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ECONOMIC VIABILITY OF COCONUT BASED FARMING SYSTEMS IN INDIA*

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ABSTRACT

Evaluation of various types of farming system models developed at different coconut research stations suggests that it is relatively more profitable to integrate a number of subsidiary crops and animal components with coconut rather than raising it as a monocrop.

INTRODUCTION

Raising a number of crops in coconut stands is an age-old practice in densely populated coconut area. Different crop mixtures are being followed by the smallholders primarily to meet their multiple needs from the limited resources and as risk precautions against the climatic and market aberrations. The coconut holding in India by and large are very small and when these units are monocropped they do not provide adequate income to the dependant families. However, against the background of the alleged superiority of coconut monocropping to inter/mixed cropping, evidence is accumulating through the farming system research to suggest that scientifically adopted coconut-based farming systems are highly efficient and rewarding. Punchihewa (1990) was right when he stated that coconut-based farming system is one way by which the income level of coconut farmers in Asia and Pacific regions could be enhanced considerably. This review attempts to highlight the economic potential of different coconut-based farming system models that were developed under various situations at the Central Plantation Crops Research Institute (CPCRI) and other coconut research stations in India.

The available literature on most of the coconut-based farming system research which was conducted in the earlier years however, do not show the economic aspects, as their main objective was to find out the technical feasibility of the system. It was perhaps assumed that the magnitude of economic viability of a model is closely associated with its degree of success based on technical feasibility. This assumption stems from some of the following basic considerations: Firstly, the coconut lands in India, by and large are conducive to produce a variety of annuals, biennials and perennials. Secondly, since coconut is planted at a wider spacing due to its characteristic morphological features, the inter-and intra-row spaces in coconut gardens are adequate to provide the best forms of cropping system without adversely affecting the productivity of the palms. Thirdly, several inter/mixed crops yield reasonably well because of their ability to tolerate coconut shade. On these accounts, the returns from the system offset the costs and ensure profits (Das, 1989 b).

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For the purpose of this review, the performance of the component crops and their impact on the yield of coconut have been considered as the shadow values of the economic returns for the systems, wherever the economics has not been worked out. However, in some cases though economics is shown the estimates were made taking the market rates for the inputs and outputs prevailing during those periods, and it is not possible to re-estimate the economic potentials of those earlier studies as the physical units of the inputs used in the model are not indicated in many cases. It was, therefore, considered to show the estimated returns at the then prevailing market rates and wherever possible, the revised estimates have been shown at the current prices.

INTERCROPPING

The field trials on intercropping in coconut stands were initiated at the erstwhile Central Coconut Research Stations, Kasaragod, Nileshwar and Pilicode (all in Kerala), during the thirties, involving different varieties of cereals, millets, pulses, oil-seeds and tuber crops in old coconut stands. The feasibility studies of some of these trials showed very encouraging response and these are discussed here.

Rice

The earliest report on the performance of rice as an intercrop was from Nileshwar in the year 1931 which showed that raising rice was not economic as the grain yield was only 140 kg/ha. However, a grain yield of 780 kg/ha was obtained from a trial carried out at Pilicode during the early forties compared to 755 to 1208 kg/ha in the open (Nambiar, Nambiar and Rajan, 1988). Gopalasundaram and Nelliat (1979) reported that during 1976–78, a trial was undertaken at Kasaragod to study the performance of upland rice in the rainy season as an intercrop in mature coconut stands. The variety 'Rohini' with a three year mean yield of 1646 kg/ha was found to be the most remunerative one among the three varieties tried. According to the estimates of Hegde, Gopalasundaram and Yusuf (1990) coconut + upland paddy raised during monsoon season could earn a net return of Rs. 13,300 while coconut alone can give Rs. 10,400/-ha/year at 1990 prices.

