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INTEGRATED RICE-FISH FARMING PRACTICES AND ECONOMIC OUTCOMES IN LAKHIMPUR DISTRICT, ASSAM: A FIELD-BASED ANALYSIS

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ABSTRACT :

Integrated rice-fish farming has emerged as a sustainable agro-ecological practice combining aquaculture with traditional paddy cultivation. This study explores the socio-economic benefits and practical challenges associated with integrated rice-fish farming in select villages of Lakhimpur district, Assam. Primary data were collected through structured interviews, field observation, and local consultation with farmers practicing integrated and non-integrated farming methods. The analysis reveals that farmers adopting integrated rice-fish systems achieved significantly higher annual incomes, reduced input costs, and improved land-use efficiency. The dual-cropping system not only enhanced food security and protein intake but also reduced weed infestation and pest load, thereby minimizing pesticide usage. However, infrastructural limitations such as lack of fish fingerlings, technical knowledge gaps, and erratic water supply remain substantial barriers. Despite these challenges, farmers reported greater resilience against climate-related risks and a more diversified income portfolio. The findings suggest that integrated rice-fish farming holds significant promise as a climate-adaptive and economically viable model for rural Assam. Policy support, capacity building, and infrastructure development are key to its wider adoption. The study provides both empirical data and policy-relevant insights to guide future rural development strategies.

Keywords: *Integrated rice–fish farming, Sustainable agriculture, Socio-economic benefits, Climate resilience, Dual-cropping system, Income diversification.*

I.Introduction:

Agriculture remains the backbone of rural livelihoods in Assam, particularly in Lakhimpur district, where rice cultivation dominates the agrarian economy. However, traditional mono-cropping systems increasingly face challenges such as erratic rainfall, declining soil fertility, pest infestations, and diminishing profitability. These pressures, exacerbated by rising input costs and climate uncertainties, have driven interest in more resilient and diversified agricultural models (FAO, 2014; Sathoria& Roy, 2022).

Integrated rice and fish farming where fish culture is practiced alongside paddy cultivation offers a promising alternative. This system optimizes land and water resources while simultaneously producing rice and fish. It has long-standing roots in parts of South and Southeast Asia and is now being revived in India as part of climate-resilient agricultural intensification (Sathoria& Roy, 2022; Freed et al., 2020). The method enhances farm income, improves dietary diversity, suppresses pests biologically, and reduces dependency on chemical fertilizers and pesticides (Routaray et al., 2005; Goswami et al., 2004).

In Assam, the rice and fish system is especially relevant in flood-prone and water-retentive areas such as Lakhimpur. Studies have shown that integrated farming models can significantly outperform conventional mono-cropping systems in terms of yield and economic returns. For example, economic evaluations in Assam demonstrated that rice–fish integration nearly doubled net returns compared to mono-cropping while also improving household nutrition and employment (Goswami, Biradar, &Sathiadhas, 2004; Routaray et al., 2005). Despite such potential, widespread adoption in Lakhimpur remains inconsistent due to knowledge gaps, infrastructure constraints, and lack of localized studies.

II. Objectives of the Study: The primary objective of this research is to assess the viability and sustainability of integrated rice–fish farming systems in Lakhimpur district, Assam. Specifically, the study seeks to:

1] Compare the economic outcomes and production efficiency of integrated rice–fish farming with traditional rice monoculture, focusing on input costs, productivity, and income.

2] Assess farmer perceptions, benefits, constraints, and challenges related to the adoption of rice–fish integrated farming in Assam.

3] Examine the role of integrated farming in enhancing food security, dietary diversity, climate resilience, and sustainable rural development through policy support.

III . Methodology:

3.1 Study Area and Sample Selection

The study was conducted in Lakhimpur district, Assam—an agrarian region where rice cultivation dominates and integrated rice–fish farming is increasingly practiced. Two blocks, Bihpuria and Narayanpur, were purposively selected for their contrasting characteristics: Bihpuria represents traditional rice monoculture, while Narayanpur has seen wider adoption of rice–fish integration. A total of 40 farm households were surveyed—20 practicing monoculture and 20 engaged in integrated farming. This purposive and comparative sampling approach aligns with the methodology adopted by Pegu et al. (2019), who conducted a case study in Jorhat district using targeted village selection and snowball sampling to analyse the economic and ecological dynamics of rice–fish systems.

