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Study Of Economic Viability And Constraints Shrimp Farming In Saline Inland Ponds In Sonipat, Haryana

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Abstract

Despite these successes, several challenges hinder the sector's sustainable growth like water quality management, high production costs, market access, etc. The study analyzes the economic viability and constraints of shrimp farming in inland saline water ponds in Sonipat district. Primary data were collected from 28 farmers through structured interviews, and enterprise performance was assessed using cost-return analysis, benefit- cost ratio, break-even analysis, and payback period. The results indicate that shrimp farming yields an average of 3,250.00 kg per acre per season, with gross returns of ₹12.84 lakh and net income of ₹4.86 lakh per acre. A benefit-cost ratio of 1.61 and a payback period of 1.07 years highlight the strong profitability and rapid recovery of investment. However, the sector faces significant challenges, particularly disease outbreaks, high feed costs, water quality management, labor shortages, and market fluctuations. The findings demonstrate that inland shrimp farming offers a profitable and sustainable alternative to traditional agriculture in saline-affected regions. Policy interventions addressing input costs, disease management, and capacity building are essential to enhance long-term sustainability and farmer resilience.

Keywords: inland saline water, Shrimp farming, cost and returns, payback period, BC ratio.

Introduction

The global aquaculture sector has undergone rapid expansion over the past few decades, emerging as a critical contributor to food security, livelihoods, and economic growth, particularly in developing nations (FAO, 2020). Among aquaculture, shrimp farming stands out as one of the most lucrative and fastest-growing industries, with the Pacific whiteleg shrimp (*Litopenaeus vannamei*) dominating production due to its superior growth performance, adaptability to diverse salinities, and high market demand (Roy *et al.*, 2010; Alcivar-Warren *et al.*, 2007) [14, 1]. Originally native to the eastern Pacific coast of Latin America, *L. vannamei* was introduced to Asia in the early 2000s and has since revolutionized shrimp aquaculture, accounting for over 80 per cent of global farmed shrimp production (FAO, 2018).

The increasing salinization of inland groundwater - driven by excessive irrigation, poor drainage, and climatic factors - has rendered vast tracts of agricultural land unproductive, particularly in the Indo-Gangetic plains of Haryana, Punjab, Rajasthan, and Uttar Pradesh (Lakra *et al.*, 2014; Mandal *et al.*, 2018)

[8, 9]. Estimates suggest that 8.62 million hectares of land in India are affected by salinity, with 40 per cent concentrated in the north-western states (Allan *et al*., 2009) [2]. This environmental degradation has severe socio- economic consequences, including reduced crop yields, declining farmer incomes, and rural unemployment (Beresford *et al*., 2001) [4]. In Haryana, around 20,000 hectares of land is severely affected by salinity.

In response to these challenges, inland saline aquaculture has emerged as a sustainable alternative, converting degraded saline lands into productive shrimp farms (Ansal & Singh, 2019) [3]. *L. vannamei* has proven particularly well-suited for this system due to its euryhaline nature, thriving in salinities ranging from 0.50 to 45 ppt (parts per trillion), and can tolerate high stocking densities (Samocha *et al*., 1993; Davis *et al*., 2004) [15, 5]. In India, shrimp farming has traditionally been concentrated in coastal regions, particularly in states like Andhra Pradesh, Tamil Nadu, Orissa, West Bengal and Gujarat, both in terms of area under culture as well as estimated production. During the 2023-24 period, India's total production of *L. vannamei* reached 1.07 million metric tonnes (MPEDA, 2025) [10]. Haryana was the first land-locked state in India to use inland saline water for commercial whiteleg shrimp farming when experimental trials were conducted by Central Institute of Fisheries Education (CIFE) in Lahli village of Rohtak district in 2012-13 (Fisheries Department Haryana, 2025) [7]. Pioneering efforts have demonstrated that inland shrimp farming can achieve yields of 7-10 tonnes/ha per crop, with net profits exceeding ₹8-10 lakhs/ha (Lakra *et al*., 2014; Ragunathan *et al*., 2024) [8, 13]. Government initiatives, including the Rashtriya Krishi Vikas Yojana (RKVY) and the Pradhan Mantri Matsya Sampada Yojana (PMMSY), have further incentivized this transition by providing subsidies for pond construction, seed procurement, and aeration systems. In Haryana alone, shrimp farming has expanded from 70 acres in 2014 to around 5,000 acres in 2024, yielding 4,000 tonnes of shrimp annually and significantly improving farmer incomes. The village panchayats are also being benefited by the aquaculture by leasing the land to farmer and have earned over ₹125 crore. Shrimp farming has become more beneficial to the panchayats where the water is saline and the barren wasteland is not suitable for traditional farming practices (Fisheries Department, Haryana, 2025) [7]. The Fisheries Department under Government of Haryana is providing subsidy upto @40 per cent (₹3.20 lakh/ha for general) and @60 per cent (₹4.80 lakh/ha for Scheduled Caste women) for construction of ponds in saline areas. Similarly for a construction of new pond nursery or seed nursery, the department provides a subsidy of ₹2.80 lakh/ha and ₹4.20 lakh/ha for general category and Scheduled Caste women, respectively (Fisheries Department, Haryana, 2025) [7].

