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Biosecurity measures to address fish health management in Mymensingh district: A baseline survey

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Abstract
Biosecurity in aquaculture is a novel idea for preventing infectious diseases of aquatic animals. The study inspected the existing biosecurity status and health management practices in 24 commercial farms located in selected upazilas (*viz.*, Mymensingh Sadar, Trishal, and Muktagacha) under Mymensingh district. Data were collected through participatory rural appraisal (PRA) tools such as questionnaire interview, focus group discussion (FGD) and key informant interview. The results revealed that monoculture was similarly preferred as polyculture (50%) by the respondents. However, a good proportion (29.16%) of the farmers did not have decent understanding on biosecurity issues. Biosecurity measures such as sprays, footbath and sanitary facility, showers, disinfection of transport equipment, protective clothing for visitors and quarantine facilities were absent in those farms. However, majority (83.33%) of the farmers had protected dykes and boundary fences in their farms. Bio hygiene measures such as control of rodents and insects in feed storage, water exchange in the pond, control of predators/pests in farm and disinfection of equipment used for culture operation etc were also followed on a very limited basis. Most farmers (87.5%) have stocked diseased free fry from various hatcheries while a few (8.33%) supplied from their own hatchery. Preventive measures such as regular health checking (66.67%), drying of pond (66.67%) and applying lime in the pond (100%) were practiced in the studied farms. About 66.67% farmers used probiotics in their farms for beneficial purposes like water quality management, growth enhancement and disease resistance. Importantly, farmers who at least partially followed biosecurity measures obtained better fish production than those who did not. The findings revealed preliminary information about the general biosecurity and current health management status of Mymensingh farms which demands further information for sustainable fish production.

Keywords: aqua farms, biosecurity measures, aquatic diseases, fish health management

Introduction
Aquaculture is one of the world's promising and fastest developing food- producing sectors with the largest potential to accomplish growing demand of aquatic food. World aquaculture has immensely grown during the last few years as well as becoming an economically significant zone. With the rising commercialization and intensification of aquaculture production, diseases and deterioration of environmental conditions are major problems in fish farming and face massive economic losses. For prevention and control of diseases, antibiotics used as traditional strategy during the last decades and also for fish growth as well as efficacy of feed conversion. Aquaculture industry is promoting overall fish production in Bangladesh but facing problems of water pollution and disease outbreaks. Certain bacteria like Aeromonas sp., Edwardsiella tarda sp, Vibrio sp., fungi like Aphanomyces invadans, Saprolegnia sp., some parasites and other factors such as environmental stress, nutritional deficiency etc. are mainly responsible for the disease outbreaks of fish and have caused significant economic losses. Potential economic losses from disease outbreaks are significant, and can affect the survival of the industry (Ahmed et al., 2015) [1].
In order to prevent disastrous epidemics of infectious organisms in aqua farms, an adoptive approach to biosecurity and disease management needs to be followed. Biosecurity can be defined as „the measures and methods adopted to secure a disease-free environment in all phases of aquaculture practices (i.e. hatcheries, nurseries, grow-out farms) for improved profitability". Participants at the workshop defined biosecurity as "an essential group of tools for the prevention, control, and eradication of infectious disease and the preservation of human, animal, and environmental health" (Lee and O"Bryen, 2003) [9, 15].
The total area of Mymensingh district is 4363.48 km2. Some upazilas under this district including Mymensingh Sadar, Trishal, Muktagachha, Tarakanda, Fulbaria, Ishwargnaj, Gouripur etc. are rich in huge amount of hatcheries and farms. Many people are involved in commercial fishing and contribute a major role in the food sector. Islam (2002) [7] reported that 92% of the pond owners wanted to culture fish and all of them were in favor of carp culture. Most farmers (64.15%) are interested on polyculture than monoculture because of high

production. This has been possible due to enormous natural water bodies in the form of pond, dighi, canal, river, beels etc. and also the support of government and non-government organizations (Rahman, 2005) [11].

