E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 76.37
(GIF) Impact Factor: 0.549
IJFAS 2022; 10(5): 14-21

www.fisheriesjournal.com
Received: 05-05-2022
Accepted: 11-06-2022

Md. Redwan Azad
Department of Aquaculture, Bangladesh Agricultural University, Mymensingh, Bangladesh

KM Shakil Rana
Department of Aquaculture, Bangladesh Agricultural University, Mymensingh, Bangladesh

Md. Hashibur Rahman
Bangladesh Fisheries Research Institute, Headquarters, Mymensingh, Bangladesh

Al-Amin
Bangladesh Fisheries Research Institute, Headquarters, Mymensingh, Bangladesh

Asma Jaman
Bangladesh Fisheries Research Institute, Headquarters, Mymensingh, Bangladesh

Sharmin Sultana Mukti
Bangladesh Fisheries Research Institute, Headquarters, Mymensingh, Bangladesh

MA Mamun Siddiquee
Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh, Bangladesh

Corresponding Author:
Md. Hashibur Rahman
Bangladesh Fisheries Research Institute, Headquarters, Mymensingh, Bangladesh

Assessment of aqua farms in Mymensingh district: Perspective of health management and probiotics use

Md. Redwan Azad, KM Shakil Rana, Md. Hashibur Rahman, Al-Amin, Asma Jaman, Sharmin Sultana Mukti and MA Mamun Siddiquee

DOI: https://doi.org/10.22271/fish.2022.v10.i5a.2724

Abstract
The study was conducted to evaluate the existing aqua farming status and health management practices in 24 commercial farms located in selected upazilas (*viz.*, Mymensingh Sadar, Trishal, and Muktagacha) under Mymensingh district. Data were aggregated through participatory rural appraisal (PRA) tools such as questionnaire interview, focus group discussion (FGD) and key informant interview. The findings uncovered that, the culture practice (monoculture and polyculture) was similarly preferred by the respondents. Both polyculture and monoculture systems were practiced in all of the selected Upazila. It was observed that most of the farmers of the study area adopted monoculture (50%). Whereas, one third (33.33%) of them preferred polyculture and a few (16.67%) followed both the culture systems. Only 33.33% farmers follow the sanitary facility which is important for security of biomass. 25% farmers monitored the farms on daily basis, while 37.5% farmers and 37.5% farmers monitored the disease condition weekly and bi-weekly, respectively. 12.5% farmers monitored the health condition of fishes on daily basis and 50% farmers monitored on bi-weekly basis in Muktagacha. On the other hand, 25% and 62.5% farmers monitored the health condition on weekly and bi-weekly basis, respectively in Trisal. About 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. The result showed that, 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. Most farmers (87.5%) have stocked diseased free fry from various hatcheries while a few (8.33%) supplied from their own hatchery.

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

Introduction
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.

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 paid 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.

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 number of hatcheries and farms. Many people are involved in commercial fishing and contribute a major role in the food sector. Vine *et al.,* (2006) [13] 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) [5].

The main purpose of an aquaculture biosecurity program is to prevent the introduction of any infectious organism into the facility. 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) [6].

Probiotics have been proven to be positive promoters of aquatic animal growth, survival and health. In aquaculture, intestines, gills, the skin mucus of aquatic animals, and habitats or even culture collections and commercial products, can be sources for acquiring appropriate probiotics, which have been identified as bacteria (Gram-positive and Gram-negative) and nonbacteria (bacteriophages, microalgae and yeasts). The research of probiotics for aquatic animals is increasing with the demand for environment-friendly aquaculture. The probiotics were defined as live microbial feed supplements that improve health of man and terrestrial livestock. The gastrointestinal microbiota of fish and shellfish are peculiarly dependent on the external environment, due to the water flow passing through the digestive tract. Most bacterial cells are transient in the gut, with continuous intrusion of microbes coming from water and food. Some commercial products are referred to as probiotics, though they were designed to treat the rearing medium, not to supplement the diet. This extension of the probiotic concept is pertinent when the administered microbes survive in the gastrointestinal tract. Otherwise, more general terms are suggested, like biocontrol when the treatment is antagonistic to pathogens or bioremediation when water quality is improved.

