Integrated Coconut Based Farming System for Sustainable Agriculture

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Coconut production in our country is predominantly depended on the small and marginal farmers. More than five million farm families grow this crop for their livelihood. Coconut utilises only 25 per cent of the land area and 40-45 per cent of the incident light. Under monocropping of coconut, farmers are underemployed since it provides only 100 man days and 130 mandays of employment under rainfed and irrigated condition, respectively. Therefore it is suggested to grow compatible intercrops for utilising the available space and light and to maximise the farm income besides employment generation throughout the year. Of late, there is an increased awareness among cultivators regarding sustainable agriculture and recycling of organic matter for getting the sustainable crop yield.

Mixed farming is a type of farming under which crop production is combined with livestock raising. The livestock enterprise is complementary to crop production programme so as to provide a balanced and productive system of farming.

In coconut, various subsidiary enterprises could also be integrated to generate more employment and income for the family. One such viable and compatible system has been developed at CPCRI, Kasaragod in an 1.2 hectare area, with the following enterprises.

- Cultivation of grasses in the interspaces
- Dairying with 5-6 milch animals
- Poultry birds (100 number broiler birds each per batch)
- Japanese quails (100 Number)
- Rabbits (10 female and 4 male)
- Acquaculture (625m^2 surface area)
- Apiculture with Indian bees
- Bio gas unit (3m^3 area)

There are several environmental factors which play an important role in integrating with different enterprises, Viz., competition, shade tolerance, trampling and soil compaction, cattle damage to young trees, tree spacing and effect of integrated system on coconut yield and the social acceptance of the any enterprise by a farmer, etc.

Grasses

Hybrid napier and Guinea grass are found to grow well in coconut garden yielding 50 to 55 tonnes of green fodder per year provided the irrigation is given during summer months.

Dairy Unit

Five to six cows can be maintained. On an average, 25-30 kg of cowdung per day can be obtained from each animal, thus by-products obtained from the dairy unit comes to 15 tonnes of FYM per year. The cowshed washings and urine collected daily can be recycled into the coconut - grass system. The cows can be fed daily

Fig1. Guinea grass intercropping in coconut

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with 25 kg of green grass and 10 kg of dry grass along with concentrates. From 5-6 cows, with proper management, we can expect 7000-7500 litre milk and can be distributed depending upon the farmers choice.

Biogas Unit

For the biogas unit, daily 25 kg of fresh cowdung should be applied, and the gas so obtained can be used as fuel. The biogas slurry left behind is found to be rich in nutrients and recycled into the garden. From the $3m^3$ biogas, $1032m^2$ gas can be generated per year.

Poultry Unit

100 number broiler birds (per batch) can be maintained. Broilers should be maintained for 8 weeks and disposed off. After each batch, the poultry manure so obtained can be recycled into the garden and fish pond. In a year 5-6 batches of broilers can be maintained and 950-1050 kg live weight of birds can be expected.

Japanese Quails

100 number quail birds can be maintained for egg purpose and disposed off when egg production comes down after one year. From these birds we can expect 200-2500 eggs per year.

Rabbitry

Ten female and four male Russian chinchilla breed can be maintained in the cage system. Green grass and concentrates can be given as feed. In a year we can expect 40-45 kg live weight.

Acquaculture

Another enterprise which has got tremendous scope in Kerala is aquaculture especially during the monsoon season when fishing in the sea is dangerous. With the modern management techniques evolved and the existing vast water resources, the state can bring about substantial increase in fish production through fresh water fish culture. A fish pond with the dimension of 27.5m length, 22.5m width and 1.5m depth was constructed at CPCRI. The soil being sandy and porous and to curtail percolation loss, the pond was lined with polythene film of 250 micron (1000 gauge). Preferably clayey or laterite soil is to be filled upto 10cm at the bottom of the pond. This soil layer will help to facilitate natural recycling of the food material and to arrest the temperature fluctuations during hot days. The pond water is maintained with the help of internal water source. To facilitate in draining of water from the pond whenever needed, an outlet pipe is provided at one ft. below the embankment so as to drain the excess water. Both the outlets and the drain pipes are fixed with strainers so that fish does not escape. As the pond is lined with polythene sheet, there will not be natural ecosystem. Hence, artificial aeration is a must. For this, 1HP blower was installed through which air is pumped into the pond at 12 different points for proper aeration all through the pond.

