INTERCROPPING WITH TUBER CROPS IN COCONUT GARDEN

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ABSTRACT

Intercropping in coconut stands with tubers revealed that raising tuber crops has no adverse effect on the main crop of coconut, provided, the same intercrop was not grown on the same plot every year and that both the inter crop and the main crop were manured adequately and separately. A five per cent increased yield of coconut over pre-experimental yield was obtained when tapioca, elephant yam, sweet potato, ginger and turmeric were grown in rotation as intercrops and 15% increase when greater yam, lesser yam, colocasia, and chinese potato were rotated. Tapioca, cultivar M-4 yielded 4.5 t/ha when grown continuously in the same plot as against 6.3 t/ha when it was alternated with elephant yam. Similarly, yield of elephant yam increased from 6.4 t/ha (continuous crop) to 11.8 t/ha (in rotation with tapioca). Further improvement in the yield of these crops was noticed in five year rotations. Among the intercrops, elephant yam and ginger were the most profitable. Besides giving higher net returns per unit area, intercrops generated additional employment to the tune of about 130 man days/ha/year.

INTRODUCTION

Coconut is essentially a small farmer's crop, the average size of holding being 0.22 ha. The fast increasing population makes it imperative to find ways and means of maximising the agricultural production per unit cultivated area and generating additional employment opportunities in the rural areas. The desirability of raising annuals or perennials in the interspace of coconut and the advantages of such practices were reported by Nelliat (1973), Nair *et al.* (1974) and Nair and Varghese (1976). The garden lands of the humid tropics respond to intensive management, but require

location-specific agrotechniques to achieve high and desirable production levels (Nelliat, 1976).

Under irrigated conditions, competition among the crops grown in the crop-mix can be overcome by judicial input management. In rainfed agriculture where a definite spell of dry weather prevails, seasonal crops are raised as intercrops to suit the rainfall pattern. If these intercrops continue to be in the field beyond the rainy season, the adverse effect and mutual competition have to be assessed and corrected, wherever possible. Reduction in the productivity of the main crop of coconut and that of the intercrops may result, if management practices were inadequate and incompatible intercrops were chosen. Hence, the present study had the following objectives.

(i) finding out the adverse effect, if any, on the main as well as subsidiary crops when tubers are intercropped in coconut stands either continuously or in rotation with other tubers.

(ii) to study the relative profitability of intercrops in coconut stands, and

(iii) to estimate the additional employment generated by such practices.

Material and Methods

Four field experiments were conducted in the experimental farm attached to the Central Plantation Crops Research Institute, Kasaragod. The data on the rainfall and other weather parameters prevailing at Kasaragod are furnished in Table 1. The soil type was red loam with 77% coarse sand, 3% fine sand, 2% silt and 18% clay. The intercrops were raised in the existing coconut plantations and the management practices followed for the different intercrops are summarised in Table 2.

Experiment 1: *Effect of raising intercrops in coconut garden.* Elephant yam and tapioca were raised in coconut stand to study their influence on the yield of coconut. The following were the three treatments.

T_1 — No intercrop-coconut manured

Table 1. *Climatic parameters at Central Plantation Crops Research Institute, Kasaragod—Mean* 1974–1977

Months	Rainfall (mm)	Maximum air temperature (°C)	Minimum air temperature (°C)	Relative humidity (%)	Sunshine hours per day	Evaporation USWB Pan (mm/day)
January	—	31.0	19.3	83.8	9.8	4.6
February	—	31.1	21.2	88.3	9.8	5.1
March	16.8	32.1	23.4	88.3	9.7	5.6
April	35.0	32.7	25.0	84.3	9.4	5.8
May	165.1	31.9	24.4	83.3	8.0	5.1
June	821.4	29.6	23.3	90.5	4.5	4.1
July	1338.5	28.1	23.1	92.8	2.0	2.4
August	616.3	28.4	22.9	93.3	4.2	2.8
September	345.2	29.2	22.9	92.8	6.2	3.6
October	202.4	30.4	22.8	91.5	6.7	3.6
November	106.4	31.1	21.7	89.5	8.0	3.8
December	12.7	32.3	19.8	81.0	9.7	4.5

