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ECONOMICS OF DIFFERENT INTEGRATED FARMING SYSTEM MODELS UNDER IRRIGATED CONDITIONS OF WESTERN MAHARASHTRA

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ABSTRACT

The experiment was carried out during 2018-2019 to 2019-2020 at All India Co-ordinated Research Project on Integrated Farming Systems, Mahatma Phule Krishi Vidyapeeth, Rahuri, District Ahmednagar, Maharashtra. The integrated farming system model was planned for 1.00 ha area for irrigated condition of Western Maharashtra region which consisted of crop component, horticulture component, livestock component (dairy, goat, poultry) and vermicompost. Seven integrated farming system models were formulated by using suitable combinations of different components in the farming system to identify the best economically viable IFS model as well as component among all seven models and six components economic analysis. The average incremental benefit cost ratio of 1.88 was highest by combination of poultry component in the IFS model. Average ICBR ratio with addition of goat and horticulture components was 1.54 and 1.53.Crop (25%), horticulture (4%), dairy + vermicompost (24%), goat (18%), and poultry (29%) contributed the most to the net monetary returns of IFS models.Treatment T_7 having all six components (crop, horticulture, dairy, goat, poultry and vermicompost) which was found to be best among all seven integrated farming system models.

Suitability of components on the basis of availability of resources was made in this research study. Livestock components goat and poultry are suitable in water scarcity zone or rainfed agriculture whereas, dairy component is suitable under irrigated conditions. Single or more than two livestock components were combined in integrated farming system model to find out the most suitable component. The integrated farming system model having combination of Crop + Horticulture + Dairy + Vermicompost + Goat + Poultry enterprises/ components had achieved good monthly net returns, intensified poultry batches provided high returns (1,49,145 ₹ farm-1) over investment of ₹ 1,70,228. Diversified cropping sequences as per treatment T_7(Crop + Horticulture + Dairy + Vermicompost + Goat + Poultry enterprises/ components) which was highest in this study includes crops like cereals, pulses, oilseeds, vegetables, cash crops and forage crops, mixed planting of guava, pomegranate, custard apple, drumstick and intercropping of marigold in horticultural trees, two Phule Triveni cows for milk and compost purpose, four batches poultry birds (400 birds batch-1), goat component initially 10 does + 1 buck and vermicompost unit for recycling or organic waste produced on farm.

(Key words: Integrated farming system models, ICBR ratio, crop, horticulture, dairy, goat, poultry, vermicompost)

INTRODUCTION

The Indian rural economy is mainly dependant on small and marginal farmers which constitute 85 % of the total farming community but posses only 44 % of total operational land. Average sizes of holdings by size group from 2000 to 2011 are given in Table 1. 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-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.

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An integrated farming system offers many opportunities for intensified cycling of nutrients, energy and water on farms. This might help in increasing profitability by reducing inputs, pollution and waste. The waste products of one production component, which would otherwise be released into the environment, are used by the other production component, which in turns returns its own waste products back to the first component (Attwood *et al*., 2017). FAO stated that 'there is no waste', and 'waste is only a misplaced resource which can become a valuable material for another product' in IFS (Anonymous, 1977). Maximum efficiency in recycling resources (e.g. waste into biogas) creates a system with minimum environment impact, and lowers operating costs (e.g. fertilizer, feed and energy). However, it requires substantial knowledge and potentially upfront investments.

Being a mixed system, it provides more opportunities to ensure sustainability of production. If one enterprise or component of the integrated farming system fails, another may compensate. As a diversified system, they contribute to a varied landscape, favoring a diverse habitats, trophic networks and interactions between taxa. More agricultural biodiversity is conserved on farm compared to more specialized system. Agricultural biodiversity not only refers to the biological variety used for food, but also the diversity which have indirect effect on agriculture, such as weed, predator, pathogen, pest, pollinator, soil flora and fauna etc. Agricultural biodiversity, provides resources which farmer needs in variable conditions in marginal areas and increase productivity in more favorable conditions (Fanzo *et al*., 2013), also foster balanced diet and consequent health (Belanger and Johns, 2008).

