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Inland Saline Shrimp Farming in Punjab: Development, Practices, and Socio-Economic Impact

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Inland saline shrimp farming has emerged as a promising aquaculture practice in Punjab by utilizing saline-affected agricultural lands for the culture of Pacific white leg shrimp (*Litopenaeus vannamei*). This farming system provides an economically viable alternative to conventional agriculture while improving the productive use of degraded land. Successful culture depends on proper pond preparation, water quality management, mineral supplementation, balanced feeding, and effective biosecurity practices. Since inland saline water is often deficient in essential minerals, appropriate supplementation is required to support healthy shrimp growth and survival. With scientific management, farmers can achieve profitable production within a culture period of 100–120 days. Inland saline shrimp farming has enhanced farmers' income, created employment opportunities, and contributed to rural development in Punjab. Despite challenges such as disease outbreaks and water quality management, it remains a sustainable and promising approach for strengthening aquaculture and improving rural livelihoods.

Keywords: Inland saline aquaculture, *Litopenaeus vannamei*, sustainable aquaculture, water quality management, biosecurity, rural livelihoods, utilization

Introduction

Punjab, traditionally known as an agrarian powerhouse of India, has in recent decades faced a serious and growing environmental constraint in the form of soil salinization and waterlogging in several regions, particularly in the south-western districts (CSSRI, 2015; Singh, 2009). Large stretches of once-fertile agricultural land have gradually become saline and unfit for conventional crop production. In this context, inland saline aquaculture especially shrimp farming using underground saline groundwater has emerged as a transformative alternative land-use system (Jena *et al.*, 2018; Kumar *et al.*, 2021). Among various species, the Pacific white leg shrimp, *Litopenaeus vannamei*, has become central to this shift due to its high adaptability, rapid growth, and strong market demand. Punjab's inland saline shrimp farming represents not just an agricultural innovation, but also a socio-economic intervention aimed at restoring productivity to degraded lands while improving rural livelihoods.

Emergence of Shrimp Farming in Punjab

In Punjab, a significant portion of land in the south-western region has become waterlogged and saline, rendering it unsuitable for traditional crops. Estimates suggest that approximately 1.90 lakh hectares of brackish and saline-affected land have potential for aquaculture development in India, including Punjab and other coastal and inland states. Historically, this land degradation created economic distress among farmers, as agricultural returns declined sharply or became completely non-viable. Punjab's inland saline aquaculture initiative began modestly but expanded rapidly after pilot-scale demonstrations proved its viability. The

Punjab's Fisheries Department initiated small-scale trials around 2016, beginning with limited land areas, which gradually expanded to pilot projects covering around 37.5 acres in 2017. The area increased to 248 acres in 2018. By 2019, the initiative had expanded significantly to approximately 410 acres, producing an estimated 750 tonnes of shrimp. Although the cultivated area slightly declined to 392 acres in 2020, Thereafter, the sector experienced rapid expansion, reaching 835 acres in 2021, 1,203 acres in 2022 and peaking at 1,315 acres in 2023 MFAHD. (2023). Subsequently, the area declined to 985 acres 2024 and further to 690 acres in 2025(PFDB), primarily due to market fluctuations, disease concerns, and reduced farmer participation. Overall, the rapid expansion observed between 2017 and 2023 reflects strong farmer interest, improved institutional support, and increasing awareness of the profitability of inland shrimp aquaculture in Punjab (Singh, L., Singh, N., & Singh, P. (2025).

Fig.1 Pacific White Leg Shrimp (*Litopenaeus vannamei*)

Suitability of Punjab's Inland Saline Water

One of the most critical factors influencing shrimp farming success in Punjab is the chemical composition of groundwater. Inland saline water differs significantly from seawater in terms of ionic composition, which directly affects shrimp growth, survival, and physiology. In Punjab, groundwater used for aquaculture typically shows:

- Elevated salinity levels suitable for *Litopenaeus vannamei* culture
- High sodium concentrations
- Imbalanced calcium, magnesium and potassium levels

Research has shown that maintaining proper potassium levels and balanced calcium to magnesium ratios is essential for successful shrimp culture in inland saline environments (Sowers *et al*., 2005; Roy *et al*., 2010).

Culture Practices Adopted in Punjab

The culture protocol followed in Punjab has largely been developed through research conducted by ICAR institutes, the Department of Fisheries, Punjab, and other aquaculture research organizations (Roy *et al*., 2010; Jena *et al.*, 2018).

1. Pond Preparation

Proper pond preparation is essential to ensure a healthy culture environment and maximize shrimp survival and growth.

2. Pond Size

Commercial shrimp ponds in Punjab generally range from 0.4 to 1.0 hectare in size, although smaller ponds are also used by marginal farmers. Most ponds are rectangular with a depth of 1.2–1.5 m, allowing efficient aeration, water circulation, and harvesting (NACA, 2014).

3. Pond Drying

After each production cycle, ponds are completely drained and sun-dried for 10–15 days. Drying oxidizes accumulated organic matter, destroys harmful pathogens and parasites, and improves soil quality. Cracks appearing on the pond bottom indicate adequate drying.

