

PERFORMANCE OF ARECA BASED HIGH DENSITY MULTISPECIES CROPPING SYSTEM UNDER DIFFERENT LEVELS OF FERTILIZERS*

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ABSTRACT

Arecanut based high density multispecies cropping system (HDMSCS) model was studied under three levels of fertilizer management i.e. full, two third and one-third dose of recommended fertilizers for productivity. The component crops included in the system were pepper (Panniyur-1) trained on arecanut palms, banana (Cheni Champa) in a triangular system (5.4 m x 2.7 m), turmeric (Kasturi) spaced 30 cm X 30 cm and pineapple (Queen) in two rows spaced 60 cm x 30 cm in between two palms of arecanut. Nine years of mean economic yield revealed that full dose of recommended fertilizer application resulted in higher production with arecanut chali yield of 2405 kg/ha, dry pepper yield of 1252 kg/ha, pineapple fruit yield of 987 kg/ha and 2127 kg of turmeric/ha. However, in banana, yield did not vary much between full and two-third dose of fertilizers (6331 to 6313 kg/ha). Under one-third dose of fertilizers all the crops recorded lowest yields with arecanut chali yield of 1975 kg/ha, 884 kg/ha pepper, 5165 kg banana bunches/ha, 543 kg pineapple fruits/ha and 1801 kg turmeric/ha. The net discounted returns under graded levels of fertilizers for the mean of nine years data revealed that application of full dose of fertilizers resulted in higher net returns of Rs 38232/ha/year followed by two-third dose of fertilizers (Rs. 36532/ha). The Benefit Cost Ratio (BCR) realized under full, two-third and one-third dose of fertilizers was 3.28, 3.43 and 3.31 respectively. The estimated Net Present Worth (NPW) was Rs 343977, Rs 329370 and Rs 279412 under full, two-third and one-third level of recommended fertilizers of crops was economically more viable for the system as a whole.

Key words: Arecanut, HDMSCS, Cropping systems, Fertilizers, Economic returns

INTRODUCTION

Arecanut (*Areca catechu* Linn.) is extensively cultivated in Assam and is treated as one of the important cash crops. Although its cultivation is mainly under homestead conditions, large scale commercial cultivation is also not uncommon. The long pre-bearing stage of arecanut and the limited availability of cultivable land has led to the growing of different annual and perennial crops

in the interspace of arecanut plantations in order to generate additional income per unit area.

Mixed cropping of pepper, banana and cocoa was found to be economical in arecanut gardens (Muralidharan, 1980; Nair, 1982; Khader *et al.*, 1992 and Shama Bhat, 1988). Growing a single crop as mixed crop in arecanut garden would not utilize the resources like land, sunshine, moisture *etc.* to the

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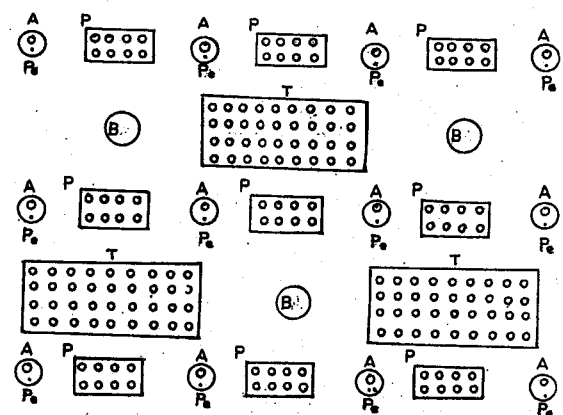
maximum extent possible. This has led to the concept of High Density Multi-species Cropping System (HDMSCS), where more than one crop is grown as mixed crops (Bavappa *et al.*, 1986). Such practice of growing more crops in a unit land area would add a lot of biomass to the soil in the form of leaf sheddings, prunings *etc.* and indirect addition of nutrients to the system. This makes it necessary to rationalise the fertilizer recommendation of crops in the system. Hence, this study was initiated to evaluate the areca based HDMSCS under different levels of fertilizers for productivity and economic viability at CPCRI Research Centre, Kahikuchi, Assam.

