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Exploring the feasibility of arecanut based farming systems in augmenting farm economy- a case study in Karnataka, India

K. P.VISHWAJITH, P. K. SAHU, B. S. DHEKALE, MD NOMAN AND P. MISHRA

Department of Agricultural Statistics
Bidhan Chandra Krishi Viswavidyalaya
Mohapur-741252, Nadia, West Bengal

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ABSTRACT

Arecanut is one of the important cash crop in India by virtue of its own merits. Any enterprise which has got potentiality for employment of human resources and which can contribute in Indian economy through substantial foreign exchanges is of much importance. Keeping in mind the resource limitation scenario vis-à-vis judicious utilization of resource, in this study, an attempt has been made to identify not only the best cropping system but also the best farming system for arecanut growers in Thirthahalli, Karnataka, India. Analysis of primary information's from 48 arecanut growers reveals that by a large arecanut based cropping system could be grouped into sole arecanut, arecanut – banana, arecanut - coco and arecanut – spices groups. Among this arecanut – spices cropping system has better monetary advantage over the others. Moreover, among the arecanut – spices combination, arecanut – pepper by far is the best one. Discriminant analysis identifies the importance of different parameters like area, labour cost, fertilizer cost etc. are the major contributing parameters in differentiating the farmers among the groups. The probability of correct classification which as high as 0.85. Among the arecanut based farming system, inclusion of poultry enterprise has raised benefit cost ratio from 2.20 (sole arecanut) to 2.72. From the study it also appears that arecanut – pepper - poultry may be good options in augmenting farm income of the arecanut growers.

Keywords: arecanut, cropping system, discriminant analysis, farming system

Arecanut (*Areca catechu*) is one of the important commercial crops of India and finds a place in all religious, social and cultural functions. Arecanut is mainly used for chewing along with betel leaves and said to increase digestion, stimulate nerves and also used in veterinary medicines. India ranks first both in area and production with 405 thousand hectare and 482 thousand tonnes respectively (Anon. 2012). In India, compound annual growth rate of production (4.20%) is comparatively below the consumption growth rate of around 5 percent per annum (Prakash, 2011). That means there is consistent domestic demand for arecanut. Though Indian productivity (1.91 t ha^{-1}) is better compared to world average productivity of 1.267 t ha^{-1}; but ranks fourth in productivity, much below the world highest productivity of 2.934 t ha^{-1} of China (Anon. 2012). In India, Karnataka ranks first in area with 236.80 thousand hectare and production 380.80 thousand tonnes (Anon. 2012).

During 2010-11, India imported 72.69 thousand tonnes of arecanut; in fact the import of arecanut is growing at a very high rate of around 23 percent compared to annual export growth rate of just around 10 percent in recent years (Anon. 2012; Prakash, 2011). This must give sufficient cause of concern for farmers, co-operatives and policy makers in India.

With the increasing demand for land for various purposes, it has become imperative to harvest maximum output per unit of land per unit of time without scarifying the environmental issues. Growing of two or more crops simultaneously on the same pieces of land called intercropping system, crop intensification in both time and space, is one of the options in this direction. In tropical countries the farm holdings are small, being less than two hectares in three-quarters of farmers, this applies to arecanut gardens as well (Anon. 2004). Existence of gestation period in perennial crops has led to a widespread practice of multiple cropping among the farmers who have evolved various systems by experience, tradition and socio-economic needs. In this context, two other issues that are relevant are the risk factors and employment generation. A small farmer cannot afford to lose the crop due to any of the climatic disasters or pest and disease attack as he is wholly subsistent on it. The multiple cropping systems may protect the farmer from any eventual risks caused by non-marketability or crop loss in any crop species. Introduction of multiple cropping increases the possibility of utilizing more labour inputs; actually arecanut based high density multiple cropping systems requires 900 man days, while mono cropping arecanut requires 405 man days per year (Anonymous, 1988). Thus, the employment opportunity is increased in the multiple cropping which is of significant importance in developing countries.

