

ECONOMICS OF COCONUT BASED FARMING SYSTEMS In

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Prafulla K. Das* 1990

Abstract

Economic evaluation of some of the promising coconut based farming system models was carried out at CPCRI with the 1988-89 factor-product costs to show the potential for resource maximization and enhancing net return from lands planted to coconut by adoption of farming systems approach.

Feasibility studies under rainfed coconut gardens involving different crop species and varieties as intercrops revealed that the tubers and rhizomatous crops were relatively more remunerative components in the systems than that of cereals, pulses and oilseeds. The economic potential in terms of net profit in the case of coconut + amorphophallus system was worked out as US \$ 1160 /ha/year and in the case of coconut + ginger system it was US \$ 896 /ha/year, while coconut monocrop under similar situation gave a net return of US \$ 319.

Among several feasible combinations under irrigated coconut gardens, one of the most successful systems was the integration of black pepper, pineapple and cocoa with adult coconut palms of over 20 years age. This multistorey system generated a net return of US \$ 1895 /ha/year, as against US \$ 1450 in the case of irrigated coconut monocrop raised under similar situation.

In the mixed farming model where some of the plant species including fodder grass along with milch cattle and rabbits were integrated with 60-70 years old coconut palms, it was observed that the net return from 1 ha system could be of the order of US \$ 1821 per year, while pure stand of irrigated coconut grove yielded a net return of US \$ 1450. When the return to family labour, management and internal resources was considered, this mixed farming system was found to be an ideal model for the self-reliant smallholder because of its high turnover (US \$ 3102) and resources use efficiency.

These systems smoothed out the peaks and valleys of labour demand which could be considered a positive factor for the smallholder environment. Two most important contributing factors for the better performance of the farming systems were nutrient cycling and biological complementarity that came from associated cropping. Yet, the reasons underlying smallholder's choices of crops and systems rest in socio-economic conditions and constraints often unrelated to research institute's site situations. Future emphasis should therefore be on on-farm testing of farming system models through out-reach programmes and institutional incentives to form a basis for tailoring technologies, regional planning and policy formulations. A successful transfer of these technologies however would go a long way toward a sustainable and self-reliant agriculture.

Introduction

Coconut based multispecies farming systems are in vogue in many parts of the coconut growing tracts in the Asian and Pacific regions for centuries. The driving force for these systems is essentially economic consideration. The smallholder raises a wide variety of crops along with coconuts in the initial 7-8 years from its planting, primarily to receive some income from the land till the palms come into production. He also raises a variety of crops from his adult coconut garden not only for own home consumption but also extra cash

income through the sale of additional products. Furthermore, coconut based mixed farming provides a considerable safeguard to the smallholder's return against the failure of coconut crop as well as the crash in prices of nuts and copra. Besides these, the farmer obtains a higher productivity of nuts from his palms when they are grown in the mixed farming systems as compared to monoculture. It is because the palms are benefited from the application of fertilizers and irrigation to the associated crops and the cultural operations given to them which are generally not available to the pure stand of coconuts.

(The morphology and growth patterns of coconut palms are found to provide strong technical support to the economic considerations for coconut based farming systems.) The young coconut palms below 9 years age group and the palms of 20 years and above do not pose any problem and let sufficient light (from 43 to 88% of normal sunlight) between their fronds from open canopy to permit successful raising of several crop species better adapted to partially shaded conditions in the understorey. Similarly, the rooting patterns of mature coconut palms planted at a spacing of 7.5 x 7.5m do not pose any problem for the uptake of nutrients and moisture from the soil by the compatible intercrops properly arranged in the system, as the effective root zone of coconuts is confined mainly within a 2 m radius around its base and the top 10 cm soil is by and large devoid of functional roots while more than 80% of the roots are found between 30 and 130 cm depth. From the land utilization point of view, a pure stand of coconut utilizes only 22% of the area at spacing of 7.5 x 7.5m leaving considerable scope for exploitation of the interrow soil potential. Hence, the coconut palms provide the best opportunity for a wide range of farming systems.

The choice and arrangement of intercrops under the palms are, however, influenced by the technical factors such as the age of the palms, climatic conditions, irrigation facilities and soil types, and economic factors like availability of labour and other inputs, financial resources, holding size, yield potential,

marketing facilities, government incentives and profitability; besides management factors namely, convenience and knowledge of the coconut farmer.

In the traditional coconut holdings in India in general and Kerala State in particular, both annual and perennial species are commonly intercropped with coconut palms. Among annual species widely grown under coconuts in Kerala, most common ones are cassava, taro, dioseorea, amorphophallus, ginger, cucumber, horsegram and rice. The most commonly grown perennials in coconut gardens are black pepper, cloves, bananas, mango, jack, breadfruit, sapota and cashew.

