Management at farmer's level to reduce the risk of shrimp disease outbreak in different farming systems

A Thesis

By

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Examination Roll No: 140625

Session: 2013-2014

The thesis is submitted to the Fisheries and Marine Resource Technology Discipline in particular fulfillment of the requirements for the degree of

Master of Science in Aquaculture

Fisheries and Marine Resource Technology Discipline
Khulna University
Khulna, Bangladesh

September, 2018

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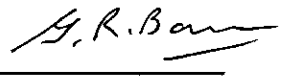
Approved as to the style and content by



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Declaration

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The results presented in the thesis with the above mentioned title are entirely of the candidate's own investigations and no part of the results has been accepted for any degree nor is it being concurrently submitted for any degree.

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DEDICATED TO

MY BELOVED PARENTS

Acknowledgement

At the very outset, with all impulse of my heart I would like to express gratitude and praise my Family and the creator of the universe, the almighty Allah who have enable me to complete the project thesis for the fulfillment the degree of Bachelor in Science in Fisheries And Marine Resource Technology.

It is immense pleasure to express my deepest sense of appreciation, heartiest gratitude and indebtedness to Md. Rashedul Islam, Associate Professor, Fisheries And Marine Resource Technology Discipline, Khulna University, Khulna for his scholastic guidance, innovate suggestions, sincere interest, constant supervision throughout the period of research work, otherwise it would be tough to complete the project work within the stipulated period.

I would like to express my deepest sense of gratitude and respect to professor and head Professor Dr. Ghausiatur Reza Banu, Fisheries And Marine Resource Technology Discipline, Khulna University, Khulna for his constant encouragement and providence all necessary facilities.

I recall with warm appreciation and great indebtedness for the support, guidance and suggestion extended to all of my respected teachers in Fisheries and Marine Resource Technology Discipline, Khulna University, Khulna.

I am thank full to my cousin M A Hasan Panna distributor of CP Aquaculture for his great support and guidance during the research work and also indebted to the people of working area for their sincere co-operation and all round support during the survey period.

I would like to convey special thanks to my friend Suvashis Vaumik and well wishers especially Mohanondo Gain, Sabbir Ahmed for their kind co-operation, encouragement and inspiration to complete this survey thesis.

Humaira Sharmin

ABSTRACT

This present study was conducted to investigate the existing status of management systems of shrimp culture at farmer's level and to find out any effective system that reduces disease outbreak in shrimp production. Proper management system in aquaculture particularly in shrimp aquaculture is not only important to increase the capacity of per unit production but also to reduce the frequency of disease outbreak which is now a major concern for sustainability of the shrimp sector. Extensive shrimp farming system is mostly practiced in Bangladesh, but in the recent time farmers shows their interest in improved or semi-intensive farming systems as high mortality of shrimp is becoming very frequent in extensive farming system. Effective management system of shrimp farming depends on a variety of factors that include age, education and farming experiences of the farmers, availability of critical inputs, credit facilities, occurrence of natural calamities, socio-political state etc. Both extensive and semi-intensive farmers were interviewed to pick up the differences in farm management systems as well as to find out the probable reasons and driving forces those lead to occurrence of shrimp disease and ultimate lose in shrimp aquaculture. It was found that, in the study area, most of the shrimp farmers were found to be quite middle aged with a range from 17 to 73 and 100% of the interviewee were male. Among the 100 interviewees, 22 respondents were found who had never attended to the school, 52 had completed their primary level. Average size of the farms were found 88.77 decimal in the Semi-intensive sector whereas it was 221.1 decimal for extensive farms. Though the pre-stocking and post stoking management were followed by the both traditional and semi-intensive farmers, the qualitative and quantitative nature of management systems in semi-intensive farms were found quite systematic, regular and scientific. In the study area, semi-intensive culture of shrimp was done for 110-120 days. In both traditional and semi-intensive culture systems, farmers stocked fry from the month of January to August every year and cycle of a culture period extends from 110 to 140 days. . The stocking density was found 2-3 PL per m^2 in traditional system and is 15 PL per m^2 in semi-intensive systems. In both systems sources of PL were mainly hatchery produced seeds. Though most of the extensive farmers did not use any supplementary feeds in their farms, in semi-intensive systems cost of feed for per acre went up to BDT

215,000. In semi-intensive system during the culture period different types chemicals and additives like Super PS, Super biotic, Mutagen, Zymatin, p^H fixer, Biotrim, Soda mix, K-max, Calmag, Sea max, a-soil and dolomite were applied, but no supplementary drugs and additives were applied in traditional culture ponds. The concept of bio-security was found to be followed very strictly in the semi-intensive farms while this concept was not well known to the traditional farmers. Finally, the semi-intensive farmers did not record any disease outbreak in the last three years while the traditional farmers recorded high mortality of shrimp up to four cycles in the last three years. Besides, net return from per unit land use was found more than twelve times higher in semi-intensive system compare to extensive one. Thus, this study revealed the effectiveness of semi-intensive farming system in the reduction of disease outbreak frequencies as well as net return size in shrimp aquaculture. However, further intensive study is needed to justify the present findings properly.

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1. Introduction

1.1 Background of the study

Fisheries and aquaculture in Bangladesh provide the main source of income for millions of people and a large proportion of the animal protein consumed. In Bangladesh, the fishery and aquaculture industry, particularly of shrimp, plays an important economic and social role providing income, employment and contributing significantly to food supply. There is a long history of such activity in Bangladesh, although development of production to any scale has only occurred since the late 1970s. Fishery and aquaculture of shrimp now provides a vital component of the Bangladesh economy, but also has a number of accompanying environmental and social issues, that must be addressed in order to provide an improved and sustainable sector in to the future.

Aquaculture has become one of the fastest-growing economic subsectors of the Bangladesh economy, providing protein-rich food, source of employment and foreign currency earnings. Presently, the sector provides income and livelihood for more than 11 percent people of the country's 160 million people. Total farmed shrimp production in Bangladesh increased from 14,773 tonnes in 1986 to 1,32,730 tonnes in 2016, an almost 9.0-fold increase over the last 30 years. The land area under shrimp farming has increased from 70,331 ha in 1986 to 2,75,509 ha by 2016. The contribution of the farmed shrimp to total shrimp production and export has been increasing over the last 15 years at a rate of about 20 percent per year (Mostafa *et al.*, 2017).

In parallel with the significant contribution of the shrimp sector to the local and national economy, it has caused some negative impacts on local ecosystems. Ecological impacts include some deterioration of soil and water quality, depletion of mangrove forest, decrease in population of native fish and shellfish species, intrusion of saline water, water pollution and changes to local hydrology. There have also been some socioeconomic consequences, most acutely on the livelihood patterns of people living in coastal areas and on rural to urban migration, particularly among the poor and unskilled.

Other impacts include deterioration of drinking water quality, loss of land for grazing of livestock and changes in agricultural cropping patterns, which has particularly affected the landless agricultural laborers (Mostafa *et al.*, 2017). Social and environmental sustainability may have been overlooked during the expansion of shrimp farming. Losses due to disease, which are still a periodic problem for the sector, are a major indicator of the current unsustainable system of shrimp farming.

At this stage, a paradigm shift is needed away from current shrimp farming practices to a more holistic and integrated approach that accounts for environmental integrity and social cohesion. Some modification and improvements have been made in recent years, and these should be extended. At the same time, incentives are needed for appropriate investment, to improve the physical infrastructure of *ghers* / a traditional shrimp farm, and for adoption of new management methods. In this there is an important role for government in formulating appropriate policy and monitoring. Without a guiding policy on the development of the shrimp sector, private businessmen are likely to move ahead in an unplanned or unregulated way.

Shrimp culture is an age-old practice in Bangladesh, taking place in brackish, saline and freshwaters of the coastal areas of Khulna, Satkhira, Bagerhat and Cox's Bazar districts. Historically, people trapped tidal water in low-lying intertidal lands by constructing small dykes to trap water, and harvested naturally occurring shrimp and finfish after three to four months. There was no stocking of fry under this system and only wild seeds of shrimp and fish carried in by tidal waters were allowed to grow and there was no form of any distinct management.

During the 1970's, after independence, interest in shrimp production grew with rising prices and demand in international markets. Shrimp farms were established in peripheral lands near the mouths of coastal rivers where inundation of saline water was possible. The success of these early farmers encouraged others to come forward and shrimp *ghers* (local name for a shrimp farm) were established on land inside saline water protection embankments, called Polders, which had been constructed by the Water Development Board in the late seventies. In Bangladesh shrimp production systems were often dispersed and extensive and relatively few shrimps were harvested at any one place and or at one time. Product had to be transported to local markets where it could be aggregated to a scale useful to traders and processors; but where

quality control and product tracking was virtually impossible to manage. The main cultivated species were, and remain, the black tiger shrimp (locally called *bagda*) *Penaeus monodon*. Other farmed shrimp species included brown/speckled shrimp (locally called *harinachingri*) *Metapenaeus monoceros*, Indian white prawn (locally called *chaka*chingri) *Fenneropenaeus indicus*, green tiger prawn *P. semisulcatus* and banana prawn *F. merguiensis* and giant river prawns (locally called *golda*) *Macrobrachium rosenbergii*.

