

## MULTIPLE CROPPING

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Multiple cropping in arecanut garden as a productive land use system has received much attention in the recent past. It is practised mainly through the use of interspaces for growing other crops of shorter duration. More than three decades ago Bavappa (1951) reported the mixed cropping or intercropping of banana, betelvine, tapioca, black pepper, colocasia, yams, pineapple, jack and coconut in arecanut garden. Abraham (1956) also indicated the successful cultivation of crops like ginger, turmeric, black pepper and cardamom in arecanut gardens. The long pre-bearing age of the main crop, small income from initial harvests, insecurity against pests and diseases, remoteness from markets and lack of transport were considered to be some of the reasons that might have prompted farmer to grow different crops in arecanut garden (Abraham, 1956; Naidu, 1959; Khader and Antony, 1968; Bhat, 1974; Nagaraj, 1974). The choice of the crop combination varied with family needs also.

### **I. Different forms of multiple cropping with arecanut**

Three different forms of multiple cropping are generally recognized, *viz.*, intercropping, mixed cropping and mixed farming.

#### **1. Intercropping**

Intercropping means growing two or more crops simultaneously on the same field. According to Nelliath and Iyer (1977) intercropping as applied to plantation crops refers to growing annuals or biennials in the interspaces of the

main crop. It indicates that no distinction is made regarding the planting pattern and row arrangements, though some workers (Freyman and Venkateswaralu, 1977; Beets, 1978) considered that intercropping should imply a definite planting pattern of the component crops in separate rows.

i. *Raising the intercrops*

A large number of crops like paddy, sorghum, cowpea, vegetables, yams, pineapple, banana, etc. are grown by the farmers as intercrops in arecanut gardens. However, their suitability and cultural requirements as intercrops are not fully investigated so far. In the absence of adequate experimental evidences, most workers (Khader and Antony, 1968; Bhat and Khader, 1970; Abraham, 1974; Bhat, 1974; Thomas, 1978; Muralidharan, 1980) have followed the package of practices prescribed for these crops under their pure culture. The planting in cultivators' fields is mostly irregular but in systematic field experiments they are planted in definite patterns and proportions. Every palm is given a circular area of about 0.75 m - 1 m radius to facilitate cultural operations like opening basins, application of fertilisers and manures, irrigation etc. The interspaces are dug or ploughed when the pre-monsoon showers are received to prepare the land for planting the intercrops. Crops like paddy (usually a shade tolerant upland variety called 'chennellu'), *Sorghum*, corn, cowpea and groundnut are sown (dibbled) in furrows. Pits or trenches are taken for crops like *Dioscorea*, elephant foot yam, taros, pineapple and banana. Crops like ginger, turmeric (Fig. 5.1) arrowroot, chillies, etc. are planted in raised beds of convenient size as recommended for the particular locality.

ii. *Productivity of intercrops and their economic returns*

Field experiments were conducted at various research stations to compare the economic returns from intercropping in arecanut garden and it was observed that the productivity and economic returns vary widely, under different agro-climatic and socio-economic conditions (Table 5.1).

Muralidharan (1980) investigated the productivity of 19 crops as intercrops in arecanut *vis-a-vis* their sole crops at the CPCRI Regional Station, Vittal, and observed that the biomass productivity of the intercrops was significantly lower than that of the corresponding sole crops (Table 5.2) except in banana and beans.