Considering the above-mentioned facts, this intensive study was planned to conduct in some selected areas of Mymensingh district to determine and compare the present status of fish farming and subsequent management strategies where the probiotics was taken into consideration to understand the infected environment in appropriate ways for saving the farmed fish stock. The present study will help the academicians and researchers to know the affiliated problems related to fish farming and the impacts of 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., questionnaire interviews, focus group discussion, cross check interviews with key informants and 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.

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

Types of culture

Both polyculture and monoculture systems were practiced in all of the selected Upazila. From the data, it was observed that most of the farmers of the study area adopted monoculture (50%). Whereas, one third (33.33%) of them preferred polyculture and a few (16.67%) followed both the culture systems. (Fig.1).

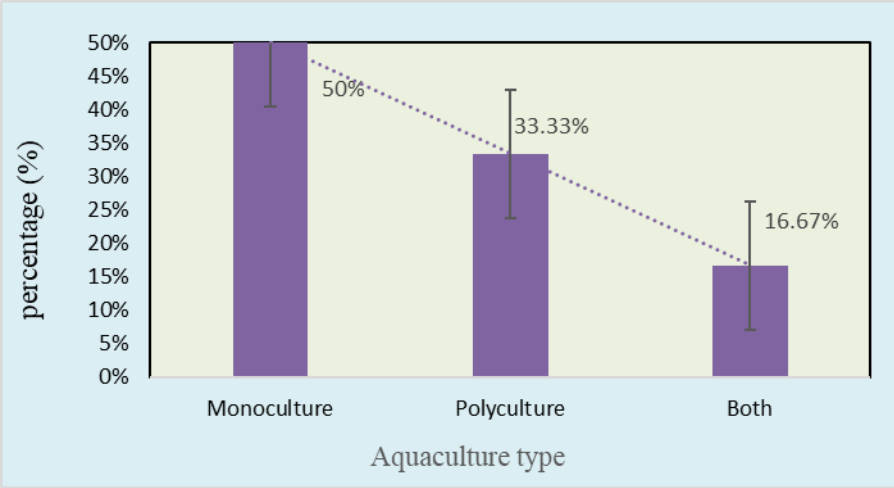

Fig 1: Culture types in Mymensingh district.

Fish production

In the selected area, pangus, tilapia, koi, shing, pabda and carp were cultured in studied farms either by monoculture system or by polyculture system. Polyculture with tilapia/pangas/koi were mostly productive than monoculture system. Data showed that fish production was varied with culture types, areas, and culture period. The highest average production was in Trisal (158.5 Kg/decimal). Whereas, the average production in Mymensingh Sadar was (157.5 kg/decimal) and in Muktagacha was (143.5 kg/decimal). It was found that, the year- round production of Pangus was highest in Trisal 245 kg/decimal and lowest (150 kg/decimal) in Muktagachha. In Muktagachha koi production was higher (160 kg/decimal) than Trisal (127.5 kg/decimal). Tilapia production data showerd the best production (77.5 kg/decimal) in Mymensingh sadar, whereas the lowest (65 kg/decimal) in Trisal. Shing production was highest (225 kg/decimal) in Mymensingh sadar where less (115 kg/decimal) was in Trisal (Table 1).

Table 1: Average production (kg/decimal) in selected upazilas of Mymensingh District.

Culture species	Mymensingh Sadar		Muktagacha		Trisal	
	Range	Avg.	Range	Avg.	Range	Avg.
Pangus	180-220	200	140-160	150	200-290	245
Tilapia	75-80	77.5	65-70	67.5	60-70	65
Koi	130-160	140	150-170	160	125-130	127.5
Carp	140-150	145	130-140	135	230-250	240
Shing	220-230	225	200-210	205	110-120	115
Avg. production		157.5		143.5		158.5

Training status

The farmers had received training from Government Organizations (GOs), Non-Government Organization (NGOs) and specially from different companies. Among them, 66.67% received training from GOs, only 8.33% from NGOs and 25% from both GOs and NGOs. Importantly, there was no farmer without institutional training (Fig.2)

