

Furthermore, carrying capacity encompasses a cultural dimension; it is a dynamic process dependent on evolving standards and innovative concepts designed to avoid ecological overreach. Emphasizing community satisfaction and economic benefits is essential, particularly through the implementation of eco-friendly technologies. Consequently, long-term sustainability is realized when community needs are met through sufficient economic rewards derived from green technologies that provide additional resource benefits (Van Senten, 2018; McQuatters et al., 2019)

4.4 Health and disease management

Vaccination and rigorous biosecurity protocols are fundamental pillars of modern aquaculture, essential for the prevention and mitigation of disease outbreaks. Enhanced health management practices, supported by rapid detection and timely response systems, minimize economic losses and curtail the excessive use of antibiotics, thereby addressing the global challenge of antimicrobial resistance (FAO, 2022b; WOA, 2023). Intensive aquaculture, particularly shrimp farming, has historically faced environmental degradation and disease crises, necessitating regulatory interventions to ensure long-term viability. In India, the native tiger shrimp (*Penaeus monodon*) industry suffered catastrophic losses due to viral pathogens, notably the White Spot Syndrome Virus (WSSV). In response, the exotic whiteleg shrimp (*Litopenaeus vannamei*) was introduced following comprehensive risk assessments and officially permitted for commercial culture in 2009. This transition significantly bolstered productivity and biosecurity management while enhancing economic returns and addressing socio-economic concerns (FAO, 2022a; Government of India Fisheries Reports, 2023).

Sustainable shrimp aquaculture has increasingly expanded into inland saline environments, such as Haryana, where eco-friendly technologies and community-based models have demonstrated environmental compatibility and improved rural livelihoods (Raghunathan et al., 2024). Achieving ecological sustainability requires scientific site selection, biosecure hatchery designs, effective effluent management, and optimized feed formulations. Furthermore, climate change poses significant risks to both freshwater and coastal systems through thermal stress, extreme weather events, and salinity fluctuations, which exacerbate disease susceptibility (FAO, 2023; IPCC, 2022). Consequently, strengthening policy frameworks and implementing climate-resilient farming strategies are critical for maintaining environmental monitoring and ensuring global seafood security

5 Fishing Regulations in India

In India, fishing is regulated within territorial waters and the Exclusive Economic Zone (EEZ); specifically, the zone within 12 nautical miles of the coast falls under the 'State List' of the Constitution. Coastal states and Union Territories (UTs) manage these activities through the Marine Fishing Regulation Act (MFRA). Modern aquaculture supports these frameworks by implementing rigorous biosecurity and disease control systems, minimizing the use of antibiotics and pharmaceuticals, and ensuring microbial sanitation. These practices maintain global hygiene standards while optimizing transport, traceability, and profitability. Furthermore, established aquaculture zones promote farm well-being by defining clear responsibilities for aquaculturists, fostering community involvement, and ensuring worker safety with equitable compensation.

To address historical ecological drawbacks, the Government of India introduced the National Policy on Marine Fisheries (NPMF) to prioritize the long-term sustainability and conservation of marine fishery resources. Key conservation measures include sea ranching, the installation of artificial reefs, and the farming of mussels, clams, and seaweed, alongside integrated cage farming systems. These efforts are central to the 'Blue Economy Growth Initiative,' which focuses on the sustainable utilization of aquatic wealth to improve the livelihoods of fishermen and their families (NPMF, 2017). By aligning resource management with economic development, the initiative seeks to realize the full potential of marine resources while safeguarding biodiversity for future generations.

6 Coastal Zone Regulations and AAI

The Coastal Regulation Zone (CRZ) Notification of 1991, enacted under the Environment (Protection) Act of 1986, imposes strict prohibitions on the expansion of industrial operations within ecologically sensitive coastal zones. Legal interventions have directed Union and State governments to discontinue intensive prawn farming in