



Coconut based high density multispecies cropping system in Assam

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Abstract

A field experiment was conducted from 1991 to 2001 to study the effect of different intercrops on yield and monetary benefits of main and intercrops at Horticultural Research Station, Kahikuchi under the All India Coordinated Research Project on Palms. The study was based on three coconut based cropping models i.e., Model-I: Coconut + black pepper + banana + Assam lemon + pineapple + ginger, Model-II: Coconut + betel vine + banana + Assam lemon + turmeric + colocasia and Model-III: Coconut alone (monocrop). The results revealed that the highest nut yield as well as per cent increase in nut yield was recorded in model-I followed by model-II and the lowest in model-III (monocrop). The soil fertility status in respect of pH, OC, N, P and K were also found to be higher in model-I than in model-II and model-III. Similarly, higher microbial population (Azotobacter) was also found in model-I as compared to the other models. The leaf nutrient status (N, P and K) of the main crop as well as the component crops in model-I showed sufficiency (above their critical levels) resulting in a direct influence on the nut yield and yield of intercrops. The model-I was found more profitable giving the highest net return of Rs.42,155/ha with a benefit cost ratio of 1.67.

Keywords: Coconut, crops model, high density, multispecies

Introduction

Coconut is cultivated in Assam as one of the important cash crops. However, its cultivation is still confined to the homestead gardens. The venetian structure and orientation of adult coconut canopy permits about 55 per cent active radiation to penetrate down (Nelliath, 1979) and the gardens with palms spaced at 7.5 m x 7.5 m could be used effectively by growing different annuals and perennials to generate additional income per unit area. The performance of plantation based high density multispecies cropping system (HDMSCS) was reported by many workers (Nelliath *et al.*, 1979 ; Bavappa *et al.*, 1986 and Rethinam, 1990). These systems utilize the resources like land, sunshine, moisture etc. to the maximum extent possible and would add a lot of biomass to the soil in the form of leaf shedding, pruning etc. resulting in addition of nutrients to the system. Though coconut is a non- traditional crop for the north-eastern part of the country, the crop is gaining popularity due to its easy adaptability, wide range of uses and higher

economic returns. However, the performance of any specific crop combination under coconut garden has not been studied for this region. Hence, the study was undertaken with the main objective to identify the most remunerative and best coconut based HDMSCS under Assam condition.

Materials and Methods

The experiment was started in 1991 in twenty years old coconut (var. Assam Yellow Tall) garden spaced at 8.0 m x 8.0 m at Horticultural Research Station of Assam Agricultural University, Kahikuchi under AICRP on Palms. Two crop models along with monocrop of coconut as control have been fitted in the experiment with an area of 3072 m² (1024 m²/model). Each model composed of 16 adult coconut palms. Crop species grown as intercrops from 1991 to 2001 are mentioned below:

Model-I : Coconut + black pepper (Panniyur-1) + banana (Chenichampa) + Assam lemon + pineapple (Kew) + ginger (Nadia).

Model-II : Coconut + betel vine (Local) + banana (Chenichampa) + Assam lemon + turmeric (Tall clone) + colocasia (Naga kochu)

Model-III : Coconut alone (control)

Fertilizer dose for coconut and other component crops were applied as per package of practices. Cultural operations and other plant protection measures were undertaken as per need. Observations on yield of base crop as well as intercrops, inputs used and economic returns were recorded and analyzed.

Soil samples were collected one m away from coconut base at three depths *viz.*, 0-25 cm, 25 -50 cm and 50-100 cm. Leaf samples for coconut were collected from the index leaf i.e., 14th leaf and leaf samples for other intercrops were collected following the diagnostic criteria proposed by Chapman (1964). Soil samples were air dried, ground to pass through 2 mm sieve and analyzed for pH, organic carbon, available nitrogen, phosphorus and potassium. Leaf samples were oven dried, ground and analyzed for available nitrogen (Subbiah and Asija, 1957), phosphorus and potassium contents by standard procedure (Jackson, 1967). Rhizosphere soil samples were also collected from each plot during May to enumerate the population of rhizosphere bacteria. Isolation of Azotobacter from rhizosphere soil samples was done using serial washing technique (Harley and Waid, 1955). For the purpose of isolation and estimation, the whole system was macerated in 100 ml of sterile water using Waring blender. Subsequently, serial dilutions were prepared up to 10⁻³ from this stock solution. One ml from each dilution was plated and the total number of colonies

of all the plates was counted and multiplied by the dilution factors to estimate the number of Azotobacter per g of the rhizosphere soil.

Results and Discussion

Data presented in Table 1 reveal that the mean nut yield of main crop (coconut) over a period of ten years was found to be the highest in model-I (1023.2 nuts/plot; 64.0 nuts/palm) followed by model –II (938.1 nuts/plot; 58.6 nuts/palm) and the lowest nut yield of 701.2 nuts/plot (43.8 nuts/palm) was recorded in model-III (control plot). The yield of banana and lemon recorded was slightly higher in model-I than in model-II. The yield of black pepper, pineapple and ginger was recorded at 19.4 kg, 134.1 kg and 93.9 kg, respectively in model-I, while in model-II, 11201.1 leaves of betel vine/plot and 113.8 kg/plot of turmeric yield were obtained.

