ISBN: 978-81-974088-6-1

18. Role of Integrated Farming System with Special Reference to Agricultural Economics

Subhajit Mukherjee, Piyush Kumar, Deepshikha Singh, Preeti Kumari

B.Sc. (Hons.) Student in Agriculture,
School of Agriculture, Lovely Professional University,
Phagwara (Punjab), India.

Abstract:

IFS is a multi-disciplinary approach and its introduction has enabled us to generate a structure as an alternate development model for improvising the micro farming operations in comparison with macro ones, it's an more like combined approach to farming rather than monoculture approach's is a system of systems where each enterprises is interrelated to each other and "waste" from one component of an enterprise utilizes as an input for another enterprise ultimately reducing cost, increasing productivity, income & Cost benefit ratio[20].

IFS serves as an viable plan to mitigate the problems like rapid urbanization & income growth, population growth, increased in crop and livestock, food insecurity and ecological imbalance [21].Adoption of IFS simply provides a threshold income to the farming sector encouraging marginal units and prevents migration of people from agriculture sector, hereby maintaining their interest in the sector.

It's a both way relevant way-out for obtaining fairly high output & substantial fertilizer economy with a motive of ecological balance leading to sustainable agriculture (Swaminathan,1987) in conditions where marginal farmers are huge and the risk is always high [22].

(Behera & France) (2016) believed that IFS which is derived from enterprises synergized product diversification and environmental reliability are less risky when they are well handled and produces substantial economic profitability and net returns [18].

However, to raise the economy of marginal farmers the planning, execution & integration of different components in IFS in our country is quite tough due to lack of scientific approach and knowledge. Appropriate acknowledgement of linkages and Interaction among different components is very essential to ensure food security in the country which also contributes in raising economy to an extent [23].

Keywords:

Integrated farming system, IFS, Conventional farming, Economic benefits, Employment, Net come, Profitability, Productivity, Sustainability, Socio economic condition.

Overview:

Throughout the developing agricultural world, resource-depleted farmers (approx. 1.4 billion people) centralized in risk prone, marginal space remains untouched by nowadays agricultural technologies. A sustainable possible approach must be developed in order to adopt and implement in a site-specific way to highly fluctuative and diverse farm scenarios, basically for resource-scarce farmers [1]. A crucial component of the Indian economy includes agriculture. 56% of Indian workers are employed by it, despite its present-day contribution to GDP being just six percent of

what it once was. Additionally, the rise in agriculture has both forward and backward linkage effects, which raise non-agriculture sector incomes. The whole scenario of land holdings in India is that it's a land of small/marginal farmers according to the study of Chand (2011). There were an approximate 98 million small/fragmented land holdings out of the 120 million (approx.) total land holding in the country data by Agricultural Census (2000-01).

Exploitation of small/Fragmented farmers is often due to merchants, middlemen, money lenders, irregularity with monsoon, inadequate irrigation, crop diseases, costly agricultural inputs, variable and unremunerated agricultural inputs, smallholdings, low yield of land are some of the important problems of agriculture[2].By implementing HYV, the intensification increases the profit margin to an extent but it's also results into environmental impacts like groundwater depletion, soil degradation, loss of crop genetic diversity and boost in concentration of pesticide in food products[3].Some of the main issues in conventional agriculture are enlisted below:

- Agriculture as unorganized sector [3]
- Economic infeasibility of marginal farmers [3]
- Burning of crop residue for timely sowing [4]
- Inadequacy of knowledge about the potential of Conventional agriculture to agricultural leaders, extension agents, and farmers [4]

So, for resolving the above issue and ensuring food security the existing agriculture production sector must overcome challenges to feed the future world's population which is estimated at 9.1 billion in 2050 and more than 10 billion at the close of the twenty-first century, as per UNPA report of 2011.This is not going to be achieved by the traditional/conventional farming method and here's comes the sustainable and holistic approach "Integrated farming system". The main objective of Integrated farming system is to ensure that with minimum expenditure profit will be maximized by incorporating different enterprises and via their interaction & influence mix operation on farm is practiced. By recycling residues and making good use of many entities that they may have in abundance, farmers can boost their productivity over time on economically basis. The farming system distributes capital across the year through the raising of meat, milk, eggs, honey, and edible mushrooms, among other things. Thus, it is important to promote the wider acceptance of IFS and provide farmers with whatever support they might need for its effective adoption with the perspective of economically built farming system model [8].