The reduction in the productivity of intercrops varied from 18 per cent under beans to as much as 87.7 per cent under fodder *Sorghum*. Arrowroot



Fig. 5.1 An intercrop of turmeric in arecanut garden

Table 5.1. Productivity and profit from intercrops in arecanut garden

Location	Intercrop	Yield (kg/ha)	Net profit (Rs/ha)
<i>Vittal</i>	Arrowroot	4000	1000
	Elephant foot yam	12000	1550
	Banana	4000	1650
	Paddy	396	-319
	Ground nut	807	789
<i>Palode</i>	<i>Dioscorea</i>	6744	1824
	Elephant foot yam	6496	1700
	Tapioca	10246	1851
	Sweet potato	712	61
	Pineapple	3942	847
<i>Kahikuchi</i>	Banana	12200	728
	Pineapple	15700	2379
	Ginger	9800	998
<i>Kannara</i>	Ginger	2650	905

Table 5.2. Biomass productivity of different crops as intercrop and sole crop

Crops	Biomass (kg/ha)			IC SC	%
	As intercrop (IC)	As sole crop (SC)	Difference (y-x)		
	1978-'79 (x)	1978-'79 (y)			
Paddy	1428**	3691	2266**		38.6
Finger millet	1075*	6560	5485**		16.3
<i>Sorghum</i>	2041	10633	8592**		19.1
Maize	2704*	10546	7842**		25.6
Ground nut	1397	4776	3379**		29.2
Beans	105	128	23		82.0
Cowpea	698	2403	1705**		29.0
<i>Dolichos</i>	1072	3370	2298**		31.8
Yam	5046**	13750	8704*		36.6
Arrowroot	6580	9852	3272*		66.7
<i>Dioscorea</i>	4078	12241	8163**		33.3
Colocasia	2191	5647	3456**		38.7
Sweet potato	1819	9904	8085**		18.3
Ginger	2116	5498	2882**		47.5
Chillies	1014	2281	1267**		44.4
Turmeric	3287	8682	5395**		37.8
Fodder sorghum	1183	9616	8433**		12.3
Hybrid napier	9515	31360	21845**		30.3
Banana	5956	10137	4181		58.7

\* Significant at P = 0.05

\*\* Significant at P = 0.01

and banana suffered only less than 50 per cent reduction, while ginger, chillies, colocasia, paddy, turmeric, yam and *Dioscorea* produced between one third to one half of their sole crop biomass. The remaining nine crops suffered severely under the intercropping system.

### iii. Effect of intercropping on arecanut

Experimental evidences, in general, indicated that intercropping in arecanut was not harmful to the main crop (Muralidharan and Nayar, 1979). A number of field experiments were conducted at different research stations of the CPCRI to assess the effect of intercropping on the productivity of arecanut. Abraham (1974) reported that no perceptible deleterious effect on the yield and condition of arecanut palm could be observed due to intercropping with tapioca, elephant foot yam, yam and sweet potato (Fig. 5.2). Similar results were reported by Sadanandan (1974) on intercropping with elephant foot yam and ginger. A comparative statement of different reports on the effect of intercropping on the yield of arecanut is given in Table 5.3.



Fig. 5.2 An intercrop of sweet potato in arecanut garden

Table 5.3. Effect of inter and mixed cropping on yield of arecanut

Inter or mixed crop	Fresh weight of nuts (kg/palm)		Difference in yield over pure crop of arecanut (%)
	Control	With other crops	
<i>Vittal</i>			
Banana	9.9	9.1	- 8.5
Banana (first three years only)	5.2	6.6	+ 26.3
<i>Kahikuchi</i>			
Ginger	9.0	10.3	+14.4
Banana	9.0	7.9	-12.2
Pine apple	9.0	8.9	- 1.1
Guinea grass	9.0	10.4	+15.5
Ginger	9.9	10.3	+ 4.0
Betelvine	9.9	9.4	- 5.1
<i>Kannara</i>			
Black pepper	10.4	10.1	- 2.9
<i>Thirthahalli</i>			
Black pepper	13.3	6.1	-54.1
Cardamom	13.3	8.3	-37.6

Banana is a very popular intercrop in arecanut gardens (Fig. 5.3) (Sundaramurthy, 1950; Bavappa, 1951; Bhat, 1974; Brahma, 1974). A detailed study to investigate the long term effects of intercropping banana in arecanut garden planted at  $2.7\text{m} \times 2.7\text{m}$  was undertaken at the CPCRI Regional Station, Vittal, since 1963. The mean yield of arecanut over a period of six years from the fifth year of planting did not show any significant difference due to intercropping with banana under different intensities of planting (Table 5.4).



