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Current Status of Shrimp Farming in the Southwestern Coast (Manroe Island, Kollam) of India

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Abstract: The aim of the present study is to provide the information on the current status of shrimp farming in Monroe Island, Kollam, India. It encompasses the resources, technologies, production systems and environmental issues of shrimp aquaculture in general. A survey on fifty eight shrimp farms (42 operational and 16 non-operational) was conducted within the Manroe island from November 2008 to August 2009. The black tiger shrimp, Penaeus monodon, Fabricius was the principal species cultured in south India. Presently, small-scale farmers carry out 90% shrimp aquaculture in Manroe Island. The farming technology is characterized by modified extensive and semi-intensive production systems, largely dependent on small ponds of less than 1 ha. These farms account for ca. 90% of the total area utilized for shrimp culture. The stocking densities range between 4 to 6 post larvae /m^2 and average shrimp yields after 90-120 days is 320-400 kg.ha^{-1}. As per our survey, the average production cost for shrimp per hectare is at least Rs. 1,50,000 per cycle. During the 1990s, shrimp was cash crop in the Kollam with a average production of 900 kg.ha^{-1}. Currently, the unsustainable practices and devastating outbreaks of diseases have forced the industry to shut down.

Key words: Shrimp farming · *Penaeus monodon* · Probiotics · chemotherapeutics

INTRODUCTION

Commercial shrimp farming is the fastest growing, economically viable ventures in Asia, Latin America and recently in Africa. Farm-reared shrimp is increasing in popularity and profitability due to its exclusive flavor and high nutritive value. The European Commission, Japan and the United States are the world's major importers of shrimp [1]. The largest exporters of farmed shrimp are China, Thailand, Ecuador, Indonesia, India, Mexico, Bangladesh, Brazil and Vietnam [1]. In Asia, India is the fifth largest producer and exporter of cultured shrimp. Farm reared shrimp accounts for about 60% of shrimp exported from the country. Marine shrimp farms in India produce about 100,000-120,000 tons of shrimps a year. Tiger shrimp, *P. monodon*, is the principal type of cultured shrimp in India, which accounts the largest part of the production. It is the largest of all cultured species that can reach up to 36 cm in length [2].

Kerala is a maritime state in the southwest coast of India with tremendous potentials for shrimp farming. Farm reared shrimp from Kerala are getting the best value owing to overseas demand from countries like Japan and United States. It is estimated that 65,000 ha of backwaters are suitable for shrimp cultivation. In Kerala, approximately 7,000 metric tons of shrimps are produced at the rate of 530 kg.ha^{-1} [3].Traditional shrimp farming practices are very popular in Kerala. The major districts in Kerala where aquaculture is practiced are, in the order of importance: Ernakulam, Alappuzha, Kannur, Thrissur, and Kollam. Our study area, Kollam is well known for marine and inland fisheries products. The estimated brackish water area suitable for undertaking shrimp cultivation in Kollam is around 7000 ha and only 10% of area is used for shrimp farming as per the latest Statistics. Approximately, 220 shrimp farms distributing an area of ~100 ha were found in the Kollam district. During the early 1990s, farming of P. monodon was a booming industry in Kollam area (Munroe Island). The increasing anthropogenic degradation of environment produced negative effect on the quality and quantity of shrimp culture. However, inadequate management of the shrimp-farming industry has resulted in frequent disease outbreaks, forcing the farmers to shut

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down their farm. Currently the shrimp-farming sector consists of 2 hatcheries and at least 90 farms utilizing approximately 55 hectares. Hitherto, no studies regarding the shrimp farming were reported from the Kollam region. Therefore, the present study/survey will provide the information on the current status of shrimp farming in Monroe Island, Kollam.

MATERIALS AND METHODS

The present study was carried out in Marine Wet Laboratory, Manroe Island, Kollam, India between November 2008 to August 2009. The farms selected for the present study were situated at Manroe island, geographically between 8°59'38" N and 76°36'43" E. in the brackish water area of Kollam district (southwest coast of India). The study is based on primary and secondary data sources. Primary data was collected from the structured questionnaire whereas the secondary data was collected from the publications through various journal and records from Aquaculture authorities. Data were collected from November 2008 to August 2009 from 58 shrimp farms (42 operational and 16 non-operational). A well-structured questionnaire was developed and used to collect information from the respondents through personnel interviews. Data regarding the physiochemical parameters, diseases and economic status were also analyzed.