Millets

At Kasaragod, raising of finger millet as an intercrop was not profitable during 1930–31 and 1931–32 as it yielded only 292 kg and 236 kg of grain per ha (Anonymous, 1932). At Pilicode during 1939–40 to 1941–42 various millets like finger millet, Kodo millet, hog millet, Japanese barnyard millet and bajra gave equal or better yields under coconut compared to their yields in the open. However, though Kodo millet performed better than other millets with 1311 kg grain/ha, the economic prospect was extremely limited due to lack of demand from local population (Anonymous, 1941; 1942; 1943). Finger millet was also tried as an intercrop in coconut gardens of Thanjavur in Tamil Nadu during the seventies and it was observed that varieties EC 4847 and EC 4849 were very poor yielders with the grain yield of 175 kg and 570 kg per ha and therefore, not profitable (Anonymous, 1978b). But a trial at Arsikere in Karnataka showed that a net return of Rs. 6473/ha was obtained from finger millet intercrop with BCR 1.15 (Shanthamallaiah et al., 1982).

Pulses

Horse gram yielded as low as 85 kg/ha at Kasaragod during 1930–31 (Anonymous, 1932). But the experiment at the same farm during 1974 gave an yield of 355 kg of horsegram grain/ha which was a satisfactory

return. However, black gram with an yield of 72 kg/ha was a failure in economic sense (Anonymous, 1975). There was another trial involving seven pulse crops separately as intercrop treatments in coconut gardens at Pilicode during 1939–40. While red gram gave an yield between 133 and 454 kg/ha all other pulses failed completely (Anonymous, 1941).

The result of the trial with different pulses at Arsikere in Karnataka conducted during 1976–77 showed that cowpea var. C152 and C448, and red gram-hybrid 3C yielded reasonably good profit as intercrops, while horse gram and green gram were not profitable. Similarly the cultivation of cowpea var. C152 as intercrop at Veppankulam in Tamil Nadu was quite remunerative whereas the other pulses like red gram, black gram, green gram, soybean var. EC. 39821 and cowpea var. PLS 370, were found to be uneconomic to grow in the coconut gardens (Anonymous, 1978a).

The experiment at CPCRI with the sowing date of August 16, 1976 revealed that cowpea var. Kunnamkulam (grain yield of 500 kg/ha), green gram var. PS 16 (grain yield of 300 kg/ha) and black gram var. 79 (grain yield of 317 kg/ha), performed much better than that of a later sowing date (September 1, 1976) and also compared to other varieties tested (Gopalasundaram and Nelliat, 1979). Bengal gram was tried as an intercrop with coconut at Arsikere and it gave a net return of Rs. 6116/ha with BCR of 1.21 (Shanthamallaiah et al., 1982).

Oil seeds

Groundnut was raised an an intercrop at Pilicode during 1939–42 and the results suggest that when it was sown in the first fortnight of May and well managed, the crop gave a good return with an yield of 1364 kg/ha, otherwise it was not remunerative to raise under the coconut stand. Eventhough at the CPCRI, Kayangulam, groundnut yielded 600 kg/ha it resulted in a fairly good amount of additional net return to the system (Sahasranaman, 1964). According to Kannan and Nambiar (1976) the impact of groundnut as an intercrop in coconut garden was substantial. Besides giving an yield of 965 kg pods/ha it could influence in increasing the productivity of coconut palm by 1.5 nuts/palm/year, thereby increasing the net return for the system over the monocrop.

During 1972–74, groundnut var. TMV 2 was raised in a middle aged coconut garden under rainfed condition located in the red sandy loam soil at Nileshwar. The average yield (1326 kg/ha) was comparable with the expected yield when it is grown in the open field. Besides this, the yield of coconut also increased. As a result of this the economic return from this coconut + groundnut system was quite encouraging (Leela and Bhaskaran, 1978).

Gopalasundaram and Nelliat (1979) reported that at Kasaragod, sesame was cultivated as an intercrop with coconut during 1940–41. While the June sowing resulted in a good return with an yield of 278 kg/ha, the August sowing was found to be less remunerative with 97 kg yield per ha. The trial of sesame as intercrop at Pilicode during rainy season of 1942–44 gave a very poor yield of 77 kg/ha (Nambiar et al., 1988).

Intercropping experiment conducted during the thirties and forties involving castor proved unsuccessful both at Kasaragod and Pilicode since none of the varieties tolerated coconut shade.

