The Pharma Innovation Journal 2023; 12(4): 1436-1438

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(4): 1436-1438

www.thepharmajournal.com
Received: 01-01-2023
Accepted: 04-02-2023

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Development of coconut based cropping system for sustainable productivity

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Abstract
Coconut is the most important crop and the livelihood of the farmers of the Karnataka state. A field experiment on coconut based cropping system was initiated during 2012-13 in Regional Horticulture Research Centre, Arsikere. Four treatments *viz*., T_1: 75% of recommended NPK fertilizer + organic recycling with vermicompost. T_2: 50% recommended NPK fertilizer+ organic recycling with vermicompost + vermiwash application + bio fertilizer application and in situ green manuring. T_3 (Fully organic): Organic recycling with vermicompost + vermiwash application + bio fertilizer application, in situ green manuring & green leaf manuring (Glyricidia lopping's) + Composted coir pith and mulching with coconut leaves. T_4 (Control): Mono crop of coconut with recommended NPK fertilizer and organic manure were laid out in non-replicated trial. Experiment results revealed that treatment T_3 (Fully organic) has produced the highest average yield of coconut (8056.67/ha), cocoa (224.20 kg/ha), lime (1010.55 kg/ha), Drumstick (798.75 kg/ha), banana (10411.67 kg/ha) Gross return (Rs.2,47,627/ ha) and net return (Rs.1,58,975/ ha).

Keywords: Coconut, coconut based cropping system (CBCS), benefit, cost ratio

Introduction
Coconut is a perennial crop with multiple uses in an ordinary person's day-to-day life and can be utilized to generate various value-added products. Considering the coconuts economic value, small and marginal farmers focus on coconut cultivation in their farms (Naik, 2017) [6]. Palms are widely found in the tropical and sub-tropical coastal regions globally and are called the Kalpavriksha or Tree of life because of their indispensable role in human life. Philippines and Indonesia are the leading coconut producers and contribute around fifty per cent of the total coconut produced globally (FAOSTST, 2018) [2]. India stands third in coconut production with better productivity of nuts per hectare (kalidas *et al.*, 2014) [5]. In India states like Kerala, Tamil Nadu and Karnataka have secured a top position by holding over two-third of the of the production and area of coconut cultivation in the country (Coconut Development Board (CDB), 2020) [1]. The coconut based cropping system gaining importance as there are serious market fluctuations for coconut and coconut products. Systematic mixed cropping of compatible crops under coconut to compensate the economic losses of sole cropping by increasing income per unit of cultivable land has become a necessity. Generating and establishing more suitable cropping system is need of the hour. Hence the present investigation was under taken to develop location specific coconut based cropping system model and to work out the economics of the model with the mono cropping of coconut.

Materials and Methods
The experiment to development of location specific Coconut Based Cropping System model was started during 2008-09 in an area of 0.40 ha. Old coconut palms are spaced at a distance of 10 m × 10 m. The inter crops like cocoa, lime and drumstick were planted in the coconut based cropping system during October 2008. Banana was added to the cropping system during October 2012. Schematic presentation of different crops arrangement is given in Fig. 1. Soil and water conservation practices were adopted by husk burial in pits before planting of intercrops. Mulching the basins of coconut and intercrops was done. During 2012-13, three treatments were imposed in the cropping system and were compared with the mono crop system of coconut. Banana was removed from the cropping systems during 2016-17 due to water scarcity and cocoa plants were also removed from cropping system during 2017-18 Vermicomposting was done using the wastes of coconut and intercrops and vermi-wash was collected it was applied after diluting to 1:10 proportions as per the treatment to different

crops. The fertilizers and organic manures- vermicompost, coir pith compost, vermiwash, bio fertilizers and green leaf manuring (Glyricidia lopping's) were applied to each crop as per treatments. The observation on the nut yield of coconut was recorded. The pods of Cocoa, drumstick and fruits of lime and banana were harvested and quantified per hectare of coconut garden. The economic analysis of the Coconut Based Cropping System under different nutrient management practices was done and compared with the mono crop of coconut. The returns were computed in rupee terms by combining the weighted average yield of various years under consideration with weighed average market prices prevailed during respective years.