Apart from these factors, the ecological advantages are substantial due to the prevention of soil erosion and

Email: vishwajithkp@gmail.com

nutrient loss in multiple cropping as compared to mono crop systems. Intercropping of compatible crops can be of great value in achieving the improved productivity with sustainable soil health (Choudhuri and Jana, 2012). Population of bacteria, fungi, actinomycetes, nitrogen-fixers and phosphate solubilizers in high density multiple cropping is more when compared to arecanut mono crop (Bopaiah, 1991). Symbiotic nitrogen fixers isolated from arecanut based high density multiple cropping system had the N-fixing capacity in the range of 2.8 to 11.8 mg N 100^{-1} (Anon. 1988).

Under irrigated condition, arecanut-cocoa and arecanut-pepper mixed cropping gave a monetary advantage of Rs.l9,163 $ha^{-1}year^{-1}$ and Rs.18,402 ha^{-1}year with a land equivalent ratio of 2.18 and 1.50 respectively (Das and Vijaya Kumar, l991). The net returns from the arecanut high density multiple cropping systems were also found to increase markedly as compared to the arecanut mono crop (Anon. 1988). Malanad region of Karnataka is famous for arecanut cultivation and growing of arecanut as pure crop is rare due above advantages of intercropping. The leaf structure and orientation of areca permit sizable amount of solar radiation to penetrate lower levels, providing ample scope for growing crops underneath. Distribution of roots in areca palms also favors cultivation of crops in the interspace leaving the base of palm up to a radius of 0.75cm.

Banana is popular intercrop and gives income during early years of planting of arecanut. Banana and other intercrops fetch interim revenue in the initial years, which will help the farmers in cash flows (Chinnappa, 2002; 2003). Black pepper is an excellent crop for mixed cropping with arecanut and high economic returns can be expected (Abraham, 1974; Nair, 1982; Nayar, 1982). In Malanad region of Shimoga district in Karnataka and Wynad district of Kerala, the cultivation of cardamom as a mixed crop with arecanut is a common practice (Korikanthimath *et al*.,1994). The reduction in arecanut yield in mixed systems was amply compensated by cardamom production (Korikanthimath *et al*., 1997; 1998). Coco is another crop which can be grown as intercrop with arecanut. The microclimate especially shade, soil moisture and temperature in the arecanut gardens were found to be ideal for cocoa (Shama Bhat and Leela, 1968; Shama Bhat and Bavappa, 1972).

Keeping in mind the importance of arecanut intercropping system, it is very important to identify the most beneficial intercrop for arecanut so as to enable more profit to the farmers. To ensure yield stability and economic sustainability of farm units, it is necessary to identify scientific multiple cropping systems. To a farmer, from subsistence as well as from farm economy point of view annual net return from his/her farm is most important. Moreover, it has been proved time and again that for maximum and judicious use of farm resources farming system approach with the inclusion of other enterprise like dairy, poultry, fishery *etc*. are most welcome. The farming systems will have to be identified keeping in view the social needs and food habits of a particular region. As such, the present study was undertaken to examine and compare the performance of different arecanut based intercropping system and to identify the most beneficial intercropping as well as farming system followed by Thirthahalli farmers.

MATERIALS AND METHODS

The study is based on primary data, the sample data is elicited based on purposive sampling. The sample respondents are selected on the basis of the list of arecanut growing farmers provided by Gram Panchayat (Hermabapura). Total sample size was 48 farmers from five different villages *viz*., Herambapura, Kunibylu, Makkimane, Nagaravalli and Thagadavalli. Information with respect to arecanut based cropping system, various input cost incurred for cultivation and returns, also regarding the allied activity followed by the farmers if any etc. were collected by using well-structured, pre tested schedule.

Based on different types of multiple cropping followed by the arecanut grower, they are divided into groups. One way ANOVA is carried out to verify the hypothesis that, various input costs *viz*., labour, fertilizer, plant protection, marketing and other extra cost and returns from different arecanut based cropping system are not same. In order to study the feasibility of investment of different cropping system Benefit Cost Ratio (BCR) are worked out. BC ratio indicates the return on a rupee of investment. It is defined as the ratio between the present worth of benefits and that of costs. A cropping system with BC ratio greater than unity is considered as viable, with comparatively higher BC ratio is considered as more beneficial.

Discriminant analysis is a statistical technique, used to study the differences between two or more groups of objects with respect to several variables simultaneously. Discriminant Function Analysis (DFA) is essentially a multiple regression where the dependent variable Y is a categorical variable, which is used to determine relative contributions of the variables to discriminate among K groups.

