PROPER BIOSECURITY CAN DETERMINE SUCCESS OR CONTINUED FAILURE IN SHRIMP FARMING (PART II)

By Stephen Newman

Part I of this article, which was published in the January/ February 2017 Issue, called for attention to biosecurity measures to minimise the impact of disease in fish and shrimp culture, with a specific focus on the broodstock stage. In this follow-up article, the author elucidates on biosecurity concerns on-site and asserts that the ultimate responsibility in ensuring the best environment for the animals rests with the farmer.

Introduction

In Part I, I explained how the negative impact of poor biosecurity in the maturation facility and the hatchery can carry over onto the farm. Movement of pathogens between linked production segments is a serious issue that can have broad reaching negative impacts on profitability. Until effectively addressed, it will continue to cause the global industry widespread damage which all the best management practices in the world cannot then undo. The strongest animals with the best genetics can only realise their potential if they are provided the environment to do so. While it is easy to blame others for failures, ultimately the responsibility rests with the farmer, and it is incumbent on them to ensure that those companies that they buy from say what they do, and do what they say.

Shrimp maturation facilities and hatcheries typically have similar production paradigms. Farming practices however are much more varied, each with their own constraints and at the same time, overlaps. Table 1 outlines these briefly, and intends to help the reader visualise the critical differences. When properly managed, the most productive are the super-intensive systems.

Table 1: Different shrimp farming production models

Paradigm	Densities	Comments
Extensive	1 to 10 m^2	Usually very large ponds; 10 or more hectares with no aeration and relatively little organic matter input. Never lined.
Semi-intensive	11 to 75 m^2	At the lower densities, ponds can still be quite large. As the stocking densities increase, typically the size of the ponds decrease. Not always aerated, although equipped with emergency aeration. May be lined (full or partial).
Intensive	75 to 150 m^2	Ponds are typically less than one ha. Heavily aerated. More often lined than not.
Super-Intensive	150 to 300 or more m^2	Ponds are a fraction of a hectare in size. Very heavily aerated. Often partial harvests are required to maximise yields. Almost always lined.

Biosecurity in maturation and hatchery set-ups focuses on trying to minimise the load of potential pathogens that may enter the production environment with the PLs. While the focus on the farm is more on controlling the presence of vectors, there are niches where pathogens can proliferate and potential pathogen loads enter ponds. Both scenarios require controlling stressors that can weaken animals which make them more susceptible to pathogens that healthy, strong animals would have no problems with.

The first step: preparing PLs for stocking

Assuming that the hatchery has done all that can be done to limit the movement of pathogens alongside the PLs, the first subsequent steps are to proactively manage the stress that the PLs are placed under during transport. This is done principally by lowering water temperatures and densities per unit volume depending on the time of transport. The PLs should be prepared at the hatchery. Suspension of heavy feeding levels before transport can lessen the accumulation of organic matter and metabolites that can stimulate undesirable bacterial growth during transport. Responsible hatcheries routinely test PLs for their ability to tolerate an extreme drop in salinity; this is an overall measure of fitness and the osmoregulatory ability of the shrimp.

Like human beings, shrimp do not synthesise ascorbic acid and studies have shown that its lack can deplete intracellular pools very quickly, stressing the animals during handling. A nominal amount of ascorbic acid added to a bag during transport can be helpful. The amount to add will be dependent on the nature of the water that they are being moved in and the duration of the transport, but typically 10 to 50 ppm is adequate.

Proper acclimation of the PLs to the farming environment is essential. Temperatures need to be equilibrated slowly and when there are differences in salinity, animals need to be acclimated to the differences. Rushing through the process stresses the animals and can result in handling mortalities and increased susceptibility to other problems. Ideally, animals should be acclimated slowly, fed well and prepared for the transition from the penthouse lifestyle they have had in the hatchery to the much more complex free-for-all environment in ponds. Some companies stock animals in nursery ponds or nursery tanks at high densities to eliminate the weaker animals and to provide adequate time for adjustment.

When animals are first placed in ponds, monitoring them is important. The use of small cages (Figure 1) for 24 to 96 hours' post stocking can provide a measure of how well the animals have fared from the stresses of transport. High mortalities in cages often portends problems in the ponds.

