COCONUT BASED FARM FAMILY MODELS IN INDIA

By

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India is the third largest coconut producing country in the World with an annual yield of 7560 million nuts from 1.43 million ha of land. In India, Kerala ranks first in area and production followed by Tamil Nadu, Karnataka and Andhra Pradesh (Table 1).

Table-1 : Area and Production of coconut in different States of India (1987-88)

State	Area (000 ha)	Production (Million nuts)
Kerala	864.6	3670
Tamil Nadu	183.8	1553
Karnataka	212.2	1092
Andhra Pradesh	48.9	480
Others	119.2	767
Total	1428.7	7562

Coconut is the mainstay of rural economy in Kerala and contributes to 35% of the agricultural income in the state. It is grown in an area of o.86 million ha (60.5% of Indian acrage) with an estimated annual production of 3670 million nuts (48.5% of Indian production). About one million people are directly employed in coconut processing industries and other activities.

Coconut palms constitute an essential and dominant component of the homesteads and garden lands alongwith West Coast of India. It occupies such a pre-eminent position that the agro-ecosystem along the coastal regions of Kerala, Karnataka and Goa is essentially a coconut based eco-system (Nair and Varghese,1980).

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Scope for Multiple Cropping in Coconut

In India, coconut is primarily a crop of small and marginal farmers and about 98% of the 5 million coconut holdings in the country are below 2 ha in size (Table 2). As the sole crop coconut provides employment for only 150 mandays/ha/year and for the rest family labour remains idle. The income derived from most of the coconut holdings is insufficient to meet the farmers' requirement and as a result multiple cropping is a rule rather than an exception.

Table-2 : Size of Coconut Holdings in India

Size of holdings (ha)	Percentage of holdings of different states			
	Kerala	Tamil Nadu	Karnataka	Andhra Pradesh
Less than 0.2	37.1	69.1	52.5	56.5
0.2 - 1.0	52.8	26.0	42.9	41.7
1.0 - 2.0	7.9	3.2	3.6	1.8
2.0 and above	2.2	1.7	1.0	-

(Source : Thampan, 1988)

The recommended spacing for coconut is 7.5m x 7.5m in the square system, mainly to accommodate the large crown of the palms. However, studies revealed that soil and air space and solar radiation are not fully utilized under 7.5m x 7.5m spacing.

Studies have shown that most of the feeding roots in well managed adult coconut palms (75%) are concentrated within a radius of 2.0 m around the palm (Kushwaha et al. 1973). This works out to only 22% of the soil area. The remaining 78% of the area is foraged only in a limited scale and can support growing of other species.

In the initial years of planting, coconut intercepts only a small percentage of incident solar radiation. As the age increases, the interception of sunlight also increases and reaches a level of about 80% by the 8th year. This level of interception continues till about 20th year and starts gradually decreasing thereafter due to gradual reduction in the

canopy size of the palms and reaches about 50% around 40th year of planting (Nelliat et al. 1974). Thus the incident sunlight is not fully utilized by the coconut in the initial years and again after 20 or 25 years. This facilitates growing of the other shade tolerant crops in the interspaces of coconut plams.

A number of coconut based Farm Models have been developed at CPCRI, Kasaragod to suit diverse soil and climatic conditions, requirements of the farmer, availabity of labour and irrigation fecilities etc. for achieving more efficeant utilization resources to maximise productivity and net returns.

Farm Family Models For Rainfed Conditions

Under rainfed coditions, inter-cropping with annuals is recommended. Intercropping refers to the practice of growing annuals in the interspaces of a perennial crop stand. Krishna Marar (1964) estimated that inter/mixed cropping is practiced in 78% of coconut gradens in Kerala and tapioca was the most popular intercrop grown in 20% of the gardens. The mean annual rainfall of the Kerala State is 2960 mm distributed in 126 rainy days. The rainfall is comparitively low in the southern districts (1800 mm in Trivandrum), compared to the northernmost districts (3500 mm in the northernmost district of Kasaragod). The southern parts of the state have better distribution of rainfall because they are benfitted by both southwest and northeast monsoons and the dry priod last for one or two months.

A variety of crops have been tested as intercrops in coconut plantations and they include cereals/millets pulses like redgram, blackgram, greengram and cowpea, oilseeds like groundnut, sesamum and soybean, tuber and rhizomatous crops like cassava, elephant foot yam, sweet potato, coleus colocasia, yams, ginger and turmeric and fruit crops like banana and pineapple.

While planting intercrops, a circular area of 2 m radius around the palms which is the active root zone

of coconut must be left free. The intercrops are planted by adopting the usual methods such as pits (cassava, elephant foot yam), raised beds (ginger, turmeric, coleus), rows (upland rice, pulses, groundnut, soybean) or trnches (pineapple). Both coconut and intercrops should be manured individually at recommended levels and the intercrops should be rotated.