RESULTS AND DISCUSSION

Shrimp aquaculture in Kollam is mainly confined to four regions, namely: Manroe Island, Kottiyam, Paravoor and Mayyanad. Even though the water quality and geographical features of this region are different, practices and production period of shrimp in these areas more or less similar. At present ~70% of the shrimp farms are distributed in the Manroe Island. The Manore Island is located at the confluence of Ashtamudi Lake (second largest back water system and the deepest estuary of Kerala) and the Kallada River. As per our survey, the ill-egal mining of sand and gravel in Kallada river threatening its very existence. The back water channels, ponds and canals of Manroe Island nurtures wide variety fish species prawns, crabs and bivalves. The average temperature is around 25°C to 32°C. The place receives an average annual rainfall of 270 cm and a vast majority of rainfalls received during the southwest (June to September) and northeast monsoon (October to November) months. Manroe Island is a swampy and water logged area, experience flood during the both monsoon. Farmers in the study area practice shrimp culture twice a year.From the end of November to February and March to May, two crops of shrimp are cultured. During this periodthe water of the surrounding lake-fed canals and channels becomes saline and idle for shrimp culture. Shrimp farms vary in size, from a few hectares to over 2 ha, and are normally tide fed, but the smaller farms with higher elevation are usually pump fed.

The shrimp aquaculture in Manroe Island was first initiated in the late 1980s. Initially, the shrimp farming was profitable and attracted many farmers who converted their land in to artificial shrimp farm. From 1991 to 1997, the total area under shrimp culture was over 100 hectares. During the late 1990s and early 1995s the production volume increased to 600 to 800 $kg.h^{-1}$ $year^{-1}$ and the price for marketable size shrimp (20 pcs./kg) has ranged from Rs. 600-700 kg^{-1} (Fig. 1). Two types of shrimp farming such as modified extensive and semi-intensive are practiced in the Monroe Island (southwest coast of India). As per the survey, it was found that 91% of farmers resort on modified extensive type of farming in small farm (<1 ha) with a stocking densities of 4-6 animals/m^2. The majority of farms were rectangular in shape. The depth of pond ranges between 1.2 to 1.5 m. Shrimp seed were purchased from the indigenous hatchery (Matsyafed) of Kollam.

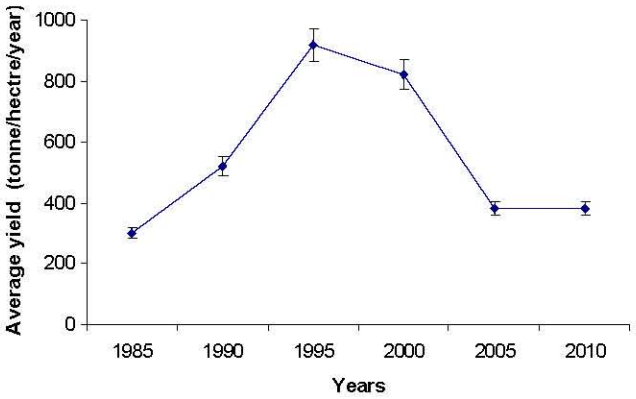

Fig. 1: Average year wise productivity of shrimp (ton/h/year) in Manroe Island

Feed management plays a major role in the shrimp culture. Godrej (Super shrimp) feed was widely used during the entire culture cycle. As per our survey the average production cost for shrimp per hectare is at least Rs. 1,50,000 per cycle. The un-availability of pollution free water was another problem in this area. The studies on the water quality and diseases outbreaks in this area are lacking.

Socioeconomic Characteristics of the Respondents: The ownership pattern for shrimp farm is varied. Most of the respondents in the survey are the farm owners cum operators (~80%), remaining are farmers group and lessee respectively. Most of the farmers had years of bonafide experience in their own farms. Around 54% of the farmers with small-scale farm (<1 ha) had 5-10 years of experience have practiced traditional type of shrimp farming, while 40% of the same category had 1-5 years of experience have practiced modified extensive farming. The experts in shrimp culture in this area (~6%) have 10-12 years of experience. This indicated that farmers were moving into this entrepreneurship and had limited experience with shrimp aquaculture. Regarding the finance for shrimp farming, 42% of farmers use their own money for shrimp farming while the rest receive loan. The expense of shrimp production have increased significantly in recent years as a result of increased price of seed, feed and wage rates of labourers.

