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INTENSIVE FARMING PROGRAMMES FOR SMALL-SIZED COCONUT PLANTATIONS

by

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ABSTRACT

In the coconut growing tropics, the pressure on arable land is high because of increasing human population, and the average size of coconut holding is diminishing. However, the climatic conditions in these regions are congenial for high productivity and the coconut palm is amenable to intensive cropping with other compatible crops. Moreover, the basic resources of crop production - soil and solar energy - are not being utilised to the fullest extent in a pure palm stand.

With a view to maximising productivity per unit area of land and unit time in coconut plantations, various cropping programmes have been evolved and put to trial at CPCRI. These consist of coconut as the pivotal crop and compatible combinations of relatively short duration crops (intercropping), long duration crops (mixed cropping) and a multispecies crop community (multistoreyed cropping) which enables interception of light at different strata by crop canopies and effective 'soil harvesting' by their root systems at distinct zones. An integrated system of mixed farming based on the concept of a balanced plant-animal-human ecosystem, particularly suitable for small farmers is also being tested.

The advantages in terms of higher productivity, enhanced net returns, more favourable cost : benefit ratio, generation of additional employment potential, better efficiency in the use of water and other inputs, and synergistic effect and non-monetary inputs are discussed in this paper. Areas for future line of work have been indicated.

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1. INTRODUCTION

The coconut growing regions of tropics are characterised by a warm humid climate, plentiful sunlight and little variation between maximum and minimum temperatures round the year. Coincidentally, these regions are also characterised by exploding rate of population increase and consequent fragmentation of holdings and thus an increasing pressure on arable land. The average holding size of coconut farm is only 0.22 ha in India though it is much higher in other countries. Therefore, it has become imperative to enhance the productivity of land by resorting to more intensive cropping programmes in coconut areas.

Coconut palms are planted wide apart to accommodate the large canopy of the palm with a view to minimising the overlapping and mutual shading of the leaves. The palm density often ranges from 125 to 175 per ha although as many as 300 palms per ha are also met with. Realisation of the fact that the effective root zone of coconut is restricted to a few metres round the base of the palm, has persuaded the enterprising coconut farmers to raising other crops in the interspaces. As a result, growing other crops in the interspaces of coconut is not an unusual practice in many of the coconut growing countries, particularly in regions where the pressure on arable land is high as in India, where only less than 10 per cent of the area under coconut is maintained as pure crop. In other countries like Sri Lanka, where extensive plantations of coconut exist, intercropping is less popular although common grasses which naturally grow in the interspaces are utilised for grazing cattle. However, the crops raised are by and large non-compatible and the management practices adopted are inadequate. This, in general, results not only in the lowering of the productivity of the main crop of coconut, but also that of the inter or mixed crop that is grown in the area.

Accepting the need to practice inter and mixed cropping in coconut plantations, work on improving the production levels under the crop mix attracted the attention of research workers in the second half of the century. Improved management practices for such crop mixes were suggested. Intercropping the coconut plantations and evolving a proper system of management, according to Santhirasegaram (1967) depends upon the availability of soil moisture and adequate manuring. Trials at Kasaragod had shown that there was no adverse effect due to raising intercrops on the main crop of coconut, provided both the crops were adequately and separately manured. Similar results were reported by Celino (1963) from Philippines where money crops like vegetables, cassava, banana, coffee, pine apple and cacao were grown. Rodrigo and Mangabat (1964) presented data on the net returns to show that cacao in the shade of coconut was more remunerative than the coconut itself. Khan (1962) suggested diversifying coconut cultivation in India by mixed cropping with pepper, clove, nut meg and cacao. Ziller and Fremond (1961) discussing the manuring of the coconut palm stated that the presence or absence of pine apple made no difference in the response but potash fertilisation did.

In the light of the concept of multiple cropping in field crops that gained emphasis and popularity in the sixties, the feasibility of increasing agricultural production from coconut plantations where the land remains committed to the crop for decades, also received attention at the hands of the research workers. The programmes that are being persued in this direction in India and their prospects are discussed in this paper.

II. AMENABILITY OF COCONUT PALM TO INTENSIVE CROPPING - BASIC PRINCIPLES

Growth habits and crown shape of coconut palm necessitate a spacing of 7.5 x 7.5 m giving a plant population of about 175 palms per hectare. However, the studies conducted at Central Plantation Crops Research Institute (CPCRI), Kasaragod, have shown that the two basic resources of crop production viz. soil and solar energy are not being utilised to the fullest extent possible in a pure stand of coconut palms.

