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PERFORMANCE EVALUATION OF BIOSECURE *LITOPENAEUS VANNAMEI* FARMS IN COASTAL ANDHRA PRADESH

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ABSTRACT

Intensive farming of Pacific white shrimp (*Litopenaeus vannamei*) has become an important aquaculture activity in coastal Andhra Pradesh. However, increasing production intensity, disease outbreaks, fluctuations in water quality and environmental pressures have highlighted the importance of biosecure farming systems. Biosecurity practices aim to minimise the introduction and spread of pathogens through effective pond preparation, quality seed selection, water treatment, controlled farm access, equipment disinfection, health monitoring and effluent management. This article evaluates the important performance indicators of biosecurity-oriented *L. vannamei* farming, using published commercial pond observations from coastal Andhra Pradesh as a case-study reference. A study conducted at Dugarajupatnam, SPSR Nellore district, reported 88–95% survival, a final average body weight of 15.92–16.74 g and a feed conversion ratio (FCR) of 1.25–1.36 over a 105-day culture period. These results provide useful production benchmarks for intensive shrimp farming. The article further discusses how biosecurity, production efficiency, shrimp health, environmental management and economic returns can be integrated into a comprehensive farm performance evaluation framework. Strengthening biosecurity and adopting scientifically managed production systems are essential for improving the sustainability and profitability of shrimp aquaculture in Andhra Pradesh.

Keywords: Shrimp Aquaculture Biosecurity, *Litopenaeus vannamei*, Sustainable Shrimp Farming

1. INTRODUCTION

Shrimp aquaculture is one of the major contributors to India's seafood production and export economy. Andhra Pradesh is a leading shrimp-producing state, with commercial farming concentrated in coastal districts such as Nellore, Prakasam, Bapatla, Krishna, West Godavari, East Godavari and Srikakulam. The availability of brackishwater resources, hatcheries, commercial feed, processing facilities and established marketing networks has

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encouraged the expansion of intensive shrimp farming. Pacific white shrimp (*Litopenaeus vannamei*) is widely cultured because of its rapid growth, adaptability to different salinity conditions and suitability for intensive production systems. However, high stocking densities and increased feed inputs can create favourable conditions for pathogen transmission, organic waste accumulation and deterioration of water quality. Diseases such as white spot syndrome, acute hepatopancreatic necrosis disease, *Enterocytozoon hepatopenaei* (EHP)- associated infections and bacterial diseases can cause substantial economic losses. Biosecure farming provides a preventive approach to these challenges. It involves a combination of physical barriers, operational protocols, health surveillance and environmental management to reduce the risk of pathogen introduction and transmission. Evaluating farm performance should therefore extend beyond total shrimp production and include survival, growth, feed efficiency, health status, biosecurity compliance and environmental performance.

2. STUDY AREA AND CASE-STUDY BACKGROUND

The present assessment uses published commercial farming observations from Dugarajupatnam, SPSR Nellore district, Andhra Pradesh, as a regional production reference. Ravuru and Mude (2026) evaluated *L. vannamei* culture in four commercial ponds, each measuring approximately 0.4 ha, during the rainy season. PL10 post-larvae were stocked at 50 PL/m² and reared over a 105-day culture period using commercial feed containing 35–42% crude protein. The study reported final average body weights of 15.92–16.74 g, survival rates of 88–95%, production of 2,348.45–3,013 kg per pond and FCR values of 1.25–1.36. These observations provide a useful reference for evaluating production performance under coastal Andhra Pradesh conditions. It is important to distinguish the published production observations from a formal biosecurity audit. The cited study reports growth, survival, water quality and economic performance but does not provide a quantified biosecurity compliance score or pathogen-screening results for each pond. Accordingly, the present article uses its production data as a case-study reference and discusses the biosecurity measures that should be assessed alongside such performance indicators.

3. MAJOR COMPONENTS OF BIOSECURE SHRIMP FARMING

3.1 Farm Infrastructure and Physical Barriers

Effective biosecurity begins with appropriate farm infrastructure. Farms should have secure boundaries, crab fencing, bird-scaring arrangements and controlled entry points. These measures help reduce the entry of potential disease carriers and unwanted organisms. Reservoirs and properly designed inlet channels allow incoming water to be screened and treated before it enters culture ponds. Separate equipment should be maintained for individual ponds to minimise the movement of pathogens between culture units. Nets, buckets, feeding trays and other implements should be cleaned and disinfected according to appropriate protocols. Workers should follow designated movement procedures and use suitable protective and disinfection facilities.

3.2 Pond Preparation and Sediment Management

Proper pond preparation helps reduce residual organic matter, undesirable organisms and potential pathogen reservoirs. After harvest, ponds should be drained, dried and cleaned. Excessive accumulated sludge should be removed, particularly from areas where anaerobic conditions may develop. Soil treatment and liming should be based on soil and water analysis. Reservoirs, canals and drainage channels should also be cleaned before the next production cycle. Effective pond preparation improves the initial culture environment and reduces the risk of carrying disease problems from one crop to the next.

