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Biosecurity status in some commercial aquafarms of Kishoreganj and Mymensingh districts

MD. TAUFIQUL ISLAM, TANVIR RAHMAN*, S. M. RAHMATULLAH, JOYSHRI SARKER[1], ROMAZA KHANUM[2] AND MUHAMMAD SALIM AL MAHADI[2]

Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
[1]Chattogram Veterinary and Animal Sciences University 4225, Chattogram
[2]Sylhet Agricultural University 3100, Sylhet, Bangladesh
*E-mail: tanvir.nishi@gmail.com

Abstract. A study was conducted to determine the present biosecurity status in some commercial aquafarms of selected Upazila under Kishoreganj and Mymensingh districts of Bangladesh. A total of 30 fish farms from Kishoreganj and Mymensingh district were surveyed. Data were collected through questionnaire interview and participatory rural appraisal tools like focus group discussion. The results showed that majority of the farmers did not have good understanding of biosecurity procedure. Biosecurity measures such as sprays and footbath facility, sanitary latrine, showers, disinfection of transport equipment, providing protective clothing for visitors and quarantine facilities were totally absent in both districts. However, 80% of the farms did not have scope for pollutant entrance and most of the farmers used ground water sources. Additionally, they took protection against fish stealing (80%), stocked disease free fry (100%), removed bottom waste and dried culture ponds after two or three production cycle (66.67%) and measured water quality parameters (53.33%) on monthly basis. Other biosecurity measures such as restriction of visitor's movement, control rodents and insects in feed storage, keeping domestic animals confined to the farm, water exchange in the pond, controlling predator in farm and disinfection of equipment used for culture operation. The collected data would be used as the preliminary study record and for further improvement of the overall biosecurity status.
Keywords: Biosecurity, Aquafarms, Fish disease

Introduction

Aquaculture has been growing fast for inland fish production. Intensification is enhancing overall production but inviting water pollution problems leading to disease outbreaks in the aquaculture industry and is gradually turning into one of the biggest constraints to the development and expansion of this sector. Faruk *et al.* (2004) observed that there were financial losses of approximately 15% of the actual production to rural fish farmers due to fish diseases. Disease causing agents that infect aquatic animals are frequently spread between aquatic organisms in the environment, or equipment used to transfer animals from one holding unit or site to another. The most common high risk inputs into aquaculture systems are: (1) stock, e.g. fingerlings/ post-larvae for stocking grow-out ponds, (2) feeds, (3) water, and (4) equipment such as harvest nets, aerators, etc. that may be shared between farms (Perera *et al.* 2008). Cultured aquatic animal health can be met up with the implementation of biosecurity measures as fish culturists could use a variety of biosecurity measures to prevent and control of disease in their fish (Plumb 1994, Winton 2002).

Biosecurity defines as management of all biological and environmental risks associated with food and agriculture, including forestry and fisheries (Perera *et al.* 2008). Biosecurity is very important to aquaculture because it prevents or limits the introduction and spread of disease within or between aquatic animal production facilities and sites. Since very few effective treatments are available for most aquatic animal diseases, effective biosecurity is the key to

preventing these diseases because biosecurity can be more easily implemented in small, intensive, and controlled farming systems than in outdoor and large-scale operations (Horowitz and Horowitz 2003). Aquaculture production of Kishoreganj and Mymensingh is increasing day by day. But fish farmers have been facing a great problem of fish diseases particularly; bacterial diseases in the fish farms and hatcheries are causing severe damage and mortality every year and ultimately hampering the national economy as a whole. One of the most important factors is that many commercial fish farmers in these regions do not have good understanding of fish health and biosecurity issues in their system. There is very few information regarding the present scenario of biosecurity measurements in the fish farms of different parts of Bangladesh. Therefore, the present study was undertaken to determine and compare the status of biosecurity management in the aquafarms of some selected areas of Kishoregonj and Mymensingh district and to understand the infected environment in appropriate ways for saving the farmed fish stock.