The main purpose of an aquaculture biosecurity program is to prevent the introduction of any infectious organism into the facility (Bebak, 1998) [2]. If this is not always practicable, the goal of eliminating or controlling infectious diseases within the facility may have to be amended. There are a variety of ways for an infectious agent to get enter an aquaculture plant. Additions of new stock, polluted water or feed; persons, animals, or equipment; and subclinical carriers within current stock are all examples. To avoid the entry of infectious organisms into the facility, each of these possible sources must be analyzed and regularly monitored. Disease prevention, disease monitoring, cleaning and disinfection between production cycles, and general security procedures would all be part of a good biosecurity program for a fish or shellfish aquaculture operation (Smith, 2012) [13].

Biosecurity requires the adoption of a set of attitudes and behaviors by people to reduce risk in all activities involving domestic, captive exotic and wild birds and their products. Disease causing organisms are often spread by people or equipment. Biosecurity measures reduce the risk of exposing farmed animals to disease causing organisms by preventing the spread of disease organisms onto and off a farm and preventing the spread of disease organisms within a farm.

With the increased intensification and commercialization of aquaculture practice, fish health has turned into a most important issue to aqua culturists. In aquaculture, application of antibiotics was generally used as the most familiar technique for dealing with the incidence of bacterial diseases. The indiscriminate use of these antibiotics for maintaining bacterial infection has been accountable for the development of antibiotic resistant bacteria, that has significant effect on the reduction of the efficiency of a treatment option and may be liable for long term unpleasant impacts in the aquaculture environment such as accumulation of those antibiotics in fish body tissues, reduction of beneficial microbiota and immune suppression of fish. Among all of the mentioned unpleasant impacts, the development of antibiotic resistant bacteria has paying more attention globally. Due to the threat related with the application of antibiotics, the improvement of a non-antibiotic eco-friendly agent is being considered as the most significant factors for proper health maintenance in aquaculture.

Considering the situation, a detailed survey is planned to conduct in some selected areas of Mymensingh district to determine and compare the situation of biosecurity management in aquafarms where the probiotics using concept and to understand the infected environment in appropriate ways for saving the farmed fish stock. The present study will enable to find out the problems related to fish farm biosecurity and will contribute using of probiotics to enhance more production of commercial fish farms in Mymensingh district.

Materials and Methods

Study area

Field data on the status of fish farming, production, occurrence of disease, farm biosecurity, using concept about probiotics and overall fish health management strategy were collected for a period of time through questionnaire survey from twenty-four aquafarms of three Upazila of Mymensingh district i.e., Mymensingh Sadar, Muktagacha, and Trisal. Necessary data were collected from fish farmers by frequent field visits and interviews.

Selection of fish farms

Four farmers from each of three upazilas were selected after successful discussions with the upazila fisheries officer, some commercial feed and animal health medicine company Officers. Total 24 farms were selected from Mymensingh Sadar, Muktagacha and Trisal under Mymensingh District. The area was selected considering the following factors: Large number of pond farms, fish culture as a rising trend, easy communication facility. The study area was near the BAU campus and thus it was less expensive as well as easier for the researcher to collect valuable data. There was no or less investigation was conducted in this respect.

Data collection method

A set of questions was organized in a sequential and required logical format to collect the data. Participatory rural appraisal (PRA) tool including focus group discussion (FGD) was conducted with fish farmers. Crosscheck interviews were conducted with key informant such as District Fisheries Officer, Upazila Fisheries Officer, different commercial feed company officer and animal health company officer working here in Mymensingh district.

Prior to field survey, background information on the number, location and distribution of fish farms and aquaculture activities were collected. Data collection method was divided into four steps i.e.,

(i) Questionnaire interviews,
(ii) Focus group discussion,
(iii) Cross check interviews with key informants,
(iv) Observations of locations.

Questionnaire interviews

The questionnaire had been divided into several sections. The first section focused on general farming and farmer‟s personal information, the second section on stocking and pond management information, the third

section covered the information on biosecurity issues and the final section focused on fish health and disease problems, their management interventions used to control disease.

Focus group discussion
Information from fish farmers were collected through focus group discussion. FGD was conducted to get an overview of fish farming activities in the study area.

Cross check interviews with key informants
Cross check, interviews were conducted with key informants such as Senior Upazila Fisheries Officer, Upazila Fisheries Officer and different commercial feed and medicine company officer working in Mymensingh district, where information was contradictory or requested for further assessment.

