Original Research Article

Economic Assessment of Intercroppingvegetable Vegetablescrops as intercropping system in Arecanutgarden Garden for additional returns

ABSTRACT

A We conducted afield experiment was conducted onforthe assessment of vegetable crops as an intercropping system in arecanut Arecanutgarden for additional returnsat different villages of Tipturtaluk, Tumkur districts of Karnataka duringfrom 2015-16 to 2016-17 to studies studythe influence of the intercropping system on chaliarecanutArecanutyield, economics of arecanutArecanutbased intercropping system with vegetable crops, and the soil fertility status of arecanutArecanutgarden. The experiment consisted of three different intercropping systems viz.,vArecanut sole cropping asfarmers practice (T_1), Arecanut + vegetable cowpea(T_2), and Arecanut + French bean(T_3) with seven replications at farmer's fields. A 26year -year-old arecanutArecanutgarden of Gubbi local variety planted at 2,7 m x 2.7 m spacing. The average twotwo-year results of experiments were recorded.The yield of arecanutArecanutwas found to be higher chaliyield (12.53 q/ha/year)underthe intercrop Ffrench bean as intercrop in arecanut garden followed by intercrop cowpeaas intercrop in the arecanutArecanut garden(12.25 q/ha/year). Whereas the lowest yield was recorded in arecanutArecanut sole crop in farmers' practice. The highest net annual income of Rs. 2,56,832/ha and B:C ratio of 2.85 were recorded in arecanutArecanut + French bean intercropping system with more additional income and market demand of beans followed by arecanutArecanut + vegetable cowpea (Rs. 2,29,083/ha and B:C ratio 2.72) with less market demand of vegetable cowpea, whereas lowest net annual income Rs.1,45,290/haand B:C ratio 2.29 were recorded in arecanutArecanut sole cropping with no additional income from the farmers practices.

The soil fertility status *viz*., NPK availabilityin the soil wasanalyzed before and after the experiment. Gradually increased N, P, and K content of soil in arecanutArecanut intercropping with beans and cowpea on far with each other, but the lowest soil fertility were recorded in arecanutArecanut as sole cropping system in farmers practices due to high biomass of french French bean and cowpea, which fixes atmospheric nitrogen, residue incorporated into soil,and suppression of weed growth results in improvement of soil fertility status. Higher net returns and improvedthe soil fertility by growing the Ffrench bean as an intercrops in the arecanutArecanut garden is a more suitable cropping system to boost the economy of farmers.

Keywords: Assessment, arecanutArecanut, income,intercrops, income, vegetable andyield.

1. INTRODUCTION

ArecanutArecanut or betel nut (*Areca catechu*L.) is one of the important commercial crops grown in India,and presently ranks first in the world both in area and production of arecanutArecanut. ArecanutArecanut is mainly used for chewing and extraction of alkaloid purposes as it has got medicinal properties such as astringent, narcotic, antihelminticantihelmintic, and vermifuge. Major ArecanutArecanut-producing countries of the world are India, China, Myanmar, Indonesia, Thailand, and Bangladesh. India ranks first in both area (58.00% per cent) and production (53.00% per cent) of arecanutArecanut in the world. The total area under arecanutArecanut is around 4.97hundred thousand lakhha withthe atotal production is around 8.33 lakh tonnes. Kerala and Karnataka account for about 70%per cent of the country's production during 2017-18 [2]. The unstable arecanutArecanutmarket prices in the national and international markets, small and marginal land holdings, lack

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of ~~value~~ value-addition facilities,*etc*. have aggravated the economic difficulties ~~to~~ ofmany ~~arecanut~~Arecanutfarmers. However, research efforts have resulted in evolving viable technologies to increase the profitability for~~arecanut~~Arecanut growers by adopting ~~arecanut~~Arecanut-based cropping systems. Adoption of an Arecanut-~~arecanut~~based intercropping system is one of the ways to utilize ~~the~~ natural resources effectively. The potential for increasing the productivity per unit area of land, time, and inputs through the ~~arecanut~~Arecanutcropping system is considerably higher in perennial crops [6, 7].