MDS Liyanage et al. (1986) have reported that in Sri Lanka, a vast range of annuals and perennials are raised as intercrops under coconuts. Among these species, cassava, sweet potato, taro, yams, finger millet, cowpea, peanuts, bananas, passion fruit, pineapple, ginger, turmeric, black pepper, clove, cinnamon, nutmeg, cocoa, coffee and pasture grass are preferred by coconut farmers in the wet zones of Sri Lanka. The survey report of Cuevas et al. (1974) indicates that in the Philippines, common intercrops under coconuts are corn, cassava, sweet potato, taro, peanuts, bananas and pineapple. As far as Malaysia is concerned Denamany et al. (1979) have described a number of perennials namely cocoa, coffee, cloves, pineapple and bananas besides a group of annual food crops that are commonly grown under coconuts. The maintenance of livestock is also fairly common in some areas. In Papua New Guinea, immature palms are sometimes intercropped with food crops and peanuts, while mature gardens are intercropped with cocoa and Robusta coffee. Cattle grazing under coconut has however, declined there (FAO,1966).

Eventhough the smallholders have been practicing coconut based mixed farming with the consideration that the systems provide with a higher return per unit area, input and time than does monoculture; yet the opportunities to maximise the economic gains are lost in most cases because of unscientific selection and arrangement of component crops. Such systems have

resulted in intense competition for resources and adversely affected the growth and performance of both the main and intercrops.

During the early seventies, research efforts on coconut based farming systems were initiated at CPCRI and other coconut research stations in India and Asia to tackle the problems that limit the efficiency of practice. These studies have conclusively proved that scientifically designed models are capable of delivering the desired results (Nelliath et al. 1974; Creencia 1978; Ramdasan et al. 1978; Nair 1979; Bavappa and Jacob 1982; Das 1984; Mathes 1986; Bavappa et al. 1986; M.D.S. Liyanage and Martin 1987; L.V.K. Liyanage et al. 1989 and Das 1989).

This paper highlights the economic prospects of some of the promising coconut based farming system models which have been concluded at CPCRI in the recent past.

Results and Discussion

Rainfed Coconut Systems

CPCRI, Kasaragod is located in the west coast of northern Kerala where the dry period spreads from November to April. Since most of the smallholders cannot afford to set up irrigation facility, the possibility of successfully raising crops that are water demanding in summer months was ruled out. Feasibility studies involving different species and varieties as intercrops in rainfed mature coconut blocks located in marginal soil revealed that the tubers and rhizomatous crops were relatively more profitable associate crops than cereals, pulses and oilseeds.

A field trial to study the effect of raising cassava and amorphophallus as intercrops on the yield of coconuts showed that when main and intercrops were fertilized as per the recommendations there was no reduction in the yield of coconuts. Rather, there was a marginal increase in annual coconut yield from 33 to

33.4 nuts per palm in cassava treatment and from 31.9 to 36.2 nuts per palm in amorphophallus treatment, because of favourable biological interactions (Varghese et al. 1978).

The economic potential in terms of net profit in the case of coconut + amorphophallus system under 1988-89 factor-product costs was worked out at US \$ 1160 /ha/year. In the case of coconut + ginger system the same was estimated at US \$ 895 /ha/year. Coconut monoculture under similar situation however gave a net return of US \$ 319 /ha/year (Table 1).

Land Equivalent Ratio

Land Equivalent Ratio (LER) and competitive Ratio (CR) for different rainfed coconut based farming systems concluded at CPCRI were worked out. The methodology as suggested by Willey (1979) and Mead and Willey (1980) was followed in these evaluations.

In the case of coconut + cassava system the total LER was 1.15, which revealed that 15 per cent more land would be required under the monocropping to obtain the same level of income realised through a combined system. The CR was 9.74 which indicated that coconut was 9.74 times more competitive over cassava. For coconut + amorphophallus combination, the total LER was 1.42 and CR was 5.43, while for coconut + ginger combination, the total LER was 1.56 and CR was 4.16.

Irrigated Coconut Systems

Irrigated coconut gardens provide better opportunities for a wide range of mixed farming systems as compared to rainfed gardens due to obvious reasons. The choice of intercrops under this situation is very large.

Multistorey Cropping

Among several feasible combinations under irrigation tried at CPCRI, one of the most successful

Table-1 Economics of coconut based intercropping experiment carried out under rainfed condition at CPCRI, Kasaragod (Estimated with 1988-89 factor-product costs).