From the late seventies and early eighties, the shrimp culture system expanded steadily. In addition to trapping of natural shrimp seeds, farmers began selective stocking of shrimp post-larvae (PL) caught from the wild. This created a new work opportunity for poorer coastal people who began to collect PL from coastal waters. From the mid-eighties, the Government launched infrastructure development programs together with improved technology dissemination and fiscal incentives for producers and processors. International development partners such as World Bank, Asian Development Bank, Food and Agriculture Organization of the United Nations (FAO of the UN) and Official Development Assistance (ODA) from the United Kingdom supported the industry with credit and technical assistance; most notably through ten projects managed by Department of Fisheries (DoF) between 1979 and 1999. Government has been very active in stimulating entrepreneurial growth in the shrimp industry. From 1986, for example, it introduced a licensing system for setting up shrimp farms through Upazila Shrimp Culture Regulation Committees, which attracted many outsider investors. These investors were generally wealthy people who found it easy to obtain licenses from the shrimp committee members. *Khas*land allocation and leasing for shrimp farming encouraged the politically powerful to access new shrimp areas.

The industry grew rapidly to the mid-1990s. There was concomitant growth of other allied activities including the establishment of processing plants, ice production plants and shrimp depots. There were also over-ambitious initiatives to setup semi-intensive shrimp farms with imported PL. Local shrimp hatcheries did not become well established until the late 1990s. In 1994 white spot disease spread throughout the semi-intensive farms, and into extensive farms, with most investors incurring heavy losses over successive years. Coastal outsider investors, in particular, lost interest in the business opportunities.

In 1998, government withdrew the shrimp licensing system and many local land owners refused to renew old lease deeds for outsiders, and others demanded higher rents for their private lands. The capital losses from shrimp disease and growing noncooperation from local landowners made it difficult for outside shrimp farmers to continue shrimp farming. They began to leave the sector and local landowners began shrimp farming themselves. Landowners split up large farms into smaller units, which they owned and could farm or they tried to operate larger farms under cooperative arrangements with other landowners. Thus, what began as a large-scale commercial shrimp farming activity was gradually replaced by small holder shrimp farming, managed predominantly by local, small landowner-cum-operators.

There are now two main shrimp species cultured in Bangladesh. The most important is *Penaeus monodon* or the black tiger shrimp (locally known as *bagda*), which contributes about 70 percent of all cultured shrimp. *Macrobrachium rosenbergii* or the giant river prawns (locally known as *golda*) contributes about 15 percent of total farmed production (Mostafa *et al.*, 2017).. The remaining 15 percent comes from other shrimp species including *Metapenaeus monoceros* or the brown/speckled shrimp (locally known as *harinachingri*), *Fenneropenaeus indicus* or the Indian white prawn (locally known as *chakachingri*), *Penaeus semisulcatus* or the green tiger prawn, and *F. merguiensis* or the banana prawn.

Khulna region is geographically situated in the mixed climatic condition between fresh, brackish and marine environment. Marine shrimp and fresh prawn are both suitable culture in this ground. Bangladesh has a great potentiality to increase the productivity of shrimp through intensive and semi-intensive culture. Shrimp export and cultivation in Bangladesh has undergone rapid expansion over the last two decades. Shrimp and prawn together represent the second largest exportable items contributing to foreign exchange earnings of Bangladesh.

Shrimp farming is growing in Bangladesh due to suitable agro-climatic conditions, adequate water resources, cheap labour force, international donor agencies and the involvement of multinational corporations. Although it provides immediate economic benefits, contributes to poverty reduction and food security, as well as generates employment from seed collectors to exporters, it has also been facing a host of challenges. They hinder the sustainable development of this otherwise thriving sector. Promoting shrimp mixed cultivation could be a management

solution for sustainable development of shrimp farming in southwest coastal Bangladesh. The National Shrimp Policy of the government also emphasized on promoting environment-friendly shrimp mixed cultivation for sustainable development of shrimp farming. However, more institutional support such as training, extension support, technical assistance, and credit facility is required to implement the policy.

1.2 Objectives of the study

The present study has been carried out to compare the management system of Bagda (*Penaeus monodon)* among traditional and semi-intensive culture methods that widely practiced in southern region with the following objectives:

1. To determine present status of management system of shrimp culture at farmers level.
2. Find out any effective system that reduces disease outbreak.

2. Review of Literature

The culture of shrimp in Bangladesh has been drawing greater attention by fish farmers, particularly in brackish waters. In the coastal area of the greater Khulna region having a tropical climate, productive and unpolluted estuarine areas is considered to be a suitable natural habitat for shrimp culture (Ali *et al.*, 2000).

Bangladesh is one of the major shrimp-producing countries in the world. It enjoys an advantageous natural setting for shrimp culture. In the 1970s, in Bangladesh, the shrimp aquaculture was started in modified rice fields which are locally referred to as '*gher*'. In Bengali, '*gher*' is a traditional earthen pond or field situated by river sides and impounded by dykes (Islam *et al.*, 2002). Generally, a '*gher*' is made for prawn cultivation by modifying rice fields through building higher dikes around the field and excavating a canal inside the periphery in order to retain water. Tidal water exchange is important in the '*gher*' system for capturing wild seeds and for maintaining water quality (Islam *et al.*, 2002). Sluice gates are constructed to maintain water flow and to control salinity levels via water exchange. They are also used as effluents to remove waste, dissolved metabolites and particulate matters, which are formed by the collective action of various chemicals, fertilizers, excreta, unused feed, unwanted organisms, detritus, etc. (Hall, 2004). However, this system has modified over time and today, there are four categories (i.e. traditional, extensive, semi-intensive and intensive) of shrimp aquaculture in Bangladesh (Islam *et al.*, 2002). This classification is entirely based on the intensity of management practices such as stocking density, inputs of feed and fertilizer and water quality management.

According to (Soundarapandian *et al.*, 2010) salinity is an important parameter in maintaining optimum growth and survival of shrimps. Even though, *P. monodon*is euryhaline aquatic species; it is comfortable when exposed to optimum salinity. At high salinity the shrimp grows slowly but remains healthy and resistant to diseases. If the salinity is low, the shell becomes weak and prone to diseases. Muthu, Soundarapandian and Gunalan and Karthikeyanrecommended an ideal salinity range of 10-35 ppt for *P. monodon* culture. While (Chanratchkool *et al.*, 1994) maintained the salinity in between 10-30 ppt. (Soundarapandian *et al.*,2010*)* stated in their study that pH is one of the vital environmental characteristics, which affects the metabolism and other physiological process of shrimps. In their study pH range was 7.6 to 8.2 for the probiotics treated

and control ponds. In the present study pH range was8-8.8 in probiotics ponds and 7.6-8.8 in controlled ponds. (Ramanathan *et al.*, 2005) said that theoptimum range of pH 6.8 to 8.7 should be maintained for maximum growth and production.Dissolved oxygen plays an important role on growth and production through its direct effecton feed consumption and maturation and low levels of dissolved oxygen can cause damages inoxidation state of substances from the oxidized to the reduced form. In the present studydissolved oxygen was found 4.3-6.2 ppm and 4.7-6 ppm in probiotic and controlled pondsrespectively. (Soundarapandian *et al.*, 2010) found 3.2 to 4.2 ppm dissolved oxygen in all theirculture ponds that is close to the present study. Low-level of oxygen hampers metabolicperformances in shrimp and can reduce growth and moulting and also causes mortality.

In Bangladesh shrimp is the third largest foreign exchange earning commodity. Shrimp (*Penaeus monodon*) farming contributes significantly to the nationaleconomy of Bangladesh and also plays a vital role in generating income andemployment opportunities among the coastal people(Islam *et al.*, 2016).

Khulna region is geographically situated in the mixed climatic condition between fresh, brackish and marine environment. Marine shrimp and fresh prawn are both suitable culture in this ground.

Shrimp farming also generated diverse employment opportunities; about 87000 persons areinvolved in shrimp farming and another 5000-6000 in shrimp processing industries (Hussain *et al.*, 1994). Now this amount reaches in 3.5 lakh in shrimp farming in Khulna region. In addition, about 300,000 to 500,000 persons are involved in shrimp larvae collection for shrimp farming (Ali, 1992). About 80% of the tiger shrimp comes from the south western region of Bangladesh ingreater Khulna region.

Bangladesh has a great potentiality to increase the productivity of shrimp through intensive and semi-intensive culture.

Shrimp export and cultivation in Bangladesh has undergone rapid expansion over the last two decades. Shrimp and prawn together represent the second largest exportable items contributing to foreign exchange earnings of Bangladesh.

Bangladesh shrimp farming are involved with traditional method and generally do not practice well-defined pond preparation, liming, fertilization, predator control or artificial feeding, where production is low, water exchange is irregular, and water management is very poor(Asif *et al.*, 2017).

3. Materials and Methods

3.1 Selection of the study area

The study was performed at Botiaghata Upozilla in Khulna region, a well-known shrimp and prawn production zone in the southwestern part of Bangladesh. Khulna region is geographically situated in the mixed climatic condition between fresh, brackish and marine environment. Marine shrimp and fresh prawn are both suitable culture in this ground. Bangladesh has a great potentiality to increase the productivity of shrimp through semi-intensive culture. Shrimp farming is growing in Khulna due to suitable agro-climatic conditions, adequate water resources, cheap labour force, international donor agencies and the involvement of multinational corporations. Although it provides immediate economic benefits, contributes to poverty reduction and food security, as well as generates employment from seed collectors to exporters, it has also been facing a host of challenges. They hinder the sustainable development of this otherwise thriving sector. Data were collected from Baguladanga, Chanderdanga, Choksholmari, Dhanibunia, Hatbati, Hogolbunia, Jabra, Khorial, Kolchebunia, Pathorighata & Per-botiaghata.

