Yield, Productivity and Economics of Integrated Farming System under Irrigated Conditions of Western Maharashtra

Abstract

The study was conducted at All India Co-ordinated Research Project on Integrated Farming System, Mahatma Phule Krishi Vidyapeeth, Rahuri during 2018-2019 and 2019-2020 to develop integrated farming system model for irrigated conditions of Western Maharashtra. The model was designed for 1 ha area with crop, horticulture, dairy, goat, poultry and vermicompost unit. The integrated farming system model generated sugarcane equivalent yield of 375 t ha^{-1}. The gross monetary returns from crop + horticulture + dairy + goat + poultry + vermicompost unit were ₹ 10,55,758 and net monetary returns of ₹ 4, 58, 943 with B:C ratio (1.77). Of this total net returns obtained from integrated farming system model per cent contribution of different components were crop (25 %), horticulture (4%), dairy (24 %), goat (18 %), poultry (29 %) and vermicompost (7 %). Employment generation in integrated farming system model was 422 Man days $year^{-1}$.

Keywords: Integrated farming system, productivity, profitability, employment generation

1. Introduction

The biggest challenge is to provide food for the ever increasing population which is increasing in a sky-rocketing manner while it's quite impossible to increase the area of production. So, the real challenge is to increase the productivity to feed the fast growing population. Assumption of present Indian population estimation was 1.3 billion by 2020. The demand for food on the basis of present consumption pattern would likely to increase from 300 to 350 mt as against present production approximately 260 mt [2]. Conventional agriculture has caused economic problems associated with increased costs of energy-based inputs, lessened farm incomes etc. It has also produced ecological problems such as poor ecological diversity, soil erosion, and soil and water pollution. Integrated Farming System (IFS) is considered as one of the best option towards intensification of small holder farm income to ensure sustainable livelihood. Integration of resources is made through a combination of land, water and animal resources of a farm through careful planning including recycling of bio-resources [10].

The Indian rural economy is mainly dependant on small and marginal farmers which constitute 85 per cent of the total farming community but posses only 44 per cent of total operational land. Due to economic conditions most of the farming operations are labour oriented and requires lot of man-power as well as energy and even after this hard work the farmer is not left with good amount of returns and hence, poor livelihood. The cost of cultivation either exceeds or is less than equal to the returns he receives at the end of farm products sale. Development of an alternative solution is an urgent need to stabilise farmer's income. Integrated Farming System (IFS) is an interdependent, interrelated often interlocking production systems based on few crops, animals and related subsidiary enterprises in such a way that maximize the utilization of nutrients of each system and minimize the negative effect of these enterprises on environment. The interrelated, inter-dependent and interlocking nature of IFS involves the utilization of primary produce and secondary produce of one system, as basic input of the other system, thus making them mutually integrated as one whole unit.

Crop-based agriculture is highly season-specific, with peaks of labour requirement at certain time of year and farmers don't have adequate employment during the rest time of the year. The IFS has ability to generate additional employment and more equitable distribution of employment throughout the year, and thus ensures a steady sink for local labour force. Integrated farming System is a labour intensive system, which creates on-farm employment and most of the labour required in the production process is contributed by the farmer and his family members [3].

2. Material and methods

The study was carried out at All India Co-ordinated Research Project on Integrated Farming Systems, Mahatma Phule Krishi Vidyapeeth, Rahuri district Ahmednagar, Maharashtra. Geographically Central Campus of Mahatma Phule Krishi Vidyapeeth, Rahuri is situated between 19° 48' and 19° 57' North latitude and 74° 52' and 74° 19' East longitude, and its mean height above sea level is 395 to 565 meters. This tract is lying on the eastern side of Western Ghats and falls under rain shadow area. It comes under transition belt having semi-arid climate. It receives most of the rainfall from South-West monsoon, commencing from middle of June. The Integrated farming system model of 1 ha area comprised of crop, horticulture, dairy, goat, poultry and vermicompost unit. Details of the components are given in Table 1. Layout of integrated farming system model is given in Figure 1.