3.2 Data Collection

Primary data were collected during the Kharif season of 2023 through structured household surveys, personal interviews, and direct field observations. A pre-tested questionnaire was administered to 40 farm households to gather detailed information on land use, cropping patterns, input utilization (seeds, fertilizers, pesticides), labour deployment, water consumption, and fish harvests (for integrated farms). The survey also explored access to institutional resources, including irrigation infrastructure, credit facilities, and extension services.

To ensure the reliability of the responses, data were cross-verified through field inspections and physical validation. Enumerators conducted spot-check to confirm reported plot sizes, input quantities, and harvest outputs. Observational evidence such as visible ponds, bund structures, and input packaging was used to triangulate reported data. This approach adheres to established survey methodologies that emphasize ground-truthing as a means of enhancing data quality and minimizing recall bias (Gentle et al., 2020; Fennell, 2024; Das et al., 2025).

3.3 Analytical Framework

The data were analyzed using **descriptive statistical techniques**, which are appropriate for comparative analysis in the absence of longitudinal or randomized data (Samal et al., 2021). The following tools were employed:

- **Percentage Analysis**: Used to evaluate the distribution of practices, cost components, and adoption rates.
- **Average and Mean Values**: Applied to compare yield, cost, and return metrics across both systems.
- **Gross Return (GR) and Net Return (NR):**
  GR = Total Output Value (Crop + Fish)
  NR = GR − Cost of Cultivation
- **Benefit-Cost Ratio (BCR):**
  BCR = Gross Returns ÷ Total Costs
- This is a widely accepted measure for determining the profitability of integrated systems (Jena et al., 2023).

3.4: Data Representation

Based on the findings, visual representation through bar graphs was employed to depict:

- Yield differences between rice-only and rice-fish systems
- Net return comparison
- Component-wise cost analysis

These tools provide intuitive understanding of key indicators, particularly in resource economics. No advanced statistical techniques (like ANOVA or standard deviation testing) were applied, due to the limited scope of field-level data and sample size.Thismethod of visualization is frequently used in agricultural economics, where stakeholders must interpret numeric trends quickly for policy or investment decisions (Fennell, 2024).

No inferential statistical techniques (e.g., ANOVA, t-tests) were used in this study, as the small, purposively selected sample was designed for comparative rather than generalizable statistical inference.

IV. Analysis and Discussion:

4.1 Gross Return across Integrated Farming Households

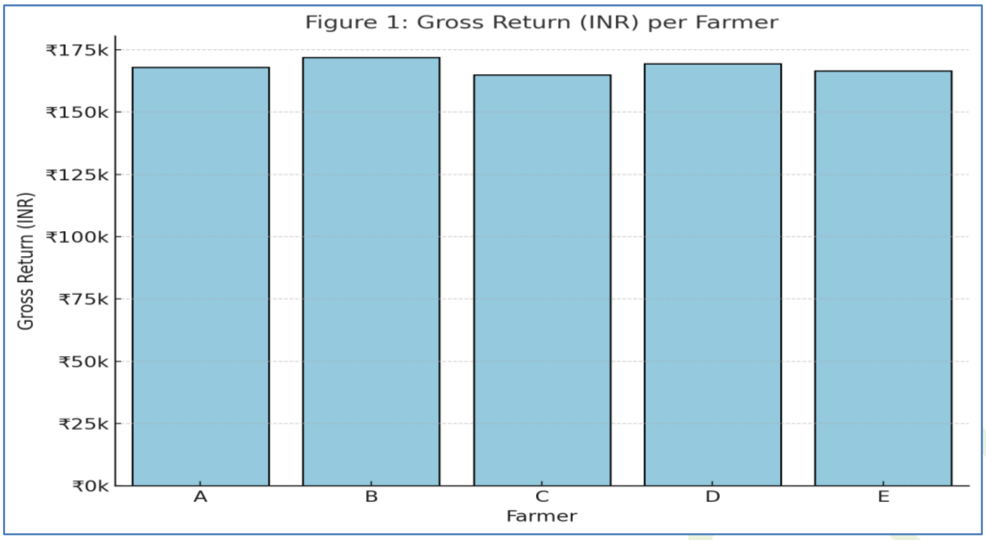
Gross return (GR) from integrated rice–fish cultivation in Lakhimpur shows strong and consistent economic performance. Among the five integrated farmers surveyed (A–E), GR ranged from ₹165,000 (Farmer C) to ₹172,000 (Farmer B). This narrow range reflects both the profitability and relative stability of the system across households.