3.2 Data collection

Data were collected from October, 2017 to May, 2018, during the season of shrimp farming and harvesting. A combination of the following survey techniques was used for data collection:

3.2.1 Secondary data collection method

Data about shrimp farming management techniques information were collected from relevant Government and non-government organizations personnel such as Department of Fisheries (DoF), Upazila Fisheries Officers and relevant NGOs.

3.2.2 Primary data collection method

Primary data were gathered by field survey through structured questionnaires of shrimp farmers face to face interviews. For the validity of data, both qualitative and quantitative methods were applying for data collection. Purposing sampling procedure had been followed to achieve the target information. Total 100 farmers were interviewed during the study period.

3.3 Data processing and analysis

Data collected from various sources were coded and entered into a database system using Microsoft Office Excel-2007 software. Numerical data which were collected in local units due to familiarity of the respondents & converted into international units before transferring to computer. Preliminary data sheets were compared with the original coding sheets to ensure the accuracy of the data entered. At each stage of survey, data were checked up, edited and coded at the field level. SPSS (Statistical Package for Social Science) was used to analyze the data. Data were summarized using descriptive statistics. The analytical process was used to identify the economically viable of the shrimp farming management techniques and the livelihoods of the associated people.

4. Experimental Results:

4.1 Age structure and sex distribution:

Knowledge of the age structure of farmers is important in estimating potential productive human resources. Planning of education, health and employment generation requires sufficient data on relevant age structures. In the study area, most of the shrimp farmers were found to be quite middle age with a range from 17 to 73. It was found that in Semi-intensive culture system among the 28 interviewee, 8 had 18 to 30 years old, 17 had 31 to 45 years old and 3 had above 45 years. In traditional culture system among the 72 interviewee, 20 had 18 to 30 years old, 35 had 31 to 45 years old and 17 had above 45 years.

From the study area, it was found that 100% of the interviewee of traditional farmers were male. On the other hand, it was found that 7.14% of the interviewee of Semi-intensive farmers were female.

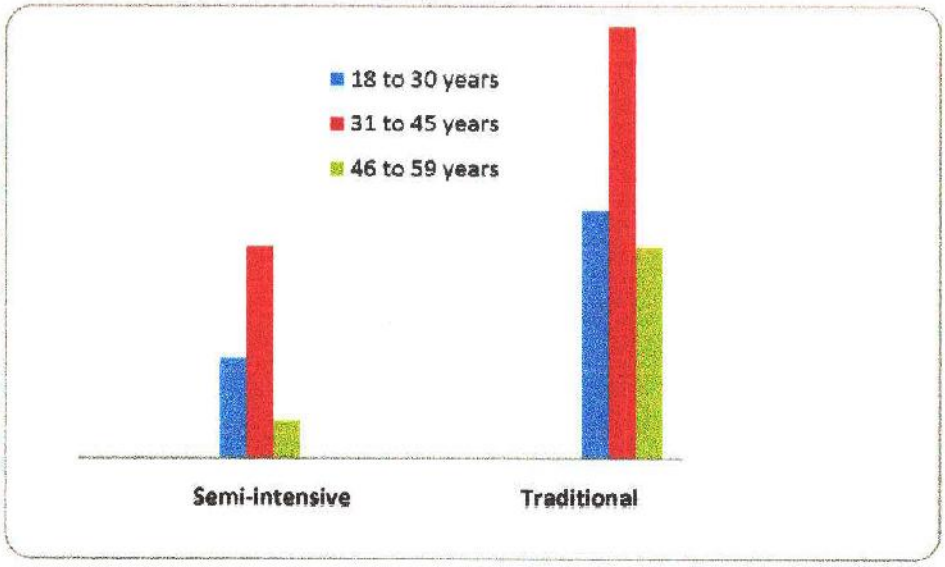

Fig-1: Age group of farmers in study areas

4.2 Education of farmers:

Four categories were used to define education level of farmers. These were-

1. Illiterate
2. Up to primary
3. Up to high school
4. Above high

Among the 28 interviewees, 1 had illiterate, 13 had education up to primary level, 5 had education up to high school and 9 had above high in the Semi-intensive management system.

Among the 72 interviewees, 21 respondents are found have no literacy or never attend school, the illiteracy rate remains high among adults whereas 39 had education up to primary level, 8 had education up to high school and 4 had above high in the traditional education system.

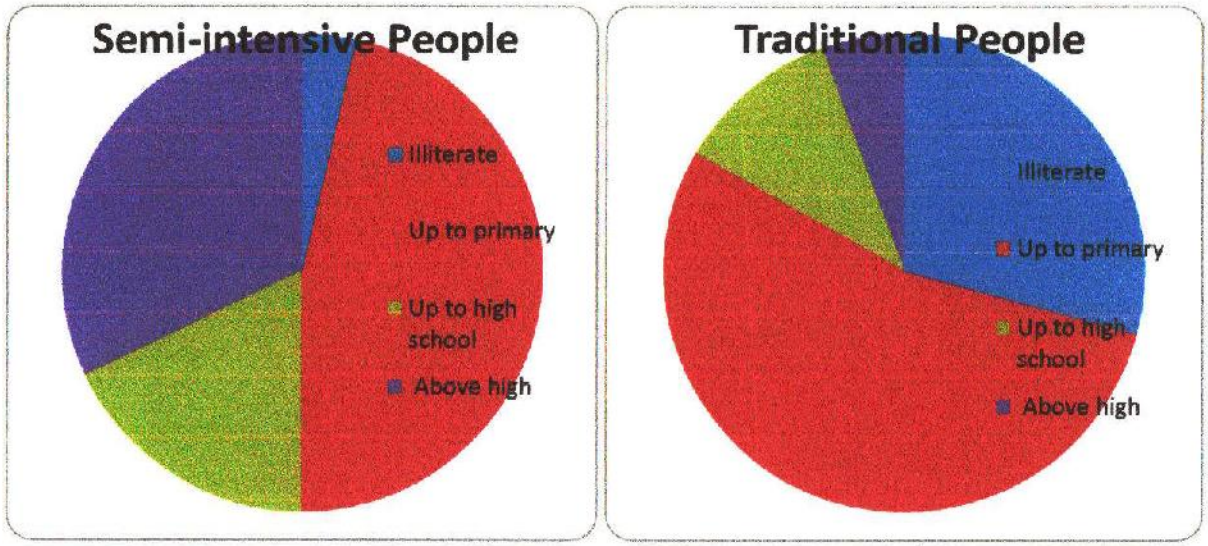

Fig-2: Literacy rate of farmers in study areas

4.3 Housing Status

From the study area it was found that among them 64% were in kacha, 10% were in semi-pucca and 25% were in pucca house dweller in the Semi-intensive management system respectively whereas 72% were in kacha, 7% were semi-pucca and 21% were pucca house dweller in Traditional management system respectively.

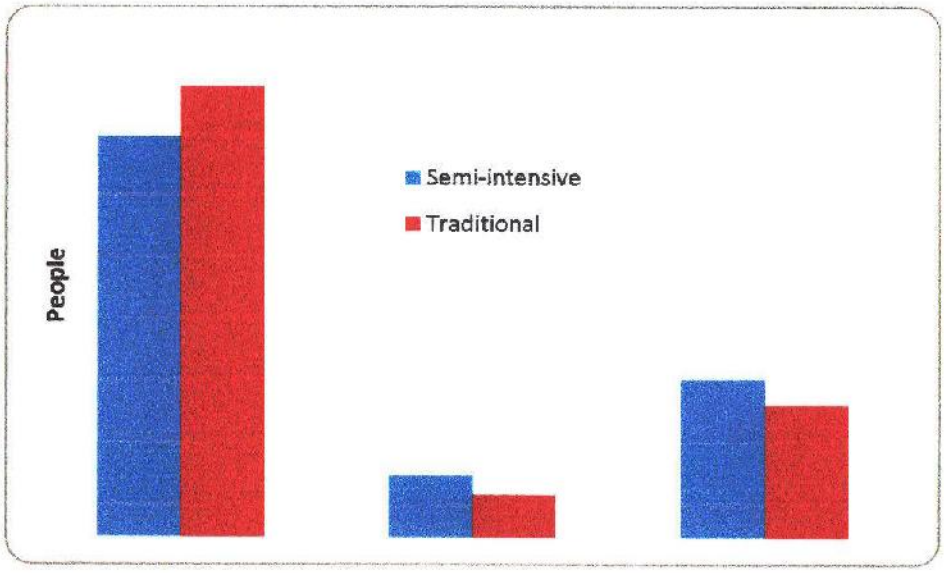

Fig-3: Percentage of farmers in respect of condition of house

4.4 Number of family members:

The average number of family members per family of shrimp farmers was estimated at 5 in Semi-intensive management system. In this management system 8 members are maximum and 3 members are minimum.

