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Livelihood improvement of rural farmers

through pond based integrated farming system model in Meghalaya

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The pond based integrated farming system model is an effective strategy for sustainable agriculture, promoting the integration of various farming activities. In northeast India, where smallholder farmers are prevalent, this model offers numerous benefits and has shown to increase system productivity by 7.5 times and profitability by 8.5 times compared to traditional farming practices. In addition, the model generates significant returns, with a total benefit-cost ratio of 2.70. Furthermore, this system contributes to environmental sustainability by improving soil fertility through agroforestry and enhancing water use efficiency with rainwater harvesting in farm ponds. The integration of livestock also helps recycle organic matter, reducing the need for external chemical inputs. Despite its benefits, the adoption of pond-based IFS faces challenges such as limited technical knowledge (80% of farmers), high input costs (70%), and marketing constraints like low product prices and transportation costs. However, the potential benefits of pond based IFS, particularly in terms of increased profitability, climate resilience, and resource efficiency, highlighting its importance for sustainable agricultural development in the region. Strengthening support systems, improving infrastructure, and enhancing farmers' knowledge will be the key to unlocking the full potential of this model in northeast India.

Keywords: Benefit-cost ratio, Constraints, Integrated farming system, Pond based IFS

THE Integrated Farming System (IFS) model is an innovative approach to sustainable agriculture that emphasizes the integration of multiple agricultural enterprises, including crop cultivation, livestock farming, fishery, agroforestry, and other farm-based activities, in a synergistic manner. This holistic approach is designed to maximize resource use efficiency, enhance productivity, improve farmers' income, and promote environmental sustainability. The IFS model helps mitigate risks by diversifying farm income sources and reducing the dependency on a single crop or activity. In the context of northeast India, the IFS model is particularly relevant due to the region's diverse agro-climatic conditions, varied farming practices, and socio-economic challenges faced by it's predominantly smallholder farmers which are backbone of the traditional agriculture. This region, consisting of states like Assam, Nagaland, Meghalaya, and Manipur, has a unique mix of agricultural practices that can greatly benefit from the diversification and resource optimization promoted by IFS model. In this region, farmers are generally practicing organic farming, therefore a farmer prefers to keep few livestock and fishery so that soil nutrient could be increased through animal excreta. Most of the people residing in this region are tribal and they are non-vegetarian in their dietary habits for which meat and fish products are very much in demand. As this region is a complex, diverse and risk prone region, farmers are essentially practicing both raising of crops and rearing of livestock and fishery. This region accounts for eight percent of the country's total land area and 3.8 percent of its total population. Approximately 30 percent of landless households and 48 percent of marginal households in the region engage in livestock farming. Various research indicated that agriculture, horticulture, animal husbandry and fishery production system individually at subsistence level but incorporation of all this system proves that these systems are not competitive rather complementary to each other and farm profitability can be increased through practicing this. Farm diversification through IFS has been recognized as a powerful strategy for achieving a range of objectives, including food and nutritional security, poverty reduction, employment creation, environmental enhancement, and the sustainable use of

natural resources. The core principles of the IFS model include:

- ***Diversity in production:*** The integration of crops, livestock, aquaculture, agroforestry, and other activities within a farm system.
- ***Resource recycling:*** Efficient use of farm waste and by-products such as crop residues, animal manure, and agro-industrial waste to reduce external input costs.
- ***Sustainability:*** Reducing soil degradation, promoting biodiversity, and ensuring long-term ecological balance.
- ***Economic viability:*** Enhancing farm income through diversified and integrated activities, reducing dependency on monoculture farming.
- ***Risk management:*** Spreading risks associated with climate change, market fluctuations, and pests/diseases through diversified farm activities.

In northeast India, IFS model can significantly contribute to the region's agricultural development by promoting sustainable practices while addressing the challenges of food security, climate change, and economic inequality.

