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Integrated Farming System -An Approach towards Livelihood Security, Resource Conservation and Sustainable Production for Small and Marginal Farmers

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Authors' contributions

This work was carried out in collaboration between all authors. Authors OK and HGS designed the study. Author DNB performed the statistical analysis. Author VSD wrote the protocol and wrote the first draft of the manuscript. Authors AP and SRR managed the analyses of the study. Author OK managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Per capita land holding has been reducing day by day due to fragmentation of land and farmers concentrate mainly on cropping systems approach rather than farming system approach. Integrated farming system (IFS) is considered as one of the best option towards farming system approach through intensification of small holder farm income to ensure livelihood security. This is an Experiment on Integrated farming system. As the IFS is an integration of all the crop components and subsidiary enterprises. The Integrated Farming System model was established and renamed as All India Co-ordinated Research Project, Main Centre for Cropping Systems Research to Integrated Farming System at Agriculture and Horticultural Research Station, Kathalagere, Karnataka during 2011-12 for 1 ha area under Indian Institute of Farming System Research (IIFSR), Modipuram, Meerut. Farming system approach includes cropping systems and

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subsidiary enterprises (Dairy, Sheep etc.,). Accordingly, the land was demarcated components wise on per cent basis out of 1.0 ha. Growing cropping systems like paddy-paddy /paddy-finger millet/paddy-pulse with 50 per cent area in order to meet the family food requirement and in addition to get better profit out of these produce. The results after 5th year of establishment of integrated farming system indicated that total production from cropping system was (16.04 t/ha /year of rice equivalent yield), Horticulture components (11.80 t/ha /year of rice equivalent yield), dairy (1.75 t/ha /year of rice equivalent yield), sheep unit (0.10 t/ha /year of rice equivalent yield) and vermicompost unit (1.88 t/ha /year of rice equivalent yield). Similarly, the net returns from various components *viz.,* crops (Rs.80, 795), Horticulture (Rs.38, 526), Dairy (Rs.4, 7278) and sheep unit (Rs.17, 876). The total quantity of produce recycled was (26,316 kg/l/nos) worth of Rs.43, 846 (three years average) was obtained. Effective recycling of farm waste in terms of vermicompost/compost can save Rs.12634 by addition of 1256 kg of nutrients in-terms of N, P & K. The total annual mandays generated out of various components varied from 515 to 932 mandays. Thus, we can conclude that adoption of integrated farming system improves the profitability and achieve sustainable production by effective recycling of natural resource in addition to meeting family needs.

Keywords: Integrated farming; benefit to cost ratio; mandays; recycle; socio-economic; enterprise.

ABBREVIATIONS

B:C : Benefit to Cost Ratio
REY : Rice Equivalent Yield
FYM : Farm Yard Manure
HF : Holstein Fresian
ICAR : Indian Council of Agriculture Research
IIFSR : Indian Institute of Farming System Research

1. INTRODUCTION

Indian agriculture faces serious challenge in attaining sustainability and profitability of farming due to decline in land holding. The average size of the landholding has declined to 1.16 ha during 2010-11 from 2.28 ha in 1970-71. If this trend continues, the average size of holding in India would be mere 0.68 ha in 2020 and would be further reduced to 0.32 ha in 2030 [1]. The farming community constitutes more than 85 per cent who belongs to marginal and small farmers. Majority are illiterate, financially handicapped, their holdings are small and scattered, resource poor and frequently posed to diverse risk conditions. Under this prevailing situation, call for an alternative farming system which integrate agriculture and subsidiary enterprises to make farming more profitable, employment generation and attain sustainability is much necessary [2,3].

The income for an average farmer from cropping system alone is hardly sufficient to sustain his family. The farmer has to be assured of a regular income for a reasonable standard of living by including other subsidiary enterprises. In the context of the above facts there is a strong need to commercialize agriculture and economic development of farming families. Farming should be considered as a system as a whole in which crop and other enterprises that are compatible and complementary. Similarly, during the last five decades, research in agriculture has emphasized on cropping system approach rather than farming system which is leading to development of crop varieties, animal breeds, farm implements and machinery and other production and protective technologies, which enabled the farmers to grow more but at the same time optimally exploit the resources. On the contrary, cropping system has failed to attain sustained livelihood security and also resulted in decrease productivity, resource use efficiency and ultimately less profitability [4,5].