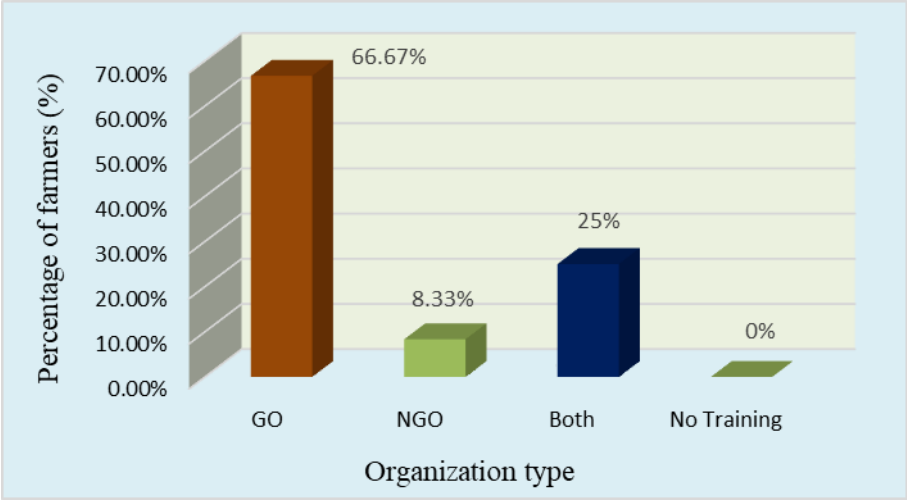

Fig 2: Proportion of farmers with their source of training.

Water Management of the Farms

It was observed that the farmers were conscious about the water sources. They knew that contaminated water sources are very harmful for their farm fishes. There were 91.67% farmers used ground water by using pump. Farmers were asked if they measure water quality parameters of their farms including temperature, dissolved oxygen, pH range, alkalinity, ammonia and others. Among them every farmer (100%) measured pH while 8.33% and 91.67% measured alkalinity and ammonia respectively (Fig.3).

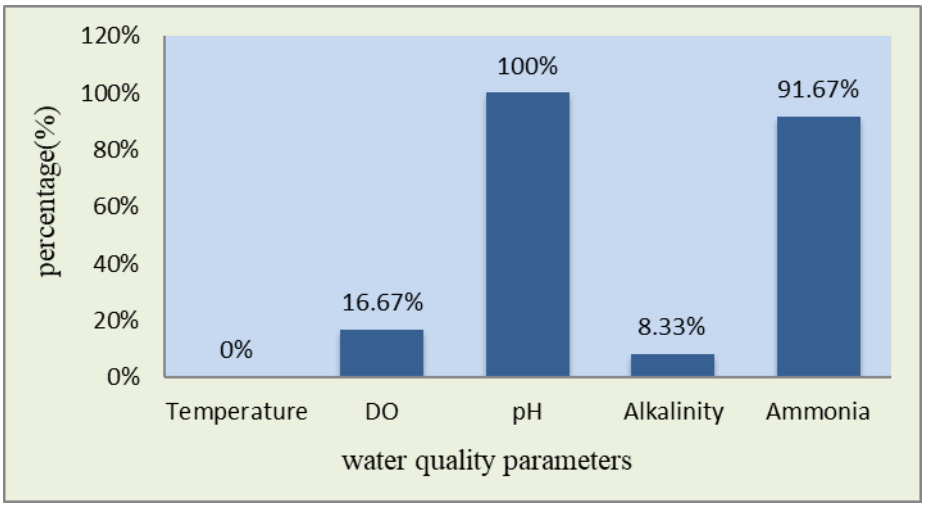

Fig 3: Farmers measure water quality parameters in Mymensingh district.

Stocking and management of fry

It was observed that 87.5% farmer's stocked diseased free fry in the Survey areas. They tried to collect the fry from renowned hatcheries and most of them were collected from Babura to avoid diseased fry and any other problems. The farmers of about 87.5% acclimatized fry before stocking into the ponds at each selected upazila of Mymensingh district. It was observed that there were no quarantine facilities in any farms.