4. Liming

Agricultural lime ($CaCO_3$) or dolomite is applied to improve soil pH and increase alkalinity. The lime requirement depends on pond soil pH, generally ranging between 200 and 1,000 kg ha^{-1}. Liming enhances microbial activity, buffers pH fluctuations, and improves nutrient availability (Boyd & Tucker, 2012).

5. Fertilization

Although shrimp culture is primarily feed-based, organic or inorganic fertilizers may be applied before stocking to stimulate the growth of natural plankton. Commonly used fertilizers include cow dung, urea, and single superphosphate, depending on pond productivity and water conditions.

6. Water Filling

7. Pumping Saline Groundwater

Saline groundwater is pumped into ponds using bore wells. Depending on local conditions, salinity generally ranges from 5 to 20 ppt, which falls within the tolerance range of *Litopenaeus vannamei* (Roy *et al.*, 2010).

8. Mineral Correction

Inland saline groundwater is frequently deficient in potassium (K^+), magnesium (Mg^{2+}), and calcium (Ca^{2+}). Therefore, mineral supplementation using muriate of potash, magnesium chloride, gypsum, or commercial mineral mixtures is commonly practiced to restore ionic balance. Adequate potassium concentration is particularly important for proper osmoregulation, molting and growth of shrimp (Roy *et al.*, 2010).

Water Quality Testing

Before stocking, farmers routinely analyze water quality parameters including salinity, pH, alkalinity, hardness, dissolved oxygen, ammonia, nitrite, and mineral composition. Regular monitoring ensures that water remains suitable throughout the culture period.

Seed Stocking

The success of shrimp farming largely depends on the quality of seed used.

1. **Specific Pathogen-Free (SPF) Seed:** Punjab farmers predominantly stock Specific Pathogen-Free (SPF) post-larvae (PL) of *Litopenaeus vannamei*, usually at the PL10–PL15 stage. SPF seed minimizes the risk of introducing viral diseases into culture ponds and contributes to improved survival rates (NACA, 2014).
2. **Stocking Density:** Stocking density varies depending on management intensity and aeration capacity. Under Punjab conditions, stocking densities generally range between 30 and 60 post-larvae m^{-2}, although intensive farms may use higher densities with adequate aeration and water management. Before stocking, post-larvae are gradually acclimatized to pond salinity and temperature to reduce physiological stress.

Feeding Management

Proper feeding management is essential for achieving optimum shrimp growth, survival, and production efficiency. Commercial pelleted feed containing **32–38% crude protein** is commonly used for *Litopenaeus vannamei*, with the feed composition adjusted according to the shrimp's growth stage. Shrimp are generally fed **three to four times daily,** and feeding trays are used to monitor feed consumption and minimize feed wastage. Under good management practices, shrimp farms in Punjab typically achieve a **Feed Conversion Ratio (FCR) of 1.2–1.6**, indicating efficient feed utilization. Maintaining a low FCR reduces production costs, improves water quality, and supports sustainable shrimp farming (FAO, 2022).

Water Quality Management

Maintaining good water quality is essential for healthy shrimp growth, survival, and high production. Dissolved oxygen should be maintained above **5 mg/L**, while pond **pH** should remain between **7.5 and 8.5**. *Litopenaeus vannamei* grows well at a salinity of **5–20 ppt** in inland saline water and at an optimum temperature of **28–32°C**. Unionized ammonia should be kept below **0.1 mg/L** through proper feeding, adequate aeration, and regular pond management. Maintaining stable water quality throughout the culture period helps improve shrimp health, growth, survival, and overall farm productivity (Boyd & Tucker, 2012)..

Health Management and Biosecurity

Effective health management and biosecurity are essential for preventing diseases and improving shrimp survival. The use of **Specific Pathogen-Free (SPF)** shrimp seed, regular disinfection of equipment, restricted visitor access, and proper pond hygiene help reduce disease outbreaks such as **White Spot Syndrome Virus (WSSV).** Incoming water should be filtered to prevent the entry of disease carriers. Bird access can be minimized using nets or fencing. The application of probiotics, such as *Bacillus* **spp.**, improves water quality, suppresses harmful bacteria, and promotes healthy shrimp growth. In addition, the application of commercial probiotics containing beneficial bacteria, such as ***Bacillus*** **spp.**, helps improve water quality, enhance the decomposition of organic matter, suppress harmful bacteria, and maintain a stable microbial environment, thereby promoting shrimp health and improving overall farm productivity.

Harvesting

Harvesting is carried out once shrimp attain a marketable size and optimal growth. Under normal farming conditions, the culture period ranges from **100 to 120 days**, depending on stocking size, feeding practices, water quality, and environmental conditions. Shrimp are generally harvested at an individual weight of **20–30 g**, corresponding to approximately **30–50 shrimp kg^{-1}**, depending on market demand. Under scientific management practices, inland saline shrimp farms in Punjab typically produce **4–8 tonnes ha^{-1} per crop**, although higher yields can be achieved in well-managed intensive culture systems. Overall production depends on factors such as stocking density, feed management, water quality, and effective disease control (Kumar *et al.*, 2021).