Observation of the locations
Besides interview, some required information was collected by direct observation including nature of the culture ponds, culture species, biosecurity issues, farming activities and harvesting and marketing system of fish etc. The photographs cover the physical features of the study areas (Fig.1).

Fig 1(a): Observation of farm area

Fig 1(b): Observation of farm area

Statistical analysis
All collected data were analyzed using "Microsoft Excel 2016". The summary tables were prepared to fulfill the objectives of this study. The results were shown in descriptive tabular and graphical presentation.

Results
Biosecurity status of some aquafarms of selected Upazila under Mymensingh district; (*viz.*, Mymensingh Sadar, Muktagacha, and Trisal) are described in this chapter.

Pond area and depth
The average pond area was ranged between 150 and 2000 decimal in Mymensingh Sadar, whereas it ranged from 100 to 1500 decimal in Trisal. However average pond area was comparatively higher in Muktagacha within

200-4000 decimal. In contrast, the highest average pond depth was 173.75 cm in Trisal followed by 152.5 cm in Mymensingh Sadar and the lowest was 147.5 cm in Muktagacha Upazila (Fig.2 and Table 1).

Table 1: Pond area selected upazila of Mymensingh district

Description	Pond area of selected upazila of Mymensingh district		
	Mymensingh Sadar	Muktagacha	Trisal
Area(dm)	150-2000	200-4000	100-1500
Avg. area (dm)	1075	2100	800
Depth(cm)	122-183	77-218	127.5-220
Avg. depth (cm)	152.5	147.5	173.75

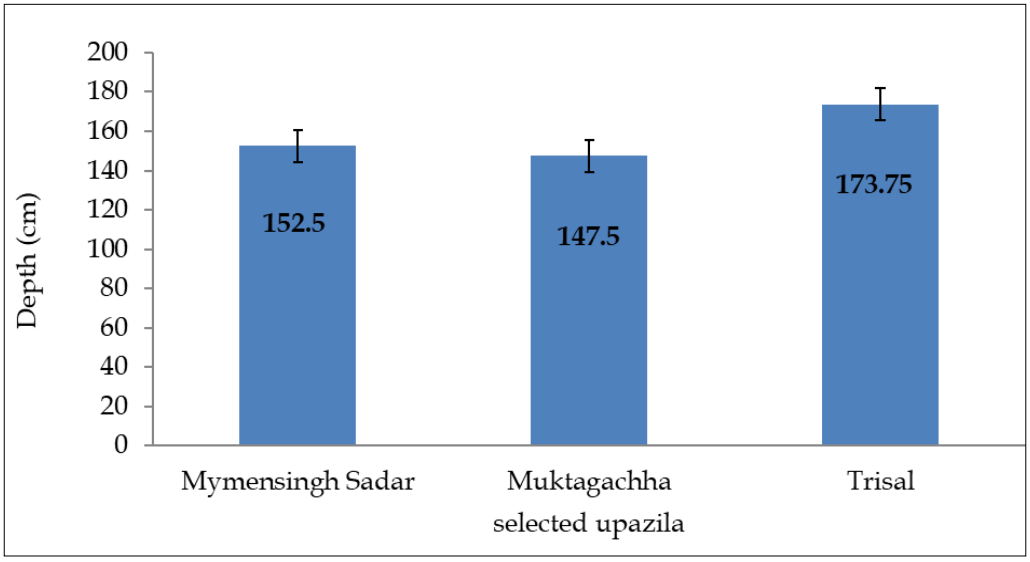

Fig 2: Average pond depth (cm) in different fish farms of study area

Pre-stocking management

Farmers prepared their ponds thorough pond drying (66.67%), pond mud removal (75%), undesirable species removal (100%), repairing pond embankment repair (83.33%), aquatic weeds removal (83.33%), liming (100%) and fertilization (16.67%) (Table 2). The percentages of different measures of pond management were more or less same in all the selected areas. In case of pond mud removal and same on embankment repairing, there was a noticeable difference seen between Muktagacha and other upazila because of comparatively bigger pond area and very often removal of pond mud due to high expenditure. In some areas farmers did not use fertilizer since they used medicine for creating suitable environment especially for enhancing phytoplankton and zooplankton growth.