Materials and Methods

***Selection of study area and fish farmers*:** Data were collected through questionnaire survey from 15 aquafarms located in 3 Upazila under Kishoregonj district (*viz.,* Kishoregonj sadar, Kotiadi and Pakundia) and another 15 aquafarms located in 3 Upazilas under Mymensingh district (*viz.,* Isharganj, Nandail and Gouripur). Five farmers from each Upazila (a total of 30 farmers, 15 from Kishoreganj and remaining 15 from Mymensingh district) were selected after successful discussions with the Upazila Fisheries Officers (UFOs).

***Data collection method*:** To collect data, a set of questions was organized following a sequential and required logical format. 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) Observation of the farm area. Focus group discussion (FGD) was conducted with fish farmers. Crosscheck interviews were conducted with key informant such as District Fisheries Officer (DFO), Upazila Fisheries Officer (UFO), Youth Development Officer, Fisheries Extension Officer (FEO) and NGO workers working with aquaculture. Prior to field survey, background information on the number, location and distribution of fish farms and aquaculture activities were collected.

***Data analysis*:** All collected data were analyzed using "Microsoft Excel 2010". The summary tables were prepared to fulfill the objectives of this study. The results were shown in descriptive tabular and graphical presentation.

Results

***Training status*:** The farmer received training from GO, NGO or both. Among them 26.67%, 20% and 0% had received training respectively from GOs, NGOs and both in Kishoreganj district. On the other hand, 53.33%, 13.33% and 6.67% had received training, respectively from GOs, NGOs and both in Mymensingh district. But 53.33% and 26.67% did not receive any training in Kishoreganj and Mymensingh, respectively.

***Average pond area and depth*:** The average pond area were ranged 70-2050 decimal and 36.67-316.67 decimal respectively in Kishoreganj and Mymensingh district. Pakundia had bigger area (100-4000 decimal) than the other upazila of Kishoreganj and Mymensingh. The

average pond depth was 1.22-1.83 m and 1.32-2.44 m gradually in Kishoreganj and Mymensingh district where Gouripur claimed more depth (0.91-3.66 m) than the other Upazila of Kishoreganj and Mymensingh.

Types of culture: It was observed that 86.67% and 93.33% farmers in Kishoreganj and Mymensingh respectively practiced polyculture whereas 6.67% and 13.33% farmers practiced in Mymensingh and Kishoreganj respectively.

Pre-stocking management: Farmers prepared their ponds by pond drying, pond mud removal, undesirable species removal, pond embankment repair, aquatic weeds removal, liming and fertilization (Table I). The percentages of different measures of pond management were approximately same both in Kishoreganj and Mymensingh district. In the case of pond mud removal, there was a noticeable difference between Kishoreganj and Mymensingh region where 60% and 33.33% (Table I) farmers removed pond mud respectively. Most of the farmers in Mymensingh district did not remove pond mud due to high expenditure.

Table I. Pre-stocking pond management of the farms (n=15)

Measures	Kishoreganj		Mymensingh	
	Total	Percentages (%)	Total	Percentages (%)
Pond preparation	15	100	15	100
Pond drying	14	93.33	13	86.67
Pond mud removal	9	60	5	33.33
Undesirable species removal	15	100	15	100
Pond embankment repair	12	80	13	86.67
Aquatic weeds removal	15	100	15	100
Liming	15	100	15	100
Fertilization	13	86.67	12	80

Types of cultured fish: Various types of fish species such as pangus, tilapia, carp, shing, pabda, gulsa were cultured in studied farms either by monoculture system or by polyculture systems carps (73.33%) were mostly practised in Kishoreganj (Fig. 1) and carp+gulsa/ pabda/ shing (40%) were mostly practiced in Mymensingh.

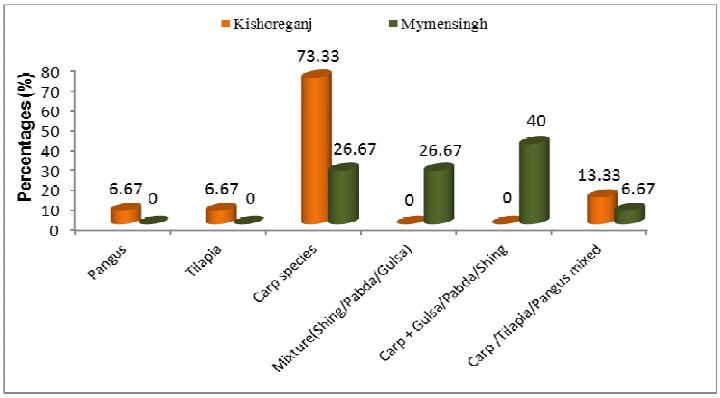

Fig. 1. Types of fish cultured in Kishoreganj and Mymensingh district.

