

Integrated farming systems for enhancing productivity and livelihood of small farmers

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Integrated Farming System (IFS) offers a viable solution by integrating multiple enterprises. The by-products of one enterprise serve as valuable inputs for another, thereby fostering resource recycling, labour use efficiency, and reduced market dependency. By promoting year-round productivity, IFS significantly improves livelihood security. IFS minimizes risks from crop failures, market fluctuations, and impacts of climatic variability. Thus, IFS is a resilient, and farmer-centric model, particularly suited to the needs of small and marginal farmers in India. Despite challenges of investment, management, and market linkages, the long-term economic, nutritional, and ecological benefits establish IFS as a cornerstone for sustainable agriculture in India.

Keywords: Enhanced income and livelihoods, Enterprise diversification, Integrated farming systems, Nutrient cycling

THE rapid growth of the global population has placed unprecedented pressure on the agricultural sector, compelling a paradigm shift in food production systems. Traditionally, agricultural research and technologies were tailored for large, mechanized farms, often leaving smallholders at a disadvantage. This technological divide has widened the gap between large landowners and small and marginal farmers. Globally, more than 80% of farmers fall into the smallholder and marginal category, who struggle to achieve livelihood security despite significant progress in global food security. India alone contributes nearly one-fourth of the world's small and marginal holdings, with the majority cultivating less than 2.0 hectares of land. For these farmers, raising income and ensuring sustainable livelihoods remain persistent challenges for researchers, policymakers, and governments. Given that land resources are finite and further horizontal expansion of cultivated area is practically impossible, focus must shift towards vertical intensification through diversification. The Integrated Farming System (IFS) offers a viable solution in this direction by integrating multiple farming enterprises such as crops, dairy, poultry, fisheries, horticulture, and others within a single farm unit. The by-products of one enterprise serve as valuable inputs for another, thereby fostering resource recycling, labour use efficiency, and reduced market dependency. By promoting year-round productivity, optimal resource utilization, nutrient recycling, and income diversification, IFS significantly improves livelihood security. Furthermore, the diversity

embedded in IFS minimizes risks from crop failures, market fluctuations, and climatic variability. As such, IFS represents a sustainable, resilient, and farmer-centric model, particularly suited to the needs of small and marginal farmers in India and across the globe.

Need of IFS

The urgency of adopting IFS arises from multiple socio-economic and ecological challenges faced by smallholder agriculture.

- **Declining landholdings:** Fragmentation of agricultural land continues to rise. Presently, approx. 85% of Indian farmers fall under the small and marginal category, collectively operating just 44.6% of the total cultivated area.
- **Self-sufficiency:** IFS promotes self-reliance among small and marginal farmers by producing food, fodder, fuel, and income within the farm boundary.
- **Year-round employment:** By integrating multiple components, IFS generates continuous employment opportunities for farm families throughout the year.
- **Efficient resource utilization:** The system ensures optimal use of available natural, human, and financial resources without diminishing the overall farm value.
- **Curbing rural-urban migration:** By improving profitability and livelihood security at the village level, IFS helps reduce distress migration of smallholders to urban centers.
- **Sustainability and risk management:** The multi-

enterprise approach enhances ecological balance, reduces dependency on external inputs, and builds resilience against climate and market uncertainties.

Components of IFS in India

IFS in India incorporates both basic and supplementary components, tailored to regional resources, farmer needs, and agro-climatic conditions.

Basic components (Core enterprises found in most systems):

- **Cropping system:** The foundation of all farming systems, present in almost every model.
- **Dairy:** The second most important component, integrated in nearly 83% of farming systems.
- **Horticulture (fruits and vegetables):** Enhances dietary diversity, nutritional security and higher returns.
- **Fisheries:** Vital in water-rich and coastal regions.
- **Poultry:** Provides quick returns and supplements household earnings.

