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ASSESSMENT OF COST ON RAINBOW TROUT FINGERLING PRODUCTION IN BHUTAN

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ABSTRACT: This study aimed to determine the cost of production of rainbow trout fingerlings reared under Bhutanese climatic conditions and evaluate the economic aspects of Rainbow trout farming. The findings provide valuable insights into the cost analysis, serving as a reference for assessing farm efficiency, returns, and profitability. By establishing a production cost of Nu. 14/- per 25 grams fingerling, significantly lower than the market price of Nu. 25/-, this study highlights the potential for cost reduction and increased affordability of high-quality Rainbow trout seeds. This enables farmers to make informed decisions about their management practices, particularly in areas such as fish feed, to ensure the sustainability and profitability of their businesses. The study emphasizes the importance of optimizing production costs to enhance returns on investment, benefiting producers, farmers, and policy makers involved in the trout farming sector in Bhutan.

Keywords: farm efficiency; feed conversion ratio; fingerling; production cost; survival rate

1. INTRODUCTION

Aquaculture in Bhutan encompasses both warm water fish farming and cold water fish farming. Warm water fish farming, primarily focused on carp species, began in the early 1980s in the southern region, while cold water fish farming, specifically the culture of Rainbow trout started in 2008 (BAFRA). Despite being a landlocked nation, Bhutan has made significant socioeconomic progress in aquaculture and fisheries.

Playing a crucial role in Bhutan's aquaculture sector is the Trout Breeding Centre (TBC), under the National Research and Development Centre for Riverine and Lake Fisheries (NRDCRLF) in Haa. The TBC is the sole farm in the country producing high-quality Rainbow trout fingerlings for distribution to private sectors. Through extensive on-farm research and trials, the center has successfully standardized breeding and culture technologies for sparking increased interest from farmers and private sectors and potential expansion at a commercial level (Wangchuk 2014).

To ensure the economic sustainability of trout farming, a thorough investigation into farm economics, specifically the cost of production is essential. The cost of production serves as a critical economic indicator, determining the return on investment and farm profitability. However, the lack of economic information on fish farming feasibility has adverse implications. It hinders decision-making processes, restricts access to necessary financing and complicates the investment insurance (Pillay and Kutty 2005), thereby impeding the overall development (Mwangi 2007).

To address this knowledge gap, it is crucial to overcome the scarcity of data and information on the production cost for Rainbow trout fingerlings in Bhutan. This scarcity is attributed to meagre data collection, the absence of accurate data and the failure to analyze the existing findings. Currently, the cost of production for trout fingerlings is solely based on historical estimates of return on investment, relying on experience rather than scientific research. Therefore, it is vital to collect proper data and conduct thorough research to access and validate the current production cost. A comprehensive study to assess the cost of production is essential for the development and management of a farm as it enables farmers to consider production costs and identify areas where cost reduction can be achieved. Additionally, production cost data assist farmers in adapting to changes and determining price points at which the product cannot be sold without incurring losses (Ahmed et al. 2008). By addressing the economic aspects of trout farming through rigorous research and data collection, Bhutan can further enhance the sustainability and profitability of its aquaculture sector. This will contribute to the growth and development of the country's fisheries sector, ensuring a prosperous future for fish farmers and stakeholders.

2. MATERIALS AND METHOD

2.1. Research site and experimental design

The study was conducted at the Trout Breeding Centre, situated in Haa, Bhutan's western region at an elevation of 2700 meters above sea level. Natural spring water served as the primary water source, with an average temperature of 12-13^0 degrees Celsius in the summer and 8^0 degrees Celsius in the winter. The study focused on monitoring the growth and development of the experimental fish starting from the stage of eyed ova until they reached fingerling size of 25 grams, which took approximately 242 days, roughly equivalent to around 8 months.

To initiate the study, eyed ova, imported from Denmark were incubated in hatching trays, each accommodating up to 4000 ova until they reached the fry stage. The early fry and fry stages were reared in rectangular and fiber-reinforced plastic troughs with stocking densities of 2 kg/m^3 and 5 kg/m^3 respectively. The advanced fry, weighing 10-15 grams, were then transferred to outdoor concrete raceways with a stocking density of 10 kg/m^3. The fish remained in these raceways until they reached the fingerling stage, weighing approximately 25-gram.