Table 2. *Cultivation practices followed for various intercrops*

Intercrops grown	Scientific name	Variety	Method of planting	Spacing	% of gross area utilised by inter crop	Fertiliser dose kg/ha		Basal dose of cattle manure t/ha of coconut	Method of application of fertilisers
						As pure crop $N:P_2O_5:K_2O$	Per ha of gross area of coconut $N:P_2O_5:K_2O$		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Tapioca	*Manihot esculenta*	M4	Mounds	0.9×0.9m	80	100:100:100	80:80:80	8	Two equal doses first at the time of sprouting and second after 60 days.
Elephant yam	*Amorphophalus companulatus*	Local	Pits	1×1m	80	60:60:120	48:48:96	8	P, K and ½ N at sprouting ½ N 30 days later.
Sweet potato	*Ipomoea batatas*	H42	Ridges & furrows	50 cm between ridges	70	75:50:75	52.5:35:52.5	7	N two splits half basal and half 30 days later

Table 2. *Contd.*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Ginger	*Zingiber officinale*	Maran	Beds of 1m width	20 cm between plants in rows	65	100:100:200	65:65:130	6.5	P and K basal, N two splits 60 and 120 days after planting
Turmeric	*Curcuma longa*	Armour	Beds of 1m width	20 cm between plants in rows	65	100:100:200	65:65:130	6.5	P and K basal, N two splits 60 and 120 days after planting
Yam	*Dioscorea alata*	Local	Pits	1m×1m	80	80:80:120	64:64:96	8	Same as for elephant yam
Lesser yam	*Dioscorea esculenta*	Local	Pits	0.75×0.5m	80	80:80:120	64:64:96	8	Same as for elephant yam
Chinese potato	*Coleus parviflorus*	Local	Beds of 1m width	20 cm between plants	70	60:60:100	40:40:65	6.5	Same as for ginger

T_2 — Intercropping with elephant yam/tapioca—only intercrop manured.

T_3 — Intercropping with elephant yam/tapioca—both intercrop and main crop manured.

The plot size was 0.10 ha and the coconut palms were aged over 50 years. There were two replications and the intercrops were sown/planted in April-May and harvested in November and December.

Recommended package of practices were followed and the data on the yield of coconut and tuber yield of intercrops were recorded.

Experiment 2: *Intercrop grown continuously and in rotation.* Yields of coconut and intercrop, in plots where tapioca and elephant yam were grown as intercrops in the same plots over several years, was compared with those in plots where the above intercrops were raised in a two-year rotation. The treatment details were:

1. Control (no intercrop)
2. Tapioca (every year—no rotation)
3. Elephant yam (every year—no rotation)
4. Tapioca and elephant yam (alternate year by rotation)
5. Elephant yam and tapioca (alternate year by rotation).

The difference in T_4 and T_5 was the choice of the first year intercrop only. Individual plot yields of intercrops and the main crop of coconut were recorded. The plot size was 0.2 ha.

Experiment 3: *Five crop five year rotation of intercrops.* Effect of a five-year rotation with five intercrops in coconut gardens was studied. The following were the treatments.

Plot No.	Sequence of rotation				
	1st year	2nd year	3rd year	4th year	5th year
1	Tapioca	Sweet potato	Elephant yam	Ginger	Turmeric
2	Sweet potato	Ginger	Tapioca	Turmeric	Elephant yam
3	Ginger	Tapioca	Turmeric	Elephant yam	Sweet potato
4	Elephant yam	Turmeric	Sweet potato	Tapioca	Ginger
5	Turmeric	Elephant yam	Ginger	Sweet potato	Tapioca

The experiment was laid out in a RBD with three replications in plots of over 0.10 ha.