Farming system approach is a complex inter-related set of crop components, horticulture, dairy, sheep and other subsidiary enterprises, etc. which are interdependent and complimentary to each other. The judicious mixture of the crops and animal enterprises must be based on the principle of minimizing the competition for resources and maximizing net returns among enterprises. Farm as a unit is to be considered and planned for effective integration of enterprises for combination along with crop activity. An economic assessment of farming systems aims at finding the magnitude of profits from each component of the farming system and also to enhance the utilization capacity of locally available resources [6,7]. Keeping in view of all these factors, the present study has been initiated to study the economics and livelihood security of farmers through integrated farming system in Bhadra command of Karnataka.

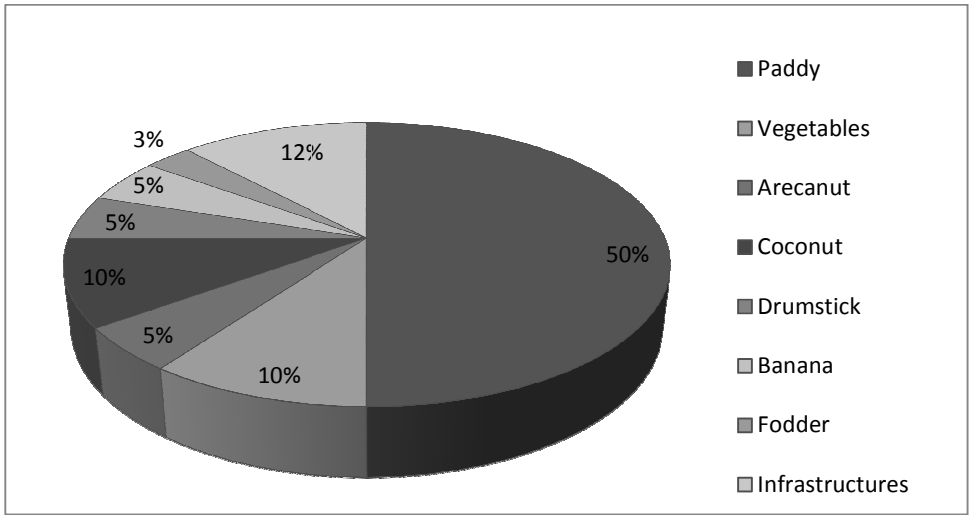

Fig. 1. Component wise area (%)

2. MATERIALS AND METHODS

The study was conducted on irrigated based integrated farming system for marginal and small farm holders with an area of 1.0 ha at Agricultural and Horticultural Research Station, Kathalagere, Davangere district of Karnataka state under Bhadra command area during 2011-12 to 2015-16 under financial and technical assistance from ICAR-Indian Institute of Farming System Research, Modipuram, Uttar Pradesh. The allocation of land resource for accommodating different enterprises was done as per the family needs (calculated for a family of 5 members as per standard given by Dr. M.S. Swaminathan, 1998) and size/numbers of individual components of the system. Out of one hectare area, 0.50 hectare was allotted for crop component (Cereals, pulses and millets), 0.35 hectare was taken up with Horticulture crops (Arecanut, Coconut, Banana, Drumstick and Vegetables). Diary and Sheep components were also introduced as additional components with buffalo (one) + HF cow (two) and sheep (10+1). Green fodder block was fixed in an area of 0.03 hectare (Fig. 1). Additional components like compost (2 units), vermicompost (3 units) and Azolla (2 units) were included subsequently in the system. Cow dung, urine, sheep excreta, farm wastes and crop residues were properly recycled by composting (FYM and vermicompost) and incorporated in to the soil. Similarly, Azolla was released in to paddy field as source of nitrogen fixer and also used as animal feed in limited quantity (1:10 ratio of azolla and feed). Cost of production includes all input costs (fixed and variable costs), labour and machineries were subjected for calculation.

3. RESULTS AND DISCUSSION

3.1 Profitability of Integrated Farming System Model

The data after 5th year of study indicated that adoption of integrated farming system by inclusion of crop based enterprises, Horticulture, Dairy, Sheep and other subsidiary units have recorded overall average net returns of Rs.186571 with the highest been contributed by crop component alone (Rs.80795), followed by dairy (Rs. 47378), horticulture (Rs. 38526) and sheep (Rs. 17876) (Table 3) and (Fig. 2). Similarly, component wise overall average farm production is (43.52 Rice equivalent yield t/ha). Crop component alone is contributing highest production (16.04 REY t/ha), followed by horticulture (11.80 REY t/ha), vermicompost (1.88 REY t/ha) and dairy (1.75 REY t/ha) (Table 1) and (Fig. 3). Apart from growing crop component alone, other subsidiary enterprises are significantly contributing in improvement of net profit of farmer. These results are conformity with the finding of [8,2,9] and [10].