***Fry and fingerling collection*:** It was observed that some farmers collected only fry, some collected only fingerling and some collected both fry and fingerling from different sources like hatchery or nursery. Farmers preferred fingerling collection both in Kishoreganj (73.33%) and Mymensingh (66.67%) district. Fry and fingerling were also collected from hatcheries in Kishoreganj (20%) and Mymensingh (26.67%) area. Fry were collected in same ratio (6.67%) both in selected district (Table II).

Table II. Fry and fingerling collection in study area (n=15)

Category	Kishoreganj		Mymensingh	
	Sources	Percentages (%)	Sources	Percentages (%)
Fry	Nursery	1(6.67)	Nursery	0(0.00)
	Hatchery	0(0.00)	Hatchery	1(6.67)
	Both	0(0.00)	Both	0(0.00)
Fingerling	Hatchery	6(40)	Hatchery	4(26.67)
	Nursery	4(26.67)	Nursery	8(53.33)
	Both	2(13.33)	Both	1(6.67)
Fry and Fingerling	Nursery	0(0.00)	Nursery	0(0.00)
	Hatchery	0(0.00)	Hatchery	0(0.00)
	Both	2(13.33)	Both	1(6.67)

***Stocking density*:** Stocking density of carp species in Kishoreganj was much higher than Mymensingh. It was found that the average stocking density of carps fingerling was maintained at Kishoreganj (11,409.19/acre) followed by 8750/acre in Mymensingh. In Mymensingh, average carp+gulsa/shing/pabda fingerling were stocked at 58,150/acre and gulsa/shing/pabda mixed fingerling was stocked at 96,565.66/acre. While in Kishoreganj, the stocking density of these species was zero. Farmers stocked average pangus/tilapia fingerling at 14,000/acre and carp/pangus/tilapia mixed fingerling at 28,277.78/acre in Kishoreganj. Only in Kishoreganj, average carps fry were stocked at 264,444.44/acre (Table III).

Table III. Average stocking density of fry/fingerling

Stocking density (fry or fingerling /acre)	Kishoreganj		Mymensingh	
	Range	Average	Range	Average
Carps (fingerling)	5,000-60,000	11,409.19	6,000-15,000	8,750
Carps (fry)	33,333.33-400,000	264,444.44	0	0
Carp + gulsa/shing/pabda	0	0	32,600-100,266.7	58,150
Gulsa/shing/pabda fingerling	0	0	72,727.27-151,515.2	96,565.66
Gulsa/shing/pabda fry mixed	0	0	160,000-318,181.8	239,090.9
Pangus/Tilapia	8,000-2,0000	14,000	0	0
Carp/Pangus/Tilapia mixed	26,000-30,555.56	28,277.78	5750	5750

***Fish production*:** Fish production also varied considerably with culture system and areas. Carp production in Kishoreganj was significantly higher than that of Mymensingh. It was found that, the production of carp was 2.32 ton/acre in Kishoreganj followed by Mymensingh (0.56 ton/acre). In Mymensingh, carp+gulsa/shing/pabda species production was 1.64 ton/acre and

gulsa/shing/pabda mixed species production was 1.67 ton/acre. On the other hand, these species production was zero in Kishoreganj. Pangus/tilapia production was 2.75 ton/acre and carp/pangus/tilapia mixed production was 6.19 ton/acre in Kishoreganj. In Mymensingh, carp/pangus/tilapia mixed production was 7 ton/acre (Table IV).

