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Impact of integrated mixed farming system in coconut (*Cocos nucifera*) garden on coconut yield and economic analysis

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ABSTRACT

An experiment was conducted to study the effect of integrated mixed farming system in coconut (*Cocos nucifera* L.) garden on coconut yield and economics. With mixed farming there was an increase in the nutrition status of coconut and nut yield over the years. The economic analysis of this system for the period, 1989–90 to 1997–98, realized a net return between Rs 49,700 and Rs 126,900. The cash flow analysis performed using a discount rate of 14% realized the benefit : cost of 1.36, the net present worth of the system was Rs 286,500, the internal rate of return was 27.44% and the pay back period was 5 years.

Key words : Coconut, Farming system, Yield, Economics

The integration of crops and /or livestock in coconut garden requires careful studies with respect to its socio-economic benefit and impact of productivity of coconut. Coconut is a small holder's crop in India and more than 90% of the 5 million coconut holdings in the country are less than 1 ha in size. These small holding coconut farms often do not provide adequate income to the dependent families (Das, 1991) and not providing gainful employment opportunities for the family labour throughout the year. However, there are possibilities of increasing the productivity and net returns from coconut stands by raising compatible subsidiary crops and integrating livestock (Gopalasundaram *et al.*, 1993). Adoption of coconut-based farming systems is one among the ways to augment the productivity by improving soil characters and coconut nutrition (Maheswarappa *et al.*, 1998) as well as the income per unit area.

A pilot model has been evolved at the Central Plantation Crops Research Institute, Kasaragod, integrating grasses, dairy,

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poultry, rabbitry and fish culture since 1989 to understand the impact of various subcomponents on the productivity of coconut as well as on its socio-economic feasibility. In the present paper the influence of coconut-based farming system on productivity, nutrition of the main crop (coconut) and its economic analysis was studied.

MATERIALS AND METHODS

Experimental site

The field experiment was conducted at the Central Plantation Crops Research Institute, Kasaragod, Kerala. The soil was red sandy loam, with field capacity 10.0% and permanent wilting point 5.2%. The bulk density was 1.54 kg/m^3. The soil was low in available N and K and but rich in available P. The field experiment was initated during 1989 in 1.0 ha coconut plantation aged 18 years with following components.

Fodder grasses: Two types of grasses, viz. guinea grass (*Panicum maximum)* and hybrid napier, 'NB 21', were planted with the spacing of 60 cm × 30 cm in the interspaces of coconut by leaving 2 m radius. For grasses NPK dose of 150 and 80 and 80 kg/ha was adopted. Before planting grass slips, 10 tonnes of FYM, full dose of P and K were applied in trenches. Nitrogen was applied as top dressing @ 20 kg/ha after each cutting of the grass. Grasses were replanted 4 years after planting. For coconut, 500; 320; and 1,200 g N; P; K/ palm were applied in 2 splits. Irrigation was provided during summer months with the sprinkler system based on IW : CPE ratio of 1.00 maintaining 20 mm depth. Pepper was trained on coconut and banana was planted all along the border.

Dairy unit: Five to six Jersey and Holstein Friesian breed cows were maintained in the system.

Poultry unit: A total of 100 layers and 100 broiler, (for each batch) birds were maintained in the system. In a year 6 batches of broilers were reared. Equal (100) number quail birds were also maintained.

Biogas unit: Biogas unit of 3 m^3 was installed for generating biogas. The cowdung slurry from the gas plant and cowshed wastes along with urine were recycled within the experimental area.

Rabbits: Ten female and 4 male Russian chinchilla breeds were maintained.

Aquaculture (625 m^2 surface area): About 4–6 cm long fingerlings of 4 selected species, viz. catla (*Catla catla*), rohu (*Sebeo rohita*), mrighal (*Cirrhinus mrighala)* and grass carp (*Ctenopharyngodon idellus)* were reared in the pond.