Regarding the educational status, it was found that, majority of shrimp farmers are primary educated. They acquired /developed these farming techniques from their interaction with the environment. In this study, four levels (illiterate, primary, secondary, and graduate) of literacy were identified. Among these, ~20% are illiterate, ~65% have primary education, ~15% have secondary education and the remaining 10% were graduates. Based on the survey it was observed that ~83% of the respondents had shrimp farming as the primary occupation, whereas the 17% of respondents had shrimp farming as the secondary occupations.

Physicochemical Parameters of Shrimp Ponds: In general, the areas of the Kollam (Monroe Island) have water suitable for the culture of *P. monodon* and other shrimp species. Besides *P. monodon*, the farmers also cultured pearl spot. Fresh water input from Kallada River and tributaries increased during the rainy season of June to August and caused local flooding which in turn alter the salinity, alkalinity and turbidity of shrimp farm. The maintenance of good water quality is essential for optimum growth and survival of shrimps. The levels of physical, chemical and biological parameters could control the quality of farm waters. Water salinity was found to be in the acceptable limits throughout the region. The salinity was recorded maximum average of 21 ppt and minimum 8 ppt during the culture period. The average pH ranged between 7.1 to 8.4, while the dissolved oxygen was ranged between 3.3 to 4.2 ppm. Water temperatures ranges between 27-30°C are generally suited for *P. monodon* culture. During the high water salinity fluctuation, the stocking practice and timing will need to be modified. Temperature and rainfall were found to have a decisive role in the disease outbreaks. Rapid increases in population, industrialization and urbanization lead to the water pollution in the shrimp farms of Monroe Island.

Shrimp Farming: Shrimp farming in Manroe Island is a long established culture practice from the years. In late 1980s, farmers converted their low lying land and rice fields in to shrimp farm. The rate of conversion of rice field to shrimp farm increased due to favourable resources and climatic conditions, such as the availability of ponds, low lying agricultural land, warm climate, fertile soil, and cheap and abundant labour. In 1990s, large scale conversion of agricultural lands and mangroves to shrimp aquaculture has taken place in Manroe Island.. Farming period starts from the end of November and finished by the end of May. A series of activities are needed in shrimp aquaculture for successful growth of shrimp. All the respondent farmers performed almost the same type of management activities, for the pond preparation and grow out. However, the application rate of fertilizer, stocking density and water exchange rates varied from farm to farm.

Pre-Stocking Management:

Pond Construction: Pond preparation is a significant activity for the establishment of each culture period. Almost all farmers in the locality practiced pond preparation. Pond dikes are constructed manually up to a height of about 1.2-1.5 m (average 1.35 m) and the width of the dike vary from 0.5-1 m. The dikes are built by excavating the topsoil adjacent to the dikes. Thus shallow canals along the periphery of the dikes are shaped to retain water and act as shrimp shelter. From the farm sediment waste are removed manually and deserted on the top or outside the dyke. Decayed grass, debris, and algae to some extent were removed at this stage. Another important aspect for the successful growth and survival of the shrimp was pond drying. Normally, the water of the used shrimp pond is washed away by the end of November and left to sundry for a three weeks. The farms applied ploughing after drying. During this time the

farmers repaired the dikes, sluice gate, guard shed and other infrastructure.

Water Intake and Liming: The pond was filled with tidal water up to 10 inches after drying and tilling. Water is raised at interval of putting each input. Agricultural limestone ($CaCO_3$) was applied after two days of tea seed application to neutralize organic acid. The average application rate of lime was 60.2 $kg.ha^{-1}$. The limestone was put in a barrel with water for the whole night and sprayed all over the farm in the subsequent day to control the pH level, which is an important factor for prawn farming to maintain a healthy and productive environment to prevent disease.

Eradication of Predators and Competitors: The weed/predatory fishes such as *Aplocheilus* sp, *Puntius* sp, *Danio* sp and cat fishes are distributed throughout the shrimp ponds of Manroe Island. Tea seed cake is widely used to kill unwanted aquatics from the farm. The applied dose was 50 $kg.ha^{-1}$. Besides the fauna, aquatic weeds vegetation such as *Lemna* sp, *Azolla* sp, *Vallicinaria* sp, *Caratophyllum* sp, *Solvinia* sp, *Pistia* sp (macrophytes) *Oscillatoria* sp, *Trichodesmium* sp, *Microcystis* sp and *Anabena* sp (cyanobacteria) are found in the ponds. Farmers used to apply algicides to eradicate these weeds.