Table 2: Pre-stocking management in selected Upazila of Mymensingh district

Measures usually taken before stocking of fish fry	Respondent		Total farmers	Positive (%)	Negative (%)
	Yes	No			
Pond preparation	24	0	24	100	0
Pond drying	16	8		66.67	33.33
Pond mud removal	18	6		75	25
Undesirable species removal	24	0		100	0
Pond embankment repair	20	4		83.33	16.67
Aquatic weeds removal	20	4		83.33	16.67
Liming	24	0		100	0
Fertilization	4	20		16.67	83.33

Biosecurity issues

From the study, it was observed that only a few farms were surrounded by boundary fences while most of the farms had no boundary. In Mymensingh district 83.33% farms were surrounded by boundary (Fig.3 and Fig.4).


Fig 3: A farm with a fairy fence **Fig 4:** A farm without boundary fence

Protected dykes

It was found that some farmers did not repair dikes due to large size of ponds. They were not well concerned about the protection of dikes. Each of the studied area had same ratio (83.33%) of protected dikes on the ponds (Fig.5 and Fig.6).


Fig 5: Unprotected dyke of a pond **Fig 6:** Protective dyke of a pond

Driveways

There were 50% farm in selected areas had the system and 50% of them had no significant driveways.

Foot or tire bath facilities, showers and cloth changing areas

It was found that there were neither a foot or tire bath facilities before entering into neither the farms nor a cloth changing area to put on a new set of freshly laundered clothing for their staffs or visitors.

Restriction on unwanted entry

Farmers were found very unwilling to limit the access of unwanted people around 17% farmers of the selected area-maintained restriction on public entry. In the survey area, it was found that most of the farmers had no worry about the cattle. A few farmers in Mymensingh sadar tried to maintain that. There was no scope to enter wild fish into the farms in Muktagacha. Some areas of Trisal were situated in low land area that‟s why wild fish could enter into the farm if the area flooded during rainy season (Fig.7). The percentage of water quality parameters measurement was shown in Fig.8.

