tracing, and cross-regional early warning systems is essential to improve the identification and response capacity for emerging and evolving pathogens (Bhassu et al., 2024).

7.2 Antibiotic misuse and antimicrobial resistance

Antibiotics have long been used in shrimp aquaculture for disease prevention and treatment, and in some regions even for growth promotion. Although this practice may alleviate disease pressure in the short term, it has led to significant concerns regarding antimicrobial resistance (AMR), drug residues, and ecological risks (Bondad-Reantaso et al., 2023; Devadas et al., 2023). Studies have shown that various antibiotics, including fluoroquinolones, tetracyclines, and sulfonamides, are still used in shrimp farming, with some of these substances restricted or banned in food-producing animals. The frequent and often suboptimal use of these antibiotics increases the selection pressure for resistant bacteria and resistance genes within aquaculture systems (Devadas et al., 2023).

Additionally, aquaculture effluents interact with pollutants from urban, livestock, and medical sources, turning aquaculture environments into hotspots for the dissemination and exchange of resistance genes. This phenomenon reflects a typical “One Health” issue, where aquatic environments, animal health, and human health are closely interconnected (Natrah et al., 2025). The rise of antimicrobial resistance not only reduces treatment efficacy but also complicates disease management. For instance, Vibrio strains associated with AHPND may harbor multiple resistance genes, thereby limiting the effectiveness of antimicrobial treatments (Devadas et al., 2023). Moreover, antibiotic use disrupts aquatic and gut microbiota, suppresses beneficial bacteria, and promotes opportunistic pathogens, creating a reinforcing cycle of disease pressure and drug dependence. Therefore, integrated strategies—including strengthened biosecurity, adoption of alternative technologies, monitoring of residues and resistance, and farmer training—are essential to reduce antibiotic reliance and mitigate associated risks (Bondad-Reantaso et al., 2023; Natrah et al., 2025).

7.3 Insufficient technology transfer and standardization

Despite significant advances in shrimp disease prevention technologies—such as SPF/SPR seedstock, molecular diagnostics, ecological aquaculture, and genomic approaches—their application at the production level remains limited. In many aquaculture regions, insufficient laboratory capacity, limited infrastructure, and a shortage of skilled personnel hinder the effective translation of advanced technologies into practical tools for farmers (Zwetlana et al., 2023; Bhassu et al., 2024; Nguyen, 2024). Furthermore, the predominance of small- and medium-scale farms, coupled with limited financial and technical resources, often leads farmers to rely on low-cost and experience-based management practices rather than investing in high-standard biosecurity and diagnostic systems. Studies indicate that barriers to the transition toward sustainable aquaculture are not solely technological but also involve institutional, financial, informational, and supply chain constraints.

In addition, insufficient technology dissemination is closely linked to gaps in training and standardization systems. In many regions, farmers lack adequate training in pathogen detection, risk assessment, and standardized management, limiting the effectiveness of available technologies (Zwetlana et al., 2023). The absence of unified standards for seedstock management, water quality control, and antimicrobial use further restricts data comparability and knowledge transfer across regions (Devadas et al., 2023). Even advanced technologies such as genetic breeding and genome editing face challenges related to ecological safety, regulatory requirements, and public acceptance (Nguyen, 2024). Therefore, promoting technology standardization, regional adaptation, and demonstration-based dissemination is essential for transforming research outcomes into practical productivity gains in shrimp aquaculture.

8 Future Trends and Perspectives

Future strategies for disease prevention and control in shrimp aquaculture are gradually moving away from reliance on antibiotics toward integrated approaches centered on ecological sustainability and multi-target regulation. These approaches aim to enhance host resistance while reducing pathogen pressure. Emerging technologies, including nanomaterials, plant-derived bioactive compounds, algal extracts, probiotics, prebiotics,