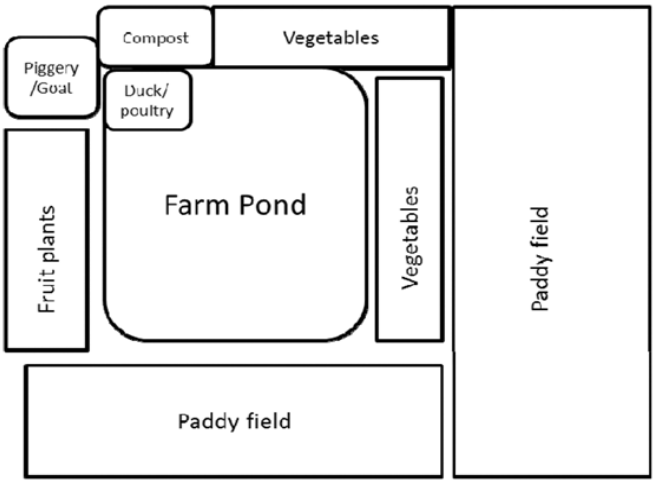
Importance of IFS in northeast India

The agricultural system in northeast India is diverse, with a significant number of smallholder farmers practicing traditional farming methods. These farmers primarily rely on shifting cultivation (also known as Jhum cultivation), a practice that has been linked to deforestation and soil erosion. This region has a significant portion of its land under forests, with over 54% of its geographical area designated as notified forests (reserve, protected, and unclassified) managed by the Forest Department. However, states like Assam (34.21%) and Meghalaya (42.34%) have less forest cover, while Sikkim has the highest forest land under governmental control. Agricultural land in this region spans 4.12 million hectares of net cultivated area and 5.7 million hectares of gross cultivated area, with Assam leading in cultivated area. Cropping intensity is highest in Tripura (184%) and lowest in Mizoram (106%), and the share of land under food grain production is highest in Manipur (78.7%), suggesting scope for diversification in cropping systems. The NER consists of various agro-climatic zones, from subtropical to alpine, with each state having distinct agricultural practices. Rice is the dominant crop in the region, with varying practices such as double cropping in Assam and Tripura, and terrace farming in Sikkim. States like Sikkim focus on crops such as maize and cardamom, while Tripura grows pineapple and arecanut, alongside rice. Given the region's hilly terrain, erratic rainfall, and limited access to modern farming inputs, IFS model presents an opportunity to improve farm productivity while also preserving the environment which includes:

- ***Soil conservation and fertility improvement:*** The combination of crop cultivation with agroforestry and livestock farming helps maintain soil health. For example, agroforestry systems involving tree species that fix nitrogen can improve soil fertility, which is particularly beneficial in the nutrient-poor soils of the region.
- ***Economic stability:*** The integration of different farming components such as dairy, poultry, fish farming, and vegetable cultivation ensures a steady income flow, reducing the dependency on a single crop and protecting farmers from market and climatic uncertainties.
- ***Climate resilience:*** Northeast India is vulnerable to the impacts of climate change, including erratic rainfall, floods, and droughts. The IFS model promotes climate-smart agriculture by diversifying farm activities and providing farmers with multiple coping strategies in the face of unpredictable weather conditions.
- ***Labour efficiency:*** IFS helps in the efficient use of labour by balancing seasonal workloads. While crop production can be labour-intensive during planting and harvesting periods, activities like livestock management, agroforestry, and fish farming provide alternative sources of work during the off-season.

Pond based integrated farming system

There are various models of IFS practiced in the north eastern region, viz. pond based IFS, pig based IFS, fish-cum-livestock IFS, horticulture cum fish culture IFS, agriculture-livestock-poultry IFS and agriculture-horticulture-piggery-fishery IFS. Pond based IFS is one of the most traditionally practiced model and served as a primary livelihood source for farmers in the region. Pond based IFS involves the integration of various agricultural components such as agriculture, horticulture (vegetables, fruits, and plantation crops), and animal husbandry (including poultry, piggery, goat farming, and duck farming), with aquaculture as the central activity. This system integrates fish farming in dugout ponds, which can be located in either the corner or the center of the farm, depending on the land's topography, alongside other farming practices like livestock, crops, vegetables, and fruits, with provisions for recycling on-farm resources.



Layout of pond based IFS
Source: Das *et al.* 2021

The NER experiences high rainfall (over 2000 mm annually), ensuring an ample supply of water. However, most of this precipitation occurs between June and October, leaving the region very dry from November to April. As a result, farmers have practiced rainwater harvesting in farm ponds for centuries, using the stored water for fish farming and to provide lifesaving irrigation during the dry season. The availability of harvested water helps mitigate the risks of crop failure during drought years, and farm diversification ensures steady income even if one or more components underperform. Consequently, pond based IFS offer resilience against climate variability and is recognized as a viable technology for promoting climate-resilient agriculture. According to the earlier researchers, this model is found to increase system production efficiency by 7.5 times and profitability by 8.5 times compared to traditional practices in the humid eastern Himalayas.