The main aim of the Krishi Vigyan Kendra is to reduce the time lag between the generation of technology at the research institution and its transfer to the farmers for increasing productivity and income from the agriculture and allied sectors on a sustained basis. KVKs are grass ~~root~~roots-level organizations meant for the application of technology through assessment, refinement, and demonstration of proven technologies under different '~~micro~~ micro-farming' situations in a district [9].Thus, we aimed to study

~~Main objective~~

~~1) To studies~~the influence of the intercropping system on ~~arecanut~~Arecanut yields, the ~~.~~

~~2) To studies~~ economics of the ~~arecanut~~Arecanut~~based~~ intercropping system with vegetable crops as compared to farmers
practice, and ~~.~~

~~3) To studies~~ the soil fertility status of ~~arecanut~~Arecanut gardens growing with vegetable crops as intercrop before and after
the conduct of ~~on~~ on-farm trials.

2. MATERIALS AND METHODS

The ~~on~~ on-farm trials were conducted forthe assessment of vegetable crops as an intercropping system in the ~~arecanut~~Arecanut garden for additional returns at the farmer's field of Tumkur district, Karnataka state during the year from 2015-16 to 2016-17.The experiment was laid outin three treatmentswith seven trialsin a 26~~-year~~-year-old ~~arecanut~~Arecanut garden of Gubbi local variety planted with a spacing of 2.7 m x 2.7 m.A plot of ~~arecanut~~Arecanut sole crops was maintained as control (Farmers' practice), French bean (*Arkasuvidha* variety), and vegetable cowpea (*Arka suman*variety) as intercrops in ~~arecanut~~Arecanut garden.Hullihalli, Margondanahalli, and Karikerevillages of Tipturtaluk, Tumkur district wereselected for the conduct of two yearsof on-farm trials with an area of 1.2 ha ~~every year~~yearly.

The experiment consisted of three different intercropping systems as follows:

T_1 - ~~Arecanut~~Arecanut sole cropping (Farmers' practice)
T_2 – ~~Arecanut~~Arecanut + vegetable cowpea (*Arka suman*)
T_3 - ~~Arecanut~~Arecanut + French bean (*Arkasuvidha*)

The critical inputs were supplied to farmers and applied as per treatments (T_2) followed University of Agricultural Sciences, GKVK. Bengaluru package of practices and treatments (T_3) followed theIndian Institute of Horticultural Research, Bengaluru (CHES, Hirehalli) as the source of technology. The ~~on~~ on-farm trial plots at farmer's fields were regularly monitored by scientists of KrishiVigyan Kendra, Konehalli, and Tiptur.Basic data ~~of~~ onthe farmer's field was collected before the initiation of ~~on~~ on-farm trials. The data were ~~analysed~~ analyzed with appropriate statistical procedures.

3. RESULTS AND DISCUSSION

3.1 Influence of intercropping system on ~~arecanut~~Arecanut yield

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The yield data (Table 1.) of ~~arecanut~~Arecanut were recorded during the year from 2015-16 to 2016-17. The yield of chali~~arecanut~~Arecanut was found toslightly increase during the first year and gradually increased to a higher (P<0.05) yield~~(12.96 q/ha/year)~~duringthe second year in ~~french~~ the French beanas intercrop in the ~~arecanut~~Arecanut garden followed by cowpea as intercrop in the ~~arecanut~~Arecanut garden ~~with11.80 q/ha/year during first year and gradually increased to higher (12.70 q/ha/year) during second year~~. ~~Whereas~~ The lowest(P<0.05)~~chali~~Chaliyield was recorded inthe ~~arecanut~~Arecanut sole crop (Farmers' practice) during two years as compared to the intercropping system in the ~~arecanut~~Arecanut garden [1, 22].The additional increase(P<0.05)in yield of ~~arecanut~~Arecanut with intercropping of vegetable crops could be due to the synergistic effect of crop combination and ~~also~~ legume~~s~~ crops ~~increases~~ increasingsoil nutrient content. Results analogous to these findings were also reported [14, 16].