Feed Preference for Fish

Farmers were asked either they preferred farm-made feed or commercial feed for cultured fishes. Around 16.67% farmers preferred farm-made feed for fish. On the other hand, almost all the farmers (83.33%) preferred commercial feed (Table 2).

Table 2: Preference of feed for fish.

Feed Type	Mymensingh Sadar		Muktagacha		Trisal	
	No. of farmers	(%)	No. of farmers	(%)	No. of farmers	(%)
Farm made	2	25	0	0	2	25
Commercial	6	75	8	100	6	75
Total	8	100	8	100	8	100

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.

Facility of sanitary latrine

The studied farms did not have proper sanitary latrine facilities. Only 33.33% farmers follow the sanitary latrine facility which is important for security of biomass (Fig.4).

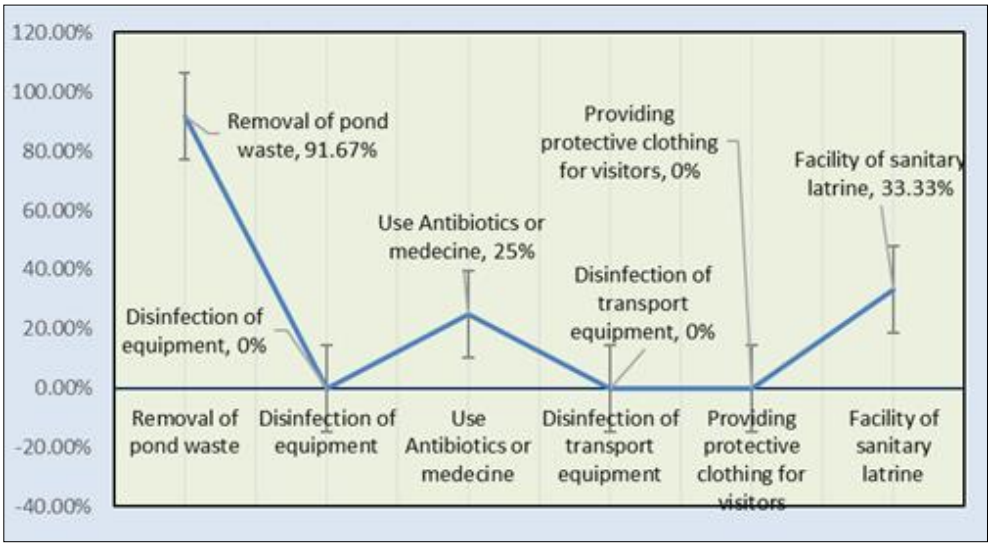

Fig 4. Disinfection strategies practiced in the selected farms area.

Health status checking of fish

There were some differences found among the selected upazila on the basis of monitoring fish health. It was found that all (100%) the farmers monitored the health condition of fishes in their ponds. In Mymensingh Sadar, 25% farmers monitored the farms on daily basis, while 37.5% farmers and 37.5% farmers monitored the disease condition weekly and bi-weekly, respectively. 12.5% farmers monitored the health condition of fishes on daily basis and 50% farmers monitored on bi-weekly basis in Muktagacha. On the other hand, 25% and 62.5% farmers monitored the health condition on weekly and bi-weekly basis, respectively in Trisal (Table 3).

Table 3: Monitoring fish health by farmers of study areas.

Criteria	Mymensingh Sadar	Muktagacha	Trishal
	n=24	n=24	n=24
Daily	25%	12.5%	12.5%
Weekly	37.5%	37.5%	25%
Bi-weekly	37.5%	50%	62.5%

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.5).