Among the various crops tested, tuber and rhizomatous crops, pineapple and banana are more profitable. The yield of different intercrops is summarised in Table 3.

Table-3: Yield and additional employment generated by intercropping with tubers and rhizome spices

Intercrop	Yield (t/ha of coconut garden)	Addl. employment (person days/ha)
Tapioca	11.2	105
Elephant foot yam	12.2	131
Sweet potato	7.1	82
Ginger	7.8	132
Turmeric	8.1	132
Coleus	5.6	115
Greater yam	10.3	76
Lesser yam	7.5	76

Economic evaluation of different intercropping systems have shown that coconut + elephant foot yam has the highest net returns of Rs. 18,550/- per ha per year followed by Rs. 14,350/- per ha per year in case of coconut + ginger system compared to Rs. 5,151/- per ha in coconut sole crop under rainfed conditions.

Models for Irrigated Conditions

In places where assured irrigation facilities are available during summer months, mixed cropping with cocoa, or high intensity systems such as multistoreyed cropping and high density multispecies cropping systems or mixed farming by integration of dairy animals with coconut is advocated.

Mixed Cropping Systems

Growing of perennial crops in the interspaces of another perennial is termed as mixed cropping. Coconut gardens aged over 20 years and with assured irrigation facilities are suitable for mixed cropping. Cocoa, pepper, cinnamon, clove, nutnug, coffee and mulberry have been tested as mixed crops in coconut. Among these crops, cocoa has been found to be the best. It may be grown as a single hedge system adopting a spacing of 2.5 m between plants along row to accommodate about 525 plants/ha. Pepper another profitable crop which can be grown using coconut trunk itself as standard and also in a double hedge system between rows of coconut using dead standards. Among tree species, clove and nutmug perform well.

Studies conducted at CPCRI have revealed that cocoa plants add about 820 and 1985 kg/ha/year of organic matter (dry wt.) in single and double hedge system respectively to the soil through leaf fall and prunings. This forms a thick mulch and checks weed growth, prevents loss of soil moisture by evaporation and recycles considerable amounts of plant nutrients. The micro-claimate inside the coconut-cocoa crop mix is much cooler. All these factors enhance the activity of beneficial micro organisms like nitrogen fixers, phosphate solublizers and produces of growth promoting substances. As a result of this beneficial effects, much higher yields have been obtained from coconuts mix cropped with cocoa (Table 4). Economic evaluation of the data has shown that single hedge system of growing cocoa in coconut is more profitable than the double hedge system.

Table-4: Yield of crops in coconut-cocoa mixed cropping system

Cropping system	Coconut(nuts/palm/year)			Cocoa
	Pre-exptl. period	Exptl. period (1972-87)	Increase (%)	(pods/plant/yr) (1985-87)
Coconut sole crop	68	107	57.4	-
Coconut + Cocoa (Single hedge)	57	109	91.2	25.5
Coconut + Cocoa (double hedge)	39	88	125.6	13.0

Multistoreyed Cropping System

This is an intensive system of mixed cropping of coconuts with pepper, cocoa and pineapple. In this system crops having varying morphological framework and rooting habits are mix-planted in such a manner that their canopies intercept solar radiation at varying heights and their roots forage the soil at different zones.

In this system, there will be 175 coconut palms spaced 7.5 x 7.5 m apart. Pepper vines are planted 1 m away from the palm on the northern side and then trained on to the coconut trunk. One row of cocoa seedlings are planted in the north-south direction adopting a spacing of 2.5 m between plants. Pineapple suckers are planted in between coconut palms along the row in trenches of 4 m length and 90 cm width at spacing of 60cm x 30 cm to accommadate 4500 plants/ha.

Pineapple could grown under this system during first six years only and it gives a mean yield of 1.24 kg fruit/plant. Later with full development of cocoa canopy, pineapple did not perform well. The yield data of other crops are given in Table 5.

Table-5 : Yield of crops in multistoreyed cropping systems (1985-88)

Crop	Unit	Yield
Coconut *	Nuts(No./palm/year)	115
Pepper	Dry berries(kg/palm/year)	0.86
Cocoa	Pods (No./palm/year)	33

* Pre-experimental yield of coconut - 45.3

Economic analysis has shown that this combination could generate a net return of Rs. 30,300/- per ha/year as compared to Rs. 17,100 /- per ha/year from middle aged irrigated coconut sole crop. This system provides employment for 335 mandays/ha/year and gives benefit cost ratio of 1.76.

High Density Multispecies Cropping System

In this system several plant species both annuals and perennials are grown together as mixed stand in a definite patron to accommodate maximum number of plants per unit area of land. It aims at effective utilization of available soil and air space and incident sunlight for production of biomas having high economic value and diverse end uses relevant to the farmer and society such as food, fuel, fodder and timber. This system can be adopted in irrigated coconut plantations aged over 25 years.