Despite these successes, several challenges hinder the sector's sustainable growth like water quality management, high production costs, market access, etc. The fisheries department aimed to bring 700 hectares of saline wasteland under shrimp farming during 2024-25 (Fisheries Department, Haryana, 2025) [7]. Sirsa, Rohtak, Hisar and Jind are the leading producers in shrimp culture, however, other districts like Sonipat, Karnal, Gurugram, etc. are also catching up the scale. Haryana, Uttar Pradesh, Punjab and Rajasthan have identified around 58 thousand hectares of saline land, however, only around 2.6 thousand hectares land is utilised for shrimp culture (PIB, 2025) [12]. This huge potential can be utilised for increasing farm income and upliftment of farming community. The higher profitability and a quicker turnaround time of shrimp farming has made it an attractive enterprise, especially, for the landless farmer and unemployed youth of rural areas, where, they can lease panchayati land and start shrimp culture. Keeping these points in sight and for better understanding of the economics and returns to farmers in Sonipat district, a study was conducted in Sonipat district of Haryana to assess the economics of shrimp farming in inland saline water ponds. The choice of study area was made due to the close proximity to the NCR (National Capital Region), where there is higher demand of such food products, as well as to the well-established fish markets of Panipat and Bahadurgarh and a well scaling shrimp farming with an area reaching 130 acres during 2024-25 in the district.

Materials and Methods

Study area and sampling design

The research was carried out in Sonipat district of Haryana, one of the emerging pockets for inland saline water aquaculture. The study focused on the culture of Pacific whiteleg shrimp (*Litopenaeus vannamei*) during the farming year 2024-25. A total of 28 shrimp farmers were selected from the district to represent the local farming practices from seven villages *viz*. Rolad Latifpur, Ashrafpur Matindu, Bhadhana, Garhi Hakikat, Bhaadi, Khanpur Khurd, Tihar Malik, where shrimp farming was performed in the district.

Data collection

Both primary and secondary data sources were used. Primary data were obtained directly from farmers through a structured and pre-tested interview schedule, covering their socio-economic background, pond characteristics, input use (seed, feed, labour, electricity or diesel, medicines, probiotics, pond preparation), production outcomes, costs, and marketing details. Secondary information was compiled from official reports and publications of the Department of Fisheries, Government of Haryana and Marine Products Export Development Authority (MPEDA).

Analytical framework Cost and return analysis

The economics of shrimp culture were evaluated following the cost of cultivation approach, which classifies expenditure into:

- **Fixed costs (TFC):** including long-term investments such as pond construction, tube well installation, and farm buildings; and
- **Variable costs (TVC):** recurring operational expenses including seed, feed, medicines and probiotics, electricity/fuel, labour, and pond preparation.

This distinction allows for a clearer assessment of both operational profitability and the long-term sustainability of investment in shrimp farming.