On the other hand, in the Traditional management system 8 peoples are maximum and 2 peoples are minimum where 4.6 was estimated as the average number of family members.

4.5 Occupation:

Three categories were used to define occupation of farmers. These were-

1. Only *gher*
2. *Gher*+ another one
3. Multiple

Among the 28 Semi-intensive management systeminterviewees, 8 were engaged with only *gher*, 15 were engaged with *gher* and another one, 5 were engaged with multiple in the Semi-intensive management system. Among the 72 Traditional management systeminterviewees, 32 were engaged with only *gher*, 36 were engaged with *gher* and another one, 4 were engaged with multiple in the Traditional management system.

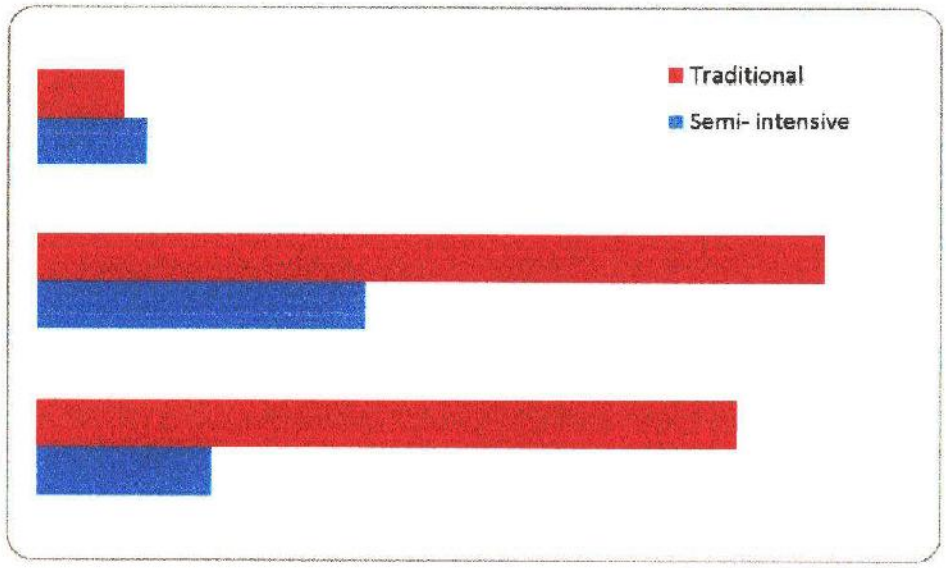

Fig-4: Variation of occupation of farmers in study areas

4.6 Land ownership:

Three categories were used to define land ownership of farmers. These were-

1. Own

2. Lease

3. Both

Majority of the Semi-intensive farmers had their own farm, however 6 had leased farmand only one had both. Average sizes of the farms were found 0.89 acre in the Semi-intensive study areas. The maximum and minimum sizes were 4 acre and 0.08 acre are found.

In Traditional management system, 19 had their own farm, 31 had leased farm and 22 had both. Majority of the farmers had both loans and leased farm. The average sizes were found 2.19 acre in the Traditional management system where the maximum and minimum values were 12.21 acre and 0.27 acre.

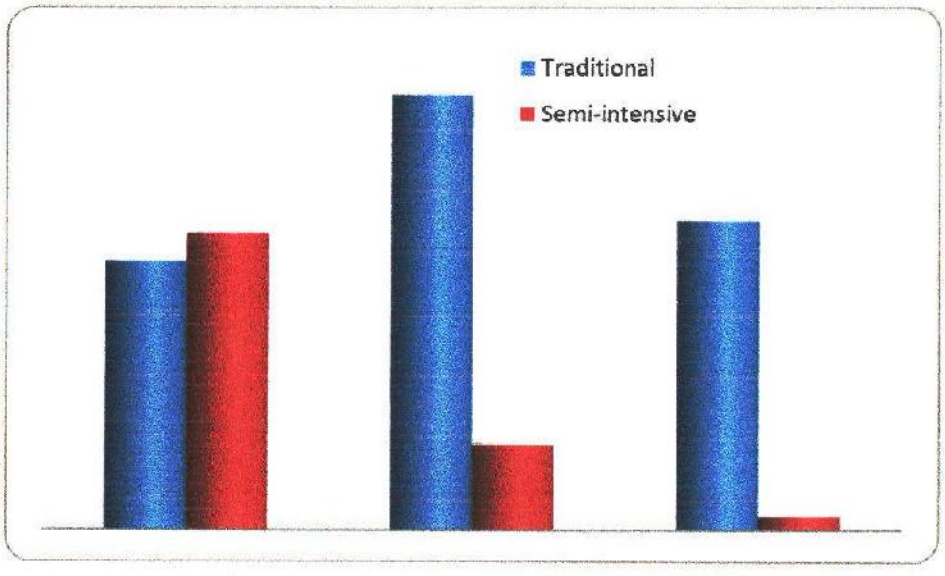

Fig-5: Land ownership of the farmers in study areas

4.7 Culture Management System:

4.7.1 Pre-stocking Management:

4.7.1.1 Re-excavation:

Traditional culture system

No specific design was followed by the farmer for traditional culture system. At the very beginning of pond preparation the bottom mud was removed by the farmer. The bottom mud was dug with a spade until the undesirable bottom black soil was partially removed.

Semi-intensive culture system

For the semi-intensive culture of shrimp was done for 110-120 days. In semi-intensive culture system it is very essential to make the farm bottom very properly. Through the inlet and outlet all the mud and sludge which were used in the last production was evacuated by centrifugal pump. Mud pumping process was continued until the harden mud was exposed. Initially farms were re-excavated and allowed to sundry to increase the capacity of oxidation of hydrogen sulphide and to eliminate other obnoxious gases.

4.7.1.2 Dike Preparation:

Traditional culture system

Dike was repaired to avoid the loss of cultural species. The farmer carried out the repaired of the dikes. The farmer pulled out manually aquatic weeds present in the farms. The netting controlled the aquatic weeds. In order to control predator, rotenone was used.

Semi-intensive culture system

For the semi-intensive culture system the farm dike need to be compact and wide to prevent the water flow from one farm to another farm. The base of each dike was 30′-40′, top of each dike was 15′-20′ and height: slope was 1:2.

4.7.1.3 Drying:

Traditional culture system

Majority of the farmers did not maintain the farm bottom drying in the proper way. This shrimp farming method is totally dependent on nature as well as presence or absence of drying.

Semi-intensive culture system

After eradicating mud and sludge from farm bottom it took 3 months (December-February) for the complete dryness. The farm bottom was scattered which indicated that the productivity of the pond would be good.

4.7.1.4 Liming:

Traditional culture system

The liming rate varied from 45-72 kg/acre yearly which were spread over the farm bottom including dike walls. Liming was done during fair weather. Lime was used by 80% farmers.

Semi-intensive culture system

20-25 kg/acre weekly $CaCO_3$ was applied with water and spreaded it all over the farm bottom. It was used to disinfect the farm bottom.

4.7.1.5 Watering:

Traditional culture system

68% shrimp farmers used direct canal water from nearby canals, 25% people used water from another farm and 7% used direct river water from nearby rivers.

Semi-intensive culture system

Like traditional system water was drawn from nearby canals of the farms. Before the entrance of saline water filter net was attached in the inlet pipe so that any foreign particle could not enter in the pond. During the high tidal period the ponds were filled by water installing filtration with

small mesh size filter net. When the salinity of river is 10-15 ppt then the water need to enter in the pond. Water was entered in the pond in the middle of February. The initial water levels in the ponds were maintained at 5 feet to 6 feet level. Water filtration net was kept fixed even after filling the water.

4.7.1.6 Installation of aerator:

Traditional culture system

In traditional culture system no farmer was found who were using aerator to add oxygen in the farm water.

Semi-intensive culture system

On the other hand in semi-intensive farming system all the farmers were found to use aerator in the farm to add additional oxygen in the ponds water. Usually four aerators consisting of four paddle wheels each (2 HP) were fixed at the four corner of the pond so that it could be used after feeding and whenever necessary. Maximum 16 hours aerator used in per day.

4.7.1.7 Water treatment:

Traditional culture system

No water treatment done in the traditional culture system.

Semi-intensive culture system

After the entrance of water into the farm it required 2-3 days for settlement. Cl was added in the bleaching powder at 30-35% to reach the level of bleaching powder 60 ppm. Mixing the mixture in hapa (made of blue net) and mixed it with the farm water. The aerator was started for 10-15 minutes as the mixture was spreaded through all over the pond. Bleaching powder was spreaded in inlet and outlet.

Dechlorination

After 3-5 days of chlorine application aerator was started at least 6 hours in day and night. Before stocking PL in the pond dragging the chain for 7-8 days so that any kind of gas would be out from the farms.

4.7.1.8 Fertilization:

Traditional culture system

In the study area farmers applied the following rate of fertilizer in their farm for shrimp production.

Table: Application rates of different types of fertilizer in farm for shrimp production (During pond preparation).

Name of Fertilizer	Application Rates (kg/ha)
Urea	37
TSP	18.5
Patash	6
Cow dung	1000
Mustard Oil Cake	247
Lime	247

Semi-intensive culture system

Molasses cooking juice

Rice polish 5-7 kg, molasses 5-10 kg, fish meal 2-3 kg and yeast powder 500-1000 gm mixture were applied for 5-7 kg/acre each day.