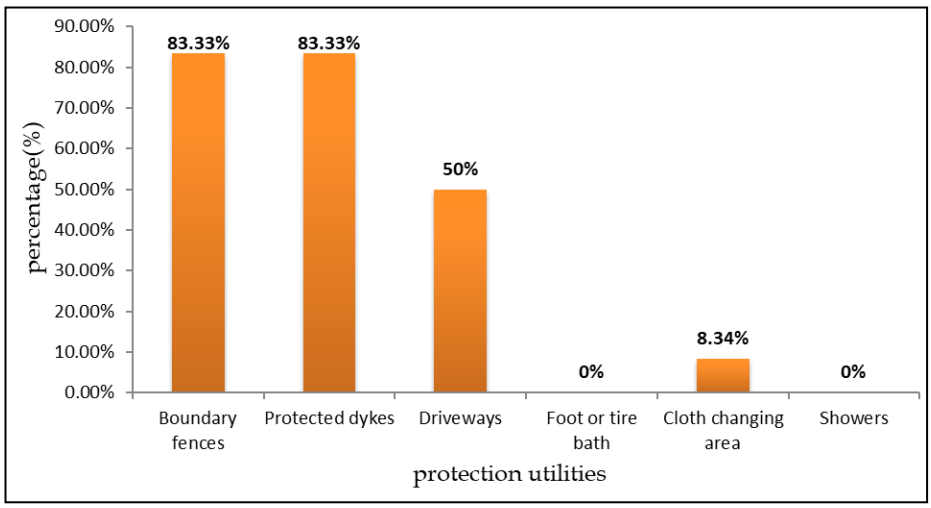

Fig 7: The protection utilities followed in Mymensingh district

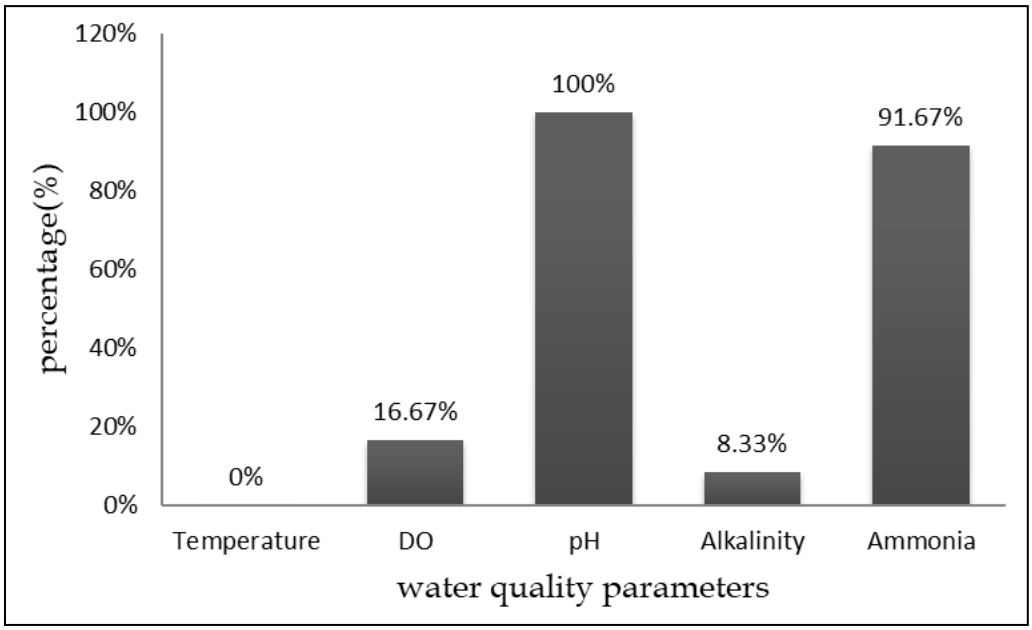

Fig 8: Farmers measure water quality parameters in Mymensingh district

Removal of pond waste

In selected Upazila of Mymensingh, 75% farmers removed pond bottom waste and dried their culture ponds after two or three cycle of production.

Providing protective clothing for visitors

It was found that farmers did not provide protective clothing for visitors and their staffs before entering into the farm. Farmers did not have awareness about this matter.

Disinfection of transport equipment

After harvesting, farmers used plastic baskets, aluminum pots, plastic drums etc. to transport the fishes to the market by transporting vehicles like manual van, pickup truck, lorry etc. There was no farmer use disinfected the transport equipment.

Facility of sprays, footbaths to disinfect boots and vehicles

There was no facility of sprays, footbath to disinfect boots and vehicles like van, truck, lorry etc. before entering into the facilities. Farmers did not follow this biosecurity program.

Major diseases concerned in the fish farms

Diseases were reported mainly in winter season over the study area. Severity occurred mostly in early and late winter. Health and disease condition of fish were examined clinically through direct observation of fish in farms or asking farmers through questionnaire and FGD. The most common diseases found in pangas were epizootic ulcerative syndrome (EUS), bacillary necrosis of pangasius (BNP), red spot disease, tail and fin rot etc. Farmers mentioned that diseases in tilapia were not a major problem. In case of tilapia- carp poly culture system, carp species were affected by various diseases followed by EUS, tail and fin rot etc. EUS and fin rot were most common diseases in the koi farms. A few farmers also mentioned that they observed ectoparasite on the fish skin. Farmers never confirmed disease outbreak by a laboratory.

Disease and health analysis of cultured ponds

Data regarding the disease and health analysis of cultured ponds showed that there were four different types of diseases found in the study area including bacterial, viral, fungal and protozoan diseases. These diseases further categorized as low, medium, highly and not concerned of the farmers. The whole data is represented in Fig.9.

