A Biosecure Nursery System for Disease Mitigation in Shrimp Farming in India

S. Felix and M. Menaga

The global shrimp industry is facing major challenges to its sustainability from dreadful diseases and a deteriorating environment. One effective strategy is biosecurity to isolate the farm physically from its surroundings and prevent waste accumulation through bioremediation and limited or no water exchange. Biosecurity and health management are among the top priorities to be addressed for the sustainable growth of shrimp aquaculture. To achieve this, innovative technologies and investments in closed systems are essential. In response to these requirements, aerobic microbial floc raceways engineered with biosecurity are being used for the nursery rearing of Pacific white shrimp in India.

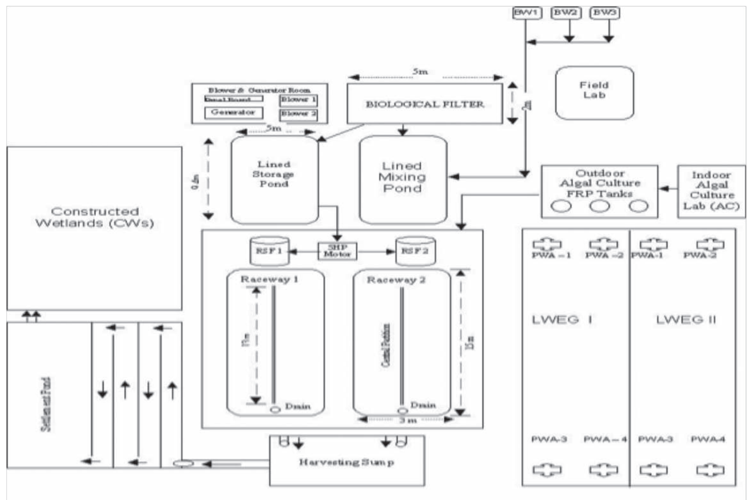


FIGURE 1. *Layout of the nursery raceway complex.*

Biosecure raceways involve a combination of physical, chemical and biological measures like use of specific pathogen free shrimp stocks, treatment of incoming water, a greenhouse shelter, no water exchange, and an airlift system for circulation and aeration to ensure high survival and production.

Nursery Phase—A Necessary Investment

Nursery culture of shrimp serves as a primary quarantine to prevent the introduction of pathogens into grow-out ponds, improving shrimp survival and feed efficiency and reducing the culture period. This improves profit potential by permitting more crops per year. Size uniformity with efficient use of grow-out tanks can be achieved by maintaining stable water quality and good feed management. A nursery phase provides an opportunity for shrimp acclimation in inland areas where water has a salinity less than 5 ppt.

Aerobic Microbial Floc Nursery Raceway Technology

Aerobic microbial floc technology is based on microbial protein generation accompanied by decomposition of organic matter under continuously-mixed and aerated conditions in super-intensive nursery raceways. The system functions by a synergistic interaction between algal and bacterial populations in water for in situ waste treatment and bioremediation, and the production of a live nutrition source. Recycling of nitrogen within the system in the form of microbial protein improves feed efficiency.

Biosecure raceways involve a combination of physical, chemical and biological measures like use of specific pathogen free shrimp stocks, treatment of incoming water, a greenhouse shelter, no water exchange, and an airlift system for circulation and aeration to ensure high survival and production.

System Specifications

To enhance survival and yield during shrimp larval rearing, concrete nursery raceways were constructed in a greenhouse. The greenhouse is 20 m long by 10 m wide and was constructed using cast iron pipe pillars, framing and roof supports. The roof consists of 80 percent non-transparent white fiberglass sheets and 20 percent transparent fiberglass sheets. Sidewalls consist of removable green shade cloth (75 percent) affixed to wooden frames.

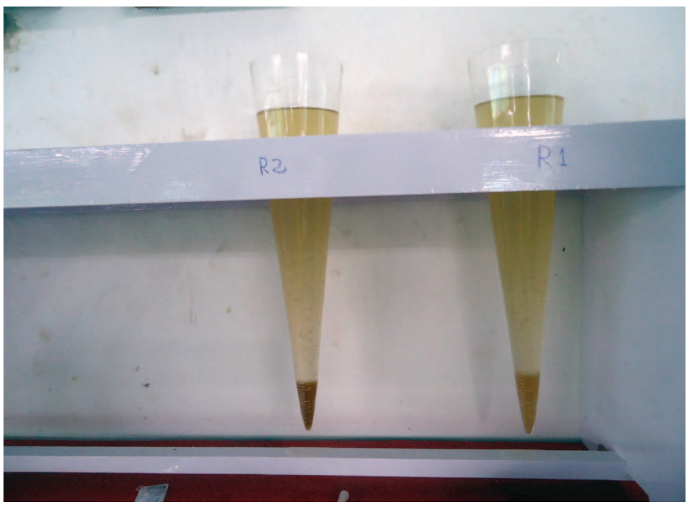
Nursery raceways are 50 m^3, rectangular (15 m long × 3 m wide × 1 m deep) and lined with HDPE. Each raceway had a central longitudinal partition placed over a 5.1-cm Schedule 40 PVC pipe designed to aid water circulation. Raceways were designed to allow drain harvest. Towards the drain end of two raceways, a single harvesting tank (2 m × 1.5 m × 2 m) was provided for water exchange, bottom waste clearing and harvesting. The outlet of raceways was located halfway between the end of the partition and the raceway end wall. Perforated filter pipes were mounted on the outlet to avoid losing shrimp when water is drained. The bottom of each raceway tank was constructed with a 0.5 percent slope to allow easy draining of water. Tanks were operated with a freeboard of 15 cm, resulting in a productive volume of 40 m^3.

