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Economic Analysis of Fish Farming in District Anantnag of Jammu and Kashmir

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ABSTRACT

The present study evaluates the socio-economic profile, cost structure, profitability, and resource-use efficiency of fish farming in District Anantnag of Jammu and Kashmir, a region endowed with abundant freshwater resources and significant aquaculture potential. Primary data was collected from 50 fish farms using structured questionnaires and economic viability was assessed through cost–return analysis, benefit–cost ratio and a Cobb–Douglas type revenue function. Economic analysis demonstrated that fish farming is highly profitable, with a benefit–cost ratio of 2.978, indicating that nearly three rupees are earned for every rupee invested. The Cobb–Douglas analysis indicated nearly constant returns to scale and regression results showed that seed cost, labour cost and miscellaneous operational expenses significantly and positively influenced fish production, whereas feed, marketing, liming, chemical and equipment costs were statistically insignificant. The study concludes that fish farming holds substantial economic potential for income generation, employment creation and rural development in the region. Strengthening training, infrastructure, subsidies and scientific management practices can further enhance the sustainability and productivity of the fish farming sector.

Keywords: *Fish farming, B/C ratio, Cobb–Douglas type revenue function, Fixed cost, Variable cost*

INTRODUCTION

Fisheries and aquaculture are among the fastest-growing industries in India and worldwide (Tacon, 2020). The fisheries sector contributes to national income and exports, ensures nutritional security, generates employment, and provides livelihood options (Kumar and Shivani, 2014) With its extensive coastline, numerous rivers, and abundant freshwater resources, the country ranks as the world’s second-largest inland fish producer and the third-largest overall fish producer. The domestic fish market is of high potential, but is highly unorganized and unregulated (Ganeshkumar *et al*., 2008). The expansion of fish farming, particularly in the last few decades, has been instrumental in addressing the food demands of a rapidly growing population. It has provided substantial economic benefits, generated employment and improving the livelihoods of millions, especially in rural and economically disadvantaged areas. In 2013-14, India produced approximately 9.58 million metric tons of fish, with the inland sector contributing 6.14 million metric tons and the marine sector 3.44 million metric tons. This robust output underscores the critical importance of both inland and marine fishing to India’s food production system and its potential for further growth. Aquaculture in India has now moved from a traditional activity to a well-developed industry Present fish production of India is 14.2 MT out of which 10.43 MT contributed by inland fisheries (Handbook of Fisheries Statistics, 2020).

Jammu and Kashmir (J&K), a region known for its stunning natural beauty and diverse cultural heritage, presents a unique case within India’s fishing industry. Spanning over two lakh square kilometers with a population density of 124 people per square kilometer, J&K offers both opportunities and challenges for the development of fish farming. Despite the increasing reliance on fishing as a source of income, the contribution of the fishing industry to J&K's Gross State Domestic Product (GSDP) remains relatively low, falling below 1%. This disparity highlights the need for targeted interventions to enhance the sector's productivity and profitability. The primary sector, which includes agriculture and related industries such as fisheries, accounts for 23% of the state's GSDP, which exceeds Rs. 63,000 crores (J & K Economic survey, 2012). Jammu and Kashmir has been able to produce 254.40 (Th. Qtls) of fish during 2021-22 as compared to the previous year 213.50 (Th. Qtls) thereby registering growth of 19.16%. 251.30 (Th. Qtls) fish production and 16.63 (Th. Qtls) Trout production has been achieved up-to ending January, 2023 (J and K Economic Survey, 2022-23). In Kashmir, Jammu and Kashmir, fishing has been a major source of income for the economically disadvantaged population. Although the states reliance on this sector, it`s contribution to states domestic product has drifted below 1% (Baba *et al.,* 2019). There is a common argument that fisheries are not given the proper attention they require (Rahman *et al*., 2002). Only a small percentage of their younger generation is able to move throughout the labor market in search of more profitable opportunities. Encouraging aquaculture is anticipated to transform the fisheries sector in the region, improving the living standards of the fishing community. Aquaculture is lucrative, offering a favorable benefit-cost ratio (Mog *et al*., 2018) and is believed to enrich values and reduce dependence on natural water resources (Naylor *et al*.,1998). However, fish culture is a capital-intensive activity that is adopted by economically better section of the society (Ahmed and Lorica., 2002).