Table IV. Fish Production (Ton/acre)

Production (ton/acre)	Kishoreganj	Mymensingh
Carp species	2.32 ± 2.22	0.56 ± 0.36
Carp + gulsa/shing/pabda	0	1.64 ± 1.24
Gulsa/shing/pabda mixed	0	1.67 ± 1.21
Pangus/Tilapia	2.75 ± 1.06	-
Carp/Pangus/Tilapia mixed	6.19 ± 3.81	-

***Soil and water analysis*:** Most of the farmers were not serious regarding soil and water analysis. About 46.67% farmers of both regions did not prefer soil analysis. Soil analysis was practiced mostly interval of six months (20%) in Kishoreganj and interval of per month (33.33%) in Mymensingh. Similarly, water analysis was practiced mostly in every six months interval (20%) in Kishoreganj and monthly (33.33%) in Mymensingh.

***Record keeping*:** Record keeping was not a very common practice by the farmers. About 13.33% and 33.33% farmers respectively in Kishoreganj and Mymensingh kept record on price of fry/fingerlings, transportation cost, feeding cost, medicine cost, harvesting cost, selling price, total income etc. On the other hand, 86.67% and 66.67% farmers in the above study areas did not keep the records appropriately.

Biosecurity issues

***Boundary fences*:** From the study, it was observed that only few farms were surrounded by boundary fences while most of the farms did not have any boundary. In Kishoreganj, 26.67% farms and in Mymensingh only 33.33% farms were surrounded by boundary (Fig. 2).

***Protected dykes and drive ways*:** It was found that some farmers did not repair dikes due to large size of ponds. They were not well concerned about the protected dikes. Each of the studied area had same ratio (33.33%) of protected dikes on the ponds. There were no driveways in the studied area but only 1 (6.67%) farm in Kishoreganj had driveways system (Fig. 2).

***Foot or tire bath facilities, showers and cloth changing areas*:** It was found that there were no foot or tire bath facilities before entering into their farms and cloth changing areas to change a complete new set of freshly laundered clothing for their staffs or visitors. There was no showers facility to make a complete head to toe shower.

***Limit access of unwanted people*:** Farmers were found very unwilling to limit the access of unwanted people. Only 6.67% and 13.33% farmers respectively in Kishoreganj and Mymensingh maintained the access of nonessential people (Fig. 2).

***Keep domestic animals confined to the farm*:** In the survey area, most of the farmers had no consciousness about this matter. In Kishoreganj, the maintenance of this criterion was totally absent and in Mymensingh it was only 6.67% (Fig. 2).

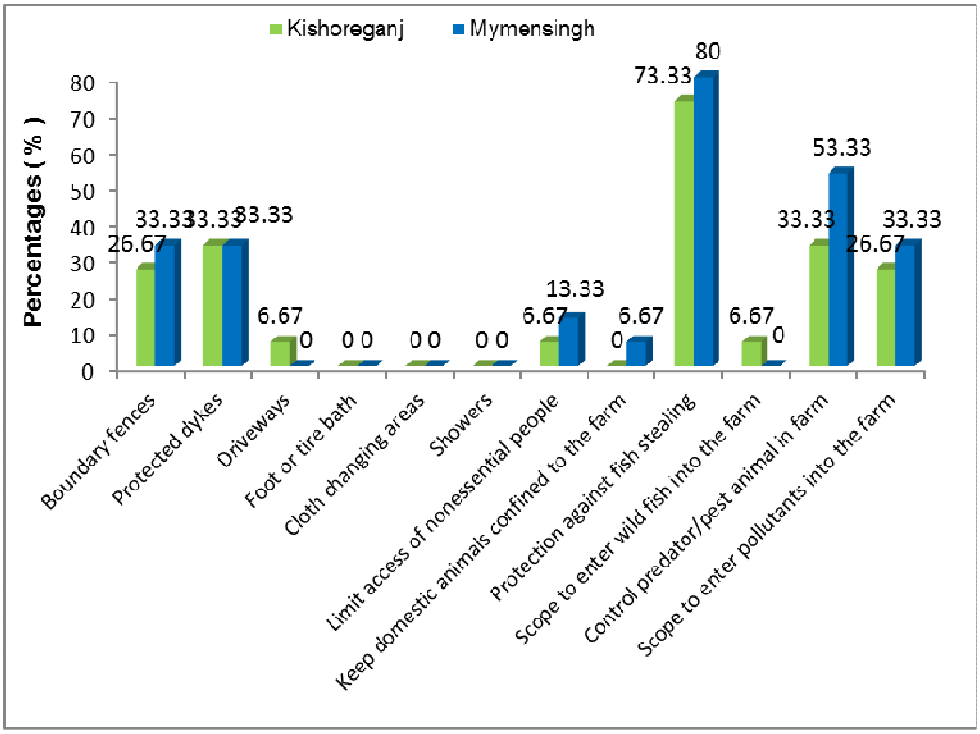

Fig. 2. Protection utilities followed in Kishoreganj and Mymensingh.

