**Benefit-Cost Analysis of Fish Farming in Azamgarh District of Uttar Pradesh, India**

**ABSTRACT**

This study examines the economic viability of inland pond-based fish farming in the Azamgarh district of Uttar Pradesh, India, with a focus on small (<0.5 ha), medium (0.5–2 ha), and large (>2 ha) farm categories. Employing a multistage stratified sampling method, data were gathered from 100 respondents to analyse cost structures, returns, and input-output relationships. The findings indicate that variable costs dominate at all scales, representing over 96% of total costs, with labour being the largest single expense, comprising between 41.85% and 46.40%. Other significant contributors include key inputs such as feed/fertiliser (23.78%–24.11%) and seed (20.32%–21.79%). Fixed costs remain minimal, ranging from 1.18% to 3.86%, primarily due to limited capital investments. In terms of returns, gross returns increase with farm size—from ₹3,79,720 for small farms to ₹4,49,714.71 for large farms—along with net returns, which range from ₹86,347.83 to ₹95,520.43. However, input-output ratios exhibit a slight decline with scale, decreasing from 1.29 for small farms to 1.26 for large farms, indicating diminishing marginal efficiency. The study concludes that while all farm sizes are economically viable, strategic enhancements—such as optimising labour costs, improving yields, and increasing input efficiency, particularly in large farms—are crucial for enhancing profitability and sustainability. The findings highlight the potential of inland aquaculture as a scalable livelihood option, provided that cost structures are managed effectively.

***Keywords:*** *Fish farming, input-output ratio, variable costs, fixed costs, inland aquaculture*

**1. INTRODUCTION**

In the past, fish farming primarily revolved around capturing fish from rivers, streams, lakes, and oceans. However, advancements in aquaculture practices led to the establishment of fish cultivation in reservoirs, ponds, and enclosed spaces by the 19th century. A facility dedicated to the release of juvenile fish into natural habitats .for the purpose of recreational fishing or to enhance the natural population of a species is typically referred to as a fish hatchery (Selvaraj, 2022). Fish farming now involves the commercial raising of fish in tanks or enclosures, primarily for food production. The fisheries and aquaculture sector plays a crucial role in the socioeconomic development of India and is an integral part of our cultural heritage in many regions of the country (Upadhyay et al., 2020). In 2022, global fisheries and aquaculture production reached an impressive 223.2 million tonnes, with 185.4 million tonnes attributed to aquatic animals. Of the total aquatic animal production, 89 percent was utilized for human consumption, translating to an estimated 20.7 kg per capita. That same year, global aquaculture production hit 130.9 million tonnes, valued at USD 312.8 billion, which accounts for 59 percent of the total fisheries and aquaculture output. Inland aquaculture contributed 62.6 percent of farmed aquatic animals, while marine and coastal aquaculture made up 37.4 percent (FAO, 2024).

India holds the second position in aquaculture and ranks third globally in fisheries production (Das et al., 2024). The nation's fish production has reached an unprecedented high of 175.45 lakh tonnes during the fiscal year 2022-2023, which includes 44.32 lakh tonnes from marine sources and 131.13 lakh tonnes from inland sources. Andhra Pradesh, West Bengal, and Karnataka emerged as the three leading fish-producing states in India during this period (DoF, 2023). Fisheries play a crucial role, ranking just after agriculture in providing employment and ensuring food security (Devi et al., 2014). With its rich protein content, essential micronutrients, and fatty acids, fish is considered one of the most affordable and widely consumed sources of animal protein.

India is home to approximately 2.36 million hectares of tanks and ponds, where culture-based fisheries are prevalent and contribute significantly to the overall fish production. Currently, production from these tanks and ponds stands at 8.5 million metric tonnes. In 2023, fish production in Uttar Pradesh was reported at 915,000 tonnes (DoF U.P., 2023). The demand for fish in Uttar Pradesh is estimated to be 1.5 million metric tonnes, corresponding to an average of 15 kg per capita per year for 54% of the state's fish-consuming population. This substantial demand presents considerable opportunities for the development of the fishing industry in the region(Maurya et al., 2018).