Profitability indicators

Total Cost (TC): This is the combined amount of fixed and variable costs, representing the overall production expense.

$$TC = TFC + TVC$$

Gross Income (GI): Calculated as the value of total shrimp harvested, based on the prevailing farm-gate price.

$$GI = Yield\ x\ Price\ per\ kg$$

Net Income (NI): This is the difference between gross income and total cost, indicating the profit (or loss) after accounting for all costs.

$$NI = Gross\ income - Total\ cost$$

Benefit-Cost Ratio (BCR): Expressed as ratio of gross income to total cost, this ratio reflects economic efficiency, values above one indicating profitability.

$$BCR = \frac{Gross\ income}{Total\ cost}$$

Contribution Margin: It is defined as the difference between price of sale and average variable cost; it measures the revenue available to cover fixed costs and generate profit.

$$Contribution\ margin = Price\ per\ kg - Average\ variable\ cost$$

Break-even Quantity: It denotes the minimum production required to cover all costs.

$$Break - even\ Qty = \frac{Total\ cost}{Contribution\ margin}$$

Break-even Price: It indicates the minimum sale price needed to avoid losses.

$$Break - even\ price = \frac{Total\ Cost}{Break - even\ quantity}$$

Average Total Cost of Production (ATC): This is the ratio of total cost to total output, showing the per-unit cost.

$$ATC = \frac{Total\ Cost}{Yield}$$

Average Variable Cost of Production (AVC): This is the ratio of variable cost to total output, indicating the per-unit operational cost.

$$AVC = \frac{Total\ Variable\ Cost}{Yield}$$

Payback Period: This is the number of years required for farmers to recover their initial investment.

$$Payback\ period = \frac{Establishment\ cost}{Net\ returns\ per\ year}$$

Result and Discussion

The results of the present study provide insights into the economic performance of inland saline water shrimp farming in Sonipat district of Haryana. The findings are presented in terms of the cost structure, returns, profitability indicators, and investment recovery period, supported by relevant financial measures such as contribution margin and break-even analysis.

Physical overview of fisheries in Haryana

Table 1 presents a physical overview of Haryana's fisheries sector. The data obtained from Fisheries Department, Haryana (2025), [7] shows that there are approximately 11,920 fish farming ponds. Around 16,000 farmers, both directly and indirectly involved in the aquaculture sector, highlights the importance of aquaculture to the local economy, especially in regions facing challenges from soil salinity and waterlogging.

Haryana has 145,054 hectares of land affected by saline or waterlogged soils, with 20,000 hectares classified as critically saline. These regions, once deemed unfit for conventional farming, present a valuable opportunity for aquaculture, especially for the cultivation of species like *Litopenaeus vannamei*, which are well-suited to saline environments. The expansion of shrimp farming in these saline areas has the potential to address land degradation and provide an alternative livelihood for farmers, as demonstrated by similar trends in other saline-affected regions of India (Debroy *et al*., 2020; Venkateswara *et al*., 2022a) [6, 16]. Studies have shown that *L. vannamei*, with its adaptability to varied salinity levels, is particularly suited for inland saline aquaculture, making it an ideal candidate for Haryana's saline-affected lands (Ragunathan *et al*., 2024) [13]. Additionally, the state's 5,000 km of rivers and tributaries provide an essential water resource to support the growth of the aquaculture industry. There are 15 government funded fish seed hatcheries in the state along with four well established fish markets *viz.* Faridabad, Panipat, Yamuna Nagar & Bahadurgarh.

Table 1: Physical overview of fisheries in Haryana

Sr. No.	Particulars	Unit
1	Number of Ponds	11920 approx.
2	No. of Farmers (directly and indirectly)	16000 approx.
3	Saline/Water Logged Area (Ha)	145054
4	Critically Saline Affected Area (Ha)	20000
5	Rivers and its tributaries (Km)	5000
6	Government Fish Seed Hatcheries (No.)	15
7	Fish Markets	4

Source: Fisheries Department, Haryana

Table 2 presents the progress report on fisheries development in Haryana up to March 2025, detailing the achievements against set targets in key areas of the sector. The table highlights five major components: area under aquaculture, fish/shrimp seed stocking, fish production, training to fish farmers, and fish seed production. The target for the area under aquaculture was set at 24,065 hectares, and the achievement stands at 23,317.50 hectares, reflecting a near-completion of the goal with a minor shortfall. This indicates steady progress in expanding aquaculture practices across the state, although further efforts are required to meet the full target.