Input and output details were collected and the market prices prevailed during the corresponding years in northern Kerala were considered to work out the economics for 1 ha. The fixed cost was reduced to an annuity using a discount rate of 14% considering the economic life-span of the system as 10 years. Tabular analysis was performed to identify the individual share of factors of production in the total cost. Based on the total return and total cost, the net return was worked out for individual years. Cash flow analysis (Sairam *et al.*, 1999) was performed, using a discount rate of 14% and the economic viability of the system was assessed through economic indicators, viz. benefit : cost ratio, net

Table 1. Nutrients recycling per year from the by-products in mixed farming

By-products/year	N(kg)	N (kg)	K (kg)
FYM 15 tonnes	75	40	75
Poultry manure 2 tonnes	20	38	12
Cows urine and cowshed washings-50,000 litres	30		28
Total	125	78	115

present worth, internal rate of return and the pay back period.

By-products: By-products obtained from the system, viz. FYM, poultry manure, biogas slurry, urine and cowshed wastes, were recycled into the coconut+grass plantation every year from 1989. Quantity of by-products obtained and their nutrient contribution is given in the Table 1. For coconut 25 kg FYM, 1 kg poultry manure was applied palm/year. For grass plot 10 tonnes FYM and 1 tonne poultry manure was applied between the rows per year. The urine, cowshed washings and slurry collected were pumped into the coconut + grass every year.

RESULTS AND DISCUSSION

Performance of grasses

The studies revealed that, the grass crops would be ready for harvest 75–80 days after planting and subsequently it can be cut at 45–50 days interval. The guinea grass and hybrid napier 'NB 21' produced on an average 50 and 52 tonnes green grass/ha/year respectively.

Impact of mixed farming on coconut nutrition and nut yield

The leaf nutrient content of coconut with respect to N, P, K, Ca and Mg in 'West Coast Tall' and 'Laccadive Ordinary' under mixed farming is given in Table 2. All the nutrients content in the index leaf of coconut was higher compared with 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 environment which favoured the higher uptake from the soil nutrients pool (Maheswarappa *et al.*, 1998). The higher uptake of Ca and Mg may be due to the continuous irrigation of mixed farming plot favoured the higher removal of these nutrients. There was an increase in the nut yield during 1992–99 under mixed farming (112.3 nuts/palm/year) compared to pre-experimental yield of 58.6 nuts/palm/year under 'WCT' and it was 163.5 nuts/palm/year under 'Laccadive Ordinary' compared to pre-experimental yield of

Table 2. Effect of mixed farming on coconut leaf nutrient status

	N(%)	P(%)	K(%)	Ca(%)	Mg(%)
Pre-experimental					
'WCT'	1.65	0.19	0.99	0.26	0.14
'LCO'	1.61	0.18	1.01	0.21	0.10
During 1998–99					
'WCT'	2.20	0.22	1.35	0.48	0.42
'LCO'	2.21	0.20	1.28	0.47	0.39

WCT, 'West Coast Tall'; LCO, 'Laccadive Ordinary'

Table 3. Effect of mixed farming on coconut nut yield

Period	'WCT'	'LCO'
Pre-experimental (average of 1986–88)	58.6	101.7
Transitional period (average of 1989–92)	60.3	106.8
Experimental period excluding transitional period (Average of 1992–99)	112.3	163.5

101.7 nuts/palm/year (Table 3) inconcommitent with improved nutritional status of the palm as well as irrigation and improvement in the soil nutrient availability status. Similar increase in leaf nutrient status and nut yield of coconut has been reported by Sahasranaman *et al.* (1983) in root (wilt) disease-affected garden when mixed farming was adopted.

Economic alanysis

Costs: The details on the cost of mixed farming system is given in Table 4. It could be inferred from the Table 4 that during 1989–90 to 1997–98, among the different factors of production, the share of cattle feed and hired labour together accounted between 56.33 and 75.72% of the total cost. In addition the entire system is maintained by 365 person days for 1 male and 1 female labour. This system is labour-intensive and under the present socio-economic conditions of states like Kerala, in which hired labour is both scarce and costly, the economic viability of this system could be increased only through active participation by the family labour. Hence it could be interred that this model is more suitable for medium or larger coconut holdings with more number of persons depending on agriculture.

