



Crop combination of coconut and cacao

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CROP DIVERSIFICATION IN COCONUT PLANTATIONS

THE coconut-growing regions all over the world are characterized by a warm humid climate, plentiful sunlight and little variation between maximum and minimum temperatures round the year. These regions are also characterized by high rate of population increase and increasing pressure on arable land. Therefore it has become imperative to increase productivity of land by resorting to more intensive cropping programmes in these areas. In the light of the concept of multiple cropping in field crops that gained emphasis and popularity, the feasibility of increasing agricultural production from coconut areas has received attention of research workers. Whereas sequential combination of crops of same or different species in quick succession is one of the aspects of the strategy of multiple cropping in annuals, parallel combinations of compatible crops of other species is the strategy to be adopted

for perennials like coconut where the land remains committed to the crop for decades. Thus, multiple cropping in plantations amounts to crop diversification.

It is a common practice in Kerala to grow other crops particularly annuals in the interspaces of coconut palms. However, this is often done without proper care and attention to fertilization and other management aspects with the result that the yield of coconut as well as that of the intercrops is often very low. Studies conducted at the CPCRI, Kasaragod, have shown that a large number of crops can be profitably cultivated in the interspaces without any adverse effect to the palms provided proper attention is paid to manage the individual species of the crop mix adequately and separately.

Growth habits and canopy shape of the coconut palm necessitate a wider spacing (7.5 m × 7.5m) for

them and therefore larger interspaces. But the active root zone of the palm extends laterally to an area of 2 m around the palm. On area basis, this would mean that over 75 per cent of total soil mass is not being utilized effectively by coconut roots.

Further, during the early stages of growth of the palms and after about 25 years of age, major portion of the incident solar energy is not intercepted by coconut leaves. Making use of this unintercepted sunlight, various crops adaptable to such conditions can be grown in the interspaces of coconut palms except during the period between 8 to 25 years of age of the palms.

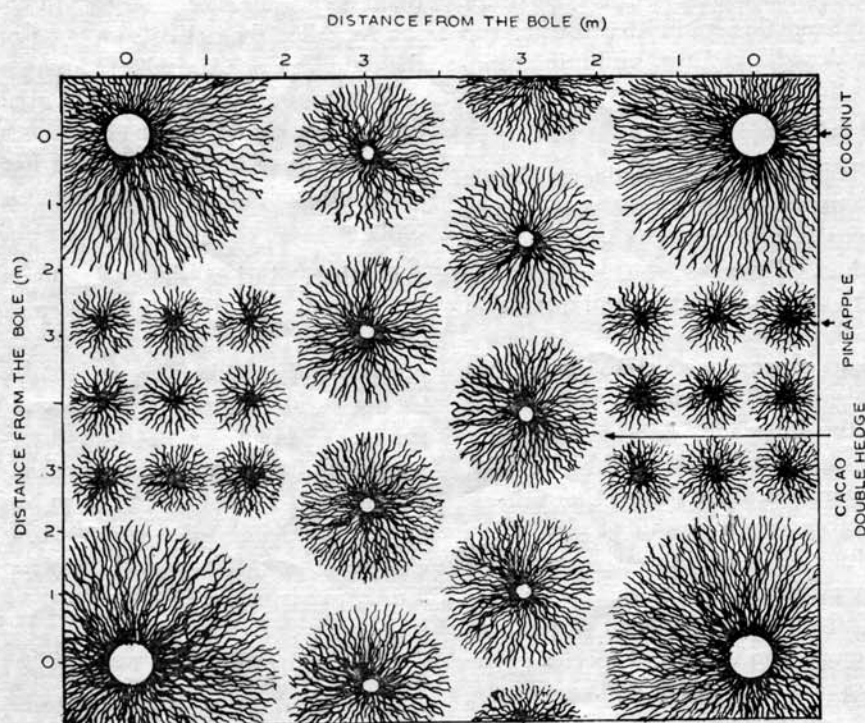
Intercropping Trials. A large number of annual and perennial crops have been tried for feasibility studies to evolve different crop combinations with coconut. Among these, the annuals and other relati-



Multi-storied crop combination of coconut + pepper + cacao + pineapple

vely short-duration crops used for intercropping included tuber crops (tapioca, elephant yam, yams, sweet potato, etc.), rhizome spices (ginger and turmeric), pulses (black-gram, horse-gram, green-gram), upland

rice, banana, pineapple, etc. Owing to the relative short duration, comparative ease of management and high calory output of the tubers, they have great potentialities as intercrops as already mentioned in



Schematic representation of pattern of horizontal root distribution of the multi-storied crop combination—Courtesy: *World Crops*

an earlier article in *Indian Farming* (July 1974, pp. 11-13).