Suppose we have an observation X_0. Then, based on the discriminant function $l(X) = \hat{a}^t X$ developed, one can allocate this observation to some class.

Allocate X_0 to population 1 if

$$\hat{Y}_0 \quad \hat{a}' X_0 \quad \bar{X}_1 \quad \bar{X}_2 \;' S^{1}_{pooled} X_0 \quad \frac{1}{2}\hat{a}'(\bar{X}_1 \quad \bar{X}_2)$$
$$= \frac{1}{2} \bar{X}_1 \quad \bar{X}_2 \;' S^{1}_{pooled} \bar{X}_1 \quad \bar{X}_2$$

Otherwise, if $\hat{Y}_0 \quad (\bar{X}_1 \quad \bar{X}_2)' S^{1}_{pooled} X_0 \quad \frac{1}{2} \bar{X}_1 \quad \bar{X}_2 \;' S^{1}_{pooled} \bar{X}_1 \quad \bar{X}_2$, then allocate X_0 to ***population 2.***

Where, $\bar{X}_1$ and $\bar{X}_2$ are the mean vector of the groups, $\hat{a}'$ is the discriminant coefficient and S^{1}_{pooled} is the pooled standard deviation for two groups under comparison.

RESULTS AND DISCUSSION

To identify the nature of the farm families, information on characters like, age, education, family size, land holding are recorded and summary of the same is presented in table-1. Out of 48 sample farmers 54.17 percent are having land holding of less than or equal to 1 hectare, 33.33 percent farmers are with 1 to 2.5 hectare and remaining 12.5 percent are having more than 2.5 hectare. Except one, all the farmers are having formal schooling.

In present study four different groups of cropping pattern have been identified namely, arecanut, arecanut-banana, arecanut-coco, and arecanut-spices. Analysis of variance (ANOVA) presented in table-2, clearly indicate that the sole arecanut growers are significantly different from other groups of farmers, both in terms of return as well as total cost. Different groups of farmers also differ from others in most of the cost items as well, except for miscellaneous cost incurred (Table 3).

Out of 48 sampled farmers, 22 farmers (45.83%) are growing arecanut as mono crop, 35.45% of farmers are growing spices as intercrop in arecanut, 6 farmers is growing coco as intercrop and only 3 farmers are growing banana as intercrop (Table 4).

Table 1: Social features of sample farmer

	Particulars	Ratings	Frequency	Percentage
1.	Land holding size (Hactare)	≤ 1	26	54.17
		1 - 2.5	16	33.33
		> 2.5	6	12.50
2.	Education Level	Illiterate	1	2.08
		Primary School	3	6.25
		High School	7	14.58
		PUC	16	33.33
		Under-Graduation	9	18.75
		Post-Graduation	10	20.83
		Doctorate	2	4.17
3.	No. of person in family	≤ 3	19	39.58
		4 - 5	26	54.17
		> 5	3	6.25
4.	Age (Years)	< 45	9	18.75
		45 - 55	28	58.33
		> 55	11	22.92

Total cost of cultivation of arecanut as a mono crop was rupees 110368.20 per hectare (Table 4). Among the various inputs costs in mono crop, labour expense was high (38.26%) followed by the cost of fertilizers 33.85 per cent and plant protection chemicals which accounts for 20.12 per cent of total cost. Similar patterns are also observed in other intercropping systems. The mean returns of arecanut as mono crop was 242272.73 rupees per hectare (Table 4) which is slightly more, statistically insignificant (Table 3) than that of returns from arecanut - banana intercropping (233888.90 Rs ha^{-1}, Table 4), which may due to *katte* (Mosaic) disease of banana, which was rampant in the study area; faces a serious yield losses and also singh *et al.,* (1982) reported that, there will be slight reduction in yield of arecanut due to mixed cropping with banana. BC ratio of arecanut as mono crop is 2.20 which is slightly more than arecanut with banana as intercrop (1.99).

From table- 4, one can clearly conclude that return from the arecanut - spices intercropping system with BC ratio 2.33 is more beneficial than other intercropping systems which may be due to high return from the spices crops, while the cost of cultivation is statistically same as arecanut - banana intercropping system (Table 3). But it can be noticed from table 4 that return from arecanut - spices is in on par with arecanut - coco (BC ratio 2.31) with an average return of 280979.41 and 266516.67 rupees per hectare respectively.