18.1 Introduction IFS:

Integrated farming system is a holistic and dynamic approach which helps the farmers to increase the income and minimize the input cost by recycling the farm residues from the farm itself. Small and marginal farmers can apply the IFS model to any Farming system effectively in any region, which will help to increase the farm income and provide employment throughout the year.

Integrated Farming System comprises of several enterprises like, crops, poultry, Fishery, Forestry, livestock, vermicomposting, biogas plant, etc., which should be combined and planned effectively according to the agro-ecological system.

Having two or more enterprises within a single farm unit, helps in income and employment generation throughout the year. Integrated Farming System approach aims to use output of one enterprise as an input for other enterprise thus reducing the dependency on chemical fertilizers and maintaining the ecological sustainability by effective recycling of the residues.

18.2 Components of Integrated Farming System:

A. Crops:

- Cereals - Rice, Wheat, Maize, Barley
- Millets - Sorghum, Bajra
- Pulses - Black gram, green gram, Chickpea, Lentil
- Oilseeds - Groundnut, Linseed, Castor, Sunflower, Mustard
- Fruit crops - Papaya, Citrus, Pomegranate
- Plantation crops- Coconut, Sugarcane, Banana, Tea, Coffee
- Root crops- Radish, Carrot, Sweet potato, Yam
- Fodder crops - Lucerne, Berseem, Guar, Sorghum, Napier Grass

The crops should be selected according to the market demand, household consumption, temperature, Rainfall requirement and soil type of the region.

B. Livestock:

Cows, Buffalo, Goat, Sheep, Pigs, Small ruminants like rabbits, Poultry birds like, Hen, Ducks, Turkey, Quail, etc.

C. Forest Trees:

Agroforestry

- Cassia tree - *Cassia siamea*
- Hickory wattle - *Acacia mangium*
- Spiked powder puff - *Calliandra calothyrsus*
- White Teak - *Gmelina arborea*

- Beggars Lice - *Desmodium spp.*

These forest trees provide many byproducts like gum, timber, rubber, medicine, reisin and wood as fuel for rural household.

Aquaforestry

- River Tamarind- *Leucaena leucocephala*
- Mulberry - *Morus alba*
- Mexican Lilac - *Gliricidia sepium*
- Drum Stick - *Moringa olifera*

These trees are planted along the borders of the ponds whose leaves are preferred by many fishes as feed.

D. Fishery:

- Grass carp - Ctenopharyngodon idella
- Java Barb - Puntius gonionotus
- Mozambique tilapia - Oreochromis mossambicus
- Snakeskin gourami - Trichogaster pectorals
- Common carp - Cyprinus carpio
- Rohu - Labeo rohita
- silver carp - Ctenopharyn godonidella

These fishes are major part of Rice - Fish Farming system and are also used for controlling weeds directly by feeding.

E. Sericulture:

The practice of sericulture involves growing mulberry, raising silkworms, and reeling silk.

There is major four types of silk worm that are reared commercially:

- Mulberry silk worm (Bombax mori)
- Eri silk worm (Philosamia ricini)
- Tassar silk worm (Antheraea mylitta)
- Muga silk worm (Antheraea assami)

F. Bee-Keeping:

Beekeeping stands out as a crucial agro-based industry that doesn't rely on raw materials from the artisan, unlike other industries. There are 2 major species cultured in India *Apis cerana indica* and *A. mellifera. Apis cerena indica* is better adapted in Himalayan region whereas, *Apis mellifera* is profitable in the plains.

G. Mushroom Cultivation:

Mushrooms are a diverse range of edible mushrooms that are present in a variety of shapes, sizes, and hues. They are grown in controlled environments that are subject to high benchmarking like other vegetables. Carrying with them a moisture content of about 90%, mushrooms are rich in high quality protein, Vitamin C, Vitamin B complex and essential amino acids.

