ANIMAL HEALTH & WELFARE (/ADVOCATE/CATEGORY/ANIMAL-HEALTH-WELFARE)

Ongoing production issues in shrimp farming, part 2

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Biosecurity, intensive nurseries and the constant threat of pathogens

Globally, the expanding shrimp farming industry has much potential to improve production efficiency through more innovation, standardization, automation and other technologies. Photo by Fernando Huerta.

Many shrimp producers still give only limited attention to routine biosecurity on their farms, because of the misconception that the potential costs of implementing biosecurity measures will outweigh the benefits, or because they do not have the needed knowledge. Effective implementation of biosecurity protocols requires awareness, discipline and a commitment by farm owners to implement them.

Shrimp farming is a relatively new industry and initially lagged behind in the development of standard health management practices. Biosecurity in shrimp aquaculture involves those practices that will reduce the probability of introduction and dissemination of a pathogen.

A cost-effective, bio-secure shrimp farm must use strong and decisive methods for pathogen exclusion from production systems, and effective screening of seedstock; appropriate environmental management; effective health management integrating genetic selection, specific pathogen free/resistant stocks, limited or zero water exchange, stocking strategies, feed management and use of immune stimulants to increase host defenses); and strict and proactive health monitoring and farm management strategies.

Farm location (site selection) and design are very important. Relatively few shrimp farms have been designed to prevent diseases, even though it is more cost-effective to incorporate disease prevention and treatment aspects during the planning rather than re-designing or retrofitting existing farms. Eliminating or reducing water exchange is an important aspect to prevent viral diseases, to exclude carriers from production systems and to minimize stressful variations in water quality that could promote outbreaks.

In the past decade, several successful, commercial farms have developed low or zero water exchange, using various layouts and treatment technologies ranging from zero exchange, activated suspension systems driven by heterotrophic microbes, to closed systems that exchange recirculated water through the production ponds.

Microbial communities – and their management through bacterial amendments – are very important components of, and play critical roles in shrimp production systems, because water quality and disease control are directly related and closely affected by microbial activity. Photo by Fernando Huerta.

Probiotics and microbial management

Probiotics are single or mixed cultures of some bacterial strains that are used in production systems to modify or manipulate the microbial communities in water and sediment, reduce or eliminate selected pathogenic species of microorganisms, and generally improve growth and survival of the targeted species. Microbial communities are very important and play critical roles in shrimp production, because water quality and disease control are directly related and closely affected by microbial activity. In shrimp hatcheries, the use of probiotics is important and relatively common to limit pathogenic bacteria.

Probiotics may act in shrimp production systems by competitive exclusion of pathogens, by enhancing digestion through the supply of essential enzymes, by moderating and promoting the direct uptake of dissolved organic materials, by active production of pathogen inhibiting substances, and possibly through other mechanisms. The pond microbial community plays a major role in the natural food availability, mineral recycling rates, and dissolved oxygen dynamics in shrimp ponds. A growing body of data indicates that management of microbial communities by supplementing limiting nutrients, selective expansion of habitat, and culture additions can have beneficial effects.

And the use of bacterial amendments has been recommended for use in aquaculture ponds for several potential benefits, including reducing blue-green algae populations and preventing off-flavor, reducing nitrate, nitrite, ammonia and phosphate levels, increasing dissolved oxygen concentrations and promoting decomposition of organic matter.

The relationship between pathogens and the normal microbial flora in shrimp production is complex, because several biological, chemical and physical factors that can stress shrimp are involved in the overall susceptibility of the animals to pathogens. Effectively managing the microbial community can help prevent or reduce the risk of a disease outbreak, but if mismanaged, the microbial community can also promote disease by creating conditions promoting growth of pathogenic bacteria.

Nursery systems – such as this covered, round one (left) adjacent to the its supported grow-out pond (right) – provide better management of environmental conditions, feeding and exclusion of pathogens, predators and competitors, leading to more efficient production. Photo by Darryl Jory.