Table 2: ANOVA for different input cost used for selected arecanut based cropping system

	SSQ	DF	MSQ	F	Sig.
Fertilizer Cost					
Treat	30570974.04	3	10190324.68	4.87	0.005185
Error	92018447.22	44	2091328.35		
Labour Cost					
Treat	786844336.82	3	262281445.61	22.73	0
Error	507813903.95	44	11541225.09		
Plant Protection Cost					
Treat	29663307.46	3	9887769.15	4.97	0.05
Error	87523381.41	44	1989167.76		
Other Cost					
Treat	5406645.50	3	1802215.17	0.86	0.467
Error	91738146.17	44	2084957.87		
Marketing Cost					
Treat	2325843.89	3	775281.30	2.79	0.052
Error	12233292.54	44	278029.38		
Total Cost					
Treat	1028563524.95	3	342854508.32	15.22	0
Error	991318165.28	44	22529958.30		
Total Return					
Treat	16586358515.80	3	5528786171.93	12.48	0
Error	19488048559.66	44	442910194.54		

Since the BC ratio of arecanut - spices is comparatively more than other cropping system, further study has been taken to identify which spices is more beneficial as intercrop with arecanut cropping system. Among the spices, this study has identified four different intercropping with spices *viz.*, arecanut – cardamom, arecanut – cardamom – nut mug, arecanut – cardamom – pepper and arecanut – pepper. Similar analytical approach is also taken up to identify the better arecanut – spices combination with emphasis on total cost and return and presented in table 5 and table 6. ANOVA clearly indicate significant difference w.r.t total cost and total return among the different arecanut – spices combinations.

Return form arecanut - pepper cropping system is rupees 298000.00 (Table 7) per hectare which is slight more than that of arecanut - cardamom - pepper (rupees 294875.00 per hectare, Table 7) but not statistically significant (Table 6). While the per hectare cost incurred in case of arecanut - cardamom - pepper is more (rupees 127664.50) than that of remaining cropping system.

As has already been mentioned, this study emphasises on finding the best combination of other enterprises like poultry, dairy and apiculture with arecanut cropping system. From table 8, among the farming system followed by the farmers, arecanut - poultry and arecanut - spices - dairy - poultry are having comparatively highest BC ratio of 2.72. It is noticed in the study that, where ever the dairy activity is included in the farming system BC ratio is less reasons for which is required to be explored. Also, earlier we noticed that spices crop with arecanut is having high BC ratio. Hence arecanut - spices - poultry may be more beneficial to the farmer as compared to other combinations. Unfortunately, this study fails to identify any such farmer; reasons for this are require to explored.

Fisher's discriminant analysis helps us in accessing the important character or the parameter which are contributing significantly towards group discriminations. It also helps in identifying the particular group for a given element. In this section our endeavor is to identify the contribution of ten characters *i.e.*, personal (area, age of the farmer, education level of the farmer and no. of person in the family and) and cost variables involved in these four types of cropping systems so that given any farmers one can identify its particular group where it should belong.

Based on the D^2 value of each and every characters in group discrimination these are ranked, highest D^2 is ranked one and the lowest one is ranked as ten and from table -9, one can see that the maximum value of D^2 is obtained in discriminating arecanut - banana and arecanut - coco, followed by arecanut as solo crop with arecanut - banana and so on. Fisher's discriminant

Table 3: Multiple comparison for different input cost used for selected arecanut based cropping system