Table 2: Progress report of fisheries development in Haryana upto March, 2025

Sr. No.	Items	Unit	Achievement	
			Targets.	Achievement
1	Area under aqua culture	Hect.	24065	23317.50
2	Fish/Shrimp seed stocking	Lakh	11678	15039.71
3	Fish Production	Tonne	233550	232339.70
4	Training to fish farmers	No.	3250	3142
5	Fish Seed Production			
	(i) Govt. Sector	Lakh	2500	2385.15

Source: Fisheries Department, Haryana

In terms of fish/shrimp seed stocking, the target was 11,678 lakh seeds, with the achievement reaching 15,039.71 lakh, significantly surpassing the target. This overachievement suggests robust growth in seed stocking, which is essential for supporting the expansion of aquaculture operations, particularly shrimp farming, a key component of aquaculture development strategy (Debroy *et al.*, 2020) [6]. For fish production, the target was set at 233,550 tonnes, with the achievement at 232,339.70 tonnes. This close alignment with the target underscores the state's effective management of fish production activities, although a slight shortfall is observed. The consistency in production levels reflects the steady growth of aquaculture and the strengthening of fish farming practices within Haryana. The training of fish farmers is another critical aspect of the development plan, with a target of 3,250 individuals trained. The achievement of 3,142 farmers trained indicates substantial progress in capacity building, although there is a slight gap from the target. Training farmers is essential for enhancing aquaculture practices, ensuring the adoption of best management practices (BMPs), and improving overall production outcomes (Venkateswara *et al.*, 2022a).

The fish seed production in the government sector had a target of 2,500 lakh, with 2,385.15 lakh achieved. While this represents a good achievement, there is still a minor gap from the target, indicating the need for increased focus on improving fish seed production capacity, which is vital for sustaining the growth of aquaculture in the region (Ragunathan *et al.*, 2024). In conclusion, the data from Table 2 demonstrates significant progress in the fisheries sector in Haryana, with key areas like seed stocking and fish production showing positive results. However, the slight shortfalls in area coverage and some aspects of fish seed production and training highlight areas where additional efforts are needed to fully meet the targets and further enhance the state's aquaculture capabilities.

Socio-economic characteristics of shrimp farmers

The data in table 3 outlines the socio-economic characteristics of shrimp farmers in the Sonipat district. It categorizes the farmers based on their operational scale (marginal, small, medium, large) and provides insights into family composition, educational status, age distribution, operational size, and land ownership patterns. In terms of family composition, the frequency of adult males and females is relatively consistent across the different farm sizes. The distribution of children in families also follows a similar trend, with marginal and small-size farms having a slightly higher proportion of children (20.83% and 23.33%, respectively) compared to larger-scale farms. The educational status of farmers varies across categories. A significant portion of the farmers in all categories have completed at least secondary or matriculation education, with higher education levels being more common in the larger farms. Interestingly, while illiteracy is not prevalent, a small fraction (3.57%) of farmers is illiterate, with a higher occurrence in the large-size farm category. This is consistent with studies indicating that larger farms often require more skilled management, leading to better access to education (Ragunathan *et al.*, 2024) [13]. This could also imply that larger farms may have a higher proportion of educated individuals who manage operations.

Table 3: Socio-economic characteristics of shrimp farmers in Sonipat district

Categories	Marginal	Small	Medium	Large	Overall
Family Composition					
Adult Males Frequency	11 (45.83)	13 (43.33)	21 (45.65)	15 (41.67)	60 (44.12)
Adult Females	8 (33.33)	10 (33.33)	16 (34.78)	13 (36.11)	47 (34.56)
Children Frequency	5 (20.83)	7 (23.33)	9 (19.57)	8 (22.22)	29 (21.32)
Total	24 (100)	30 (100)	46 (100)	36 (100)	136 (100)
Educational Status					
Illiterates	0 (0.00)	0 (0.00)	0 (0.00)	1 (33.33)	1 (3.57)
Primary	1 (10.00)	0 (0.00)	1 (14.29)	0 (0.00)	2 (7.14)
Secondary	3 (30.00)	2 (25.00)	2 (28.57)	0 (0.00)	7 (25.00)
Matriculates	3 (30.00)	3 (37.50)	2 (28.57)	1 (33.33)	9 (32.14)
Intermediates	2 (20.00)	2 (25.00)	1 (14.29)	0 (0.00)	5 (17.86)
Graduates	1 (10.00)	1 (12.50)	1 (14.29)	1 (33.33)	4 (14.29)
Total	10 (100)	8 (100)	7 (100)	3 (100)	28 (100)
Age distribution					
Young (<35)	3 (30.00)	3 (37.50)	2 (28.57)	0 (0.00)	8 (28.57)
Adult (35-50)	5 (50.00)	3 (37.50)	4 (57.14)	2 (66.67)	14 (50.00)
Old (>50)	2 (20.00)	2 (25.00)	1 (14.29)	1 (33.33)	6 (21.43)
Total	10 (100)	8 (100)	7 (100)	3 (100)	28 (100)
Operational size of holding of farmers					
Frequency	10 (35.71)	8 (28.57)	7 (25.00)	3 (10.71)	28 (100)
Average land holding (in	1.92	5.03	14.62	29.7	12.82
Average pond size (in	1.02	3.5	5.57	7.16	4.31
Percentage acreage under	53.13	69.58	38.10	24.11	33.65
Type of ownership					
Owned	2 (40.00)	2 (33.33)	4 (44.44)	4 (50.00)	12 (42.86)
Leased	2 (40.00)	2 (33.33)	3 (33.33)	3 (37.50)	10 (35.71)
Owned + Leased	1 (20.00)	2 (33.34)	2 (22.23)	1 (12.50)	6 (21.43)
Total	5 (100)	6 (100)	9 (100)	8 (100)	28 (100)