3.2 Employment Generation in Integrated Farming System

Integrated farming system has created more number of working hours in the system due to involvement of more enterprises than cropping system alone. It was obtained that 1.0 ha model

has generated 515 mandays, 760 mandays, 1070 mandays and 932 mandays per hectare per year during 2012-13, 2013-14, 2014-15 and 2015-16, respectively (Table 7). This has provided employment opportunity throughout the year due to involvement of more than one enterprise in the system. The results are in accordance with the findings of The results are in accordance with the findings of [6,5] and [11].

3.3 Resource Recycling in Integrated Farming System

The average quantity of nutrients recycled from farm waste from various components (2013 to 2015) accounted for 26316 kg/l/no's of worth Rs.43847 (Table 4). The total quantity of farm waste recycled from different components during the year 2015-16 accounted for 15433 kg, Out of total recommended NPK of farming system (crop component and horticultural crops), inorganic and organic source of nutrients are estimated for 300 kg/ha and 3000 kg/ha, respectively. Presently, the total quantity (462.50 kg) of organic source of nutrients are being recycled from farm waste obtained from different components. More than 35 per cent of NPK requirement would be met through recycling of farm wastes in form of compost and vermi compost within the system itself and was found very economical in saving the use of chemical fertilizers or its substitutes and also improves the soil health condition, there by enhanced the organic matter and microbial activity which resulted in sustainable production. This finding is in accordance with the findings of [5,4].

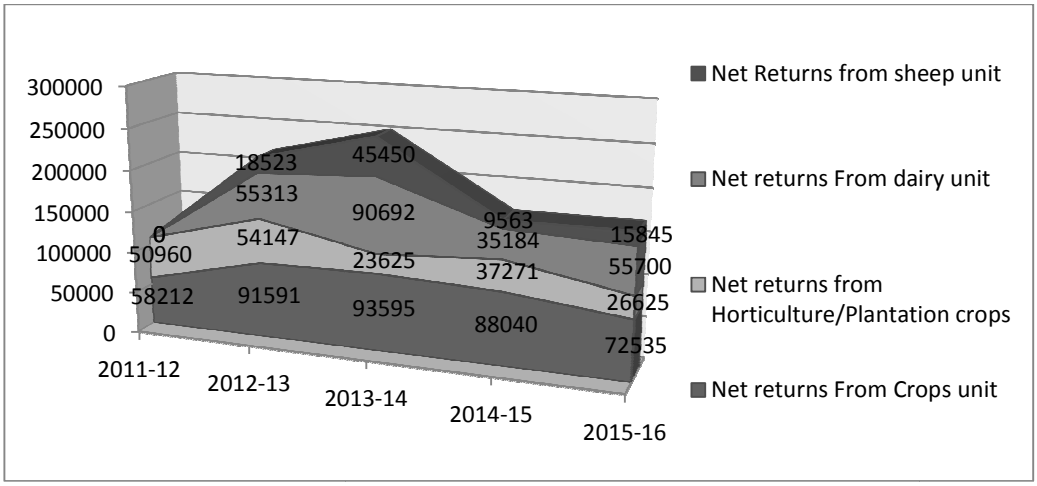

Fig. 2. Component wise net returns of integrated farming system

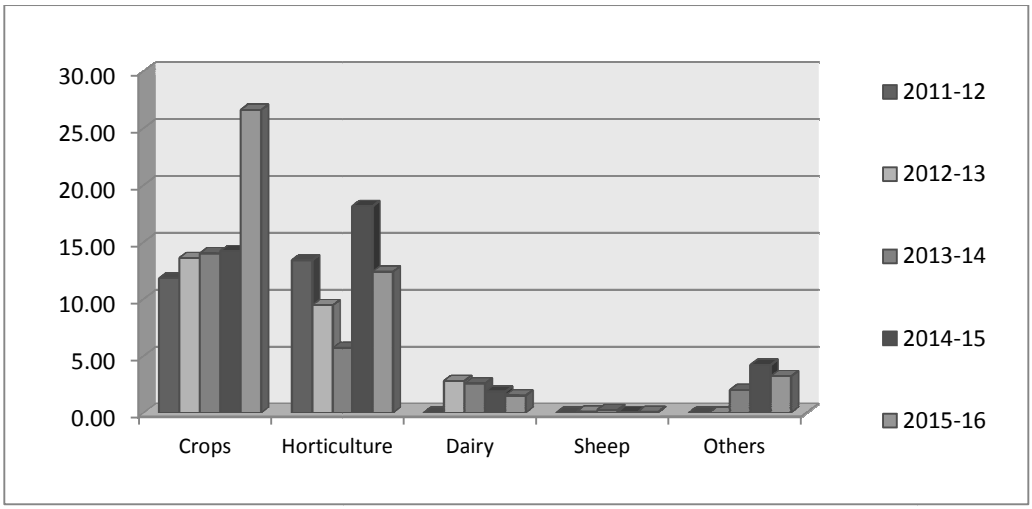

Fig. 3. Component and year wise total production (REY t/ha)

