

3. Integrated Farming System for Doubling Farmers' Income

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Abstract:

Integrated fish farming systems refer to the production, integrated management and comprehensive use of aquaculture, agriculture and livestock, with an emphasis on aquaculture. Asia has a long and rich history of integrated fish farming. Written records from the first and second centuries B.C. documented the integration of aquatic plant cultivation and fish farming. From the ninth century, records showed fish farming in the paddy field. From the fourteenth to sixteenth centuries, there were records of rotation of fish and grass culture; and by the 1620s, the mulberry-dike fishpond, the integration of fish and livestock farming and complex systems of multiple enterprises integrated with fish farming were developed. Integrated fish farming is the methods by which fish is cultured along with paddy, piggery, poultry or any livestock, or flower culture. This type of farming practices helps to improve economic sustainability of the farmers. It also helps to develop climate resilient culture system by improving production potential, reserving biomass, increase food security without any negative effect on environment. Thus, in future, integrated farming system will help in sustainable development of human and environment both.

Keywords:

Agriculture, diversification, food security, income doubling

3.1 Introduction:

Integrated farming system is the farming of different agricultural practices such as crop cultivation, livestock rearing, poultry farming, fish farming and agroforestry in a mutually beneficial way to maximize production and income. Integrated farming can help in doubling farmers' income by providing multiple sources of income and reducing dependence on a single crop or activity. It can be a sustainable and profitable approach for farmers to double their income. However, it requires careful planning, proper management, and technical expertise. Governments and organizations can provide support in terms of training, credit facilities, and market linkages to help farmers adopt integrated farming practices. Integrated farming system (IFS) is a sustainable agricultural production system that aims to optimize the use of natural resources, increase productivity, and improve livelihoods. IFS approach promotes the efficient use of resources by utilizing the by-products of one farming activity as inputs for another. For example, the manure produced by livestock can be used as organic

fertilizer for crop production. Similarly, the crop residues can be used as feed for livestock, and the livestock waste can be used for biogas production. This approach not only reduces waste but also improves soil health and fertility, leading to increased crop yields. In an IFS, crop production is often combined with livestock production, which helps to diversify income streams for farmers. Livestock provides additional income through the sale of milk, eggs, meat, and other products. Forestry and fishery components in an IFS provide additional benefits such as soil conservation, water conservation, and biodiversity conservation. Trees planted in and around the farm help to prevent soil erosion, provide shade for livestock, and improve microclimatic conditions. Fish ponds provide an additional source of protein, which is essential for the health and well-being of the rural population. The IFS approach promotes the efficient use of natural resources, increases productivity, and helps to mitigate the adverse effects of climate change. The system is also socially and economically sustainable, providing a means of livelihood for small-scale farmers, enhancing food security, and reducing rural poverty. The system provides multiple benefits, including increased productivity, soil conservation, water conservation, and biodiversity conservation. The IFS approach has the potential to transform rural livelihoods, enhance food security, and mitigate the adverse effects of climate change.

Why Diversification Is Needed in Farming System?

Diversification in agriculture refers to the practice of growing a variety of crops or integrating multiple farming activities on a single farm. There are several reasons why diversification is necessary in agriculture

- By diversifying their crops or activities, farmers can reduce the risk of crop failure due to weather or other environmental factors. For example, if a farmer relies on a single crop and that crop fails due to drought or disease, the farmer will suffer a significant financial loss. However, if the farmer has multiple crops or activities, they can still generate income from other sources, which helps to cushion the impact of crop failure.
- Diversification can help farmers to generate a more stable income throughout the year. For example, by integrating livestock production with crop production, farmers can generate income from both sources, which helps to balance out the income stream. This can be particularly important for small-scale farmers who may not have access to financial safety nets.
- Growing a variety of crops can help to improve soil health by reducing soil erosion, increasing soil fertility, and reducing the build-up of pests and diseases. Crop rotation, which involves planting different crops in different seasons, is a common practice used to improve soil health.
- Diversification can help to promote environmental sustainability by reducing the use of chemical inputs, conserving water, and reducing greenhouse gas emissions. For example, integrating livestock production with crop production can help to reduce the use of synthetic fertilizers and pesticides, while also providing a source of organic fertilizer for crops.
- It can help to improve food security by increasing the variety of foods available to local communities. This can be particularly important in regions where food availability is limited.

