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Scientific approaches for sustainable agriculture through integrated farming system

A. P. S. Dhaliwal, Palwinder Singh*, Vinay Singh, Sarvpriya Singh and Gurmeet Singh Dhillon

Krishi Vigyan Kendra, Bathinda, Dabwali Road,
Near Kheti Bhawan, Distt. Bathinda 151 001, Punjab, India

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ABSTRACT

The present study was conducted at PAU, Krishi Vigyan Kendra Bathinda, Punjab for the evaluation of the performance of 'Integrated Farming System' (IFS). This IFS system includes the field crops (Grains, oilseed, pulses and fodders), livestock (Dairy animals and poultry birds), kitchen garden, orchard, biogas plant, vermi-compost unit, mushroom unit, beekeeping unit and boundary plantation of forest trees that makes the system: economically viable, socially supportive and ecologically sound. These components were interlinked with each other and provide the benefits to one or more components and vice-versa. These links and benefits enhanced the farm productivity and ensure sustainability, profitability and balanced food availability. After adoption of advanced practices in each component net profit of four IFS systems increased by 8.6%, 8.8% , 8.2% and 6.3 % respectively in 2019-20 as compared to 2018-19. This eco-friendly model also reduces the environmental degradation by minimizing the use of Agro-chemicals. Due to the flexibility of this model, farmers can opt any combination of components as per their requirement and purpose rather than mono-culture practices. This Ifs system improves the economic condition of farmers as well as soil health condition of farmer's field.

Key words: *IFS, Components, Evaluation, Sustainability, Profitability.*

Introduction

In the present era, 85 % of the farming community belongs to small and marginal landholdings (Kumar *et al*., 2018). Due to the shrinkage of land and increase in day to day expenses, there is need to shift towards the diversify farming. The rise of Integrated Farming Systems (IFS) has empowered us to build up a structure for an elective advancement model to improve the practicality of small sized farming operations as comparable to bigger ones (Ravisankar *et al.,* 2006). Integrated farming system (IFS) is the best instance for diversified farming which is economically viable, socially supportive and ecologically sound option for small and marginal farming community. This system includes a favourable and adequate combination of crops, livestock, aquaculture, agro-forestry, agri-horticulture so as to ensure sustainability, profitability, balanced food availability and employment generation. IFS gives greater importance for sound management of farm resources to enhance the farm productivity and reduce the environmental degradation, improve the living standard of resource poor farmers and maintain sustainability (Kumar *et al.,* 2013). In this system, an inter-related set of enterprises is used so that the "waste" from one component becomes an input for another part of the system, which reduces cost and improves production and/or income. Integrated farming is a system which tries to imitate the

nature's principle, where not only crops but, varied types of plants, animals, birds, fish and other aquatic flora and fauna are utilized for production throughout the year (Kumar *et al.*, 2015). Integrated farming system works as a system of systems (Chan, 2006). Major benefits of integrated farming system involves recycling of wastes, reduced dependence on external high-energy inputs to conserve natural recourses, multiple uses of resources, soil health improvement and reduction in the risk involved due to market price crash as well as natural calamities.

Garibaldi *et al.* (2017) portray agricultural sustainability as an idea which considers the monetary, natural, and social parts of cultivating, while likewise advancing the strength and persistence of gainful cultivating scenes. Sustainable agriculture production means an integrated approach to increasing farm yield and managing resources in order to address all three critical aspects of sustainability: economic, environmental and social. So there is need to develop an ideal IFS model for small and marginal framers along with economic analysis. So this study was designed with following objectives:

1. To study the inter-linkage between various IFS components and their beneficial effect on each other.
2. To study the economics of different IFS modals adopted by small and marginal farmers
3. Comparative study of economic returns : Diversified farming vs monoculture

Materials and Methods

The present study was conducted during 2018-2020 at PAU, Krishi Vigyan Kendra Bathinda, Punjab for the evaluation of the performance of 'Integrated Farming System' (IFS). During the study four locations (KVK Bathinda and three Villages: Mehma swai, Mehma sarja and Mehraj) was selected to analyse interlink age between various IFS components and their economic impact on each other. At each location 2.5 acre land selected for integrated farming. During 2018-19 these farming systems were operated under common farmer practices and next year in 2019-20, advanced practices followed for assessing the impact of scientific approach for sustainable agriculture. Following table represents the basic data of these IFS units and their components.