Throughout the study, the fish were fed pelleted and formulated trout feed from Biomar, Denmark. The feeding regime followed the guideline provided by the manufacturing company, taking into account the increasing biomass of the fish and varying water temperature across different stages, ranging from swim-up to the fingerling stage. During the swim-up stage, the fish were fed 32 times per day and the frequency gradually reduced to 4-6 times per day for the advanced fry stage. It took approximately 145 days for the fry to attain a weight of 2 grams and 97 days to reach the fingerling stage weighing 25 grams from the fry stage.

2.2 Water quality parameters

To ensure optimal water conditions for the growth and survival of the fish, daily recordings of vital water quality parameters were recorded. The parameters assessed included Dissolved Oxygen (DO), pH, and water pH, and water temperature. Measurements for DO and pH were taken using HANNA instruments (model number HI 9813-6) while a mercury thermometer was used to record water temperature.

2.3. Fish Sampling

To assess the growth performance of the fish, a systematic sampling approach was employed. A total of 100 fish were randomly sampled for measurement and analysis during each sampling period. The frequency of sampling varied at each stage, with sampling conducted once every 2 weeks for early fry, twice a month for fry and once a month for fingerlings.

2.4 Sorting

During the advanced fingerling stage, the fish were manually sorted based on their body size. This sorting process was necessary to ensure adequate space for the increasing biomass of the fish. The sorting was conducted three times throughout the study period.

2.5 Mortality

Daily monitoring of fish mortality was carried out and the recorded data was documented separately. Over the course of the study, from the stage of eyed ova to the fingerling stage, a total of 45,961 fish deaths were recorded. The survival rate (SR) of the fish from eyed ova to fingerlings was calculated using the following formula:

$$\text{SR}\ (\%) = \frac{\text{Number of fish at the end}}{\text{Number of eggs at the beginning}} X100$$

2.6. Data collection

To accurately assess the production cost of rearing trout, two types of data were systematically collected: production data and operational cost data. The production data included various biological parameters crucial for evaluating the growth and performance of the fish. These parameters included body weight, body length, quantity of feed fed and survival rate. Additionally, physico-chemical parameters related to water quality, such as dissolved oxygen (DO), pH and water temperature were also recorded.

Concurrently, the operational cost data covered all expenses associated with trout rearing. This included both variable cost, which fluctuates based on the level of production (e.g., feed, eyed ova, electricity, treatment, transportation), and fixed costs, which remain constant regardless of the production level (e.g., capital costs, staff salaries, equipment depreciation). The total cost incurred was calculated by adding the operational and fixed cost at the end of the study period. From the findings, per fingerling cost of production was determined.

2.7. Performance indicators

In addition to the cost analysis, various performance indicators were also assessed to gauge the efficiency and productivity of the trout farming system. These indicators included specific growth rate (SGR), body weight gain (BWG), and feed conversion ratio (FCR). The calculations for these indicators were done using the following formulas:

$$\text{SGR}\ (\%) = \frac{\log n\ \text{final fish wt.} - \log n\ \text{initial fish wt)}}{\text{Time interval}} X100$$

$$\text{FCR} = \frac{\text{Feed consumed}}{\text{Wt. gain in fingerlings}} X100$$

$$\text{BWG (g)} = \text{Final body wt.} - \text{Initial body wt.}$$

These performance indicators serve as essential metrics to assess the growth potential, weight gain, and feed efficiency of Rainbow trout throughout the study period. By analysing and interpreting these indicators, valuable insights into the overall performance and effectiveness of the trout farming operation were obtained.

2.6. Statistical analysis

The data was analysed using Microsoft Excel, utilizing the formulas incorporated within the Excel sheet.

2. RESULTS

Throughout the duration of the study period, the average water quality parameters remained consistently within the optimal range for successful trout farming. The average values recorded for water temperature, amount of oxygen dissolved in the water and the level of acidity (pH) were 9.53, 5.17, and 7.44, respectively, throughout the entire period of the study. The slightly lower water temperature can be attributed to the winter season when the eyed ova was received in October. However, the water quality did not present any significant challenges, as the source of the water was clean and clear spring water.

Of the total of 100,000 eggs that were imported, 3% accounted for mortality during transportation. This resulted in the production of 51,039 fingerlings corresponding to a survival rate of 52.62% from eyed ova to fingerlings (Table 1). The specific growth rate (SGR) of 1.74% indicates that, on average, the trout exhibited a daily growth rate of 1.74% over the 242-day period. This growth rate is a positive indication of healthy growth and development in fish. Furthermore, the study demonstrated efficient feed consumption by the trout, as evidenced by a weight gain of 26.6 grams during the same period. The calculated feed conversion ratio (FCR) of 0.95 suggests that the fish effectively utilized the provided feed. The lower FCR value suggests a superior feed quality. Overall, these findings underscore favourable growth and efficient utilization of feed in the operation of trout farming.