Tuber crops

The tubers – cassava and colocasia were tried as intercrops in coconut stands aged

about 50 years at Pilicode during 1967–75. As far as coconut + cassava intercropping is concerned, the average yield of cassava was 15.4 t/ha and the average yield per palm rose from 55.9 nuts during the pre-treatment period to 61.0 nuts in the intercropping period. The total additional net profit from the system was estimated as Rs. 2047/ha at 1974 market prices. In the case of elephant-foot-yam treatment, the average yield from the intercrop was 6.2 t/ha and the yield of coconut increased by 30.3% from 45.1 to 58.8 nuts/palm. The additional net return from the system was estimated as Rs. 2178/ha at 1974 prices (Kannan and Nambiar, 1976).

Nair and Gopalasundaram (1990) have reported that the tubers and rhizomatous crops were highly labour intensive. While elephant-foot-yam, ginger and turmeric generated additional employment to the tune of 131–132 mandays per ha, other tubers demanded 76 to 115 mandays/ha/year.

Varghese et al. (1978) reported the results of two experiments conducted at Kasaragod during 1972–78. These experiments revealed that when the same tubers were grown continuously in a plot there was reduction in the yield of palms, but when the tubers were raised on rotation the palms showed a marginal rise in the net yield. Besides, there was a significant increase in the tuber yields under rotation. For example, the rotation with cassava on alternate years increased the yield of elephant-foot-yam to 11.8 t/ha from 6.4 t/ha when it was grown every year in the same plot with coconuts. However, its yield under the 5 year rotation trial involving five tuber crops gave still higher yield of 12.2 t/ha under coconut stands. Hence from economic point of view it is not advisable to grow the same tuber crop as an intercrop in the same plot year after year.

The economic analysis of coconut + cassava cropping system under red sandy loam soil of Kerala showed that based on the market situation of 1990–91, an additional net income of Rs. 8168/ha could be realised from cassava intercrop. However, the combined net income from the system could be of the order of Rs. 15220/ha, an increase of 190%over coconut monocrop (Das, 1991).

Another study at Kasaragod showed that tubers like greater yam, lesser yam, chinese potato and sweet potato, were compatible intercrops with coconut and these crops were found to be economically viable. Hegde et al (1990) worked out the net return from various intercropping systems under 1990 market rates and these were: coconut with sweet potato Rs. 16,420: with greater yam Rs. 18,562; with lesser yam Rs. 13,125; and with chinese potato Rs. 12,700.

Das (1989a) analysed the economic potentials of elephant foot yam and ginger as intercrops in coconut stands and found that under the 1988 factor-product price situation that prevailed in Kerala, coconut + elephant-foot-yam combination gave a net profit of Rs. 18,550/ha/year and coconut + ginger system resulted in a net return of Rs. 14,350/ha/year, while coconut sole crop under similar situation yielded a net return of Rs. 5,150/ha/year. Das and Vijayakumar (1990) have reported that under rainfed system, the Land Equivalent Ratio (LER) for coconut + ginger and coconut + turmeric were 1.56 and 1.41.

During 1978–79 a trial was conducted at Pilicode involving different tuber crops under coconut stands. While sweet potato and colocasia performed very badly with a very poor yield of 0.6 t and 0.3 t per ha, respectively, turmeric with an yield of 4.4 t/ha and cassava with an yield of 13.8 t/ha gave net profits of Rs. 2,597 and Rs. 1,200/ha, respectively (Nambiar et al, 1988).

A paper by Lalitha Bai and Vikraman Nair (1982) gives details on shade response of some common rainfed intercrops. According to the observation of those authors sweet potato was shade sensitive and therefore all growth parameters including yield and harvest index showed an exponentially decreasing trend with increase in shade intensity. In shade tolerant crops, the growth parameters showed either a linear decreasing trend with shade, as in coleus or an initial passiveness with a sharp decline after 50% shade intensity as in colocasia. On the other hand, in shade loving crops such as ginger and turmeric the growth parameters showed a positive beneficial effect upto 25% and 50% shade respectively, with sharp decline thereafter.

Banana

The economic feasibility of growing banana under irrigated coconut gardens was studied at Kasaragod during 1976–78. The weight of fruits per bunch varied from 4.7 kg to 10 kg during the first two years but the third year crop with second ratoon was a great-loss because of extremely poor crop. Therefore, according to Gopalasundaram and Nelliat (1979) when banana is raised as an intercrop with coconut, it should be replanted after the first ratoon crop in order to obtain a good economic return. Hegde et al, (1990) have estimated a net return of Rs. 25,675/ha/year from coconut + banana cropping system against a net return of Rs. 10,400 from coconut sole crop.