Table 1. Average sizes of holdings by size groups 2000-11

Category of holdings	Size of holding	Average size of holdings		
Year	**-**	**2000-01**	**2005-06**	**2010-11**
Marginal	< 1 ha	0.40	0.38	0.39
Small	1-2 ha	1.42	1.38	1.42
Semi-medium	2-4 ha	2.72	2.68	2.71
Medium	4-10 ha	5.81	5.74	5.76
Large	10 ha and above	17.12	17.08	17.38
All holdings	**-**	**1.33**	**1.23**	**1.15**

Source: Anonymous, (2015)

MATERIALS AND METHODS

The experiment was carried out during 2018-2019 to 2019-2020 at All India Co-ordinated Research Project on Integrated Farming Systems, Mahatma Phule Krishi Vidyapeeth, Rahuri, District Ahmednagar, Maharashtra. The integrated farming system model was planned for 1.00 ha area and consisted of crop component, horticulture component, livestock component (dairy, goat, poultry) and vermicompost. Seven integrated farming system models were formulated by using suitable combinations of different components in the farming system. The models of integrated farming system were as follows, T_1: Crop + Horticulture + Dairy + Vermicompost, T_2: Crop + Horticulture + Goat+ Vermicompost, T_3: Crop + Horticulture + Poultry + Vermicompost, T_4: Crop + Horticulture + Dairy + Goat + Vermicompost, T_5: Crop + Horticulture + Dairy + Poultry + Vermicompost, T_6: Crop + Horticulture + Goat + Poultry + Vermicompost and T_7: Crop + Horticulture + Dairy + Goat + Poultry + Vermicompost, respectively. Details of the components are given in Table 2. Layout of integrated farming system model is given in Figure 1.

Table 2. Details of the components of 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**

Economic analysis was done by using standard formula for calculation of cost of cultivation, gross monetary returns and net monetary returns and incremental benefit : cost ratio.

$$\text{B: C ratio} = \frac{\text{Gross monetary returns}}{\text{Cost 'C' } i.e. \text{ total cost}}$$

Incremental cost benefit ratio (ICBR)

$$\text{ICBR} = \frac{\text{Added returns}}{\text{Added cost}}$$

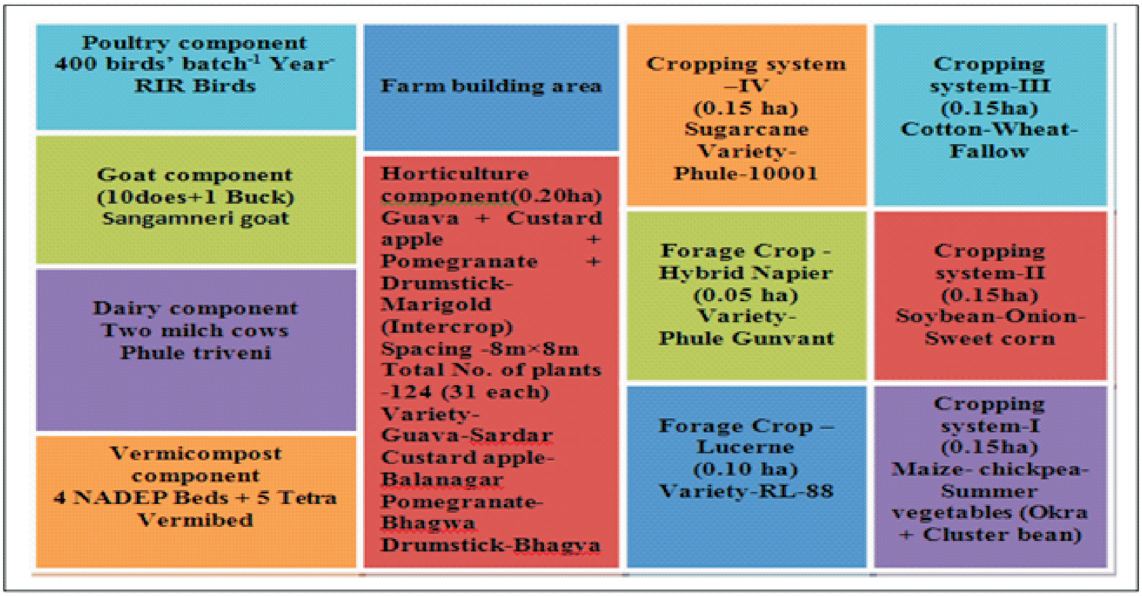

Fig. 1. Layout of IFS model at AICRP on Integrated Farming System, MPKV, Rahuri

RESULTS AND DISCUSSION

Economic Returns and Incremental Benefit : Cost Ratio of Different Integrated Farming System Models