MATERIALS AND METHODS

In the year 1985-86, arecanut based HDMSCS model was laid out in a 26 year old arecanut plantation of 0.285 ha comprising of 432 arecanut palms at a spacing of 2.7m x 2.7m at

CPCRI Research Centre, Kahikuchi. The experimental site is situated at 20° 18' North latitude and 91°78' East longitude with an altitude of 60m above MSL. The average annual rainfall is about 3000 mm, of which major portion is received during South West monsoon (June to September). There is a dry spell from October to March with occasional showers from March to May. The soil of the experimental site is mainly alluvium with lower laterite strata having a pH of 4.4 to 5.6. Five different crops *viz.* pepper (Panniyur-I), banana (Cheni Champa), pineapple (Queen) and turmeric (Kasturi) were grown as inter-crops. The layout plan, crop varieties and their spacings are given in Fig 1.

During 1986-87, the plot was sub-divided into three different blocks and three levels of fertilizers *viz.* full, two-third and one-third dose of recommended fertilizers were introduced for arecanut and other component



Code	Crop	Variety	Spacing	Bed Size	Population
A	Arecanut	Local	2.7 mx2.7 m	-	432 N.
Pe	Pepper	Panniyur	2.7 mx2.7 m	Trailed on	432 No.
B	Banana	Cheni Champa	5.4x2.7 m (Triangular)	-	196 No.
P	Pineapple	Queen	60 cmx30 cm (Double row)	1mx1m (8 suckers/bed)	414 beds
T	Turmeric	Kasturi	30cmx30cm	2.5mx1m (36 rhizomes)	195 beds

Fig. 1. Plan and layout of Arecanut based HDMSCS model

crops. The recommended dose of NPK fertilizers for crops was as follows:

Crop	Unit	N	P ₂ O ₅	K ₂ O	Method of application
Arecanut	g/palm	100	40	140	In two split doses (June and Sept.)
pepper	g/vine	100	40	140	-do-
Banana	g/plant	160	160	320	-do-
Pineapple	g/bed	64	32	64	-do-
Turmeric	g/bed	7.5	5	5	As basal dose

Urea, single super phosphate and muriate of potash were used as the source of NPK. Other inter cultivation operations and plant protection measures were taken up as per the requirement and 1% bordeaux mixture was sprayed to arecanut during pre and post monsoon period as a prophylactic measure against *Phytophthora* diseases. Irrigation was provided at regular intervals during dry months through sprinklers.

Banana and pineapple were replanted once during 1992-93. Turmeric cultivation was not taken up during 1991-92, and 1993-94. Yield data of each crop was recorded separately

from 1987-88 onwards. The economic analysis was under taken from 1987-88 to 1995-96 based on the market prices at Assam for the corresponding years. To assess the economic viability of the system, cash flow analysis was undertaken using a discount rate of 15 per cent which was the bank interest rate for the opportunity cost for investment (Das, 1982).

RESULTS AND DISCUSSION

Yield response to fertilizers

The yield data of arecanut and other component crops in the system are given in Table 1. The results revealed that arecanut yield was higher with full dose of fertilizer application in all the years except during 1988-89, 1993-94 and 1994-95 compared to two-third dose of fertilizer application. In 1988-89; 1993-94 and 1994-95, two-third dose of fertilizer treatment maintained higher chali yield of 2864, 2138, and 2485 kg/ha respectively. One-third dose of fertilizer treatment recorded lowest chali yield in all the years compared to two third and full

Table 1. Yield response of different crops under different levels of fertilizers in arecanut based HDMSC System

Crop	Treatment	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	Mean
Arecanut (kg Chali/ha)	Full dose	3038	2379	2053	2560	2263	2643	2078	2253	2381	2405
	2/3rd dose	3022	2864	2042	2066	2089	2443	2138	2485	2339	2388
	1/3rd dose	2653	2211	1453	1664	1895	2317	1663	1969	1954	1975
Pepper (dry) (kg/ha)	Full dose	-	-	-	410	1627	1669	1074	1411	1320	1252
	2/3 rd dose	-	-	-	432	1463	1622	1032	1032	1188	1128
	1/3rd dose	-	-	-	410	2000	1374	853	800	867	884
Banana (kg bunch/ha)	Full dose	7139	5812	6222	6339	7423	-	5328	6476	5766	6313
	2/3rd dose	7623	5222	5559	8845	7092	-	4659	5592	6053	6331
	1/3rd dose	5296	3769	4674	7897	6044	-	4443	4380	4820	5165
Pineapple (kg/ha)	Full dose	-	948	947	421	422	-	-	2348	839	987
	2/3rd dose	-	284	758	368	316	-	-	2011	662	733
	1/3rd dose	-	294	589	316	210	-	-	1358	492	543
Turmeric (kg/ha)	Full dose	2511	2253	2516	2074	-	-	-	1663	1744	2127
	2/3rd dose	2590	1884	2284	2010	-	-	-	1432	1640	1973
	1/3rd dose	2948	1853	1816	1263	-	-	-	1243	1685	1801

dose of fertilizers (1453 to 2653 kg chali/ha). The mean of nine years yield indicated that full dose of fertilizers gave higher chali yield of 2405 kg/ha, followed by two-third with 2388 kg/ha and one-third with 1975 kg/ha.