Uttar Pradesh boasts immense potential in inland fisheries, driven by the growing need for protein-rich food sources such as fish. By advancing capture fisheries, culture fisheries, and culture-based capture fisheries, these resources can be effectively harnessed to meet domestic market demands, expand export opportunities, and significantly increase fish production. This boost in output not only ensures a greater supply for consumers but also satisfies local demand, ultimately leading to more stable market prices (DoF, 2023).

This study aims at analysing the economic aspect of inland fish production from ponds, thus providing a glance at the scope and opportunities for increasing production and improving the living standard of the producers.

**2.** **OBJECTIVE :** To work out cost and return analysis of fish production.

**3. METHODOLOGY**

**3.1 Sampling design**

The multistage stratified sampling technique was employed for the selection of the district, block, village, and respondents. Azamgarh district in Eastern U.P. has significant potential for fish farming, and the investigator's familiarity with the area informed the purposive selection of this district. A comprehensive list of all 22 blocks within the chosen district was compiled and arranged in ascending order based on fish farming area. From this list, the two blocks with the highest fish production were purposefully selected.

Subsequently, a list of all villages engaged in fish farming was prepared, and five villages from each selected block were chosen randomly. A list of respondents involved in fish farming from each selected village was created, and 10 respondents from each village were selected for the study. In total, 100 respondents were randomly chosen for the present study, calculated as follows: 1 district × 2 blocks × 5 villages × 10 respondents = 100 respondents.

**3.2 Analytical procedure**

The primary data were gathered on various expenses related to fish production, including electricity charges, feed costs, fertiliser costs, seed expenses, labour charges, and other associated costs. Additionally, fixed costs such as interest on land and depreciation were calculated. The depreciation cost was determined for investments in capital assets, accounting for wear and tear of equipment, machinery, and other gear. An analysis of costs and returns for fish production in ponds was conducted for the year. The net return per rupee invested was calculated by dividing the net return by the total cost.

**Fixed cost:** It includes the depreciation cost and interest on fixed capital.

**Variable cost:** Variable cost used in the study includes cost of labour, cost of material inputs i.e., seed, feed, fertilizer, lime, manures, cost of disease and predatory control measure, maintenance cost, interest on working capital (7% per annum) etc.

**Returns:**

Gross return = Total production (in kg.) × Price per kg.

Net return (Rs.) = Gross return - Total cost

Input-Output ratio = Gross return / Total cost(Variable cost + Fixed cost)

**4. RESULT AND DISCUSSION**

As indicated in Table 1, the cost and return analysis of fish farming for small farmers indicates that variable costs overwhelmingly dominate, comprising 99.20% of the total cost (₹2,91,024.44 out of ₹2,93,372.17). Labour constitutes the largest portion of the total cost at 46.40%, highlighting the labour-intensive nature of the operation. Other significant contributors include feed and fertilizer, which account for 23.78%, and seed costs at 20.32%, both of which are crucial for productivity. Supporting expenses such as fuel and electricity represent 2.61%, while net costs and interest on working capital contribute 1.42% and 4.68%, respectively. Fixed costs are relatively low at 1.18%, comprising minimal depreciation at 0.42% and interest on fixed capital at 0.38%, reflecting a limited investment in long-term assets among small farmers.

The farm achieves a gross return of ₹3,79,720 from the sale of 34.52 quintals of produce at ₹110 per kilogram, leading to a net return of ₹86,347.83, as detailed in Table 1. The input-output ratio stands at 1.29, indicating that for every ₹1 invested, the farm yields ₹1.29 in return. This demonstrates moderate profitability and operational sustainability. However, the considerable share of labour costs suggests opportunities for enhancing efficiency, potentially through mechanisation or improved labour management. Overall, the enterprise is viable; however, targeted efforts to reduce key input costs or improve yields could significantly enhance profitability.