(i) Soil: The effective root zone of an adult bearing coconut palm, growing under normal management is confined laterally within a radius of 2 metres around the base of the palm and vertically within 30-120 cm depth from the soil surface (Kushwah et al. 1973). This would mean that at a planting distance of 7.5 m x 7.5 m between coconut palms, about 77% of the total soil area in a pure stand of coconut is not effectively utilised by the coconut roots.

(ii) Solar energy utilisation: Studies on the distribution of light profile in coconut plantation and the pattern of changes in the apparent coverage of ground by coconut canopy with increase in age of the palms have shown that during the early years of growth, the percentage of sunlight transmitted through the coconut leaves decreases gradually with increase in age till about 8 years after planting when the palm attains steady bearing. At this stage, the percentage transmission of light decreases to about 20%, and this remains almost constant till about 25 years. Subsequently, the percent light transmission increases progressively and the canopy coverage of ground decreases in an inverse proportion. Ultimately by the time the palms are about 40 years old, the light transmission increases to about 50% (Nelliat et al. 1974).

(iii) Water use efficiency: The amenability of coconut palm to intensive cropping through parallel combinations of compatible crops in the interspaces is revealed from the above analyses. In addition to these considerations, the water use efficiency also could be enhanced considerably under such a programme. For example, the total irrigation requirement of any crop at potential production level, is decided primarily by the evaporative demand of the climate pertaining to the area where the crop is grown. In other words, irrespective of the number of crops grown in an area, the water requirement of the area which depends primarily on the potential evapo transpiration, remains almost the same. Therefore, the water use efficiency of a mixed community of crops is greatly enhanced over that of a pure palm plantation.

(iv) Concept of balanced plant-animal-human ecosystem: The cropping programmes are usually centred around crops with human beings as entrepreneurs, but an integrated system of alternative husbandry involving human beings as the pivotal link of the whole unit also could be developed to suit the special conditions of diminishing farm size of the coconut farmers. A farmer with a small holding of around half hectare of coconut plantation, can maintain a few milch animals, on pasture legumes and grasses grown in coconut interspaces, which, in turn, are benefitted by the cowdung, urine, etc. A gas plant working with cowdung will meet the energy requirement of the farmer's family. Human wastes can also be added to the soil. Thus, an efficient organic recycling involving the whole ecosystem is possible.

III. SALIENT FINDINGS ON THE CROPPING PATTERNS TRIED

With the above principles in view, a few cropping patterns have been evolved and put to trial at the CPCRI. The programme involved coconut as the pivotal crop with combinations of relatively short duration crops (intercropping) or long duration perennials (mixed crops). An integrated system of mixed husbandry involving human beings and animals in addition to crops, based on the concept of a balanced ecosystem is also being tried. Salient features and findings on these are given below:

(i) Intercropping: Intercropping as applied and perennial plantations refers to the practice of growing annuals or other relatively short duration crops in the interspaces. A number of annuals and other short duration crops have been tried at CPCRI, Kasaragod. These included tuber crops, rhizome spices, pulses, upland rice, banana, pine apple, etc. Most promising among them were tubers and rhizome spices, their yield and economic considerations are given in Table 1. Owing to the relative short duration, relative ease of their management and high calory output of the tubers, they have great potentialities as intercrops. The pulses tried include green gram (Phaseolus aureus), black gram (Phaseolus mungo), horse gram (Dolichos biflorus), as well as soyabean (Glycine max). However, the performance of pulses has not been satisfactory. Pulses are known to require high intensity of light for proper grain production. Therefore, varieties adapted to low light conditions may have to be evolved. On the other hand pine apple and banana performed very well (CPCRI 1972, 73, 74).

Table 1: Yield and Economic considerations of intercropping (1973-74)

Intercrop	Scientific name	Variety	Yield (t/ha)		Net return per unit amount of cost of cultivation	Energy equivalent of harvested produce/ha* (million K Cal.)
			Gross area of coconut	Net area of intercrop		
Elephant foot yam	Amorphophalus companulatus	Local	12.85	16.06	1.28	10.15
Cassava	Manihot utilissima	H. 165	10.51	11.90	1.37	16.50
Sweet potato	Ipomoea batatus	H. 42	9.53	13.61	1.00	11.46
Yam	Dioscorea alata	Local	12.72	15.90	1.70	17.14
Lesser yam	Dioscorea esculenta	Local	9.00	11.25	1.29	12.06
Coleus (Chinese potato)	Coleus barbatus	Local	6.00	9.23	1.83	2.94
Ginger	Zingiber officinarum	Rio-de-Janeiro	11.57	17.80	2.46	7.75
Turmeric	Curcuma longa	Armoor	12.93	19.90	0.29	11.25

* hectare gross area of coconut plantation

(ii) Mixed cropping: Mixed cropping is the practice of growing perennials in the interspaces. The important crops tried are cacao (Theobroma cacao), cinnamon (Cinnamon zeylanicum), nutmeg (Myristica fragrans), clove (Eugenia caryophyllata) and black pepper (Piper nigrum). Based on the results obtained so far, the most promising among them is cacao. In a mixed cropping experiment of coconut and cacao at CPCRI, there was considerable increase in the yield of coconut over the pre-experimental yield (CPCRI 1973, 74).

