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Evaluation of case studies of different integrated farming system models practiced by selected farmers in indo-gangetic plain region of India

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Abstract

Economic evaluation of the farmer practising integrated farming systems is crucial step towards providing feedback to research institutes through identification of combination of enterprises, economic benefits, existing gaps and practical problems associated in integration of certain enterprises. In this background the documentation of selective integrated farming system case studies conducted in three blocks of Haryana and Uttar Pradesh states in India. The in-depth case analysis of five farmer adopted integrated farming systems revealed that practices of integration, recycling of farm resources combined with adoption of on-farm resource conservation techniques provide more stability towards risk and economic profitability to farmers. Study further analyse risk encountered by Indo-Gangetic plain region farmers in integration of enterprises and suggested some feasible measures to minimise the risks for promoting Integrated Farming System.

Keywords: Integrated farming system, case study, resource recycling, indo-gangetic region

Introduction

A Farming system is a complex process of interactions among several inter-dependent enterprises, where an individual farmer allocates and manages required quantities and qualities of farm resources (Behera 2008) ^[5]. At the present scenario of shrinking in average landholding size of agricultural households (NABARD, 2018) ^[17] in the country having more than 80% of small holdings (Chand 2011) ^[11], farming is no more a profitable venture unless integrated and recycled farm resources effectively with suitable farming enterprises (Behera *et al.* 2004 ^[4]; Kumar *et al.* 2012 ^[10]; Behera *et al.* 2013 ^[6]; Ansari *et al.* 2014 ^[1]). According to Singh *et al.* (2009) ^[18] Integrated farming system reorient the present ways of doing agriculture with a focus to improve productivity and efficiency of farm resources to provide regular returns to meet farmers daily needs. In a nutshell, the entire concept of Integrated Farming System (IFS) aims at increasing small holder's productivity, profitability and employment through the integration of various farm enterprises and recycling of on-farm resources within the farm (Behera and Mahapatra 2004; Behera *et al.* 2008) ^[4, 5]. However, the success of any IFS doesn't only depend on merely integration or addition of enterprises. But, the integration should be based on the cardinal principles of minimizing the competition and maximise the complementarities between the enterprises (Annadurai *et al.* 1994; Chandrasekaran *et al.* 2008) ^[2, 8] and the extent of knowledge processed by farmers to integrate the system (Morries 1999) ^[11]. Meanwhile, recycling of farm resources is associated with gaining of benefits like additional nutrients to soil (Rangaswamy and Jayanthi 1994

^[15]; Baishya *et al.* 2005 ^[3]; Kumar *et al.* 2012) ^[10] resulted in the decrease in dependency on external inputs (chemical fertilisers) that will reduce input cost. Considering the benefits and advantages of practicing IFS many attempts were been made by agriculture scientists to evaluate different farming system models (Kumar *et al.* 2012 ^[10]; Kashyap *et al.* 2015 ^[9]; Singh 2015 ^[13]; Sharma *et al.* 2017) ^[12] in the research farm to identify the suitable enterprise combinations under various agro-climatic regions in India. But effective transfer or recommendation of any technology or models depends on how it performs under realistic field condition under varying resources and constraints. Hence, evaluation of a farmer practicing IFS models was taken for study. The study focuses on in-depth economic evaluation of farmer adopted IFS in Indo-Gangetic region to explore its profitability and identification of existing gaps with case analysis for further implications.

Study area and sampling technique

The present study was undertaken in Muzzafarnagar district of western Uttar Pradesh and Gurgaon and Nuh districts of Haryana state located in Indo-Gangetic plain region of India. An in-depth investigation of a farmer practicing individual IFS models explored through personal interview, observation and documentation through purposive (non-probability) sampling method. The IFS practising progressive farmers were identified through snowball technique in discussion with scientists of Indian Council of Agriculture Research Institutes located in the region. Total 9 IFS case studies were documented from the Kathauli and Jansath blocks of Muzzafarnagar district and 6 IFS case

studies are collected from the Pataudi and Nuh blocks of Gurgaon and Nuh districts respectively. Considering the nature of integration and clarity of data obtained a total of 5 unique IFS case studies, were analysed and presented in the paper.

Tools and techniques

An economic analysis of IFS models were assessed by calculating total cost (variable and fixed cost), gross returns and net returns for individual enterprises. The sums of all the individual enterprises of each case study were added to obtain farm level costs and returns. Further, we calculated Net returns per day and cropping intensity of the each enterprise for comparison.

Results and Discussion

IFS models and its components

Six different farmers practising IFS models with different combinations of components and area are documented to know the resource flow, profitability, employment generation, potential risks and existing gaps under farmer's field conditions. Further, economic analysis of the different components is worked out through B: C ratio and Net Returns per day to assess the profitability of each component. After careful analysis and observation of components and their integration, about 5 IFS case studies were evaluated and presented in detail to understand their economic feasibility, profitability, employability and risks associated with practising Integrated Farming System in farmer field under practical situation.