Types of mushrooms used in IFS model-

- Oyster mushroom
- Milky mushroom
- Button mushroom

H. Biogas Plant:

Biogas is an affordable and environmentally friendly energy source that can be easily produced with minimal investment.

It is generated from cow dung through anaerobic decomposition, a complex biochemical process where microorganisms break down cellulose materials into methane and carbon dioxide. Biogas can be used for cooking, lighting lamps, and powering pumps**.** [4,7,15]

Table 18.1: Difference Between Conventional and Integrated Farming System

Conventional Farming System	Integrated Farming System
The main aim of conventional farming system is to get maximum returns.	The main aim of IFS is to promote sustainability along with returns.
Conventional farming system requires less level of knowledge input.	Integrated farming system demands more extensive knowledge input compared to the conventional system.
Conventional agriculture degrades biodiversity as a result of increased chemical usage.	Integrated farming system maintains and conserves the biodiversity.
The use of chemical fertilizers and pesticides is resulting in the pollution of soil, groundwater, and drinking water.	The components in IFS are effectively connected to recycle waste materials, thereby reducing environmental pollution.
Due to the significant rise in energy and raw material consumption, there is an increasing reliance on the availability and pricing of these resources, leading to higher input costs.	The waste material from one process can be repurposed as input for another, thus reducing the production costs and establishing a direct link between waste utilization and production, eliminating the need for intermediaries.
Produce from conventional farming often contains traces of fertilizers, pesticides, hormones, antibiotics, and heavy metals.	The agricultural products obtained through integrated farming systems (IFS) are healthier and contain minimal amounts of chemicals as it

Conventional Farming System	Integrated Farming System
	follows Integrated nutrient system approach.
Conventional farming only provides income for a limited period or part of the year.	The interaction between various types of businesses ensures a consistent flow of income for the farmer throughout the year.
The fertilizer application in the Conventional farming system primarily consists of inorganic materials/ fertilizers.	The fertilizer application in the integrated farming system primarily consists of organic materials.
Weed-suppressing varieties are employed in	Weed-suppressing varieties are employed in
Conventional Farming System	Integrated Farming System
conventional farming only when they prove to be economically profitable.	Integrated farming, as much as possible so as to reduce the dependence on weedicides.
Due to higher input costs, the benefit-cost ratio is lower compared to Integrated farming system.	Due to lower input costs, the benefit-cost ratio (B:C Ratio) is higher compared to conventional farming methods.
The soil and ecological health get deteriorated gradually, if conventional farming is practiced continuously.	The soil and ecological well-being are preserved in the long run.

[7,10,14]

18.3 Integrated Farming Systems Models for India's Agro-Ecological Zones [9]:

Classification of India's agro ecological zones according to NATP (National Agricultural Technology Project) is done in 5 zones which are -rainfed, irrigated, coastal, arid, hill and mountains.

Based upon socioeconomic conditions and agro-ecological conditions, the farming system in one agro-ecosystem varies from another.

ARID- Pearl millet+lucerne+oilseed+goats

COASTAL-coconut+rice+fruit based+fisheries

HILL AND MOUNTAINS-horticultural crops+rice+vegetables

RAINFED-rice+oilseed+cotton+buffalo

IRRIGATED-rice+sugarcane+cow

18.4 Goals of IFS:

The four primary goals of IFS are:

- Maximize yield with stable income.
- Aims to achieve agro ecological equilibrium.
- Minimization of disease, Pest, weed infestation by natural cropping system.
- Minimize use of synthetic fertilizer/pesticide and promote chemical free/organic farming.[8]

18.5 Advantages of IFS:

[8,9,12,17]

A. Increase in productivity -By diversifying activities related to crop husbandry and animal husbandry, aquaculture, agroforestry, etc. IFS presents an opportunity to improve economic output per unit of land area and time.

B. Increased profitability - Economic returns from farming an integrated system offers a possibility to use the product, surplus or by-product from one component to another one at a lower cost. consequently, this will lead to lower cultivation costs which imply more profits in the long run, which means the ratio of benefit cost stands higher than 1.

C. Help in sustainability -To preserve the environment, the system employs on-farm resources and recycles waste thus minimizing chemical inputs in growing crops. Furthermore, creating a favorable crop environment suppresses pest and disease attack hence there is no need for plant protection substances. Therefore, IFS ensures that production potential is upheld in the future.