It could be further observed from Table 4 that the cost of poultry feed which was Rs 4, 930 during 1989–90, increased to Rs 18,610 during 1997–98 (by 277.5%). The total cost of the system (including the annuity value) which was Rs 134, 800 during 1989–90, increased to Rs 167,000 during 1997–98 (by 23.9%)

Returns: The returns from coconut and milk was maximum, accounting for 50 to 70% of the total (Table 5). The returns from coconut increased from Rs 50, 361 during 1989–90 to Rs 88,200 during 1997–98 (by 75.1%). The share of coconut in the gross returns was stable over years. However inter-year fluctuations was there due to price fluctuations for coconut. In case of milk the total returns decreased from Rs 92,071 to Rs 78,576 (by–14.7%), since the number of milch cows was reduced. The share of milk in the gross return exhibited a declining trend. The returns from broiler birds exhibited an increasing trend, and the same, which was Rs 10,600 during 1989–90 increased to Rs 70,800 during 1997–98 and its share in gross return increased from 5.96% to 26.45%. The share of fish in the gross cost also exhibited an increasing trend. One of the major advantages of this system is that it produces and recycles organic manures like farmyard manure, biogas slurry and poultry manure at regular intervals. This could meet about 75% of the organic requirement for coconut and other subsidiary crops and their value was worth about 1% to 2.62 % of the gross return. The realized gross returns increased from Rs184,900 to Rs 293,900 (by 59.29%), (by

Table 4. Cost of coconut-based mixed farming systems

Year	Labour (Rs/ha)	Cattle feed (Rs/ha)	Poultry feed (Rs/ha)	Veterinary medicine (Rs/ha)	Broiler birds (Rs/ha)	Paddy straw (Rs/ha)	Ferti-lizer (Rs/ha)	Finge-rlings (Rs/ha)	Fish feed (Rs/ha)	Fodder grasses (Rs/ha)	Irrigation (Rs/ha)	Miscella-neous (Rs/ha)	Total cost (Rs/ha)	Total (Rs/ha)
1989–90	20,000	53,800	4,930	3,890		480	3.500			4,800	1,000	1,927	94,300	130,700
1990–91	20,000	49,180	9,340	1,780		2,370	3,670			5,200	1,000	114	93,500	129,900
1991–92	24,000	55,870	13,740	2,350	3,900	2,640	3,800	1,150	3,200	5,830	1,000	1,117	118,700	155,100
1992–93	26,000	50,160	16,630	2,650	3,900	3,620	6,080	1,150	3,200	5,940	1,500	1,159	122,000	158,400
1993–94	26,000	68,680	16,690	4,930	1,000	2,500	6,130	1,200	3,350	6,360	1,500	1,320	139,700	176,100
1994–95	30,000	64,540	17,640	3,440	1,000	2,230	6,200	1,200	3,350	6,360	1,500	1,333	138,800	175,200
1995–96	30,000	63080	34,240	2,610	3,000	5,500	6,300	1,250	3,400	6,360	2,000	1,514	159,300	195,700
1996–97	34,000	57,620	40,580	1,970	8,360		7,000	1,250	3,500	6,360	2,000	1,573	164,300	200,700
1997–98	40,000	40,190	18,610	1,880	5,220	3,000	7,200	1,300	3,500	6,360	2,000	1,229	130,600	167,000