**Table 1: Cost and return analysis of small fish farmers having area of pond less than 0.5 hectares(Rs./ha./year)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl. No.** | **Item** | **Cost(in Rs.)** | **Percentage** |
| **VARIABLE COST** |
| 1. | Fuel/Electricity | 7647.73 | 2.61 |
| 2. | Feed/Fertilizer | 69750.00 | 23.78 |
| 3. | Seed | 59613.64 | 20.32 |
| 4. | Labour | 136113.64 | 46.40 |
| 5. | Net | 4163.64 | 1.42 |
| 6. | Interest on working capital @ 4% per annum | 13736.09 | 4.68 |
| A. | SUB TOTAL | 291024.44 | 99.20 |
| **FIXED COST** |
| 1. | Depreciation @ 5% per annum | 1235.65 | 0.42 |
| 2. | Interest on fixed capital @7% per annum | 1112.08 | 0.38 |
| B. | SUB TOTAL | 3459.81 | 1.18 |
| C. | TOTAL COST(A+B) | 293372.17 | 100.00 |
| D. | GROSS RETURN(34.52 QT @ 110/KG) | 379720 |  |
| E. | NET RETURN | 86347.83 |  |
| H. | INPUT-OUTPUT RATIO | 1.29 |  |

The cost-return structure of medium farms also suggests that variable costs are the major constituent of the total expenditure, comprising 97.98% of the total cost as depicted in Table 2. Among these expenses, labour accounts for 43.65%, making it the most significant cost, followed by feed and fertiliser at 24.11% and seeds at 21.79%, both of which are crucial for productivity driven by inputs. Other costs, such as fuel and electricity (2.78%), netting (1.87%), and interest on working capital (3.76%), have a smaller but essential role in maintaining operations. Fixed costs are minimal, at just 2.01%, indicating low capital intensity and limited reliance on long-term physical assets or infrastructure.

According to Table 2, the farm yields 38.65 quintals, resulting in a gross return of ₹4,25,150 and a net return of ₹92,475.82 after considering all associated costs. The input-output ratio of 1.27 indicates that for every rupee invested, there is a return of ₹1.27, demonstrating moderate profitability. While the operation is economically viable, enhancing input efficiency or yield could further bolster returns and sustainability, particularly for small and medium-scale farmers.

**Table 2: Cost and return analysis of medium fish farmers having area of pond between 0.5-2 hectares(Rs./ha./year)**

|  |  |  |  |
| --- | --- | --- | --- |
| Sl. No. | Item | Cost(in Rs.) | Percentage |
| **VARIABLE COST** |
| 1. | Fuel/Electricity | 9255.36 | 2.78 |
| 2. | Feed/Fertiliser | 80225.00 | 24.11 |
| 3. | Seed | 72500.00 | 21.79 |
| 4. | Labour | 145212.53 | 43.65 |
| 5. | Net | 6225.28 | 1.87 |
| 6. | Interest on working capital @ 4% per annum | 12536.72 | 3.76 |
| A. | SUB TOTAL | 325954.89 | 97.98 |
| **FIXED COST** |
| 1. | Depreciation @ 5% per annum | 2550.97 | 0.76 |
| 2. | Interest on fixed capital @7% per annum | 4168.32 | 1.25 |
| B. | SUB TOTAL | 6719.29 | 2.01 |
| C. | TOTAL COST(A+B) | 332674.18 | 100 |
| D. | GROSS RETURN(38.65 QT @ 110/KG) | 425150 |  |
| E. | NET RETURN | 92475.82 |  |
| H. | INPUT-OUTPUT RATIO | 1.27 |  |

Fish farming operations by large farmers having an area of pond above 2 hectares reflect relatively less variable costs than small and medium farms, as depicted in Table 3.The variable costs for large farms account for 96.14% of the total expenditure. Among the variable components, labour is the most significant expense, accounting for 41.85%, which highlights the high dependency on labour within the operation. Other major costs include feed and fertiliser at 24.06% and seed costs at 21.32%, both of which are vital for generating yield. Additionally, smaller yet essential expenses, such as fuel and electricity at 2.90%, net at 2.32%, and interest on working capital at 3.70%, also play a role. Fixed costs are relatively low at 3.86%, primarily due to depreciation at 1.48% and interest on fixed capital at 2.38%, indicating a minimal investment in permanent infrastructure or equipment.