An experiment was initiated at Veppankulam in 1980 in a 20 year old coconut garden at a spacing of 7.5 x 7.5 m. Two culinary varieties — Kanchi and Mondhan and four table varieties Poovan, Rastali, Karpuravalli and Jurmany banana were planted at the interspaces at a spacing of 2.4 x 2.4 m. The cost of cultivation for this intercrop alone was of the order of Rs. 2,000/ha/year. The average yield of banana intercrop was 3000 kg/ha and the income from it was Rs. 2250/ha/year. Thus the net profit of this intercrop was only marginal (Rs. 250/ha/year). However, the intercrop had an impact in increasing the yield of coconut for which net additional return from coconut was Rs. 1950/ha/year and for the whole system was Rs. 2200/ha/year (Ramanathan, Chandrasekharan and Ramachandran, 1982).

Krishnaji et al., (1976) reported that banana under coconut stands of Kerala gave an average net profit of Rs. 2905/ha at 1975 prices. At Veppankulam in Tamil Nadu, banana var. Kanchi and Karpooravalli performed well as intercrop in coconut stands giving a yield of 11.4 kg fruit/bunch, while var. Dwarf Cavendish failed to establish (Anonymous, 1978b). Since dwarf Cavendish variety performed fairly well under Kasaragod situation its failure at Veppankulam might perhaps be due to poor quality planting material.

The feasibility study undertaken at Pilicode and Nileshwar during 1970–79 indicated that var. Robusta was a highly profitable intercrop at both the locations with the yields of 9.0 and 9.9 kg bunch weight, followed by var. Palayankodan (8.0 and 11.6 kg) and Nhalipoovan (3.7 and 10.5 kg). Var. Nendran was however, not a remunerative intercrop because it did not perform well under the coconut shade. Var. Palayankodan was also found as a very good yielder with coconut at RARS, Kumarakom with the first year yield of 32.9 t bunch weight/ha and first ratoon crop yield of 57.8 t/ha. Var. Monthan and Padathy yielded 35.0 t and 25.8 t/ha in the first year and 52.5 t and 48.3 t/ha in the second year, while var. Nendran yielded less than 50% of other varieties (Nambiar et al., 1988). According to Suma et al., (1989), var. Poovan was the

most profitable cultivar for intercrop in coconut garden earning a net profit of Rs. 13,132/ha/year followed by var. Chenkadali (Rs. 11,620) and Palayan (Rs. 11,473). Mathewkutty and Kuttikrishnan (1989) have reported that with an yield rate of 20 to 30 t/ha banana intercrop could generate a net return of Rs. 10,000—Rs. 12,000/ha/year, besides increasing the profitability prospect of the coconut.

Pineapple

At Kasaragod, pineapple var. Kew was tried as an intercrop in coconut stands both under rainfed and irrigated conditions. The report indicated that both the number of fruits/ha and the fruit weight were significantly higher in the irrigated plot compared to the rainfed one (Anonymous, 1979). Hegde et al., (1990) have reported a net return of Rs. 17,450/ha/year for the coconut + pineapple cropping system under irrigation in Kasaragod condition. Ramanathan et al. (1982) in their paper have reported that pineapple var. Kew was not a successful intercrop in the sandy loam soils of Thanjavur district of Tamil Nadu as the cost of raising this crop (Rs. 2,232/ha/year) did not commensurate with the income (Rs. 208/ha/year) from this crop. However, there was a 32% increase in the yield of the main crop (coconut) in the interplanting plot over the control.

Chillies

According to Sahasranaman (1961) chillies as an intercrop gave a net additional return of Rs. 100/ha at 1960–61 prices. At the present market rates the profitability of this system could be sizeable. A study on intercropping trial at Arsikere in Karnataka revealed that the maximum net income/ha was obtained with chillies (Rs. 8784) and the BCR was 1.43 (Shanthamalliah et al., 1982).