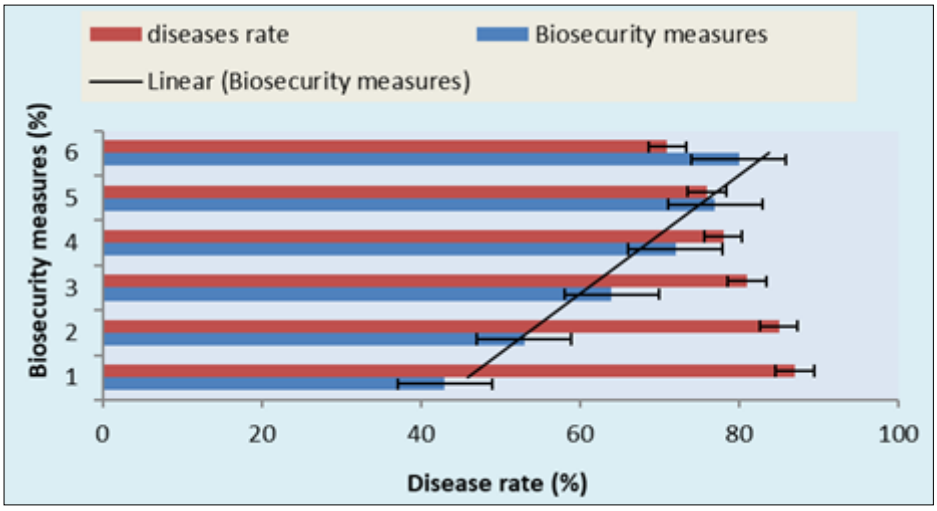

Fig 5: Relationship between biosecurity measures and disease.

Minimal additional cost of biosecurity also provided the higher profits through fish production.

Table 5: Additional cost of biosecurity measures.

Biosecurity measures	Additional cost (tk/decimal)	Depreciation cost (Tk/yr/dm)
Fencing	240.34±5.64	81.67±3.06
Pond dykes	587.95±3.14	117.59±2.14
Water treatment facilities	108.33±4.67	108.33±4.67
Total	312.30±3.97	103.59±3.54

*Depreciation cost= total cost/longevity

From the data found that additional cost of biosecurity increased the fish production up to 6-7% which provided 8-10% extra profits.

Use of probiotics

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.6).

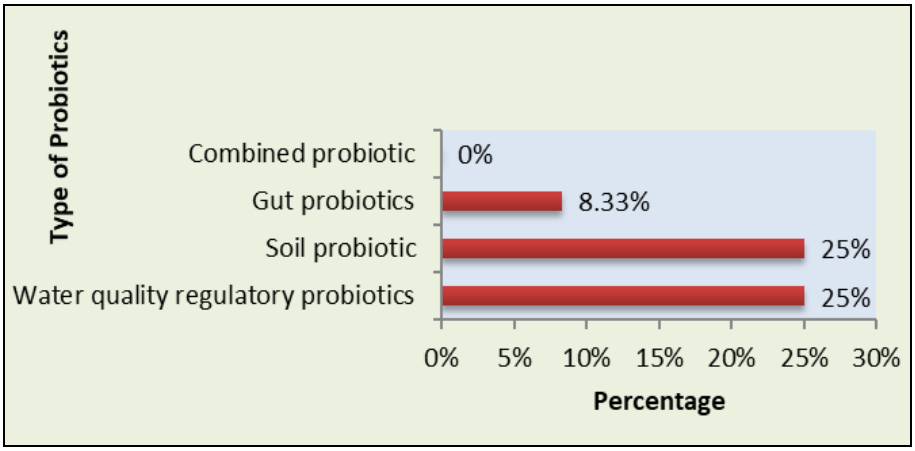

Fig 6: Types of probiotics used in Mymensingh district.

During the study period the growth performance was comparatively high by deducting feed cost, labor cost and overall maintenance cost where the overall production was high. The data showed that the production increased by 4-5% after applying probiotics.

Discussion

A commercial fish farm's farm boundary is critical to its biosecurity program's performance. Only a few commercial fish farms were found to be enclosed by fences, whereas the majority of the farms were not. As a result, the most common occurrence in the research region was wild animal entrances, which could be sources of pathogens for disease outbreaks in the farms. It was not typical to place restrictions on movement into fish farms. Only a few farms were found to maintain this measure, with the majority of farms lacking these facilities. Cattle grazing inside farms were a typical occurrence that might be a major source of disease transfer into the farm.