Results and Discussion

Inter-linkage of components

It is clear from the Figure 1 that in IFS, the components were interlinked in such way that they provide multiple benefits to each other. From crop production, farmers were getting wheat and paddy straw which was used for making compost and it also utilized for mushroom cultivation. This manure was thus utilized for the crop production, vegetable and fruit production and also utilized for fish production. In the same way, poultry and dairy manure

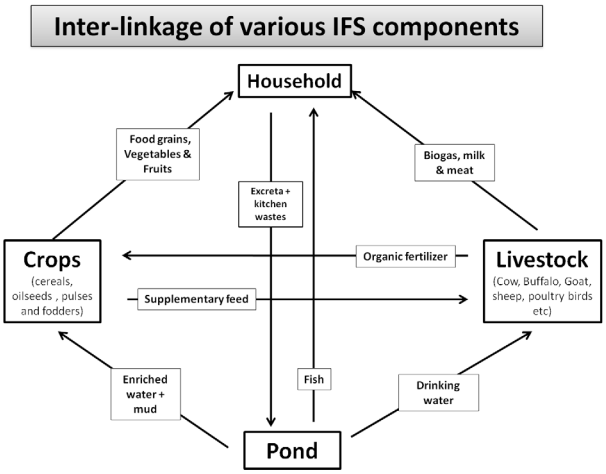

Fig. 1. Inter-linkage of various components of IFS

Table 1. Location and components of Integrated farming systems

Sr No.	Location	Components
IFS 1	KVK Bathinda	Field crops, Fruits cultivation, Poultry, Dairy, Fishery, Kitchen gardening, Mushroom cultivation
IFS 2	Mehma Swai	Field crops, Dairy, Organic vegetable production, Vermicomposting, Processing (Pickle, murabba, chutaney, Butter, butter milk, cooked sarso saag etc.)
IFS 3	Mehma Sarja	Crops, Poultry farming, cultivation of chilli(CH-27), Dairy, Potato seed production and Kitchen gardening
IFS 4	Mehraj	Crop cultivation, Fish production, Dairy, Fruit cultivation, Kitchen garden and Backyard poultry

from poultry and dairy farming was utilized as fertilizer. The excess produce or waste materials from horticulture are used for Vermicomposting along with cow dung. Addition of animal and plant wastes in the system could also help in the improvement of soil-health and thereby productivity over a long period with lesser ecological risks (Gill *et al*., 2009b; Kumar *et al*., 2017). Thus, IFS is best suited for sustainable production in agriculture.

Scientific approaches in IFS

Use of scientific techniques in the IFS components resulted in better returns. Economics of four integrated farming systems represented in Table 2. These tables includes the area, gross return, net return and B:C ratio of various components of each farming system. It is clear from the data that in 2019-20 net return from each component increased due to adoption of advanced practices.

Crop production: The data from the study revealed that use of improved cultivar instead of local cultivars can increase the crop production. In IFS 1, benefit cost ratio increased from 3.9 to 4.6. Our results are in close agreement with Yadav *et al*. (2013), who found that adoption of improved package and practices on farmer's field in Tripura can expand the yield of harvests when contrasted with conventional system.