So, diversification is necessary in agriculture to manage risk, stabilize income, improve soil health, promote environmental sustainability, and enhance food security. By diversifying their crops or activities, farmers can create a more resilient and sustainable farming system that can adapt to changing environmental and economic conditions.

3.2 Principle of IFS:

IFS is based on the idea that farming activities can complement and enhance each other creating more efficient, sustainable and profitable system. The main principles of this system are mainly crop diversification, recycling of nutrients, conservation of natural resources, optimization of resource and input in a farming system along with integrated crop and nutrient management.

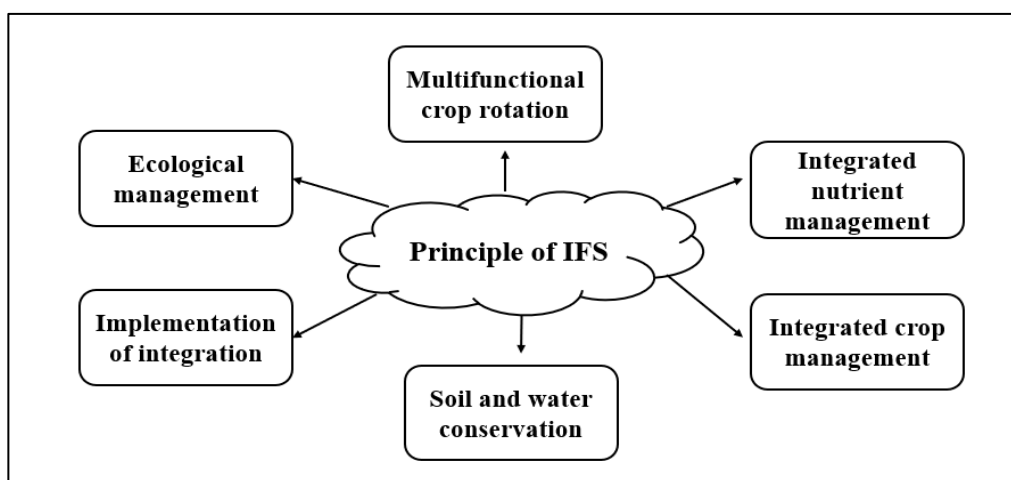


Figure 3.1: Principle of IFS

3.3 Objectives of IFS:

- A. The objectives of IFS are to optimize resource use, increase productivity, improve livelihoods, promote environmental sustainability, enhance food security, and mitigate climate change. By achieving these objectives, IFS can contribute to a more sustainable and resilient agricultural system. The objectives of IFS are-
- B. To optimize the use of natural resources: IFS aims to make the best possible use of natural resources, such as land, water, and energy, by integrating different farming activities. By using the by-products of one activity as inputs for another, IFS reduce waste and maximizes resource efficiency.
- C. To increase productivity: By combining different farming activities, IFS can increase productivity and yield. For example, livestock waste can be used as organic fertilizer for crops, which improves soil health and leads to increased crop yields. Livestock can also provide draft power for land preparation and transportation, reducing the need for expensive machinery.
- D. To improve livelihoods: IFS provides opportunities for small-scale farmers to diversify their income streams by integrating different farming activities. Farmers can generate

additional income from various sources, such as the sale of milk, meat, eggs, crops, and fish. This diversification helps to reduce the risks associated with single-crop or single-livestock farming and provides more stable incomes for farmers.

- E. To promote environmental sustainability: IFS aims to reduce the negative impacts of agricultural production on the environment by promoting practices such as agroforestry, conservation tillage, and integrated pest management. These practices can help to prevent soil erosion, improve soil health, conserve water, and reduce greenhouse gas emissions.
- F. To enhance food security: IFS can contribute to food security by increasing agricultural productivity, diversifying income streams for farmers, and providing a more diverse range of foods for local consumption.
- G. To mitigate climate change: IFS can help to mitigate the adverse effects of climate change by promoting practices that reduce greenhouse gas emissions, such as the use of renewable energy, carbon sequestration, and sustainable land use practices.