Supplementary Components (value-adding enterprises):

- **Apiculture (Beekeeping):** Enhances pollination and provides honey.
- **Vermicomposting:** Ensures organic manure for crops and reduces input costs.
- **Boundary plantation:** Strengthens ecological services and adds income.
- **Biogas units:** Convert animal waste into renewable energy while supplying nutrient rich slurry for enhancing soil fertility.

Across India, nearly 25 types of farming systems have been documented, developed through various permutations and combinations of farming enterprises. Among these, seven major systems account for nearly 76% of the total share nationwide. The most dominant and widely adopted system is the crop + dairy combination, practiced by approximately 42% of farmers. This is followed by crop + dairy + horticulture, which contributes 11%, while crop + dairy + goatry accounts for 7%. A more diversified model, crop + dairy + goatry + poultry, represents about 5% of the systems.

Crop diversification in IFS for higher income and nutritional security

Crop rotation is one of the basic principles of the IFS. IFS encourages the cultivation of multiple crops, including cereals, pulses, oilseeds, vegetables, and fruits. This diversification reduces the risk of crop failure due to climatic uncertainties and ensures a continuous supply of food. In an IFS model, cereals such as wheat, rice, maize, and millets form the backbone of staple food production, ensuring household food security. These are strategically combined with pulses like pigeon pea, chickpea, mung bean, urd bean, etc. which contribute significantly to dietary protein intake and improve soil fertility through biological nitrogen fixation. Oilseed crops such as mustard, groundnut, sunflower, and sesame enhance dietary diversity and market opportunities while helping to disrupt pest and disease

cycles in rotations. Fodder crops such as Napier-Bajra hybrid, berseem, and sorghum are integrated to support livestock units and reduce dependency on external feed purchases. Proper crop sequencing and intercropping not only maximize land use efficiency but also improve soil health through diverse root architectures and residue incorporation.

Horticulture: Fruits and vegetables

Horticultural crops significantly enhance both income and nutritional security. Incorporating seasonal vegetables such as tomato, brinjal, okra, cucurbits, and leafy greens into the IFS ensures a steady cash flow and dietary diversity. Perennial fruit crops like mango, guava, jackfruit, papaya, and banana contribute to long-term income stability while improving farm biodiversity. Vegetables grown in sequence—*kharif*, *rabi*, and summer seasons, ensure year-round production and market availability. The integration of protected cultivation, micro irrigation, and improved hybrids further boosts productivity, while market-oriented varieties help smallholders capture better prices.

Livestock and fisheries enterprises

Livestock rearing and fisheries are vital components of IFS, especially in the Indo-Gangetic Plains (IGP) where protein deficiency is widespread. Dairy is the cornerstone enterprise, providing regular income through daily milk sales. Regionally suited high-yielding crossbred cows, buffaloes, or indigenous breeds are selected, and their productivity is enhanced through balanced ration, mineral supplementation, and hygienic housing. Poultry, whether backyard or semi-intensive, offers quick returns, supplying eggs and meat for both household use and market sales. Goat rearing and duckery can also be integrated where grazing lands and water bodies are available. These enterprises efficiently recycle crop residues, weeds, and kitchen waste efficiently, reducing feed costs while contributing to nutrient recycling via manure.

Fisheries complement IFS wherever water resources exist. Farm ponds or reservoirs can be stocked with species such as rohu, catla, mrigal, and tilapia under polyculture systems. Integrating aquaculture in waterlogged or low-lying areas enhances productivity of marginal lands. Fish farming not only supplies high-quality protein but also optimizes resource use by utilizing farm wastewater and enabling integration with duckery or horticulture along pond embankments. Composite fish culture maximizes ecological niche utilization, improving yield per unit area.