Results and Discussions

Yield of different crops

The influence of treatments on average yield of coconut based cropping system and monocrop are presented in Table 1. With respect to nut yield, different treatment showed significant variation among the treatments. The highest number of nuts harvested in T_3 (8056.67 nuts/ha) whereas lowest was recorded in T_4 (7645.00 nuts/ha). The average nut yield of five years clearly indicates that there was gradual increase in the yield under all the treatments. With respect to the yield of cocoa the maximum average yield was recorded in treatment T_3 (224.20 kg/ha) and minimum was recorded in treatment T_1 (186.40 kg/ha). Cocoa crop was removed from the cropping system experiment in the year 2016-17 due to acute shortage of water. The highest average lime yield was recorded in T_3 (1010.55 kg/ha) and the lowest was in treatment T_1 (871.33 kg/ha). Drum stick average yield also showed gradual increase over the years in all the treatments, the maximum yield recorded in T_3 (798.75 kg/ha) and minimum yield was observed in T_1 (726.17 kg/ha). With respect banana crop yield, only three year data was recorded due to water scarcity and crop was discontinued from cropping system in the year 2016-17. During The cropping period highest yield of banana was recode in T_3 (10411.67 kg/ha) and the lowest yield was recorded in T_1 (9246.00 kg/ha). Application of organic manure and the total quantity of farm waste recycled from different components may the main reason for increase in yield in treatment T_3. Similar findings were also reported by many studies (Gill *et al.*, 2009; Jayanthi *et al.*, 2003) [3, 4].

Economics

The economics of the coconut based cropping system and the coconut mono cropping system was analyzed in the terms of average gross return, net return and benefit cost ratio. The average of five years data presented in Table 2. The maximum average gross return obtained in T_3 is Rs. 2,47,627/ ha. Whereas minimum average gross return of Rs. 1,13,270/ ha were obtained in T_4. With respect to average net return T_3 recorded highest of Rs. 1,58,975/ ha in comparison with T_4 which has recorded lowest average net return of Rs.66,532/ ha. Benefit cost ratio was also calculated for both the models where T_1 recorded highest of 4.00 whereas T_4 recorded the lowest of 2.42. Success of any model depends on amount of net return generated, treatment T_3 has generated highest net return of Rs. 1,58,975/ ha.

Glycricidia (Green leaf manure crop)				
Coconut		Drum stick		Coconut
	Cocoa		Banana	
Lime		Drum stick		Lime
	Cocoa		Banana	
Coconut		Drum stick		Coconut
Glycricidia (Green leaf manure crop)				

Fig 1: Schematic representation different crops in CBCS

Table 1: The influence of treatments on average yield of coconut based cropping system and mono crop of coconut

Treatment	Crop components	Yield of coconut and intercrops					
		2013-14	2014-15	2015-2016	2016-17	2017-18	Average
T_1	Coconut (No/ha)	9880.00	9000.00	9000.00	9000.00	9160.00	7673.33
	Cocoa (kg/ha)	171.00	236.00	257.00	268.00	-	186.40
	Lime (kg/ha)	868.00	965.00	1100.00	1170.00	1125.00	871.33
	Drumstick (kg/ha)	948.00	785.00	838.00	873.50	912.50	726.17
	Banana (kg/ha)	12642.00	8692.00	6404.00	-	-	9246.00
T_2	Coconut (No/ha)	10210.00	9300.00	9310.00	9210.00	9690.00	7953.33
	Cocoa (kg/ha)	190.00	276.00	282.00	295.00	-	208.60
	Lime (kg/ha)	966.00	986.00	1178.00	1266.00	1291.60	947.93
	Drumstick (kg/ha)	1082.00	829.00	912.00	943.00	990.00	792.67
	Banana (kg/ha)	12508.00	9033.00	6802.00	-	-	9447.67
T_3	Coconut (No/ha)	10420.00	9430.00	9480.00	9490.00	9520.00	8056.67
	Cocoa (kg/ha)	195.00	288.00	314.00	324.00	-	224.20
	Lime (kg/ha)	986.00	1116.00	1260.00	1368.00	1333.30	1010.55
	Drumstick (kg/ha)	988.00	862.00	964.00	971.00	1007.50	798.75
	Banana (kg/ha)	13800.00	9825.00	7610.00	-	-	10411.67
T_4	Coconut (No/ha)	9130.00	9170.00	9220.00	9270.00	9080.00	7645.00

Table 2: Economics (per ha) of coconut based cropping system (Average of five years data from 2014 to 2018)

Treatment	Gross returns (Rs.)	Cost of production (Rs.)	Net returns (Rs.)	B:C
T_1	227041	80900	146141	2.81
T_2	242897	89121	153776	2.73
T_3	247627	88652	158975	2.79
T_4	113270	46738	66532	1.70

Conclusion

The experiment results revealed that the treatment T3: (fully organic): Organic recycling with vermicompost + vermiwash application + bio fertilizer application, in situ green manuring & green leaf manuring (Glyricidia lopping's) + Composted coir pith and mulching with coconut leaves has produced the highest average yield (8056.67/ha), Gross return (Rs. 2,47,627/ ha), net return (Rs. 1,58,975/ ha). Hence, it can be concluded that the fully organic coconut based cropping system was more economical and would sustain the production and profit of the local farmers

Acknowledgment

The authors are grateful to University of Horticultural Sciences, Bagalkot, Karnataka and Central plantation Crops Research Institute, Kasaragoad, Kerala, for the financial assistance and support.

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