Double cropping sequence systems

At Arsikere, intercropping trials were also carried out with double cropping sequence systems in coconut gardens. The maximum net income per ha was obtained with potato-wheat (Rs. 12,801), followed by french bean-wheat (Rs. 12,750) and finger millet-wheat (Rs. 9208) systems. The estimated BCR for potato-wheat was 1.38, for french bean-wheat 2.58 and for finger millet-wheat 1.22 (Shanthamalliah et al. 1982). According to Nair and Gopalasundaram (1990) potato, french bean and chillies followed by wheat were highly profitable crop sequences under Maidan/Plateu areas of Karnataka and they provided employment for 479 days/ha/year.

Vegetables

At Kasaragod, a second generation intercropping trial was initiated from 1989 involving several vegetables in sequence in mature coconut stands. Brinjal, amaranthus and snakegourd during rainy season (*Kharif*), bottlegourd in winter (*rabi*) and brinjal, amaranthus and chillies in summer were found to be remunerative intercrops under Kasaragod condition (Anonymous, 1990).

MIXED CROPPING

The systematic feasibility studies on mixed cropping in coconut gardens were initiated at different Coconut Research Stations during the seventies and eighties involving several perennial crops. The findings of these trials revealed that the coconut mixed cropping with compatible perennials like cacao, black pepper and tree spices were highly rewarding, while some other perennials like mango, jackfruit, breadfruit, papaya and coffee (var. San Ramon) were so far not successful. The following discussions centres round the economically prospective mixed crops.

Cacao

At Veppankulam a trial was carried out in 20 year old coconut gardens with cacao var. Criollo during 1969 but it failed for several reasons like malformations and premature dropping of pods, large-scale occurrence of fruit rot, occurrence of mealy bugs and shortage of water, besides the lack of marketing facilities. The estimated cost of cultivation of cacao was Rs. 1212/ha/year while the income was as small as Rs. 519/ha/year (Ramanathan et al., 1982).

Cacao var. Forastero was planted at Kasaragod during 1970 in single hedge (350 plants) and double hedge (600 plants) systems in loamy soil in a 14-year old coconut plot spaced at 7.5 m x 7.5 m and this experiment was brought under irrigation. The mean yield of wet bean per ha. per year was 652 kg for single hedge and 801 kg for double hedge system. The yield of coconut palms also showed a significant increase (Nelliat et al., 1979). The economic analysis of this system revealed that the net return from cacao grown in the interspaces of coconut in single hedge amounts to Rs. 2900/ha/year while the coconut-cacao system as a whole promised a net return of Rs. 16,500/ha/year at 1981-82 prices (Das, 1984). In another study, Das and Vijayakumar (1990) have estimated the monetary advantage of Rs. 14,920/ha/year for this system.

At Pilicode, a similar experiment was laid out in a 50 year old coconut plot spaced at 9 m x 9 m in which cacao natural hybrid of *Forastero* and *Criollo* were planted. The yield data showed that during the period 1976–83, the average dry bean production was the order of 165.4 kg. in single hedge and 377.6 kg in double hedge system. The mean yields of coconut in single hedge cacao plot and double hedge cacao plot were 8090 nuts and 7800 nuts per ha per year against 8108 nuts in the plot without cacao. The average net return from cacao worked out to Rs. 2542 and Rs. 5880 per ha per year under the single and double hedge systems, respectively, at the respective prices prevailed during 1976–83 (Khader, Rajamoney and Balakrishnan, 1984). However, the net return from the coconut+cacao (double hedge) was Rs. 14,300/ha/year compared to Rs. 6,050/ha/year for coconut mono-crop (Nambiar et al., 1988).

Pepper

In 1971-72, black pepper var. Panniyur I was planted and trailed on coconut palms aged over 60 years in one ha plot at Kasaragod. Though the highest yield of 5.5 kg dried berries per vine was recorded, the mean yield was 2 kg (Anonymous, 1977). At the present rate of market prices, the net return from this combination could be somewhere around Rs. 30,000/ha/year (Das, 1990).

