CMFRI

Course Manual

Winter School on

Recent Advances in Breeding and Larviculture of Marine Finfish and Shellfish

30.12.2008 -19.1.2009

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PRESENT STATUS OF SHRIMP FARMING

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Introduction

Global shrimp production as well as trading values and volumes have grown significantly in the past 20 years. The major shrimp producing countries – China, Indonesia, India and Thailand have also experienced substantial increases in recent years. The main shrimp species produced world wide is white-leg shrimp, *Litopenaeus vannamei* which has replaced the native giant black tiger shrimp, *Penaeus monodon* especially in China and Thailand. Recently, government of India has given permission to import the species to India. In recent years, production of *P.monodon* declined mainly due to disease problems. The Better Management Practices (BMPs), when well designed and implemented can support producers to increase productivity by reducing risk of shrimp health problems as demonstrated in some farms in Andhra Pradesh by the joint MPEDA/NACA project. The latest development is organic shrimp farming which has already produced good results in some countries. The cage culture of shrimp is another important development.

Shrimp production

Shrimp production from capture and culture has expanded over the past decade from 2.4 million MT in 1987 to 4.2 million MT in 2000 to reach a record high of6.6 million MT in 2006. The world's largest shrimp producing country is China with 2.7 million MT. The others three shrimp producing countries – Indonesia, India and Thailand have also experienced substantial increase in recent years to over 500000 MT production in 2006.

The main shrimp species produced is white-leg shrimp, *L.vannamei*. This species has replaced, in the last years, the native giant tiger shrimp, *P. monodon*. Nowadays, about one third of total shrimp production is *L.vannamei*. Production of tiger shrimp peaked at 726 000 MT in 1994. In recent years, disease problems in the main producing countries and the already mentioned replacement with *L.vannamei* led to a decline in output. Inland shrimp production showed some important increase in recent years. The world shrimp aquaculture production, which had stabilized in the 1990s, have shown strong increases in recent years. In 2006, shrimp aquaculture exceeded 3.2 million MT, which was 500000 MT more than in 2005. China is, by far, the main shrimp culturing country with 1.2 million MT, followed by Thailand with 500000 MT.

Disease problems had overshadowed the production during the years in many countries, generally after a strong production period in the starting of the production cycle. There was a disease which whipped out Chinese Ecuadorian production (1999) and the Brazilian production in 2006. However, in recent years, most of the disease problems have been overcome. In addition, the introduction of *L.vannamei* to Asia has created a production boom especially in Asia.

In Thailand, *L. vannamei* replaced tiger shrimp. The culture of *L.vannamei* can be completed in 90 days. It can grow to a 12 to 15g in 90 days and the farmers can get a count of 80 to 90/kg. Due to increase in production, the sale price of *L.vannamei* came down in 2007 from 6 to 7 dollars/kg to 2-3 dollars/kg. As a result of this, the revival of culture of *P. monodon* took place. During 2007, the total production of tiger shrimp was 0.9 million tones, production of *L.vannamei* was 1.2 million MT and the production by the *Fenneropenaeus chinensis* was 0.6 million MT, thus making the total production, 2.7 million MT.

In India, the total shrimp production during 2006-2007 was 0.144 million MT from 1.50 lakh hectare water spread area. The average production was 760 kg/ha. During 2007-2008, the area under culture was reduced to 1.2 lakh hectares and the total shrimp production was reduced to 0.106 million metric t. The production of the giant fresh water

prawn (Scampi), *Macrobrachium rosenbergii* was 30,000 MT from an area of 40,000 ha. during 2006-2007. But during 2007-2008, the scampi production was 27,000 MT from 35,000 hectares. In general, the major part of the production (shrimp and scampi) comes from Andhra Pradesh. Recently, the government of India has given permission for the culture of *L.vannamei,* following strict quarantine procedures. Since the duration of the culture for *L.vannamei* is shorter (90 days), three crops can be obtained in an year.