(I) Treat	(J) Treat	Fertilizer Cost (₹ ha^{-1}) MD (I-J)	SE	Sig.	Labour Cost (₹ ha^{-1}) MD (I-J)	SE	Sig.	Plant Protection Cost (₹ ha^{-1}) MD (I-J)	SE	Sig.
A	AB	-3125.252*	890.04	0.001	-4890.400*	2090.86	0.024	1480.303	868.03	0.095
	AC	-169.697	666.04	0.800	-3823.774*	1564.65	0.019	-1203.03	649.57	0.071
	AS	310.695	466.99	0.509	-9042.616*	1097.04	0.000	-1244.907*	455.44	0.009
AB	A	3125.252*	890.04	0.001	4890.440*	2090.86	0.024	-1480.300	868.03	0.095
	AC	2955.555*	1022.58	0.006	1066.667	2402.21	0.659	-2683.333*	997.29	0.010
	AS	3435.947*	905.61	0.000	-4152.290	2127.43	0.057	-2725.210*	883.21	0.004
AC	A	169.697	666.04	0.800	3823.737*	1564.65	0.019	1203.030	649.57	0.071
	AB	-2955.556*	1022.58	0.006	-1066.670	2402.21	0.659	2683.333*	997.29	0.010
	AS	480.392	686.71	0.488	-5218.954*	1613.21	0.002	-41.876	669.73	0.950
AS	A	-310.652	466.99	0.509	9042.691*	1097.04	0.000	1244.907*	455.44	0.009
	AB	-3435.477*	905.61	0.000	4152.288	2127.43	0.057	2725.210*	883.21	0.004
	AC	-480.922	686.71	0.488	5218.952*	1613.21	0.002	41.876	669.73	0.950
		Other Cost (₹ ha^{-1})			Total Cost (₹ ha^{-1})			Total Returns (₹ ha^{-1})		
A	AB	-324.475	324.52	0.322	-6987.378*	2921.31	0.021	8383.838	12952.60	0.521
	AC	5.881	242.85	0.981	-5084.590*	2186.11	0.025	-24243.939*	9692.81	0.016
	AS	400.593*	170.27	0.023	-10262.409*	1532.77	0.000	-38706.684*	6796.02	0.000
AB	A	324.775	324.52	0.322	6987.370*	2921.31	0.021	-8383.840	12952.60	0.521
	AC	330.556	372.85	0.380	1902.077	3356.33	0.574	-32627.777*	14881.40	0.034
	AS	725.268*	330.20	0.033	-3275.102	2972.42	0.277	-47090.522*	13179.20	0.001
AC	A	-5.881	242.85	0.981	5084.590*	2186.11	0.025	24243.939*	9692.81	0.016
	AB	-330.556	372.85	0.380	-1902.780	3356.33	0.574	32627.777*	14881.40	0.034
	AS	394.712	250.39	0.122	-5177.890*	2253.95	0.026	-14462.700	9993.59	0.155
AS	A	-400.593*	170.27	0.023	10262.490*	1532.77	0.000	38706.684*	6796.02	0.000
	AB	-725.268*	330.20	0.033	3275.101	2972.42	0.277	47090.522*	13179.20	0.001
	AC	-394.012	250.39	0.122	5177.809*	2253.95	0.026	14462.750	9993.59	0.155

Note: A: Arecanut, B: Bannana, C: Coco, S: Spices, MD: Mean Difference, SE: Standard Error, Sig: Significance Level

Table 4: Average per hectare cost and return of arecanut based intercropping system

Cropping system	Frequency	FC (₹ ha^{-1})	LC (₹ ha^{-1})	PPC (₹ ha^{-1})	OC (₹ ha^{-1})	MC (₹ ha^{-1})	TC (₹ ha^{-1})	TR (₹ ha^{-1})	B:C
Arecanut	22	37363.64	42231.82	22213.64	7272.73	1286.36	110368.18	242272.73	2.20
Arecanut - Banana	3	40488.89	47122.22	20733.33	7400.00	1611.11	117355.56	233888.89	1.99
Arecanut - Coco	6	37533.33	46055.56	23416.67	7166.67	1280.56	115452.78	266516.67	2.31
Arecanut - Spices	17	37052.94	51274.51	23458.54	7958.82	885.85	120630.67	280979.41	2.33

Note: FC: Fertilizer Cost; LC: Labour Cost; PPC: Plant Protection Cost; OC: Other Cost; MC: Marketing Cost; TC: Total Cost; TR: Total Returns

Table 5: ANOVA tables for arecanut-spices intercropping system

Total cost for arecanut spices intercropping system					
Source of variation	**SSQ**	**df**	**MSQ**	**F**	**Sig.**
Treat	461800000	3	153900000	10.871	0.001
Error	184100000	13	14160000		
Returns for arecanut spices intercropping system					
Treat	3251000000	3	1084000000	4.417	0.024
Error	3190000000	13	245400000		