Experiment 4: *Feasibility trials.* Other tuber crops like greater yam (*Dioscorea alata*), lesser yam (*D. esculenta*), chinese potato (*Coleus parviflorus*), Colocasia (*Xanthosoma sagitifolium*) were raised as intercrops by rotation in middle aged coconut stands since 1973–74 to assess their performance and adverse effect, if any, on the main crop of coconut.

An area of 2 m radius around the base of coconut was left without any intercrop in all the above experiments to facilitate fertiliser application to coconut as per the normal practice.

Results and Discussion

Data on the mean annual yield of nuts/palm in different treatments are presented in Tables 3 and 4 and Fig. 1.

In experiment 1, there was a general reduction in the yield of coconut which had crossed their prime bearing age. But there was no such reduction when both the intercrop and the main crop were manured as per the recommended package of practices. The greater reduction in the yield of coconuts (16 nuts/palm/year) when the intercrop alone was manured (T_2) compared to that in the treatment where there was no intercrop (9.7 nuts/palm), was due to the competition for nutrients between the

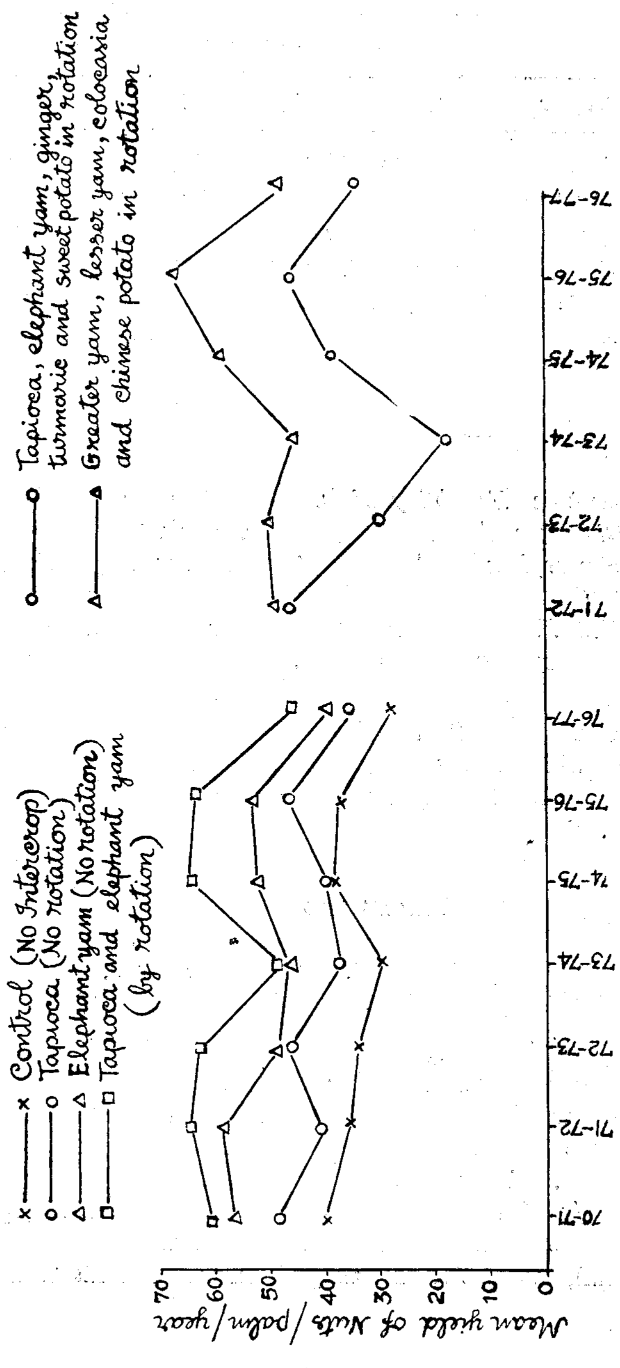


Fig. 1. Yield of coconut intercropped with tuber crops

Table 3. *Effect of raising intercrop in coconut gardens—Yield data for main crop and intercrop*