Table 1. Details of the components in IFS Model

Sr. No.	Components			Area (ha)
A	Cropping systems			-
	Kharif	*Rabi*	Summer	-
1	Maize	Chickpea	Summer vegetables(Okra and Cluster bean)	0.15
2	Soybean	Onion	Sweet corn	0.15
3	Cotton	Wheat	-	0.15
4	Sugarcane			0.15
5	Lucerne			0.10
6	Hybrid Napier			0.05
7	Total			**0.75**
B	Horticulture (Mixed planting) 31 plants each 8 m × 8 m distance			**0.20**
8	Guava (Sardar-49)			-
9	Pomegranate (Bhagwa)			-
10	Custard apple (Balanagar)			-
11	Drumstick (Bhagya)			-
12	Intercropping of Marigold (Calcutta marigold yellow and orange)			-
C	Dairy			-
13	Two *Phule Triveni* cows			**0.01**
D	Goat			-
14	*Sangamneri* goats (10 Does + 1 Buck)			**0.01**
E	Poultry (1600 birds year^{-1})			-
15	*RIR/ Kaveri* birds 400 Birds batch^{-1} Four batches year^{-1}			**0.01**
16	Vermicompost 4 NADEP beds and 5 Tetra vermibeds			**0.02**
17	Total			**1.00**

Average yield of both the years (2018-2020) was used for analysis. The integrated farming system was analysed for productivity, profitability and employment generation. The system productivity was worked out by converting the yield of different components in to sugarcane equivalent yield (t ha^{-1}) based on farm gate price of the produce. The formula used for component and system productivity given by De Wit, [4] is given below,

$$SEY = \frac{\sum(\text{Production } (t^{-1}) \text{ of } i^{th} \text{ crop/component x price } (t^{-1}) \text{ of that } i^{th} \text{ crop/component})}{\text{Price of Sugarcane } (t^{-1})}$$

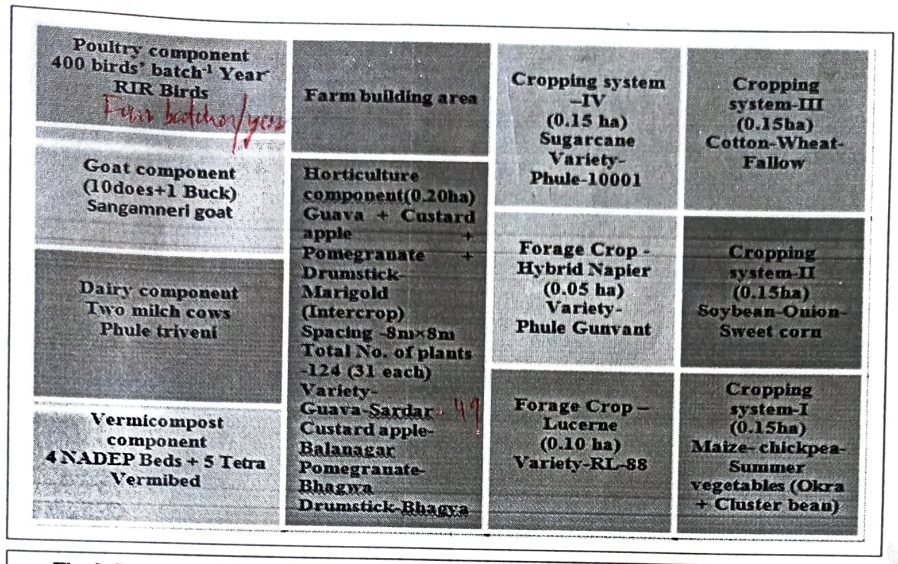

Fig. 1. Layout of IFS model at AICRP on Integrated Farming System, MPKV, Rahuri

3. Results and Discussion

The details of yield obtained from various components in integrated farming system are given in Table 2 to Table 5.

3.1 Crop component

Crop yield obtained from various crops during *kharif* season in integrated farming system were maize grain yield 9.37 q, stover yield 14.51 q, soybean grain yield was 3.48 q and stover yield 3.90 q from 0.15 ha area. Cotton yield was 4.12 q having stalk yield of 4.85 q. *Rabi* crops consisted of chickpea, onion and wheat. The respective yield of *rabi* crops were chickpea grain 4.65q, onion bulb 35.06q and wheat grain 6.72 q. During summer in cropping system-I two vegetable crops okra and cluster bean were cultivated. Okra yield on 0.10 ha area was 11.93 q and the by-produce yield was 9.12 q. Cluster bean was grown on 0.05 ha area which gave yield of 2.85q and by-produce yield accounted 2.28 q. In cropping system-ii sweet corn yielded 3056 no. of cobs and 15.89 q stover yield during summer. Sugarcane yield was 155 q and the trash yield was 11.45 q. Forage crops lucerne yielded 122.50 q which was cultivated on 0.10 ha area and hybrid napier 74.22q on 0.05 ha area (Table 2).