Table 1: Survival rate, BWG, SGR and FCR for trout fingerling

Parameters/Indicators	Value
No. of eggs at the initial (Nos.)	97000
No. of fingerling at the end (Nos.)	51039
Survival rate (%)	52.62
Body weight Gain (grams)	26.6
Specific Growth Rate (%)	1.74
Feed Conversion ratio	0.95

Operational cost included cost of seed, feed, electricity, transportation of eyed ova to farm site, treatment and staff salary (Figure 1). The operational cost accounted for 89.09 % of the total cost. The major component of the operational costs was the import of seed, accounting for 39.40% of the total expenses. The cost of feed constituted to 38.53% of the operational expenses, representing another substantial portion of the overall costs.

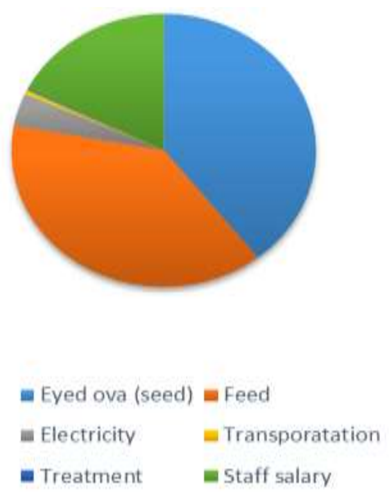

Figure 1: Operational cost incurred for Rainbow trout fingerling production

The fixed cost included expenses for structure and maintenance as well as the equipment depreciation and its maintenance (Figure 2). The fixed cost constituted 10.91% of the total cost indicating their relatively smaller proportion compared to the operational costs. Among the fixed costs, the major portion was attributed to structure expenses, which accounted for 61.38% of the fixed cost. Depreciation of equipment and its maintenance expenses accounted for 21.54% of the fixed cost.

The total cost for producing 51,039 fingerlings until they reached a weight of 25 grams was calculated to be Nu. 709,403.33 (Table 2). This cost includes both operational and fixed expenses incurred during the trout farming process. Out of the total cost, the operational cost accounted for Nu. 632,020.48, while the fixed cost amounted to Nu. 77,382.85. Among the components of the total cost, the cost of seed contributed the largest portion, constituting 35.10% of the total cost. The cost of feed was the second highest, representing 34.33% of the total cost. In stark contrast, the expenses for structure maintenance and treatment constituted merely 0.2% and 0.17% respectively of the total cost.

Figure 2: Fixed cost incurred for Rainbow trout fingerling production

Table 2: Economic analysis and determination of cost of production for Rainbow trout fingerling

Cost	Value (Nu.)	% Contribution to the total cost
A. Operational cost	632020.48	
a. Eyed ova	249000	35.10
b. Feed	243540	34.33
c. Electricity (monthly)	24339.44	3.43
d. Transportation	3000	0.42
e. Treatment	1200	0.17
f. Staff salary (hourly)	110941	15.64
B. Fixed cost	77382.85	
a. Capital cost (structure)	47500	6.70
b. Structure maintenance (3%)	1425	0.20
c. Equipment depreciation	16667.25	2.35
d. Equipment maintenance (3%)	11790.6	1.66
C. Total cost	709403.33	
No. of fingerling produced	51039	
D. Cost per fingerling	14	

Based on the calculations, the cost per fingerling was determined to be Nu. 14 for a fingerling weighing 25 grams. The detailed breakdown of the costs is provided in the Table 2.

4. DISCUSSION

The findings of this study provide valuable insights into the production cost of Rainbow trout fingerlings, highlighting the significance of accurate cost of analysis in managing a fish farm. The calculated cost of Nu. 14 per fingerlings is significantly lower than the current production cost of Nu. 25 per fingerlings. These results establish a scientific basis for the production cost of rainbow trout fingerlings, enabling the Trout Breeding Centre and private farms to make informed decisions regarding procurement of inputs and develop efficient production plan in future.