Table 2. Economics of different IFS modals

Components	Area (acres)	2018-19			2019-20		
		Gross return	Net return	B:C ratio	Gross return	Net return	B:C ratio
IFS 1							
Field crops: Rice, wheat, fodder,	1.3	111072	88391	3.9	119432	98212	4.6
Fruits cultivation	0.5	67249	50366	3	71542	55347	3.4
Poultry	0.1	5225	4140	3.8	5500	4500	4.5
Dairy	0.1	214600	153580	2.5	223542	165140	2.8
Fishery	0.25	21864	18001	4.7	22540	19150	5.6
Kitchen gardening	0.1	13705	10925	3.9	13985	11500	4.6
Mushroom cultivation (with 10 qtl compost)	0.15	9108	6816	3	9200	7100	3.4
Total	2.5	442824	332219	3	465741	360949	3.4
IFS 2							
Field crops: wheat, sugarcane	1.45	211103	158873	3	224578	174586	3.5
Dairy	0.3	338749	249741	2.8	356578	271458	3.2
Organic vegetable production	0.7	25428	19956	3.6	26487	21458	4.3
Vermicomposting	0.05	20813	14558	2.3	21457	15487	2.6
Processing (Pickle, murabba, chutaney, Butter, butter milk, cooked sarso saag etc.)	-	24290	19434	4	24786	20457	4.7
Total	2.5	620384	462562	2.9	653886	503446	3.3
IFS 3							
Crops: wheat, maize, mustard	0.7	177290	135561	3.2	186542	145765	3.6
Poultry farming,	0.2	52697	40663	3.4	54876	43258	3.7
cultivation of chilli(CH-27)	0.7	65144	51985	4	67145	54721	4.4
Dairy	0.25	236491	166062	2.4	254127	182486	2.5
Potato seed production	0.55	105766	81458	3.4	112457	88541	3.7
Kitchen gardening	0.1	8038	6065	3.1	8457	6521	3.4
Total	2.5	645425	481793	2.9	683604	521292	3.2
IFS 4							
Crop cultivation: Wheat, rice, pulses	1.2	117369	89823	3.3	124754	96584	3.4
Fish production	0.3	42374	35329	5	44576	37584	5.4
Dairy	0.4	254094	191290	3	264571	201358	3.2
Fruits	0.4	10554	7773	2.8	11457	8542	2.9
Kitchen garden	0.1	14418	10345	2.5	15487	11245	2.7
Backyard poultry	0.1	19263	16314	5.5	20475	17542	6
Total	**2.5**	**458072**	**350875**	**3.3**	**481320**	**372855**	**3.4**

Dairy farming: It is one of the integral enterprises in farming system in Punjab. The local breeds of buffaloes in Punjab have low milk production. Data from Table 2 revealed that under integrated farming system farmer earned 7 % more profit in 2019-20 as compared to 2018-19. This increment is caused by improved breeds, balanced feed and regular check-up of animal. This agrees with the findings of Menale Kassie *et al*. (2008).

Vegetable production: In Punjab, farmers are growing vegetables in the form of kitchen gardening for self consumption and commercial cultivation for economic returns. The vegetable yield was poor in 2018-19 due to local cultivars, imbalanced fertilization and other management practices. But, in 2019-20 farmers got more profit due to adoption of improved cultivation methods and use of quality seeds and better management practices under integrated farming system. The increase in yield of vegetables with improved practices could be attributed to improved vegetative growth, better availability of nutrients at vital growth period and greater synthesis of carbohydrates and their translocation to the storage organs (Yadav *et al.,* 2013). The observations of the present study are in line with the findings of Brahma *et al.* (2010).

Fruit production: In 2018-19, the fruit plants grown by the farmer in IFS 1 were not properly maintained. He was also not utilizing the space between the two rows. But in 2018-19, he started intercropping and earned a net profit of 55347 which is 9.88 % more than previous year's net profit in fruit production. The higher fruit production in integrated farming system due to use of quality seed material and better management practices. Ghosh (2008) also reported increment in fruit production under improved practices.