The age distribution shows that a larger proportion of shrimp farmers are between the ages of 35 and 50, with 50 per cent of the adult farmers in the age range of 35-50. Interestingly, younger farmers, usually below 35 years age, are more prevalent in smaller farms, which might suggest that younger generations are increasingly engaging in aquaculture due to the growing profitability of the sector (Ragunathan *et al*., 2024) [13]. The presence of older farmers (above 50 years) in the larger farms may reflect the experience and accumulated knowledge in managing larger operations.

The operational size of holdings varies significantly between farm categories. The marginal farmers typically have smaller landholdings (1.92 acres on average) and smaller pond sizes (1.02 acres), while large-scale farmers possess much larger landholdings (29.7 acres on average) and bigger ponds (7.16 acres). This data aligns with the expected trends where larger-scale farms are more capital- intensive, requiring larger land and pond sizes for greater production (Debroy *et al*., 2020) [6]. The percentage of land dedicated to shrimp farming also differs, with smaller farms dedicating a higher proportion of land to shrimp farming (53.13% for marginal farms) compared to large farms (24.11%), which may indicate more diversified operations in larger farms (Venkateswara *et al*., 2022b) [17].

Regarding ownership, a notable proportion of shrimp farmers use leased land (35.71% overall), with a higher percentage of marginal and small-scale farmers leasing land compared to larger farms. This reflects the tendency for smaller-scale farmers to lease land as a means of reducing initial capital investment and expanding their operations without incurring the full cost of ownership. Large-scale farmers, on the other hand, tend to have higher proportions of owned land (50% of large farmers own land), reflecting the investment capacity and need for long-term stability (Ragunathan *et al*., 2024) [13].

Cost-benefit analysis Establishment cost

Table 4 outlines the establishment costs for shrimp farming in Sonipat district. The total establishment cost per acre amounts to ₹5,18,500.00, distributed across various components essential for setting up the shrimp farming infrastructure. The largest portion of the cost is attributed to the farm building, with an expenditure of ₹2,50,000.00. This reflects the importance of constructing a proper building for operations such as storage, office space and space for labor to stay. The next significant cost is for tubewell construction, amounting to ₹1,00,000.00, which is essential for water sourcing in the aquaculture operation. Given the reliance on groundwater for shrimp farming, particularly in regions like Haryana, the tubewell is crucial for maintaining water supply and ensuring optimal conditions for shrimp farming (Venkateswara *et al*., 2022b) [17].