Microbial flocs remain suspended by twin-lobe air blowers (5 and 10 hp) that provide aeration for dissolved oxygen management and air for operation of airlift pump systems for continuous water circulation

(CONTINUED ON PAGE 66)

Raceways (40 m³) using biofloc technology for nursery rearing of Pacific white shrimp.

Checking the concentration of biofloc using an Imhoff cone.



Settled biofloc in Imhoff cones.

Stocking Pacific white shrimp post-larvae into biofloc nursery tanks.

(Fig. 1). Air is supplied by three 5-hp blowers that operate alternatively every three hours. Water circulation in raceways depends primarily on airlift pumps. Air is introduced at a depth of 30 cm to attain a maximum uplift of water through a vertical PVC pipe, which has a 90º elbow at the top. Water is lifted through the pipe from the bottom and is directed through the elbow in the desired direction to develop unidirectional water flow in the raceway. There are six airlift systems in each raceway, with three on each side of the central baffle, and each set is provided with three airlift pipes. Airlift pumps are fixed to wooden cross-beams with stainless steel screws that allow adjustment of the height of the airlift pump discharge in raceways when water level is low.

A rapid sand filter (Waterco, Australia) with manual backwash and a water filtration capacity of about 20 m3/h was provided for each raceway. The sand filter can be used to filter incoming seawater or raceway water. The main water circulation bypasses the sand filter.

Nursery raceways to raise shrimp from PL_{10-15} to 2-3 g is a good approach to improve survival of shrimp in grow-out systems because there is high risk to stock PL_{10-15} directly into grow-out ponds. Advantages of this system are high output, efficient use of land and labor, multiple crops per year, lower cost per water volume and biosecurity.

Nursery Raceways for Rearing Pacific White Shrimp

Nursery raceways to raise shrimp from PL_{10-15} to 2-3 g is a good approach for shrimp farmers to improve survival of shrimp in grow-out systems. Being the crucial phase of rearing, farmers will benefit by procuring seed from such raceway based nurseries because there is high risk to stock PL_{10-15} directly into grow-out ponds.

Indoor nursery raceways are technically feasible and a potentially viable system economically as an approach to combat emerging pathogens in shrimp farming (Tables 1-3). Three advantages of this system are high output, efficient use of land and labor, multiple crops per year, lower cost per water volume and biosecurity assuring the health of the target crop by blocking introduction of excludable pathogens. An added advantage of zero water exchange driven technology is the enhancement of shrimp growth by microbial floc.

TABLE 1. Mean production values from two biofloc nursery raceways with *Litopenaeus vannamei* conducted at Advanced Research Farm Facility, Madhavaram, Chennai, India.

System volume (m^3)	40
Stocking density (PL/m^3)	6000
Salinity (ppt)	7
Initial weight (g)	0.39±0.01
Final weight (g)	1.90±0.09
Specific Growth Rate	5.59±0.30
Weight gain (g)	1.50±0.10
Feed Conversion Ratio	0.84
Protein Efficiency Ratio	2.79
Survival (%)	91.2
Yield (kg/m^3)	0.35
Days	30
Four water top-offs at 10% evaporation rate (m^3)	16
Total water consumption (m^3)	56

TABLE 2. Investment costs for nursery raceway for rearing *Litopenaeus vannamei*.

ITEM	COST (US$)
Raceway tanks (two of 50 m^3)	1263
Green house	1114
Blowers (10 hp & 5 hp; one each)	1784
Generator (15 KVA)	1486
Rapid sand filter (20,000 LPH)	595
Borewell , water pump and airline	1486
Miscellaneous	223
Total	5870

TABLE 3. Variable costs to raise one nursery crop in raceways.

ITEM	COST (US$)
Shrimp seed (6000/m^3)	892
Inputs to produce floc	15
Feed (30% protein)	27
Power	45
Fuel for generator	30
Labour	89
Interest on Investment cost (fixed for one crop)	186
Miscellaneous	30
Total	1314

TABLE 4. Economic feasibility of annual operation of a biofloc nursery system.

ITEM	
Expected annual yield, assuming 95% survival (kg/m^3)	8.5
Number of crops per year	5
Estimated annual seed production	228,000
Cost of production (US$/seed)	0.01
Total expected returns @ US$ 0.03/ seed for one crop (US$)	6840
Net returns per crop (US$)	5526
Net returns per year (US$)	27,630

Notes

M. Menaga, Division of Aquaculture, ICAR-Central Institute of Fisheries Education,
Panch marg, Off-Yari Road, Versova, Andheri(w), Mumbai-400061, India
mena.fishcos@gmail.com.