3.4 Approaches of IFS:

There are several approaches or components to implement IFS, including crop-livestock integration, agroforestry, fish farming, multiple cropping, and renewable energy. These approaches can be combined in different ways to create a more diverse and sustainable farming system.

- A. Crop-livestock integration: This approach involves integrating crop and livestock production on the same farm. Livestock can provide manure for crops, while crop residues can be used as feed for livestock. This approach helps to optimize resource use and increase productivity.
- B. Agroforestry: Agroforestry involves planting trees and other perennial crops on the farm. The trees can provide shade, conserve soil moisture, and improve soil fertility. They can also provide a source of fuelwood and timber. Agroforestry can be integrated with crop and livestock production to create a more diverse and sustainable farming system.
- C. Fish farming: Fish farming can be integrated with crop and livestock production to provide a source of protein and income. Fish ponds can be stocked with fish species that are well adapted to the local conditions. The fish waste can be used as fertilizer for crops, and the fish can be sold for food.
- D. Multiple cropping: Multiple cropping involves growing two or more crops on the same piece of land in a single growing season. This approach can help to optimize resource use and increase productivity. Multiple cropping can be combined with livestock production and agroforestry to create a more diverse and resilient farming system.
- E. Renewable energy: Renewable energy can be integrated into IFS by using solar panels, wind turbines, or biogas digesters to generate electricity. The electricity can be used for lighting, cooking, and other farm activities. Biogas digesters can also produce fertilizer and reduce greenhouse gas emissions.
- F. Soil and water conservation: Soil and water conservation practices are essential components of an IFS. Soil erosion can be reduced by planting cover crops, terracing, contouring, and conservation tillage. Water conservation can be achieved through rainwater harvesting, irrigation efficiency, and water recycling.

G. Value addition and marketing: Value addition and marketing are important components of an IFS. Value addition involves processing raw agricultural products into value-added products such as jams, pickles, and juices. Marketing involves selling agricultural products in local or regional markets, which helps to generate income for farmers and promote food security.

3.5 Doubling Farmers' Income Through IFS

IFS is a farming system that combines different farming practices such in a mutually beneficial way to maximize production and income. Integrated farming can help in doubling farmers' income by providing multiple sources of income and reducing dependence on a single crop or activity. Here are some of the ways in which integrated farming can help in doubling farmers' income-

A. Diversification of Income:

IFS can play a vital role in income diversification for farmers. Income diversification refers to the practice of generating income from multiple sources, which can help to reduce the risk of financial losses due to a single crop failure or market downturn.

- In crop cum livestock IFS the integration can provide farmers with an additional source of income through the sale of milk, meat, and other animal products.
- It can also involve integrating trees and other perennial crops into the farming system, which can provide an additional source of income through the sale of timber, fruits, and other non-timber forest products.
- IFS can involve integrating fish production with crop and livestock production, which can provide an additional source of income through the sale of fish.
- It can involve adding value to farmed products through processing and packaging, which can create additional income opportunities for farmers. For example, fruits can be processed into jams, pickles, and juices, while milk can be processed into cheese, yogurt, and other dairy products.
- IFS can also involve diversifying the market channels through which farmers sell their products. This can include selling products directly to consumers through farmers' markets or community-supported agriculture (CSA) programs or selling products to local or regional processors, which can help to create more stable income streams for farmers.

By diversifying their income sources, farmers can become more resilient to economic and environmental challenges and improve their livelihoods.

B. Sustainable Development:

IFS can contribute significantly to sustainable development by promoting the efficient use of natural resources, reducing environmental impact, and improving social and economic conditions.