Poultry farming: Backyard poultry farming has been adopted by most farmers for household consumption and at commercial scale. Earlier, they were rearing local strains, but in 2019-20 they started rearing RIR breed. In the present study, we found that egg and meat production increased under IFS. In IFS, B:C ratio improved from 3.8 to 4.59 (Table 2). IFS 3 And IFS 4 also showed increments in this ratio. These findings are in line with those of

Table 3. Scientific approaches toward various components in an Integrated farming system

Components	Common practices (followed during 2018-19)	Advanced practices (followed during 2019-20)
Crop production		
1. Variety	1. Local or improved varieties	1. Improved cultivars
2. Method of cultivation	2. Conventional practices	2. Improved practices
Vegetable cultivation		
1. Cultivars	1. Local	1. Improved
2. Techniques	2. Conventional	2. Improved
3. Manure & fertilizer	3. FYM	3. Well rotten manure
Fruits cultivation		
1. Irrigation	1. Flood irrigation	1. Drip irrigation
2. Fertilization	2. Below recommended dose	2. Recommended dose
3. Training & pruning	3. Irregular	3. At regular interval
Poultry		
1. Breed	1. Local	1. Improved birds
2. Feed	2. Local	2. Quality and concentrated feed
3. Health care	3. Rarely	3. Proper vaccination
Dairy		
1. Breed	1. Local	1. Improved breeds
2. Feed	2. Wheat flour+ mustard cake	2. Balanced feed
3. Health care	3. Rarely	3. Regular check-up
Fishery		
1. Feed	1. Natural feed	1. Natural+ concentrated
2. Fertilization	2. Cattle dung	2. Well rotted organic & inorganic fertilizers
3. Fingerlings	3. Local	3. Improved
4. Stocking density	4. Below stocking density	4. Optimum density
5. Pond liming	5. Pond liming	5. Proper at certain interval

Ershad (2005).

Fish production: Fishery is the highly profitable component in integrated farming system along with dairy farming. In 2018-19, due to local fingerlings and low stocking density the farmers did not earned maximum net profit from fishery. In 2019-20 farmers adopted scientific approaches in IFS system like improved fingerlings and use of natural and concentrated feed which resulted in 6.38 % more net profit as compared to 2018-19 (Table 2). Similar findings were represented by Yadav *et al*. (2013).

Comparison of B:C ratio

Table 6 represent the list of various practices followed in IFS systems during 2018-2020. Figure 2 shows the B:C ratio of four integrated farming system and two other farming systems. From the figure it is clear that benefit cost ration improved after the change in practises. In both cases B:C ratio of Ifs systems was more than rice-wheat system and cotton wheat system which means that net returns in case of IFS system is more that mono cropping system. In 2019-20 range of B:C ratio of IFS units was 3.2 to 3.4. This ratio was 1.6 in cotton-wheat system and 2.0 in rice-wheat system.

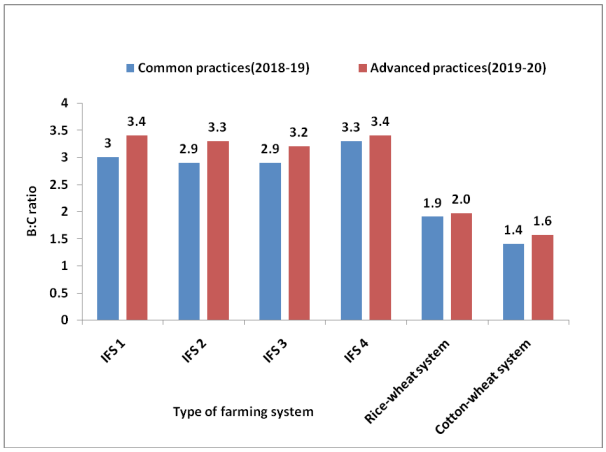

Fig. 2. Benefit cost ratio of various farming systems

Conclusion

IFS have a tremendous impact on small and marginal farmers to enhance the productivity and economic returns. The farmers in the study followed common cultivation practises in 2018-19 and adopted advanced practises in 2019-20. The study highlighted how scientific approaches increased the net profit of IFS units. IFS system became more sustainable with adoption of advanced techniques. It is also concluded fro study that various segments of IFS were interlinked with one another and give the advantages to at least one segment and the other way around. B:C ratio in case of IFS units ranges from 3.2 to 3.4 which was almost double than monoculture system.

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