The importance of understanding production costs and their implications for farm management cannot be overstated. As stated by Douglas W. Lipton (2019), an accurate analysis of cash flow can assist in predicting investment returns and guiding financial decisions. By providing a reliable assessment of production costs, this study helps identify cost-related challenges that may arise in managing a fish farm, allowing farmers to proactively address these issues and optimize their operation (Lipton 2019).

Additionally, the establishment of a production cost baseline for Rainbow trout fingerlings will be beneficial for the Trout Breeding Center in advising upcoming trout farmers on the efficiency and profitability of trout farming. Furthermore, these findings will encourage farmers to procure fingerlings at a lower cost and shift focus on producing and selling table fish at higher rates. The cost of seeds and feed, which are significantly contributors to productions cost, can be targeted for cost reduction efforts. By reducing the cost of seeds alone, farmers can allocate the savings to other inputs, enhancing overall efficiency and profitability (Aydin 2000).

It is important to acknowledge the limitations of this research study. The results are specific to Rainbow trout farming in the country and cannot be directly extrapolated to other types of fish farming, such as carp farming, due to variations in culture systems and climatic conditions. In addition to the limitations mentioned earlier, there a few other factors that should be considered.

- This study was conducted using a specific sample size and may not represent the entire population of Rainbow trout farms in the country. A larger sample size would provide a more comprehensive understanding of production costs and their variability within the fishery sector.
- The study focused on the cost of production without considering market dynamics and price fluctuations. The profitability of trout farming is influenced not only by production costs but also by market demand, competition, and pricing strategies. Future research could incorporate market analysis to provide a more holistic perspective on the economic viability of trout farming.
- The study did not extensively investigate the potential impact of environmental factors, such as water availability, water quality variation, or climate change, on production costs. These factors can have significant implications for fish health, growth rates and overall farm management. Future studies could explore the relationship between environmental conditions and production cost to enhance the sustainability and resilience of trout farming practices.

Therefore, it is essential to consider these limitations when applying the research findings, as they have limited applicability beyond the scope within which the study was carried out.

5. CONCLUSION & RECOMMENDATION

Rainbow trout fingerlings play a vital role in the aquaculture sector, particularly for private farmers and entrepreneurs, and associated production costs have a significant impact on farm economics. This study has provided valuable insights into the cost of producing Rainbow trout fingerlings in Bhutan, revealing that the cost per 25-gram fingerling is Nu. 14/- which is significantly lower than the current prices price of Nu. Nu. 25/-. These findings establish a baseline for assessing farm efficiency, profitability, and price thresholds, filling the existing gap in well-established records of production cost for Rainbow trout in the country. The determination of accurate production costs is essential for effective farm management and decision-making (Lipton 2019)). By having a clear understanding of production costs, farmer can better navigate market fluctuations and establish optimal pricing strategies to generate favorable returns. This study not only provides a benchmark for assessing costs but also offers a point of reference for future evaluations, facilitating that as assessment changing costs, such as feed and seed, and the evolution of prices over time. Furthermore, research findings emphasize the need to revise the current price of fingerlings to along with the actual production costs. This adjustment will not only reduce financial burdens on farmers but also empower them to make informed management decision (Brown, 2020) that ensure the long-term viability of trout farming in Bhutan. The availability of accurate cost data will guide the adoption of new management principles and practices aimed at enhancing efficiency and productivity in the fishery sector. Based on the research findings, it is recommended that the Trout Breeding Center under NRDCRLF revise the price of Rainbow trout fingerlings in alignment with the determined production cost of Nu. 14/- per 25 grams fingerlings. This adjustment will promote fairness and transparency in the market, support the economic sustainability of trout farming, and encourage necessary changes in the current cost structure. Moreover, ongoing monitoring and evaluation of production costs should be conducted to account for any future changes in input prices, market dynamics, and farm-specific factors (Lipton 2019). Regular updates on the cost assessment will enable farmers to adopt to evolving conditions and ensure the continued profitability of their operations. Additionally, further research is warranted to explore market dynamics, consumer preference and the potential for value-added products in the trout farming sector (Brown 2020). This comprehensive analysis will provide a more holistic understanding of the fishery sector's economic landscape and enable farmers to diversity their revenue streams and maximize profitability. In conclusion, this research study has filled a significant knowledge gap by establishing a baseline for the cost of producing Rainbow trout fingerlings in Bhutan. The accurate assessment of production cost will empower farmers, guide policy decisions, and promote the sustainable growth of Rainbow trout farming sector in the country.

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