Aquaculture boom

L. vannamei, the white-leg shrimp, is by far the main species cultured. This species was responsible for drastic increases in recent years. In 2006 the production of this species reached 2.1 million MT, up from 1.6 million MT in 2005. As a reaction to this boom, prices of *L.vannamei* shrimp fell sharply below those of black tiger, which triggered some producers in Asia to return to black tiger shrimp production. Black tiger still plays an important role in the artisanal shrimp production and its production peaked at almost 730000 MT in 2003, and recently declined to 650000 MT. The share of aquaculture production in total shrimp production has grown in recent years. The trend goes for aquaculture getting close to 50% in the near future. In 2006, the share was already 43%. In India, the major species cultured is *P.monodon*. Recently permission has been granted by Government for the culture of *L.vannamei*.

Sustainable shrimp farming

The main theme with regard to sustainable shrimp aquaculture over the years was the protection of mangroves, which in the early days of shrimp aquaculture were widely destroyed. Nowadays, most of the major producing countries have good protection measures for mangroves, including mangrove replanting. Waste water is another major problem of shrimp aquaculture, as water coming from the farms might contain high levels of contaminants. There is a move towards shrimp production systems that are not discharging anything into the outside environment. The use of antibiotics in shrimp farms are under close observation by the health authorities in many importing countries, catching from time to time countries and companies allowing too high level of antibiotics in their shrimp farms. Feed resources have to be sustainable, which involves in the case of fishmeal the main producing countries such as Peru and Chile. In these countries, a lot has been done recently to protect the fish resource used for fishmeal production through stringent quota systems. The stocking density has an obvious impact on the well being of farmed shrimp, and should be restricted in order to give more space to each specimen. The escape into the wild is an additional threat to the environment, even though not such a problem for the shrimp industry.

The recent development is the success achieved by shrimp farmer societies in Andhra Pradesh by Better Management Practices (BMPs) especially to overcome the white spot disease problem. The Krishna District covers about one third of total brackishwater area developed into shrimp ponds in Andhra Pradesh in India. Although, until mid 1990s, shrimp farmers earned returns, the investment in technologies for good management practices were generally ignored. As a result, shrimp farming in Krishna District failed to withstand impact of vital disease. As the situation failed to improve, large number of farmers abandoned shrimp farming. However, the work by the National Centre for sustainable Aquaculture (NaCSA) to establish more than 100 farmer societies and introduce management practices (BMPs) has helped to turn this situation around. A joint project of Marine Products Export Development Authority (MPEDA) with NACA to support shrimp farmers in disease control and coastal management was initiated in 2002, leading to participatory development of Better Management Practices (BMPs). The project supported farmers to implement BMPs through formulation of self help groups around 'local clubs'. Economic analysis of 15 farmer groups in Andhra Pradesh clearly demonstrated that farmers adopting BMPs have higher profitability, lower cost of production, and are able to produce quality and traceable shrimp without using any banned chemicals. The activities of the project have been absorbed into the newly formed National Centre for Sustainable Aquaculture, an outreach organization of MPEDA, dedicated to supporting self help clubs and adoption of BMPs.

Since there are lot of opportunities for value added shrimp products, the block frozen headless should be really a thing of the past. There are other possibilities to add value, by producing organic shrimp or by highlighting the quality of a product through geographical denomination of origin.

Organic shrimp farming is popular in U.S.A., Viatnam, Thailand and Bangladesh. The organic shrimp farm in USA produces its own shrimp feed formulas. Other sustainable processes at this organic shrimp farming operation included; zero discharge and water quality control through natural inputs such as molasses and beneficial bacteria. To achieve this, water much be tested every four hours for levels of nitrates, nitrites and ammonium as well as oxygen levels. If nitrate, nitrite or ammonium levels rise, shrimp feeds are reduced. If oxygen levels drop, aeration is increased and ponds can be inoculated with water from ponds to raise oxygen levels. This requires multiple ponds for inoculation which is impractical in India and other countries where shrimp farms are located in close proximity to each other, leaving no room for expansion for the construction of addition ponds. In a recent work at the oceanic Institutes, Hawai, a feed formulation was developed for rearing shrimp to market size (15-20g) with low levels of cholesterol and elevated levels of Omega-3 fatty acid, docosa hexanoic (DHA). The results of the experiments indicate that the levels of cholesterol and DHA in shrimp tail muscles were significantly influenced by the composition of the diet. The organic block tiger shrimp farming is also done in Thailand. In India, the MPEDA has entered into a consultancy agreement with Naturland, a Certification Agency. The MPEDA has selected a certified shrimp hatchery, an organic feed producing company and an organic scampi hatchery. MPEDA plans do organic shrimp farming in West Bengal, Andhra Pradesh and Kerala. The results obtained so far are encouraging.

