6.3 Biofiltration capacity and self-purification differences

Biofiltration capacity is one of the clearest differences among farming systems. In RAS, nitrogenous wastes cannot be controlled safely without in situ nitrification and denitrification through biofilters or bioreactors, and different systems support distinct nitrifying communities that determine how effectively nitrogen is converted and removed. By contrast, ponds depend more heavily on natural self-purification in the water column and sediment interface, which makes them biologically flexible but less predictable under high feeding and organic loading (Ott et al., 2025). This distinction is central to Chinese sea bass farming because more industrialized systems replace ecological buffering with engineered microbial treatment, while traditional ponds rely more on sediment processes, phytoplankton uptake, and water exchange.

Recent work shows that engineered biological treatment can substantially improve both water quality and production, but outcomes depend on the treatment pathway used. In recirculating ponds, adding a bacteria-microalgae association with biofilm carriers reduced TN by 29.15%, TAN by 51.28%, and nitrite-N by 33.48%, while fish production increased by 13.3% (Wang et al., 2022). Advanced oxidation in RAS similarly reduced NH_4^+-N and NO_2^--N, and O_3/UV treatment also increased fish length and weight, although it increased antibiotic resistance genes and therefore introduced a clear biosafety trade-off (Xue et al., 2023). Other side-loop treatments show comparable promise: woodchip denitrification with sand filtration achieved 96% denitrification efficiency and supported safe water reuse, while nitrate diffusion from RAS tailwater into pond sediments improved native sediment denitrification and lowered sediment ammonium accumulation (Lindholm-Lehto et al., 2021; Jia et al., 2022).

7 Feeding Management and Behavioral Adaptation

7.1 Feeding frequency and feeding strategy differences

Feeding frequency is a major determinant of growth efficiency in sea bass culture because it governs feed access, digestive loading, and the regularity of nutrient supply. In *Asian seabass* fry, feeding three times daily produced the best final body weight, specific growth rate, feed conversion, and survival, whereas feeding once daily gave the poorest overall performance (Hassan et al., 2021). A second fingerling study reached the same practical conclusion, showing that feeding frequency significantly affected feed intake, feed utilization efficiency, protein efficiency ratio, and relative growth rate, with the best results again at three meals per day. For Chinese sea bass production, this supports the use of moderate meal frequency as a core management tool, especially in systems where fish competition and feed loss are likely to increase under low-frequency feeding schedules.

Feeding strategy interacts with the farming environment rather than operating as a fixed rule across systems. In a freshwater aquaponic system for sea bass, four or eight meals daily produced higher final weight, weight gain, and specific growth rate than two meals, while survival was not affected by feeding frequency itself. By contrast, striped bass reared in recirculating systems showed no growth or efficiency penalty when feeding frequency was reduced, because fish compensated by eating more per meal and less over the full trial. These results indicate that optimal feeding schedules for L. *maculatus* are likely to depend on whether the system is a pond, cage, aquaponic, or RAS environment, since water exchange, feed recovery, and fish access to pellets differ substantially among those systems.

7.2 Behavioral adaptation under different farming environments

Behavioral adaptation to farming conditions is strongly shaped by density, oxygen availability, and the predictability of feeding. Under high stocking density, farmed fish often shift toward more cohesive and synchronized group behavior, and in gilthead sea bream this included reinforced schooling and a more clearly organized swimming rhythm centered on feeding time. High-density fish also showed reduced feed intake and growth, indicating that behavioral coordination under crowding is adaptive for coexistence but not necessarily favorable for production (Holhorea et al., 2023). For Chinese sea bass, similar adjustments are likely in cage and intensive pond systems, where crowding and competitive feeding can force fish to prioritize synchronized access to feed over low-cost routine behavior.