Figure 1: A typical cage evaluating survivals of shrimp, post-stocking

Grow-out pond considerations

Lining: Grow-out ponds can be solely soil based, partially lined with plastic or concrete or completely lined. Liners that cover 100% of the pond bottoms eliminate all interactions between sediments and soils and the water and the animals. There are many good reasons why this should be considered as an important element of biosecurity, but there are no absolutes and there are many with non-lined pond based systems which can deal reasonably with the major biosecurity concerns. Table 2 describes some of the differences between these different approaches.

Table 2: Some characteristics of shrimp farms based on liners

Approach	Comments
Soil based	*Difficult to eliminate all vectors. Some pathogens, such as EHP spores, can accumulate to very high levels. Nutrients in the sediment feed many different types of organisms, a number of which are known vectors for a variety of potential shrimp pathogens. Furthermore, as ponds age, heavy metals added through feeds can accumulate and impact pond ecology. Soil based ponds will tend to have more diverse biological compositions, increasing the chances of vectors being naturally present. Difficult to adequately control effectiveness of disinfection.*
Partially lined	*Concrete surfaces cannot be adequately disinfected. They are porous. Areas with liner limit the impact of sediment and accumulating organics. Areas not lined can easily undo this benefit.*
100% lined	*Eliminates all interactions between the sediments and the water and thus the animals. However, as organics accumulate, they must be dealt with, as many natural control mechanisms present in the soils (for example complex microbiomes that control pathogen loads) are no longer active. This problem can be dealt with through bioremediation and responsible interim disposal. Can be readily disinfected.*

Biosecurity on the farm is multifaceted and far too complex to describe adequately in a short article like this one. Nonetheless it is clear that there are approaches to management that will ensure that pathogen loads are kept to a minimum and that discourage their proliferation.

Figure 2: Bag filtration system

The use of smaller micron (<280) bag filters can keep many vectors out of ponds

Ponds that are completely lined offer better potential control of pathogen carrying vectors. For soil based ponds, the use of lime, tilling the soil, allowing the sun to dry the ponds and bake the organics out, etc. should all be standard elements of preparation before stocking. Skipping this step can have disastrous consequences. Many companies assume that they can skip cycles. While this is not always a problem, it increases biosecurity risks.

Pathogen and nutrient loads: Disinfection and/or filtration of incoming water should be of paramount importance. Different production models require different approaches. In systems that rely heavily on water exchange, usually in extensive and semi-intensive paradigms, it is more difficult to ensure adequate disinfection. Filtration is an essential step to limiting the presence of pathogen carrying vectors (Figure 2).

Vectors and pathogens can readily enter in with water used as make up water or exchange if filtration is not adequate (Figure 3).

Figure 3: Filter failures increase the chances of problems

Chlorine is often the disinfectant of choice because of its low cost, ease of use and effectiveness. The composition and source of the water will impact what levels work best. Moreover, chlorine can cause problems and is not particularly effective on soils. In some areas, farms should be operated closed with the least amount of possible make up water. The make up water should also be disinfected and filtered.

Fertilisation strategies typically are paradigm-dependent. Excessive use of fertilisers and/or process-generated nutrient loads can result in heavy blue green algae blooms (Figure 4). This in turn can have significant negative impacts on the stock from oxygen crashes and toxin production.

Figure 4: Large amounts of filamentous blue green algae on paddlewheels

Feeds and feeding: Feed should be sourced from reputable suppliers who appreciate that there is a balance between optimal growth rates and the protein content of their products. Excessively high protein levels in feeds can lead to rapid deterioration of water quality; more is not always better. Avoid feeding trash fish or offal, and if you make your own feed, use only ingredients that are high quality and free of pathogens. In the case of shrimp, feed them frequently: shrimp eat at all hours and there is convincing data that supports frequent smaller feedings as being consistent with better growth, less stress and cleaner production environments. Using an automatic feeder can ensure that they have feed available throughout the day and night.

Source of water: Well water, if it has the right chemical composition, can be very useful for avoiding some types of problems. Pathogens rarely enter farms through well water. When farms rely on surface water that must be added to reservoirs and disinfected before use they introduce more variables. Perhaps the largest potential problem that is overlooked is that these reservoirs often trap organics which can accumulate to very high levels. Reservoirs should be constructed and designed to facilitate being completely dried out and accumulated organics physically removed if possible, treated with lime, allowed to bake in the sun, and bacteria added to allow bioremediation of any residuals that might remain. Outlet (drainage) canals can also serve as a potential source of problems.