One of the critical challenges facing the fishing industry in J&K, and indeed across India, is the inefficiency and disorganization of the supply chain. The fresh fish market is plagued by the involvement of numerous middlemen, including auctioneers, who add layers of complexity and cost, often to the detriment of fishermen's earnings. Furthermore, the domestic seafood market remains largely unregulated, leading to price volatility and exploitation of producers. These systemic issues underscore the urgent need for better supply chain management, marketing strategies, and processing facilities to support the sector's growth (Nisar *et al.,* 2017). Many fishermen and aquaculture farmers lack access to modern equipment and technologies that could enhance productivity and ensure sustainability. Investment in technology transfer, training, and education is crucial to enable these communities to adopt best practices and improve their yields. Sustainable aquaculture practices, which optimize resource use and minimize environmental impact, are essential for the long-term viability of the industry Integrated fish farming, for instance, which combines fish cultivation with agriculture, represents a promising approach that can yield significant benefits. (J and K Economic Survey, 2022-23).

A wide gap in yield potential and yield obtained is responsible for low yield. Most of the farmers are not aware of proper and adequate technologies of fish production. Complexity of technology and non-availability of technologies were the most severe constraints in the adaptation of scientific fish farming (Niangti *et al*., 2020). The lack of value addition for enhancing profit margin was one of major technology related constraints in adaptation scientific methods of fish farming (Uttej *et al*., 2023). The lack of proper training is also a major serious issue affecting the adaptation of fish farming by farmers (Surendran and Alex., 2022).

METHODOLOGY

The study was conducted in District Anantnag, Jammu and Kashmir. The Anantnag district was purposively selected as the study area of this research because it contains the higher number of fresh water bodies among all the districts of Kashmir, which means it has the higher potential for fish farming and a huge number of the total population of the district is involved in fish farming.

A pilot survey was conducted prior to main research because the fish farms were scattered all over the district. The study was conducted in 50 fish farms across the district with the help of structured questionnaires. The questionnaire comprised of two sections:

Section 1: Socio-demographic information of respondents (gender, age, household size, educational status, fish farming experience, size of the fish farm, distance between home and fish farm).

Section 2: Economic information (seed costs, feed costs, equipment cost, costs on fencing, lighting and cabling per unit, transport or marketing costs rate per kg, revenue generated, costs on liming (kg), costs on protection chemicals (kg).

