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Integrated farming system approach for enhancing the livelihood security & productivity of hill farmers

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Abstract

Objective: Integrated farming System approach is thought of as a sure way of enhancing farm productivity by judicious use of resources thus providing livelihood security to farmers. Keeping this in consideration one hectare on station integrated farming system model was established in 2010 to assess system productivity, profitability, relative efficiencies, and resource use to optimize individual components of farming systemat the Research Farm of CSKHKV, Palampur for 2016-17.
Methods: One hectare model consisted of 0.65 ha for field crops, 0.175 ha for Horticulture cum vegetable, 0.10 ha for fodder crops, 0.075 ha for dairy, poultry, vermin compost and Mushroom unit. Economic analysis was done by calculating cost of cultivation, gross returns, net returns, B:C ratio on the basis of prevailing market prices for inputs and outputs in 2016-17. Maximum yields obtained in Rice-wheat cropping system in farmers' field were the base for comparison with one ha IFS Model.
Findings: The one hectare IFS model resulted in gross returns of ₹3, 06,270/-, net returns of ₹1, 28,698/- and B:C ratio of 0.76. However, rice-wheat cropping system in the entire area would result in only net returns of ₹44,000/-.Thus; the net returns to the tune of 2.92 times higher in IFS model were compared obtained to that obtained in rice-wheat cropping system. However, replacing rice-wheat with maize + soybean-potato cropping system would result in net returns of ₹184200/- per hectare. Maize + soybean - peas cropping system gave the least net returns (₹33930/- per hectare), though the B:C ratio was higher (2.12) followed by B:C ratio of 2.10 in maize + soybean - potato. Vegetable intercropping in Horticulture plantation resulted in net returns of ₹9627/-, dairy unit gave net returns of ₹49,604/-, fodder crops (₹17,031/-), and Mushroom cultivation (₹1847/-). The profit share of different components viz. cropping systems (33.71%), forage (13.23%), Mushroom (8%) and vegetable (7.4%) of the total net returns was obtained.
Application: With the raising of complementary and interdependent components in IFS Model variety of products viz. cereals, pulses, oilseeds, vegetables, fruits, milk, eggs, mushroom were obtained which gave balanced nutrition to the family, regular income throughout the year, and more employment generation round the year.
***Keywords*:** Maize -wheat, Rice-wheat, cropping system, Farming system, Net Returns.

1. Introduction

Maize/rice-wheat is the two most prevalent cropping system of Himachal Pradesh. Out of the total cropped area of 954 thousand hectares in the state maize, wheat & rice occupy 294, 341 and 73.69 thousand hectare with a production of 737, 667, 129 thousand tonnes, respectively. The cropped area occupied by maize, wheat and rice is 74% of the total cropped area of the State. However, the average productivity of rice, wheat and maize crop in our state is 25.1, 19.6, 17.6 q/ha, respectively [1]. The main reason for low productivity of these cropping systems are i) 85% area is under rainfed cultivation coupled with low fertility and poor soil physical properties, ii) low response of fertilizer application under water scarcity condition, iii) 20% irrigated area is also under tradition rice- wheat /maize – wheat cropping system, iv) minimum crop diversification. Average productivity of milk and meat is also hovering around2.84 kg/cow/day or 2.65 kg/buffalo/day and 20.61 kg/animal (sheep, goat and pig), respectively over the last many decades.

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The main reason for low productivity of meat and milk in animals in our state is the scarcity of green and dry fodder. There is shortage in supply of green and dry fodder to the tune of 51% and 45% respectively in our state. Observed that small farm in India was superior in terms of production performance but was weak in terms of generating adequate income and sustaining livelihoods [3]. Crop diversification in area, where continuous cropping systems is in vogue, has been advocated as one of the effective tools to break the monotony of the predominant cereal based system and to sustain productivity over a period of time [5] and for diversification of rice/maize-wheat cropping systems, many options are available [4], [8], [1]. Any system which requires less input and contributes more is considered to be the efficient. Therefore, the present study was conducted to find out the possibility of diversification in traditional rice-wheat cropping system in view of sustainability and to overcome the problem of agrarian crisis in Himachal agriculture.