A. Soil

Initial dose was 6-7 kg/acre was applied. It actually helps to develop the plankton development in the farm.

p^H fixture

Initial dose was 1.5-2 kg/acre. It helps to stable the p^H in the pond. The suitable range of p^H is 7.5 to 8.5.

Blue mix

Applied dose was 1-2 kg/acre. It helps to the growth of phytoplankton.

Dolomite

Initial dose was 15-20 kg/acre. It was used as p^H buffer. It was also a source of Ca, Mg and CO_3.

Super PS

Before stocking the PL this kind of probiotics was applied for 5-7 liter/acre.

4.7.2 Stocking Management:

4.7.2.1 Source of fry

Traditional culture system

For traditional culture system, sources of PL included both wild means natural source of fry and hatchery produced fry. Majority of them used natural PL for avoiding disease.

Semi-intensive culture system

The sources of PL were mainly hatchery. For the stocking of PL the best size is PL-15, PL-16, PL-17. As the culture system was semi-intensive PL was stocked through PCR testing. One third of the polybag was filled with water. Before the packing and transportation of PL the ppt of the water in the polybag and rearing pond was maintained.

4.7.2.2 Stocking time

Traditional culture system

In traditional culture system farmers stocked fry from January to August. They stocked fry 15/ 20 days interval. Stocking was done in the morning because shrimp fry were highly sensitive to abrupt changes of water temperature and exposure to sunlight.

Semi-intensive culture system

For culturing two crop in the farm, 1st crop was stocked in the last of February to June and the 2nd crop was stocked from August to December. For the best time of stocking PL is morning and evening. During this time the temperature, DO is found in the optimum level and the survival rate is also good. In the semi-intensive culture system stocking density of PL is depend on the aeration.

4.7.2.3Acclimatization

Traditional culture system

The farmer stocked fry were carried to the farm in an earthen container called "Hari". The farmer acclimatized the fry through gradual exchange of transported water with the farm water. This was done by slowly adding pond water to the container.

Semi-intensive culture system

The survival rate of Pl depends on the adaptation of PL in the farm. Then hapa was made by sting or rope at the depth of 2-2.5 ft from the surface of the farm. PL carrying polybag was kept in the hapa for 10-15 minutes and water was sprinkled on the polybag. The polybag was uptight in the hapa and the water of the hapa and the pond was mixed so that the water temperature of the water was stable for the PL.

4.7.2.4 Stocking rate

Traditional culture system

The stocking rate for traditional farms was 2/3 per m^2 for shrimp PL.

Semi-intensive culture system

The stocking density of PCR tested Bagda PL was 13-15/m^2 which were purchased from commercial hatchery Gopalkhali, Batiaghata, Khulna.

4.7.2.5 Stocking of other species

Traditional culture system

In traditional farms, stocking of other species were galda, rui, katla, silver carp, mrigal.

Semi-intensive culture system

In semi-intensive farms there was only Bagda species.

4.7.3 Post-stocking Management:

4.7.3.1 Feed management

Traditional culture system

However, for traditional farms the farmer didn't use supplementary feed. Some of them used boiled rice.

Semi-intensive culture system

Composition of the feed ingredient needs to supervise carefully. Two kg feed was required for per 1 lakh PL on daily basis. The feeding schedule was based on the feed chart given by the CP Aquaculture (India) Pvt. Ltd. Company. Later the feeding was adjusted based on the check tray observation and body weight sampling. Four check trays were installed in each pond for monitoring feed intake. The required amount of feed were dispensed at certain interval in 24 hours period as follows- 25% in the morning (6.00am), 20% at noon (11.00 pm), 30% at evening

(6.00 pm) and 25% at night (10.00pm). The feed was broadcasted by rope method. The feed code which was used in the farm are: code 001, code 002, code 003, code 004s, code 004 and code 005. From the first day of PL stocking code 001 feed was implemented.

4.7.3.2 Sampling

Traditional culture system

In contrast, no sampling was done in traditional culture *ghers*.

Semi-intensive culture system

Sampling was done in quarterly for measuring body weight of the species and water quality parameters were checked.

4.7.3.3 Fertilization

Traditional culture system

In the study area farmers applied the following rate of fertilizer in their *Gher* for shrimp production.

Table: Application rates of different types of fertilizer in *gher* for shrimp production (During culture).

Name of Fertilizer	Application Rates (kg/ha)
Urea	18.5
TSP	10
Cow dung or Compaste	125 (Irregular)
Lime	60

Semi-intensive culture system

During the culture period different types of soil, water and feed probiotics such as Super PS, Super biotic, Mutagen, Zymatin, p^H fixer, Biotrim, Soda mix, K-max, Calmag, Sea max, a-soil

and dolomite were applied for maintaining soil, water quality and feed consumption of shrimp in probiotics ponds.

Probiotics	Applied Dose
Super PS	15-20 liter/acre
Super biotic	3 kg/acre
Zymatin	5 g/kg feed
p^H fixer	2 kg/acre
Biotrim	1 kg/acre

Minerals	Applied Dose
Soda mix	15 kg/acre
K-max	6 kg/acre
Calmag	10 kg/acre
Sea max	15 kg/acre

Nutrient	Applied Dose
A-soil	5 kg/acre

Binder	Applied Dose
Mutagen	5 kg/kg feed

4.7.3.4 Water quality parameters

4.7.3.4.1. Water temperature

Semi-intensive culture system

The water temperature values were varied between 28°C and 33°C in all the ponds. The water temperature values were found to fluctuate in all the ponds during the culture period.

Traditional culture system

The water temperature values did not observe.

4.7.3.4.2. Water Alkalinity

Semi-intensive culture system

The water alkalinity values were varied between 120mg/L and 190 mg/L in all the ponds. The water alkalinity values were found to fluctuate in all the ponds during the culture period.

Traditional culture system

The water alkalinity values were not seen.

4.7.3.4.3. Salinity

Semi-intensive culture system

The water salinity was varied between 7 ppt and 14 ppt in all the ponds. The salinity gradually increased from March to May in all the ponds. There after it started to decline. The fluctuation of salinity values showed different patterns in all the ponds throughout the culture period.

Traditional culture system

The water salinity was not seen.

4.7.3.4.4. pH

Semi-intensive culture system

The pH values were varied between 8 and 8.2 in all the ponds. The fluctuation of pH values showed different patterns in all the ponds throughout the culture period.

Traditional culture system

The pH values were not recorded.

4.7.3.4.5. DO

Semi-intensive culture system

The DO values were varied between 4 ppm and 9 ppm in all the ponds. The fluctuation of DO values showed different patterns in all the ponds throughout the culture period.

Traditional culture system

The DO value was not recorded.

4.8 Special measures to control disease outbreak

It was observed that, among all respondent 30% farmer has complete bio-security in their farms, 40% farms had no bio-security in their farms in traditional system and 30% had partial bio-security in their farms.