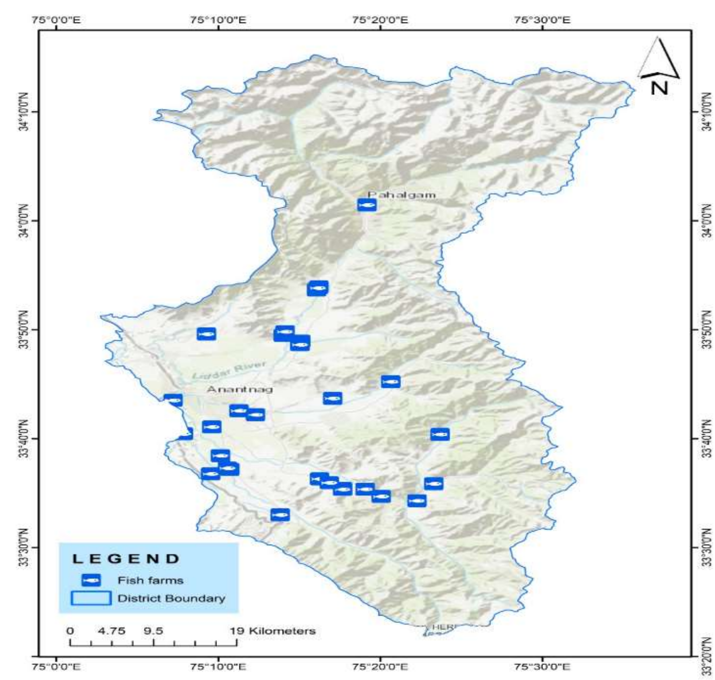

Fig. 1. Map showing study sites in district Anantnag

Estimation of fixed and variable cost

In order to evaluate whether fish farming is a profitable venture, the formula B/C has been applied. Costs are usually thought of as expenditure incurred in production by a farmer as variable costs and fixed costs. The variable costs comprises human labor, chemical fertilizers, manures, transport charges, feed, fingerlings and miscellaneous charges. Fixed costs comprise average initial cost for setting up the venture, deprecation charges of tools and equipments.

Profitability analysis was used to assess the profitability of fish farming production. The total revenue is the amount in rupees realized after the sales of fish harvested from the ponds. It was calculated by multiplying the total fish output in kg by the unit price. On the other hand, total variable cost is the sum of all costs (in Rs) used in production that change in proportion to the quantity of fish stocked in the ponds, i.e., the cost associated with variable inputs.

The fixed cost was calculated by depreciating the fixed items such as ponds and equipment used in fish farming.

Costs and Return Analysis

Total costs have been divided into two components viz fixed costs and variable costs.

TPC=TFC+TVC

where,

TPC=Total Production cost, TFC=Total Fixed Cost, TVC=Total Variable Cost

The benefit-cost ratio is defined as total revenue divided by the total cost. It measures the strength and viability of a firm and its benefits in monetary terms.

The benefit and cost ratio was calculated as;

$$Benefit\ cost\ ratio = \frac{Total\ revenue}{Total\ cost}$$

Cobb-Douglas type revenue function

Cobb-Douglas type revenue function was used to estimate the resource –use efficiency in fish production.

$$\text{Log } Y = a + b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3 + b_4 \log x_4 + b_5 \log x_5 + b_6 \log x_6 + b_7 \log x_7 + b_8 \log x_8$$

Where,

a=constant, Y=Revenue, X_1=Seed cost, X_2=Feed cost, X_3=Misc. cost, X_4=Marketing cost, X_5=Liming cost, X_6=Labour cost, X_7=Chemical cost, X_8=Equipment cost

RESULTS

Socio-demographic profile:

The results of socio-demography of the fish farmers indicates a strong male dominance in fish farming activities, with 92% males and only 8% females. This indicates that fish farming in the study area is largely a male-driven occupation, possibly due to cultural, physical, or social factors that limit women's participation. The majority of fish farmers have primary (38%) or graduate-level education (40%), while 20% have secondary education. Only 2% possess a postgraduate degree. This suggests that fish farming attracts individuals from diverse educational backgrounds and does not require advanced academic qualifications. The relatively high percentage of graduates indicates growing interest among educated youth.

The respondents were largest in the age group of 41–50 years (40%), followed closely by 21–30 years (38%), and 31–40 years (20%) and least in the age group of above 50 years (2%). A majority of the respondents (62%) were married, while 38% were single. Almost all participants (96%) rely on a combined income from agriculture and fish farming, indicating that fish farming is commonly practiced as an integrated livelihood rather than a stand-alone profession. Most respondents have medium experience (4–10 years) at 62%, showing an established fish farming community with practical knowledge. A large portion of the fish farmers (72%) have their fish farms located within 1 km of their homes, making monitoring and management easier. Furthermore, majority of the respondents (66%) operate medium-sized fish farms (1–2 kanals; 1 kanal=5445 square feet), while 30% manage small farms (<1 kanal), whileas, only 4% have large farm holdings (>2 kanals).