No farm was discovered to have foot bath facilities prior to entering their premises or to provide protective clothes for their own employees or visitors. In the instance of fish hatchery biosecurity, Faruk *et al.* (2012) [2] obtained

comparable results. Except for a few well-established large-scale fish farms in the research area, most of the farms were found to lack sanitary toilet facilities. It was discovered that the majority of farmers do not have a bin to store empty packets or pots. Many farmers throw away the empty packets or pots after utilizing medications or other materials in the ponds, thereby deteriorating the farm environment.

Due to their smaller size than pangas farms, tilapia and koi farms were shown to have less potential to introduce pollutants into ponds, since the farmers adequately prepared pond dikes. Most pangas farms have the potential to introduce pollutants via surface run-off from industrial, domestic, and agricultural sources, particularly those that were converted from beels. Biosecurity is easier to establish in small, intensive, and regulated farming systems than in outdoor and large-scale operations, according to Horowitz & Horowitz (2003) [12].

A good water source is a must for a commercial aquaculture enterprise to succeed. It is critical to provide contamination-free water to the aqua farm from a biosecurity standpoint. Fish farms, according to Piper *et al.,* (1992) [11], must be based primarily on access to surface or subsurface water sources. In this study, it was discovered that farmers were quite knowledgeable about water sources, and that the majority of farmers drew water from deep tube wells and shallow tube wells. This enabled the farms to maintain the required amount of water during the pre-monsoon and post-monsoon seasons. Mony (2012) [10] found that most hatcheries supply good quality water in their hatcheries in a comparable study.

For the biosecurity program of an aqua farm, it is necessary to collect and stock disease-free fry. The majority of farmers stocked disease-free fry in their farm ponds, according to the findings of this study. Santahar, Adamdighi, and Bogra were the most common places from where farmers collected pangas fry/fingerling. They used to get tilapia and koi fingerlings from government and private hatcheries in Mymensingh, as well as some local nurseries. Farmers have attempted to generate pangas spawn in their own hatcheries, but the results have been disappointing. The farmers suspected that the soil quality and other criteria in the Mymensingh region were not ideal for generating pangas spawn, but the causes of failure were unknown.

Almost all of the farmers used commercial pelleted feed purchased from various fish feed farms, and the majority of the commercial farms had good feed storage facilities and attempted to maintain correct storage conditions. To avoid contamination, most farmers kept their feeds in a store chamber above ground level on a wooden or bamboo-made rack. They also made an effort to keep the storeroom well ventilated in order to keep the feeds in good condition. To maintain a higher quality of feed, most farmers cleaned or disinfected their feed storage rooms on a regular basis.

The pond bottom wastes must be evacuated after a set period of time to safeguard the fish from various diseases from a biosecurity standpoint. Deposition of sediment on the pond's bottom causes water quality to deteriorate and fish growth to be stunted. After a set amount of time, almost all tilapia and koi growers removed pond bottom garbage and dried their culture ponds. The majority of pangas producers likewise eliminated their pond trash every three years. Some pangas farms were so large that removing bottom waste was difficult, if not impossible. Because of the large volume of bottom decomposed mud, the water quality often worsened, weakening the fish and making them prone to disease.

The majority of farmers were found not to disinfect their transport equipment, such as plastic baskets and aluminum pots, as well as their transport vehicles, such as manual vans, pickup vans, and trucks. According to Koblentz (2010) [9], before using equipment anywhere on or off the farm, it must be cleaned, disinfected, and dried for the best outcomes in destroying microorganisms.

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 (Chang and Liu, 2002) [1], improved resistance against diseases (Yoshimizu, 2003) [8], enhanced ability of beneficial microbes to adhere and colonize in the gut to antagonize harmful organisms (Pietrak *et al*., 2010) [4] and to produce polyamines and digestive enzymes (Winton, 2002 and Islam, 2018) [7, 3].