- IFS can promote the efficient use of natural resources such as water, soil, and energy. For example, by integrating livestock and crops, farmers can use animal manure as a fertilizer, reducing the need for synthetic fertilizers.
- IFS can promote soil health through the use of organic fertilizers, crop rotations, and intercropping.
- It can promote biodiversity by incorporating a range of crops, trees, and other vegetation into the farming system. This can also help to provide habitat for wildlife and promote ecosystem services such as pollination and pest control.
- IFS can help to mitigate the impacts of climate change by reducing greenhouse gas emissions through practices such as use of renewable energy.
- This system can provide social and economic benefits to farmers by creating additional income opportunities, improving food security, and promoting rural development.
- IFS can also promote sustainable value chains by integrating small-scale producers into the market and creating opportunities for value addition and marketing. Thus, it can help to reduce food waste, increase market access for small-scale farmers, and promote social and environmental sustainability.

C. Nutritional Food Security:

IFS can improve nutritional food security by promoting the production and consumption of a diverse range of food products, including crops, livestock, fish, and fruits. Here are some ways in which IFS can improve nutritional food security:

- IFS can promote the production of nutrient-rich varieties of crops and livestock that are suited to the local environment.
- IFS can also improve access to nutritious food by promoting local production and consumption, reducing the reliance on imported food products. Additionally, it can improve access to food for vulnerable populations through initiatives such as community gardens and school feeding programs.
- Farmers can process fruits and vegetables into jams, pickles, and other value-added products, increasing their market value and promoting their consumption through IFS.
- IFS can improve soil health through the use of organic fertilizers and crop rotations, which can increase the nutrient content of crops and improve their nutritional value.
- IFS can promote the integration of trees and crops, to improve soil health and increase the availability of nutrient-rich foods such as fruits and nuts.
- It can also enhance food safety by promoting the use of natural pest control methods and reducing the use of harmful chemicals in food production.

D. Employment Generation:

IFS can contribute to employment generation by promoting entrepreneurship in rural areas. Crop-livestock integration can create additional income opportunities for farmers by selling livestock products such as milk, meat, eggs and also provide a source of organic fertilizer for crop production. Additionally, agroforestry can provide employment opportunities in activities such as pruning, harvesting and processing of forest products. This can create employment opportunities in processing, marketing, and distribution of value-added products. IFS develop sustainable fisheries by integrating fish production with crops and

livestock which can create employment options. Farmers can sell surplus electricity generated from biogas to the grid or use it for other productive activities. IFS can also promote rural tourism by developing farm-based tourism activities such as farm stays, nature walks etc to create additional income opportunities in the area.

E. Efficient Use of Resources:

IFS can enhance the efficient use of resources by optimizing the use of inputs, reducing waste and improving resource use efficiency. Livestock waste can be used as fertilizer for crops, reducing the need for chemical fertilizers and promoting the efficient use of nutrients. Additionally, it can promote the use of drip irrigation systems and other water-management technologies to reduce water wastage, improve water retention and increase water use efficiency.

Farmers can use solar-powered irrigation systems, biogas plants and solar dryers to reduce energy consumption and improve resource use efficiency. Organic waste of IFS can be used for composting, biogas production and reducing waste disposal. IFS can promote the use of conservation agriculture practices, such as minimum tillage and cover cropping, to reduce soil degradation and improve resource use efficiency.

F. Increase in Productivity:

IFS can increase productivity by synergistic interactions among different farming components. It can enhance intercropping, where different crops are grown together in the same field to increase productivity by improving soil fertility, reducing pest infestations, and increasing yields. Diversification can promote income generation and reduce the dependence on a single crop or livestock species. IFS can promote sustainable fisheries by integrating fish production with crops and livestock. This can increase productivity by promoting nutrient cycling, reducing pest infestations, and improving water use efficiency, leading to increased fish yields.

G. Input Cost Reduction:

IFS reduce input cost by enhancing resource use efficiency, reducing the dependence on external inputs and promoting the use of locally available resources. IFS promote nutrient management by integrating livestock and crops, reducing the cost of inputs, while improving soil fertility and crop productivity. It influences integrated pest management (IPM) by promoting natural pest control methods like the use of biological control agents. This can reduce the need for chemical pesticides, leading to lower input costs.

Proper water management can reduce the cost of irrigation and promote efficient use of resources. IFS also promote energy management by using renewable energy sources and reducing the use of fossil fuels. This can reduce energy costs, while promoting sustainable energy use. In IFS livestock can be fed on crop residues and agro-industrial by-products, reducing the cost of feed and promoting resource use efficiency. Thus, by adopting IFS, farmers can reduce input costs, improve profitability, and promote sustainable agriculture.