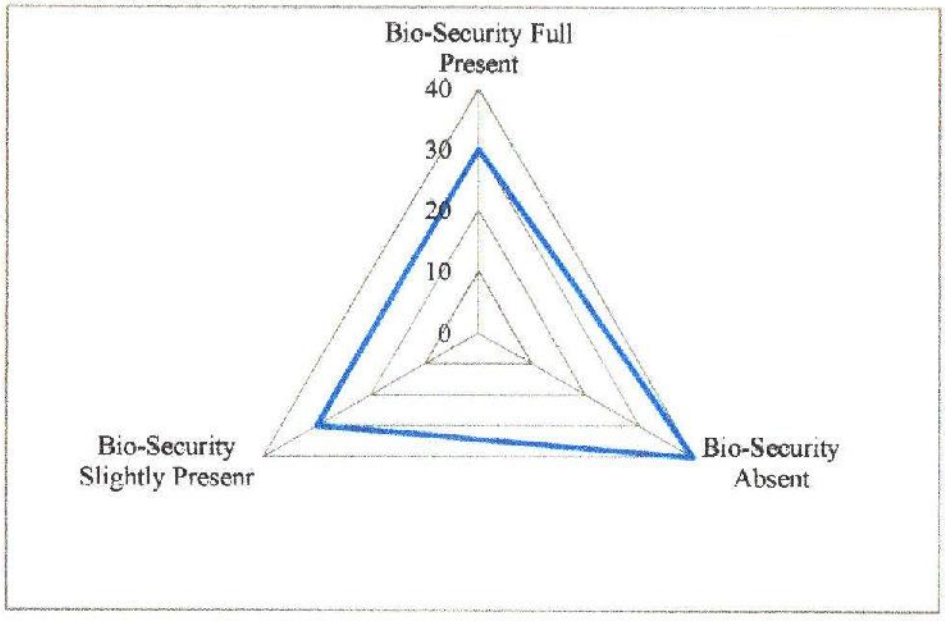

Fig-6: Bio-security measures to control disease outbreak in farms

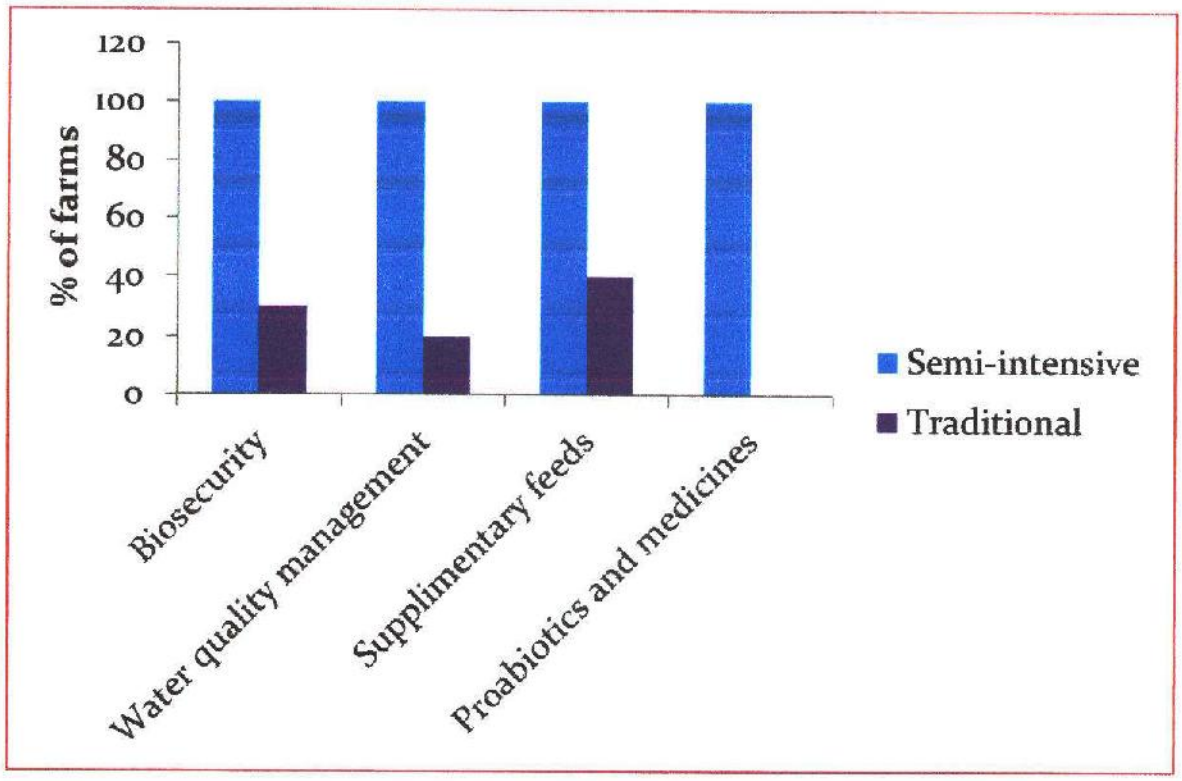

Fig-7: Special measures to control disease outbreak

1.8 Disease outbreak frequency

It was observed that, January-February and September to December is the most vulnerable month for the extensive and intensive. It was found that, in January-February 5 Semi-Intensive farms were out broken with diseases and 10 traditional farms were affected. In the month of March-April the outbreak reduces and 2 Semi-Intensive farms were out break with diseases and 5 traditional farms were affected. In the month of May-June, 2 Semi-Intensive farms were out break with diseases and 4 traditional farms were affected. In the month of July-August, 2 Semi-Intensive farms were out break with diseases and 6 traditional farms were affected. In the month of September-October, 4 Semi-Intensive farms were out break with diseases and 15 traditional farms were affected. In the month of November, December, 7 Semi-Intensive farms were out break with diseases and 18 traditional farms were affected.

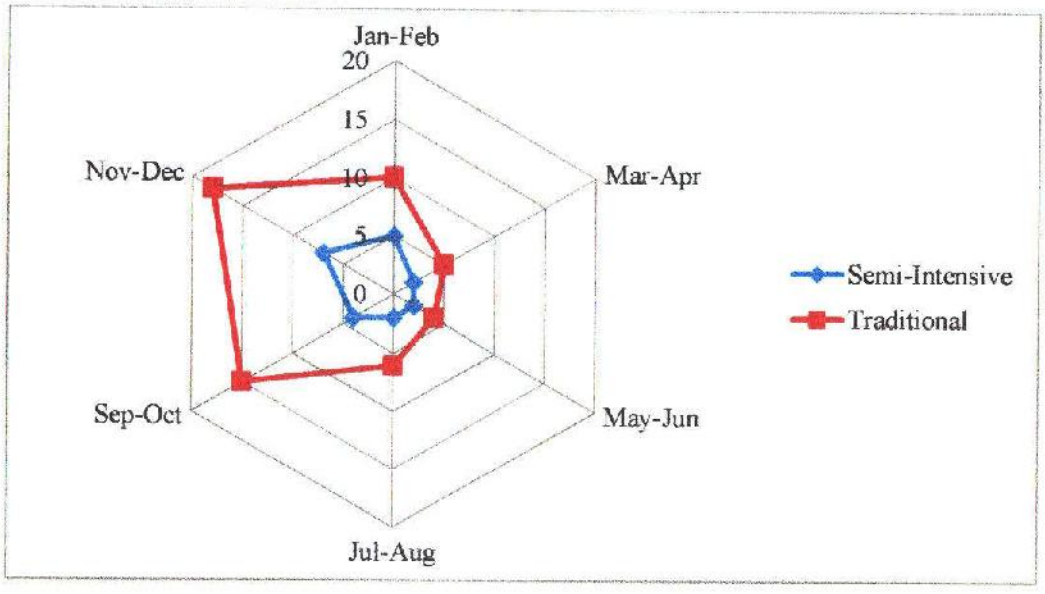

Fig-8: Disease outbreak frequency in study area

4.10 Cost-benefit Analysis:

Estimated cost for per acre in Semi-intensive Culture System and Traditional Culture System:

Description	Total Cost (Taka) Semi-intensive	Total Cost (Taka) Traditional
Lease Price	30,000/=	25,000/=
Pond Preparation	50,000/=	10,000/=
Fertilization	5,000/=	2,000/=
PL Stocking	30,000/=	10,000/=
Feeding	1,00,000/=	20,000/=
Medicine & Pro-biotics	1,50,000/=	-
Labor	80,000/=	8,000/=
Harvesting	5,000/=	2,000/=
Miscellaneous	1,30,000/=	3,000/=
Total amount	6,00,000/=	80,000/=

Estimated production for per acre for one cycle in Traditional Culture System:

Total production (kg)	Rate/kg (Taka)	Total Sell (Taka)
313	400	1,25,200

Estimated production for per acre in Semi-intensive Culture System:

Total production (kg)	Rate/kg (Taka)	Total Sell (Taka)
1,994	700/–	13,95,800

Net profit= Total cost-Total sell

Culture system	Net profit (Tk /acre)
Traditional Culture System	45,200
Semi-intensive Culture System	7,95,800

In the present study, it was found net low benefit from the traditional ponds and a higher benefit was gained from the semi-intensive ponds.

From the table it is clear that semi-intensive culture system is economically more feasible than that of traditional culture system.

5. Discussion

In the study area, most of the shrimp farmers were found to be quite middle age with a range from 17 to 73. It was found that in Semi-intensive culture system among the 28 interviewee, 8 had 18 to 30 years old, 17 had 31 to 45 years old and 3 had above 45 years. In traditional culture system among the 72 interviewee, 20 had 18 to 30 years old, 35 had 31 to 45 years old and 17 had above 45 years. Kaiya *et.al,* (1987) found that fish culture efficiency varied with the age and number of owners of pond in Tangail district. Vaumik *et. al,* (2017) stated that, 30% farmers were 31-35 years old, 31% were between 36-40 in Lalmonirhat district. Sharif *et. al,* (2015) concluded 85% farmer has the age of 40 and above in Jessore district. Islam *et. al,*(2015) founded in sundarban the maximum age level was 20-30 years old. Islam *et al.* (2014) revealed 44% farmer had a age level 31-40 years as well as Asif *et. al,*(2017) research found the 38% people has an age group of 51-60 years which is similar with the present study. Majority of fish agrarians (33.33%) were 31-40 years old. Alternatively, 30% respondents were 21-30 years old, 20% defendants were 41-50 years old, 13.33% respondents were above 50 years old (Islam, 2017). Among the 72 interviewees, 21 respondents are found have no literacy or never attend school, the illiteracy rate remains high among adults whereas 39 had education up to primary level, 8 had education up to high school and 4 had above high in the traditional education system. Zaman *et.al,* (2006) found that 23.3% farmers were illiterate whereas 14.4%, 8.9% and 6.7% were educated up to primary, secondary and higher secondary or above level respectively in Rajshahi district. Asif *et. al,* (2015) 46% of traders have institutional education; Asif *et. al,* (2017) stated 36% had primary level, 42% had secondary level (up to X), 10% had S.S.C. level, 4% had H.S.C. level and 4% had bachelor level of education. Hossain *et. al,* (2016) found most of the respondents (40%) are illiterate. In Meherpur another study found 16% farmer had primary level, 36% had secondary level, 20% had S.S.C. level, 14% had H.S.C. level, and 6% had bachelor level of education (Islam *et. al,* 2017). Hossain *et. al,* (2015) mentioned only 18.33% are secondary educated in Dinajpur district. Rahaman *et. al,* (2015) stated, most traders were quite young, with an average age estimated at 36 with a range from 23 to 57.Rahman *et. al,* (2017) mentioned that, 33% of the contact farmers had up to secondary level of education (S.S.C) and only 7% of the contact farmers had masters' degree and Sultana *et.al,*(2015) revealed 44% of farmers had age of 36 to 50 years which is more or less similar with present study.