Fig. 5.3 An intercrop of banana in arecanut garden

Roy (1974) reported that the yield of arecanut grown in the alluvial soils of North-Eastern India was not significantly influenced by intercropping with banana. Similar results were also observed by Nagaraj (1974) and Bhandary (1974). However, significantly adverse effect of intercropping with banana on the yield of arecanut was observed in the experiments conducted at CPCRI, Research Centre, Hirehalli (1972-1980) and Kahikuchi (1973-1978). Though the yield of arecanut was reduced by growing banana as intercrop, it still remained as a profitable intercrop, since the income from banana alone was Rs. 4047.60 per ha at the market rates during 1980 at Hirehalli. Earlier workers also reported net

profits ranging from Rs. 728 to Rs. 1650 per ha as reviewed by Muralidharan and Nayar, (1979). Studies conducted at CPCRI Research Centre, Kannara, to select the best variety of banana for intercropping with arecanut have indicated that 'Mysore Poovan' gave the highest yield (Anonymous, 1981).

**Table 5.4.** *Effect of continuous growing of banana as intercrop on yield of arecanut (1975-'76)*

Treatments	Number of nuts/palm	Wet wt. of nuts (kg/palm)
Control (pure crop of arecanut at 2.7 m × 2.7 m)	144.7	5.24
Banana throughout the experimental period at full level <i>i.e.</i> , 1:1	102.7	3.83
Banana at full level for three years and no banana thereafter	182.9	6.62
Banana at full level for three years and at reduced level for the rest of the period	134.5	4.83
Banana at full level for three years and at reduced level for next three years	130.2	4.57
Banana at full level for six years and no banana thereafter	136.4	5.14
Banana at full level for six years and at reduced level thereafter	143.2	5.32
Banana at full level for six years, reduced level for next four years and no banana thereafter	140.2	5.09
CV (%)	31.4	32.0

## 2. Mixed cropping

The term mixed cropping is used to denote growing perennial crops in the interspaces of plantation crops like coconut and arecanut, (Nelliath and Iyer, 1977). Watt (1892) reported that (tree crops like coconut, citrus, jack etc. were grown in arecanut gardens of the erstwhile Mysore State. In Kerala, especially in southern districts, arecanut is seldom grown as a pure crop.) A large number of tree crops are grown with it due to compelling socio-economic situations resulting in overpopulated polyculture. However, the search for parallel combinations of compatible species is of recent origin. A number of field experiments were initiated at the CPCRI Regional Station, Vittal and other Research Centres and conclusive results are emerging on the suitability of different crops like cocoa, black pepper, coffee etc. for mixed cropping with arecanut.

### i. Mixed cropping with cocoa

Preliminary studies initiated during 1964 at CPCRI Regional Station, Vittal indicated that cocoa can be an ideal combination with arecanut (Fig. 5.4). (Bhat and Leela, 1968). Bhat (1978) presented conclusive evidences on the positive performance of cocoa-arecanut mixed cropping system (Table 5.5).

The mean yield per arecanut palm in the mixed cropping experiment (arecanut and cocoa at 50:50) was higher than that of arecanut as a monocrop.

The gross annual income from the mixed garden, based on market prices between 1973 and 1975, was Rs. 18,949 per ha as compared to Rs. 13,083 per ha from the pure plantation of arecanut (Table 5.6) (Bhat, 1979).