Particulars	Coconut monocrop	Coconut + Cassava (US \$ ha ⁻¹ yr ⁻¹)	Coconut + Amorphophallus	Coconut + Ginger
Costs				
Labour wages @ \$ 1.75/day	209	439	439	1084
Planting materials	-	16	281	406
Manures & Fertilizers	110	250	183	348
Plant protection	28	38	38	63
Contingencies	28	41	34	63
Total variable cost	375	784	975	1964
Annual fixed cost	675	675	675	675
Gross cost	1050	1459	1650	2639
Returns				
Coconut @ \$ 0.16/nut and by-product	1369	1553	1522	1522
Cassava @ \$ 0.16/kg	-	600	-	-
Amorphophallus @ \$ 0.13/kg	-	-	1288	-
Ginger @ \$ 0.44/kg	-	-	-	2013
Gross return	1369	2153	2810	3535
Net return	319	694	1160	896
Imputed value of family labour				
	157	329	329	813
Return to family labour, management and internal resources.				
	476	1023	1489	1709

US \$ 1 = Indian Rupees 16

systems was the integration of black papper, cocoa and pineapple in an adult coconut garden of above 20 years. This block was receiving irrigation during the dry months through perfospray. In this system, the pepper vines were trained on coconut palms and cocoa and pineapple were raised in the interspaces of coconut palms in such a way that both root and canopy competitions could be avoided. The number of stands under each species in one ha plot were: 175 coconut, 175 black pepper, 400 cocoa and 10600 pineapple. This 4-tier system was known as multistorey cropping.

An economic analysis of the multistorey cropping was carried out under the 1988-89 factor-product costs. According to this analysis, the gross cost and gross return of this 4-tier coconut based farming system were US \$ 2213 and US \$ 4108 respectively, giving a net return of US \$ 1895 /ha/year. However, the net return realisation from an irrigated middle-aged coconut sole crop was estimated at US \$ 1450 /ha/year. The estimated return to the family labour, management and internal resources from this multistorey cropping was of the order US \$ 2336 /ha/year (Table 2). The cost-benefit analysis of this trial further showed that the BCR was 1.76, IRR was higher than 22%, NPW US \$ 12553 and ANPW was US \$ 2044 /ha/year.

Yet, the economic potential of the multistorey cropping could not be fully realized because of the few limitations. Firstly, the Panniyur-I variety of black pepper did not perform well under the given microclimate. Some of the vines were even lost due to the quick wilt disease caused by Phytophthora palmivora. Secondly, the yield of cocoa was adversely affected due to rodent damage. Thirdly, pineapple fruiting was severely affected in the later stages (8 to 10 years after the initiation of the trial) under the thick shade of cocoa- not only the fruit size was very small but also its quality was poor due to microclimate effect. Moreover, there was crow damage to the pineapple to certain extent.

TABLE-2 Economics of coconut based multistoreyed cropping experiment under irrigation at CPCRI, Kasaragod (Estimated with 1988-89 factor-product costs).

Particulars	Coconut monocrop (Irrigated)	Coconut + Cocoa (SH) + Pepper + Pineapple
	(US \$ ha ⁻¹ yr ⁻¹)	
Costs		
Labour wages (@ \$ 1.75/day	253	588
Manures and fertilizers	191	228
Plant protection	28	50
Contingencies for irrigation and other items	41	56
Total variable cost	513	922
Annual fixed cost	1025	1291
Gross cost	1538	2213
Returns		
Coconut (@ \$ 0.16/nut and byproducts	2988	2988
Cocoa	-	460
Pepper	-	266
Pineapple	-	394
Gross return	2988	4108
Net return	1450	1895
Imputed value of Family labour	190	441
Return to family labour, manage- ment and internal resources	1640	2336

US \$ 1 = Indian Rupees 16

Mixed Farming

An experiment on coconut based mixed farming was initiated in 1972 at CPCRI in a 60 year old coconut garden covering an area of 1.04 ha. In this system hybrid Napier and other fodder grasses were raised in the interspaces of coconut palms, black pepper was trained on palms, bananas and vegetables were grown in the backyard of farm house and 5 units of crossbred cows and 30 units of rabbits were maintained on fodder produced from this experimental block. Besides, dry fodder and concentrate feed mixture were fed to the milch cattle as supplements to the green fodder. Summer irrigation was provided to the entire field.

The economic analysis of this field trial indicated that the gross cost of mixed farming was US \$ 4144 /ha/year and the gross return was US \$ 5965 /ha/year giving a net return of US \$ 1821 /ha/year at the 1988-89 factor-product costs. When the return to family labour and management was considered, this system was found to be an ideal model for the self-reliant smallholder because of its high turn over to the tune of US \$ 3102 /ha/year (Table 3).