Table 1. Farm production details from integrated farming system model

Year	Total farm production (Rice equivalent yield-t/ha)	Total production (REY t/ha) from crops unit	Total production (REY t/ha) from fruits and vegetables crops	Total production (REY tons) from dairy unit	Total production (REY tons) from sheep unit	Vermicompost (REY tons)
2011-12	28.84	11.80	13.40	0.00	0.00	0.00
2012-13	36.04	13.60	9.45	2.81	0.10	0.00
2013-14	37.42	14.00	5.70	2.57	0.24	2.00
2014-15	58.66	14.20	18.15	1.85	0.06	4.20
2015-16	56.64	26.60	12.40	1.51	0.09	3.22
Average	**43.52**	**16.04**	**11.80**	**1.75**	**0.10**	**1.88**

*** Please consider Farmer Gate Price of an individual farm commodity and also use it when converting in to REY and Gross and Net returns*

Table 2. Gross returns (Rs. /ha) from the integrated farming system model

Year	Total Gross returns (Based on Actual farm area as well as per hectare basis)	Gross returns From Crops unit	Percent to total Gross returns	Gross returns from Horticulture/ Plantation crops	Percent to total Gross returns	Gross returns From Livestock unit and	Percent to total Gross returns	Gross Returns from sheep unit	Percent to total Gross returns	Gross returns from other enterprises and its percent to total GR
2011-12	150599	76440	69.68	72059	117.68	0	0	0	0	0
2012-13	280419	113600	103.55	73230	119.59	67464	112.48	25250	103.06	-
2013-14	349122	143480	130.79	38480	62.84	117642	196.14	59000	240.82	-
2014-15	231454	117150	106.79	54120	88.38	44434	74.08	15750	64.29	-
2015-16	258980	97850	89.20	68280	111.51	70350	117.29	22500	91.84	-
Average	**254115**	**109704**	**100.0**	**61234**	**100.00**	**59978**	**100.00**	**24500**	**100.00**	**-**

*** Please consider Farmer Gate Price of an individual farm commodity and also use it when converting in to REY and Gross and Net returns*

Table 3. Net returns (Rs. /ha) from the integrated farming system model

Year	Total Net returns (Based on actual farm area as well as per hectare basis)	Net returns from crops unit	Percent to total net returns	Net returns from horticulture/ plantation crops	Percent to total net returns	Net returns from dairy unit	Percent to total net returns	Net Returns from sheep unit	Percent to total net returns	Net returns from other enterprises and its percent to total NR
2011-12	109172	58212	72.05	50960	133.21	0.0	0.0	0	0.0	0
2012-13	219574	91591	113.36	54147	141.54	55313	116.75	18523	103.62	-
2013-14	251722	93595	115.84	23625	61.76	90692	191.42	45450	254.25	-
2014-15	170058	88040	108.97	37271	97.43	35184	74.26	9563	53.50	-
2015-16	182330	72535	89.78	26625	69.60	55700	117.57	15845	88.64	-
Average	**186571**	**80795**	**100.00**	**38526**	**100.71**	**47378**	**100.00**	**17876**	**100.00**	**-**

*** Please consider Farmer Gate Price of an individual farm commodity and also use it when converting in to REY and Gross and Net returns*

Table 4. Total recyclable nutrients (kg)

Components	Total produce recycled (kg/lit./Nos.) 2013-14	Total produce recycled (kg/lit./Nos.) 2014-15	Total produce recycled (kg/lit./Nos.) 2015-16	Pooled data of total produce recycled (kg/lit./Nos.) 2013 to 2015	Total value of recycled product (Rs.) 2013-14	Total value of recycled product (Rs.) 2014-15	Total value of recycled product (Rs.) 2015-16	Pooled data of Value of recycled product (Rs.) 2013 to 2015
Crops (Paddy straw, weeds and crop residue)	5750	7562	11780	8364	10500	17875	16665	15013
Horticulture(Crop residue & Banana waste)	2000	5685	3375	3687	0.0	5685	3375	3020
Dairy (Dung, urine & shed waste)	1000	6623	12128	6584	2000	0.0	0.0	667
Sheep (Dung & litter)	2214	2208	4462	2961	6642	6624	13386	8884
Vermicompost (Raw dung, urine and shed waste)	2000	4197	3217	3138	10000	20985	16085	15690
Other units (Dried leaves & coconut plant debris)	0.0	1582	3164	1582	0.0	1720	0.0	573
Total	**12964**	**27857**	**38126**	**26316**	**29142**	**52889**	**49511**	**43847**