Various components under study during the year 2018-2019 were formulated into different combinations of integrated farming system models. There were seven integrated farming system models formed combining different components studied on farm. One criterion followed while forming models was crop, horticulture and vermicompost components were combined in all seven integrated farming system models. Benefit : cost ratio and incremental benefit : cost ratio was calculated to compare the profitability of integrated farming system models. To identify the economically viable component in integrated farming system model ICBR ratio was worked out along with it's per cent contribution from each component in gross and net returns is also given in Table 3, respectively.The model wise explanation regarding economic returns and benefit : cost ratio for identification of the economically best suitable model is given in Table 4. Per cent contributions of different components in gross and net returns are depicted in Figure 2 and Figure 3, respectively.The model wise average data regarding gross returns, net returns and benefit : cost ratio are shown in Figure 4.

In 2019-2020 the maximum incremental benefit : cost ratio of 2.94 was contributed by goat component. The ICBR ratio recorded by addition of horticulture component during 2019-2020 was observed to be increased from 1.37 to 1.69, likewise in dairy + vermicompost unit ICBR ratio increased from 1.37 to 2.62. ICBR ratio from poultry component recorded in 2019-2020 was 1.98. The increase in added returns over added cost of an enterprise was due to reduction in the non-recurring cost, which was incurred during 2018-2019. Another reason for increase in added returns was increase in economic characteristics of goat component like live weight of animals and number of animals in herd. Maximum net returns in second year of experiment were increased due to decrease in cost of production and increase in input recycling within the farming system. Increase in productive characteristics of livestock components might be due to increase in live weight of animals for meat purpose.

The average incremental benefit : cost ratio of 1.88 was highest by combination of poultry component in the IFS model. This was followed by average incremental benefit : cost ratio of 1.84 was obtained from addition of dairy and vermicompost components in IFS model. Average ICBR ratios with addition of goat and horticulture components were 1.54 and 1.53. During initial two years of orchard establishment marigold as an intercrop provided larger economic benefits in horticulture component. Vermicompost as a joint product of dairy had been indispensible part of the system. Dairy was more profitable when vermicomposting was taken as a processing unit along with other activities.

Average per cent contribution of different enterprises/ components in gross monetary returns in integrated farming system models were crop (26 %), horticulture (3 %), dairy + vermicompost (25 %), goat (14 %) and poultry (32 %). Average per cent contribution of different enterprises/ components in net monetary returns in integrated farming system models were crop (25 %), horticulture (4 %), dairy + vermicompost (24 %), goat (18 %) and poultry (29 %).

Net returns varied from various models studied during the year 2018-2019. The highest net returns were observed in treatment T_7: Crop + Horticulture + Dairy + Goat + Poultry + Vermicompost (Rs. 3,42,096 farm^{-1}) followed by treatments T_6: Crop + Horticulture + Goat + Poultry + Vermicompost (Rs. 3,37,380 farm^{-1}),T_5: Crop + Horticulture + Dairy + Poultry + Vermicompost (Rs. 3,38,764 farm^{-1}),T_4: Crop + Horticulture + Dairy + Goat + Vermicompost (Rs. 2,01,479 farm^{-1}),T_3: Crop + Horticulture + Poultry + Vermicompost (Rs. 3,34,048 farm^{-1}), T_2: Crop + Horticulture + Goat+ Vermicompost (Rs. 1,96,763 farm^{-1}) and T_1: Crop + Horticulture + Dairy + Vermicompost (Rs. 1,98,147 farm^{-1}).

Addition of each enterprise/component in integrated farming system model increased the added returns. The enterprise/ component which resulted in high additional returns over added cost in the integrated farming system model were considered as profitable in a particular model. The highest B:C ratio of 1.90 during 2018-2019 was observed from addition or combining poultry component into the integrated farming system model T_3: Crop + Horticulture + Poultry + Vermicompost. The benefit cost ratio (B:C ratio) from various models studied was found to be greater than unity. With addition of each livestock component in integrated farming system model the net returns increased. Increasing diversification in farm increased net income on farm. The diversified system provided opportunity for additional net returns as well as saved the farming system from complete failure if adverse climatic condition prevailed during crop season.

As the year progresses returns obtained were also observed to be increased. The highest net returns of Rs. 575757 farm^{-1}received from integration of all the components in integrated farming system model T_7 (Crop + Horticulture + Dairy + Goat + Poultry + Vermicompost). The benefit : cost ratio was also observed to be doubled as compared to the previous year of experiment. Hence, it can be assumed that as the model progresses year by year net income is also doubled by proper management of resources.