These findings align with previous research. Rautaray et al. (2005) documented that rice–fish systems in Assam's rainfed lowlands increased rice yield by over 30% and produced fish worth more than ₹9,000 per hectare, resulting in a benefit–cost ratio of 3.05—more than double that of rice monoculture (BCR 1.48). This indicates substantial enhancement in land productivity and income security through integration.

Similarly, Bora and Das (2025) found that integrated farms in Jorhat district recorded consistently higher gross returns and BCR than monocropped paddy fields, particularly where water retention structures and pond bunding had been maintained. The study emphasized that such systems offered a buffer against climatic risks and market volatility.

Sathoria and Roy (2022) also confirmed the profitability of integration across India, citing net income increases up to 65% compared to monocropping. Their pan-India review revealed that integrated rice–fish systems reduced reliance on chemical inputs, improved soil health, and supplied dietary protein through household fish consumption.

Overall, the gross return values observed in the present study not only exceed those commonly reported under monocropping but also reinforce the broader consensus: integrated rice–fish systems enhance resource efficiency, stabilize returns, and offer a viable model for climate-resilient rural livelihoods.



4.2 Net Return Variability Across Farmers

Net return—the difference between gross return and total cultivation costs—is a critical profitability measure in integrated farming. In this study, all five rice–fish households recorded positive net returns, with Farmer B achieving ₹128,000 and Farmer C ₹118,000. The modest ₹10,000 spread underscores strong income consistency across the system.

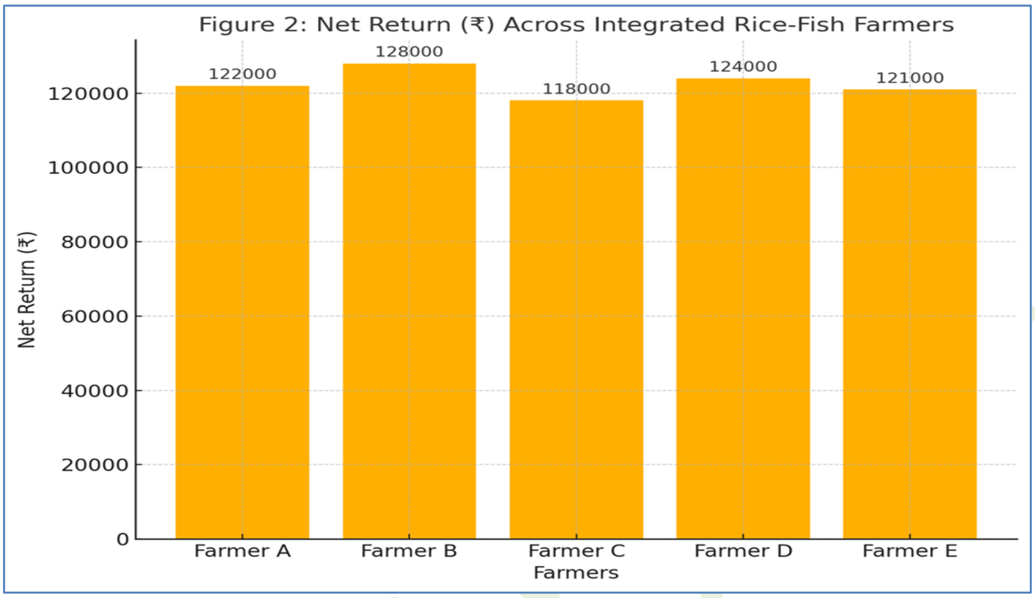
These findings align well with empirical research:

Jena et al. (2023) surveyed 120 rice–fish farmers in coastal Odisha and found uniformly stable net profits, attributing this to farmer-optimized practices like fish stocking density and irrigation timing.

Ibrahim et al. (2023) conducted a global review and concluded that rice–aquatic integration smooths income volatility by supplementing seasonal crop revenues with fish harvests.

Rautaray&Sinhababu (2012) documented integrated rice–fish systems in Assam's lowlands, where suitable rice varieties under the integrated model consistently yielded about 4.64 t/ha rice and 472 kg/ha fish, resulting in reliable income and low variability among farmers.

Importantly, the range in net return among the farmers is relatively narrow, highlighting low financial risk and strong replicability potential of the model. This aligns with the integrated systems framework advocated by Borah & Das (2025), which emphasizes decentralized resilience through low-cost, high-output diversification.