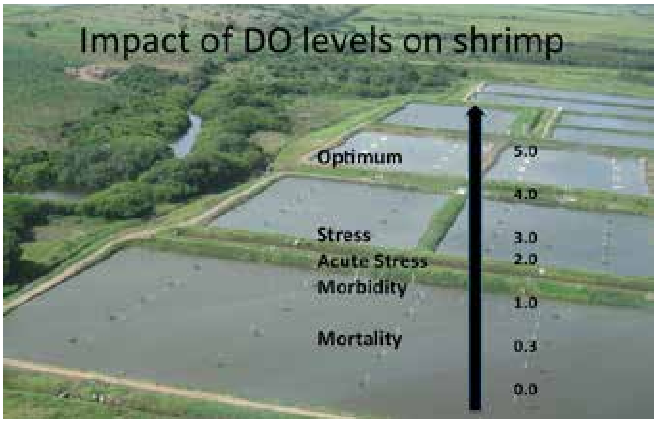
Removal of organic matter: It has become apparent in the last few years that the accumulation of organic matter in ponds, reservoirs and discharge canals is imprudent in areas where EMS or AHPNS is endemic. While there is evidence that the plasmid responsible for the toxin that injures shrimp and opens them to massive secondary infections can be moved between different bacteria, the predominant strain that carries this, a strain of *Vibrio parahaemolyticus*, has an affinity for accumulated organic matter. Many farms are coping with this by removing organics as they accumulate through the use of sumps that allow these pollutants to be pumped out (Figure 5).

Figure 5: Highly biosecure lined ponds with crab fences, bird netting and drain sumps to eliminate organic matter as it accumulates

Keeping other vectors out: Figure 5 shows, in addition to a sump to drain excess organic matter, crab fences and bird netting which are also important components of biosecurity. Limiting the movement of visitors from other farms through the property, while a bit controversial, does lessen potential risk. Some companies go to extremes, using disinfectants on tyres of incoming vehicles, and on the boots of employees or visitors that walk about the property. Far too often though, this is too little, too late. It makes little sense to expend resources on limiting the potential entry of pathogens via vehicles or humans if animals (cattle, sheep, etc.) have free rein of the farm.

Water-related stressors: Often under-appreciated is the importance of overall water quality. Pathogens can be opportunistic and if you have an environment in which shrimp are weakened because of poor water quality, opportunistic pathogens will cause animal health issues. These are organisms that would not be able to cause disease in healthy strong animals but can readily infect stressed, weakened animals. Oxygen is of critical importance and it is one of the easiest things to control; failure to do so will stress animals and increase the likelihood of disease outbreaks. As the dissolved oxygen levels drop, the animals react physiologically (Figure 6). Even when they survive low oxygen exposures, they are weakened and the best pathogen containment strategies in the world will not help if a shrimp's immune system cannot fight off the constant onslaught of bacteria that is the norm. This can be said of many other water-related stressors (CO_2, ammonia, nitrite, hydrogen sulfide, etc.).

Figure 6: Impact of dissolved oxygen on shrimp



Summary

Cohesive, structured biosecurity plans are essential elements of sustainable farming practices. This begins in the hatchery and ends at harvest. Understanding where in the production process the critical control points are that impact animal health requires a broad understanding of the nature and complexity of the production paradigms; how problems move between different elements of production; an ongoing commitment to monitoring animal health; and an appreciation of the vulnerability that unethical suppliers create and take advantage of.

Dr. Stephen Newman is a marine microbiologist whose early career focused on the development of the first commercial fish vaccines. Since the early 1990s, he has been working closely with shrimp farmers in almost every country that farms shrimp. In 1996 he founded Aquaintech Inc., to provide a wide variety of products and consulting services to the international aquaculture community. He is an internationally recognised expert in aquaculture and has extensive experience in product development and sales and consulting with clients on a wide variety of topics ranging from business plan preparation and due diligence to auditing of operations with the goal of improving productivity. More details are available at www.aqua-in-tech.com and www.sustainablegreenaquaculture.com.