Probiotics and shrimp farming

The live bacterial supplements that improve animal health known as 'probiotics' are used in shrimp feeds, hatcheries and grow-out ponds. Probiotic bacterial cultures added to shrimp ponds typically are composed primarily of heterotrophic bacteria, or a mixture of heterotrophic bacteria and autotrophic nitrifiers. Heterotrophic bacteria are those bacteria that primarily obtain their nutrition from organic sources. The primary source of carbon for these bacteria is carbohydrates. Nitrogen is typically obtained from the proteins in the organic material consumed by the bacteria. Just like the shrimp, heterotrophic bacteria excrete ammonia as a by-product of the metabolism of the proteins they consume. Some heterotrophic bacteria, however, are able to utilize ammonia directly as an alternative source of nitrogen.

Shrimp feeds used in intensive shrimp ponds typically have at least 35% protein. These feeds do not contain a lot of carbohydrate. C:N ratios in these feeds typically run around 9:1. The bacteria require about 20 units of carbon per unit of nitrogen assimilated. With such a low C:N ratio in the feed, carbon is the limiting nutrient for heterotrophic bacteria populations. The bacterial population will not expand beyond a certain point due to the limited availability of carbon. The protein in the organic detritus supplies most of the nitrogen requirement for the heterotrophic bacteria under these circumstances, and inorganic ammonia is not utilized as a nitrogen source to any great extent. If the C:N ratio is increased, either by feeding lower protein feeds with a higher percentage of carbohydrate, or by adding a carbohydrate source such as molasses in addition to the regular feed, the increased availability of carbon allows the heterotrophic bacterial population to consume a higher percentage of the protein in the organic material. This results in more complete digestion of the organic material in the pond by the heterotrophic bacteria. As the C:N ratio increases, the heterotrophic bacteria resort increasingly to ammonia metabolism to meet their nitrogen requirements. As C:N ratios are increased even further, a point is reached where nitrogen, rather than carbon, becomes the limiting nutrient. At this point ammonia concentrations should be close to 0 mg/L in the pond.

It should be pointed out that holding the feed protein constant and supplementing with pure carbohydrate will result in much higher bacterial counts in the pond. The oxygen required to support this additional bacterial biomass will increase proportionally with the increase in bacterial population. Likewise, CO_2 production will increase, driving pH down. If we are contemplating carbohydrate supplementation to increase C:N ratios, make sure that the pond is well-aerated and circulated to keep the organic detritus suspended in the water column where there is sufficient oxygen for the heterotrophs. Also, once we develop a dense population of heterotrophs through carbohydrate supplementation, don't discontinue the carbohydrate supplementation suddenly. This will starve the bacteria of carbon, a die-off will occur and an ammonia spike will be obtained.

Another point that should be considered before enhancing C:N ratios in *P.monodon* ponds. *P.monodon* does not utilize the organic detritus and associated bacterial protein as effectively as a food source as does *L.vannamei*, C:N

ratios can be enhanced by lowering the overall feed protein levels and utilizing feeds that are high in carbohydrate. Because *L.vannamei* feeds on the organic flocs and utilizes bacterial protein efficiently, growth rates don't suffer and protein utilization efficiencies improve dramatically. With *P.monodon*, feeding low-protein, high-carbohydrates diets will likely result in lower growth rates. Therefore, it might be necessary to depend more on supplementation with pure carbohydrates to boost C:N ratios. But this will result in more bacterial biomass, more BOD and higher CO_2. This makes it somewhat questionable, whether it is worth the risk to manage a *P.monodon* pond with high C:N ratios.

The recent development in shrimp farming is the cage culture. This has been done in some countries like Cambodia, Brazil and recently a beginning has been made in India. More studies are needed in this environmentally friendly method of shrimp farming.

Conclusion

It is very necessary to develop and promote sustainable and eco-friendly methods of shrimp farming. The use of probiotics in shrimp ponds may be popularized instead of antibiotics. Organic farming of shrimps needs to be standardized and popularized. The cage culture of shrimps is another eco-friendly method which needs to be standardized and popularized.

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