Although the mixed farming model provided a substantially higher return as compared to coconut monoculture, the economic potential of the system could not be fully exploited because of a few constraints. Firstly, the milch cows in the system were fairly low yielders. Thus the average milk yield per cow did not go beyond 1455 litres per annum despite good management. Secondly, the cows were mostly fed nonleguminous fodder as it was not possible to produce adequate quantity of leguminous fodder from the system. Thirdly, the contribution from the black pepper was very low to the system because of the fact that the pepper vines were not successfully established in most of the coconut palms, though the average yield of pepper per vine in this experiment was much higher than the yields realised from the other plots of CPCRI.

TABLE-3 Economics of coconut based Mixedfarming experiment under irrigation at CPCRI, Kasaragod (Estimated with 1988-89 factor-product costs).

Particulars	US \$ ha ⁻¹ yr ⁻¹)
Costs -	
Labour wages \$ 1.75/day	1488
Fertilizers for the system including fodder grass	150
Plant protection	34
Cattle feed, dry fodder and concentrates	979
Veterinary expenses	35
Expenditure on rabbits	25
Contingencies	152
Total variable cost	2863
Annul fixed cost including depreciation	1281
Gross cost	4144.
Returns -	
Coconut @ \$ 0.16/nut and byproducts	2469
Pepper @ \$ 1.87/kg for 235 kg	439
Milk @ \$ 0.31/Lit for 8760 litres	2716
Subsidiary crops and rabbits (30 Nos)	341
Gross returns	5965
Net return	1821
Imputed value of family labour	1281
Return to family labour, management and internal resources	3102

US \$ 1 = Indian Rupees 16

Employment Generation

The field trials on coconut based farming systems concluded at CPCRI have not only produced significantly higher return, but also generated a more substantial employment potential per ha than monoculture. According to our assessment, the labour input increased from 120 days/ha/year in the rainfed coconut monocrop to 251 days in coconut + amorphophallus system and to 620 days in coconut + ginger system (Table 4). In other words, the labour absorption capability of coconut based farming system under rainfed condition went up by 417% over the coconut monocrop.

The employment potentials of some of the irrigated mixed farming models were observed to be still higher than that of rainfed system. According to our estimates, the labour input utilization increased from 144 days/ha/year in the case of irrigated coconut monocrop to 335 days in multistorey cropping - a rise by 133%. When the labour absorption potential of the mixed farming model was assessed, it was found to be as high as 850 days/ha/year (Table 4). This rise came to 490% over irrigated monocrop and 608% over rainfed monocrop of coconut. From Table 4 it was further evident that coconut based farming systems were capable of distributing the labour inputs more or less uniformly over the year unlike the monoculture.

In other words, these systems smoothed out the peaks and valleys of labour demand on the farm to enable the family members to optimise their productivity.

Conclusion

There were a variety of reasons for the better performance of the farming systems over monoculture. Two most important contributing factors were : nutrient cycling and biological complementarity that came from associated cropping, apparently there was a synergistic effect of cocoa on coconuts. Besides, there was no expenditure on organic manure to the system as

TABLE-4 Assessment of employment potential of coconut based farming systems models of CPCRI, Kasaragod
(Persondays ha-1yr-1)

	Persondays ha-1yr-1					% change over monocrop	
	Jan-Mar	Apr-June	Jul-Sept	Oct-Dec	Total	Rainfed	Irrigated
Rainfed systems							
(i) Coconut monocrop	15	15	57	33	120
(ii) Coconut + Amorphophallus	115	25	70	41	251	109	..
(iii) Coconut + Ginger	239	265	81	35	620	417	..
Irrigated systems							
(i) Coconut monocrop	27	19	57	41	144	20	..
(ii) Multistoreyed cropping (Coconut + Cocoa (SH) + Pepper + Peneapple)	82	70	113	70	335	179	133
(iii) Mixedfarming (Coconut + Pepper + Fodder grass + subsidiary crops + Milch Cattle + Rabbits)	232	193	203	222	850	608	490

it was adequately met from the system through cocoa leaf-fall and enhanced microbial activity in the soil in the mixed stand. There was also considerable saving in the contingent expenditure as the weeds were suppressed below the thick mulch and as such no weeding operation was warranted for the system. The profitability of the system however, depended on relative costs of the inputs, relative prices of the products and the degree of complementarity or competition of the activities.

Affordable Technologies

The models under this review were by and large modified versions of already existing crop mixtures and the suggested modifications were technically simple and operationally feasible. The use of purchased inputs in these systems was relatively much less while there was reliance on non-cash inputs. Thus, these technologies could be sustainable at a lower external cost unlike high-tech agriculture. The limited resources farmers would, therefore, not find it difficult to adopt the resource efficient technologies which could be affordable as well as profitable.

If we consider the goal of the farmer, he is interested in minimising risk and maximising profit rather than maximising the yield. In that context, the aims of the CPCRI farming system trials have by and large met with a fair degree of success.

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