Fig: 2 Harvesting of Market-Size *Litopenaeus vannamei*

Transition from Traditional Agriculture to Aquaculture

The transition from traditional agriculture to shrimp farming in Punjab's saline regions represents a structural change in rural land use. Farmers who previously relied on low-yield or failed agricultural crops due to salinity are increasingly turning toward aquaculture as a more profitable and stable alternative. Unlike conventional crops that may require a full season or longer to generate returns, shrimp farming cycles are relatively short, typically ranging from 100 to 120 days **(**FAO, 2022**).** This allows farmers to potentially undertake multiple production cycles annually, significantly increasing income potential.

Production Performance and Economic Returns

Punjab's inland shrimp farming has demonstrated strong production outcomes under proper management practices. While yields vary depending on salinity levels, pond management, and water quality correction, successful farms have reported:

- Substantial production increases over initial pilot phases
- Significant improvements after adopting scientific management practices
- Higher productivity in well-managed low-to-moderate salinity ponds

Institutional Support and Technological Development

The expansion of shrimp farming in Punjab has been supported by collaboration between state fisheries departments and national research institutions. These organizations have played a critical role in:

- Developing farming protocols for inland saline conditions
- Training farmers in shrimp culture techniques
- Promoting biosecurity measures to prevent disease outbreaks
- Introducing Best Management Practices (BMPs) for sustainable production

The shift toward scientifically guided aquaculture has been essential because inland saline farming is more complex than conventional coastal shrimp farming (NACA, 2014).

Challenges

Despite its success, inland saline shrimp farming in Punjab faces several challenges:

- Water Chemistry Imbalance
- High Initial Investment
- Disease Risk and Biosecurity
- Technical Skill Requirements:
- Market Dependence

Environmental and Agricultural Benefits

- Reduce waterlogging in affected areas
- Improve soil conditions over time
- Prevent further secondary salinization in surrounding regions
- Convert unproductive land into economically viable systems

Socio-Economic Impact

- Income Generation: Farmers have reported substantial increases in income compared to traditional agriculture, improving household economic stability.
- Employment Creation: Shrimp farming operations generate employment opportunities in pond construction, feed supply, harvesting, processing, and transportation.
- Rural Transformation: Saline-affected villages, once economically distressed, are gradually transforming into aquaculture-based production hubs.
- Reduced Agricultural Distress: Farmers facing crop failure due to salinity are finding an alternative livelihood, reducing migration pressure and economic vulnerability.
- Women and Local Participation: Aquaculture activities often involve family labor, contributing to broader rural participation in income generation.

Future Prospects

- Expansion of farmer clusters for economies of scale
- Improved water chemistry correction technologies
- Development of disease-resistant shrimp varieties
- Strengthening cold chain and market infrastructure

Conclusion

Punjab's inland saline shrimp farming represents a successful example of agricultural diversification in response to environmental degradation. The use of saline groundwater for *Litopenaeus vannamei* cultivation has transformed unproductive land into a valuable aquaculture resource. Although challenges related to water chemistry, investment, and technical expertise remain, the overall socio-economic benefits have been substantial. The rapid expansion of shrimp farming in Punjab demonstrates that with scientific intervention, institutional support, and farmer participation, inland saline ecosystems can be effectively converted into productive and profitable aquaculture systems.

References

1. Boyd, C. E., & Tucker, C. S. (2012). *Pond Aquaculture Water Quality Management*. Springer.
2. CSSRI. (2015). *Vision 2050*. ICAR–Central Soil Salinity Research Institute, Karnal, India.
3. Department of Fisheries, Punjab. (2021). *Annual Report 2020–21*. Government of Punjab.
4. Food and Agriculture Organization (FAO). (2022). *The State of World Fisheries and Aquaculture 2022: Towards Blue Transformation*. Rome: FAO.
5. Jena, J. K., Das, P. C., Gopalakrishnan, A., & Kumar, R. (2018). Inland saline aquaculture: Prospects and challenges in India. *Journal of Aquaculture Research and Development*, 9(8), 1–8.
6. Kumar, R., Jena, J. K., Gopalakrishnan, A., & Roy, L. A. (2021). Inland saline aquaculture in India: Opportunities for sustainable livelihood improvement. *Aquaculture International*, 29, 1541–1563.
7. MFAHD. (2023). Ministry of fisheries, Animal Husbandry and Dairying, Government of India. *Department of Fisheries, Press Information Bureau (PIB), Delhi*. 29 September, 2023. https://pib.gov.in/Press
8. Network of Aquaculture Centres in Asia-Pacific (NACA). (2014). *Better Management Practices for Whiteleg Shrimp (Litopenaeus vannamei) Farming*. Bangkok, Thailand.
9. Roy, L. A., Davis, D. A., Saoud, I. P., Boyd, C. E., Pine, H. J., & Boyd, C. A. (2010). Shrimp culture in inland low-salinity waters. *Reviews in Aquaculture*, 2(4), 191–208.
10. Singh, L., Singh, N., & Singh, P. (2025). Economic Development of the Indian State of Punjab: Prospects and Policies. In *India Policy Forum* (Vol. 21, No. 1, pp. 200-259). National Council of Applied Economic Research.