Economic analysis of fish farming

Benefit- Cost analysis

The benefit–cost analysis (Table 1) shows that the fish farming in the study site is economically viable and highly profitable. The total output generated was ₹1060,400, while the total cost of production amounted to ₹538,622, dominated largely by feeding expenses, which alone accounted for more than 80% of the total cost. Other variable costs such as seed, labour, liming, chemicals, and marketing were comparatively low, indicating a simple production system with minimal additional inputs.

The calculated Benefit–Cost Ratio (BCR) of 2.978 indicates that for every rupee invested, farmers earned nearly three rupees in return, reflecting strong profitability. Despite the high feeding cost, the farms overall achieved substantial economic gains, suggesting that fish farming in the study area is a financially sustainable and attractive livelihood option.

Table 1. Benefit cost ratio analysis of fish farming

Total output (Rs)		1060400/-
Variable costs (Rs)	Seed cost	58940/-
	Feeding cost	447800/-
	Marketing cost	508/-
	Misc. cost	6660/-
	Liming cost	602/-
	Labor cost	22000/-
	Chemical cost	890/-
	Equipment cost	1222/-
	Total cost	538622/-
Benefit cost ratio		**2.978**

Cobb - Douglas type revenue function analysis

A Cobb–Douglas type revenue function (Table 2) was estimated with revenue as the dependent variable and major input costs as explanatory variables to examine the elasticity of revenue with respect to input expenditure. Before employing revenue function, log-linear transformation was applied to both endogenous and exogenous variables. Variance Inflating Factor (VIF) was estimated to detect multicollinearity and value of VIF was 4.67 which is indication that there is no multicollinearity among variables. Hausmans test was employed to detect endogeneity and the p-value of test was greater than > 0.05 which suggests no evidence of endogeneity and for heteroscedasticity, white test reveals no heterogeneity of variances. In context to returns to scale, the sum of estimated elasticities is 0.99, suggesting approximately constant returns to scale, implying that proportional increases in input expenditure result in nearly proportional changes in revenue.

Table 2. Cobb-Douglas type revenue function analysis of fish farming

	Estimate	**Std. error**	**t-value**	**P(>|t|)**
Intercept	2.07097	0.58957	3.513	0.00108 **
Seed cost	0.17535	0.10144	1.729	0.05124 *
Feeding cost	0.19061	0.11881	1.604	0.11613
Misc. cost	0.40628	0.21257	1.911	0.04281 *
Marketing cost	0.14260	0.12123	1.176	0.24610
Liming cost	-0.09021	0.26010	-0.347	0.73046
Labor cost	0.25845	0.12059	2.143	0.03794 *
Chemical cost	-0.01019	0.16932	-0.060	0.95231
Equipment cost	-0.08041	0.23192	-0.347	0.73054

Sig. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 Multiple R-squared: 0.5972, F-statistic: 7.785 on 8 and 42 DF, p-value: 2.405e-06

A multiple linear regression analysis was conducted to assess the influence of different cost components on fish production. The regression model was found to be statistically significant (F = 7.785, df = 8, 42; $p < 0.001$), indicating that the selected explanatory variables jointly explain variations in fish production. The model accounted for 59.72% of the total variation in fish production (Multiple $R^2 = 0.5972$), suggesting a good explanatory power. The intercept was positive and statistically significant (β = 2.071, t = 3.513, p = 0.001), representing the baseline level of fish production when all cost variables are held constant.

Among the independent variables, seed cost had a positive and marginally significant effect on fish production (β = 0.175, t = 1.729, p = 0.051), indicating that higher investment in seed contributes to increased fish output. Miscellaneous cost also showed a positive and statistically significant relationship with fish production (β = 0.406, t = 1.911, p = 0.043), suggesting that expenditure on supporting inputs enhances production. Similarly, labour cost exerted a positive and significant influence on fish production (β = 0.258, t = 2.143, p = 0.038), highlighting the importance of labour inputs in aquaculture operations. Although feeding cost (β = 0.191, p = 0.116) and marketing cost (β = 0.143, p = 0.246) had positive coefficients, their effects on fish production were not statistically significant. Liming cost, chemical cost and equipment cost showed negative coefficients; however, these variables were statistically insignificant, indicating that they did not exert a measurable influence on fish production during the study period. Overall, the findings reveal that seed cost, miscellaneous cost and labour cost are the most significant determinants of fish production, while other cost components do not significantly affect output.