Nutrient recycling and vermicomposting

A critical strength of IFS lies in internal nutrient cycling. Crop residues, livestock manure, poultry droppings, and agro-wastes are recycled into compost or vermicompost, reducing reliance on costly chemical fertilizers. Vermicomposting using species like *Eisenia fetida* produces nutrient-rich organic manure that improves soil structure, water-holding capacity, and

microbial activity. Similarly, farmyard manure (FYM) and enriched compost supply macro- and micronutrients, ensuring sustainable soil fertility management. These organic inputs promote nutrient recycling, minimize environmental pollution and support a closed-loop farming system.

Boundary plantation

Planting fruit-bearing and multipurpose species along farm boundaries optimizes land use while providing ecological and economic benefits. Karonda (*Carissa carandas*), jackfruit (*Artocarpus heterophyllus*), and guava (*Psidium guajava*) are well-suited for boundary plantations in many agro-climatic zones. These species offer seasonal fruits for home consumption and sale, provide shelterbelts against wind, and support pollinator diversity. The perennial nature of these plants ensures long-term income without compromising the primary cropping area.

Mushroom production

Mushroom cultivation is an emerging component in IFS with high returns from a small area. Species like oyster (*Pleurotus spp.*), button (*Agaricus bisporus*), and milky mushroom (*Calocybe indica*) can be grown using crop residues such as wheat straw, paddy straw, and maize cobs. Besides being a nutrient-rich food source, mushroom cultivation creates employment opportunities for family members, especially women. Post-harvest spent mushroom substrate can be used as organic manure, further enriching the nutrient cycle within the farm.

Multilayer vegetable farming

Multilayer farming involves growing compatible vegetable crops at different canopy levels to maximize sunlight interception and land productivity. For instance, creepers like bitter melon or bottle gourd can be trained on trellises above shorter crops like okra or

amaranthus, with root vegetables like radish or carrot underneath. This system ensures higher yields per unit area, diversified income sources, and efficient utilization of space and resources. In IFS, multilayer farming is particularly effective in homestead gardens and peri-urban areas where land is limited.

IFS as a pathway to nutritional well-being

While food security ensures availability and access to food, nutritional security focuses on dietary quality and diversity. In IGP despite high agricultural output, malnutrition remains due to limited dietary diversity and over-reliance on staples like wheat and rice. IFS bridge this gap by delivering a balanced food basket rich in proteins, vitamins, minerals, and other essential nutrients.

Diversifying the farm, diversifying the plate

IFS integrates cereals (supply carbohydrates), pulses (provide proteins and micronutrients), vegetables, and fruits (offer vitamins, antioxidants, and dietary fiber) to create a nutrient-rich diet. This crop diversity ensures farming families and communities enjoy balanced meals throughout the year.

Organic practices for healthy and safe produce

By using farmyard manure, crop residues, and compost from livestock waste, IFS promotes organic farming. This reduces chemical residues in food, safeguards consumer health, and enhances soil fertility for long-term productivity.

Combating hidden hunger through nutrient-dense crops

Micronutrient deficiencies (“hidden hunger”) are a major concern in rural IGP. Inclusion of crops such as millets, leafy greens, and fruits in IFS helps tackle this. For instance, iron-rich spinach and vitamin C-rich citrus fruits grown alongside staples can reduce anaemia and micronutrient deficiencies.



Round the year fodder production in IFS at Western Uttar Pradesh for livestock improvement



A



B



C



D

Promising interventions at farmer's field (A) Azolla for animal feeding (B) Bundur Sheep (C) Duplex for backyard poultry (D) Improved shed for goatry (Photo courtesy: AICRP-IFS-OFr)

Implementation on a small scale

High implementation costs limit the direct replication of IFS models. However, the Indian Institute of Farming Systems Research (IIFSR), through its scheme AICRP-IFS-OFr, has demonstrated that strategic, region-specific interventions can significantly enhance smallholders' livelihoods. By focusing on limited yet targeted interventions tailored to specific modules and local conditions, the programme showcases the potential for scalable solutions that improve productivity and profitability of small farms across diverse agro-climatic zones. Under the AICRP-IFS-OFr on-farm research component, IFS interventions were refined with farmer participation. These refinements were based on location-specific, module-based, low-cost practices designed to strengthen food security, nutrition, environmental sustainability, and income for small and marginal farmers. The refinements covered four key modules:

- **Benchmarking:** Recording baseline data on crops, livestock, other farm components, and the household as a whole.
- **Cropping system diversification/improvement:** Introducing efficient cropping systems suited

to farmers' resources, preferences, and market opportunities, while improving existing practices.