Pepper started yield from fourth year of planting. Although in the initial years, pepper yield did not vary much due to fertilizer treatments, from third year of yield it varied substantially. Application of full dose of recommended fertilizers gave higher dry pepper yield compared to lower levels of fertilizer treatments. The mean yield also revealed that full dose of fertilizer gave the highest yield (1252 kg dry pepper/ha) followed by two-third dose (1128 kg/ha) and one-third dose (884 kg/ha).

Banana gave higher yield under full and two third dose of recommended fertilizers in most of the years as compared to one-third dose. Between full and two-third dose, yield did not vary much. However, one-third dose recorded lowest yield in most of the years. The mean yield was 6313 kg bunches/ha with full dose, 6331 kg bunches/ha with two-third dose and 5165 kg bunches/ha with one-third dose. In general, banana yield realized in this model was higher compared to the yield levels reported by Khader *et al.*, (1993) from Vittal and Sanamarappa (1993) from Hirehalli (both in Karnataka) under arecanut based HDMSCS models.

The pineapple yield was lowest with two-third and one-third dose of fertilizer application in all the years compared to full dose. The lowest mean fruit yield was recorded with one-third dose of fertilizer application (543 kg/ha) as compared to two third with 733 kg/ha and full dose 987kg/ha. Khader *et al.*, (1992) reported that although in the beginning, pineapple yield was higher

(1263 kg/ha), in the subsequent years it had declined and the system realized lower yields even with full dose of recommended fertilizers.

It is evident from Table-1 that, full dose of fertilizer application gave higher rhizome yield of turmeric in most of the years compared to other two levels of fertilizers. The mean yield also was higher with full dose of fertilizer application (2127 kg/ha) followed by two-third dose with 1973 kg/ha and one-third dose of fertilizer application with 1801 kg/ha. Turmeric being a nutrient exhaustive crop, showed decline in yield from second year particularly under reduced dose of recommended fertilizer treatments. Hence, turmeric cultivation was discontinued for three years during 1991-94.

The findings of the study clearly revealed that of the four crops tried as component crops in the high density multispecies cropping system, productivity was higher in three crops (pepper, banana and turmeric). Pineapple did not perform well and was found to be uneconomical as component crop in areca based HDMSCS model.

Economics

The details on cost of cultivation over the years is furnished in Table-2. It could be inferred from the data that under full dose of fertilizers, the total cost had increased from Rs. 25,278/ha to Rs 42,576/ha (by 68.43%) from 1987-88 to 1995-96. The increase in case of two third of fertilizer dose was from Rs. 24,565 to Rs 37,984/ha by 54.62%) and the same was Rs. 22,231 to Rs 32,270/ha (by 45.16%) under one-third dose of fertilizers. During the period 1987-88 to 1995-96 the share of arecanut in the total cost of cultivation had marginally increased from 21.21%

to 26.50% and that of pepper from 13.55 to 23.00%. However, during the same period the share of banana in the total cost of cultivation had marginally declined from 23.14% to 21.45% and that of pineapple from 15.12% to 8.32% and turmeric from 27.07% to 20.67%. This decline in cost of cultivation was mainly attributed to ratoon crops of banana and pineapple and low cost of turmeric planting material in 1995-96.

The details on returns from the arecanut based HDMSCS model furnished in Table-2 reveals that under full dose of fertilizers, the total returns had increased from Rs 56,875/ha to Rs. 2,28,095/ha (by 301.05%) from 1987-88 to 1995-96. For the same period the increase in case of two-third of fertilizer dose was from Rs 58,617 to 2,15,329 (by 267.34%) and the same was Rs. 53,363 to Rs 1,72,792/ha (by 223.8%) under one-third of fertilizer dose. During the same period the share of arecanut in the total returns had marginally decreased from 33.30% to 30.43% and that of banana from 31.38% to 12.64%. Similarly in case of pineapple and turmeric also the share towards total returns had declined from 35.32% to 9.94% and from 12.07% to 3.59% respectively. However, the share of pepper in the total returns had increased from 12.47% to 43.40. In case of two-third and one-third levels of fertilizers also the total returns had increased at almost the same rate from 1987-88 to 1995-96 (Table 2).