2. Data & Methodology

The study was conducted during 2016-17 at the Badhiarkhar Research farm of the Department of Agronomy CSKHPKV, Palampur under "All India Coordinated Research Project on Integrated Farming Systems Research". The integrated farming system model experiment was initiated during *kharif* 2010. The experimental area is situated between latitude of 32°6' and 76°3'E longitude at an elevation of 1290.8 m above mean sea level. Agro climatically, Palampur represents mid hill zone of Himachal Pradesh and is characterized by humid sub temperate climate with average rainfall of 2500 mm/annum. The soils of the area are typic hapdaulf and characterized as typic brown podzolic with pH ranging from 5.2 to 6.0.The texture ranges from clay loam to silty clay loam. Generally the soils are medium to high in OC content 0.97 – 1.2% with available nitrogen between 234.6-276.0 kg/haand available P and K in the range of 26.9-49.3 &101.9-132.4kg/ha respectively. The CEC varies from 9 to 13 me/100gm soil.

The study was conducted on a 1.0 ha model (10,000sq m area) and area distributed for use was as follows: 6500 sqmfor field crops i.e. cereals, pulses, oilseeds, green fodder etc; 1750 sq m for horticulture and vegetable crops' intercropping, viz. okra, cauliflower, broccoli, brinjal, gobhisarson, fodder maize, vegetable pea etc., 1000sq m for fodder crops, 750 sq m for dairy, poultry, vermin compost and mushroom unit. In addition to this boundary plantation of Grewia, Leucaenia, Bauhinia and transplanting of setaria seedling has been done on bunds of different fields. Economics of different farming systems including dairy were analyzed for which suitable statistical analysis such as percentages, cost of cultivation, gross returns, net returns, benefit: cost ratio were carried out to explain the results for proper inferences of the study.

3. Results and Discussion

The data presented in Table 1 and 2 have also been calculated on 1000 sqmtrs basis for the comparison of different cropping systems. The different cropping system was allocated area as per household requirements and market availability for other crops. The data presented in Table 1 depicted that maize + soybean – potato cropping system gave maximum net returns of Rs. 18420/- based on 1000 sq m basis followed by paddy-wheat-fodder maize (₹5857/-), followed by paddy-wheat cropping system (₹5345/-).

Table 1. Economic analysis of cropping system (2016-17)

Cropping System	Area (ha)	Economic Yield (kg)	Gross returns ₹		Input costs ₹		Net returns ₹		B:C ratio
			Total	1000 sq m	Total	1000 sq m	Total	1000sq m	
Paddy - wheat	0.46	1331-709	46097	10021	21506	4675	24591	5345	1.14
Paddy – wheat-Fodder Maize	0.04	116-62-270	4818	12045	2476	6190	2343	5857	0.95
Maize + Soybean-Pea	0.06	32-34-69	3636	606	1600	2666	2036	3393	2.12
Maize + Soybean-Potato	0.09	48-50-1187	24197	26885	7781	8654	16416	18240	2.10

Price (Rs per q): Rice-1500; wheat-2000; fodder maize-3000; maize-1500; soybean-3000; pea- 2000; potato - 1500

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The least net profit was recorded in maize + soybean - peas (₹3393/-). However, highest B:C ratio was recorded in maize + soybean- pea (2.12) followed by maize+ soybean- potato (2.10), followed by paddy - wheat (1.14) and minimum in paddy-wheat- fodder maize (0.95). The inputs costs were found to be highest in maize + soybean – potato ₹8654/- followed by paddy-wheat - fodder maize (₹6190/-) followed by paddy-wheat (4675) and least in maize + soybean - pea (₹2666/-). The data therefore, showed that diversification of existing cropping system i.e. paddy-wheat resulted in higher net returns and B: C ratio.