Intercrop	Treatment	Mean annual yield of coconut				Response		Mean yeild of intercrop (1967–70)
		Pre-treatment 1964–67		Treatment 1968–70				
		per palm	per ha	per palm	per ha	per palm	per ha	t/ha
Elephant yam	T_1 —No intercrop coconut manured	47.0	8225	38.4	6720	—8.6	—1505	—
	T_2 —Intercrop alone manured	49.2	8610	33.1	5793	—16.1	—2817	8.41
	T_3 —Both crops manured	31.9	5583	36.2	6335	+4.3	+752	9.18
Tapioca	T_1 —No intercrop coconut manured	46.5	8138	35.8	6265	—10.7	—1873	—
	T_2 —Intercrop alone manured	50.1	8768	34.0	5950	—16.1	—2818	2.85
	T_3 —Both crops manured	33.0	5775	33.4	5845	+0.4	+70	5.08

Table 4. *Yield of coconut during pre-experimental and experimental period under different treatments*

Sl. No.	Treatment	Mean yield of nuts/palm/year							Yield of nuts		Response		Percentage increase (+) or decrease (—)
		1970-71	71-72	72-73	73-74	74-75	75-76	76-77	Pre-expt.* period	Expt.** period	nuts/palm	nuts/ha	
1	Control (no intercrop)	50.5	45.8	45.1	40.1	48.8	48.2	38.7	48.2	45.2	—3.0	—525	—6.2
2	Tapioca (every year no rotation)	58.8	50.8	56.7	48.0	50.3	57.5	45.8	54.8	51.2	—3.6	—630	—6.6
3	Elephant yam (every year no rotation)	67.4	69.2	59.4	57.1	63.0	63.7	51.1	68.3	59.3	—9.0	—1575	—13.2
4	Tapioca and elephant yam in alternate years	71.3	74.7	72.7	57.7	75.0	73.8	55.9	73.0	68.2	—4.8	—840	—6.6
5	Elephant yam and tapioca in alternate years	65.0	68.1	62.5	59.2	69.3	65.3	52.6	66.6	62.4	—4.2	—735	—6.3

(Cond.)

6	Mean of items 4 and 5	68.1	71.4	67.6	58.5	72.2	69.6	54.4	69.8	65.3	—4.5	—787	—6.5
7	Tapioca, elephant yam, sweet potato, ginger, and turmeric in 5 year rotation	—	57.9	41.4	29.4	50.4	58.4	48.5	49.7	52.1	+2.4	+420	+4.8
8	Yam, lesser yam, colocasia and coleus in rotation	—	59.8	61.9	55.5	69.8	79.4	60.3	60.8	69.8	+9.0	+1575	+14.8

*For items 1 to 6 mean yield of years from 1970 to 72 and for items 7 and 8 from 1971–73.

**For items 1 to 6 mean yield of years from 1974 to 1977 and for items 7 and 8 from 1975–77.

main crop and the intercrop. This was overcome by fertilising both the crops as evidenced by yield of coconut in treatment 3. This study revealed that growing root crops in the interspace of coconut is advisable and profitable, only when both the main and the subsidiary crop are given the recommended management practices, as if they are grown as pure crops.

In experiment 2, the palms were more than 65 years old. The reduction in the mean yield of coconut in the control plot, where no intercrop was grown, was 3 nuts/palm/year (6.2%) over the pre-experimental period; the reduction in the yield, when intercrops were raised, was almost of the same magnitude except in the plot where elephant yam was grown continuously. In the plot where elephant yam was grown year after year, the reduction in the yield of coconut was 13.2% (9.0 nuts/palm/year). The results indicated that, when tubers are grown as intercrops under rainfed conditions, crop rotation was more beneficial than growing the same intercrop continuously on the same area.