Intensive nurseries

These systems commonly produce higher overall survival rates per production unit area, and also more efficient capital utilization than single-phase or direct stock grow-out systems. They also provide better management of environmental conditions, feeding, and exclusion of pathogens, predators and competitors.

Biosecurity concerns make it very important to know the numbers, survival rates, overall quality and condition of postlarvae (PL) before stocking into ponds and before investing substantial resources and several months of efforts into a production cycle. Intensive nursery systems involve the rearing of PL at very high densities (2,500 to 10,000 PL per square meter) in specially designed facilities (typically greenhouses or ponds) for 20 to 40 days – with strict feeding, water quality monitoring and technical maintenance – significantly improve shrimp production and profitability.

A two-stage grow-out system using a nursery phase as a quarantine area can improve overall biosecurity and regularly produces higher production and overall survival rates per unit area relative to single-phase grow-out systems. Indoor (enclosed) nursery systems increase turnover (number of grow-out production cycles) by reducing subsequent rearing time to market size in grow-out ponds. Consequently, grow-out ponds are used more efficiently as a biological system and with greater capital and operating efficiency. A nursery system also improves accuracy estimating the juvenile population before stocking into grow-out ponds.

Stocking juveniles allows for a more accurate estimate of the initial population and biomass and improving feeding rate estimates when formulated feed becomes up to 60 percent of the direct production cost. Indoor, intensive nursery systems can additionally expand the effective stocking windows for seasonal hatchery outputs, permitting greater efficiency for hatcheries and farms.

Shrimp farms in areas with lower water salinities can use the nursery as an acclimation system. And intensive nursery head-start strategies may permit farms without hatcheries to purchase seedstock in advance of the peak demand periods, possibly at lower cost and with improved certainty of seedstock delivery.

Managing intensive, bio-secure nursery systems in tanks and raceways is more difficult compared to standard grow-out ponds stocked directly, but the many benefits derived from a two-phase grow-out strategy, using first a nursery system followed by final grow-out to market size, can significantly improve production and profitability.

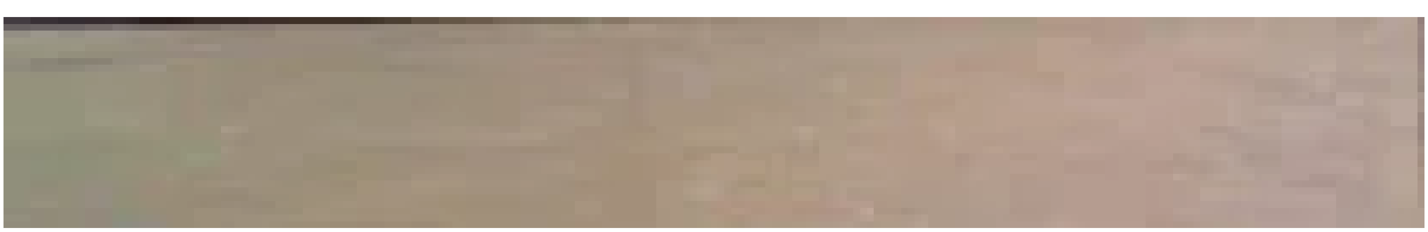
Inland production

Marine shrimp farms have traditionally been built in tropical coastal areas, very close to the ocean or to an estuary or river. But shrimp farms have also been established in other areas that would not appear suitable for this activity, including inland areas. Some farms are located in inland deserts with available underground waters and could provide a new direction for the expansion of the industry, because deserts and other dry lands constitute more than 40 percent of the global land area.

Growing the industry away from the oceans can be a biosecurity strategy, for example, using low salinity waters. Effluent can be used to irrigate various crops, thus minimizing effluent disposal efforts. This approach is an opportunity to expand the industry on marginal arid land or agricultural sites, reducing demand for shrimp farming on limited, high-cost and contested coastal areas. Limited seawater use during a relatively short acclimation phase and complete reuse of effluent water for irrigation of agricultural crops can provide for environmentally friendly, integrated systems. The Pacific white shrimp (*Litopenaeus vannamei*) is successfully farmed in low salinity ground waters with varying ionic composition and salt concentrations in several regions of the world.