- **Livestock diversification/improvement:** Promoting year-round fodder production, mineral mixture supplementation, deworming, and integration of low-cost, location-specific components such as backyard poultry, duckery, piggery, and goat rearing.
- **Product diversification:** Supporting value addition through preparation of mineral mixtures, processing of market surplus products, and promotion of kitchen/roof gardens.

Across the country, a total of 73 farming systems were refined through these farmer-participatory approaches. Interventions were made in critical inputs with an average cost of ₹7,889 per system. Net returns varied widely—from ₹4,786 at Mandla (Madhya Pradesh) to ₹1,87,994 at Alappuzha (Kerala). On average, net returns rose to ₹55,573 per system, representing an 86% increase within the second year of intervention.

Economic advantages of IFS

- **Enhanced and stable farm income:** Diversification through IFS ensures multiple and complementary

income reducing farmers' vulnerability to market volatility and climatic uncertainties. For instance, earnings from livestock, aquaculture, or high-value horticultural produce can buffer losses from staple crop failures, ensuring year-round revenue flow.

- **Rural employment and livelihood security:** The multifaceted nature of IFS demands skilled and unskilled labour for activities such as animal husbandry, fish rearing, and intensive crop management. This not only generates substantial on-farm employment but also curbs rural-to-urban migration by creating sustainable livelihood opportunities within villages.
- **Reduction in production costs:** Efficient recycling of crop residues, livestock manure, and other farm by-products within the IFS framework significantly minimizes dependence on external inputs such as synthetic fertilizers and pesticides. This integrated resource-use strategy lowers input costs while maintaining soil fertility and ecological balance.

Environmental benefits of IFS

IFS contribute not only to food and nutritional security but also to environmental sustainability through the following pathways:

- **Building living soils:** Inclusion of legumes, agroforestry components, and organic inputs improves soil fertility, stimulates microbial activity, and reduces risks of land degradation.
- **Securing every drop:** Practices such as rainwater harvesting, efficient irrigation, and tree-based systems minimize water losses and enhance groundwater recharge.
- **Locking away carbon:** Agroforestry and organic

management increase carbon sequestration potential in IFS, thereby mitigating climate change impacts.

Challenges in IFS adoption

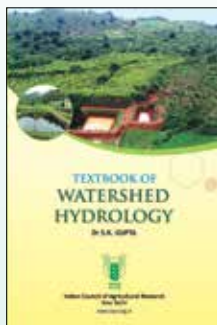
Despite its potential, IFS adoption faces several challenges. Initial investment in infrastructure for multiple enterprises can be high for resource-poor farmers. Management complexity increases as multiple components require knowledge, labour, and timely interventions. Market access for perishable produce, lack of extension services, and absence of integrated value chains often limits profitability. Climatic uncertainties, pest pressures, and fragmented landholdings further hinder adoption. Addressing these challenges require targeted policy support, capacity building, and farmer-to-farmer learning models.

SUMMARY

Integrated farming systems offer a resilient pathway for small and marginal farmers to achieve higher productivity, diversified income, and enhanced livelihood security. By integrating crops, livestock, fisheries, horticulture, boundary plantations, mushrooms, and multilayer vegetable farming with efficient nutrient recycling, farmers can optimize resource use and ensure year-round returns. Although challenges remain in terms of investment, management, and market linkages, the long-term economic, nutritional, and ecological benefits establish IFS as a cornerstone for sustainable agriculture in India.

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