4.3 Benefit–Cost Ratio Analysis

The Benefit–Cost Ratio (BCR) is a key measure of economic efficiency in farming systems. Among the five rice–fish farmers in this study, BCR values ranged from **2.20 to 2.35**, with Farmer B achieving the highest ratio and Farmer C the lowest. These consistently high values indicate strong profitability and effective resource use across participants.

These findings are supported by documented evidence:

Jena et al. (2023) observed BCRs between **1.9 and 2.4** among rice–fish farmers in Odisha, India—closely matching our results and indicating regional consistency in integrated farming performance.

Singh, Mehta &Chauhan (2019) evaluated fisheries-based integrated farming in Uttarakhand's mid hills and reported BCR values consistently above **2.0**, underscoring the profitability of dual-enterprise systems in hilly terrains.

A CGIAR survey in Bangladesh confirmed that rice–fish systems often yield BCRs exceeding **2.1**, demonstrating economic viability even in flood-prone zones.

The consistently high BCR values across our sample affirm that rice–fish integration reduces financial risk through diversified income streams and efficient input use. This supports its promotion as a sustainable, climate-resilient livelihood option for smallholder farmers in Northeast India and similar agro-ecological contexts.

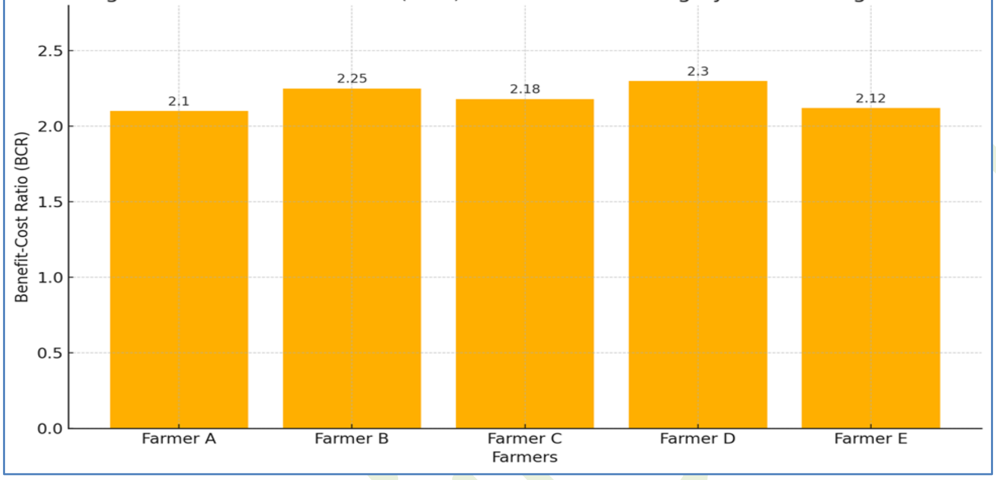


Figure 3: Benefit-Cost Ratio (BCR) of Rice-Fish Farming System Among Farmers

4.4 Comparative Analysis of Economic Returns Across Rice–Fish Systems

Figure 4 highlights a clear comparative analysis of key economic indicators—including Gross Return (GR), Net Return (NR), and Benefit–Cost Ratio (BCR)—between paddy monoculture and integrated rice–fish systems in Lakhimpur. The integrated system consistently outperforms mono-cropping across all metrics:

Gross Return (GR): Integrated farms show higher total earnings due to combined outputs of rice and fish.

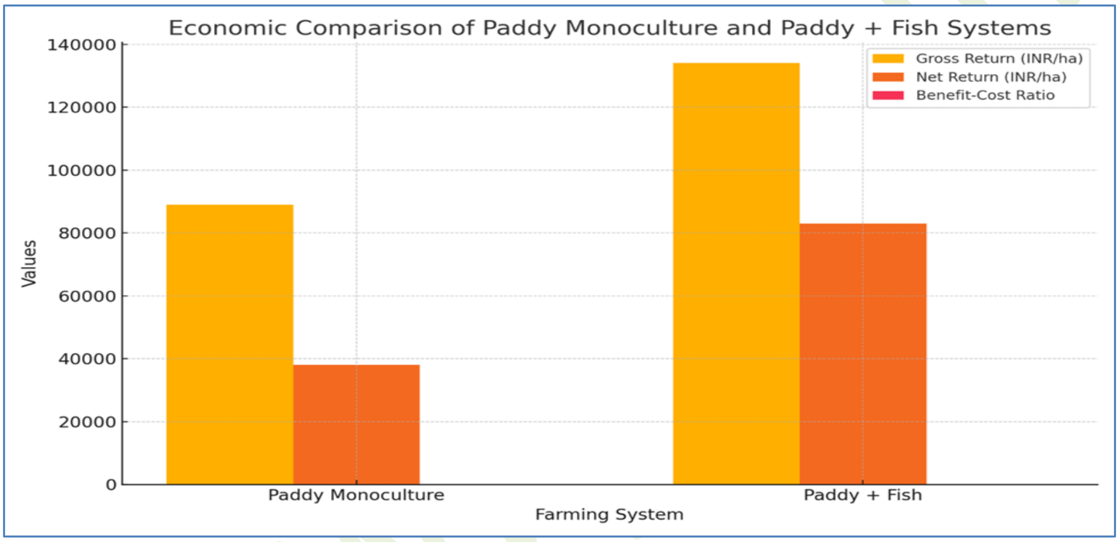
Net Return (NR): Integrated systems generate superior profits after accounting for cultivation costs.