Table 1: Influence of intercropping system on ~~arecanut~~Arecanut yield

Tech. option	Details of technology	~~Arecanut~~Arecanut~~chali~~ Chaliyield (Q/ha/year)		Cumulative ~~2~~ 2-year mean ~~arecanut~~Arecanut~~chali~~ Chaliyield (Q/ha/year)
		2015-16	2016-17	
T_1	~~Arecanut~~Arecanut sole crop (Farmers' practice)	10.08	10.06	10.07
T_2	~~Arecanut~~Arecanut + Veg. cowpea	11.80	12.70	12.25
T_3	~~Arecanut~~Arecanut + French bean	12.10	12.96	12.53

3.2 Influenced of intercrop yield by cropping system

The yield data on intercrops were recorded (Table 2.) The variation in the yield of the intercrop was found during the cropping period. The data revealed that the intercrop yield of cowpea ~~(29.70 q/ha)~~and ~~french~~ French bean ~~(38.45 q/ha)~~during the first year~~,which~~increased ~~to 36.10 q/ha and 45.15 q/ha~~ during the second year in cowpea and ~~french~~ French bean ~~respectively~~.Similar results were recorded in the growth and yield parameters of vegetable crops as intercrops in the ~~arecanut~~Arecanut garden (Table 3.). This might be due ~~that~~ tothe growing of legume~~s~~ crops such as cowpea and ~~french~~ French bean as intercrops in ~~arecanut~~Arecanut garden, residual incorporated into soils which improve the physical, chemical, and biological ~~property~~ propertiesof soil[5, 20].~~Whereas~~ However,no additional crop~~s~~ yield was obtained in farmer's practices ~~and~~ whichalso decreases soil fertility status[8, 12].

Table 2: Influenced of intercrop yield by cropping system

Tech. option	Details of technology	Vegetable yield (q /ha)		Cumulative ~~2~~ 2-year mean vegetable yield (q/ha)
		2015-16	2016-17	
T_1	~~Arecanut~~Arecanut sole crop (Farmers' practice)	Mono-cropping	Mono-cropping	
T_2	~~Arecanut~~Arecanut + Veg. cowpea	29.70	36.10	32.90
T_3	~~Arecanut~~Arecanut + French bean	38.45	45.15	41.80

Table 3: Growth and yield parameters of vegetable crops as influenced by cropping system

Tech. option	Details of technology	Growth and yield parameters of vegetable crops						
		Germination percent (%)	Plant height (cm)	No. branches	No. of harvest	No. of pods/plant	Length of pod (cm)	Yield (q/ha)
T_1	~~Arecanut~~Arecanut sole crop (Farmers' practice)	--	--	--	--	--	--	--
T_2	~~Arecanut~~Arecanut + Veg. cowpea	75	72	24	4	65	17	32.90
T_3	~~Arecanut~~Arecanut + French bean	78	64	21	3	56	14	41.80

3.3 Economics of intercropping system in ~~arecanut~~Arecanut

The economicsof the intercropping system in the ~~arecanut~~Arecanut was worked out by calculating the total cost of cultivation, gross return, net return, and B:C Ratio (BCR) of all treatments. The total cost of cultivation was calculated by the total sum of expenditure of land preparation, seed, manure, and fertilizers, plant protection measures, irrigation and labo~~u~~r component, ~~and~~ *etc.* in ~~arecanut~~Arecanut and intercrops. The data (Table 4) revealed thatthe highest net returns~~(Rs. 2,56,832/ha/year)~~and BCR ~~(2.85)~~w~~as~~ere obtained in French beans as intercrops in ~~arecanut~~Arecanutfollowed by cowpea as intercrops in ~~arecanut~~Arecanut with net return (Rs.2,29,083/ha/year) and BCR (2.72).Whereas the lowest net returns ~~(Rs. 1,45,290/ha/year)~~and BCR~~(2.29)~~ ~~was~~were obtained in the ~~arecanut~~Arecanut as the sole crop in farmers' practice. This might be due to ~~that~~ theadditional income obtained from growing cowpeas and French beans as intercrops in the ~~arecanut~~Arecanut garden and also the market rate of beans as more demand compared to cowpeas as less demand in the market [4, 18]. The farmers soldthe market price of chali~~arecanut~~Arecanut at Rs. 25570/q, price of beans at Rs. 18/kg, Veg. cowpea Rs. 15/kg at the farmer field, and on that ~~base~~ basis,profitability was calculated [3, 15].