Mixed Cropping. Mixed cropping as applied to plantation crops is the practice of growing perennials in the interspaces. The important crops tried are cacao (*Theobroma cacao*), and tree spices such as cinnamon (*Cinnamomum 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. Cacao can be planted as a double hedge of two rows in between the rows of coconut. The distance between cacao plants in a row is 3.0 m and the rows are spaced 2.5 m apart. The cacao plants in adjacent rows alternate in triangular positions, and thus 600 cacao plants can be accommodated per hectare of coconut plantation. In a mixed cropping experiment of coconut and cacao at the CPCRI, there was up to 55 per cent increase in the yield of coconut when cacao was grown with coconut as compared with pure palm stand. The yield response of palms of various yield groups is given in Table 1. This increase in productivity has been attributed to the beneficial effect of crop combination. The activity of the beneficial micro-organisms (like free nitrogen fixers, phosphate solubilisers and toxin synthesisers) in the rhizosphere and the available major nutrients (N, P and K) in the active root zone were more in the crop mix as compared with pure palm stand.

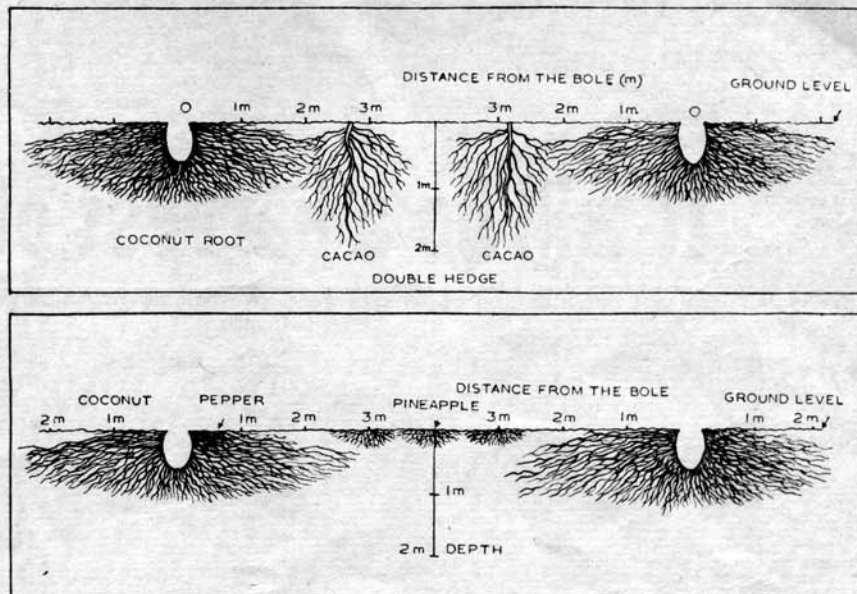
Multi-storied Cropping. To increase the cropping intensity, multi-storied crop combination consisting of crops of varying canopy orientations and rooting habits have also been developed. One such combination is coconut + black pepper + cacao + pineapple. Coconut palms grown at a height of 10 to 30 m forms the top floor of this crop building. Black pepper which is trailed on coconut trunks up to 6 to 8 m with little lateral spread forms the second floor. Cacao with a canopy height of 1.5 to 2.5 m and pineapple having a

relatively lesser stature constitute the first and ground floor, respectively. This way, in an existing coconut plantation of 175 palms/ha, 600 cacao plants and 3,500 pineapple plants can be accommodated in addition to the black pepper trailed on each palm.

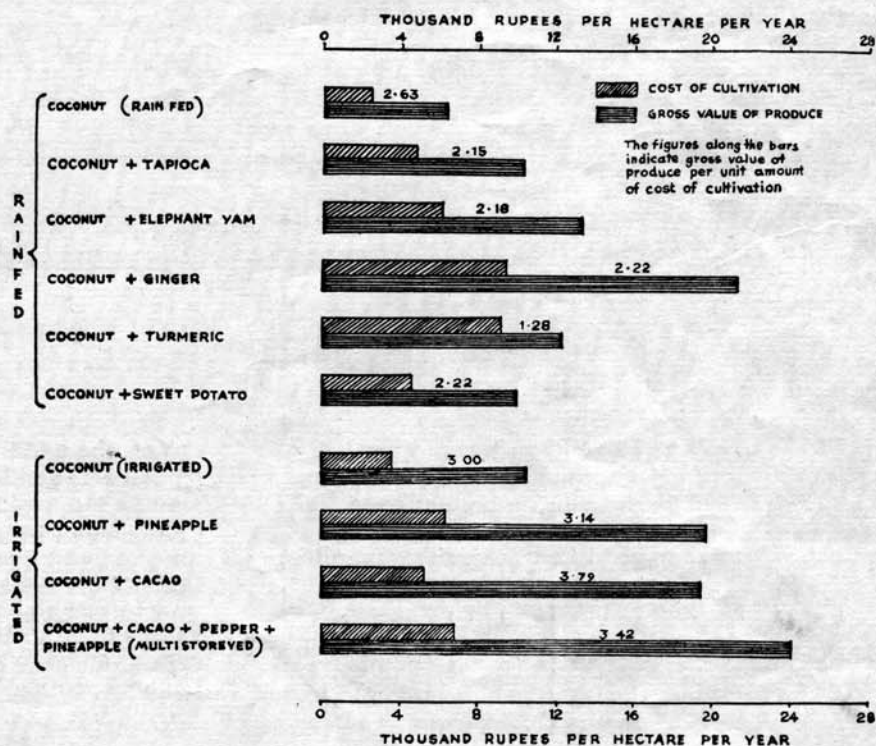
Agronomic Desirabilities. In such high intensity cropping programmes, a higher efficiency in the utilization of solar energy incident on a given area is obtained as it is intercepted at vertical intervals by the canopies of these crops. Rooting patterns of these crops are also mutually exclusive horizontally as well as vertically. Water use efficiency could also be enhanced considerably under such a programme, because the total irrigation requirement of any crop at a potential production level is decided primarily by the evaporative demand of the climate pertaining to the area. Therefore, irrespective of the number of crops grown in the area, the water requirement of the area remains almost the same. Similarly, the expenses on weed control and inter-cultivation which is a major component of cost of cultivation of a pure palm stand can be totally dispensed with.

