Holistic Approach to Shrimp Farming

Introduction

India has made rapid strides in shrimp aquaculture mainly due to the introduction of the exotic species *L. vannamei* during the last decade. There has been a sevenfold increase in the estimated shrimp production in India that grew from 1 lakh ton/annum in 2009-10 to 7.5 lakh tons at present. Despite the phenomenal growth of the sector, the shrimp aquaculture sector is beset with challenges like environmental impacts, food safety and occurrence of diseases and crop losses.

Any successful shrimp farming necessitates disease management during the entire culture period besides addressing other production issues like poor water quality, lack of nutritional diet etc that may crop up during different phases of culture. Production losses due to slow growth, disease affliction and high Feed Conversion Ratio (FCR) may ultimately affect the profitability of the farmers. Proper care needs to be taken from sourcing the seed up to the harvest for successful shrimp farming.

Activities involved in successful shrimp farming

- Hatchery selection / seed quality and screening
- Pond preparation
- Water management
- Pond bottom management
- Feed management
- Disease management
- Biosecurity protocol (hatchery and farm)

I. Hatchery Selection/ Seed Quality Screening

The Adage "as you sow so you reap" holds true in shrimp farming. A critical stage in shrimp farming is identifying a reliable hatchery with proven track record of giving top priority to customer satisfaction. The quality of seed suffers as brooders get older. Seed from healthy brood stock in the early cycles have proven to perform well in grow-out. Feeding the brood stock with Specific Pathogen Free (SPF) healthy and nutritious live feed is of utmost importance in the brood stock management in a hatchery.

The farmers have to identify the hatchery and then ensure that all the screening is done for disease detection and physical state of Post Larvae (PL). The hatchery has to be informed well in advance regarding the water quality parameters in the grow-out. The quantity of seed packed depends on the duration of the transport: more the distance, less the numbers in each bag. The use of mild sedatives will help to reduce the activity level of seed packed so that more seed can be packed in unit volume. Proper care must be taken during stocking for gradual acclimatization of seed.

To assess the post-stocking survival, the common practice is to keep seed in a '*Hapa*' while checking the survival every 24 hours up to three days. In case of substantial mortality in the beginning, it is advisable to weigh the pros and cons of going ahead with the crop or aborting the crop. The farmer has two options at this stage to either go with less stocking density and go for a higher count gaining in unit value and cutting the cost or stock higher density and harvest larger quantity in a shorter time. In view of this high-risk operation, it is advisable to do partial harvesting and make the crop break-even at the earliest.

A recent trend in grow-out is nursery rearing for around 3 weeks. Nursery serves as a primary quarantine. Better feed monitoring and compliance to parameters are possible in the early days of culture compared to the blind feeding regime followed in direct stocking for the first month in grow-out. Also, some of the diseases like Enterocytozoon Hepatopenaei (EHP) which have low prevalence in Post Larvae get detected and huge loss in grow-out rearing due to direct stocking is avoided. It is possible to have more crop cycles when the grow-out period in pond gets reduced by almost a month. Moreover, ponds get less aged with such nursery system compared to those with direct stocking. Hence pond preparation for subsequent crop cycle takes lesser time. Early immunity of juveniles can be enhanced with improved biofloc nurseries. The production cost and risk are mitigated in the nursery system. However, there are certain disadvantages in the nursery system like increased shrimp handling, requirement of more labour and the additional cost for construction of the nursery rearing facility.

II. Pond Preparation

Proper pond preparation is very important in successful farming. Use of high-quality inputs like seed and feed may not result in a good crop if the pond bottom conditions are hostile to shrimps. Poor preparation can lead to deterioration of the soil during farming. Good pond preparation is a proactive measure for disease control and should be a critical aspect of the disease management strategy. Considerable quantity of feed is used in intensive farming during the crop period. This organic matter accumulation could lead to excessive organic load and deterioration of pond soil. Important steps in the pond preparation are sludge removal; drying the pond bottom; disinfection and application of lime; and tilling the pond bottom.

Sludge Removal

The sludge containing lot of organic matter that accumulates and appears in the centre of the pond as a mount has to be removed for a better pond bottom. Top layer of the soil has to be removed, if there is excessive deposition during the previous crop. Removal of the top soil layer which contains sludge/organic matter is also a good biosecurity protocol against diseases.