Increase in total productivity per unit area from crop combination of coconut and cacao is given in Table 2. The increase in productivity has been attributed to the synergistic effect of the compatible crop combination and a few components of non-monetary inputs involved have also been identified (Nair et al. 1975). Tree spices such as cinnamon, nutmeg, clove, etc. also have been found to grow well as compatible mixed crops with coconut.

(iii) Multistoreyed cropping: In order to further intensify the cropping intensity, multistoreyed crop combination consisting of crops of varying canopy orientations and rooting habits have also been evolved (Nelliat et al. 1974). Such a combination enables interception and utilisation of light at different vertical intervals and facilitates "soil harvesting" by the root system in distinct layers and columns. One such combination is coconut + black pepper + cacao + pine apple. Coconut, spaced 7.5 m apart and growing 20 to 30 m tall functions as the top floor of this crop building. The second floor crop of pepper develops the canopy on the coconut trunk at a height of 3 to 8 m. Cacao which grows to 1.5 m to 2.5 m height forms the first floor and pine apple with its shallow root system constitutes the ground floor. This way, in an existing coconut plantation of 175 palms per ha, 800 cacao plants and 3500 pine apple plants could be accommodated in addition to the black pepper vines trailed on to each coconut palm. Table 3 gives the yield of some of the crops in an observatory trial initiated in 1970. More systematic experiments of this nature have been initiated in 1972.

(iv) Mixed farming: Experiment on mixed farming was initiated at CPCRI, Kasaragod in 1972 with the main objective of determining the optimum size of the viable family farm. A dairy unit of a few milch animals are maintained, the animals are fed with fodder grass (Hybrid Napier) and legumes (Stylosanthes gracillis) cultivated in the interspaces. Black pepper vines are trailed on to coconut trunk. The whole unit is looked after by a farmer and his family and the cost-income analysis is made according to economic principles. The results of the past two years indicated

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Table 2: Total productivity of coconut and cacao in a four year old mixed cropping experiment

Treatment	Plant population per hectare		Average yield of coconut palm (nuts/palm/year)			Annual increase in productivity per ha over the pre-experimental level	
	Coconut	Cacao	Before planting cacao	After planting cacao	Response	Coconut (no. of nuts)	Cacao (dry beans kg.)
Coconut alone	175	—	73.25	120.39	47.14	8249	—
Coconut + single hedge cacao	175	350	66.50	112.03	45.53	7932	200
Coconut + double hedge cacao	175	650	50.45	108.95	58.50	10237	275

Table 3: Yield data during 1973-74 of different crops in an observational trial on multistoreyed cropping at CPCRI initiated in 1970

Sl. No.	Treatment	Gross area Sq.m.	Coconut			Cacao		Total yield of pine apple (kg)
			No. of palms	Yield of nuts per palm/year		No. of plants	Total no. of pods harvested	
				Pre-treatment average	Average for 2 years 1972-73 & 1973-74			
1.	Coconut + cacao	1000	26	57.92	82.40	77	310	—
2.	Coconut + pine apple + cacao	1000	20	61.35	87.53	75	945	402
3.	Coconut + cacao + pepper	910	17	57.50	73.25	68	834	—
4.	Coconut + cacao + pepper + pine apple	920	15	50.16	65.79	50	411	192

that yield of coconut palms in the experimental plot has increased by 29%. Even without accounting for this, the input-output relationship worked out to 1 : 1.2. The employment potential generated by way of the labour of the farmer and his family worked out to about 1000 man-hour per year per hectare.

IV. ADVANTAGES OF THE SYSTEM

(i) Higher productivity: The programme is itself directed towards the goal of attaining maximum productivity per unit area of land and time. In attaining this even a little decline in production of coconut or the main crop cannot be reckoned as a serious handicap, provided the total productivity per unit area is enhanced in the process. However, in all the cropping patterns tried (elucidated earlier), the yield of coconut has in most cases increased, as a result of the synergistic effect of the crop combination (Nair et al. 1975). The magnitude of the increase in productivity can be seen from the fact that the yield of intercrops and mixed crops raised in the interspaces is an additional item of production (Table 2). In the case of intercropping the total area available for intercrops is about 70-80% of the gross area of plantations (Nair et al. 1974). Therefore, the yield of intercrops on unit areas basis (Table 1) is about 75% of the yield of pure crop of the same species.