Fig. 5.4 Mixed cropping of arecanut and cocoa

**Table 5.5.** Yield of cocoa and areca mixed garden (1964 planting)

Year	Treatments	Cocoa		Areca
		No. of pods/plant	No. of nuts/palm	Weight of nuts/palm (kg)
1970-'71	1	64	225	7.7
	2	-	170	6.8
	3	36	125	4.4
1971-'72	1	50	322	12.2
	2	-	169	6.8
	3	17	233	8.0
1972-'73	1	77	391	13.3
	2	-	210	7.5
	3	22	242	8.3
1973-'74	1	107	230	8.4
	2	-	130	8.4
	3	40	124	4.3
1974-'75	1	95	314	11.4
	2	-	270	10.0
	3	41	267	9.3

Treatments: 1 - Areca and cocoa (50:50)  
 2 - Pure plantation of areca  
 3 - Cocoa as a border crop in areca garden

**Table 5.6.** Yield and gross income from areca-cocoa mixed garden and pure areca garden

Particulars	Yield in the mixed garden		Yield in pure plantation of arecanut
	Cocoa	Areca	
Number of fruits per tree	78	296	187
Number of trees per ha (4m×4m)	625	625	1250
Estimated number of fruits ('000/ha/year)	49	185	134
Estimated dry weight (kg) of cocoa beans or arecanut kernel/ha/year	1225	1482	1869
Estimated value of produce/ha/year (Rs.)	8575*	10374**	-
Gross income (Rs.)	18949		13083

\* Cocoa at Rs. 7.00 per kg

\*\* Arecanut at Rs. 7.00 per kg

Based on the encouraging results of the preliminary studies, a detailed experiment was started at CPCRI Regional Station, Vittal to determine the optimum spacing and manurial requirements of cocoa under mixed cropping with arecanut. In this study *Forastero* variety of cocoa was planted with local cultivar ('South Kanara') of arecanut under six different spacings (Table 5.7) and two fertiliser

levels ( $M_1=100\text{g N}:40\text{g P}_2\text{O}_5:140\text{g K}_2\text{O}$ /arecanut palm and  $200\text{g N}:80\text{g P}_2\text{O}_5:280\text{g K}_2\text{O}$ /cocoa plant). The yield of areca per ha was maximum at a spacing of  $2.7\text{m}\times 2.7\text{m}$  with cocoa at  $5.4\text{m}\times 5.4\text{m}$  and the yield of cocoa per ha was maximum at a spacing of  $3.3\text{m}\times 3.3\text{m}$  with areca also at  $3.3\text{m}\times 3.3\text{m}$ . The combined yield of areca and cocoa per ha was maximum when both were spaced at  $3.3\text{m}\times 3.3\text{m}$  (Bhat, K. S., 1982, personal communication) (Table 5.7).

**Table 5.7.** *Areca-cocoa mixed cropping—mean yield (wet weight of fruits) of three years (1978-'79 to 1980-'81)*

Spacing	Areca	Mean yield/tree/year (kg)		Mean yield/ha/year (kg)		
	Cocoa	Areca	Cocoa	Areca	Cocoa	Areca+cocoa
$2.7\times 2.7\text{ m}$		4.78		6562		25,745
$2.7\times 2.7\text{ m}$			13.98		19,119	
$2.7\times 2.7\text{ m}$		5.46		7490		24,137
$2.7\times 5.4\text{ m}$			24.27		16,647	
$2.7\times 2.7\text{ m}$		6.70		9186		18,543
$5.4\times 5.4\text{ m}$			27.28		9,357	
$3.3\times 3.3\text{ m}$		6.76		6212		26,787
$3.3\times 3.3\text{ m}$			22.41		20,575	
$3.9\times 3.9\text{ m}$		6.36		4184		18,737
$3.9\times 3.9\text{ m}$			22.13		14,553	
$1.8\times 5.4\text{ m}$		5.83		5995		19,465
$3.6\times 5.4\text{ m}$			26.19		13,470	
CD (P=0.05)		1.37	6.62	1564.6	3735.8	(not tested)

Another experiment started in 1969 at CPCRI Research Centre, Kannara with six cross combinations of cocoa, two levels of fertiliser application ( $100\text{g N}:40\text{g P}_2\text{O}_5:140\text{g K}_2\text{O}$  and  $200\text{g N}:80\text{g P}_2\text{O}_5:280\text{g K}_2\text{O}$ ) and two methods of alignment (quincunx and square) did not show any significant difference between any of the treatments. The arecanut yield was in no way affected by mixed cropping with cocoa. Based on the results of these trials, cocoa is now recommended as an ideal crop for mixed cropping with arecanut.