***Protection against fish stealing*:** It was known from the forces that most of them took necessary steps against fish stealing. They used guard for observing the farms, electrical light at night over the pond and even they made small houses for remaining themselves inside the farms so that they could observe the situation of stealing at night. About 73.33% and 80% farmers respectively in Kishoreganj and Mymensingh maintained the protection against fish stealing properly (Fig. 2).

***Scope to enter wild fish into the farm*:** There was no scope to enter wild fish into the Mymensingh farms while 6.67% farms in Kishoreganj were found having scope to enter wild fish into the ponds. Some farms in Kishoreganj were situated in low land area that's why wild fish could enter into the farm by flooded water in rainy season (Fig. 2).

***Control predator/pest animal in farm*:** Birds like king fisher, pankouri, herons, water fowls, kites were found around the fish farms to prey fish. About 33.33% and 53.33% farmers respectively in Kishoreganj and Mymensingh were capable to control pests. Farmers tried to control predatory birds by hanging polythene in horizontal ropes over the ponds. They also used wounding fishing gear like koach to kill the snakes and other reptiles (Fig. 2).

***Scope to enter pollutants into the farm*:** There was a little scope to enter pollutants into the ponds. Pollutants entered into 26.67% and 20% farms respectively in Kishoreganj and Mymensingh. The pollutants could be entered into the farms through the surface run-off of industrial, household, agricultural and poultry farm sources (Fig. 2).

***Water sources*:** Almost all the farmer used ground water by using tube well and shallow well. However, in Kishoreganj some farmers used rain water during pond preparation and in Mymensingh, some farmers used river water by using canal.

***Water exchange and water quality measurement during culture period*:** During culture period 13.33%, 6.67%, 6.67% and 40% farmers in Mymensingh exchanged pond water respectively by weekly, bi-weekly, monthly and when needed whereas 33.33% did not exchange pond water . On the other hand, only 26.67% farmers in Kishoreganj exchanged pond water when needed and 73.33% did not exchange pond water. About 26.67%, 13.33% farmers in Kishoreganj measured water quality parameters respectively by monthly or if they feel necessary whereas 60% farmers did not measure. About 6.67%, 53.33% and 13.33% farmers in Mymensingh measured water quality parameters respectively by bi-weekly, monthly or if they feel necessary while 26.67% farmers did not measure.

***Stocking of disease free fry*:** It was observed that 80% and 100% farmers stocked diseased free fry respectively in Kishoreganj and Mymensingh. They tried to collect the fry from renowned hatcheries and fishery to avoid diseased fry and any other problems.

***Acclimatization of fry and quarantine facilities*:** 80% and 86.67% farmers acclimatized fry before stocking into the ponds respectively in Kishoreganj and Mymensingh but no quarantine facilities were seen practiced in farms of Kishoreganj and Mymensingh to control fish diseases (Table V).

Table V. Fry management in Kishoreganj and Mymensingh district

	Kishoreganj	Mymensingh
Stocking of disease free fry	80%	100%
Acclimatization of fry	80%	86.67%
Quarantine facility	0	0
Control of rodents in feed storage	20%	33.33%

***Control rodents and insects in feed storage*:** Farmers in both study areas did not maintain the feed storage properly. From the data, it was found that only 20% and 33.33% farmers respectively in Kishoreganj and Mymensingh controlled rodents, insects and birds in feed storage (Table V).

***Feed preference for fish*:** About 26.67% farmers in Kishoreganj and 6.67% farmers in Mymensingh preferred farm-made feed for fish. On the other hand, 73.33% farmers in Kishoreganj preferred commercial feed but in Mymensingh, 93.33% farmers preferred.