Tree spices

The feasibility studies on clove, nutmeg and cinnamon as intercrops in coconut stands were initiated at Kasaragod during 1970. In this trial, one plant of a tree spice was planted in the centre of four coconut palms. Cinnamon however, was not a success as the quality of the bark was not good and therefore, there was no demand for it though each plant gave an yield of 82 g of quills and 30 g chips (Anonymous, 1979). It is estimated that coconut + clove mixed cropping system could give a net return of Rs. 46,800/ha/year at current price against Rs. 23,200/ha/year in the case of coconut monocrop raising under irrigation. Similarly, one could expect a net return of as high as Rs. 95,300/ha/year from coconut + nutmeg mixed cropping system raised under very ideal management (Nair et al., 1991).

Mulberry

An observation trial to study the feasibility of growing mulberry in coconut gardens was laid out for three years from 1978 at Arsikere in Karnataka. The results indicated that growing mulberry as a mixed crop had no adverse effect on the growth and productivity of coconut crop. The economic analysis revealed that the net return by growing mulberry with coconut was Rs. 26,248/ha/year against Rs. 7,800 in the case of coconut monocrop (Shanthamallaiah et al., 1982). As reported by Nair and Gopalasundaram (1990) by integrating sericulture with coconut, an additional employment of 128 mandays/ha/year could be generated and 375 kg of cocoons produced from one ha coconut + mulberry system.

MULTISTOREYED CROPPING

Nelliat (1979) reported about an experiment which was laid out at Kasaragod in a coconut garden above 20 years old in 1970 with a population of 175 coconut, 175 black pepper, 400 cacao and 10,600 pineapple per ha. The entire block was given irrigation. The average output from the four crops were recorded as 17,000 coconuts, 300 kg dry cacao beans, 60 kg dry berries of pepper and 4,000 kg pineapple/ha/year.

The economic analysis of this system under the 1988 market situation suggests that this combination could generate a net return of Rs. 30,300/ha/year while the net return realisation from an irrigated middle aged coconut sole crops was Rs. 23,200/ha/year. The benefit-cost ratio in this system was 1.76 and the internal rate of return was higher than 20% (Das, 1989a).

The multistoreyed cropping experiment involving coconut, black pepper (using coconut as live standard), cacao (single and double hedge) as well as pineapple was also carried out at Pilicode during 1970 onwards. The estimated net profit from this system was Rs. 17,430/ha/year (Nambiar et al., 1988).

According to an estimate made by Das (1990) the labour input requirement in the case of multistoreyed cropping had increased at Kasaragod to 335 mandays/ha/year from 144 days/ha/year in irrigated coconut monocropping. This rise comes to as high as 133 per cent.

MIXED FARMING

As reported by Mathew and Shafee (1979) a mixed farming trial was initiated at Kasaragod in 1972 in an area of 1.04 ha holding 60 year old 191 palms. Hybrid napier and Brasilean lucerne fodder grass were planted in the interspaces of palms. While pepper was trailed on some coconut palms, banana, cassava and vegetables were raised on field bunds and along the border of the plot in a family farm pattern. Besides these crops, 4–5 number of milch cattle were integrated to the system and almost all the operations were carried out by a family unit.

The economics of this system when worked out at 1988 prices, showed a net return of Rs. 29,500/ha/year against a net return of Rs. 17,000/ha/year for coconut sole crop raised under irrigation with the similar age group of palms in Kerala situation (Das, 1989a). When the labour absorption potential of the mixed farming model at Kasaragod was assessed, it was found to be as high as 850 mandays/ha/year. This rise comes to 490% over irrigated coconut monocrop. Moreover, this system smoothed out the peaks and valleys of labour demand on the family farm to optimise their productivity (Das, 1990).

CONCLUSION

The feasibility studies have shown that most of the annuals, biennials and perennials

tried under the coconut-based farming systems are compatible to coconut. Not only most of them were found beneficial to coconut productivity because of better management of the systems and consequential site enrichment; but also the productivity of those component species were often more than proportional to their cost of raising under various conditions. Hence, the coconut-based farming systems are capable of improving the financial status of the smallholder, while permitting him to use the available resources more efficiently. But the success of the farming systems depends on the choice of component species based on several factors, such as soil condition, weather, availability of water for irrigation, shade level, disease and pest hazards, varieties, time of planting, package of practices, size of holding, labour resource, management skill, access to capital and credit, market outlet, price behaviour, theft problem, pre-bearing period and domestic needs, besides the farmer's attitudes and goals. To sum up, the crop mix is the best way for smallholder coconut farming than monocropping.

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