The highest average net returns of two years were Rs. 4, 58,927 from treatment T_7: Crop + Horticulture + Dairy + Goat + Poultry + Vermicompost with B: C ratio of 1.77. The average B: C ratio of two years in models T_1(Crop + Horticulture + Dairy + Vermicompost) was 1.80,T_2 (Crop + Horticulture + Goat+ Vermicompost) 1.83 , T_3(Crop + Horticulture + Poultry + Vermicompost) 1.95, T_4 (Crop + Horticulture + Dairy + Goat + Vermicompost) 1.73, T_5 (Crop + Horticulture + Dairy + Poultry + Vermicompost) 1.83 and T_6 (Crop + Horticulture + Goat + Poultry + Vermicompost) 1.84.

The capital investment on goat increases with the increase in intensity or number of animals in herd (Rawat *et al*., 2015). Goat are high remunerative livestock component giving more than 2 B:C ratio overtime (Kumar and Shivani, 2018).Compared to conventional farming system the total net returns increased with the adoption of various enterprises in integrated farming system (Sahoo *et al*., 2015). A trail conducted on IFS model at PDKV, Akola Saoji *et al.* (2020) recorded the profit of Rs. 16450from 58 birds reared in backyard poultry having B:C ratio of 2.16.Sujitha and Shanmugasundaram (2020) conducted an experiment at Agriculture Engineering College and Research Institute, Kumuluron economic feasibility and profitability of marigold under protected condition and reported that floriculture as business is in limited scale which can be expanded due to rising demand of flowers in market. According to them marigold can provide Rs. 8, 15, 915 acre^{-1}and can raise the economics of farmer by cultivating marigold. Ponnusamy and Devi (2017) concluded that with suitable combination of enterprises in the integrated farming system can generate additional income.

Surve *et al*. (2014) compared three IFS models research farm IFS model, on-farm IFS model and cropping sequence model and found that research farm IFS model consisting of crop + horticulture + dairy + poultry + fishery gave higher returns of Rs. 5, 61, 579 than on farm IFS model and cropping sequence model.Singh and Burark (2016) reported that on the basis of net returns household^{-1}, the most profitable farming system adopted under the rainfed situation was IFS model (Crop + Goat + Dairy) with profit of Rs. 57600.95 farm^{-1}, while on the basis of returns rupee^{-1} investment it was IFS model (Crop + Goat + Poultry) having profit of Rs. 1.57. Under irrigated situation, IFS model (Crop + Vegetable) was the most profitable farming system on net return basis (Rs. 147287) and returns rupee^{-1} investment received Rs. 1.63.Sharma *et al.* (2017) studied that theIFS model under irrigated conditions proved to be more remunerative with highest average net returns of ¹ 452096 indicating better economic viability and better employment generation capacity as compared to IFS model under rainfed conditions.Patel *et al*.(2019) reported that in seven years of integrated farming system model of which nearly 50 % income generated from crop component. Pawariya and Jheeba (2015) concluded that the poultry farms were more viable and economic overtime.

The variability in climate occurring every year is making rainfed agriculture vulnerable to climate change. Decreased yield occurring due to change in rainfall patterns, temperature and humidity. Therefore, there is need to diversify income and food source in agriculture to ensure food security as well as livelihood of rural population. Change in assured rainfall patterns may cause water scarcity. There is need to adopt farming system according to its water use. Integration of farming system by combining livestock components along with agriculture and horticulture is required to ensure income round the year. Suitability of components on the basis of availability of resources was made in this research study. Livestock components goat and poultry are suitable in water scarcity zone or rainfed agriculture whereas, dairy component is suitable under irrigated conditions. Single or more than two livestock components were combined in integrated farming system model to find out the most suitable component. The integrated farming system model having combination of Crop + Horticulture + Dairy + Vermicompost + Goat + Poultry enterprises/ components had achieved good monthly net returns, intensified poultry batches provided high returns (1,49,145 Rs. farm^{-1}) over investment of Rs. 1,70,228. Diversified cropping sequences as per treatment T_7 (Crop + Horticulture + Dairy + Vermicompost + Goat + Poultry enterprises/ components) which was highest in this study includes crops like cereals, pulses, oilseeds, vegetables, cash crops and forage crops, mixed planting of guava, pomegranate, custard apple, drumstick and intercropping of marigold in horticultural trees, two Phule Triveni cows for milk and compost purpose, four batches poultry birds (400 birds batch^{-1}), goat component initially 10 does + 1 buck and vermicompost unit for recycling or organic waste produced on farm.