Fertilization: Fertilization is the last activity for pond preparation before shrimp fry stocking. After 2-4 days of liming the pond was applied with semi dried cow dung. The farmer used the highest quantity of cow dung (950 $kg.ha^{-1}$), Urea, Triple Super Phosphate (TSP) and muster cake for improving pond productivity. The use of cowdung, mahua oil cake and bleaching powder in shrimp farms sometimes causes concern in areas where pond water is used for drinking or bathing.

Seed Selection: Quality of fry is an important factor for production and profitability, so farmer must ensure that he or she gets healthy fry by purchasing them from reliable hatchery or hatcheries. Most of the farmers (90%) were purchased fry from Matsyafed hatchery, Kollam and 10% of farmers purchased it from other places. As per our microbiological studies, shrimp larvae of Matsyafed hatchery were found to healthy and pathogen free. The farmers usually select good quality seed of post larvae (PL) 15-22 based on the parameters like size, morphology, color and behavior to ensure profitable harvest. Stocking larger post larvae can improve survivability due to more developed resistance to disease, stronger feeding behavior and improved predator resistance.

Post-Stocking Management:

Feed Management: From our survey, it was found that majority of farmers in the Manroe Island are using Godrej (Super shrimp) feed during the entire cycle. It may be due to the unavailability of other commercial feeds in the local market. Feed constitutes the major portion (40-60% of operational cost) of production cost. Average feed cost per hectare (4-5 animals/m^2) was found to be Rs. 80, 000. In addition to feed, farmers used a variety of vitamin, mineral, probiotic and feed supplements. Feeding schedules of shrimp are observed for three feeding periods. During the first two weeks after stocking, farmers do not encourage the feeding practices. After thirty days of culture the feeding rates were based on estimated survival. From forty to ninety days of culture, the daily feeding rate were adjusted using feed trays and increased to four to five times per day.

Water exchange: Most existing shrimp ponds in Manroe Island require either pumping water in for stocking, or pumping water out for drainage. Majority of the framers done water exchange in their ponds for one hour from the 20^{th} day of culture up to 50 thday, and from the 51 stday onwards water is exchanged for 3-5 hours up to the end of the culture. Around 80% of the farms used motor pump for water intake due to higher land elevation inside the farms. Besides the pumping cost, pump maintenance would be the major problem for farmers in this area. Farmers are concerned with environmental impact, particularly in crowded areas where influent and effluent waters of all farms have the same source. In this study, it was found that almost all farms, exchanged water through the sluice gate made of wood or concrete. Majority of the farms used the same gate for drainage and flushing purposes. Very few had separate drainage and flushing gates.

Security: In Monroe Island, many of the existing farms are constructed away from roads and houses. As a result, shrimp may not be fed and water quality may not be monitored on a regular basis. Most farms not have outer fences, thus allowing open access to people and animals. During the later stage of the crop, theft found to be a major problem for all the ponds at night. Predatory birds such as cormorants, fish eagles, herons, kingfishers, grebes, gulls, and terns are very common in the shrimp farm of Manroe Island, causing 5-15% of economic loses, sometime it may serve as a carriers of pathogenic organisms, such as salmonellae, faecal-colliforms and the bacterium *Edwardsia tarda,* might be spread through the contamination of water bodies by bird droppings [4].

Grebes, fish-eating eagles and crows are thought to be agents for the white spot virus. In order to ward off the predatory birds, different types of bird scaring devices, plastic net are used.

Disease Occurrence: Rapid growth of shrimp farming industry has created substantial income for many developing countries, as well as developed countries, but zoonoses and drug residues associated with shrimp farming are of great concern to public health. Disease is found to be the primary menace of the shrimp aquaculture in south India. There is a lack of wet lab facility/services in this region. Shrimp diseases have become a regular occurrence in the study area since 2000. Major shrimp diseases are viral (WSSV) [5] bacterial (Vibriosis) [5] protozoan and fungi. The farmers admitted that there was drastic loss of shrimp aquaculture due to the occurrence of shrimp diseases in 2000-2005. In 2005, majority of the shrimp farms experienced white spot diseases. From the survey report it was found that around 90% of the farmers are reported that the diseases are occurring repeatedly during shrimp farming. It was found that 70% of the shrimp farm is affected by vibriosis [6] and 40% of the shrimp farms are the victims of viral diseases whereas the protozoan, microsporodians are very common.