Table 6: Multiple comparison arecanut spices cropping system

		Cost per hectare in rupees			Return per hectare in rupees		
(I) Treat	**(J) Treat**	**MD (I-J)**	**SE**	**Sig.**	**MD (I-J)**	**SE**	**Sig.**
AM	AMN	-791.1	2180.760	0.723	-2827.78	11439.60	0.809
	AMQ	-8450.16*	2003.150	0.001	-26875.00*	10508.00	0.024
	AQ	-2587.61	1888.590	0.194	-30000.00*	9907.02	0.010
AMN	AM	791.10	2180.760	0.723	2827.77	11439.60	0.809
	AMQ	-7659.06*	2280.690	0.005	-24047.20	11963.90	0.066
	AQ	-1796.51	2180.760	0.425	-27172.22*	11439.60	0.034
AMQ	AM	8450.16*	2003.150	0.001	26875.00*	10508.00	0.024
	AMN	7659.06*	2280.690	0.005	24047.22	11963.90	0.066
	AQ	5862.54*	2003.150	0.012	-3125.00	10508.00	0.771
AQ	AM	2587.61	1888.590	0.194	30000.00*	9907.02	0.010
	AMN	1796.51	2180.760	0.425	27172.22*	11439.60	0.034
	AMQ	-5862.54*	2003.150	0.012	3125.00	10508.00	0.771

Note: A: Arecanut, M: Cardamom, N: Nut Mug, Q: Pepper, MD: Mean Difference, SE: Standard Error, Sig: Significance Level.

Table 7: Average cost per hectare and return of arecanut - spices based intercropping system

Cropping system	Frequency	Percentage	Total cost(₹ ha^{-1})	Total return(₹ ha^{-1})	B:C
Arecanut - Cardamom	5	29.41	119214.33	268000.00	2.25
Arecanut - Cardamom - Nut Mug	3	17.64	120005.43	275112.00	2.29
Arecanut - Cardamom - Pepper	4	23.52	127664.50	294875.00	2.31
Arecanut - Pepper	5	29.41	121801.95	298000.00	2.45

Table 8: Cost and return of arecanut intercropping system with allied activity

Farming system	Percentage	Total Cost (₹ ha^{-1})	Return (₹ ha^{-1})	B:C
Arecanut - Banana - Dairy	7.14	140266.70	260833.30	1.86
Arecanut -Coco - Apiculture	3.57	119434.30	275833.30	2.31
Arecanut -Coco - Dairy	3.57	133201.00	269100.00	2.02
Arecanut -Dairy	28.57	144908.30	298208.30	2.06
Arecanut - Apiculture	7.14	114600.00	256250.00	2.24
Arecanut -Poultry	7.14	222366.70	605000.00	2.72
Arecanut -Spices - Dairy	39.28	148991.70	305637.90	2.05
Arecanut -Spices - Dairy -Poultry	3.57	177368.70	481933.30	2.72

Table 9: Results of discriminant analysis

Cropping systems	Area	Age	NPF	EDU	FC	LC	PPC	OC	MC	TR	D^2	POM
	Character rank											
A vs AB	5	9	3	2	1	4	8	7	6	10	50.83	0.146
A vs AC	10	6	7	4	9	1	2	8	5	3	17.00	
A vs AS	10	7	4	6	9	3	2	8	5	1	8.99	
AB vs AC	5	7	4	2	3	10	1	8	9	6	223460370.00	
AB vs AS	1	9	6	3	10	7	2	8	4	5	29.03	
AC vs AS	1	6	5	7	10	2	3	8	4	9	8.44	

Note: NPF: No of person in family; EDU : Education Level; FC : Fertilizer Cost; LC: Labour Cost; PPC: Plant Protection cost; OC: Other cost; TR: Total Returns; POM: Probability of misclassification

analysis could classify the famers to the extent of more than 85 percent with probability of misclassification being less than 0.15 from the table 9; it is found that none of the character could uniformly be taken as the best one in all groups' discrimination. Area plays most contributing factor in discriminating arecanut - spices with arecanut - banana as well as arecanut - coco. Whereas fertilizer cost in arecanut versus arecanut - banana, labour cost in arecanut versus arecanut - spices, plant protection cost in arecanut - banana versus arecanut - coco are contributing characters. This discriminant analyses once again prove the role of different parameters under study in different cropping systems. Thus, the farmers following a particular enterprise among the above mentioned four cropping system should concentrate on the respective parameter.