Drying the Pond bottom

Drying the pond bottom is a pro-active step to improve the pond performance and to minimize the risk of potential disease outbreaks. The pond has to be dried till it cracks for the release of unwanted gases trapped inside. Proper drying helps to reduce the high organic load by oxidation; oxidize inorganic compounds such as Hydrogen Sulphide and Ammonia; decrease the anaerobic bacterial load and increase the aerobic bacterial load; and destroy the benthic algal mats, fish eggs, burrowing crustaceans and predators. It may be noted that the excessive drying makes soil too dry. Drying period of 2-3 weeks is normally adequate.

Disinfection and Liming

The next stage is disinfection and application of lime. The lime is applied uniformly throughout the soil @ 50% of the total required amount.

Tilling the pond bottom

The pond bottom is ploughed at 20 cm depth, preferably three times within a period of 3-5 days for proper drying. This process of pond bottom ploughing exposes more surface area of the soil, increases the oxidation effect and encourages the growth of more aerobic bacteria.

III. Water Management

The water used for shrimp farming has to be pumped into reservoir after adequate filtration. It needs to be properly disinfected with chlorine or any other suitable compound and allowed to stand for 48 hrs for complete disinfection. Complete de chlorination of the water has to be ensured by proper aeration before using it in the culture ponds. Water should be fertilized with organic (oiled cakes/ bran, molasses) or inorganic (urea, Sodium nitrate, Ammonium phosphate) fertilizers for the development of proper algal bloom.

Proper fertilization of the pond water will sustain the natural productivity of the pond and will provide essential micro nutrients to shrimps. The phytoplankton acts as natural biofilter and regulator of water quality in the pond. They are the most efficient and economical means of aerating the shrimp pond. An optimum level of phytoplankton has to be maintained so that the light penetration through water column does not affect and stress the shrimp. Application of fertilizers varies from farm to farm and depends upon the pond soil condition, salinity, ambient nutrient levels and natural productivity of intake water.

IV. Pond Bottom Management

Modern shrimp farms have a sludge removal system, also known as '*Shrimp toilet*'. This is a central evacuation system with a central pit and siphoning system. It also controls the anaerobic zone in a pond. More frequent and severe pathological vibrio infections affect those shrimps prior-exposed to ammonia. The management strategy aims to convert toxic ammonia to nitrite and then to nitrate. This process of nitrification requires a substrate for the growth of nitrifying bacteria, high dissolved oxygen and adequate alkalinity.

V. Feed Management

Feed is an external input that has to be provided adequately to ensure that the farmed animals attained desired harvesting size within the targeted time frame. It is the major input in shrimp farming that forms about 50% of the total cost of production. It has to be managed and utilized properly as besides being costly, excessive feeding could also affect the water quality. There are considerable day-to day variations in feed consumption depending upon fluctuations in water quality, overcast skies, lunar cycles, shrimp moulting and availability of natural feed in a shrimp pond. The probiotic-coated feed is now-a-days used in shrimp farming that leads to improved nutrition resulting in enhanced FCR and growth. Probiotic-coated feed will also reduce the abundance of potential pathogens in shrimp gut and faeces.

VI. Disease Management

Shrimp health is determined by factors like rates of survival, mortality and growth; size variation; FCR; and general appearance. The health of farmed animals has to be monitored on a day-to-day basis. This may be done by the feeders and water quality testing personnel. Besides behaviour, the condition of hepatopancreas of shrimp is also an indicator of its health. Hepatopancreas is a delicate organ that is opened to outside environment through its mouth. It helps in the digestion, absorption and storage of food. Malfunction of this organ could result in slower growth. Providing better environmental and biological conditions to the infected population will increase its ability to resist diseases.

Major diseases in shrimp

White gut disease

There are six species of Vibrio associated with shrimp white gut disease. These species are *V. harveyi, V. parahaemolyticus, V. alginolyticus, V. anguillarum, V. vulnificus and V. splendidus.* Mortalities due to vibriosis occur when shrimps are stressed by factors such as poor water quality, crowding, high water temperature, low DO and low water exchange. Outbreaks may occur when environmental factors trigger the rapid multiplication of bacteria already tolerated at low levels by the shrimp. White gut disease will result in the necrosis of epithelial mucosa that resembles haemocytic enteritis.

