

because they are simple and compatible with standard commercial feeds and protein formulations. They can support good growth and acceptable feed conversion when carefully calibrated, especially when diet quality is high and protein levels match shrimp requirements. At the same time, such strategies are vulnerable to errors in biomass estimation and cannot react to short-term variations in appetite or environmental conditions. More dynamic strategies, including multiple small meals, feed restriction in biofloc or green-water systems, and automated delivery, offer important gains in feed utilization and growth. Studies with reduced feeding rates in biofloc show that moderate restriction can improve both growth and feed efficiency by leveraging natural productivity, while high-protein diets and functional additives further enhance performance. Increasing feeding frequency and using automatic or acoustic demand feeders improves growth and economic returns without compromising survival, indicating that closer matching of feed supply to shrimp demand is a core principle of effective feeding strategies. Intelligent precision approaches based on biomass prediction and IoT platforms are beginning to unify these elements into integrated feeding systems.

Despite substantial progress, existing research on feeding strategies for Pacific white shrimp has several limitations. Many trials are relatively short in duration, focus on a single production phase, or are conducted in experimental tanks and small ponds rather than full commercial farms. This constrains understanding of long-term impacts on pond ecology, sediment dynamics, and multi-cycle sustainability. Moreover, most studies evaluate one dimension at a time—such as protein level, ration size, or feeding frequency—rather than systematically exploring their interactions across different culture intensities and environments. There are also gaps in the evaluation of emerging intelligent and automated technologies. Machine-learning-based biomass prediction and IoT-enabled feeders have demonstrated technical feasibility and good prediction accuracy, but evidence on their robustness across seasons, farm scales, and management styles remains limited. Economic analyses often emphasize feed cost and gross revenue without fully accounting for capital expenditure, maintenance, training, or data-management requirements. In addition, much of the AIoT literature is fish-focused, with relatively fewer shrimp-specific applications, leaving questions about model transferability, behavior-based appetite detection in crustaceans, and integration with health and disease-monitoring systems.

Intelligent precision feeding is poised to become a central pillar of precision aquaculture for Pacific white shrimp. Future systems are likely to couple real-time water-quality sensing, computer vision or acoustic monitoring of feeding activity, and data-driven biomass models to continuously adjust ration size, timing, and spatial distribution. Shrimp-specific machine-learning models that integrate environmental, nutritional, and behavioral data can refine estimates of appetite and growth potential, allowing automatic feeders to minimize overfeeding while sustaining rapid weight gain. As IoT hardware and cloud platforms mature, these tools are becoming more accessible, including for small and medium-scale farms. At a broader scale, intelligent feeding will be increasingly linked to farm-level and even regional management. Integration with AIoT farm-management systems can align feeding decisions with energy use, aeration control, and disease-risk forecasting, improving resilience and lowering environmental footprints. Advances in precision aquaculture point toward multimodal sensor fusion, digital twins, and explainable AI, which could help farmers understand and trust automated recommendations while optimizing FCR, nutrient retention, and economic returns. To realize these prospects, future work must address challenges of cost, interoperability, data quality, and capacity building, ensuring that intelligent precision feeding contributes not only to higher productivity, but also to long-term economic and ecological sustainability of shrimp farming.

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Conflict of Interest Disclosure

The author affirms that this research was conducted without any commercial or financial relationships that could be construed as a potential conflict of interest.