Management Strategies: The affected farmers had also taken different measures to cope with shrimp diseases. Most of the farmers harvested early when disease occurred in his or neighbor's farms. Farmers had a tendency to use chemicals like Ciprofloxacin – Chloramphenicol Estolate – erythromycin, during the occurrence of diseases. Water quality improvement measures were not practiced besides exchange of water during tidal variation. When the extent of the disease was severe farmers reduced all the water and let the bottom of the farm to dry up under the sun. The remaining shrimp took refuge into the canal along the periphery of the farm.

Use of Chemotherapeutics: It was found that 90% of the farmers agreed to have used antibiotics at least once in shrimp aquaculture as a remedial measure against shrimp diseases. Currently, the antibiotics are not encouraged in shrimp farming by the farmers due the refutation of shrimps in international markets. Surazolidone-Oxytetracycline, Ciprofloxacin – Chloramphenicol and Estolate – erythromycin, erythromycin phosphate are the commonly used antibiotics in shrimp farms of Kerala. A more detailed research on the use and impact of chemotherapeutants is required to assess problems and develop policies and guidelines for their use.

Use of Probiotics: As a preventive measure against diseases, around 55% of the farmers are using probiotics, from this 55% percentage 77% reported that effect of probiotics is varied from time to time. The commonly used probiotics in Kollam area are Epicine – US, Shrimp pro V-Malaysia, Priveb G – Malaysia, Juvite – Taiwan, Biozyne and Pond pro D.

Harvesting: Harvesting is carried out after 90-120 days of modified semi-intensive shrimp farming. During the harvest used farm water is drained out to the canal. Shrimp were caught manually by casting nets all over the farm and remaining was handpicked.

Export: The shrimp production and its commercial viability of Manroe Island depend on international markets. More than 70% of the harvested cultured shrimp are exported, going mostly to United States of America and countries of European Union.The market chain from farmers to international markets passes through a number of intermediaries: shrimp traders, agents and processing plants. In Manroe Island, the peak season of shrimp marketing is from February to June.

Socioeconomic Aspects: One of the main points raised out by the farmers during the field interviews/survey is the palpable lack of information on scientific shrimp farming. Differences between the types of production technologies (intensive, semi-intensive, extensive, organic etc.) and the environmental, economic and social consequences of shrimp farming are yet to exposed. The continuous disease outbreaks, high capital investment, variable market value and operating capital requirements of commercial shrimp production led to the shutdown of many small-scale farms. In the present survey 95% of the farmers mentioned problems with diseases, higher labour cost, predation and land tenure as the main reasons for abandoning the ponds. Majority of the farmers seemed generally less interested in continuing shrimp farming. This could be due to the less productivity associated with disease outbreaks. As per our survey, the average production rate of the farms falls between 340-400 $kg.ha^{-1}$ indicating lower productivity. Market information indicates that prices are likely to remain moderate (ca. Rs. 350/kg, depending on the demand) for the largest shrimp. The majority of the farmers produced yields of more than 700 $kg.ha^{-1}$ of *P monodon* during the 1990s, but, since 2000, production has declined due to the repeated disease outbreaks, and annual yields dropped to around 300-400 $kg.ha^{-1}$. In 2008-09, the diseases (vibriosis and WSSV)

resurfaced the study area, reducing shrimp yield very severely. The shrimp farmers did not have access to scientific applications/services. Majority of them seeks help from representatives of feed/feed supplement companies whose prime target is to sell their products. In the current situation, the shrimp farmers of Kollam, needs scientific/technical assistance for developing infrastructure and skills to produce large, healthy, good quality shrimp.

The analysis of the information gathered during the course of the study from existing documentation, reports, and from the conversations with different shrimp farmers, leads to conclude that, Manroe Island has all of the essential resources necessary to produce large quantities of shrimp but there are increasing concerns about the impact of shrimp farming on the environment. Moreover, among the existing shrimp farmers, there is a strong need for technical back-up concerning shrimp farming development and management in Manroe Island.

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