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Profitability Analysis of Cold-Water Fish Farming in Northern Pakistan: A Case Study of Aziz Trout Farm District Chitral

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ABSTRACT

Analysis of economic profitability is essential for establishing the financial viability of any business enterprise. In the context of trout farming in the Pakistani district of Chitral, this study evaluates the financial implications of this profitable and sustainable technique. In July of 2020, a structured questionnaire was used to collect data on profitability indicators for the study. The investigation reveals that the overall cost of producing 398 kilograms of fish on the farm was 596,013 rupees. This cost analysis offers great insight into the economic ramifications of trout farming in the region. In addition, the study indicates a good Benefit-cost ratio of 1.67, demonstrating that the benefits of trout farming outweigh the associated expenses. Additionally, the Rate of Return on Investment (RRI) is an amazing 0.78, further demonstrating the enterprise's profitability. The Variable Cost (RVC), which has a large value of 0.60, is one of the main aspects that contribute to the profitability of trout farming. This illustrates the potential profitability and cost-effectiveness of trout farming in District Chitral. The study demonstrates that fish farming, specifically trout farming, offers individuals a lucrative option to support themselves. With its favorable financial indicators and potential for long-term profitability, trout farming is a viable source of income for residents in the region.

Introduction

Under the umbrella of aquaculture, there are numerous subfields, each of which plays a significant role in the whole industry. Fish farming is commonly regarded as one of the most profitable and well-known of these sub industries (Føre et al., 2018). In its most fundamental definition, "fish farming" refers to the process of producing fish for commercial purposes in a managed or controlled environment. This technique, which has been used for centuries and is an integral part

of the fishing industry, has a long and exciting history dating back to the early days of the enterprise (Beveridge & Little, 2002).

Recent decades have placed a special emphasis on the industrial production of salmonid species. This shift in emphasis resulted directly from rising demand (Brown, 2012). The salmonid fish family, which includes trout and char, is significant to the aquaculture sector. This category comprises salmon, trout, and char (Buschmann & Muñoz, 2019). It is worth mentioning that the industrial cultivation of these species is not limited to a few countries or regions; rather, it is a widespread practice that spans almost every corner of the globe (Buschmann et al., 2006; Arismendi et al., 2009).

An in-depth analysis of the distribution of salmonid production across the world reveals that certain regions contain a significantly higher concentration than others. Norway and Chile are two of the most prominent players in this industry, with 36% and 19% of the world's production, respectively (Noakes et al., 2000; Buschmann et al., 2006; Mou, 2013). The current dominance in this regard may be primarily attributed to the vast and diversified marine ecosystems that are prominent within these countries, in addition to the progressive aquaculture policies that are in place. These regulations intrinsically support and emphasize the nurturing and proliferation of these specific species, which has led to an increase in the prominence of these species (Blann & Healey, 2006).

However, it is crucial to note that other regions, most notably North America, have begun to make substantial gains toward increasing global salmonid output. Even though their current percentage of total output is small, the North American countries have demonstrated a noteworthy capacity for future growth in this sphere (Bostock et al., 2010). Their unwavering dedication to expanding and improving their aquaculture operations distinguishes them as formidable competitors in the worldwide arena. As they work to expand and improve their pisciculture operations, these North American countries emerge as notable players with tremendous global potential (Dibble et al., 2015).

Within the world of salmonid species, the Atlantic salmon (*Salmo salar*) deserves special mention. Because of its significant contributions to the world of natural harvest, this species holds a remarkable and distinguished status (Harrison, Rybråten, et al., 2018). The Atlantic salmon (*Salmo salar*) has transcended its natural habitat to become an indispensable cornerstone of the fish farming industry. Through its widespread cultivation, this species plays a pivotal role in bolstering the collective yield of salmonids on a global scale (Harrison, Kochalski, et al., 2018). Its robust presence significantly contributes to the overall production within the industry, thereby solidifying its vital significance. The purposeful and commercialized culture of Atlantic salmon has evolved into an important aspect of fishing operations in several countries. This thorough integration emphasizes the species' enormous worth within the business, as cultivation attests to its enduring importance and contribution (Handå, 2012).