Fish farming component contributes the highest returns in the system, with B:C ratio of 4.37 followed by the egg and fruit component (B:C ratio of 3.40 and 3.05, respectively). Rice farming has the lowest B:C ratio of 1.80, suggesting the least profitable component in the system, though it still generates a positive return. The total benefit-cost ratio of the entire pond-based farming system is 2.70, depicting for every ₹1 invested, ₹2.70 is returned in net profit. This indicated that the pond based IFS model as a whole is profitable, with the highest returns coming from fish and egg.

Table 1. Economics (₹/unit) of pond based IFS

Components	GR	NR	B:C
Fish	17500	13000	4.37
Egg	2550	1800	3.40
Piglets	28000	15400	2.22
Vegetables	4100	2700	2.92
Fruits	5500	3700	3.05
Rice	1800	800	1.80
Total	59450	37400	2.70

GR, Gross Return; NR, Net Return; B:C, Benefit-Cost Ratio.

Constraints faced by farmers in pond based IFS

While the pond based IFS model holds great promise for sustainable agriculture in northeast India, its adoption faces several challenges due to lack of awareness, limited access to resources, inadequate infrastructure, cultural barriers, climate change, etc. The constraints are categorized into three main areas: Production constraints, Marketing constraints, and Financial constraints.

The Production constraints are challenges related to the actual farming process and resource availability. A significant portion of farmers (86.66%) face delays or lack of timely access to necessary farming inputs, which hampers production. Similarly, many farmers accounting to 86.66% struggle with the rising costs of labour, which can affect profitability and productivity. Another major constraint is lack of technical knowledge regarding pond based IFS (80%) among the farmers, limiting their ability to optimize the system followed by the high cost of inputs (70.00%) and insufficient power supply (63.33%).

Marketing constraints refer to challenges related to the sale and pricing of farm products. Low remunerative price for the product is being faced by the high percentage of farmers (86.66%) followed by the price fluctuations (86.33%). High transportation costs are another significant issue being faced by the 80% of the farmers. 73.33% of farmers report a lack of demand for their products, meaning they struggle to find buyers or sell their produce at profitable prices. The lack of proper storage facilities for perishable items result in higher risks of spoilage and waste, further affecting the income of the farmers.

Financial challenges such as lengthy procedure of loan sanctions hinders the ability of the farmers to finance their operations. Significant proportion of farmers (73.33%) faces difficulties in accessing subsidies or credit. On the other hand, for those who manage to access credit, high interest rates are a major issue increasing the overall financial burden.

Table 2. Constraints faced by the farmers in adoption of pond based IFS (N=30)

Sl. No.	Particulars	Response	
		Frequency	(%)
Production constraints			
1	Non-availability of inputs in time	26	86.66
2	High wage rates	26	86.66
3	High cost of inputs	21	70.00
4	Insufficient power supply	19	63.33
5	Lack of technical knowledge regarding IFS	24	80.00
Marketing Constraints			
1	Low remunerative price for the product	26	86.66
2	Price fluctuations	25	86.33
3	High transportation costs	24	80.00
4	Inadequate demand for outputs in market	22	73.33
5	No storage facilities for perishable farm produce	16	60.00
Financial constraints			
1	Length procedure of loan sanctions	26	86.66
2	Non availability of subsidies and credit	22	73.33
3	High interest rate	19	63.33

SUMMARY

The Integrated Farming System (IFS) model offers a viable solution for addressing the agricultural challenges faced by farmers in northeast India. By integrating various agricultural enterprises, IFS enhances resource use efficiency, promotes sustainability, and improves farm income. Pond based IFS has proven to be a viable and sustainable agricultural model for northeast India, where it effectively integrates fish farming with crop cultivation, livestock, and agroforestry. This approach not only helps improve farm productivity and resource use efficiency but also supports the livelihoods of smallholder farmers by providing diversified income sources. Given the region's unique agro-climatic conditions and the importance of fish and livestock in local diets, pond-based IFS offers significant benefits in terms of soil fertility enhancement, climate resilience, and economic stability. However, its adoption faces challenges such as limited access to technical knowledge, financial constraints, and infrastructural limitations. To fully realize its potential, there is a need for increased awareness, better access to resources, and support from government policies and programmes. With right interventions, pond based IFS can contribute to sustainable agriculture, food security, and improved livelihoods in northeast India.

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