D. Employment generation - (IFS) offers a potential solution to mitigate financial risks and improves employment opportunities; by incorporating numerous enterprises, it boosts labour demand which contributes to reducing unemployment

E. Risk minimization -As IFS leads to a sustainable production system through diversified crops and enterprises, this helps in risk minimization and resilience to climate change.

F. Income throughout the year - Output of different enterprises of IFS helps to maintain cash flow throughout the year.

G. Environmental safety- In IFS waste materials are utilizes efficiently, to reduce the environmental pollution, by increasing the soil fertility. For example, rice straws are utilized as manures and can be feed to cattles. Also, IFS accounts for efficient use of resources and recycling of materials, by which farmers dependency on external inputs and agro chemicals is reduced, by this environmental pollution is minimized.

H. Improves soil health - By the integration of livestocks, fisheries and crop, soil microbial activity is increased, which leads to improvement in soil fertility.

I. Improves nutritional food security -IFS focuses and guarantee the security of the core of the resources by efficiently recycling waste and residues within the system, which leads to nutritional and food security.

J. Biodiversity conservation - IFS have the potential to restore biodiversity and improve ecosystem functioning, increase agricultural and economic development

throughout the system If a farm or farming community uses plant species, livestock varieties or other types of plants occur, this is called agricultural variety. IFS promotes biodiversity conservation.

18.6 Constraints of IFS:

- The majority of farmers in the IFS are struggling with serious issues such as low output prices, unavailability and high cost of HYV (High Yielding Variety) seeds, and a shortage of concentrated feed and fodder for Livestock.
- Small and marginal farmers lack the necessary skills to effectively plan an IFS model due to their lack of knowledge about integrating different agricultural enterprises.
- Lack of information about the kinds and sizes of enterprises that should be involved; ignorance of the integration features of enterprises; and ignorance of efficient off-farm waste recycling.
- Heavy investment in the initial years and the lack of available labor continue to be major concerns for integrated farming systems.

18.7 Socio-Economic Condition of Indian Farmer:

The agriculture sector is backbone of the country's economy and all-time shelter for bulk population, which provides employment throughout the year and partially minimizes population flow from rural to urban areas.

In 2007-08, agriculture accounted for 17.8% of India's GDP while 70% of work power were involved in it.

A. Socio-Economic Status of Farmers:

A study was conducted in Jaunpur (UP) where a random sampling was done on about 100 farmers and it was observed that majority of them were middle aged, primary educated, mostly from backward class with small holding and agriculture as main occupation without any subsidiary or alternate enterprises [13].

Table 18.2: Socio-Economic Status of Farmers

Sr. No	Categories	No. of farmers	Percentage
1.	High (score >=25)	16	16.0%
2.	Medium (score 18-34)	66	66.0%
3.	Low (score <=17)	18	18.0%
	Total	100	100.0%

Table 18.2:"The data indicates that the majority of farmers (66%) are classified in the middle socioeconomic class stand while as 16% are high producers and 18% are low producers." [13**]**

B. Comparison Between IFS and Conventional Farming System Table:18.3[16]

Yield (rice equivalent yield), profitability, and the employment of jobs in conventional cropping and integrated agricultural systems (pooled data of three years)

Source: Channabasavanna et al. (2009) [16]

Table 18.3: Comparison Between IFS and Conventional Farming System

	Productivity (kg/ha/yr)	Net returns ($)	Employment generation (man-days/ha/yr)
Integrated farming system	7088	369	275
Conventional farming system	5611	279	459

Channabasavanna et al. (2009) conducted a study on Integrate farm management system Involving farming, goat rearing, fishery, crops and poultry at Agricultural Research Station, Siruguppa, Karnataka, India, respectively for the years 2003-04 and 2005-06 in both wet and dry seasons.

To compare it with a conventional (rice-rice) cropping system in Karnataka Tungabhadra project area, IFS will be evaluated on grounds of productivity. The combined system of agriculture had an increment of 26.3 percent output increase than the normal type of farming (rice followed by rice) **(Table 18.3) [16]**

C. Comparison of Net Income of Single Enterprise and IFS:

This table shows the scope of an IFS that how it improves farm profitability over single enterprise by increasing net income of the farm.