Beyond Atlantic salmon, other salmonid species also play crucial roles in the industry. It's worth noting that the Rainbow trout (*Oncorhynchus mykiss*) and Arctic charr (*Salvelinus alpinus*) have made notable achievements in their annual productions across the entire global fisheries sector (Dalsgaard et al., 2013). These two species' productivity has increased significantly year after year, demonstrating their substantial potential and growing relevance in the business (Simmons, 2018). Each of these species has a unique combination of characteristics and advantages that contribute to their growing appeal in fish farming operations around the world. These natural qualities

contribute to their appeal and feasibility in aquaculture methods, making them desirable cultivars. As their distinct characteristics are recognized and utilized, their dominance in the field of fish farming becomes more evident and ubiquitous (Noakes, 2014). Among these species, the rainbow trout (*Oncorhynchus mykiss*) stands out due to its widespread presence in aquaculture operations across multiple countries (Simmons, 2018). This popularity can be due to its appropriateness for small-scale farming as well as the constant and reliable yields it provides. Because of these compelling causes, rainbow trout has emerged as the most widely grown species in a variety of places, effectively establishing itself as a critical resource for local fish farmers (Gurung, 2016).

Nonetheless, like with any rapidly developing industry, the burgeoning rise of fisheries is not without its share of obstacles. The most pressing issue that has received substantial attention is the growing worry about the potential negative effects of fish farming on the fragile balance of natural aquatic ecosystems (Quiñones et al., 2019). These concerns mostly revolve around the potential damage of nearby indigenous ecosystems, as well as the looming threat of over-exerting wild fish stocks for feed production (Pelicice et al., 2017).

Given these challenges, efforts have been made to develop and promote sustainable and eco-friendly practices within the industry. A large part of this effort involves finding alternative means of livelihood for marginalized and neglected communities worldwide. By focusing on these communities, it's hoped that the industry can contribute to food security while also reducing the environmental impact of fish farming (Garcia et al., 2012)

Taking these considerations into account, the current inquiry was launched with the primary goal of delving into and measuring the economic benefits of trout farming. This study's major objective is to shed light on and quantify the financial benefits associated with this specific type of aquaculture. By undertaking a comprehensive examination of trout farming's economic advantages, this study intends to provide crucial insights on trout farming's potential to serve as a financially and ecologically viable component of aquaculture. By assessing the quantifiable economic benefits of this technique, this study lays the framework for future research in this area. The project is not only an intellectual exercise; rather, it is a key step toward establishing trout farming as an alternate means of subsistence. In addition, it adds to the ongoing endeavour to guarantee that the fisheries industry, particularly trout farming, matures into an economically significant and sustainable sector of global agriculture. The results of this preliminary investigation will undoubtedly provide a strong foundation for future studies and pave the way for the continued growth and development of the fisheries industry.

Materials and Methods

Study Area: Situated between 350’-12’0 to 360-50’ North Latitude and 710-2’ to 370-53’ District Chitral is the largest District of the Khyber Pakhtunkhwa Province of Pakistan (Afshan et al., 2015).

The district is very hilly and rocky, and the valley is fenced by tall mountains of the Hindukush and Karakoram ranges, ranging from 15000 to over 25000 feet in height (Hussain Shah et al., 2016).

The River Chitral along with tributaries provide an excellent freshwater habitat to fishes of the area. The 31 perennial glaciers of the Hindukush range perpetually feed the rivers of the district (Ali et al., 2022). River Chitral pours into River Kabul with then joins River Indus of Pakistan

(Shah et al., 2022). The freshwater streams of the area provide excellent habitat to salmonid species. Fingerlings of Rainbow Trout *(Onchorhyncus mykiss)* are stocked in the cold streams of the area (Marshman et al., 2012).

Aziz Trout Farm: Established in 1985, Aziz Farm is one of the oldest private fish farm of the area. The farm contains Rainbow trout, *Onchorhynchus mykiss* and Brown Trout, *Salmo trutta* reared in an area 3 hectares. Both trout species are reared in ponds but are segregated on the basis of age. The farm is provided with cold freshwater from the Jughoor Gol stream. Fish are fed with commercially available formula feed with standard feeding rates based on weight of the fish as recommended by Pocketbook (Pocketbook, 2015).