Input Requirements. The requirements of inputs such as fertilizers and other agrochemicals, human labour, etc., per unit area are also correspondingly high in such intensive cropping programmes. Table 2 gives the requirement of fertilizers and human labour per hectare per year of a multi-storeyed crop combination.

Economic Advantages. Such cropping programmes enable to raise the productivity from the land considerably. An example is given in Table 3. The magnitude of this increase can be seen from the fact that the yield of inter-crops or mixed crops raised in the interspaces is an additional item of production. This increase in productivity is often more than proportional to the expenses and consequently the net return per unit amount of investment is considerably



Schematic representation of pattern of vertical root distribution of the multi-storeyed crop combination—Courtesy: *World Crops*



Economics of various crop combinations with coconut at full bearing stage

enhanced. The cost of cultivation and gross income per hectare of different crop combinations at the full bearing stage are given in the Fig. above. The gross return per rupee invested in each case is also indicated. The generation of employment potential

through the intensive cropping is even more 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

TABLE 1. YIELD RESPONSE OF COCONUT PALMS OF VARIOUS YIELD GROUPS WHEN MIX-CROPPED WITH CACAO

Yield group of palms No. of nuts/ palm/yr	Yield of nuts per palm per year								
	Pure palm stand*		Coconut + single hedge cacao			Coconut + double hedge cacao			
	Pre-exptl	Exptl.	Response	PEY	EY	R	PEY	EY	R
30	19	57	38	22	74	52	15	85	69
30-60	50	125	75	42	141	95	53	118	68
60	88	178	90	83	170	87	78	190	111
Mean	73.3	120.4	47.1	66.5	112.0	45.5	50.4	109.0	58.5

PEY—Pre-experimental yield
EY—Experimental yield
R—Response

*The increase in yield of coconut during the experimental period is due to better management practices such as irrigation and increased dose of fertilizers introduced after the commencement of the mixed cropping experiment.

TABLE 2. INPUT REQUIREMENTS (FERTILIZERS AND HUMAN LABOUR) PER HECTARE OF A MULTI-STOREYED CROP COMBINATION AT FULL BEARING STAGE

Crops	per plant (g)			Nutrients per year per hectare (kg)			Number of man days per year
	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	
Coconut	1,000	640	2,400	175	112	420	100
Cacao	100	40	140	60	24	84	70
Pepper	100	40	140	18	7	25	20
Pineapple	6	4	6	24	16	24	50
Common	..	..	..	..	..	..	120
Total	..	..	..	277	159	553	360

TABLE 3. ANNUAL PRODUCTIVITY PER HECTARE OF A MULTI-STOREYED CROP COMBINATION

Crop	No. of plants/ha	Productivity/ha		Rate	Gross value Rs/ha
		Units	Quantity		
Coconut	175	No. of nuts	1,7500	Rs 60/100	10,500
Cacao	600	Dry beans (kg)	750	Rs 12/kg	9,000
Pepper	175	Dry pepper (kg)	100	Rs 8/kg	800
Pineapple	3,500	Fresh fruits (kg)	5,000	Rs 75/100 kg	3,750
		Total			24,050

multi-storeyed crop combination as illustrated above, the total labour requirement per year is 360. Thus the feeling of inertia resulting from under-employment of a small farmer who is a monoculturist of coconut can be overcome by intensive cropping. Moreover, under conditions of monoculture, the farmer runs the risk of market glut resulting in low price for the produce. On the contrary crop diversification is an insurance against such a risk and helps to keep the farmer and his family occupied for greater part of the year.

AN ICAR PUBLICATION

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By Usha Ganguli

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