Table 18.4: Comparison of Net Income of Single Enterprise and IFS

Sr. No	Single enterprise	Net Income	Integrated farming system	Net Income	Improvement%	Reference
1.	Rice	306	rice+azolla+fish	424	38	Balusamy et al. (2003)
2.	Cashew	484	Rice-brinjal+rice-cowpea+ mushroom+poultry	1005	107	Manjunath and itnal (2003)
3.	Tuber crops	970	Tuber crops+vegetables+field crops+livestock+aquaculture	5306	447	Shankar et al. (2018)
4.	rice-green	139	crop+mushroom+poultry+-	1041	651	Nath and

Sr. No	Single enterprise	Net Income	Integrated farming system	Net Income	Improvement%	Reference
	gram		vermicompost=vegetables			barik (2013)
5.	Arable farming	321	Crops+2cows+15goats+10poultry+10 duck+fish	599	86	Tiwari et al. (1999)
6.	Cotton	1129	cotton+chrysanthemum+fodder+bullock+cow+buffalo	2443	116	Rao et al (2017)

Table 18.4[18]

18.7.1 Economic Benefits of IFS:

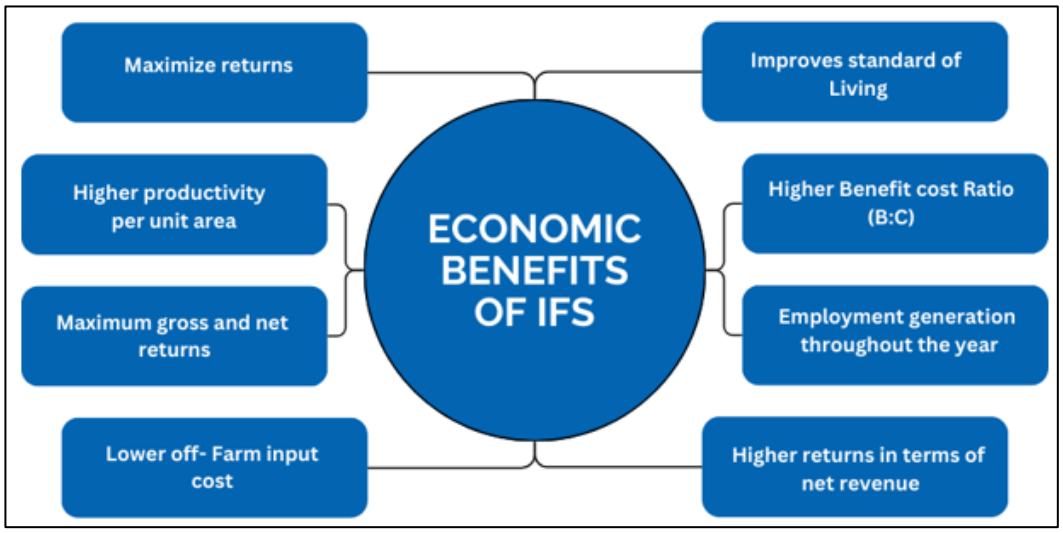

Figure 18.1: Economic benefits of IFS

Based on data available in [16]

A. Effect of Integrated Farming System on Farm Income and Employment:

- The study indicates that Integrated Farming Systems (IFS) can significantly improve farm profitability by increasing net income by 265% compared to single-crop farming. For example, a 14% increase in net income was observed in a system combining Rice, Azolla/Calotropis, and Fish, while a system involving Crops, Pigeon, Buffalo, Agroforestry, and a farm pond showed an impressive 1838% increase over monocropping. Additionally, the employment potential under IFS showed improvements ranging from 30% to 485%, with an average increase of 143% over single-crop farming.
- The increased diversification of products in IFS, particularly in livestock such as dairy and poultry, has the potential to create daily income for small and marginal farmers.

Diversifying products not only ensures daily income, but also results in a continuous need for labor across various crops and livestock, offering opportunities for increased employment and keeping farm families engaged in agricultural activities.