DISCUSSION

The results of the present study revealed that 96% of the respondents were male and 4% of the respondents were female. The results revealed that the majority of the fish farmers were male which shows male dominance in fish farmers. Adewuyi *et al*. (2010) and Aheto *et al*. (2019) also reported that fish farming as a male dominant venture. The results showed that 40% of the respondents were graduate, 38% of the respondents have completed their primary school education, 20% of the respondents have received secondary school education and 2% of the respondents were post graduate. The fish farmers in the study can be said to be more literate compared to other farmers in other agricultural activities. A high level of education could be because of the scientific and technical knowledge required in fish farming for effective production (Olaoye *et al*., 2013). The maximum respondents belonged to the age group 41-50 years (20%) followed by the age group 21-30 years (19%), 31-40 years (10%) and least percentage of respondents (1%) were above 50 years. The large proportion of the fish farmers were their economically active age. This implies that fish farming was embarked upon by men and women who are physically and mentally to face the various challenges which might occur in the fish farming business. Given relevant incentives and a competitive market, the group of people will improve productivity since they are still active, strong, and willing to improve their standard of living. This is because age is an important influencer of labor quality and availability on the farm, thus affecting productivity (Mukaila *et al*., 2022).

The results revealed that 96% of the respondents had agriculture and fish farming as their sources of income and 4%of the respondents were engaged in agriculture, fish farming as well as private jobs which were their sources of income. Fish farming serves as major means of livelihood, income, and sustenance among the respondents as the majority had it as their major occupation. The results showed that 62% of the fish farms had existed for 4-10 years. The years of fish farms could have a positive relationship with the fund security status of the farm. This is because the more the number of years of existence of fish farms, the more likelihood of financial capital accumulation in the form of savings or retained earnings over the years. The no. of years spent in a business influences the owner’s skills, knowledge, and management positively (Mukaila *et al*., 2021). Thus, the fish farmers could be regarded as well experienced who are knowledgeable and possess skills required in fish farming ventures which could enhance their fund security. The fish farmers were given initially a subsidy from government in construction phase to build their fish farms.

The study showed that the 66% of respondents have 1-2 kanals of land under fish farm, followed by 30%which had 1 kanal and 4% had more than 2 kanals of land under fish farm. Farm size had a positive and significant influence on the fund security of the fish farms. This implies that the profitability of a fish farm being fund secure increases as the farm size increase. The study also showed that 34% of the ponds have a stocking density of 3 thousand, 30% had a stocking density of 4 thousand, 24% had 5 thousand and 12% had a stocking density of 2 thousand per pond. Stock density, which is a measure of fish farm size, determines the output of the fish farms. It further enhances fish farm profit-ability (Aheto *et al*., 2019). Thus, a farm with a large size, in terms of stocking size, is more fund secure than those with a small size. The type of the species that was cultured at all the fish farms in our study was Rainbow trout. Rainbow trout are better suited for cultivation in Kashmir valley because this fish species is easy to domesticate and acclimatize with the cold-water conditions.

The economic analysis of fish farming in the study area, shows that fish farming is a profitable venture and is highly beneficial and creates job opportunities for local communities. In this study, all the respondents agreed that fish farming provides great employment opportunities. This is crucial in rural areas where employment opportunities may be limited. The sale of fish within local market stimulates the economic activity, providing income to fish farmers. Kashmir has a growing demand for fish, particularly species like trout which are considered delicacy. With increasing awareness of the health benefits of fish consumption, fish farming can meet local demand and reduce reliance on imports. The benefit-cost ratio was calculated and it was 2.978, that means if the expenditure of fish farming is rupee 1, the benefit is rupees 1.9, which shows that the investment is desirable and the benefits from the investment outweigh the cost and the fish farming is highly profitable, which is in sync with the studies of Adewuyi *et al.* (2010), Iruo *et al.* (2018) and Omobepade *et al*., (2015).