The net returns realized from the system under full dose of fertilizers had increased from Rs 31,597/ha in 1987-88 to Rs 1,85,520/ha in 1995-96 (487.14%). The respective increase under two-third and one-third dose of fertilizers was from Rs 34,052/ha to Rs 1,77,344/ha (420.8%) and from Rs 31,132/ha to Rs 1,40,521/ha

(351.3%). Similar higher gross returns of Rs. 1,76,757/ha was recorded by 8th year of planting from arecanut based HDMSCS model in Maidan parts of Karnataka with full dose of recommended fertilizer application (Sannamarappa, 1993).

The major contribution towards the total net returns was from the component crop pepper (48%) and this was followed by main crop arecanut (31.3%) with full dose of recommended fertilizers in 1995-96. Profitability of growing pepper with areca was also reported earlier by Singh *et al.*, (1982) and Khader *et al.*, (1992). The remaining 20.6% returns were contributed by banana (10.6%), turmeric (7.5%) and pineapple (2.5%). In lower levels of recommended fertilizers the contribution from the main crop of arecanut was slightly increased (33.0% with two third and 34.8% with one-third dose) and component crops marginally decreased. This indicates that component crops responded to full dose of recommended fertilizers for higher production. The lowest contributor towards total net returns was pineapple contributing only 1.2% to 2.5% returns under different doses of recommended fertilizers in 1995-96. In many previous years, it had resulted in negative returns (Table 2). This could be attributed to the low production of fruits in pineapple due to higher shade. Singh *et al.* (1982) and Khader *et al.* (1992) also reported uneconomical returns from pineapple under arecanut based HDMSCS models. Although the returns were predominantly from areca and pepper due to high price for their produce, in the event of a crash in areca and pepper price, banana and turmeric could also play a vital role in sustaining returns. Pineapple did not perform well and was found to be uneconomical as component crop in areca based HDMSCS model.

Table 2. Economics (Rs/ha) of arecanut based HDMSCS model for nine years (1985-1996)