Among all respondents 64% were lived in kacha, 10% were in semi-pucca and 25% were in pucca house dweller in the Semi-intensive management system respectively whereas 72% were in kacha, 7% were semi-pucca and 21% were pucca house dweller. Rahman (2003) reported that 70% of were katcha, while 21% were semi-pucca and only 9% were pucca in Gazipur district. Ahmed (2001) also found that 62% of katcha housing structure of prawn farmers in Mymensingh area. Asif and Habib (2017) stated around 88% had concrete house in Jhikargachha upazila, Jessore which is not similar with the study. Sharif *et. al,* (2015) found 54% farmers used semi pucca, 19% of fish farmers used to live pucca houses and rest of 27% farmers used to live earthen houses in Chaugachha, Jessore. Islam *et.al,* (2014) revealed full katcha (17 %) houses were few, while the semi-pucca (40%) and pucca (43%) houses were more abundant. Asif *et. al,* (2015) revealed, 78% of traders have own house but only 22 % of trader live in rental house or place. Islam *et. al,* (2017) stated, Majority (40%) of the respondents had tin shed house, 23.33% had semi-paka, 20% had paka house and only 16.67% had kacha house. Most of the collectors (63%) lived in mud walled with golpata shed, whereas 26% lived in tin shed houses, 8% lived in semi-pucca houses and others 3% lived in pucca houses (Islam *et. al,* 2015).It was estimated at 5 in semi-intensive management system. In this management system 8 members were maximum as well as 3 members are minimum. Alternatively, in the traditional management system 8 peoples were maximum as well as 2 peoples are minimum where 4.6 were estimated as the average number of family members. Joint family was predominant in the study area which also correspondents well with the findings of Ali *et.al,* (2009) in Mymensingh district; Ali *et.al,* (2016); Asif *et. al,* (2015); Asif and Habib (2017); Hossain *et. al,*(2015); Hossain *et.al,* (2016); Sharif *et.al,* (2015); Vaumik *et. al,* (2017) and Zaman *et. al,* (2017) also found the similar family in their research. Moreover, it was found that Small family was 24%, medium family was 54% and large family was 18%. Farid *et. al,*(2013) found that, 58% fishermen were lived in joint families which are similar with the present study. Masud (2000) observed in his study that average family size of farmers related to fish culture in inundated water bodies was 6.36 (members) in Kishorgonj district. Among the 28 interviewees, 8 were engaged with only *gher*, 15 were engaged with *gher* and another one and 5 were engaged with multiple in the Semi-intensive management system. Among the 72 interviewees, 32 were engaged with only *gher*, 36 were engaged with *gher* and another one, 4 were engaged with multiple in the Traditional management system. Asif and Habib (2017) stated, about 82% farmers had a primary occupation

of agriculture and others were involved in business (8%), service (4%) and politics (4%). Asif *et. al,*(2015) clarified, about 261 (87%) traders have secondary business like rickshaw business, fruit business, cloth business, fish trading etc.; Islam *et. al,* (2014) revealed, 51% farmers was involved solely in fish farming, 22% in fish farming with agriculture, 27% in fish farming with other profession. Razeim *et.al,* (2017) marked that; compared to 31.1 percent having highly favorable and only 18.9 percent had slightly favorable works. Ali *et. al,*(2016) stated, fish culture was found as the primary occupation, in terms of income, for 95% farmers. Zaman *et. al,*(2017) figured, the highest proportion (41%) of the people was involved in Pangasius farming as main occupation and their age was between 31-40 years and a study also observed that the farmers were massively involved in fish fish business in Noakhali district (Leela *et.al,*2018) which results is more or less similar with the present study.Average sizes of the farmswere found 88.77 decimal in the Semi-intensive study areas. The maximum and minimum sizes were 399.96 and 8.25 decimal are found. In Traditional management system, 19 had their own farm, 31 had leased farm and 22 had both. Majority of the farmers had both loans and leased farm. The average sizes were found 221.1 decimal in the Traditional management system where the maximum and minimum values were 1050 decimal and 26.4 decimal. Khan (1986) stated that fish culture efficiency varied with the size of ponds in Bangladesh. The average depth of pond depth is 3 meter. Razeim *et al.* (2017) found farm size of the Pangas farmers varied from 0.20 to 6.06 hectares. The average farm size was 1.35 hectare with a standard deviation of 1.01. According to DoF (2017) the average depth of ponds in Bangladesh is between 2 and 5 meter which correspond well with the study. Highest number of pond (40%) occupied by single owner, 20% was multiple owner, 30% was single lease and 10% was multiple lease. Hossain *et.al,* (2002) reported that multiple pond ownership was a major constrains for pond aquaculture in Naogoan. Zaman *et. al,* (2017) Average pond size was 0.17 ha of which 85% was perennial and 15% was seasonal. The mean pond size was 0.41±0.21 ha (0.343 to 0.478 at 95% CL). The minimum and maximum size was recorded 0.13 ha and 0.97 ha respectively (Ali *et. al,* 2016). Asif and Habib, (2017) stated most of them (32%) had ponds with size of 34-66 dec. On the other hand, 14 (28%) farmers had 15-33 dec. ponds, 14% had up to 100 dec., 22% had 101-330 dec. and 4% had 330-above decimal ponds. Islam *et. al,* (2017) stated the average pond size in the area was found 15 decimal with a range of 7 to 35. Before starting fish culture all the farmers got training and inputs support for fish culture from a local NGO called Daridra Bimochon Sangstha (DBS).

Vaumik *et. al,*(2017) revealed the average area of pond was 0.41 hectare and a depth of 1.69 meter. For the semi-intensive culture of shrimp was done for 110-120 days. In semi-intensive culture system it is very essential to make the farm bottom very properly. For the semi-intensive culture system the farm dike need to be compact and wide to prevent the water flow from one farm to another farm. The base of each dike was 30'-40', top of each dike was 15'-20' and height: slope was 1:2. Majority of the farmers did not maintain the farm bottom drying in the proper way. Chandra *et. al,*(2010) found that as pre-stocking management 54.47% farms were dried. Maximum 75% farms were dried in Fakirhat whereas 65% farmers in Sadar Thana did not dry their farms. After eradicating mud and sludge from farm bottom it took 3 months (December-February) for the complete dryness. The liming rate varied from 112-750 kg/ha which were spread over the farm bottom including dike walls. Liming was done during fair weather. Lime was used by 80% farmers. About 20-25 kg/acre $CaCO_3$ was applied with water and spreaded it all over the farm bottom. Mohanty *et. al,* (2014) stated pre-stocking pond preparation for brackish water monoculture of *P. monodon* included horizontal ploughing followed by application of lime ($CaCO_3$) at the rate of 300 kg ha-1 followed by longitudinal ploughing and application of lime ($CaCO_3$) at the rate of 200 kg ha-1. It was used to disinfect the farm bottom. About 68% shrimp farmers used direct canal water from nearby canals, 25% people used water from another farm and 7% used direct river water from nearby rivers. When the salinity of river is 10-15 ppt then the water need to enter in the pond. In Taiwan, 90% of water supplies consist of open sea water mixed with underground fresh water, keeping salinity constant at 10–15‰ (Kongkeo, 1997). Water was entered in the pond in the middle of February. The initial water levels in the ponds were maintained at 5 feet to 6 feet level. Initial water level retained as 0.95ha-m Mohanty *et. al,*(2014). After 3-5 days of chlorine application aerator was started at least 6 hours in day and night. Before stocking PL in the pond dragging the chain for 7-8 days so that any kind of gas would be out from the farms Mohanty *et. al,* (2014) revealed the similar strategy. Urea 37 kg/ha, TSP 18.5 kg/ha, Patash 6 kg/ha, Cow dung 1000 kg/ha, Mustard Oil Cake 247 kg/ha, Lime247 kg/ha were applied during the pre-stocking. Mohanty *et. al,* (2014) revealed fertilizer (Urea : Single Super Phosphate; 1:1) application at the rate of 4 ppm. Seven days after pond preparation, stocking operation was carried out. Ahmed *et. al,*(1999) revealed that, based on the level of acid content gher bottom was flushed 3-5 times with tidal water to minimize the acidity. Lime were also applied depending upon the pH level of the soil. Cow dung and mustard