A High Density Multispecies Cropping System experiment is in progress at CPCRI, Kasaragod since 1983. In a coconut plantation with palms spaced at 8 x 8 m and aged 18 years, 17 species of crop plants viz. clove, nutmeg, mango, jack, breadfruit, sapota, acidlime, guava, pepper, subabul, banana, papaya, coffee, pineapple, elephant foot yam, colocasia and tapioca were planted taking the population to 13,030 plants/ha. Small microplots with different crop combinations are being studied to identify compatable and highly productive crop combinations.

The initial indications are that such high density cropping systems could be maintained at a high level of productivity with a reduced level of fertilizer application. The WCT coconut palms under this system have recorded a very high yield of 152 nuts/palm/year during the period 1985-86 to 1987-88. Among the other crops, banana and pineapple are performing well and give satisfactory yields. Clove and nutmeg have made good growth and many of the clove plants had just started yielding by the sixth year.

Tapioca was withdrawn from the system in the first year, papaya, elephant foot yam and colocasia in the second year, coffee in the fourth year and lime, subabul, mango, sapota and guava in the fifth year. Most of the perennials among the crops withdrawn did not perform well probably because of higher shade levels.

Based on the results of the first generation high density multispecies cropping system experiment, two new models have been laid out during 1989 after eliminating the crops which did not perform well and including only those crops whose performance was satisfactory.

The first model includes black pepper (156 plants/ha) trained on coconut, clove (156 plants/ha), banana (780/ha), elephant foot yam (2184/ha) and turmeric, besides coconut. The second model includes pepper trained on coconut (156/ha), cocoa (468/ha), banana (963/ha), elephant foot yam (468/ha) and pineapple (3900/ha) in addition to 156 coconut/ha spacing 8 m apart in the square system of planting.

Mixed Farming Systems

Animals can be profitably integrated with coconut by growing fodder grasses and legumes in the interspaces of palms which can be used for maintaining milk animals. The cow dung can be used for producing biogas to meet the fuel and lighting requirements of the farmer and the digested biogas slury can be recycled as manur for the coconut-fodder mixed stands. In addition, pepper can be grown using palm trunk as the standard and tubers, vegetables and banana can be raised along the field bunds and borders.

Earlier studies have revealed that guinea grass and hybrid napier (NB 21) perform better under the shade of coconut palms and give a fodder yield of 60 t/ha/year. Among the legumes Brazilean lucerne (Stylosanthes gracilis) and cowpea (Vigna unguiculala)) produce about 30 t of fodder/ha/year. A mixed farming unit on the above lines was established in one ha of coconut plantation aged 60 years with 5 cross bred milk cows. There were about 191 coconut palms and guinea grass and NB 21 were grown in the inter spaces. Pepper was trained on coconut palms and inter crops like banana, tapioca and vegetables were raised along the border and field bunds. The milch animals were fed with the grass harvested from the

plots @ 30 kg green fodder/animal/day in addition to concentrates. A gobar gas plant of 3.0 m^3 capacity was also built to produce fuel (biogas) to meet the lighting and cooking needs of the family and lighting the cowshed etc.

The total output from the system has been found to be 15,900 coconuts, 218 kg dry pepper, 695 kg tubers, vegatables and banana, 7500 litres of milk and 550 m^3 of biogas (ha/year). It was observed that the net return from 1 ha of coconut plantation in the 60-70 year age group could be as high as Rs. 29,500/- per annum and the mixed farming system provides employment for 850 mandays/ha/year.

Second generation mixed farming experiments have been initiated recently to achieve further intensification of the system by including pultry (layers, broilers and Japanese quails) and rabbits (Soiet Chinchilla).

Cropping Systems for Plateu Areas

In parts of Karnataka, coconut is generally spaced much wider at 9m x 9 m spacing or even more. This facilitates greater light penetration through coconut and offers increased scope for multiple cropping. Results from CRS, Arsikere have shown that French bean or chillies or potato followed by wheat are highly profitable crop sequences under plateu areas and provided employment for 479 days/ha/year. Mulberry also comes up well under coconut shade in maidan tract and leaves could used for rearing silk worms. Studies at Arsekere have shown that by integrating sericulture with coconut, additional employment could be generated for 128 mandays/ha/year and 375 kg of cocoons produced one ha of coconut garden.

Conclusion

Coconut provides opportunities to grow a wide range of crops in the inter spaces for maximising productivity from unit area of land per unit time. The

crops will have to be selected carefully so that the farmer derives the maximum advantage with lower inputs, increased employment opportunities for family labour and high net returns. A lot of research is needed to understand the various inter/intra species interactions among plants, input requirments for different systems, identification of new crop combinations and screening of new crop/varieties for their shade tolerance.

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