Table 4: Establishment cost for shrimp farming in Sonipat district

(₹/acre)

S. No.	Particulars	Amount (₹)
1	Pond Digging & Construction	73,500.00
2	Farm Building	2,50,000.00
3	Tubewell Construction	1,00,000.00
4	Wiring & Pumpset	95,000.00
	Total Establishment cost	5,18,500.00

Pond digging and construction account for ₹73,500.00, which is a necessary investment to create the ponds where shrimp will be cultured. Pond construction is an initial capital investment, critical for the success of shrimp farming, as it directly impacts water quality management, stocking density, and overall farm productivity (Ragunathan *et al*., 2024). Additionally, wiring and pumpset costs are ₹95,000.00, which are vital for maintaining the water flow and aeration systems, ensuring that the shrimp have the proper environment for growth. These systems help in oxygenating the water, controlling temperature, and removing waste, all of which are crucial for maintaining healthy shrimp populations (Debroy *et al*., 2020) [6]. In conclusion, the total establishment cost of ₹5,18,500.00 reflects the significant capital investment required to set up a shrimp farm in Sonipat. This cost structure is typical of the initial phase of aquaculture establishment, where infrastructure, water management, and basic operational facilities need to be put in place. These costs must be carefully managed to ensure the profitability and sustainability of shrimp farming operations in the region.

Cost of production

Table 5 presents the cost of shrimp production in an inland saline water pond in Sonipat district, detailing both fixed and variable costs on a per-acre basis. The total fixed cost amounts to ₹52,630.63 per acre pond, making up 6.60 per cent of the total cost per crop season.

Table 5: Cost of production of shrimp in inland saline water pond in Sonipat district (₹/acre)

S.	Particulars	Description	Amount	Percentag
A.	Fixed Cost			
1.	Depreciation on fixed		26,687.50	3.35
2.	Lease rent of land		17,500.00	2.19
3.	Miscellaneous expenses		5,000.00	0.63
4.	Interest on fixed assets		3,443.13	0.43
	Total fixed cost		52,630.63	6.60
B.	Variable Cost			
5.	Pond preparation		36,500.00	4.58
6.	Cost of seed	100000 seeds	60,000.00	7.52
7.	Cost of feed	2500 kg	2,30,000.0	28.84
8.	Fertilizers	20 bags of MOP	34,000.00	4.26
9.	Medicines/Probiotics		21,000.00	2.63
9.1	Magnesium	12 bags	6,000.00	0.75
9.2	Mineral Mix		15,000.00	1.88
9.3	Lime	480 kg	6,720.00	0.84
10.	Aerator	2HP each, 4 in	1,40,000.0	17.56
11.	Water quality		2,350.00	0.29
12.	Electricity/Fuel charges		53,400.00	6.70
13.	Harvesting charges		12,250.00	1.54
14.	Labour charges	1 in no. for 7	1,05,000.0	13.17
15.	Miscellaneous expenses		22,600.00	2.83
16.	Interest on working		74,482.00	9.34
	Total variable cost		7,44,820.0	93.40
	Total cost/crop/season		7,97,450.6	100.00

The largest portion of the fixed cost is depreciation on fixed assets, which accounts for ₹26,687.50 (3.35% of the total cost). Depreciation accounts for the wear and tear on the infrastructure used in shrimp farming, such as ponds, pumps, and machinery. The lease rent of land comes next at ₹17,500.00 per acre (2.19%), indicating that land leasing is a significant ongoing expense for farmers, especially in areas with saline or waterlogged lands (Ragunathan *et al.*, 2024) [13]. Other fixed costs, such as miscellaneous expenses and interest on fixed assets, contribute relatively smaller amounts to the total cost at ₹5,000.00 (0.63%) and ₹3,443.13 (0.43%), respectively.

Variable costs account for a substantial 93.4 per cent of the total cost, amounting to ₹7,44,820.00 per acre. The largest expense is the cost of feed, which totals ₹2,30,000.00 (28.84%), reflecting the high demand for quality shrimp feed, which is critical to the growth and health of the shrimp (Venkateswara *et al.*, 2022b) [17]. Usually, the mortality is taken at an average of 15 per cent of seedlings, 1,00,000 seedlings are used for an acre pond. Therefore, cost of seed contributing significantly at ₹60,000.00 (7.52%), a necessary investment for the initial stocking of the shrimp pond. Other notable variable costs include pond preparation, at ₹36,500.00 (4.58%), and fertilizers (₹34,000.00; 4.26%), which are essential for maintaining water quality and providing the necessary nutrients for the shrimp. Four aerators of 2 horse power (HP) each (₹1,40,000.00; 17.56%) and labor charges (₹1,05,000.00; 13.17%) are also major costs, underscoring the capital-intensive nature of shrimp farming, especially in maintaining optimal water conditions and ensuring labor for day-to-day operations (Debroy *et al.*, 2020) [6]. Water quality monitoring and electricity and fuel charges contribute ₹2,350.00 (0.29%) and ₹53,400.00 (6.7%), respectively, highlighting the ongoing costs of managing water conditions and energy requirements. Additional expenses include medicines/probiotics (₹21,000.00; 2.63%), essential for maintaining shrimp health, and miscellaneous expenses (₹22,600.00; 2.83%), covering various other operational costs. Lastly, interest on working capital is ₹74,482.00 (9.34%), representing the financing cost for the capital needed to carry out daily operations.