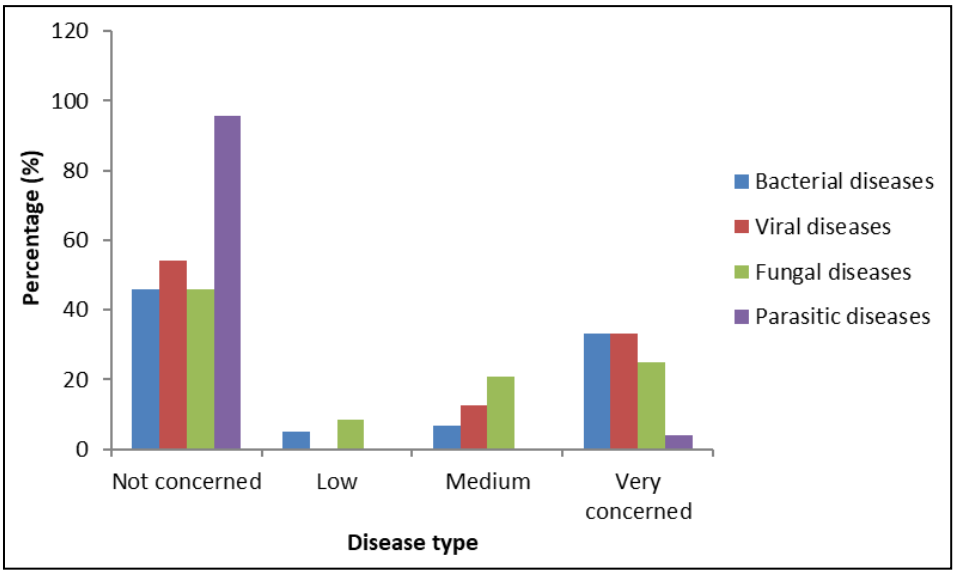

Fig 9: Status of type of diseases in Mymensingh district

Preventive measures

Most of the farmers took some preventive measures such as regular fish health checking, pond drying, application of lime, weeding the pond, removing water turbidity, addition of water etc. Almost all the farmers (100%) in the selected area, always apply lime in their pond. About 0% farmers in the study area took measures to remove water turbidity where 58.34% farmers always added water into the pond. Controlling aquatic weed was practiced always by 41.67% farmers (Table 3).

Table 3: Preventive measures took by the farmers of three Upazila (n=24)

Measures practiced	Average farmers response		
	Never	Usually	Always
Regular fish health checking	0%	33.33%	66.67%
Pond drying	8.33%	25%	66.67%
Application of lime	0%	0%	100%
Weeding the pond	16.66%	41.67%	41.67%
Removing water turbidity	100%	0%	0%
Addition of water	33.33%	8.33%	58.34%
Other	100%	0%	0%

Use of antibiotics and chemicals

From the survey it was found that only 25% farmers in the selected upazilas used different types of antibiotics and chemicals to control diseases. About 75% farmers did not use any types of antibiotics and chemicals to control diseases. Farmers used some common antibiotics like Cepro-vet, Renamycine, ACE ox, Bio-Oxy, Cepro plus, Rich-Bio, Sumithion, Gas trap, Zeolite, Virex, Oxy Vast etc. Application of lime and salt were the most commonly used chemicals for the treatment of diseases.

Impact of biosecurity on pond

From the survey it was found that the ponds which were practiced biosecurity measures (partially) got higher annual production than the ponds which were not practiced.

Table 4: Comparison of avg. fish production (kg/decimal/year) after following biosecurity measures (partially practiced)

Mymensingh Sadar			Muktagacha		Trisal	
Biosecurity partially practiced n=4		No biosecurity measures n=4	Biosecurity partially practiced n=5	No biosecurity measures n=3	Biosecurity partially practiced n=5	No biosecurity measures n=3
158.5±3.11		150.5±5.97	145.5±2.92	138.33±3.06	161.6±3.12	153.33±4.51
161.3±3.01		145±4.7	142.03±3.09	133.94±4.1	170.9±3.41	157.83±3.97
149.25±2.90		153.03±5.3	151.57±2.34	141.54±3.75	163.64±4.92	162.74±4.21
164.28±3.65		156.25±4.94	139.07±4.81	-	169.39±2.04	-
-		-	147.68±3.29	-	171.76±3.07	-
Avg.	158.32±3.17	151.19±5.21	145.17±3.29	137.94±3.63	167.46±3.31	157.96±4.2

Biosecurity (partially) practiced ponds reduced the risk of disease introduction, increased the quality of fish health. In this study, there was a reversing relationship between biosecurity measures (%) and disease rate (%). A farm following around 80% of biosecurity measures minimized almost 20% disease introduction from no or less followed farms (Fig.10).