In the semi-intensive system, as the natural food available in the pond will not be sufficient for the fish, it is necessary to supplement it with cowdung, chemical manure and artificial food. First instalment is to be applied into the pond about 24 days before releasing the fish. If at any point of time, algal growth is more, application of manure is to be temporarily suspended so that its growth is arrested. Chemical manure is to be broadcasted all over the pond whereas cowdung may be dumped in the corner of the pond.

About 4-6cm long fingerlings of four selected species *viz.* Catla *(Catla catla)*, Rohu *(Sebeo rohita)*, Mrighal *(Cirrhinus mrighala)* and Grass carp *(Ctenopharyngodon idellus)* were released in the pond. Generally in one hectare pond area, about 3750-7000 fingerlings can be accomodated. The density of the population depends according to the level of management and the number of species of fishes that are to be left.

Use of concentrates helps in quick growth of fish. It is recommended to give mixture of groundnut cake and rice bran in 1:1 ratio

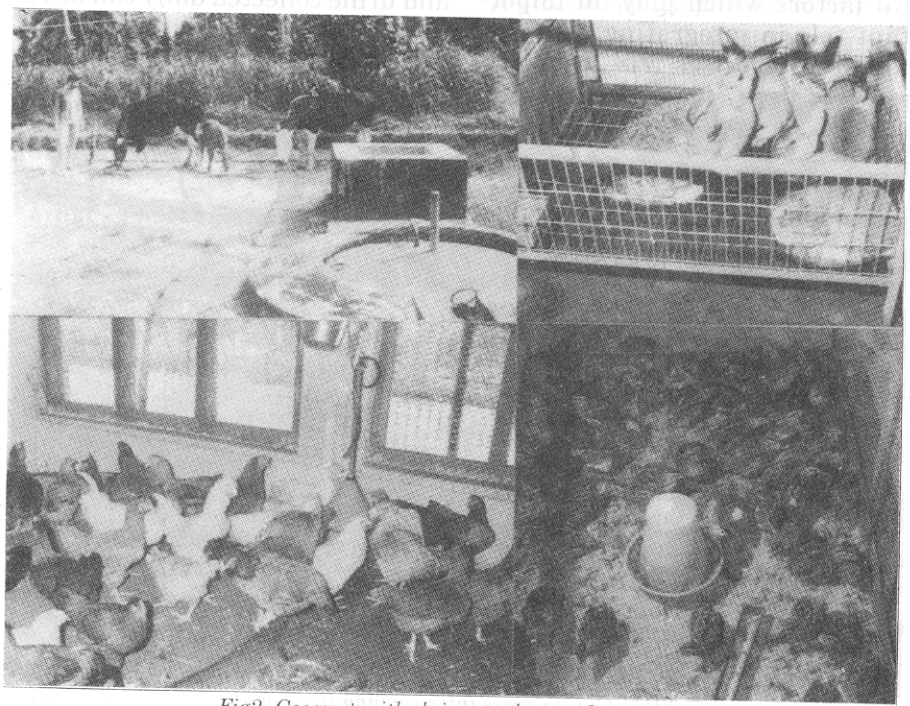

Fig2. Coconut with dairy, poultry and rabbitry

at the rate of one to 3 percent of body weight of fish. These materials are to be mashed thoroughly and made into ball with the help of water and suspended at minimum four places in the pond. Since poultry droppings were available in the system, around 1kg of poultry droppings were also applied every day to the pond. It helps to provide ready-made food for the fish. For grass carp variety, green grass was supplied every day.

Normally fish is to be harvested from pond after 10 to 12 months period. Maximum weight of the fish at the end of one year varies from 900 to 1200g per fish depending on the variety. In the present study the weight ranged from 810g in the case of Mrighal to 1180g in the case of Grass carp. It is desirable to harvest the fishes at periodical intervals so that the remaining ones in the pond can attain good weight. On an average, from one hectare of pond area under integrated fish culture, it is possible to get 3000 to 4000 kg fish per annum.

Precautions to be observed in fish pond management

1. As and when weeds are seen in the pond, they have to be removed.

2. The pond water should be neutral in pH for better development of fishes. In case the pH drops below 7.0, add 200 to 250 kg of lime per ha area.