For raising cocoa in arecanut garden pits of  $75\text{ cm}^3$  are dug at  $2.7\text{m}$  apart in between alternate rows of standing arecanut palms and filled with top soil and

compost. The cocoa seedlings are planted with the onset of monsoon showers. In gardens where shade is insufficient, the cocoa seedlings are provided with artificial shade. When new gardens are established, arecanut can be planted at 3.3 m apart and cocoa seedlings planted at the centre of four arecanut palms (quincunx method). In such cases both arecanut and cocoa should be given adequate shade by growing intercrops like banana. Training and rest of the cultural operations for cocoa as an intercrop is the same as that for a pure crop.

ii. *Mixed cropping with black pepper, cardamom and tree spices*

Among the many perennial crops grown with arecanut, black pepper and cardamom are very important (Abraham, 1956). Net income ranging from Rs. 255 (Abraham, 1974) to as high as Rs. 17,666 per ha, (Anonymous, 1977) was reported from mixed cropping of black pepper with arecanut. In many parts of Kerala and Karnataka arecanut palms are used as live standards for training black pepper (Fig. 5.5).

Nayar (1982) recommended the black pepper hybrid *Panniyur-1* for well-spaced (2.7m × 2.7m) arecanut gardens where the infiltration of light is higher and 'Karimunda' for more densely planted gardens.

When black pepper is grown on arecanut, the manurial and fertiliser dose applied to arecanut should be doubled. Each palm should receive in addition to its normal recommended dose of 10 kg of farm yard manure or compost, 100g N, 40g P<sub>2</sub>O<sub>5</sub> and 140g K<sub>2</sub>O, an equal additional dose of manures and fertilisers to support the pepper crop starting from the third year of planting. During the first and second years,  $\frac{1}{3}$  and  $\frac{2}{3}$  respectively of the additional dose of manures and fertilisers should be applied. Application of lime at the rate of 500 g per standard during April-May in alternate years is reported to be beneficial (Nayar, 1982).

Nayar (1982) reported that the advantages of training black pepper on arecanut palms are not fully exploited by most of the farmers due to the fear that growing black pepper on arecanut may depress the yield of arecanut as well as the yield of black pepper. Experimental data from a mixed crop of arecanut and black pepper for a duration of 10 years showed that there was no significant detrimental effect on the yield of arecanut palms due to training black pepper on them (Table 5.8). Further it helped to augment the net income of the farmer by about Rs. 8,940 per ha from black pepper alone.

Bhandary (1974) reported that the yield of arecanut was lowered by 54.4 per cent due to mixed cropping with black pepper, though the yield of pepper had compensated the loss of revenue from arecanut. However, it was not known whether pepper received adequate manuring in this trial.



Fig. 5.5 Mixed cropping of arecanut and pepper

**Table 5.8.** Yield of arecanut (mean of 80 palms) from the arecanut-black pepper mixed garden

Period	Yield of arecanut/palm			
	Arecanut alone		Arecanut+pepper	
	No. of nuts	Fresh wt. of nuts (kg)	No. of nuts	Fresh wt. of nuts (kg)
1969-'70	225.7	7.5	207.0	6.90
1970-'71	303.0	10.0	265.3	8.8
1971-'72	370.0	12.6	366.3	12.2
1972-'73	267.6	8.9	256.6	8.4
1973-'74	280.0	9.3	278.8	9.0
1974-'75	225.9	7.5	240.7	8.2
1975-'76	275.4	9.1	280.8	9.6
1976-'77	418.7	13.6	413.0	13.0
1977-'78	362.5	12.8	376.9	12.1
1978-'79	373.0	12.4	381.9	12.7
Mean	310.2	10.4	306.6	10.1