Table 3.Incremental benefit : cost ratio and per cent contribution of different components in integrated farming system models

IFS Components	Added cost	Added returns (₹ farm^{-1})	ICBR	GMR (%)	NMR (%)
2018-2019					
C	-	-	-	26	37
C + H	25619	35160	1.37	3	3
C + H + D + VC	169239	231577	1.37	22	18
C + H + D + G + VC	176023	179355	1.02	17	1
C + H + D + G + P + VC	178828	319445	1.79	31	41
2019-2020					
C	-	-	-	19	24
C + H	24814	42000	1.69	3	4
C + H + D + VC	100974	264924	2.62	28	25
C + H + D + G + VC	65397	192341	2.94	22	18
C + H + D + G + P + VC	161628	319300	1.98	27	30
Average					
C	-	-	-	26	25
C + H	25217	38580	1.53	3	4
C + H + D + VC	135107	248250	1.84	25	24
C + H + D + G + VC	120710	185848	1.54	14	18
C + H + D + G + P + VC	170228	319373	1.88	32	29

Note: C: Crop, H: Horticulture, D: Dairy, G: Goat, P: Poultry and VC:Vermicompost

Table 4. Economics of different integrated farming system models

IFS Models	CoC	GMR	NMR	B:C ratio
	(₹ farm^{-1})			
2018-2019				
T_1: C + H + D + VC	341399	539547	198147	1.58
T_2: C + H + G + VC	369663	566426	196763	1.53
T_3: C + H + P + VC	372468	706516	334048	1.90
T_4: C + H + D + G + VC	517422	718902	201479	1.39
T_5: C + H + D +P + VC	520227	858992	338764	1.65
T_6: C + H + G + P + VC	548491	885871	337380	1.62
T_7: C + H + D + G + P + VC	696250	1038347	342096	1.49
2019-2020				
T_1: C + H + D + VC	270353	561494	291141	2.08
T_2: C + H + G + VC	256755	577807	321052	2.25
T_3: C + H + P + VC	352986	704766	351780	2.00
T_4: C + H + D + G + VC	335750	753835	418085	2.25
T_5: C + H + D +P + VC	431981	880794	448813	2.04
T_6: C + H + G + P + VC	418383	897107	478724	2.14
T_7: C + H + D + G + P + VC	497378	1073135	575757	2.16
Average				
T_1: C + H + D + VC	305876	550520	244644	1.80
T_2: C + H + G + VC	313209	572117	258908	1.83
T_3: C + H + P + VC	362727	705641	342914	1.95
T_4: C + H + D + G + VC	426586	736368	309782	1.73
T_5: C + H + D +P + VC	476104	869893	393789	1.83
T_6: C + H + G + P + VC	483437	891489	408052	1.84
T_7: C + H + D + G + P + VC	596814	1055741	458927	1.77