4. Recycling of residues

The wheat, pea straw and maize stover was used to feed three cows, two heifer and two young female cows. Part of the paddy straw was fed to dairy unit and the remaining quantity was sold in the market. Soybean and potato plant residues were used to prepare vermin compost/FYM. On average potato haulm residues containing 2.62, 0.225 and 1.72 % N, P & K, respectively contributed about 33, 2.8 and 21.5 kg N, P & K, respectively. Likewise, soybean straw containing 0.52, 0.185 and 0.83 % N, P and K, respectively contributed 0.4, 0.13 and 0.58 kg N, P, K, respectively. In nutshell these residues contained fertilizer amounting to ₹1205 which upon recycling improve soil health.

Table 2. Straw/stover produced and utilized in IFS (2016-17)

Cropping system	Straw/Stover (kg)		
	Production	Used as input in IFS	Used as nutrient source
Paddy	2126	610	0
Wheat	1095	1095	0
Maize	620	620	0
Soybean	70	0	70
Pea	54	54	0
Maize Fodder	270	0	0
Potato	1250	0	1250

5. Economics of horticulture unit

The Pecan nut and peach plantation was done in 2010 and inter row spacing of 1750 sqm was utilized for raising vegetables and oilseeds crops. The data of Table 3 has been explained on the basis of 1000 sq m for comparison of cropping system. The perusal of Table 3 revealed that okra - gobhisarson resulted in highest net returns of ₹4630/- based on 1000 sqms basis followed by maize fodder-gobhisarson with net returns of ₹3980/-. The input cost was very high in okra – gobhisarson (₹7540/-) followed by maize fodder-gobhisarson (₹1593/-). Therefore, highest B: C ratio of ₹2.49 was recorded in maize fodder – gobhisarson followed by okra-gobhisarson (0.62).

Table 3. Vegetables in the horticulture unit as intercrop (2016-17)

Cropping System	Area (sq m)	Economic yield (kg)			System Gross return ₹		System cost ₹		System net return ₹		B:C ratio
Okra-Gobhisarson	1150	Okra		GS	Total	in 1000 sq m	Total	in 1000 sq m	Total	in 1000 sq m	
		Veg.	Seed		13996	12170	8671	7540	5325	4630	0.62
		116	18	76							
Maize fodder-Gobhisarson	600	310- 40			3344	5573	956	1593	2388	3980	2.49

6. Economics of dairy component

There were three cows in milking, two heifers and two young female calves in 2016-17. The cows were cross breed (Jersey X Red Sindhi). The total milk yield in 2016-17 was 3719 litres and it comes about 310 litre per month i.e. 10 litres per day. The data presented in Table 4 depicted that net profit earned from Dairy enterprise was to the tune of ₹49,684/.

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Gross revenue earned from dairy component was ₹170,943/-. Variable cost was to the tune of 1, 21,259/-. It included cost of feed, medicines and labour. B: C ratio for dairy components was 0.41. The B: C ratio was lower as the maintenance cost of cows was very high.

Table 4. Economics of dairy component (2016-17)

Particulars	Amount ₹
Income generated by sale of milk(sale rate of milk is ₹40/litre)	148760
Cow dung used to prepare FYM/ Vermicompost	22183
Gross income (A)	170943
Cost of feed& Medicines	30870
Labour Cost	36500
Input cost (Fodder)	53889
Total input cost (B)	121259
Net Profit (A –B)	49684
BC ratio	0.46

7. Economics of forage unit

The forage crops were grown in 1000 sq m. The different forage crops raised were maize, sorghum in *kharif* season and oats, sarson and berseem in *rabi* season. Net returns of ₹17,031/- were obtained from forage unit with B: C ratio of 7.6.

8. Economics of mushroom and Poultry unit

In case of mushroom unit, net returns of ₹5070/- were obtained with input costs of ₹5, 265/- B: C ratio of 1.0 was obtained in mushroom unit. A total net returns of ₹1,847/- and B: C ratio of 0.3 was recorded in case of poultry unit.