- Incorporating high-value vegetables and spice crops into the farm is more profitable than exclusively growing crops for extended periods. The livestock component, including dairy, goat farming, poultry, and pig farming, serves as a form of farm insurance in the event of crop failure and offers employment opportunities in other sectors, even if one enterprise is unable to produce due to factors such as storms, rain, drought, pest infestations, diseases, and so on.
- The integrated farming system has increased net income and gross returns, while decreasing the number of small and marginal farmers migrating to neighboring cities in search of jobs and livelihood. As a result, it provides more employment and income to small and marginal farmers within the rural areas themselves.

B. Comparison of Employment of Single Enterprise and IFS:

Below mentioned table illustrates the improvement in employment opportunity for rural people by integrating different components of IFS in the farm. The implication of IFS is one of the strategies to reduce economic insecurity by providing more employment opportunities. Due to the diversities in crops and animal farming in the integrated farming system, employment opportunities are also high that will keep the farm families engaged in farming activities.

Table 18.5: Comparison of Employment of Single Enterprise and IFS

Sr. No	Single Enterprise	employment	IFS	employment	Improvement %	reference
1.	Cotton	649	Cotton,chrysanthemum,fodder,sorghum+bullock+cow+buffalo	808	24	Rao et al (2017)
2.	Rice alone	437	rice+dairy+fish	555	172	Behera et al (2013)
3.	Wheat	217	Fieldcrops+goat+poultry+mushroom	502	131	Kumar et al. (2012)
4.	Makhana	247	Makhana+fish+water cheshnut	347	40	Kumar et al (2017)
5.	Tuber crops	203	Tuber crops +vegetables +field crops+livestock +aqualture	263	30	Shankar et al. (2018)

Table 18.5 [18]

18.8 Zero Budget Natural Farming:

[24] [25]

Due to the deteriorating effect of chemicals, there is a Newly introduced technique among farmers called Zero Budget Natural Farming (ZBNF), also known as Zero Budget Spiritual Farming (ZBSF), which has gained significant success in southern India, particularly in Karnataka where it was originated.

Zero budget farming is a sustainable farming practice that enables farmers to maintain soil fertility, rejuvenate soil health, and ensure chemical-free agriculture, all while keeping production costs low and potentially doubling the farmers' income. The concept of ZBNF was first introduced by Maharashtrian Agriculturist, Padmashri Subhash Palekar.

Some fundamental practices followed in ZBNF is the use of Jeevamrit, Beejamrit, Agniastra, Neemastra, Brahmastra, Waaphasa, etc.

How ZBNF is Economically Profitable?

Due to the implementation of Zero Budget Natural Farming's biological inputs, the cost of inputs per hectare and the share in the paid-out costs per hectare of crops have decreased, leading to a reduction in farmers' reliance on external inputs. As a result, the farmers have gained more independence from external input markets.

The Input materials needed to make Bijamrit, Jeevamrit, Brahmastra,Neemastra, and Agniastra are sourced from local resources such as dung, urine, dairy products from local cows, leaves, and other materials available in the area.

This helps in providing cost-effective inputs for farmers to cultivate crops. The inputs used in ZBNF are cost-effective because they are prepared locally by the farmers using available ingredients. Additionally, the occurrence of seasonal crop pests has decreased due to ZBNF, saving farmers from the high costs of chemical fertilizers and pesticides.

18.8.1 Impact of IFS in Doubling Farmers Income:

A. Overview:

In India, farming along with different enterprises has been practiced since immemorial, but after green revolution (1960) & economic liberalization (1990) farmer started getting restricted to few enterprises due to several factors:

- High profit in initial phase of green revolution led to livelihood diversification
- Reduction of farm size
- Fluctuation in commodity prices
- Labour shortage due to factory development and urbanization.

These factors caused severe impact on food and nutritional security of millions of marginal farmers. Due to resource depletion and farm holding shrinkage, farmers started facing economic loss and somewhere it has also led to unwillingness to continue farming. After multiple analysis. Government of India have made an announcement about doubling farmers income by 2022. One of the best suggestions that came out after evaluation was to evaluate the potential of age-old Integrated Farming System.