oil cake (MOC) were applied at the rate of 500 kg and 100 kg/ha, respectively. For traditional culture system, sources of PL included both wild means natural source of fry and hatchery produced fry. Majority of them used natural PL for avoiding disease. Rahman *et. al,* (2017) stated the major source of fry were hatchery. Only 20% farmers of Fakirhat Thana released naturally collected PL and farmers of other Thana did not stock any PL of natural resource. Farmers of Mongla and Kachuathana (60% of each) used hatchery produced PL whereas 80% farmers in Rampal and 75% farmers in Mollahat Thana released both natural and hatchery PL Chandra *et. al,* (2010). Some believe that exponential aquaculture growth relieves pressures on marine resources and the natural stock of fish and contributes positively towards ecosystem and habitat modification (Naylor *et. al,* 2000, Frankic and Hershner, 2003, Costa-Pierce, 2010).For the stocking of PL the best size is PL-15, PL-16, PL-17. Chandra *et.al,* (2010) stated culture system was semi-intensive PL was stocked through PCR testing. Few differences in production were created due to differences of farm sizes, stocking densities, feed and management skills etc. Keawtawee *et. al,* (2012) revealed the post larvae (PL) 18 of *P. monodon* with the average size about 15-18 mm were stocked at the density of 15-20 PL/m^2. In traditional culture system farmers stocked fry from January to August. They stocked fry 15/ 20 days interval. The stocking density should be reduced to 20 m^2 (Kongkeo, 1997). For culturing two crop in the farm, 1st crop was stocked in the last of February to June and the 2nd crop was stocked from August to December. For the best time of stocking PL is morning and evening and the farmer stocked fry were carried to the farm in an earthen container called "Hari". The farmer acclimatized the fry through gradual exchange of transported water with the farm water which is similar with the acclimating time period study of Shabuj *et. al,* (2016); Rahman *et. al,* (2015); Shabuj *et. al,* (2016); Islam *et.al,*(2016); Hossain *et al.* (2016); Islam *et al.* (2017b); Shajib *et al.* (2017); Neowajh *et al.* (2017) and Zafar *et. al,* (2017). The survival rate of PL depends on the adaptation of PL in the farm. Then hapa was made by sting or rope at the depth of 2-2.5 ft from the surface of the farm. PL carrying polybag was kept in the hapa for 10-15 minutes and water was sprinkled on the polybag. Survival rates reveals in a study of Rahman *et.al,* (2017) were 75–80%. The stocking rate for traditional farms was 2/3 per m^2 for shrimp PL. The stocking rate of PCR tested Bagda PL is 15 PL which were purchased from a commercial hatchery were stocked at a density of 13/m^2. Stocking density of *P. monodon* seed were 15000/ha-17500/ha (Ahmed *et. al,* 1999). Rahman *et. al,* (2017) stated that, Stocking density of farmed shrimp were 400–500(No./m^2).

Keawtawee *et. al,* (2012) stated, the post larvae (PL) 18 of *P. monodon* with the average size about 15-18 mm were stocked at the density of 15-20 PL/m^2. Chandra *et al.* (2010) confirmed the average stocking density of shrimp PL golda and bagda was 24.16 and 12.16 thousand/ha in the farms. The stocking density is 21 post-larvae per m2, average survival rate was 63 percent stated by Gammanpila (2015). Low oxygen levels, which are a common problem in ponds with high shrimp stocking density, increase sensitivity to vibriosis in penaeid shrimp (LeMoullac *et. al.*, 1998). Maia *et al.*, (2016) stated, Shrimp *L. vannamei*(2.09 ± 0.3 g) were stocked in 2.6 ha ponds without liners at a density of 98 shrimp m-2. Ravuru and Mude (2014) found the stocking density and initial stocking was 60(m2). Gammanpila (2015) mentioned major differences between semi-intensive and intensive levels are in stocking density, aeration systems, farm size, production and investment. Annual shrimp production (kg/ha) from these systems are, 6,663 for semi-intensive and 7,801 for intensive system in 1995. In traditional farms, stocking of other species were galda, rui, katla, silver carp, mrigal. In semi-intensive farms there was only Bagda species. However, for traditional farms the farmer didn't use supplementary feed. Some of them used rice. Composition of the feed ingredient needs to supervise carefully. Two kg feed was required for per 1 lakh PL on daily basis. The feeding schedule was based on the feed chart given by the CP Aquaculture (India) Pvt. Ltd. Company. Later the feeding was adjusted based on the check tray observation and body weight sampling. Four check trays were installed in each pond for monitoring feed intake. The required amount of feed were dispensed at certain interval in 24 hours period as follows- 25% in the morning (6.00am), 20% at noon (11.00 pm), 30% at evening (6.00 pm) and 25% at night (10.00pm). Rahman *et al.* (2017b) stated that Feeding frequencies was four time in a day and *Penaeusmonodon* production ranged from 4275 to 9645.66 kg /ha cycle in semi-intensive farms. Keawtaweee*t al.* (2012) stated, Shrimps were fed with commercial shrimp feed (crude protein content 42%, C.P. Shrimp feed No. 1-3) at 3 or 4 times a day. Gammanpila (2015) mentioned initial average weight of post larvae 0.01 g and end of the culture cycle, average size of the harvested shrimp was around 27.0 g. Feed conversation ratio (FCR) was 1.3. Kautsky and Ronnback (2000) revealed , extensive aquaculture does not involve feeding of the organism; semi-intensive aquaculture involves supplementation of natural food by fertilization andror the use of feeds; intensive aquaculture is highly managed with culture species maintained entirely by feeding with nutritionally complete diets. Maia *et al.*, (2016) stated, the post larvae were fed 3 times a day (at 0800, 1200 and 1600 h), with a commercial shrimp feed

with 40% crude protein and 10% crude lipids, and adjusted daily according to the estimated shrimp consumption, mortality rate and leftover feed. The optimum feeding rate and frequency of presentation must, therefore, be determined for individual feeds and farms by carefully monitoring feed consumption, growth and feed efficiency over several growing seasons (Tacon, 1993). Bush *et. al.*, (2010) stated, the fisheries for gravid females; the possibilities for crustacean diseases to enter the culture system from the wild and the fish meal required for shrimp feed. Mohanty*et al.*, (2014) stated, under three different feed management protocols, treatment-wise estimated TWU was 2.52, 2.44 and 2.41 ha-m 119d-1, while the computed CWUI was 7.28, 6.88 and 6.34 in T1 (Regular feeding, 4-times a day), T2 (2-weeks feeding followed by 1-week no feed) and T3 (4-weeks feeding followed by 1-week no feed), respectively.Galappaththiand and Nayak (2017) stated, permanent enclosures created by shrimp aquaculture farms in the lagoon restricted free flow of both fresh (from rivers) and saline (from the sea) water, nutrients, natural fish seed and feed. In contrast, no sampling was done in traditional culture *ghers*. Sampling was done in quarterly for measuring body weight of the species and water quality parameters were checked. Sampling density (%) was found by (Kongkeo, 1997) 1.6 to 5.0 in different Asian countries. In case of semi-intensive culture methods the water temperature values were varied between 28°C and 33°C in all the ponds. The water temperature values were found to fluctuate in all the ponds during the culture period. The water alkalinity values were varied between 120mg/L and 190 mg/L in all the ponds. The water alkalinity values were found to fluctuate in all the ponds during the culture period. The water salinity was varied between 7 ppt and 14 ppt in all the ponds. The salinity gradually increased from March to May in all the ponds. There after it started to decline. The fluctuation of salinity values showed different patterns in all the ponds throughout the culture period. The pH values were varied between 8 and 8.2 in all the ponds. The fluctuation of pH values showed different patterns in all the ponds throughout the culture period. The DO values were varied between 4 ppm and 9 ppm in all the ponds. The fluctuation of DO values showed different patterns in all the ponds throughout the culture period. But in extensive culture method, in most of the cases farmer does not measure their pond's physical parameters. Temperature was found more or less similar and ranged from 24.7±5.59°C to 26±5.63°C and the other parameter like pH, Do and alkalinity were also found in optimum level (Rahman *et.al.*, 2017b). Such kind of relevant study were conducted by, Ali *et al*, (2016); Shabuj *et. al*, (2016a); Shabuj *et.al*, (2016b); Rahman *et. al*, (2015); Ahmed *et.al*, (2016); Shajib *et.al*,

(2017) Rahman *et. al,* (2017) and Islam *et. al,* (2016) which revealed the pH, DO and alkalinity parameters of the pond. It was observed that, among all respondent 30% farmer has complete bio-security in their farms, 40% farms had no bio-security in their farms and 30% had partial bio-security in their farms Shabuj *et. al,* (2016) found the similar findings in his shrimp disease outbreak study.

6. Conclusion

In the present study it is observed that semi-intensive culture system is better in all aspects of growth and economic feasibility (growth rate, survival rate, production rate, net profit and gross profit) than the traditional culture systems. Production cost in semi-intensive culture system is higher than the traditional culture system, which could be compensated by the total profit. The reason for the higher production rate in the semi-intensive culture system is due to higher stocking rate of PL, use of feed, regular use of lime, fertilizers, chemicals and better pond management practice.

To overcome the above-mentioned problems Government and Non-Government agencies should expand their extension services to the rural farmers to make them understand about scientific culture system of shrimp. It is also argent to set up a new micro-credit service system only for shrimp farmers in the coastal zone of Bangladesh. The credit system should be easy for the illiterate farmers to get loan within shortage period of time. Research activities on shrimp disease should be given immediate priorities, so those farmers might be taken preventive measurement against the outbreak of viral diseases. If proper steps are taken to overcome the problems of the farmers, they will get benefit by these, which promote our national economy.

7. Recommendations

1. Shrimp hatcheries should be increased to ensure the availability of the good quality PL to the farmers.
2. Insufficient credits to do semi-intensive culture practice.
3. Lack of extensive service from Government and Non-Government organization.
4. Proper training of the farmers is necessary to improve their skill in farming technologies.

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