H. Value Addition of End Product:

IFS contribute to value addition by promoting the integration of different farming components and adding value to agricultural products. Processing of agricultural products such as fruits, vegetables, fish and grains is promoted to add value and increase shelf-life.

In livestock milk can be processed into yogurt, cheese, and other dairy products, while meat can be processed into sausages, surimi and other value-added products. Organic production can reduce the use of chemical inputs and add value to organic products by providing a premium price.

Farmers can also form producer groups and cooperatives to jointly process and market their products, which can lead to increased bargaining power and higher prices through IFS.

3.6 Different Integrated Farming Systems:

There are different integrated farming systems based on the compatible combination of culture practices. The nomenclature of IFS is generally based on the name of primary and secondary crop culture. The different standard and profitable IFS practices adopted by the farmers are as given in the table.

Table 3.1: The Different Standard and Profitable IFS Practices Adopted by The Farmers

Sr. No	Name of IFS	Primary crop SD	Secondary crop SD	Primary production	Additional production
Plant cum livestock culture					
1	Agroforestry	Forestland	Chicken-5-10 birds/m ² Cow- 1-2/ha Goat-4-5/ha	Fruit, leaf, timber, honey	Animal meat, milk, eggs
Agri-aqua based culture					
2	Paddy cum fish culture	Paddy	2000 - 3000 fish fingerling/ ha	20-30 quintal/ha	500-750 kg/ha/year
3	Makhana cum fish culture	Makhana - 80kg/ha	6000 fish fingerling/ha	1500 kg/ha	1500 - 2000 kg/ha/year
5	Sericulture cum fish system	5000-6000 fish fingerling/ha	Mulberry plants	Fish- 3-4t/ha/year	30 tonnes mulberry leaves/ha, 3.75 tonnes vegetable/ha
6	Horti cum fish system	5000-6000 fish fingerling/ha	500 - 1000 plant/ha	3-4 t/ha/year	2 t/ha/year
7	Aquatic weed & fish system	6000-8000 fry/ha	Aquatic weeds	2-3 t/ha/year	6-8 t/ha/year

Sr. No	Name of IFS	Primary crop SD	Secondary crop SD	Primary production	Additional production
Animal husbandry-fish based system					
8	Cattle cum fish system	7000-8000 fish fingerling/ha	5-6/ha	3-4 ton /ha/year	9000 L milk, 10 ton/ha dung
9	Pig cum fish system	Do	40-45/ha	Do	4000 kg Pig meat
10	Goat cum fish system	Do	50-60/ha	Do	700-900 kg Goat meat
11	Poultry cum fish system	Do	1000/ha	Do	1 lakh eggs, 1500 kg meat
12	Duck cum fish system	Do	200-300/ha	Do	6000 eggs, 500-700 kg meat

3.7 Opportunities of IFS:

IFS offer a range of opportunities to farmers, rural communities, and the broader society. Here are some of the opportunities -

- IFS can provide opportunities for increased income by diversifying production.
- This can lead to improved livelihoods and economic development in rural areas.
- It can promote sustainable farming by reducing the use of external inputs, improving resilience to climate change and environmental impacts.
- IFS can generate employment opportunities in rural areas by adding value to agricultural products, and promoting local economic development.
- IFS can also contribute to nutritional food security by promoting the consumption of diverse and nutritious foods. This can improve health outcomes, especially in vulnerable populations.
- This can lead to reduced input costs, improved productivity, and improved environmental sustainability.
- IFS promote value chain integration by integrating different farming components and adding value to agricultural products leading to local economic development.

3.8 Challenges of IFS:

IFS offer many opportunities, there are also several challenges that need to be addressed to effectively implement and promote IFS.

- Lack of awareness and knowledge about IFS among farmers and extension workers can hinder its adoption and promotion.
- IFS require a range of inputs and resources, which may not be readily available or affordable to smallholder farmers, especially in remote areas.
- It requires value addition and market access to generate income and improve livelihoods.
- IFS include supportive policies, regulations, incentives as well as adequate institutional capacity to maintain policy and institutional support.