B. Survey:

A survey was conducted in trivallur and thanjavur of Tamil Nadu on 150 farmers to find contribution of IFS in their total income. Similar trials were also conducted in multiple districts of Haryana.

C. Observation:

As per survey, an observation was made that the farmers practicing IFS with multiple enterprises were having better net income in compare to one who were just practicing monocropping.

The one who was growing only paddy got net income of rs.40755/ha by spending rs.45942/ha, when they added new enterprise(livestock) the income increased with convenient decrease in cost of cultivation as cowdung was also utilized as FYM, increase in rs.7880 was observed in previous net income. Similarly, following increment was observed along with addition of enterprise:

- Rs.12680 for crop+dairy+poultry
- Rs.57530 for crop+dairy+poultry+fishery
- Rs.35840 for crop+dairy+poultry+sheep/goat.

Note- The income mentioned above are additional income along with net income of paddy cultivation i.e.Rs.40755/ha. (19)

18.9 Conclusion:

IFS has huge potential of uplifting rural condition to their maximum potential, specific to agroclimatic and socio-economic condition. Improved farm practices have the potential to improve production, return, productivity, etc. IFS presents one-of-a-kind chance of improvement of biodiversity conservation and expansion. It also plays a pivotal role in land conservation and water conservation and minimization of environmental contamination. (14)

It can be concluded that concept of IFS revolves around better utilization of the available resources. It enhances production and helps in achieving higher economic returns. Moreover, farm families get a scope of gainful employment round the year. Thus, IFS is the requirement in India to help small and marginal farmers which ensures better livelihood, high income and can act as a cause in nations economic growth. (16)

18.10 References:

1. Altieri, M. A. (2002). Agroecology: the science of natural resource management for poor farmers in marginal environments. *Agriculture, ecosystems & environment*, *93*(1-3), 1-24.
2. Macharla, I., & Lal, B. S. (2017). Issues and problems of small and marginal farmer: A study in Karimnagar District. *International Journal of Academic Research*, *4*, 203-10.
3. Patil, S., Reidsma, P., Shah, P., Purushothaman, S., & Wolf, J. (2014). Comparing conventional and organic agriculture in Karnataka, India: Where and when can organic farming be sustainable? *Land use policy*, *37*, 40-51.
4. Poonam, A., Saha, S., Nayak, P. K., Sinhababu, D. P., Sahu, P. K., Satapathy, B. S., ... & Pathak, H. (2019). Rice-fish integrated farming systems for eastern India.
5. Bhan, S., & Behera, U. K. (2014). Conservation agriculture in India–Problems, prospects and policy issues. *International Soil and Water Conservation Research*, *2*(4), 1-12.
6. Patra, A. K. (2016). Concept, scope and components of integrated farming system. *Training Manual-a model training course on root and tuber crop based integrated farming system: A way forward to address climate change and livelihood improvement*, 8-13.
7. Rana, S. S., & Chopra, P. (2013). Integrated farming system. *Department of Agronomy, College of Agriculture, CSK Himachal Pradesh Krishi Vishvavidyalaya: Palampur, India*.
8. Bhati, Priyanka & Saikia, Anadi & Chaudhary, Shivani & Bahadur, Raj & Nengparmoi, Th & Talukdar, Nilabh & Hazarika, Sanjay. (2024). Integrated Farming Systems for Environment Sustainability: A Comprehensive Review. Journal of Scientific Research and Reports. 30. 143-155. 10.9734/jsrr/2024/v30i11834.
9. Mujahed, Belal Ahmad & Singh, Janardan & Saqib, Abdullah. (2023). Integrated Farming System: Trends, Advantages and Constraints -A review. RASSA Journal of Science for Society. 5. 65-69. 10.5958/2583-3715.2023.00011.4.
10. Vereijken, P. (1986). From conventional to integrated agriculture. *Netherlands Journal of Agricultural Science*, *34*(3), 387-393.
11. Al Mamun, S., Nusrat, F., & Debi, M. R. (2011). Integrated farming system: prospects in Bangladesh. *Journal of Environmental Science and Natural Resources*, *4*(2), 127-136.
12. Mohd, Salim & Naikoo, Nasir & Amin, Zakir & Bhat, Tauseef & Nazir, Dr & Kanth, Raihana & Singh, Parmeet & Raja, Waseem & Singh, Lal & Fayaz, Shayista & Ahngar, Tanveer & Palmo, Tsultim & Rehman, Ummaisa. (2022). Integrated Farming System: A Tool for Doubling Farmer's Income. Journal of Experimental Agriculture International. 47-56. 10.9734/JEAI/2022/v44i330808.
13. Singh, D. K., Singh, A. K., Yadav, V. P., Singh, R. B., Baghel, R. S., & Singh, M. (2016). Association of socio-economic status with economic motivation of the farmers. *Indian research journal of extension education*, *9*(2), 53-56.
14. Seth, D., Ghosh, P., & Roy, L. (2023). Integrated farming systems a way for long-term farming viability: a review. *Plant Archives (09725210)*, *23*(1).
15. Nedunchezhiyan, M., Jata, S. K., Gowda, K. H., Chauhan, V. B. S., Bansode, V. V., & Mukherjee, A. (2016). Livelihood improvement through tuber crops based