There were also various constraints faced by fish farmers such as lack of marketing facilities, lack of proper subsides, high price of seed and feed, lack of skilled labour, lack of insurance, lack of knowledge of modern and scientific trout farming as already found out by Baba *et al.* (2021).

The regression analysis indicated that various cost components exert differential influences on fish production, with seed cost, miscellaneous cost, and labour cost emerging as significant positive determinants. The positive impact of seed cost on fish production corroborates recent findings that investment in quality fry and fingerlings is fundamental to productive aquaculture systems. The rising cost of feed and seed has been highlighted as a key challenge that shapes profitability in intensive mariculture, demonstrating that these inputs critically affect production economics (Reyes-Gonzalez *et al*., 2025). This suggests that farmers who allocate resources effectively toward seed acquisition are better positioned to achieve higher yields.

The significant positive effect of labour cost reflects the role of effective farm management and labour-intensive activities in enhancing output. Labour remains a major variable cost in aquaculture operations, often determining how well feeding regimes, water quality monitoring, and pond maintenance are executed (Debnath *et al*., 2007). Furthermore, recent comparative economics studies in India reinforce that labour and other variable costs are central elements defining profitability and production levels in freshwater cultured fish systems (Das *et al*., 2024), which aligns with our results showing that labour investment significantly increases fish production.

The significant contribution of miscellaneous cost can be interpreted as indicative of the broader set of management practices—such as pond repair, water management, and auxiliary inputs—that support efficient production. Such operational expenditures are often linked to improved overall performance, as seen in contemporary analyses of aquaculture cost–benefit frameworks which stress the value of comprehensive input management for production sustainability (Samat *et al*., 2024).

Although feed cost had a positive coefficient, its statistical insignificance suggests that feed expenses alone do not guarantee higher fish production unless coupled with efficient feeding practices and adequate feed conversion ratios—an understanding increasingly echoed in current discussions of feed cost management in aquaculture economics (Reyes-Gonzalez *et al*., 2025).

The insignificant effects of marketing cost and the negative coefficients for liming, chemical, and equipment costs imply that these inputs do not consistently translate into higher production. This may reflect either low utilization efficiency or context-specific dynamics where these inputs do not directly enhance biological growth, a pattern sometimes noted in profitability assessments of pond fish farms where capital and corrective costs do not follow a direct relationship with output (Samat *et al*., 2024).

Overall, the findings suggest that biological and management-oriented inputs—particularly seed quality, labour management, and variable operational costs—play more decisive roles in boosting fish production than post-production or capital costs. These insights reinforce current perspectives in aquaculture economics that emphasize strategic cost allocation and efficient input use to achieve sustainable production increases ((Das *et al*., 2024; Reyes-Gonzalez *et. al*., 2025).

CONCLUSION

The study clearly demonstrates that fish farming in District Anantnag of Jammu and Kashmir is a profitable and sustainable enterprise with substantial potential to enhance rural livelihoods and employment generation. The high benefit–cost ratio confirms the economic viability of the activity, while the regression results emphasize that efficient allocation of biological and management-related inputs, particularly quality seed, labour and miscellaneous operational practices plays a critical role in improving fish production. However, despite favorable natural conditions and strong market demand, the sector continues to face challenges such as high input costs, inadequate technical knowledge, limited access to modern technologies and weak marketing and institutional support. Addressing these constraints through strengthened extension services, targeted subsidies, capacity-building programs and improved market infrastructure would not only enhance productivity and profitability but also enable fish farming to contribute more meaningfully to the regional economy and sustainable development of Jammu and Kashmir.

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