Instances of cardamom being grown as a suitable mixed crop with arecanut were reported by Abraham (1954) and Bhandary (1974). Cardamom is planted under the shade of arecanut in the lower valleys of certain cardamom plantations at 1.5–2 m apart in between arecanut palms. Though precise data are not available on the yield performance of cardamom under such a system, the cardamom appeared to have no adverse effect on the yield of arecanut. Package of practices for both the crops should be followed for sustaining their yield at a high level.

Tree spices like cinnamon, clove and nutmeg are often grown in arecanut gardens. In a mixed cropping experiment with cinnamon conducted at CPCRI Research Centre, Hirehalli, the yield of arecanut increased from 17,892 kg per ha to 24,445 kg per ha within a period of three years, a 36.6 per cent increase over the pre-experimental yield of arecanut. In this experiment one year old cinnamon seedlings were planted at a spacing of 2.7m × 2.7m *i.e.*, in 1:1 proportion with arecanut (Fig. 5.6). The seedlings were planted in pits of 45 cm<sup>3</sup> filled with top soil and compost. The garden was irrigated. Clove is a high cash value tree spice that can be grown as a mixed crop in arecanut plantation at a spacing of 5.4m × 10.8 m.

### iii. Mixed cropping with other perennials

Of the many other perennial crops that can be grown in arecanut gardens, atleast two, *viz.*, betelvine and coffee (Fig. 5.7) require special consideration. Roy



Fig. 5.6 Mixed cropping of arecanut and cinnamon

(1974) reported that an additional income of Rs. 3691 per ha can be obtained from growing betelvine in arecanut gardens. There was five per cent reduction in the yield of arecanut due to growing betelvine (Anonymous, 1977). Experiments conducted at Kahikuchi and Hirehalli also support this view, indicating that there was no significant difference between the yield of arecanut under monoculture and mixed cropping with betelvine (Roy, 1974).

Preliminary studies on mixed cropping arecanut with four varieties of coffee, viz., *arabica* S-6, *arabica* S-1936, San Ramon and *robusta* at the CPCRI Research Centre, Hirehalli showed an yield increase of 12.9% in arecanut.

## II. Advantages of multiple cropping in arecanut

The advantage of multiple cropping in arecanut (as in any other multiple cropping system) is the ability to provide substantial yield increase per unit area through better utilization of resources like land and light.



Fig. 5.7 Mixed cropping of arecanut and coffee

Bhat and Leela (1968) found that more than 80% of the roots of arecanut are within a radius of 75 cm from the base in palms spaced at  $2.7\text{m} \times 2.7\text{m}$ . The normal cultural operations are also confined within about 75–85 cm radius from base. Thus, the arecanut palms exploit only 2.27 sq. m. of ( $r=0.85\text{m}$ ) land area out of 7.29 sq. m. ( $2.7\text{m} \times 2.7\text{m}$ ) land available to each palm. This estimate indicates that about 68.9 per cent of land is not effectively utilized by the root system of arecanut palm. Multiple cropping system in the arecanut garden can more effectively utilize this unused land volume.

Muralidharan (1980) reported that 32.7–47.8 per cent of incident light rays pass down through the canopy of a 14 year-old arecanut garden depending on the time of the day. Normally in a pure arecanut crop spaced at  $2.7\text{m} \times 2.7\text{m}$ , this light energy reaches the ground and wasted. Multiple cropping in arecanut garden can advantageously utilize this energy.

The tremendous potentialities of multiple cropping in coconut and arecanut plantations to generate employment opportunities for improving the quality of rural life has been indicated by Nair and Bavappa (1975). Apart from increasing the production of additional crops and employment potential, multiple cropping system can act as a social security against instability of yield such as crop loss due to severe incidence of *Mahali*.

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