***Removal of pond waste*:** In Mymensingh, 66.67% farmers removed pond bottom waste and dried their culture ponds after two or three cycle of production. In comparison to Mymensingh, only 40% farmers in Kishoreganj removed their pond waste because of large sizes (Fig. 3).

***Disinfection of equipment used for culture operation*:** Only 20% and 26.67% farmers respectively in Kishoreganj and Mymensingh disinfected the equipment like nets, buckets, hapas, plastic bowls and other essential utensils (Fig. 3). Farmers generally used potassium permanganate as disinfectant.

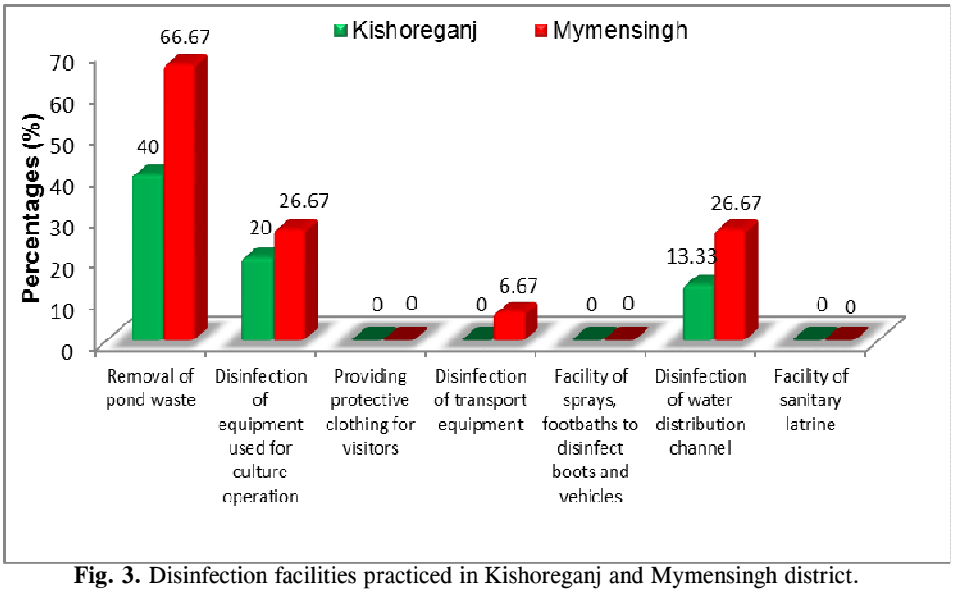

Fig. 3. Disinfection facilities practiced in Kishoreganj and Mymensingh district.

***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 sort of biosecurity activities (Fig. 3).

***Facility of sanitary latrine*:** The studied farms did not have proper sanitary latrine facilities.

***Disinfection of water distribution channel*:** It was found that only 2 (13.33%) out of 15 farmers in Kishoreganj and 4 (26.67%) out of 15 farmers in Mymensingh disinfected water distribution channel using potassium permanganate before supplying water into the pond (Fig. 3). Farmers supplied water into the ponds through earthen drains, plastic or polythene pipes.

***Idea on biosecurity measures*:** Only one farmer (6.67%) in Kishoreganj had a little idea about biosecurity measures while fish farmers (100%) of Mymensingh had no clear idea about this program. They consented to only one measure which is the presence of boundary fences, protected dikes and different facilities in farms so that undesirable species could not enter into the farms.

***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, aluminium pots, plastic drums etc. to transport the fishes to the market by transporting vehicles like manual van, pickup truck, lorry etc. Farmers in Kishoreganj did not disinfect their transport equipment(Fig. 3) while only 6.67% farmers in Mymensingh disinfected the transport equipment using potassium permanganate.

***Health checking of fish*:** There was a vast difference between Kishoreganj and Mymensingh based on the health status checking of fish. About 66.67% farmers in Kishoreganj did not monitor the health condition while only 13.33% farmers in Mymensingh did not monitor the health condition of fish. On an average, 13.33%, 6.67% and 13.33% farmers in Kishoreganj monitored the health condition monthly, bi-weekly and quarterly basis. On the other hand, 13.33%, 60% and 13.33% farmers in Mymensingh monitored the health condition respectively on weekly, monthly and half yearly basis (Table VI).

