconut garden. Application of *Glyricidia* prunings could supply around 90, 25 and 15% of N, P and K, respectively.

Use of biofertilizers in coconut gardens can reduce dependency on chemical fertilizers and thus bring both economic and ecological benefits. The coconut roots harbour several associative nitrogen-fixing bacteria and phosphate-solubilizers. The population of phosphate-solubilizing bacteria and fungi are higher in coconut-based high-density multiple species cropping, multi-storied cropping with cacao and mixed farming with Napier grass as compared to coconut monocrop. The common genera of P-solubilizing bacteria are *Bacillus, Pseudomonas* and *Micrococcus,* while those of fungi are *Aspergillus, Fusarium* and *Penicillium*. These microscopic beneficial organisms can be mass-multiplied and formulated using locally available materials such as vermicompost and coir pith as carrier media and used as biofertilizers for sustainable organic coconut farming. The inoculation of associative diazotrophs such as *Azospirillum, Arthrobacter, Azoarcus, Herbaspirillum, Bacillus, Burkholderia* and *Pseudomonas* enhance growth and vigour of polybag raised coconut seedlings. These bioinoculants are highly effective in enhancing root biomass and branching of secondary roots of the coconut seedlings. Organic amendment along with microbial inoculation brings about a greater level of plant response.

Recycling of Crop Residues

The availability of waste biomass from a well-managed coconut garden with 175 trees/ ha has been estimated as 14-16 tonnes/ha/year in the form of leaves, stipules, spathe, bunch waste and husk. A considerable portion of husk is used for extraction of coir fibre. About 7.5 million tonnes of coir pith, by product of coir processing, is available in our country from various coir defibering units. The natural decomposition of these wastes and nutrient release are very slow due to high lignin content and nature of lingo-cellulose complex of coconut waste materials. If they are recycled fully, this waste biomass can meet a major portion of nitrogen and a part of other nutrient requirement of crops. Recycling of coconut waste biomass is possible without affecting the prospects of husk or shell based industries. It also helps to replenish the nutrients exhausted by palms internally without depending on external sources.

Vermicomposting of Coconut Leaves

Vermicomposting can be done ideally in permanent cement or brick tanks constructed under shaded conditions to maintain appropriate quantity of substrate, optimum moisture and temperature. Partially weathered organic wastes are to be treated with cowdung @ 10 per cent by weight in the form of slurry and must be allowed to undergo a preliminary decomposition for about 2–3 weeks. The earthworms @ 1,000 worms per tonne of coconut leaves are to be introduced and the compost bed should be mulched properly using any locally available plant material or gunny bags and has to be protected from direct sunlight. Watering is to be done to maintain enough moisture. In 60-75 days, compost becomes ready, leaving behind only a portion of non-decomposed material. On an average, 70 per cent recovery of vermicompost is obtained.

Vermicomposting can also be done *in situ* in coconut plantations using coconut leaves and other biomass including wastes from intercrops especially from banana. *In situ* recycling of coconut wastes by vermicomposting in trenches dug in interspaces of four coconut palms yield on an average recovery of 70% in a composting period of 90 days. The average nutrient composition of vermicompost recovered is around 1.2-1.8% (N), 0.1-0.2% (P) and 0.2-0.4% (K), organic carbon (17.84%), and C/N (9.95:1.00). The composted palm wastes contain higher levels of micronutrients such as Fe, Zn, Cu and Mn compared to untreated substrate.

The coconut waste used for oyster mushroom production is also suitable for vermicomposting. It has higher content of nutrients and low C: N ratio. The composted spent-substrate also contains higher levels of micronutrients such as Fe, Zn, Cu and Mn compared to untreated substrate. Apart from coconut leaves, other pineapple waste, banana pseudostem and leaves, and glyricidia green manure can also be effectively used along with coconut leaves for vermicomposting.

Vermiwash

This vermiwash is honey- brown in colour with a pH of 8.5 and contains both major and minor nutrients in appreciable quantity. Growth promoting hormones like IAA and GA are also present in vermiwash. Application of appropriately diluted coconut leaf vermiwash increases germination and seedling vigour index of cowpea and paddy seeds in laboratory bioassays. Field trials conducted on cowpea, maize and oksa in the Institute farm during 2004-2005 showed its capacity to enhance the biomass and yield of the crops accompanied by increase in soil microbial populations, enzyme activities and organic carbon content of the soil.

Microbial Resources

Biofertilizer formulations containing *Azospirillum* spp. and phosphate-solubilising bacteria having 10^8 colony forming units of bacteria prepared in carriers such as lignite are to be applied @100 g per palm. The biofertilizer should be mixed with one kg vermicompost and applied to soil and incorporated with onset of monsoon especially when palms are maintained under rainfed condition. However, under irrigated conditions, it can be applied at any time, since maintaining optimum moisture is not a problem.

The beneficial nature of biofertilizers becomes even more important in coconut-based mixed cropping/ farming systems as component crops continually add plant residues to soil which undergo organic recycling. In mixed cropping, dominant nitrogen-fixing microbial group is the bacterium *Beijerinckia* and phosphate-solubilizers such as *Pseudomonas* sp., *Bacillus* sp., *Aspergillus* sp. and *Penicillium* sp. are present in higher numbers. Higher inhibition potential of resident soil bacteria to phytopathogens is observed in coconut-based cropping systems compared to coconut monocropping systems. When coconut is grown with cocoa, rhizosphere activity is found to increase and a better mobilization of phosphates takes place coupled with nitrogen fixation and production of growth substances such as auxins and gibberellins in rhizosphere.

Feasibility of organic coconut production

A field experiment initiated at CPCRI, Kasaragod, during 2002-03, reveals that organic cultivation gives significantly higher nut yield compared to the control. There was 34 per cent increase in yield. The mean percentage improvement in yield of organically cultivated coconut over 'no management practice' was 60 and 59 in case of WCT and COD x WCT. Analysis of soil samples collected from rhizosphere of coconut palms indicates that total microbial population in general and that of function-specific microbes are higher under organic treatments.

In coconut-based farming system with intercropping of fodder grass in inter spaces of coconut, yield of coconut in organic cultivation was 108 nuts/palm/ year and of fodder 106 tonnes/ha/year. The system is highly remunerative with a net return of Rs 1,37,164/ha/year, achieving economic and environmental advantages under organic farming.

SUMMARY

There have been significant technological advancements in the development of agro-technologies based on principles of organic farming in plantation crops. The growth habit and planting methods of coconut make it highly amenable for organic farming based on low-cost technologies utilizing the local resources. Technologies are available for production of sufficient quantities of organic matter, efficient recycling and generation of high- quality compost and growth-promoting liquid formulations and utilization of microbes to supply the plant nutrients without any ecological damage as is the case with chemical agriculture. The organic cultivation of coconut is an environment-friendly, sustainable and economically-viable proposition.

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