3.3 Quality Seed and Stocking Management

The use of healthy, tested and certified post-larvae from authorised hatcheries is fundamental to biosecure shrimp production. Seed should be evaluated for size uniformity, swimming activity, physical condition and relevant pathogen status. Procurement records, hatchery details and seed health documentation should be maintained. Gradual

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acclimatization to pond temperature, salinity and pH reduces stocking stress. Stocking density should be determined according to pond carrying capacity, aeration availability, water quality management and farm infrastructure. Excessive stocking can increase stress, oxygen demand and disease transmission, reducing overall production efficiency.

3.4 Water Quality and Aeration Management

Water quality has a direct influence on shrimp growth, survival and disease susceptibility. Important parameters include dissolved oxygen, temperature, pH, salinity, alkalinity, total ammonia nitrogen and nitrite. These parameters should be monitored regularly, with additional observations during rainfall, cloudy weather and periods of high biomass. Adequate aeration is particularly important in intensive systems. Paddle-wheel aerators help maintain dissolved oxygen and promote water circulation. Aeration capacity should be increased as shrimp biomass rises, and emergency power arrangements should be available to prevent oxygen depletion during electricity interruptions.

3.5 Feed and Waste Management

Feed is one of the largest operational costs in intensive shrimp farming. Feed should be supplied according to shrimp biomass, average body weight, feeding response and environmental conditions. Feeding trays and regular sampling help farmers adjust daily feed quantities and avoid excessive feed wastage. Uneaten feed and faecal matter contribute to organic loading, ammonia production and sediment deterioration. Appropriate feeding schedules, regular sludge management and controlled water exchange help maintain pond stability. A well-managed feeding programme improves FCR and reduces the environmental burden of intensive production.

4. EVALUATION OF PRODUCTION PERFORMANCE

The performance of a shrimp farm should be evaluated using standard production indicators. These measurements help compare ponds, identify management weaknesses and assess the effectiveness of biosecurity-oriented practices.

- **Survival rate:** Survival rate indicates the proportion of stocked post-larvae that remain alive at harvest. High survival generally reflects suitable seed quality, effective environmental management and good health conditions. However, survival alone cannot establish that a farm is biosecure; disease surveillance and operational records are also necessary.
- **Average body weight:** Final average body weight provides an indication of growth performance. Regular sampling helps identify variations in growth and supports appropriate feeding adjustments.
- **Feed conversion ratio:** FCR represents the quantity of feed required to produce a unit of shrimp biomass gain. Lower FCR values generally indicate better feed utilisation, although comparisons should consider feed type, stocking density, culture duration and harvest biomass.
- **Production per unit area:** Total production and yield per hectare are important indicators of farm productivity. However, maximum yield should not be the only objective, because excessive stocking and feed inputs may increase disease and environmental risks.
- **Economic performance:** Gross revenue, total production costs, net returns and benefit-cost ratio provide an overall assessment of farm profitability. Seed, feed, electricity, labour, health management, testing and biosecurity infrastructure should all be included in cost calculations.

5. REPORTED PRODUCTION PERFORMANCE IN COASTAL ANDHRA PRADESH

The Dugarajupatnam study provides the following production observations from four commercial ponds during a 105-day culture period.

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Parameter	Reported performance
Number of ponds	4
Pond area	0.4 ha each
Stocking density	50 PL/m²
Culture duration	105 days
Final average body weight	15.92–16.74 g
Survival rate	88–95%
Production per pond	2,348.45–3,013 kg
Feed conversion ratio	1.25–1.36

The observed survival range indicates that a substantial proportion of stocked shrimp reached harvest. The FCR values also suggest efficient feed utilisation under the reported culture conditions. Pond B2 recorded the lowest FCR, whereas Pond B4 achieved the highest production and net profit (Ravuru & Mude, 2026). These results demonstrate the importance of consistent feeding, water quality management and aeration. Nevertheless, they should be interpreted as observations from a specific commercial study rather than as proof that biosecurity measures alone caused the reported production performance.

6. BIOSECURITY ASSESSMENT AND FARM-LEVEL PERFORMANCE INDICATORS

A comprehensive performance evaluation should include a structured assessment of biosecurity practices. The following indicators can be used during farm inspections and production-cycle reviews.

Biosecurity component	Important assessment indicators
Farm infrastructure	Boundary fencing, crab fencing, bird barriers and controlled access
Water management	Reservoir availability, inlet screening and water treatment
Seed quality	Authorised hatchery, seed health records and pathogen screening
Pond preparation	Drying, sludge removal, soil treatment and equipment sanitation
Personnel management	Entry control, worker hygiene and movement protocols
Equipment management	Pond-specific implements and regular disinfection
Health monitoring	Routine shrimp sampling, mortality records and laboratory diagnosis
Feed management	Feed records, feeding response and FCR assessment
Waste management	Sludge removal, effluent treatment and safe disposal
Record keeping	Stocking, water quality, health, production and harvest records

For practical farm evaluation, each component can be scored using a standard checklist, such as 0 for absent, 1 for partially implemented and 2 for fully implemented. The total score can then be expressed as a percentage of the maximum possible score. Such a checklist is a proposed assessment tool and should be validated before being used for formal comparisons between farms.