Table 1: Allocation of different enterprises under Integrated farming system models practiced by progressive farmers

Case study	Enterprise combination
IFS Model 1	Crop + Horticulture + Fodder crop + Dairy farming + Vermicompost unit
IFS Model 2	Crops + Horticulture + Fodder + Dairy farming + Agro-forestry + Compost unit
IFS Model 3	Crop + Horticulture + Fodder + Dairy + Goat farming + Fish farming + Compost unit
IFS Model 4	Crop + Horticulture + Fodder + Dairy + Mushroom + Vermicompost unit
IFS Model 5	Crop + Horticulture + Fodder + Dairy farming+ Agro-forestry + Vermicompost unit

Six different farmers practicing successful farming system models with different combinations of enterprises (Table 1) and area are documented to know the resource flow, profitability, employment generation, potential risks and existing gaps under farmer's field conditions. Among the five farming systems documented from farmers, crop

production and dairy is the major components. However, model 2, 4, and 5 having Agro-forestry component and model 3 having goat farming, fish farming and model 4 having mushroom production unit in an addition to crop and dairy enterprises.

Table 2: Allocation of area under different enterprises of integrated farming system models practiced by progressive farmers

IFS	Land Holding (ha.)	Crop (ha.)	Horticulture (ha.)	Fodder (ha.)	Dairy (No.)	Agro-Forestry (ha.)	Goat (No.)	Fish Pond (ha.)	Mushroom unit (ft)
1	0.42	0.16	0.48	0.16	3	-	-	-	-
2	2.19	1.86	0.26	0.2	7	0.1	-	-	-
3	2.6	2.4	0.4	0.6	4	-	3	0.15	-
4	2.6	3.32	0.2	0.4	6	-	-	-	10*12
5	4	2.8	1	0.4	2	0.2	-	-	-

Selective five cases studies of integrated farming system models practiced by progressive farmers were documented and evaluated with different land holdings (Table 2). The systems include (1) Crop + Horticulture + Fodder + Dairy, (2) Crop + Horticulture + Fodder + Dairy + Agro forestry, (3) Crop + Horticulture + Fodder + Dairy + Goat farming + Fish farming, (4) Crop + Horticulture + Fodder + Dairy + Mushroom production, (5) Crop + Horticulture + Fodder + Dairy + Agro forestry combinations practiced by in 0.42, 2.19, 2.6, 2.6, & 4 ha of land holdings, respectively. Further, the area allotment on different crops in a year is shown in Table 2. The detailed adoption of different components of the IFS models were compared and show in the Table 3. In all the case studies farmer adopted traditional cereals crops with commercial horticulture crops and fodder component due to adoption of Animal husbandry component in all

cases.

The Agro-forestry system was practised in case 2 & 5 models. In IFS model 3 and 4 adopted enterprises/components with *pisciculture* and mushroom production, respectively. From the table 3 it was observed that all the model IFS farmers were adopted or followed different resource conservation measures and on-farm recycling technique to improve income and reduce external resource application includes diversified crop selection, intercropping systems, recycling of farm waste through vermin-compost production, mulching techniques, micro-irrigation, use of cow based organic liquid manures like jeevamrutha and use of Jaivik decomposer for *in-situ* decomposition of farm waste. Hence, the IFS models were align with the major principles of Integrated Farming System.

Table 3: Crop and Livestock details of IFS models practiced by progressive farmers

IFS Model	Crop	Horticulture	Fodder	Dairy	Agro-forestry	Goat	Fish or mushroom	Vermi-compost (ft)	Resource conservation practices adopted
Model 1	Lemon Grass	Broccoli and Papaya (inter-crop)	Sorghum	Cow, Buffalo, Calf	-	-	-	15x15	Diversified Cropping, Intercropping, jaivik decomposer and Vermicompost
Model 2	Sugarcane	Potato	Sorghum, Napier	2 Cow, 4 Calves; 1 Bull	Populus		-	60x40	Ratoon cropping, mulching, compost recycling, strip cropping, agro-forestry etc.
Model 3	Wheat and Mustard	Brinjal	Sorghum, Bajra	2 Buffalo, 2 Calf	-	3	Rohu; Catla	15x15	Compost recycling, diversified enterprises, recycling of kitchen waste and dung for fish and fish cultured water for crops
Model 4	Sugarcane, Rice and wheat	Mango and guava	Sorghum, Maize	Cow; Bull; 2 Calves	-	-	Mushroom	15x15	Adoption of diversified crops and enterprises. Recycling of mushroom waste
Model 5	Cotton; Sesame; Pearl Millet	Tomato; Chilly; Citrus	Sorghum	Desi cow and Buffalo	Neem	-	-	60x40	Vermicompost, green manuring, use of jeevamrutha and adoption of water and labour saving techniques like sprinkler, drip and etc.