White faeces syndrome

Many farmers adopted improved stocking densities in the pursuit of higher production during early 2010s. Increased feeding rates coupled with abnormally-high water temperatures (>32°C) lead to increased organic matter in the pond. This results in the occurrence of a new pathological condition called White Faeces Disease. It affects both *L.vannamei and P.monodon* and causes huge economic losses due to reduced growth, increased FCR and higher variation in the end product. White faecal matter is caused by damage to the hepatopancreas and sloughing of hepatocytes. The sloughed cells are released into the gut and the gut looks white in colour. The White gut and White faecal matter are two different problems in shrimp culture ponds that can possibly lead to loose shell syndrome.

Enterocytozoon Hepatopenaei (EHP)

Enterocytozoon Hepatopenaei (EHP) is a yeast-like fungus belonging to a group called "microsporidia" which are obligate intracellular parasites. The spores are very small (1.1 ± 0.2 by 0.6-0.7 ± 0.1 µm). It was discovered in *Penaeus monodon* in Thailand in 2004. EHP is confined to the shrimp hepatopancreatic tubular cell. The main organ affected in shrimp is hepatopancreas. EHP affects the digestive and absorptive functioning of the hepatopancreas resulting in poor growth and immunity. EHP does not appear to cause mortality. EHP should not be confused with Agmasomapenaei, another microsporidian that infects muscle tissue and connective tissue in *P. monodon, P. merguiensis and P. vannamei* in Asia leading to gross signs of "cotton shrimp disease" or "white back" disease. EHP affects both *P. monodon and P. vannamei.*

White Spot Syndrome Virus (WSSV)

Among the shrimp diseases, White Spot Syndrome Virus (WSSV) is the most pathogenic virus that has affected the shrimp industry worldwide. White spot disease (WSD) is a contagious viral disease of penaeid prawns and is caused by white spot syndrome virus (WSSV). This is an enveloped, rod-shaped virus containing a double-stranded DNA genome. The WSSV was first reported from both Taiwan and the People's Republic of China (PRC) in 1992. Subsequently, it spread throughout the East, Southeast and South Asia, North, South and Central America. In aquaculture, White spot disease outbreaks are often characterized by high and rapid mortality of infected populations. In farmed penaeid prawns, mortality can reach 100% within a few days of the onset of clinical signs.

Running Mortality Syndrome (RMS)

Running Mortality Syndrome results in high mortality in low-saline ponds. The dead shrimps settle at the bottom of the pond. Mortality is noticed only during the inter-moult stage. The symptoms of RMS include cut antennae, red color of the uropods, reddish yellow hepatopancreas, and dark red shrimp body. White or yellow faecal matter is also noticed in the gut.

VII. Shrimp Farm Biosecurity Protocols

The biosecurity systems are used in aquaculture mainly to prevent and control the spread of diseases and to comply with regulations. The key elements of biosecurity are reliable source of stocks; adequate detection and diagnostic methods for excludable diseases; disinfection and pathogen eradication methods; and best management practices. Hence, the principles and strict guidelines of biosecurity need to be adapted in individual farms and cluster wise in farming areas.

The disease carriers can enter the culture system through water, air and overland transport routes. Waterborne transport routes may include contaminated water (e.g., pond effluents, processing plant effluents) and natural hosts in water. Airborne transport (e.g., migratory birds, insects, wind) of pathogens is a concern in open farming systems without cover. Overland transport (e.g., human beings, animals, vehicles, farm equipment) is the most common route of introducing the pathogen into the culture system. The major biosecurity infrastructure in the farms include peripheral fencing of the farm, tyre bath, hand dips, foot dips, crab fencing and bird fencing.

Conclusion

Adoption of a holistic approach to shrimp farming by farmers is the need of the hour. This includes screening of Post Larvae for pathogens before stocking, proper use of feed and other inputs and inclusion of nursery phase to have more control on diseases and faster growth. Central drain will help to remove the wastage that accumulates in the pond. Farmers need to follow Best Management Practices (BMPs) to have a sustainable and disease-free shrimp farming industry.

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