Table VI. Health status of fish checked in Kishoreganj and Mymensingh district

	Kishoreganj	Mymensingh
Weekly	0.00	13.33
Bi-weekly	0.00	0.00
Monthly	13.33	60.00
Bi-monthly	6.67	0.00
Quarterly	13.33	0.00
Half yearly	0.00	13.33
No checking	66.67	13.33

***Major diseases in the fish farms*:** The disease outbreak was occurred mainly during the winter season in most of the studied farms. Sometimes diseases also occurred in early and late winter. Four types of diseases such as bacterial, viral, fungal and parasitic diseases were noticed. From the data it was found that 66.67% farms in Kishoreganj were not concerned with bacterial diseases and 20% farms were very concerned with such diseases; while, in Mymensingh 60% farms were not concerned with bacterial diseases and 33.33% farms were very concerned. All the farms (100%) in Kishoreganj were not concerned with viral diseases. While, 46.67% farms were not concerned with viral diseases in Mymensingh where, 33.33% farms were very concerned. About 53.33% farms were not concerned and 20% farms were very concerned with fungal diseases in Kishoreganj. While in Mymensingh, 60% farms were not concerned and 20% farms were very concerned with fungal diseases. Parasitic diseases were not so common in both districts. Most of the farms (73.33%) in Kishoreganj and 100% farms in Mymensingh were not concerned with parasitic diseases but only 6.67% farms in Kishoreganj were very concerned (Figs. 4a and 4b).

Major bacterial diseases like MAS (Motile Aeromonas Septicemia) / Dropsy, Tail and fin rot disease, fungal diseases like Gill rot disease, Saprolagniasis, EUS (Epizootic Ulcerative Syndrome) and parasitic diseases like Argulosis were most common diseases in studied farms.

Although viral diseases occurred sometimes but these diseases could not identified properly. Farmers never went to any laboratory for the diagnosis of diseased fish or disease outbreaks.

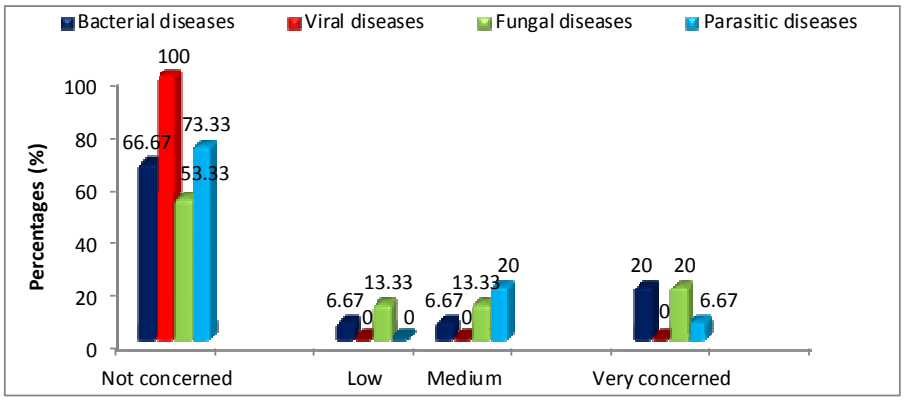

Fig. 4a. Status of the type of diseases in Kishorganj district.

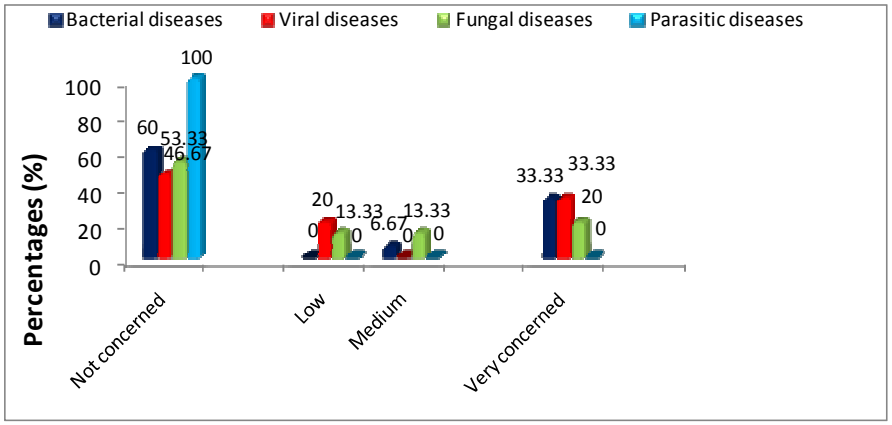

Fig. 4b. Status of the type of diseases in Mymensingh district.