Table 5. Relative efficacy of different farm enterprises of integrated farming system mode

Farm enterprises	Size of the unit (ha)	Gross returns(₹/ha)	Total Cost (₹/ha)	Net returns (₹/ha)	B:C Ratio
1) Cropping systems	0.65	78748	33363	45385	1.4
2) Horticulture					
i)Vegetables	0.175	17340	7713	9627	1.2
ii) Fruit crops					
a) Peach		568	514	54	0.1
b) Peacanut					
c) Pomegranate					
d) Litchi					
3 Agro-forestry	Border plantation				
i) Leucenia Plants					
ii) Setaria grass	Bunds plantation (D block, B block, A block) 5000 seedlings				
4) Livestock					
i) Dairy animals		170943	121259	49684	0.4
6) Others (Fodder Block)	0.1	19278	2247	17031	7.56
7) Mushroom		10335	5265	5070	0.96
8) Poultry		9058	7211	1847	0.26
Total	0.925	306270	177572	128698	0.72

A net returns of ₹44,000/- were obtained from rice – wheat cropping system. Moreover, the returns are obtained two times annually. Whereas, the data in (Table 5) clearly show that in Integrated Farming System approach, a farmer can obtain net returns of ₹1, 28, 698/- per ha.

In cropping system ₹121/ha/day can be obtained, whereas, from Integrated Farming System the returns were ₹353/ha/day, ₹221/ha/day extra over rice-wheat cropping system (Table 6). Dairy unit provides income on daily basis. Vegetable cultivation gave net returns of ₹9627/- from 1750 m^2 area.

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Dairy unit provided net profit of ₹49,684/- in a year. However, from fodder crops net returns of₹17,031/- were obtained in one year. Mushroom cultivation was also done along with other components which gave gross returns of ₹10,335/- with costs incurred of ₹5,265/- resulting in net returns of ₹5070. From Poultry segment ₹1,847/- were obtained as net returns. The perusal of Table clearly showed that 1.0 ha model developed for marginal and small farmers gave gross returns of ₹3,06,270/ha, costs incurred of ₹1,77,572/ha and net returns by deducting all variable costs of ₹1,28,698/ha which were about 2.92 times more than the prevailing rice-wheat cropping system.

Under the gradual shrinking of size of land holding (1 ha per house hold in H.P), it is necessary to integrate land based enterprises like livestock, poultry, horticulture cum vegetable, forages, mushroom and vermin composting etc within the biophysical and socioeconomic environment of the farmers to make farming more profitable and dependable [2]. No single farm enterprise is likely to be able to sustain the small and marginal farmers without resorting to integrated farming systems for the generation of adequate income and gainful employment year round [7]. Hence, there is necessity of adoption of "Farmer System Approach" to solve the problem of livelihood security and economic uplift of hill farmer.

Table 6. Estimated economic analysis of rice-wheat cropping systems

Cropping Systems	Rice-wheat (Rs per ha)
Rice grain yield (42 q/ha)	₹63,000/-
Wheat grain yield (35 q/ha)	₹70,000/-
Gross Returns	₹1,33,000/-
Cost of Cultivation	₹89,000/-
Net Returns	₹44,000/-

**Sale price of rice is ₹15/- & wheat is ₹20/-*

9. Conclusion

Maize + soybean – potato cropping system resulted in net returns of Rs. 16,416 (₹18,240/- per 1000 sq m) highest among different cropping system and a B:C ratio of 2.10. In horticulture cum vegetable block, okra – gobhisarson resulted in highest net returns of ₹5325, however, the B:C ratio was highest in maize fodder-gobhisarson cropping system, since the cost of production of okra – gobhisarson was higher as compared to maize fodder – gobhisarson cropping system. The total milk yield was 3719 liters/annum which brought net returns of ₹49,684/- Mushroom unit resulted in net return s of ₹1,847/-, whereas, fodder unit gave net returns of ₹17, 031/- with B:C ratio of 7.6. Therefore, it is concluded that 1.0 ha model developed for small and marginal farmers of H.P. gave gross returns of 3,06,270/-and costs incurred were ₹1,77,572/- resulting in net returns of₹1,28,698/- by deducting all variable costs which were for higher than prevailing rice/maize –wheat cropping system. Therefore, the farming system approach should further be extended so as to raise the socio economic status and prosperity of hill farmers.

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