Data Collection

A comprehensive questionnaire was developed to gather data on the economics of trout farming in Aziz Trout Farm in April 2019 as recommended by Lasner et al (Pocketbook, 2015). Data about capital cost, recurring cost, production, total sale of each farm was collected during the data collection. The following formulae were used to calculate capital cost, variable cost, and revenue per kilogramme of fish weight output per month, as recommended by Bobel et al (13). All the parameters of economics analysis are expressed in Pakistani Rupees (PKR).

Total Variable Cost = Unit Price of the variable inputs x Quantity of the product (trout fish)

Total Revenue = Per Unit Price of variable outputs x Quantity of the product

Gross Marginal Income = Total Revenue - Total Variable Cost

Total Cost = Total Variable Cost + Fixed Cost

Net Farm Income = Gross Margin Income – Total Fixed Cost

Rate of Return on Investment = Net Farm Income ÷ Total Cost x 100

Variable Cost Ratio = Total Variable Cost ÷ Total Revenue

Benefit Cost Ratio = Total Revenue ÷ Total Cost

Expense Ratio = Total Fixed Cost ÷ Total Cost

Statistical Package for Social Sciences (SPSS), version 20 was used for data analysis.

Results

The study conducted in July 2020 examined the economic profitability of Aziz Trout Farm in Jughoor, Chitral, Pakistan, focusing on the rearing of Rainbow trout (Onchorhyncus mykiss) and Brown Trout (Salmo trutta). The collected data on numerous economic variables demonstrated that trout farming is a lucrative endeavor in the region.

Benefit-cost ratio (BCR) is an essential metric used to evaluate the profitability of trout farming by comparing the advantages achieved to the total expense. A BCR of 1.67 shows that the benefits of trout farming are 67% greater than the expenses. This indicates that Aziz Trout Farm has the potential to generate revenue through trout farming. The Rate of Return on Investment (ROI),

which quantifies the return on investment as a percentage of the initial investment, is another essential indicator in economic analysis. A ROI of 0.78 suggests that Aziz Trout Farm anticipates earning $0.78 for each dollar invested in trout farming. This is a positive return on investment, albeit it is lower than that of other agricultural operations. BCR and ROI are only two of the numerous indicators that may be used to evaluate the profitability of trout farming.

The Expense Structure Ratio (ESR) was also assessed in order to comprehend the expense allocation inside the trout farming activity. The ESR is a financial indicator that gauges the ratio of variable to total expenses. Feed, labour, and maintenance are examples of variable expenses that fluctuate with production level. On the other hand, fixed expenses are those that do not fluctuate with production level, such as rent and insurance. The ESR is determined by dividing variable expenses by overall spending. An ESR of 0.13 shows that variable costs constitute 13% of total expenses. This indicates that 87 percent of the expenditures are fixed costs. A high ESR shows that a substantial amount of the expenses are committed to the operation and maintenance of the trout farm. This is an indication of inefficiency, as it indicates that the farm is unable to generate enough income to pay its variable expenses. However, a high ESR might also be indicative of a farm's ability to maintain low fixed expenses, indicating its efficiency.

In addition, the study evaluated the Gross Margin Income (GMI), which is the revenue gained from trout sales minus the variable production expenses. The GMI of trout farming at Aziz Trout Farm was determined to be 398,988 Indian rupees (INR), which indicates a profitable enterprise where income exceeds variable costs. The GMI is a crucial indicator of the enterprise's profitability. A high GMI suggests that the business will likely be profitable, whereas a low GMI indicates that the business will likely be unprofitable. Numerous factors, including the size of the farm, the stocking density, the feed conversion ratio, and the price of trout, can influence the GMI of trout farming.