The coconut palms in experiment 3, in which five different intercrop rotations were tried, gave an increased yield of 2.4 nuts/palm over pre-experimental yield. Further increase in yield, 9.0 nuts/palm, was noticed in experiment 4, where different tubers other than tapioca and elephant yam were tested to assess their suitability for intercropping in coconut stands. It is, therefore, evident that the main crop of coconut was not adversely effected when intercropping was taken up with tubers, provided rotation of intercrops and proper management practices were adopted.

Effect on yield of intercrops

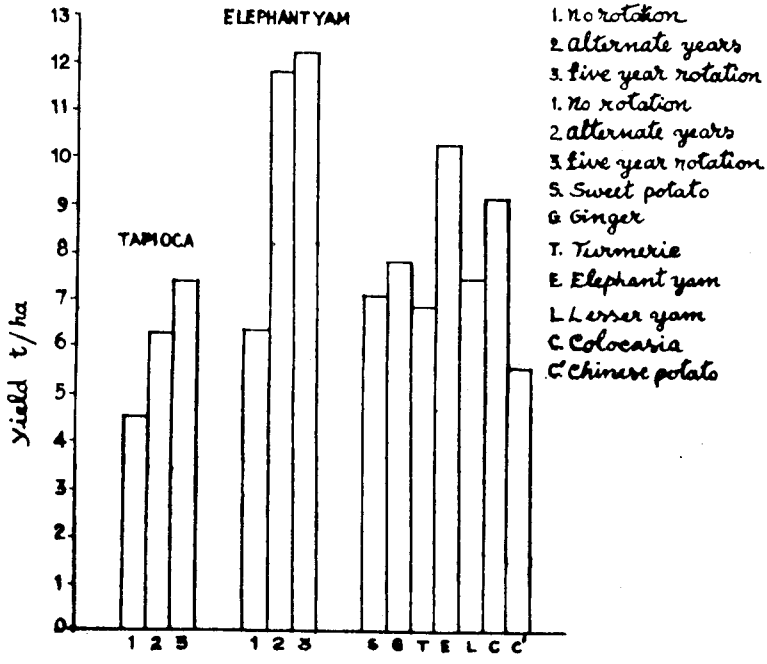
Yield of the intercrops in different experiments, per ha gross area of coconut stand, is presented in Table 5 and Fig. 2. In the experiment 2, it was observed that the yield of the tubers was adversely effected when the same tuber viz. tapioca or elephant yam was raised in the same field year after year. When tapioca was grown continuously as the intercrop, its mean yield was 4.5 t/ha, the range being 2.6 to 6.2 t/ha; but when it was rotated with elephant yam, the mean yield was 6.3 t/ha, the range being 3.2 to 8.3 t/ha. The yield of elephant yam also followed a similar trend.

Table 5. *Yield of intercrops*

Sl. No.	Intercrops grown	Yield in t/gross ha of coconut plantation				
		1973–74	1974–75	1975–76	1976–77	Mean
1.	Tapioca (every year—no rotation)	5.8	2.6	6.2	3.2	4.5
2.	Tapioca alternated with elephant yam	7.1	6.7	8.3	3.2	6.3
3.	Elephant yam (every year—no rotation)	5.6	7.6	9.5	3.0	6.4
4.	Elephant yam alternated with tapioca	16.2	8.9	13.8	8.1	11.8
5.	**Rotation experiment**					
	(a) Tapioca	7.7	7.4	14.2	8.3	7.6**
	(b) Elephant yam	12.9	9.2	15.2	11.6	12.2
	(c) Sweet potato	9.5	6.5	7.2	5.2	7.1
	(d) Ginger	11.6	3.9	NA*	NA*	7.8
	(e) Turmeric	10.9	NA	8.2	5.2	8.1
6.	Greater yam	12.7	5.4	12.8	10.3	10.3
7.	Lesser yam	9.0	8.5	7.4	5.3	7.5
8.	Colocasia	NA	NA	11.8	6.6	9.2
9.	Chinese potato	6.0	6.6	6.7	3.0	5.6

*Ginger crop was destroyed by soft-rot disease.
**Mean yield for 1973–74 and 1974–75 only.