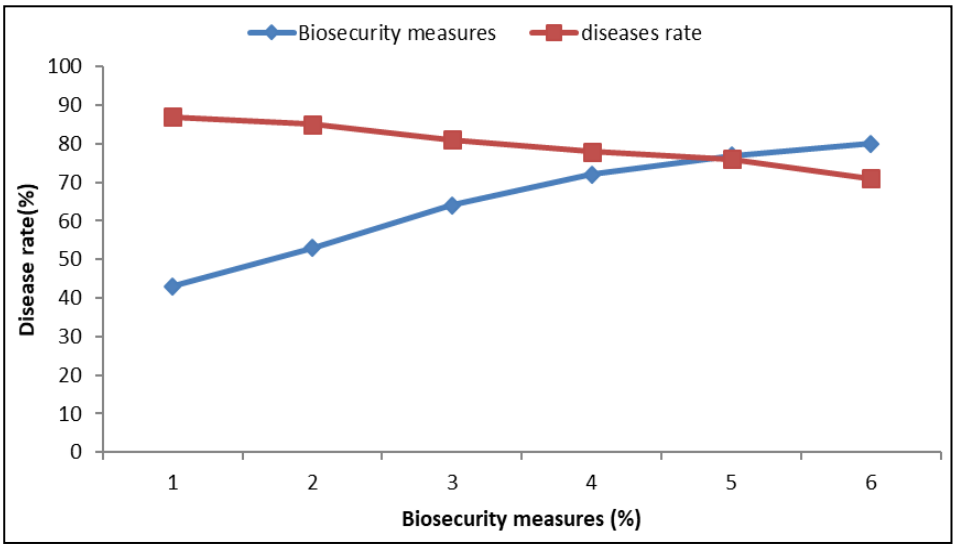

Fig 10: Relationship between biosecurity measures and disease

Use of probiotics

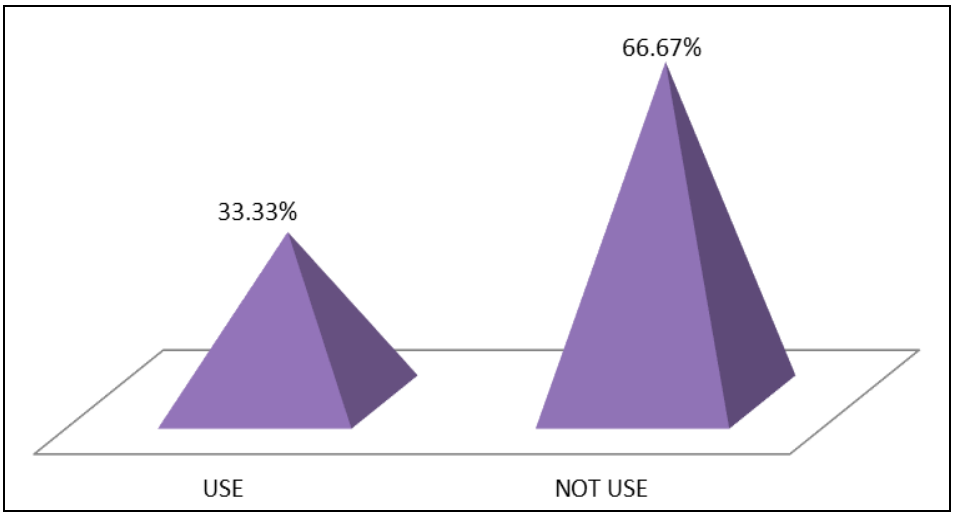

Fig 11: Probiotics using farms

Among the participants only 33.33% farm owners used probiotics in the pond for beneficial purposes where 25% of farms used water quality regulatory probiotics, 25% of farms used soil probiotics and 8.33% used gut probiotics (Fig.11).

Discussion

The goal of this study was to learn more about the ongoing level of biosecurity in commercial fish farms of the Mymensingh District. Farm location, exposure to entering pollutants, predators, wild fish and animals, visitors movement, sources of water, water treatment facilities, sources of fry, quarantine facilities, disposal of dead and moribund fishes, feed storage facilities, waste management, disinfection of nets and other farm equipment, and general farm hygiene were all factors considered. Despite the fact that commercial farmers lacked a thorough understanding of biosecurity procedures, several reputable farmers were working to enhance their farms' biosecurity status.