7. DISEASE SURVEILLANCE AND HEALTH MANAGEMENT

Disease prevention is more effective than depending exclusively on treatment after an outbreak. Regular observation of feeding activity, swimming behaviour, body colour, gut condition, hepatopancreas appearance and mortality patterns can help identify early signs of health problems. Laboratory examination should be undertaken when abnormal behaviour, reduced feeding, unusual mortality or clinical signs are observed. Appropriate diagnostic

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methods may include polymerase chain reaction (PCR), histopathology, bacteriological examination and microscopic analysis, depending on the suspected disease. Particular attention should be given to WSSV, EHP, bacterial infections and other locally relevant pathogens. Farm-level disease surveillance should include routine record keeping and timely reporting to competent authorities. When an outbreak occurs, movement of shrimp, water and equipment between ponds should be avoided. Diseased stocks and wastewater should be managed according to applicable disease-control and disposal protocols. The Shrimp Health Management Extension Manual developed through NACA and partner institutions is particularly relevant because its recommendations were based on farm-level disease-risk studies conducted in Andhra Pradesh (NACA et al., 2005).

8. ENVIRONMENTAL MANAGEMENT AND REGULATORY COMPLIANCE

Biosecure shrimp farming must also minimise adverse effects on surrounding aquatic ecosystems. Excess feed, faecal matter, suspended solids and chemical residues can affect receiving water bodies if farm effluent is discharged without suitable treatment. Effluent Treatment Systems (ETS), sludge management, controlled water exchange and responsible input use are important components of environmental protection. Farms should maintain records of water quality, feed application, seed procurement, production and harvest. Compliance with registration and operational requirements of the Coastal Aquaculture Authority (CAA) is essential for coastal shrimp farms. The Coastal Aquaculture Authority Act, as amended in 2023, defines biosecurity as an integrated approach to analysing, managing and preventing the introduction and spread of harmful organisms. The CAA's updated regulatory framework also addresses SPF certification, disease surveillance, aquaculture inputs and environmental safeguards (CAA, 2025). Farmers should follow the latest applicable guidelines for farm registration, stocking, health monitoring, wastewater treatment and waste management.

9. MAJOR CHALLENGES IN BIOSECURE SHRIMP FARMING

Despite the benefits of biosecurity, its implementation can be difficult for small and medium-scale shrimp farmers. The installation of reservoirs, treatment facilities, fencing, aeration systems and monitoring equipment requires substantial investment. Limited technical knowledge and inadequate access to diagnostic laboratories may also affect the implementation of scientific disease surveillance. Seasonal variations create additional management challenges in coastal Andhra Pradesh. Heavy rainfall may cause sudden changes in salinity and pH, while high summer temperatures can increase oxygen demand. Disease outbreaks, fluctuations in feed prices, seed quality variations and market uncertainty further influence farm profitability. Another major challenge is inconsistent implementation of biosecurity protocols. Even farms with suitable infrastructure may experience disease transmission if workers, equipment or water are moved between ponds without adequate sanitation. Therefore, biosecurity must be treated as a continuous management practice rather than a one-time infrastructure investment.

10. RECOMMENDATIONS FOR IMPROVING FARM PERFORMANCE

Farmers should adopt a preventive and farm-specific approach to biosecurity. Quality seed should be obtained from authorised hatcheries, and stocking density should be matched with pond carrying capacity and aeration facilities. Regular monitoring of water quality, shrimp growth, feeding response and mortality should be maintained throughout the production cycle. Pond-specific equipment, controlled worker movement, effective inlet screening and proper effluent treatment should be implemented consistently. Periodic laboratory testing and professional disease diagnosis are important when abnormal signs are observed. Digital farm records and automated water quality sensors can further improve monitoring and decision-making. Farmer groups and aquaculture clusters can also benefit from shared diagnostic facilities, technical training, coordinated disease surveillance and common water treatment infrastructure. These approaches may reduce individual costs while improving biosecurity across neighbouring farms.

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11. CONCLUSION

Performance evaluation of biosecure *Litopenaeus vannamei* farms should integrate production efficiency, shrimp health, biosecurity compliance, environmental management and economic returns. Commercial pond observations from Dugarajupatnam, coastal Andhra Pradesh, reported survival of 88–95%, final average body weight of 15.92–16.74 g and FCR of 1.25–1.36 over a 105-day culture period. These results provide useful regional production benchmarks, while highlighting the importance of systematic pond and feed management. However, high production performance alone does not confirm effective biosecurity. Formal evaluation should also include seed health documentation, water treatment, physical barriers, equipment sanitation, disease surveillance and effluent management. The integration of these measures with scientific farm management can reduce production risks, improve profitability and promote environmentally responsible shrimp aquaculture in coastal Andhra Pradesh.

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