From 0.75 ha area occupied by crop component the ne returns obtained were ₹1,18,137, the total cost of cultivation was ₹ 1,45,553. The results regarding economics were similar with Singh *et al.* [20], Yadav *et al.* [23], Surve *et al.* [21], Singh and Burark [19], Sharma *et al.* [17] and Patel *et al.*[9].

Table 2 Yield and prices of field crops in crop component

Cropping system	Area (ha)	Yield (q ha^{-1})					
		Kharif		*Rabi*		Summer	
		Main produce	By produce	Main produce	By produce	Main produce	By produce
Maize-Chickpea-Summer vegetables (okra and cluster bean)	0.15	9.37	14.51	4.65	5.75	11.93	9.12
						2.85	2.28
Soybean-Onion-Sweet corn	0.15	3.48	3.90	35.06	0.44	3056	15.89
Cotton-Wheat	0.15	4.12	4.85	6.72	6.00	-	-
Perennial crops							
Sugarcane	0.15	155	11.45	-	-	-	-
Lucerne	0.10	122.50	-	-	-	-	-
Hybrid napier	0.05	74.22	-	-	-	-	-

Chart 1 Profitability of different cropping system in crop component

Cropping system	Area (ha)	Yield (q ha^{-1})						Total	
		Kharif		*Rabi*		Summer			
		GR	NR	GR	NR	GR	NR	GR	NR
		(₹)							
Maize-Chickpea-Summer vegetables (okra and cluster bean)	0.15	17333	5854	17190	6031	30625 16308	20196 8472	81455	40550
Soybean-Onion-Sweet corn	0.15	11886	2014	28057	10720	32939	16451	72882	29185
Cotton-Wheat	0.15	23110	8936	15295	4513	-	-	38405	13448
Perennial crops									
Sugarcane	0.15	39404	18480	-	-	-	-	39404	18480
Lucerne	0.10	24185	14197	-	-	-	-	31545	16475
Hybrid napier	0.05	7360	2279	-	-	-	-		
Total	-	-	-	-	-	-	-	**263690**	**118137**

3.2 Horticulture component

Yield from fruit crops in initial two years 2018-2019 and 2019-2020 of experiment was not obtained as it takes three years for fruiting and establishment of orchard. Therefore, yield obtained from drumstick and marigold was taken from horticultural component of integrated farming system model (Table 3)

Table 3 Yield of horticultural component in integrated farming system model

Horticulture Component	Yield (q)	Gross monetary returns	Cost of cultivation	Net monetary returns
		(₹)		
Drumstick	4.96	38580	25217	13363
Marigold	7.90			

Drumstick: ₹ 30 kg^{-1}, Marigold: ₹ 30 kg^{-1}

Yield obtained from marigold and drumsticks were 7.9 q and 4.96q. The net returns obtained from horticulture crops were ₹ 13363. It was observed that marigold or floriculture plays an important role as intercrop especially during the Indian festival season of *Dasshera* and *Diwali*. These festival seasons are gave opportunity for getting high prices for flowers produce. Drumstick has great importance in horticultural component as it starts yielding from the first year of planting. *Bhagya* is dwarf variety, having self pruning property and less prone to disease and pest incidence. Dwarf characteristic of drumstick decreased the time of harvesting. Drumstick is a cherished vegetable during summer. Supply and demand relationship plays an important role during summer. In summer there is less supply of vegetables in markets compared to demand, which increases prices of vegetables. Summer is a peak time of drumstick harvesting. Recent awareness of nutritional value of drumstick there is demand for drumstick in market.

3.3 Livestock component

From dairy component 4299 litres of milk was obtained during a 12 months period. The manure obtained from dairy was 6069 kg. Two calves were born in a year to both of the cows giving additional profit. The weight of 10 does and a buck was 342 kg. 11 kids were born in first year out of which 7 kids were sold weighing 210. Remaining 4 does were added in the main herd. The average weight of

the goats was 584 kg. Milk yield obtained in a year from goat component was 156 litres. Goat manure obtained during a period of 12 months was 3543 kg. Total 1600 birds in four batches of 400 birds were reared in a year. The total weight of 1600 birds was 3179 kg and poultry manure obtained weighed 1178 kg (Table 4)

The capital investment on goat increases with increase in intensity or number of animals in herd [14]. Goat are high remunerative livestock component giving more than two B:C ratio overtime [8].Compared to conventional farming system the total net returns increased with adoption of various enterprises in integrated farming system [15]. With suitable combination of enterprise in the integrated farming system generates additional income. These results were in agreement with Ponnusamy and Devi [12]. Poultry farms are more viable and economic overtime. These results were in agreement with Pawariya and Jheeba [11].