According to Chang and Liu, 2002 [3] it is critical to prevent predators or pests from entering farms since they can spread disease to other farms. In aquaculture farms, birds are key predators or pests. It's been proven that birds can spread bacteria and viruses through their droppings. Fish can also be dropped from one body of water to another by birds. Various aquatic birds were observed surrounding fish farms in this study, with the majority of farmers attempting to manage predatory birds like as kingfishers, pankouris, and herons, but other farmers

were unable to do so because to the scale of the farm. Farmers tried to keep predatory birds at bay by draping polythene ropes horizontally over the ponds.

Record keeping is a paramount to the success of any biosecurity program. The fish producers in this study found that keeping records was not a frequent practice. Most farmers kept a basic record of fry prices, transportation costs, labor costs, feeding costs, medicine use, netting and harvesting costs, selling prices, and income, among other things. Faruk *et al*. (2012) [6] found similar results when looking at the biosecurity of fish hatcheries.

Smith (2012) [13] stated that an important area of disease prevention and control that is often overlooked in the aquaculture industry is disinfection. Routine disinfection is used to reduce the pathogen load in a facility, thereby reducing the risk of spreading an infectious organism between groups of fish or shellfish in a single facility.

A few farmers were found to be using various sorts of antibiotics and pesticides to control infections, according to the report. Antibiotics such as Ciprofloxacin, Tetracycline, Oxytetracycline, and chemicals like Zeolite, Bleaching Powder, Phostoxin, Rotenone, and others were used. Farmers are unaware of the long- term effects of these synthetic medications, according to Faruk *et al*. (2008) [4]. Chemical costs were found to be the most expensive, accounting for 25.77% percent of overall costs in the Noakhali district, according to Shohel (1998) [12]. Lack of understanding about chemical use, suitable dose, application method, and indiscriminate chemical use were all recognized as concerns in the study. Therefore, farmers could be suggested to take some preventive measures at the beginning of the winter season which includes application of lime and salt, disinfecting of equipment, addition of water etc. (Faruk *et al*., 2004) [5].

In the present study, it was found that many farmers used probiotics in their ponds for beneficial purposes such as growth enhancement, disease resistance, water quality improvements etc. Most studies concerned with the effects of probiotics on cultured aquatic animals and emphasized a reduction in mortality or conversely, increased survival (Change and Liu, 2002) [3], improved resistance against diseases (Yoshimizu, 2003) [15], enhanced ability of beneficial microbes to adhere and colonize in the gut to antagonize harmful organisms (Pietrak *et al*., 2010) [10] and to produce polyamines and digestive enzymes (Winton, 2002 and Islam, 2018) [14, 8].

In summary, from the survey it was found that the ponds which were practiced biosecurity measures (partially) got higher annual production than the ponds which were not practiced. Biosecurity (partially) practiced ponds reduced the risk of disease introduction, increased the quality of fish health. In study, there was a reciprocal relationship between biosecurity Minimal additional cost of biosecurity also provided the higher profits through fish production. From the data found that additional cost of biosecurity increased the fish production up to 6-7% which provided 8-10% extra profits.

Conclusions

Biosecurity difficulties in Bangladeshi commercial fish farms are not widely understood, and the phrase "biosecurity" is unfamiliar to the farmers. Despite the fact that most farmers did not have a thorough understanding of biosecurity protocols, they took some biosecurity precautions to avoid disease introduction and spread on their farms. It was discovered that all of the farms were located outside of flood zones and had high pond dike to keep flood water from entering the farms, and that the majority of the farmers managed predators on their farms. The majority of the farms lacked the ability to enter contaminants and relied on groundwater supplies. Biosecurity measures such as limitations of visitor's movement, facility of sanitary latrine, disinfection of equipment and water distribution channels were also used to some extent. No farm was found having any foot bath and quarantine facilities to control fish diseases. Farmers did not use any protective clothing and most of the farms were not surrounded by boundaries. From the study, it is advised that present fish farming methods must be upgraded through institutional and organizational measures in order to improve the overall biosecurity status of fish farms. Commercial farmers should be made more aware of biosecurity principles, and they should be encouraged to properly implement biosecurity programs on their fields.

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