(ii) Enhanced returns: The increase in productivity is often more than proportional to the expenses and consequently the net return per unit amount of investment is considerably enhanced. The advantages of these cropping systems in terms of better water use efficiency have already been discussed earlier. Other inputs, like fertilisers are also utilised more efficiently in these crop mixes. Some of the cultural operations like irrigation, care of plants etc. are common to all the species involved in the crop mix and certain others such as intercultivation can be even dispensed with.

(iii) Employment potential: The generation of employment potential through the intensive cropping is substantial. Under South Indian conditions, the total labour requirement for the maintenance of a hectare of adult bearing coconut plantation is estimated to be 150 man days per year whereas in a multistoreyed crop combination of coconut + pepper + cacao + pine apple, the total labour requirement per year is 600 and in a mixed farming unit, it is more than 1000. Thus the feeling of inertia resulting from underemployment of a small farmer who cultivates only one crop can be overcome by intensive cropping. Moreover, under conditions of monoculture, a farmer runs the risk of market glut resulting in low prices for produce. On the other hand, crop diversification is an insurance against such a risk and helps to keep the farmer and his family better occupied for greater part of the year.

(iv) Non-monetary inputs: Intensified research on various aspects of new and even existing crop combinations may open up new vistas in management by exploitation of non-monetary inputs which have so far remained hidden. For example, preliminary investigations on the rhizosphere micro-organisms of the coconut-cacao

mixed cropping plots have revealed the presence of beneficial micro-organisms such as free nitrogen fixers (Beijerenkia sp.) phosphate solubilisers (Pseudomonas sp. and Aspergillus sp.) and Indol Acetic Acid Synthesizers (Escherichia sp., Aspergillus flavus and Aspergillus fumigatus) in the rhizosphere of coconut and cacao, their number being more when plant population of cacao (mixed crop) was more (Nair, 1974). Similarly, the microclimate of the irrigated coconut cacao systems was reported to be mild as compared to that of pure stand of coconut palms (Balakrishnan et al. 1975). The available nutrient status, particularly that of phosphorus was also more under this crop combination (Nair, P.K.R. - unpublished data). These are some of the identified aspects of non-monetary inputs of this particular crop combination. More elaborate studies on these and other aspects of different cropping systems are warranted.

V. FUTURE LINE OF WORK

(i) Evolving varieties suitable for cropping: In crop combinations involving coconut as base crop, the palm utilises the land and light to varying extents. Since the demand for light by coconut palm is relatively more than for land space, it is obvious that species to be interplanted with coconut should be those which are capable of coming up under low light intensity. This is amply clear from success that has been obtained with cacao which is one crop requiring shade to some extent. Very systematic trials with varieties of different crop plants to isolate those adaptable to low light have to be taken up. Even within certain groups of plants (eg. pulses) which do not come up well under low-light conditions it may be possible to evolve varieties adaptable to such conditions.

(ii) Crop mix and rotation studies: The efficient use of the land in coconut will depend upon not only the growing of a few crops but also identifying favourable combinations. There are sequences in growing the crop as well as related management aspects of these crop combinations which have great influence on total productivity of the land and food needs of the farmer. While grass and legumes for basing a dairy programme in coconut are possible, integration of a production programme of tubers which will meet at least a portion of the calory requirement of the family will be most welcome. The effort has to be maximisation of the net return with built in mechanism for the maintenance of soil structure and fertility. This will mean that a plant-animal-human ecosystem, mutually complementing and supporting in production line, should be worked out at the micro level of the average farmer.

(iii) Detailed study on the compatibility of crop combinations: Indications are available that certain crop combinations like cacao and coconut can have synergistic effect which enhances cost : benefit ratio. Soil microflora, soil nutrient mobilisation, the microclimate that comes up in such crop mixes and

other interactions in totality for all areas are to be worked out in greater depth in order to understand the mechanism of the favourable effect of these crop combinations.

(iv) Change in the existing management practices: The conditions existing in the farmers' fields that have been already planted up with coconut vary very widely both in relation to spacing of coconut and other plant species. The study of the situation for effecting an appropriate change over will be necessary so that the recommendations could be made according to the actual conditions available in the field.

A coconut farmer, who is at present a monoculturist, when introduces other crops like cacao and tuber crops on his farm, has to be thoroughly trained in the management aspects as well as post-harvest technology of each of these species. The farmer should be ever alert and vigilant to safeguard his crops from biological hazards and management pitfalls. Yet the programme has tremendous potential and looks feasible and commendable.

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