From a financial perspective, large farms generate a gross return of ₹4,49,714.71 by producing 40.88 quintals sold at ₹110/kg, yielding a net return of ₹95,520.43 after accounting for all costs, as illustrated in Table 3. The productivity of large farms is noticeably higher than that of small and medium farms. An input-output ratio of 1.26 indicates that for every rupee spent, there is a return of ₹1.26, reflecting moderate profitability. It can be observed that with an increase in farm size, there is an intensive use of inputs, resulting in increased production. The significant proportion of labour and input costs highlights the potential for cost optimisation, particularly through efficiency improvements or the adoption of technology. While the enterprise is economically viable, there remains an opportunity to enhance profit margins by increasing yields, decreasing reliance on labour, or better management of inputs.

**Table 3: Cost and return analysis of large fish farmers having area of pond above 2 hectares(Rs./ha./year)**

|  |  |  |  |
| --- | --- | --- | --- |
| Sl. No. | Item | Cost(in Rs.) | Percentage |
| VARIABLE COST |
| 1. | Fuel/Electricity | 10255.36 | 2.90 |
| 2. | Feed/Fertilizer | 85225.00 | 24.06 |
| 3. | Seed | 75500.42 | 21.32 |
| 4. | Labour | 148212.73 | 41.85 |
| 5. | Net | 8225.36 | 2.32 |
| 6. | Interest on working capital @ 4% per annum | 13096.75 | 3.70 |
| A. | SUB TOTAL | 340515.62 | 96.14 |
| FIXED COST |
| 1. | Depreciation @ 5% per annum | 5236.45 | 1.48 |
| 2. | Interest on fixed capital @4.5% per annum | 8442.21 | 2.38 |
| B. | SUB TOTAL | 13678.66 | 3.86 |
| C. | TOTAL COST(A+B) | 354194.28 | 100.00 |
| D. | GROSS RETURN(40.88QT @ 110/KG) | 449714.71 |  |
| E. | NET RETURN | 95520.43 |  |
| H. | INPUT-OUTPUT RATIO | 1.26 |  |

**Fig. 1: Cost and return of fish farming of different farm size.**

**5. CONCLUSION**

The cost and return analysis of small, medium, and large pond-based fish farming units in Azamgarh district, Uttar Pradesh, reveals a consistent pattern characterised by labour-intensive operations and a significant reliance on variable inputs, particularly feed, fertiliser, and seed. Labour costs emerge as the most significant component across all scales, accounting for 41.85% to 46.40% of total expenses. While fixed costs remain minimal due to limited infrastructure investments, the predominance of variable costs—exceeding 96% in each case—indicates that most farms operate with short-term working capital. Despite all farm sizes demonstrating positive net returns and viable input-output ratios ranging from 1.26 to 1.29, marginal efficiency tends to decrease with scale, suggesting that increased input use does not necessarily lead to proportionately higher profitability..

Comparative analysis reveals that large farms benefit from greater production volumes and net returns; however, they tend to exhibit slightly lower input-output efficiency due to higher input intensity. Medium-sized farms manage to strike a balance between efficiency and profitability, while small farms achieve higher marginal returns despite lower absolute profits. This indicates the necessity for strategic enhancements tailored to each farm size, such as the adoption of mechanisation to reduce labour costs, bulk procurement of inputs, and improved input management to enhance productivity without significantly raising costs. In conclusion, while pond-based inland aquaculture in the region holds economic promise, its sustainability and scalability depend on cost optimisation, technological advancements, and improved resource-use efficiency.

**DISCLAIMER (Artificial Intelligence)**

The authors hereby acknowledge their utilization of generative AI technologies, including Large Language Models, in the writing and editing phases of the manuscripts. This disclosure will include the name, version, model, and source of the generative AI technology used, as well as all relevant input prompts employed throughout the process.

**CONSENT**

In accordance with international and university standards, the written consent of participants has been duly obtained and retained by the author(s).

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