Table 4 Yield of livestock components in integrated farming system model

Component	Production	Yield	GR	Cost of production	NR
			(₹)		
Dairy	Milk (lit.)	4299	164252	113378	50875
	Cow dung (kg)	6069			
	Calf (no.)	2			
Goat	Milk (lit.)	155.5	185848	120710	65138
	Live weight (kg)	584			
	Manure (kg)	3543			
Poultry	Live weight (kg)	3179	319373	170228	149145
	Manure (kg)	1178			
Total	-	-	**669473**	**404316**	**265157**

Dairy: milk ₹ 34 litre^{-1}, cow dung 1.5 kg^{-1} , calf : 9000
Goat: meat ₹ 300 kg^{-1}, milk ₹40 litre^{-1}, goat manure ₹ 1.25 kg^{-1}
Poultry: live weight ₹ 100 kg^{-1}, ₹ 1.25 kg^{-1}

3.4 Vermicompost component

Total vermicompost obtained 7385 kg. Vermiwash collected from the compost was 263 litres and the vermiculture sold was 18360 (no.). Vermicompost as a finished product has more demand in organic manure market. Vermicompost is rich in macro as well as micronutrients. The returns obtained from vermicompost were higher than the investment (Table 5).

3.5 Integrated farming system model

The integration of different components on 1 ha area resulted into a total productivity of 375 t ha^{-1} Sugarcane equivalent yield. The net returns obtained from an entire system was ₹4,58,943. Integration of goat component in the existing model increases the net income. Intensifying poultry batches also increased net returns. Limited employment is generated from crop component alone. Integration of different components generated additional employment. The integrated farming system model generated an employment of 422 man days year^{-1}.

Crop in combination with livestock and other suitable enterprises not only provided income but round the year employment, employment in lean season where relaxation is observed in traditional agriculture Ravisankar *et al.*, [13].The observed results were in agreement with Surve *et al.* [21], Goverdhan *et al.* [6], Kumar *et al.* [7], Babu *et al.* [1], Patel *et al.* [9] and Tejaswara Rao *et al.* [22].

Setboonsarng [16], Sharmin *et al.* [18] and Goswami and Dasgupta [5] discussed about role of woman in integrated farming system, they said integration of farming system is beneficial as it provides employment to woman in poultry rearing, cattle rearing and goat rearing. Since resources for livestock are produced on farm (fodder and poultry feed) woman doesn't require traveling longer distances. Farm outputs are sold in local market which gave cash income.

Table 5 Yield of Vermicompost component in integrated farming system model

Vermicompost component	Yield	GR	COC	NR
Vermicompost (kg)	7385	59080	21730	62285
Vermiwash (lit.)	263	6575		
Vermiculture (No.)	18360	18360		
Total	-	84015	21730	62285

Vermicompost: ₹8 kg^{-1}, vermiwash: ₹ 25 $litre^{-1}$, Vermiculture: ₹ 1 $worm^{-1}$

Table 6 Productivity,Profitability and employment generation of integrated farming system model

Particular	Crop	Horticulture	Dairy	Goat	Poultry	Vermicompost	Total
Productivity(t ha^{-1}	86	15	57	69	125	23	375
CoC	145553	25217	113378	120710	170228	21730	596816
GR	263690	38580	164252	185848	319373	84015	1055758
NR	118137	13363	50875	65138	149145	62285	458943
B:C	1.81	1.53	1.45	1.54	1.88	3.87	-
Employment generation	107	23	98	137	32	22	422

4. Conclusion

Integrated farming system provides diversified cropping system within 1 ha area which fulfils the requirement of cereals, pulses, oilseeds, fruits and vegetables of the farm family. The integrated farming system having combination of Crop + Horticulture + Dairy + Goat + Poultry + Vermicompost achieved higher system productivity of 375 sugarcane equivalent yield (SEY t ha^{-1}). Economically livestock components provided income round the year. Intensified poultry batches were found to be profitable in the studied model. Along with poultry, goat and vermicompost component were also found economical. The mean net returns obtained from Crop + Horticulture + Dairy + Goat + Poultry + Vermicompost ₹ 4,58,927, respectively. Addition of components in the integrated farming systems helped in employment generation up to 422 man days $year^{-1}$. In order to double farmer's income and generate employment round the year IFS approach is better over specialized farming system.

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