Though arecanut alone may give sufficient economic stability to farmers, intercropping is more beneficial than mono cropping which also increases the possibility of more labour utilization. Among the intercropping, arecanut - spices is found to be more advantageous in monetary term. Within the arecanut - spices intercropping system arecanut - pepper found high beneficial with highest BC ratio in the study area. Arecanut – spices (pepper) – poultry may also be beneficial farming system; unfortunately study fails to identify any such combination in the study area; reason for which is need to be explored. From the study it can be concluded that intercropping of arecanut and also the farming systems of arecanut intercropped (specially with pepper) in combination with other enterprise would be more beneficial.

REFERENCES

Abraham, K.J., 1974. Intercropping in arecanut helps to build up farmers economy, *Arecanut Spices Bull.*, **5**:73-75.

Anonymous 1988. *Annual report,* Central Plantation Crops Research Institute, Kasaragod., pp.205.

Anonymous 2004. *Annual report,* Central Plantation Crops Research Institute, Kasaragoad., pp. 121.

Anonymous 2012. http://dasd.gov.in. Directory of arecanut and spices development, Ministry of agriculture, GOI. last assessed on 15th July 23, 2014.

Anonymous 2012. http://faostat.fao.org. Last assessed on 15th July 2014.

Anonymous 2012. http://indiastat.com. Last assessed on 15th July, 2014.

Bopaiah, B.M. 1991. Soil microflora and VA mycorrhizae in areca based high density multispecies cropping and areca mono cropping systems. *J. Plant. Crops.*, **18**:224-28.

Chinnappa, B. 2002. Techno-economic appraisal of arecanut plantation in nontraditional areas. *J. Plant. Crops.*, **30**:64-67.

Chinnappa, B. 2003. Economic significance of intercropping in new arecanut plantations under two irrigation methods. *J. Plant. Crops*, **31**: 53-56.

Choudhari, P. and Jana, J. C. 2012. Effect of intercropping on yield and economics of cabbage. *J. Crop Weed*, **8**: 155-57.

Das, P.K. and Vijaya Kumar, K. 1991. Evaluation of LER and advantages in coconut and arecanut based systems. *J. Plant. Crops*, **18**: 356-58.

Korikanthimath, V.S., Hiremath, G.M., Hegde, R., Mulge, R. and Hosmani, M.M. 1997. Comparative input utilization pattern in mono v/s mixed cropping of arecanut with cardamom. *J. Maharashtra Agric. Univ.*, **22**: 210-12.

Korikanthimath, V.S., Rajendra Hegde and Hegde, R. 1994. Cardamom and arecanut mix-cropping systems. *Indian Cocoa Arecanut Spices J.*, **18**: 109-12.

Korikanthimath, V.S., Rajendra Hegde, Ravindra Mulge, Hosmani, M.M., Hegde, R., and Mulge, R. 1998. Mixed cropping of arecanut and cardamom compatibility and yield pattern. *Karnataka J. Agric. Sci.,* **11**: 751-756.

Nair, M.G. 1982. Inter cropping with pepper. *Indian Farming*, **32**: 17-19.

Nayar, T.V.R. 1982. Grow pepper in arecanut gardens. *Indian Farming,* **32**: 27-31.

Ratnam, R. 1961. Introduction of criollo cacao into Madras State *South Indian Hort.*, **9**:24-29.

Shama Bhat, K. and Bavappa, K.V.A. 1972. Cacao under Palms. In: *Cacao and Coconuts in Malaysia* (Wastie R.L. and Earp D.A. Eds]. Incorporated society of Planters, Kuala Lumpur, pp. 116-21.

Shama Bhat, K. and Leela, M. 1968. Cacao and arecanut are good companion for more cash. *Indian Farming*, **18**: 19-20.

Singh, R. K., Yadukumar, N., Roy, B.K.N and Roy, A.C. 1982. Intercropping in areca gardens in North Bengal. *Indian Farming*, **32**:13-15.

Praskash, T.N. 2010. Arecanut in the national economy. *Annual report,* Scheme on Cost of Cultivation of Principal Crops of Karnataka. Department of Economics, UAS (B).