Table 4: Yield and economics of ~~arecanut~~Arecanut-based cropping system with vegetable crops

Tech. option	Details of technology	Yield of ~~arecanut~~Arecanut (q/ha/yr)	Yield of vegetable (q/ha)	Gross income (Rs./ha)	Cost of production (Rs./ha)	Net income (Rs./ha/yr)	B:C ratio
T_1	~~Arecanut~~Arecanut sole crop (Farmers' practice)	10.07	--	2,57,490	1,12,200	1,45,290	2.29
T_2	~~Arecanut~~Arecanut + Veg. cowpea	12.25	32.90	3,62,583	1,33,500	2,29,083	2.72
T_3	~~Arecanut~~Arecanut + French bean	12.53	41.80	3,95,632	1,38,800	2,56,832	2.85

(Market rate of chali~~arecanut~~Arecanut atRs. 25570/q, Price of beans Rs. 18/kg, Veg. cowpea Rs. 15/kg)

3.4 Effect of intercrops on soil fertility status of ~~arecanut~~Arecanut

The soil fertility status *viz*., NPK availability, pH, and electrical conductivity (EC) in soil were analyzedbefore initiation and after the experiment and compared with the pre- pre-experimental (Farmers practice) soil fertility status. The numerical improvedimprovement(P<0.05)in all the threemajor nutrients werewasobserved over the pre-treatment observation. The available N (282 kg/ha), P (22 kg/ha), and K(198 kg/ha)status was higher inarecanutArecanut + French bean intercrops, which is on far with fromarecanutArecanut + cowpea intercrops. Whereas the lowest (P<0.05)available N (262 kg/ha), P (17 kg/ha), and K (189 kg/ha) status was recorded in arecanutArecanut as sole crops [19]. This might be due to that theincorporation of residual after harvest of beans and cowpea pods[14]and also the high biomass of French beans and cowpea, which fixes atmospheric nitrogen, residue incorporated into soil and suppression of weed growth results in improvement of soil fertility status [17].

Table 5: Soil fertility status of arecanutArecanut intercrops with vegetable crops

Soil fertility status	ArecanutArecanut sole crop(FP)		ArecanutArecanut + Veg. cowpea		ArecanutArecanut + French bean	
	Pre-treatment (2015-16)	Post Post-treatment (2016-17)	Pre-treatment (2015-16)	Post Post-treatment (2016-17)	Pre-treatment (2015-16)	Post Post-treatment (2016-17)
N (Kg/ha)	268	262	268	278	268	282
P (Kg/ha)	19	17	19	21	19	22
K (Kg/ha)	192	189	192	195	192	198
pH	7.1	7.2	7.1	7.0	7.1	7.1
EC(ds/m)	0.30	0.31	0.30	0.29	0.30	0.28

4. CONCLUSION

The experiment concluded that the highestchaliarecanutArecanut yield, annual net return,and B:C ratio were recorded in french the French bean as intercrops in arecanutArecanut garden with more additional income and market demand of beans followed by cowpea as intercrops in arecanutArecanut garden, less market demand of vegetable cowpea, whereas the lowest net annual income were wasrecorded in arecanutArecanut sole cropping with no additional income from the farmers' practices. The soil fertility status of N, P, and K content ofthe soil in arecanutArecanut intercropping with beans and cowpeas on far with each other, but the lowest soil fertility were wasrecorded in arecanutArecanut as sole cropping system in farmer's practices. Higher net returns and improvedthe soil fertility by growing the french French bean as intercrops in the arecanutArecanut garden is a more suitable cropping system to boost the economy of farmers.

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Comment [es1]: MUST BE UPDATED as only 4.5% (1 out of 22) of the listed references were published in the past five years. The percentage has to increase to at least 35-40%. Old and un-updated references negatively impact the study and indicate that the study is no longer a point of interest

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Fig 1.Assessment of vegetable crops in the ~~arecanut~~Arecanut garden