*Rounded total; Annuity in all years was Rs/ha 36,400

Table 5. Returns from coconut-based mixed farming systems

Year	Coconut (Rs/ha)	Milk (Rs/ha)	Pepper (Rs/ha)	Banana (Rs/ha)	Broiler (Rs/ha)	Quail (Rs/ha)	Hen egg (Rs/ha)	Quail egg (Rs/ha)	Rabbit (Rs/ha)	Fish (Rs/ha)	FYM (Rs/ha)	Poultry manure (Rs/ha)	Fodder grasses (Rs/ha)	Biogas (Rs/ha)	Byprod. Others (Rs/ha)	Gross return* (Rs/ha)	Net return (Rs/ha)
1989–90	50,361	92,071	3,150	1,250	10,600	1,500	11,985	1,884	1,750		2,250	1,000	4,800	900	1,000	184,500	53,800
1990–91	64,041	89,033	3,360	981	7,975	1,500	2,594	1,974	900		3,875	1,250	5,200	1,000	4,600	188,300	58,400
1991–92	50,199	74,440	2,790	1,500	18,240	2,240	1,448	1,680	600	20,000	3,750	1,000	5,830	1,100	5,800	190,600	35,500
1992–93	61,859	63,016	2,700	2,304	10,745	1,600	4,229	4,084	980	21,100	3,750	1,875	5,940	1,300	6,400	191,900	33,500
1993–94	64,414	97,857		4,200	16,000	1,720	5,392	2,515	900	20,000	5,400	2,250	6,360	1,500	6,200	231,700	55,600
1994–95	76,500	92,350		4,000	28,930	1,800	7,000	1,100	500	20,000	5,100	2,250	6,360	1,500	6,900	254,300	79,100
1995–96	77,552	117,711		4,400	32,630	2,500	5,774	1,018		20,200	4,800	1,600	6,360	1,700	7,500	284,700	89,000
1996–97	87,354	71,376		4,800	76,300	2,000	544	2,596		21,500	6,000	1,600	6,360	2,000	7,700	290,100	89,400
1997–98	88,200	78,516		4,000	70,800	2,000		2,620		22,200	7,000	2,500	6,360	2,300	7,400	293,900	126,900

*Rounded total; **In case of FYM and poultry manure, the imputed value of quantity produced within the system was considered as return

Table 6. Cash-flow analysis of coconut-based mixed farming system

Years	Total cost	Total return	Discounted		
			Cost	Return	Margin
1989–90	134,800	184,500	118,246	161,842	43,596
1990–91	134,000	188,300	103,109	144,891	41,782
1991–92	155,100	190,600	104,688	115,150	10,462
1992–93	158,400	191,900	93,786	113,620	19,835
1993–94	176,100	231,700	914,61	120,338	28,877
1994–95	175,200	254,300	79,819	115,856	36,037
1995–96	195,700	284,700	78,209	113,777	35,568
1996–97	200,700	290,100	70,357	101,697	31,340
1997–98	167,000	293,900	51,354	903,77	39,023
Total			791,028	1,077,547	286,520
Benefit : cost ratio					1.39
Net present worth					306,770
Internal net return					27.5
Pay back					05

155.33%).

Cash-flow analysis: To assess the economic viability of this coconut-based mixed farming system model, the cash-flow analysis was performed to work out the benefit : cost ratio, net present worth, internal rate of return (IRR) and pay back period using a discount rate of 14% (Table 6). The benefit : cost ratio (BCR) and net present worth (NPW) were 1.36 and Rs 286,520 respectively. This indicated that for every 1 rupee of investment in this system the additional returns was Re 0.36, which confirmed that under well-managed conditions, coconut-based mixed farming system is economically viable. The NPW of about Rs 286, 520 further indicates that this system would more profitable. The internal rate of return was 27.44%, indicating the economic worthiness of financing this system. The pay period of 5 years indicated that the total initial investment of 0.26 million could be taken back by 5 years. These indicators confirmed the economic worthness of investment in coconut-based mixed farming system. The system is able to provide fodder grass for feeding the cows worth of Rs 4,800 to Rs 6,400/year and if value is not imputed to the cattle feed cost, the BCR could increase to 1.41 and the net present worth to Rs 315,400. However, there was change in the values of IRR and pay back period.

The above coconut-based farming system resulted in increase in nutritional status of main crop along with sustainable increase in productivity of the system. The economic analysis of coconut-based mixed farming system revealed that the internal rate of return was 27.44% and the pay back period was 5 years. These results clearly indicate the economic viability of the system in medium and larger coconut holdings under irrigated conditions.

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