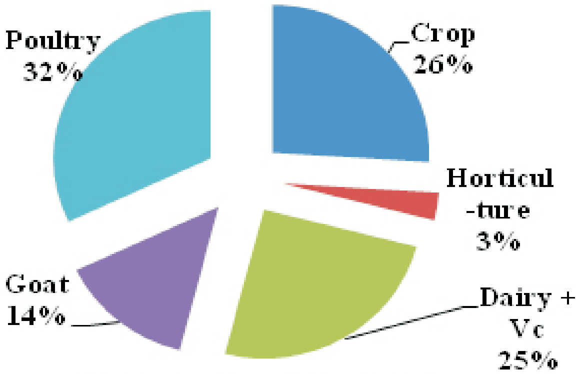

Fig. 2. Per cent contribution of different components in Gross monetary returns

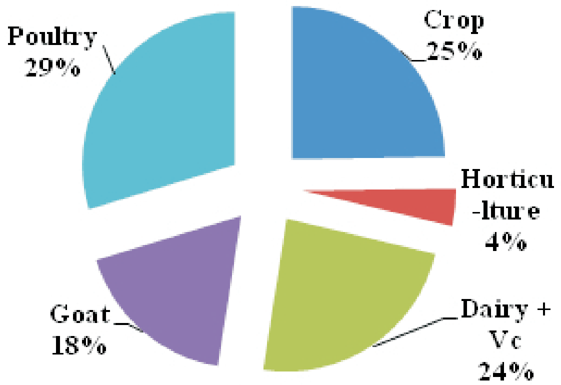

Fig. 3. Per cent contribution of different components in net monetary returns

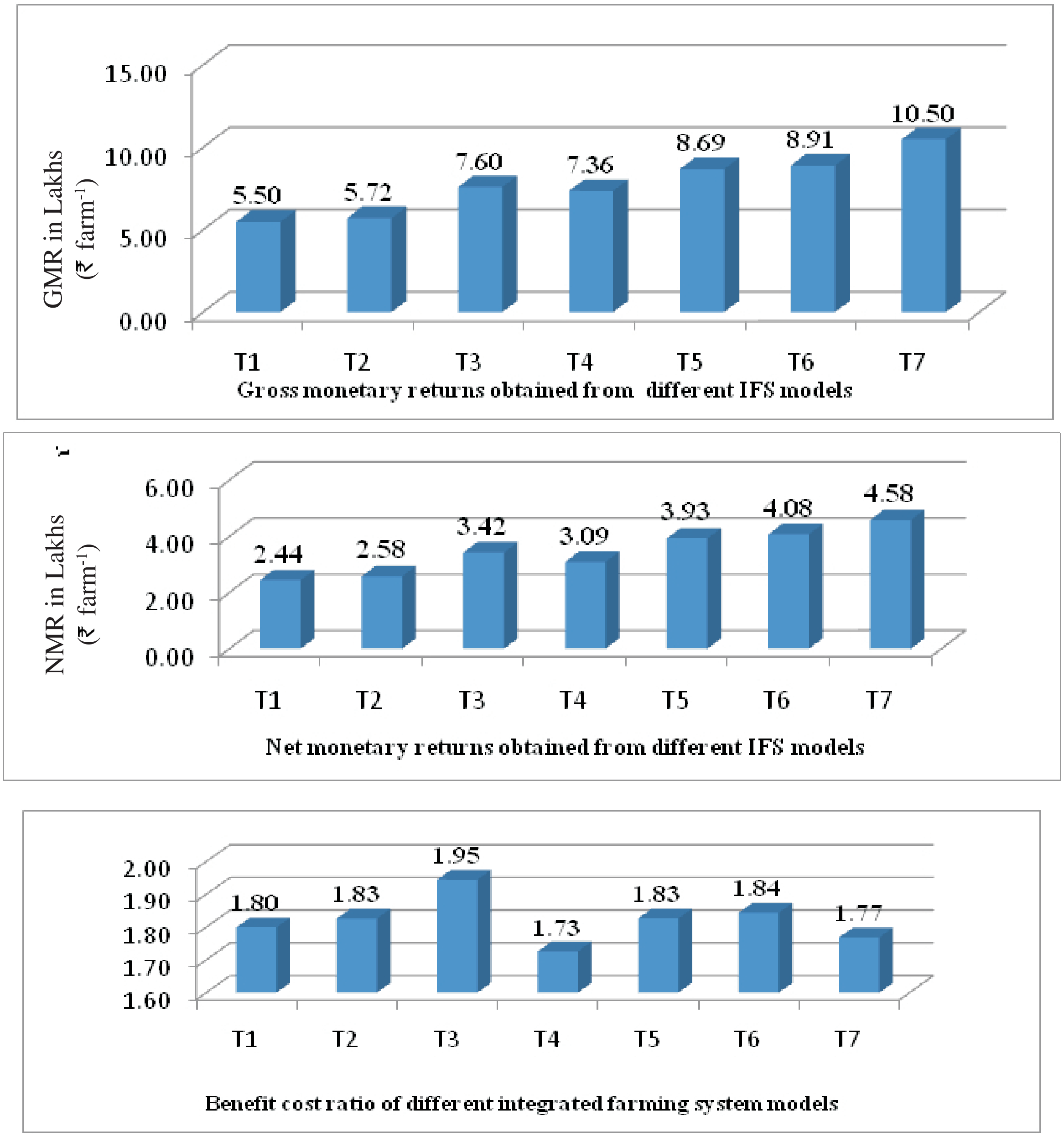

Fig. 4. Average economics of different integrated farming system models

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