Fig.2. MEAN YIELD OF DIFFERENT TUBERCROPS
(1973 – 1977)



Rotation with elephant yam, in alternate years, increased the yield of tapioca by about 52% over that of tapioca raised continuously. In the experiment 5, where tapioca repeated after five years in the rotaion, it was observed that the mean yield of tapioca was as high as 7.6 t/ha (variety M4) and in the subsequent two years, the variety H 165 yielded 11.3 t/ha which were considerably higher than the mean yield of 4.5 and 6.3 t/ha, when tapioca was grown continuously and in alternate years, respectively.

The elephant yam also showed similar yield trends. In experiment 2, elephant yam without rotation yielded 6.4 t/ha compared to 11.8 t/ha, when it was alternated with tapioca. In the intercrop rotation, where elephant yam was grown only once in five years, its yield was 12.2 t/ha. Elephant yam was also observed

to reduce the yield of the main crop of coconut to the tune of 9 nuts/palm/year (1575 nuts/ha) when it was raised in the same field continuously. Hence, elephant yam as an intercrop in coconut stands is to be grown preferably in rotation with other crops.

These results emphasise the need to practice intercrop rotations and suggest wider interval before repeating the crop. The feasibility studies revealed that tubers like greater yam, lesser yam, colocasia and coleus are also compatible intercrops.

Relative profitability of intercrops

The mean yield of intercrops, cost of cultivation, value of the produce, net gain/ha and gross net income/ha including that from coconut are presented in Table 6. It can be seen that a net income of Rs 7,000 to Rs 8,000/ha can be obtained even under rainfed conditions by raising tubers as subsidiary crops in coconut stands. Elephant yam followed by ginger gave the highest total net returns/ha. However, ginger cultivation has to be taken up with caution, as it is highly susceptible to soft rot-a disease which can cause total loss of the crop.

Employment opportunities

One of the ills of the rural areas is the underemployment of agricultural labour. A monocrop of coconut provides employment for hardly 150 man-days/ha/year. Intercrops like elephant yam, turmeric and ginger are more labour intensive than tapioca and sweet potato (Table 6). Elephant yam as intercrop doubles the labour employment in a ha of coconut stand.

It is, thus, evident that raising tuber crops in the interspace of coconut has no adverse effect on coconut, provided the intercrops and the main crop are adequately and separately manured and proper rotation of the intercrops is practised. Such a cropping system enhances the agricultural production and net income per unit area and also generates employment opportunities in the rural area.

Table 6. *Net returns and additional employment generated per year from one hectare of coconut garden intercropped with tuber crops*

Intercrop	Yield of intercrop t/ha	Value of intercrop Rs/ha	Cost of cultivation Rs/ha	Net returns from intercrop alone Rs/ha	Input: output ratio for intercrop	Total net income including coconut	Additional employment	
							Man-day	Women-day
Coconut alone	—	—	2900	—	—	5500	—	—
Tapioca	11.2	4480	2122	2358	2.11	7858	93	12
Elephant yam	12.2	9760	3246	6514	3.01	12014	123	8
Sweet potato	7.1	2840	2055	785	1.38	6285	56	26
Ginger	7.8	9750	4730	5020	2.06	10520	108	24
Turmeric	8.1	3248	4568	1808	0.71	3692	108	24
Chinese potato	5.6	4480	2035	2445	2.20	7945	92	23
Greater yam	10.3	5150	2827	2323	1.82	7823	64	12
Lesser yam	7.5	4500	2827	1673	1.59	7173	64	12

Value of intercrops in Rs/t: Tapioca—400, Elephant yam—800, Sweet potato—350, Ginger—1250, Turmeric—400, Coleus—800, Greater yam—500, Lesser yam—600, Coconut Re. 0.80/nut.

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