Year	Economic Indicators	Arecanut			Pepper			Banana			Pineapple			Turmeric			Total		
		Full	2/3rd	1/3rd	Full	2/3rd	1/3rd	Full	2/3rd	1/3rd	Full	2/3rd	1/3rd	Full	2/3rd	1/3rd	Full	2/3rd	1/3rd
1987-88	Cost of cultn.	5339	4983	4653	3425	3630	2112	5949	5650	5218	3823	3661	3782	6642	6642	6466	25278	24565	22231
	Gross returns	18939	18840	16539	-	-	-	17848	19058	13240	-	-	-	20088	20720	23584	58617	58617	53363
	Net returns	13600	13857	11886	-3425	-3630	-2112	11999	13408	8022	-3823	-3661	-3782	13246	14078	17118	31597	34052	31132
1988-89	Cost of cultn.	7303	6631	6031	3260	1975	1843	6984	6227	5579	4205	3806	3489	6635	6411	5620	28388	25049	22562
	Gross returns	18671	22478	17353	-	-	-	17436	15666	11307	7584	2272	2352	19151	16014	15751	62842	58430	46732
	Net returns	11368	15847	11321	-3260	-1975	-1843	10452	9439	5728	3379	-1534	-1137	12515	9603	10131	34454	31380	24200
1989-90	Cost of cultn.	6772	5663	5348	4013	3123	2380	8198	7304	5570	3593	2355	2162	6929	6889	6311	29504	25134	21771
	Gross returns	18745	18644	13266	-	-	-	20222	18067	15191	7576	6064	4712	22644	20556	16344	69186	63331	49513
	Net returns	11973	12982	7918	-4013	-3123	-2380	12023	10763	9620	3983	3709	2551	15715	13867	10033	39682	38197	27742
1990-91	Cost of cultn.	6917	6318	6514	3112	2266	1653	6795	6598	4873	3939	3480	2599	7311	6863	6382	28073	25526	22022
	Gross returns	49322	39804	32059	13530	14256	13530	22187	30958	27640	3789	3312	2844	19703	19095	11999	108530	107425	88071
	Net returns	42405	33486	25545	10418	11990	11877	15392	24360	22767	-150	-168	245	12392	12232	5616	80457	81899	66049
1991-92	Cost of cultn.	7313	6624	5848	5619	4853	3751	9141	7585	6647	7184	5962	4898	-	-	-	29257	25024	21144
	Gross returns	48254	44544	40407	53691	48279	66000	29692	28368	24176	3798	2844	1890	-	-	-	135435	124035	132473
	Net returns	40941	37919	34559	48072	43426	62249	20551	20784	17529	-3386	-3118	-3008	-	-	-	106178	99011	111329
1992-93	Cost of cultn.	10630	9474	9258	8319	8572	7040	10457	10283	9210	9301	6728	6350	-	-	-	38707	35057	31858
	Gross returns	58609	54174	51379	46732	45416	38472	-	-	-	-	-	-	-	-	-	105341	99590	89851
	Net returns	47978	44699	42122	38413	36844	31432	-10457	-10283	-9210	-9301	-6728	-6350	-	-	-	66634	64533	57993
1993-94	Cost of cultn.	10537	10225	9657	4401	8418	7987	10531	10283	9269	3254	2328	1617	-	-	-	28723	31253	28530
	Gross returns	48632	50036	38920	38664	37152	30708	23976	20966	19994	-	-	-	-	-	-	111272	108154	89621
	Net returns	38095	39812	29263	34263	28734	22721	13445	10683	10725	-3254	-2328	-1617	-	-	-	82549	76901	61092
1994-95	Cost of cultn.	13966	6626	10747	12619	11223	9221	11906	10171	9323	6721	5872	4470	8919	8418	7337	54131	42310	41098
	Gross returns	54588	60209	47707	86071	62952	48800	30761	26562	20805	23480	20110	13580	21619	16159	16159	218519	188449	147051
	Net returns	40623	53583	36960	73452	51729	39579	19855	16391	11483	16759	14238	9110	12700	10198	8822	162388	146139	105953
1995-96	Cost of cultn.	11308	9711	8089	9791	8305	6779	9134	8514	7388	3542	3369	3138	8600	8085	6875	42576	37984	32270
	Gross returns	69413	68189	56965	99000	89100	65025	28830	30285	24100	8180	6455	4797	22672	21320	21905	228095	215329	172792
	Net returns	58105	58478	48875	89209	80795	58246	19696	21751	16712	4638	3085	1658	13872	13235	15030	185520	177344	140522

Table 3. Cash flow analysis of arecanut based HDMSCS model at Assam (Rs/ha)

Years	Discounted Cost*			Discounted total return*			Discounted net returns*		
	full	2/3rd	1/3rd	Full	2/3rd	1/3rd	Full	2/3rd	1/3rd
1987-88	22,000	21,391	19,348	49,478	50,957	46,435	27,478	29,565	27,087
1988-89	21,474	18,904	17,089	47,486	42,647	35,388	26,011	23,743	18,299
1989-90	19,397	16,504	14,334	45,500	41,621	32,547	26,103	25,117	18,213
1990-91	16,066	14,637	12,579	62,035	61,406	50,371	45,969	46,769	37,793
1991-92	14,567	12,429	10,490	67,318	61,650	65,876	52,750	49,220	55,385
1992-93	16,731	15,175	13,791	45,524	43,060	38,866	28,793	27,885	25,075
1993-94	10,789	11,767	10,714	41,842	40,676	33,684	31,052	28,910	22,970
1994-95	17,685	13,828	13,436	70,774	61,588	48,087	53,089	47,760	34,652
1995-96	12,110	10,802	9,182	64,840	61,202	49,121	52,731	50,400	39,939
Mean	16,758	15,048	13,440	54,977	51,645	44,486	38,219	36,596	31,046
BCR	3.28	3.43	3.31						
NPW	3,43,977	3,29,370	2,79,412						

* Averaged based on rounded figures of total cost and total returns

It could be inferred from the cash flow analysis of the system (Table 3) that the realized benefit-cost ratio under full, two-third and one-third dose of fertilizers was 3.28, 3.43 and 3.31 respectively. The estimated net present worth was Rs 3,43,977, Rs 3,29,370 and Rs 2,79,412 respectively under full, two-third and one third dose of fertilizers. These results had indicated that among the three levels of fertilizer treatments, the treatment with

two-third level of fertilizers was economically more viable in the system as a whole.

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