The mean pre-experimental nut yield/palm/year from 1985 to 1990 and during the experimental period from 1991 to 2001 revealed (Fig.1) that the yield gradually increased over the period after planting the intercrops irrespective of the models. The maximum increase (82.2 %) of nut yield was recorded in model-I followed by model-II (62.7 %), while only 18.8 % increase was observed in model-III, over the initial yield. The increase in nut yield is due to the beneficial effect of intercrops which include improvement in soil fertility, increased microbial activities, higher interception of sun light, better micro-climate, reduced weed growth etc. The intercropping that helped to improve the nut yield of the main crop was also reported by many workers (Kannan and Nambiar, 1976; Rethinam, 1993 and Singh *et al.*, 2002).

Table 1. Annual nut production and yield of different intercrops

Crops	Model	Annual production /plot*										Mean of 10 yrs.
		'91-'92	'92-'93	'93-'94	'94-'95	'95-'96	'96-'97	'97-'98	'98-'99	'99-2000	2000-01	
Coconut(nuts)	M- I	604.0	786.0	824.0	976.0	1010.0	1122.0	1129.0	1248.0	1255.0	1278.0	1023.2
	M-II	630.0	776.0	807.0	825.0	868.0	983.0	1045.0	1108.0	1154.0	1185.0	938.1
	M-III	455.0	489.0	592.0	564.0	551.0	696.0	724.0	969.0	996.0	976.0	701.2
Black pepper(kg)	M-I	7.1	9.5	10.1	13.5	15.5	22.0	24.5	30.4	32.00	30.0	19.46
Betel vine (No. of leaves)	M-II	4726	5760	8600	10800	11550	12085	12950	14950	15250	15340	11201
Banana (kg)	M-I	114.3	135.0	186.8	193.0	230.0	239.0	257.0	265.8	275.0	268.0	216.4
	M-II	97.8	130.0	178.0	186.0	202.0	225.0	249.0	251.0	255.0	258.0	203.2
Assam lemon (No. of fruits)	M-I	164.0	249.0	280.0	315.0	355.0	377.0	440.0	465.0	478.0	496.0	362.0
	M-II	145.0	204.0	235.0	258.0	285.0	314.0	398.0	445.0	458.0	460.0	320.2
Pineapple(kg)	M-I	0.0	50.0	78.0	125.0	150.0	165.0	175.0	190.5	198.0	210.0	134.1
Ginger(kg)	M-I	75.0	98.0	92.0	85.0	98.0	91.0	93.2	91.3	110.0	106.0	93.9
Turmeric(kg)	M-II	79.5	102.0	97.0	94.0	109.0	112.0	125.2	132.0	125.1	162.0	113.8
Colocasia(kg)	M-II	69.0	72.0	79.0	76.0	86.5	78.5	99.3	88.0	97.5	108.6	85.4

* Plot size = 1024 m²

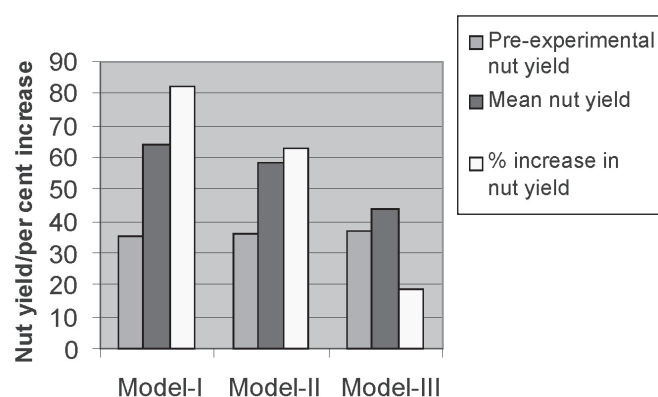


Fig.1. Average nut yield and per cent increase of nut yield in different models (1991-2001)

Soil and leaf nutrient status

The data summarized in Tables 2 and 3 revealed the nutritional status of the soil as a function of different crop combinations. It is clear from the tables that the nutrient content was higher in the surface soil as compared to the subsurface soil in all the models. The soil pH, organic carbon, available N, P and K content of soil were higher in model-I followed by model-II, whereas, it was the lowest in coconut monocropping plot. This indicates that recycling of organic waste adds considerable amount of organic matter into the system, thereby increasing various microbial and biochemical properties in the crop models than in the monocropping plot.