Table 4: Economics of IFS models practiced by progressive farmers

IFS Model	Gross Cropped Area (ha.)	Net Sown Area (ha.)	Cropping Intensity (%)	Total Cost (₹)	Gross Returns (₹)	Net Returns (₹)	Net returns/day (₹/day)	B:C Ratio
Model 1	0.51	0.42	121.4	207823	543640	335817	920	2.6
Model 2	2.42	2.19	110.5	412325	900650	488325	1337	2.2
Model 3	4.4	2.6	169.2	483664	1120114	636450	1743	2.3
Model 4	3.92	2.6	150.7	440433	954325	513892	1408	2.2
Model 5	4.4	4	110.0	346366	722675	376309	1031	2.08

An economic evaluation of each case study shows that all models are giving better returns and higher benefit-cost ratio on every rupee invested (see table 4). In case of model 1 net sown area is lowest of 0.42 ha, however the B:C ratio is 2.6 highest among all the other IFS models. This is possible due to effective management and recycling of the resources by farmers in a limited area of land, thereby reducing total cost (₹ 207823) for management of different components and improving the gross returns (₹ 543640). Hence, effective management resources and practice of Integrated farming system in small holder farms also give a better returns to small hold farmers. Further, model 2,3 and 4 provides almost similar B:C returns to farmers and it will give almost double income as per rupee invested as seen from table 4. Further, in case of model 5 our results revealed that farmer with 4 ha of land having B:C ratio comparatively less than other small holder farmers. This is mainly due to increase in the land may some cases will reduce the farmers strategy in planning the resource utilization may not so effectively as in case of the small holders where they can manage with the available resource and family labor, that drastically reduce total cost of production of different enterprises. This can also observed in indicators like low cropping intensity in case of model 5 and loss of income due to market glut. The case analysis also provides insight into how IFS will ensure better benefits even during the failure of one another

enterprises/component. The case analysis of the model 3, farmer incurred a loss of ₹ 300000, due to failure of *Pisciculture* (death of entire fish in pond), similarly case analysis of model 2 reveals farmer incurred loss due to low market rate/ less price for potato (Horticulture crop) & in the case 5 farmer reported decrease in price of Chilli due to market glut, all of these affected the farmers revenue during the study year. However, due to diversified components/enterprises and adoption of on farm resource conservation and recycling measures the total loss was decreased and compensated by other enterprises. Even after the uncertain risk due to market and unforeseen loss of unit the B:C ratio of the models were recorded more than 2 in all cases. The net return of the each model was calculated and provides better income per day to farmers as shown in table 4.

Practical constraints in practicing IFS by farmers

An in-depth analysis of selected case studies reveals that market price fluctuations for high-value horticulture crops are a significant risk for farmers who adopt horticulture, as observed in Case 3 and Case 5. These price fluctuations pose a major threat to crop diversification from the sugarcane-wheat and rice-wheat systems, where farmers receive assured income, particularly in the Indo-Gangetic region. Additionally, Case 4 illustrates threats like disease or death of fish in *pisciculture*, often resulting in substantial

financial losses for farmers. However, the case studies also show that farmers are able to compensate for losses in one enterprise through gains in another, indicating that the Integrated Farming System (IFS) helps in minimizing overall economic risk. Farmers noted that the adoption and integration of certain enterprises, such as pisciculture, mushroom production, and beekeeping, were limited due to a lack of specific management skills and necessary inputs (e.g., knowledge of mushroom cultivation or beehive maintenance). Additionally, there were challenges in accessing information and markets, such as sourcing mushroom seeds or beehive cages, as observed in Case 2 and Case 5.

Conclusion

The analysis of six case studies shows that the Integrated Farming System (IFS) is effectively demonstrated and managed by farmers under field conditions. The results from these IFS models indicate a positive benefit-cost ratio per rupee invested, ranging from 1.9 to 2.6 across different land holdings (refer to Table 1). Despite the Constraints faced by IFS farmers, the case studies highlight that farmers are obtaining remunerative returns due to increased risk-bearing capacity and compensation provided by one or more other enterprises in the event of failure of any one enterprise. Therefore, we recommend implementing effective policy measures to address the adoption constraints of enterprises such as mushroom cultivation, poultry, beekeeping, and *pisciculture*. This can be achieved by establishing proper backward and forward linkages for easy availability of inputs and equipping farmers with the necessary management skills for crop and enterprise diversification, thereby optimizing farm resource utilization. Additionally, there is a need to raise awareness among farmer groups about the economic benefits of adopting IFS, using case studies of farmers who have successfully implemented the system. This will motivate others, particularly in the Indo-Gangetic Plain region, to shift from mono-cropping to the more sustainable IFS approach.

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