Table1: Profitability analysis of trout farming (PKR)

Economic Indicator	Calculated Value
Total Cost	596013 Rs
Annual Production	398 kg
Per Unit price	2500.kg
Total Revenue	995000 Rs
Gross Margin Income	398987 Rs
Net Farm Income	318987 Rs
Rate of Return on Investment	0.78
Variable Cost Ratio	0.60
Benefit Cost Ratio	1.67
Expense Structure Ratio	0.13

In addition, Net Farm Income (NFI) was determined by deducting fixed expenditures from Gross Margin Income. The study established an NFI of 318,987 PKR, proving that trout farming at Aziz Trout Farm is profitable. The NFI is a crucial indicator of the enterprise's profitability. A high NFI suggests that the business will likely be profitable, whereas a low NFI indicates that the business will likely be unprofitable. At 0.78, the Rate of Return on Investment (ROI) indicates continuous profitability. This indicates that for every unit invested in trout farming, 0.78 units can be expected in return. The ROI is a valuable indicator of an investment's profitability. A high ROI

suggests the investment is likely successful, whereas a low ROI indicates the venture is likely unprofitable. In addition, the Variable Cost Ratio (VCR) was examined. The VCR indicates the proportion of variable costs to overall production costs. The study calculated a VCR of 0.60, indicating that a substantial fraction of the total cost is variable and production-level dependent. Managing and optimizing variable expenses can contribute to the further improvement of trout farming's profitability.

Discussion

Benefit-cost ratio (BCR) is a financial metric used to determine an enterprise's profitability. It is determined by dividing the overall benefits of a firm by its total expenses (Homagain et al., 2011). A BCR greater than one implies that the business is profitable, whereas a BCR below one suggests that the business is not profitable. BCR is a valuable tool for determining the financial feasibility of a fish farm in the context of fish farming. A high BCR indicates that the fish farm is likely profitable, whereas a low BCR suggests that the fish farm is likely unprofitable. A variety of factors can affect the BCR of a fish farm, including the species of fish being farmed, the scale of the fish farm, its location, and its management procedures. A benefit cost ratio greater than one indicates a beneficial enterprise, whereas a benefit cost ratio equal to or less than one indicates the enterprise has no profit or loss (Macfadyen et al., 2012). (Olaoye et al., 2013) discovered that the BCR for fish aquaculture in Nigeria ranged from 1.69 to 1.9. This illustrates that fish farming in Nigeria is a viable enterprise. However, (Ngazy, 2004) observed a BCR of 1.5 for fish farming in Uganda's ZALA Park, where fish farming is widespread.. This shows that the profitability of fish farming may vary by region. The BCR of a fish farm can also be affected by the price of fish, the cost of feed, and the cost of labour, in addition to the aforementioned variables. If the price of fish increases, so will the BCR of the fish farm. However, the BCR of the fish farm will decline as the cost of feed or labour increases.

Our analysis determined the Gross Margin Income (GMI) of trout farming to be 398,987 Rs, suggesting a viable enterprise where revenue surpasses variable expenses. These estimates correspond to the findings of Adewuyi et al (2010). Similarly, Emokaro et al. (2010) determined that catfish farming in Nigeria generated a gross margin income of $2,915. Ibok et al. (2017) observed comparable findings, with GMI ranging from N400,000 to N700,000 year in Nigeria's Kalabar State. These studies provide additional evidence of the economic sustainability and potential profitability of fish farming businesses.

The rate of return is an essential metric for determining the profitability of an investment. It indicates the net profit or loss created by an investment over a certain time period, expressed as a percentage of the investment's starting cost (Arrow & Kruz, 2013). The rate of return is extensively used by financial analysts, investors, and regulators as a significant indicator for assessing the performance and profitability of investment endeavours. During the current investigation, a 0.78 rate of return on investment (RRI) was determined. In addition, (Olaoye et al., 2013) did an in-depth examination of fisheries in Nigeria and determined a Rate of Return on Investment of 0.88. This finding highlights the financial viability of investments in the fishery sector within the Nigerian context. Adding further support to these conclusions, (Emokaro et al., 2010) corroborated the parallel findings, emphasizing the consistent nature of the rate of return as a reliable indicator for assessing investment performance.