Effluents and reduced water use

The shrimp farming industry can still significantly reduce and improve water use, which will help address issues continually raised by those that oppose marine shrimp farming, and also improve biosecurity practices. For several years, the large-scale application of zero exchange and recirculation technologies has increased producer confidence in and awareness of the potential for reducing or eliminating routine water exchange.



The farmed shrimp industry will continue facing increasing pressure to more efficiently use water and reduce its effluents. Photo by Darryl Jory.

Nutrient-rich effluents from intensive shrimp production systems can contribute to the eutrophication of receiving waters, potentially affecting both natural biota and local culture operations. Water exchange can be reduced or eliminated, and supplemental aeration can have a key role in the successful operation of semi-intensive and intensive, closed production systems.

Paddlewheel aeration must be increased over levels traditionally applied in intensive culture to maintain appropriate dissolved oxygen levels. Better placement of mechanical aerators and use of backup aeration and alarm systems are also necessary. Formulated feeds are the main nutrient input into shrimp production systems, and as water exchange is reduced or eliminated, feed formulations and feed management become critical factors as levels of intensification increase. The design and management of production facilities to reuse water, minimize exchange and eliminate discharge will improve the outlook for more profitable and sustainable production technologies.

The concentrations of suspended solids in effluents should be limited for several reasons. The suspended solids may create turbidity in receiving water bodies, which may be visually unpleasing by forming a plume of discolored water in the discharge area, and the plume may reduce light penetration and phytoplankton productivity. Restricted light penetration by turbidity also affects sea grasses, coral reefs and other sensitive underwater habitats. Sedimentation in shallow water may interfere with local navigation, fishing, and other beneficial uses. Excessive sedimentation can stress or kill trees where effluent is directed into mangroves.

In addition, sediment accumulation can bury and smother benthic organisms. A high-sediment oxygen demand can produce undesirable anaerobic conditions, and toxic metabolites may enter the water from anaerobic sediment and harm sensitive aquatic animals. Settling basins are especially efficient for treating shrimp farm effluents because the high concentrations of cations in seawater and brackish water tend to neutralize the negative charges on suspended clay particles, which will flocculate and settle. Plankton cannot be removed efficiently by sedimentation, and products such as aluminum sulfate, lime, and selected organic colloids often used in wastewater treatment to promote sedimentation are not needed in shrimp farm settling basins.

Globally the farmed shrimp industry will continue facing increasing pressure to more efficiently convert the nitrogen in shrimp feeds to shrimp biomass, and to minimize or eliminate residual nitrogen waste before effluent discharge into receiving waters. Accomplishing this will require an increasing understanding of the transformations of dietary nitrogen in shrimp production systems and their effluent treatment systems. The goal is to reduce nitrogen waste from shrimp ponds through improvements in feed formulations and feed management, genetic selection for improved feed conversion ratios, improved in-pond processing of nitrogen, and improved design and management of effluent treatment systems. Significantly reducing waste nitrogen is an integrated and multidisciplinary endeavor involving geneticists, nutritionists, ecologists and engineers.

Current production of farmed shrimp could nearly double by 2030. But more attention to various ongoing issues is necessary, including genetic improvement, nutritional requirements and feed ingredients, health management, environmental and other issues. Photo by Fernando Huerta.

Perspectives

Global farmed shrimp production has grown over four times since 1995 (from 1 to 4 million metric tons) and is projected to continue increasing significantly in the next two decades, particularly in Southeast Asia, India and Latin America. However, shrimp grow-out production technology is still mostly extensive to semi-intensive, and there is considerable potential to improve production efficiency through increasing innovation, standardization and automation at various levels.

Ongoing consolidation within the industry both in Asia and the Americas is resulting in several large and vertically integrated companies that can maximize their efficiencies and economies of scale. And new projects are being developed in many countries. As a result, current production could nearly double by 2030; however, more attention to various ongoing issues is necessary, including genetic improvement, nutritional requirements and feed ingredients, health management, environmental and other issues.

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