The total cost of shrimp production per acre per season is ₹7,97,450.63. The distribution of costs shows that shrimp farming in Sonipat is heavily reliant on variable costs, particularly feed, seed, aerators, and labor, which together account for the majority of the expenses. Fixed costs, while significant, represent a much smaller share of the overall production cost. The high proportion of variable costs reflects the intensive nature of shrimp farming, where ongoing operational costs dominate, and effective management of these costs is crucial for profitability and sustainability (Ragunathan *et al.*, 2024) [13].

Returns and viability

Table 6 provides key returns and profitability indices for shrimp farming in Sonipat district, offering insights into the financial performance of the enterprise. The shrimp, harvested after 120-150 days, attains a size 35-40 gm. The yield of shrimp per season is 3,250.00 kg/acre pond, which @₹395.00/kg gives gross returns of ₹12,83,750.00/acre. This indicates a productive farming operation, with substantial revenue generated per season. The gross returns highlight the potential profitability of shrimp farming, particularly in areas like Sonipat, where saline-affected lands are increasingly being used for aquaculture (Debroy *et al.*, 2020) [6]. The average cost of production per kg of shrimp is ₹245.37, while the average variable cost stands at ₹229.18 per kg. The high proportion of variable costs (which include feed, labor, and other consumables) emphasizes the intensive nature of shrimp farming, where operational costs dominate (Ragunathan *et al.*, 2024). These costs are necessary to ensure the production of healthy and high-quality shrimp, which can be sold at competitive market prices. The net income from the farming operation is ₹4,86,299.38/acre pond. The Benefit-Cost (BC) ratio is 1.61, which means that for every rupee spent, the farmer earns ₹1.61. This is a strong profitability ratio, signifying that shrimp farming is a lucrative enterprise, with earnings nearly twice the costs. The ability to generate a significant net income indicates that the sector has substantial economic potential, even after accounting for operational costs (Ragunathan *et al.*, 2024).

Table 6: Returns and profitability indices in shrimp farming in Sonipat district

S. No.	Particulars	Amount (₹)
1.	Yield of shrimp/season (in Kg)	3,250.00
2.	Gross returns	12,83,750.00
3.	Average cost of production per kg of shrimp	245.37
4.	Average variable cost of production per kg of shrimp	229.18
5.	Net income	4,86,299.38
6.	B:C ratio	1.61
7.	Contribution margin	225.82
8.	Break-even output (kg)	2,018.86
9.	Break-even price (₹)	245.37
10.	Payback Period (years)	1.07

A contribution margin of ₹225.82 indicates the amount available to cover fixed costs and generate profits after covering variable costs. The break-even point for shrimp farming is 2,018.86 kg of shrimp, which corresponds to ₹245.37/kg in sales. This means that the farm needs to sell a little over 2,000.00 kg of shrimp to cover all costs. Given the gross return of ₹12,83,750.00, the farm easily surpasses this threshold, suggesting that profitability is achieved relatively early in the production cycle (Venkateswara *et al.*, 2022b) [17].

The payback period of 1.07 years, or around 12.84 months, shows how quickly the investment is recovered. The suitable growing season for shrimp farming in Sonipat district is from April/May to October and the farm can become profitable within two seasons. This short payback period is indicative of a highly efficient and profitable aquaculture operation, which recovers the initial capital investment in under a year. This quick turnaround is crucial for attracting investors and ensuring the sustainability of the operation (Debroy *et al*., 2020) [6]. The data from Table 6 suggests that shrimp farming in Sonipat is not only economically viable but also highly profitable. With a strong B:C ratio, quick payback period, and healthy net income, shrimp farming presents a lucrative investment in Haryana's saline-affected regions. These financial indicators support the continued expansion of aquaculture in the region, especially as the demand for shrimp and other seafood grows globally (Ragunathan *et al*., 2024) [13].