During the present analysis, the Expense Structure Ratio was calculated to be 0.13. Remarkably, results of our study are consistent with the study of (Olaoye et al., 2013). Their investigation into

fish farming in Oyo State, Nigeria, reported an ESR value of 0.15, substantiating the consistency of our results. In addition, a second study by (Oluseye & Damilola, 2019) conducted in Ogun State, Nigeria, revealed an ESR value of 0.18, bolstering the financial sustainability and potential profitability of fish farming in Nigeria. As a significant financial statistic, the ESR provides vital information into the distribution of expenses within a business, allowing entrepreneurs and investors to assess the economic viability of fish farming endeavours. Individuals interested in launching fish farming businesses can optimise profitability and ensure long-term viability by examining the results of our study and the research.

The Gross Marginal Income (GMI) is an important indicator of the enterprise's profitability. A high GMI suggests that the business will likely be profitable, whereas a low GMI indicates that the business will likely be unprofitable. Numerous factors, including the size of the farm, the stocking density, the feed conversion ratio, and the price of trout, can influence the GMI of trout farming. Gross Margin Income was determined to be 398987 PKR for trout farming in the current study, whereas Net Farm Income was determined to be 318987 PKR. Our study's conclusions about the profitability of fish farming are consistent with those of earlier research. Similar results were observed by (Adewuyi et al., 2010) for the gross margin income of fish farming in Nigeria. Similarly (Emokaro et al., 2010) determined that catfish farming in Nigeria generated a gross margin income of $2,915. The study of (Ibok et al., 2017) found comparable results with GMI between N400,000 and N700,000 per year in Kalabar State, Nigeria. The results of this study indicate that trout farming can be a lucrative business in Pakistan. It is essential to highlight, however, that the GMI of trout farming might vary based on the location of the farm, the management techniques employed, and the market conditions.

The Variable Cost Ratio (VCR) is a financial metric that measures the proportion of variable expenses to total costs. Feed, labour, and maintenance are examples of variable expenses that fluctuate with production level. On the other hand, fixed expenses are those that do not fluctuate with production level, such as rent and insurance (Ayodele & Shittu, 2013). The VCR is determined by dividing variable expenses by total spending. A VCR of 0.60 shows that variable costs constitute 60% of total expenses. A lower VCR suggests a more efficient cost management approach since it indicates that a greater share of the total cost is assigned to fixed or non-variable expenses, which can contribute to increased profitability. Variable costs are expenses that vary with production level, such as feed, labour, and maintenance. A lower VCR suggests a more efficient cost management approach since it indicates that a greater share of the total cost is assigned to fixed or non-variable expenses, which can contribute to increased profitability.

Table 2: Comparative Analysis of Profitability Parameters of fish Farming in Various Studies

Parameter	Studies	Calculated Value
Benefit Cost Ratio	Current study	1.677
	Olaoye et al (Olaoye et al., 2013)	1.69
	Tunde et al (Olaoye et al., 2013)	1.9
	Nzagi (Ngazy, 2004)	1.5
Rate of Return on Investment	Current study	0.78

Expense Structure Ratio	Olaoye et al (Olaoye et al., 2013)	0.88
	Emokaro and Ekunwe (Emokaro et al., 2010)	0.77
	Current study	0.13
	Olaoye et al (Olaoye et al., 2013)	0.15
	Oleseye and Damilola (Oluseye & Damilola, 2019b)	0.18

Conclusion

The comprehensive findings derived from this study unequivocally illustrate the remarkable profitability associated with engaging in trout farming as a lucrative entrepreneurial venture within the specified area. The results of this study bring to light a highly compelling and captivating possibility for individuals seeking to cultivate a flourishing business that not only ensures sustainable livelihoods but also presents substantial financial benefits. The implications of these findings underscore the transformative potential inherent in trout farming, positioning it as an exceptionally auspicious and alluring option for individuals aiming to establish a prosperous and thriving economic endeavor, thus safeguarding their long-term livelihoods effectively and reliably. Such a venture offers an unparalleled opportunity to not only generate substantial financial gains but also contribute to the preservation of a healthy and vibrant ecosystem, promoting sustainability and ecological balance. Therefore, based on the extensive and in-depth analysis conducted, it is abundantly clear that trout farming possesses exceptional potential for entrepreneurs and presents itself as an attractive avenue for long-term economic success, ensuring a sustainable and prosperous future.

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