integratedfarming system. *Root and tuber crops based integrated farming system: A way forward to address climate change and livelihood improvement*, 22.

16. Walia, S. S., Dhawan, V., Dhawan, A. K., & Ravisankar, N. (2019). Integrated farming system: enhancing income source for marginal and small farmers. *Natural resourcemanagement: ecological perspectives*, 63-94. (socio-economic)
17. Venkatesh, Paramesh & Ravisankar, Natesan & Behera, UmaKant & Vadivel, Arunachalam & Kumar, Parveen & Rajkumar, Solomon & Dhar, Shiva & Kumar, R Mohan & Prusty, A K & D., Jacob & Panwar, A.S. & Mayenkar, Trivesh & Reddy K, Viswanatha & Rajkumar, Susitha. (2022). Integrated farming system approaches to achieve food and nutritional security for enhancing profitability, employment, and climate resilience in India. Food and Energy Security. 11. 321. 10.1002/fes3.321.
18. Venkatesh, Paramesh & Ravisankar, Natesan & Behera, UmaKant & Vadivel, Arunachalam & Kumar, Parveen & Rajkumar, Solomon & Dhar, Shiva & Kumar, R Mohan & Prusty, A K & D., Jacob & Panwar, A.S. & Mayenkar, Trivesh & Reddy K, Viswanatha & Rajkumar, Susitha. (2022). Integrated farming system approaches to achieve food and nutritional security for enhancing profitability, employment, and climate resilience in India. Food and Energy Security. 11. 321. 10.1002/fes3.321.
19. Ponnusamy, K., & Devi, M. K. (2017). Impact of integrated farming system approach on doubling farmers' income. *Agricultural Economics Research Review*, *30*.
20. Soni, R. P., Katoch, M., & Ladohia, R. (2014). Integrated farming systems-a review. IOSR Journal of Agriculture and Veterinary Science, 7(10), 36-42.
21. Kumar, S., Bhatt, B. P., Dey, A., SHIVANI, S., Kumar, U., Idris, M., ... & Kumar, S. (2018). Integrated farming system in India: Current status, scope and future prospects in changing agricultural scenario. *The Indian Journal of Agricultural Sciences*, *88*(11), 1661-1675.
22. Khobragade, S., Mohapatra, S., Mahananda, M., Singh, A., & Singh, A. (2021). Integrated Farming System (IFS): A Review. *International Journal of Economic Plants*, *8*(Aug, 3), 181-187.
23. Maitra, S., & Shankar, T. (2019). 1. Integrated Farming System. *MODERN TRENDS IN AGRICULTURE*.
24. Budget, Z. (2022). Zero Budget Natural Farming. *Research Today*, *4*(3), 186-189.
25. Bishnoi, R., & Bhati, A. (2017). An overview: Zero budget natural farming. *Trends in Biosciences*, *10*(46), 9314-9316.
26. Galab, S., Reddy, P. P., Raju, D. S. R., Ravi, C., & Rajani, A. (2020). Impact assessment of zero budget natural farming in Andhra Pradesh. A comprehensive approach using crop cutting experiments. Report for the agricultural year 2018–19.