Constraints

While shrimp farming in Sonipat district shows strong profitability and potential for growth, there are several constraints that farmers face which may impact the sustainability and scalability of the industry. Table 7 presents the major constraints faced by shrimp farmers in Sonipat district. The data reveals that disease outbreaks are the most significant challenge, with 92.86 per cent of farmers indicating that disease management is a major issue. Shrimp farming is particularly susceptible to diseases such as White Spot Syndrome Virus and Early Mortality Syndrome, which can lead to substantial losses in shrimp populations. This highlights the importance of biosecurity measures, disease prevention strategies, and regular health monitoring to protect shrimp stocks (Venkateswara *et al*., 2022a) [16]. The second most reported constraint is high feed costs, affecting 89.29 per cent of farmers. As feed constitutes a large portion of variable costs, its high price severely impacts the profitability of shrimp farming. The cost of high-quality feed, which is essential for the optimal growth and health of shrimp, remains a significant burden for farmers, especially as feed prices fluctuate in response to global market conditions (Debroy *et al*., 2020) [6].

Table 7: Constraints faced by shrimp farmers in Sonipat district (N=28)

Sr. No	Constraint	No. of Farmers	Percentage (%)
1	Disease Outbreaks	26	92.86
2	High Feed Costs	25	89.29
3	Water Quality Management	22	78.57
4	Lack of Skilled Labor	19	67.86
5	Market Fluctuations and Price Instability	12	42.86
6	Land Leasing and Ownership Issues	7	25.00

Water quality management is also a significant constraint for 78.57 per cent of farmers. Keeping the right levels of salinity, pH, and oxygen is vital for shrimp health and growth. Given that Sonipat is located in a saline-affected area, managing water quality becomes even more challenging. Proper monitoring and adjustment of water quality parameters are essential but can be both time- consuming and expensive (Ragunathan *et al*., 2024) [13]. Another key challenge is the lack of skilled labor, reported by 67.86 per cent of farmers. Shrimp farming requires specialized knowledge, including understanding water management, disease control, and feed management. The shortage of skilled labor in rural areas may limit the efficiency and productivity of farms. Training and capacity- building initiatives are crucial to address this gap and ensure that the industry can expand sustainably (Ragunathan *et al*., 2024) [13].

Market fluctuations and price instability are major issues for 42.86 per cent of farmers. The price of shrimp is volatile and influenced by factors such as global supply and demand, international trade policies, and local market conditions. Price instability can affect the income stability of farmers, especially when production costs are high and market prices are unpredictable (Debroy *et al*., 2020) [6]. Finally, land leasing and ownership issues are reported by 25 per cent of farmers. While leasing land provides an opportunity for smaller farmers to enter the shrimp farming business, it can lead to long-term instability due to fluctuating lease rates or uncertainty in land tenure. These issues may hinder long-term investments in farm infrastructure and development (Venkateswara *et al*., 2022).

Conclusion

The study concludes that shrimp farming in inland saline water ponds of Sonipat district is a highly profitable venture. With an average yield of 3,250.00 kg per acre per season (April/May to October) and gross returns of ₹12.84 lakh, farmers earn a substantial net income of ₹4.86 lakh. A benefit-cost ratio of 1.61 and a short payback period of just 1.07 years clearly show that the shrimp farming in inland saline water is economically viable. By converting saline and waterlogged lands into productive use, shrimp farming provides an attractive alternative to traditional agriculture and contributes significantly to livelihood diversification and rural income enhancement. Despite these promising returns, farmers encounter serious challenges. Disease outbreaks, high feed costs, and difficulties in maintaining water quality are the most pressing issues, followed by shortages of skilled labor, market fluctuations, and land leasing constraints. To address these concerns, policy support is crucial. Interventions should prioritize affordable and locally produced feed, the establishment of diagnostic and biosecurity facilities, training and capacity-building programs for farmers, and improved access to institutional credit and stable marketing channels. In conclusion, shrimp farming in Sonipat has the potential to serve as a model for sustainable aquaculture in landlocked states. With its strong profitability indicators and ability to utilize degraded saline lands, the sector can play a pivotal role in improving farm incomes and resource efficiency, provided that supportive policies and technological innovations are implemented effectively.

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