Table 2. Soil nutrient status (0-25 cm depth)

	pH	OC(%)	N(ppm)	P(ppm)	K(ppm)	Azotobacter population (x 10 ³ /g of rhizosphere sample)
Model-I:						
Coconut + Black pepper	5.40	1.21	515.2	83.5	526.9	11.46
Banana	4.85	1.25	628.3	81.60	617.0	12.75
Lemon	4.84	0.76	501.4	60.38	252.0	10.06
Ginger	4.90	0.98	426.3	47.7	102.0	10.0
Pineapple	4.70	0.67	338.1	37.4	114.0	9.86
Model: II						
Coconut + Betelvine	5.38	0.92	352.6	51.62	348.6	7.01
Banana	5.40	1.21	494.6	77.30	580.5	11.03
Lemon	4.53	0.70	489.4	59.38	226.5	8.77
Turmeric	4.80	0.97	488.7	38.30	198.6	10.0
Colocasia	4.70	0.86	427.0	36.40	106.4	8.62
Model: III						
Coconut alone	4.91	0.75	386.7	36.40	265.0	8.26

Table 3. Soil nutrient status (25-50 cm, 50-100 cm depth)

	pH	OC(%)	25-50 cm depth			pH	OC(%)	50-100 cm depth		
			N(ppm)	P(ppm)	K(ppm)			N(ppm)	P(ppm)	K(ppm)
Model-I:										
Coconut + Black pepper	4.95	0.96	402.6	55.2	452.6	4.57	0.77	226.0	17.7	23.9
Banana	4.73	0.87	486.4	62.46	506.8					
Lemon	4.54	0.68	361.0	36.48	174.0					
Ginger										
Pineapple										
Model: II										
Coconut + Betel vine	4.55	0.82	351.4	49.14	408.2	4.40	0.61	129.6	14.43	515.0
Banana	4.44	0.71	376.0	50.6	486.4					
Lemon	4.32	0.63	281.0	29.8	150.4					
Turmeric										
Colocasia										
Model: III										
Coconut alone	4.21	0.54	326.7	30.4	129.0	4.11	0.41	121.4	12.6	197.0

The data presented in Table 4 revealed that N, P and K contents in the coconut leaf were higher in model-I

Table 4. Leaf nutrient status

Model	N(%)	P(%)	K(%)
Model-I:			
Coconut	1.79	0.16	1.61
Black pepper	2.45	0.17	3.10
Banana	2.97	0.22	2.38
Lemon	3.08	0.20	2.68
Ginger	1.71	0.20	2.15
Pineapple	1.12	0.12	2.08
Model: II			
Coconut	1.65	0.16	1.57
Betelvine	2.98	0.25	2.99
Banana	2.81	0.21	2.16
Lemon	2.62	0.18	2.46
Turmeric	2.83	0.22	2.75
Colocasia	2.46	0.24	2.16
Model: III			
Coconut alone	1.63	0.14	1.45

Table 5. Economics of coconut based high density cropping system

	Model	Period(years)									Mean of 10 yrs.	
		1991-92	'92-'93	'93-'94	'94-'95	'95-'96	'96-'97	'97-'98	'98-'99	'99-2000		2000-01
Gross return (Rs/model)	M-I	3442.50	4643.25	5148.00	6061.75	6696.75	7621.25	8001.20	8931.05	9271.50	9174.0	6899.20
	M-II	3481.85	4301.00	4933.75	5229.50	5622.25	6123.00	6672.50	7065.25	7266.90	7576.4	5827.10
	M-III	1365.00	1467.00	1776.00	1692.00	1653.00	2088.00	2172.00	2907.00	2988.00	2928.00	2103.60
		<u>Mean of 10 years</u>										
		<u>M-I</u>			<u>M-II</u>			<u>M-III</u>				
Gross return (Rs./ha)	:	67,375			56,905			20,543				
Cost of production (Rs. /ha)	:	25,220			25,976			10,645				
Net return (Rs./ha)	:	42,155			30,929			9898.				
Benefit cost ratio	:	1.67			1.19			0.93				

than in model-II or model-III. In banana, the N, P and K contents were higher in model-I than in model-II. Similar is the case with lemon. Among the other component crops, the highest concentration of leaf N (3.08 %), P (0.25 %) and K (3.10 %) were obtained in lemon, betel vine and black pepper, respectively; whereas, the lowest values were registered in pineapple. The leaf nutrient status of the base crop as well as the component crops are more than their critical levels which showed a direct influence on yield of the respective crop.

Azotobacter population

Among the different crop species, the maximum population of Azotobacter was registered in the rhizosphere of banana plant and the model-I showed more population than model-II and model-III. It is possibly due to the presence of higher organic carbon content in soil as well as favourable soil temperature and soil moisture as prevailed in model-I .

Economics of intercropping

An assessment of data presented in Table 5 showed that out of the three models, the model-I with crop combinations of coconut, black pepper, banana, Assam lemon, pineapple and ginger recorded the highest net return and benefit cost ratio of Rs. 42,155/ha and 1.67 respectively, followed by model-II (Rs. 30,929/ha and 1.19), whereas, the lowest net return of Rs. 9898/ha with a benefit cost ratio of 0.93 was obtained under model-III. Das (1991), Sairam *et al.* (1997) and Singh *et al.* (2002) also observed increased production of nuts and enhanced overall returns from the coconut based cropping systems.

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