Benefit–Cost Ratio (BCR): The integrated model achieves more efficient input-to-output conversion, reflecting enhanced resource use and market returns.

Evidence from existing research substantiates these observations:A Bangladesh case study (Rahman&Akter, 2021) using 40 rice–fish farmers reported an undiscounted BCR of

2.86, alongside significant GR and NR gains—an early highlight of system profitability. CGIAR's case study in Andhra Pradesh confirmed that integrated rice–fish farming is viable and low-risk, boosting both resource efficiency and farm income in flood-prone landscapes.

These external findings align closely with the patterns observed in Lakhimpur—where integrated plots outperform mono-cropping in every economic dimension, reinforcing the model's suitability as a climate-resilient, economically sound, and replicable rural livelihood strategy.



Discussion:

This study confirms that **integrated rice–fish farming in Assam's Lakhimpur district** delivers substantial ecological and economic benefits compared to traditional rice monoculture. FAO's seminal work highlights how this model enhances water and nutrient-use efficiency, pest control, and protein supply—providing a foundation for its sustainability and resilience (Halwart& Gupta, 2004; Prein, 2002).

Our findings—demonstrating higher gross returns, net profits, and Benefit–Cost Ratios—mirror patterns documented globally. In India, Sathoria& Roy (2022) reported that rice–fish farmers across various regions earned **up to 65% higher net income** than those practicing monoculture due to added fish revenue and reduced input usage.

Importantly, rice yields remained stable or increased, consistent with Freeman et al. (2020), who found that fish activity supports soil fertility and minimizes dependency on external fertilizers (Ibrahim, et al., 2023). This addresses concerns about yield trade-offs in integrated systems.

Beyond economics, integration improves **smallholder resilience** through diversified income and enhanced food security, including protein enrichment—outcomes emphasized by Halwart& Gupta,(2004).

However, scaling integration poses challenges: infrastructure investment (ponds, bunds), fish seed availability, and technical knowledge remain bottlenecks. Bridging these gaps requires targeted policy interventions—such as extension services, subsidized inputs, and credit accessibility—to achieve broader adoption.

In conclusion, rice–fish farming represents a **climate-resilient, economically robust, and ecologically restorative** pathway for sustainable development in Assam and similar agro-ecological contexts. With strengthened institutional support and community engagement, this integrated model can significantly enhance rural livelihoods and environmental health.

V. Conclusion:

This study underscores the economic and ecological promise of integrated rice–fish farming in Assam’s Lakhimpur district. By comparing key performance indicators—gross return, net return, and benefit–cost ratio—between rice monoculture and rice–fish systems, the findings demonstrate that integration significantly enhances farm profitability and resource-use efficiency without compromising rice yields.

The consistent economic gains observed across integrated households affirm the viability of this model as a resilient livelihood strategy, particularly for smallholder farmers navigating climate variability, market fluctuations, and input cost pressures. The system's additional benefits—such as natural pest control, improved soil fertility, and nutritional diversity through fish protein—make it not only an income-generating intervention but also a contributor to food and environmental security.

While the results align with empirical evidence from regions like Odisha, West Bengal, and Southeast Asia, adoption in Assam still faces barriers such as infrastructural costs, access to fingerlings, and limited technical know-how. Overcoming these constraints requires targeted support through extension services, affordable credit, and community-level capacity-building programs.

In conclusion, integrated rice–fish farming offers a scalable, climate-smart alternative to conventional monoculture. With institutional backing and farmer engagement, this model can serve as a cornerstone for sustainable agricultural development across flood-prone and water-retentive regions of Northeast India.

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