- Women, youth, and marginalized groups may face additional barriers to accessing resources, knowledge, and benefits from IFS due to social inequities.

3.9 Future Perspective of IFS:

IFS have a promising future, as they offer a range of benefits, including increased income, employment generation, nutritional food security, resource use efficiency, climate change mitigation and value chain integration. Technology and innovation can play a significant role in promoting IFS, by improving access to inputs and resources and enhancing market access and value addition. Emerging technologies such as precision agriculture, digital platforms and climate-smart solutions can enhance the efficiency of IFS.

Future perspectives of IFS include the integration of climate-smart solutions like conservation culture to enhance the resilience and sustainability. It can improve market-oriented production by integrating different farming components, adding value to agricultural products, and promoting local economic development. Knowledge and capacity development are essential for the promotion and scaling-up of IFS. Development and dissemination of knowledge and skills among farmers, extension workers, researchers and policymakers are necessary to enhance the effectiveness and sustainability of this system.

3.10 Conclusion:

IFS is a sustainable and holistic approach to agriculture that can bring about multiple benefits. It offers a promising future, as it can be adapted to different contexts and needs, and can contribute to various development goals including poverty reduction, gender equality and environmental sustainability. However, promoting and scaling-up IFS requires addressing various challenges, such as limited access to inputs, markets, inadequate policy support and limited institutional capacity. To unlock the full potential of IFS, there is a need for a multi-stakeholder approaches that involve farmers, extension workers, policymakers, researchers and other stakeholders. Overall, IFS is a promising approach that can contribute to sustainable farming practices, rural development and food security in a better way.

3.11 References:

1. Dashora, L.N., Singh H. (2014). Integrated farming system-need of today. *International Journal of Applied Life Sciences and Engineering*.;1(1):28-37.
2. Gupta, V., Rai, P.K., Risam, K.S. (2012) Integrated crop-livestock farming systems: A strategy for resource conservation and environmental sustainability. *Indian Research Journal of Extension Education*, Special 2:49-54.
3. Rathore, V.S., Tanwar, S.P., Kumar, P., Yadav, O.P. (2019) Integrated farming system: Key to sustainability in arid and semi-arid regions. ICAR.
4. Singh, J.P., Ravisankar, N. (2015) Integrated farming systems for sustainable agricultural growth: Strategy and experience from research. In Proceedings of National Seminar on “Integrated Farming Systems for Sustainable Agriculture and Enhancement of Rural Livelihoods;13-14.
5. Jayanthi, C., Vennila, C., Nalini, K., Vivek, G. (2007). Farmer participatory integrated farming system for improving livelihood of small and marginal farmers. In: proceedings

- of third national symposium on integrated farming systems and its role towards livelihood improvement held at PDCSR, Modipuram from October 26–28;1–3.
6. Jayanthi, C., Sakthivel, N., Sankaran, N., Thiyagarajan, T.M. (2006). Integrated farming system: A path to sustainable agriculture. Tamil Nadu Agricultural Univ., Coimbatore, India.
 7. Chaubey, D., Prakash, V., Yadav, T.C. and Singh, G. (2018). Doubling of Farmers' Income through Integrated Farming System Approaches in Bihar *International Journal of Current Microbiology and Applied Sciences*, 7(12): 1602-1613
 8. Saxena, R., Naveen. P.S., Balaji, S.J., Usha, R.A. and Joshi, D. (2017). Strategy for Doubling Income of Farmers in India. Policy paper 31. National Institute of Agricultural Economics and Policy Research (NIAP), New Delhi.
 9. Suhas, P.W. and Singh, D. (2017). Doubling Farmers' Income: Challenges and Opportunities. Proceedings of National Workshop on Doubling Farmers' Income through Scaling-up: KISAN– MITrA (Knowledge-based Integrated Sustainable Agriculture Network - Mission India for Transforming Agriculture). No: 3 pp 2-3. March 15- 16, 2017. New Delhi.
 10. www.justagriculture.in