Conclusions

The purpose of this study was to find out health management techniques on several farms in the Mymensingh district. Personal interviews and participatory rural appraisal (PRA) techniques such as focus group discussion (FGD) with fish farmers in the examined area were used to conduct the study. It was discovered that the majority of farmers-maintained monoculture of high-value fish, but polyculture of fishes were not yet well established. The majority of them had little knowledge of biosecurity issues. They did not receive the intended benefit due to a lack of comprehension. As a result, a small number of farmers were dissatisfied with their operations. Disinfection facilities such as protective clothes, disinfected transport equipment, spray and footbath facilities, and so on were found to be few or non-existent. Stocking disease-free fry, acclimating fry, eliminating water turbidity, aquatic weed removal, pond trash clearance, and fish health checks, on the other hand, were all better practices. Farms may benefit from the usage of probiotics because it has been linked to a decrease in mortality, better survival, and enhanced disease resistance.

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. They evaluated water quality measures, stocked disease-free fries, and properly disposed of dead and moribund fish. They also kept the feed in good working order. Commercial farmers should be made more aware of biosecurity principles, and they should be encouraged to properly implement biosecurity programs on their fields.

References

1. Chang CI, Liu W. An evaluation of two probiotic bacterial strains, *Enterococcus faecium* SF 68 and *Bacillus touoi* for reducing *Edwardsiellosis* in cultured European eel. Journal of Fish Diseases. 2002;25(5):311-

315.
2. Faruk MAR, Mony SFA, Hasan MM. Status of bio-security and health management in fish hatcheries. International Research Journal of Applied Life Sciences. 2012;1(5):15-26.
3. Islam MT. Biosecurity status in some commercial aqua farms of Kishoreganj and Mymensingh districts, MS Thesis, Department of Aquaculture, Bangladesh Agricultural University, Mymensingh; c2018.
4. Pietrak M, Leavitt D, Walsh M. Biosecurity on the farm: guidelines & resources for developing a biosecurity plan. NRAC Publication No. 208-2010, University of Maryland, 2113 Animal Science Building College Park, Maryland. 2010;208:6.
5. Rahman AKA. Freshwater Fishes of Bangladesh. Zoological Society of Bangladesh, Dhaka, 2005.
6. Smith SA. Biosecurity and Fish Health Monitoring for Aquaculture Facilities, 2012. www.atlantech.ca/public/articles/Biosecurity3.pdf.
7. Winton JR. Fish health management. In: GA Wedemeyer (editor), Fish hatchery management, Second edition, American Fisheries Society, Bethesda, MD; c2002.
8. Yoshimizu M. Control strategy for viral diseases of salmonids and flounder. In: CS Lee and PJ O'Bryen (Editors), Biosecurity in Aquaculture Production Systems, Exclusion of Pathogens and Other Undesirables. The World Aquaculture Society Baton Rouge, Louisiana, USA; c2003. p. 35-50.
9. Koblentz GD. Biosecurity reconsidered: calibrating biological threats and responses. International Security. 2010;34(4):96-132.
10. Mony SFA. Evaluation of the Status of Biosecurity and Health Management in Fish Hatcheries, MS Thesis, Department of Aquaculture, Bangladesh Agricultural University, Mymensingh, Bangladesh; c2012.
11. Piper RG, McElwain IB, Orme LE, McCracken JP, Fowler LG, Leonard JR. Fish Hatchery Management. US Fish and wildlife service, Washington DC; c1982. p. 517.
12. Horowitz A, Horowitz S. Alleviation and prevention of disease in shrimp farms in Central and South America: A microbiological approach. In: CS Lee and PJ O'Bryen (Editors), Bio-security in Aquaculture Production Systems, Exclusion of Pathogens and Other Undesirables. The World Aquaculture Society, Baton Rouge, Louisiana, USA; c2003. p. 117-138.
13. Vine NG, Leukes WD, Kaiser H. Probiotics in marine larvae culture. FEMS Microbiology Reviews. 2006;30(3):404-427.
14. Ahmed GU, Faruk MAR, Rahman MK, Haque MN. Aqua-drugs and chemical: Impact on Fish health and production in Mymensingh, Bangladesh. Res. Agric., Livest. Fish. 2015;2(1):161-168.