Table 5. Total Input cost and percent share of the inputs purchased/generated and recycled within the system

Year	Total input cost (Rs.) (TIC)	Value of inputs purchased from market (Rs.) and its percent share in TIC	Value of Inputs (Rs.) generated and recycled within farm and its percent share in TIC	Number of labour engaged, annual expenditure on it and its percent share in TIC
2011-12	16000	40403 (87.06)	-	-
2012-13	63370	25445 (12.5%)	75295 (75%)	25720 (12.5%)
2013-14	97400	10200 (7.80%)	23142 (17.70%)	97400 (74.50%)
2014-15	61397	16860 (6.45%)	39676 (15.17%)	44537 (17.03%)
2015-16	90900	20995 (23.72%)	49511 (44.06%)	60505 (68.37%)
Average	**71894**	**18375**	**46906**	**57041**

Table 6. Contribution of different farm enterprises in resource recycling and overall saving (%) in production cost

Year	Cost of production (Rs.)	Enterprise wise value of recycled products and by-products (Rs)					Total value of recycled farm products	Farm labour engaged		Saving with recycled farm products (%)	Saving from farm labour engaged (%)
		Crops	Dairy	Horti.	Fishery	Others (Biogas/ Mushroom etc)		Man days	Value		
2011-12	46403	-	-	-	-	-	-	-	-	-	-
2012-13	63370	-	-	-	-	-	-	515	56650	-	-
2013-14	97400	9000	2000	-	-	16642	29142	830	124500	29.92	10.73
2014-15	61397	2940	20985	5685	-	10066	39676	1070	160500	15.17	17.03
2015-16	90900	12220	16085	3375	-	17831	49511	932	139800	44.06	68.37
Average	**71894**	**4832**	**7814**	**1812**	**0**	**8908**	**23666**	**669**	**96290**	**-**	**-**

Table 7. Employment generation in different components (Mandays)

Components	2012-13	2013-14	2014-15	2015-16
Paddy	75	120	182	70
Vegetables				60
Banana	155	180	156	30
Arecanut				65
Coconut				
Dairy	180	180	317	325
Sheep	-	250	315	320
KG*, BP* etc.,	105	100	100	62
Total mandays	**515**	**760**	**1070**	**932**

** KG – Kitchen garden, BP – Boundary Plantation*

Table 8. Total amount of nutrient added through recycling and its market value during 2014-15

Recyclable farm waste	Quantity (kg)	Nutrient content (%) and total recyclable nutrients (kg)			Quantity of fertilizers (kg)	In terms of rupees (Rs.)
		N (kg)	P (kg)	K (kg)		
Vermi compost	3213	32.13	11.88	17.02	331.30 (Urea)	2319
Cow dung	5213	57.34	22.41	24.50	316.40 (SSP)	2753
Sheep litter	2208	63.18	16.33	40.41	139.30 (MOP)	2786
Total	**10634**	**152.65**	**50.62**	**81.93**	**-**	**7858**

Table 9. Total amount of nutrient added through recycling and its market value during 2015-16

Recyclable farm waste	Quantity (kg)	Nutrient content (%) and total recyclable nutrients (kg)			Quantity of fertilizers (kg)	In terms of rupees (Rs.)
		N (kg)	P (kg)	K (kg)		
Vermicompost	3217	32.17	11.91	17.05	540.5 (Urea)	3784
Cow dung	7754	85.29	33.34	36.44	489.2 (SSP)	4256
Sheep litter	4462	131.63	33.02	81.65	229.7 (MOP)	4594
Total	**15433**	**249.09**	**78.27**	**135.14**	**-**	**12634**

4. CONCLUSION

Farming per cent is reducing day by day due to fragmentation of land holding which has in-turn resulted in declining per cent population involving in Agriculture; and rural youths are migrating to urban area in search of employment. Similarly, farming practices is purely dependent on rainfall which is erratic and unseasonal, and also excess use of toxic chemicals and inorganic fertilizers, under such circumstances agriculture has proved to be non-profitable. Similarly, recycling of farm wastes generated in the system in the form of compost and vermi compost has reduced use of chemicals fertilizers thereby minimized heath and environmental hazards. Integrated farming system improves economic condition of the small and marginal farmers which enhanced the education, health and social obligations and overall improvement in livelihood security. This shows the soundness of Integrated Farming System approach and its utility for small and marginal landholders of the region.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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