3. In area where heavy rain is received and if cloudy weather persists for a long period it is common to observe the growth of algae on the surface of water. Under cloudy weather due to excessive growth of algae there is a possibility of mortality of fishes due to eutrophication. This particular malady is called oxygen kill. To overcome the algal growth, it is suggested to remove it manually or broadcast copper sulphate.

Table-1 . Nutrients recycling from the by-products

By-products / year	N (kgs)	P (kgs)	K (kgs)
FYM-15 tonnes	75	40	75
Poultry manure-2 tonnes	20	38	12
Cows urine and cowshed washings - 5000 litres	30	--	28
Total	125	78	115

In this system at CPCRI the green grass obtained was used as feed for cows and fish. The by-products obtained in the system were recycled in the garden every year. The nutrient cycling from the system is given in the *Table 1.*

Impact of mixed farming on soil physico-chemical and biological properties

In the top layer of 0-25cm depth, the increase in maximum water holding capacity of the soil was 30.4 to 33.6 per cent under mixed farming system from the initial value of 24.0 per cent both in coconut basins and grass cultured plots as revealed in the study at CPCRI. The porosity of the soil was also improved (44.5 to 46.0 per cent) from the initial value (38.2 to 39.0 per cent). However, the bulk density of soil under mixed farming was found to decrease (1.4 to 1.42 g cc^{-1}) from the initial value of 1.54 g cc^{-1}. The reason for increase in maximum water holding capacity and porosity and decrease in bulk density has been primarily attributed to the increase in soil organic matter owing to the recycling of FYM/ poultry manure and dead roots.

The organic carbon status of the soils under mixed farming system was found to increase marginally compared to initial status due to the contribution from root biomass and recycling of dairy and poultry wastes. The available soil nitrogen showed almost a similar trend as that of organic carbon. The available nitrogen content was found to increase in soils both under basin and interspaces of grass cultured area. Almost a similar trend of data has been recorded for available P and K in different depths of soil under mixed farming. The secondary and micronutrient status of soils showed the reverse trend as that of N, P and K. The soils under mixed farming generally showed relatively lower value of available Ca, Mg, Mn, Cu and Zn whereas there was marginal increase in available Fe status. This is obvious because besides coconut, grasses were also found to exhaust these nutrients from the soils.

The bacteria and fungi count were more in the root region soils of both coconut-napier grass and coconut- guinea grass system as compared to coconut alone as monocrop. The N_2 fixers (*Beijerinckia* spp.) and phosphate solubilising bacteria were more in the mixed farming system as compared to coconut monocropping system. The soil enzyme activities (Urease and dehydrogenase) and soil microbial biomass in coconut based mixed farming also were higher.

Impact of mixed farming on leaf nutrient status and yield of coconut

The leaf nutrient content of coconut with respect to N, P, K, Ca and Mg in WCT and LO under mixed farming clearly reveals that all the nutrients content in the index leaf of coconut was found to be higher when compared to that of initial status of coconut in both the varieties. This is due to beneficial effect of mixed farming system in improving the soil physical, chemical and biological envi-

ronment which favoured the higher uptake from the soil nutrients pool. There was increase in the nut yield during 1989-96 under mixed farming (79.7 nuts/palm/year) compared to pre-experimental yield of 58.6 nuts/palm/year under WCT and it was 130.8 nuts/palm/year under Laccadive Ordinary compared to pre-experimental yield of 101.7 nuts/palm/year. Honey bees were found to play an important role in the pollination of the coconut in addition to providing honey.

Economic viability and employment potential of the system

At CPCRI, the above system generated an employment potential of 1000 man days. The total variable cost (average of five years) involved in maintaining the above system was around Rs.1,25,000. Of which Rs.97,000 was spent for the purchase of commercial feed and paddy straw. Total returns from the system was Rs.2,50,000. The contribution from the dairy was Rs.84,100, from the poultry was , Rs.58,670, and from the coconut was Rs.94625. Amount available to the two member family for management of the system was Rs.89,900 per annum. The average additional net profit from dairy alone was Rs.35,000 to 38,000 per annum, from poultry alone Rs.20,000 to 22,000 per annum. and with fish culture it was Rs.12,000 to 13,000 per annum. Depending upon the interest one can select any of the above enterprises for getting additional income.