***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 and vaccination. About 66.67% and 73.33% farmers in Kishoreganj and Mymensingh, respectively usually weeded out their pond. About 60% farmers in Kishoreganj and 53.33% in Mymensingh usually took measures to remove water turbidity; 60% in Kishoreganj and 33.33% in Mymensingh usually added water into the pond. Lime was applied always by 60% farmers both in Kishoreganj and Mymensingh. Vaccination program was never practiced in the visited/studied farms (Table VII).

Table VII. Preventive measures taken by the farmers of Kishoreganj and Mymensingh

Measures	Kishoreganj **(n=15)**			Mymensingh **(n=15)**		
	Never	Occasionally	Always	Never	Occasionally	Always
Fish health checking	6(40%)	2(13.33%)	3(20%)	3(20%)	7(46.67%)	5(33.33%)
Pond drying	12(80%)	3(20%)	0(0.00%)	6(40%)	9(60%)	0(0.00%)
Application of lime	0(0.00%)	9(60%)	6(40%)	0(0.00%)	9(60%)	6(40%)
Weeding the pond	0(0.00%)	10(66.67%)	5(33.33%)	0(0.00%)	11(73.33%)	4(26.67%)
Removing turbidity	5(33.33%)	9(60%)	1(6.67%)	6(40%)	8(53.33%)	1(6.67%)
Addition of water	0(0.00%)	9(60%)	6(40%)	0(0.00%)	5(33.33%)	6(40%)
Vaccination	15(100%)	0(0.00%)	0(0.00%)	15(100%)	0(0.00%)	0(0.00%)

***Problems in fish farm*:** The problems of farmers such as lack of knowledge on diseases 53.33% and 20%, lack of proper medicine 40% and 6.67%, lack of knowledge on medicines for specific diseases 46.67% and 26.67%, high price of medicines 53.33% and 33.33%, absence of disease expert and 33.33%, weather 13.33% and 0% existed respectively in Kishoreganj and Mymensingh. About 0% and 26.67% farmers did not have any problem in Kishoreganj and Mymensingh (Fig. 5).

***Use of antibiotics and chemicals*:** From the survey it was found that 66.67% farmers in Kishoreganj and 73.33% farmers in Mymensingh used different types of antibiotics and chemicals to control diseases. Only 33.33% farmers in Kishoreganj and 26.67% farmers in Mymensingh did not use any types of antibiotics and chemicals to control diseases. Farmers used some common antibiotics like Oxy-Dox F, Cepro plus, Aqua care, Curex, Ranaquin, Biotax etc. Farmers also used chemicals such as Aqua pure, Timsen, Quinex, Oxylife, Bio-aqua, Sumithion, Gastrap, Zeolite, Virex, Aquamin, Oxy A, Oxymax, Argulex, Spa, Eon Fish Grower etc. Application of lime and salt were the most commonly used chemicals for the treatment of diseases.

***Disposal of diseased fish*:** It was observed that 60% farmers in Kishoreganj and 73.33% farmers in Mymensingh disposed the dead or moribund fish. Most of the farmers opined that it was very difficult to search and collect the dead or moribund fish and was also laborious and expensive process. Some farmers buried under soil after collecting dead or moribund fish. About 40% farmers in Kishoreganj and 26.67% farmers in Mymensingh were not aware on disposal of diseased fish.

***Assistance for health management*:** Farmers did not get proper assistance on disease control and health management from non-governmental organization (NGOs) and government extension officers. Only 53.33% farmers in Kishoreganj and 40% farmers in Mymensingh got some sort of advice either from GO or NGO. Farmers hardly went to the Upazila Fisheries Officer (UFO) to inform any disease problem or for advice.

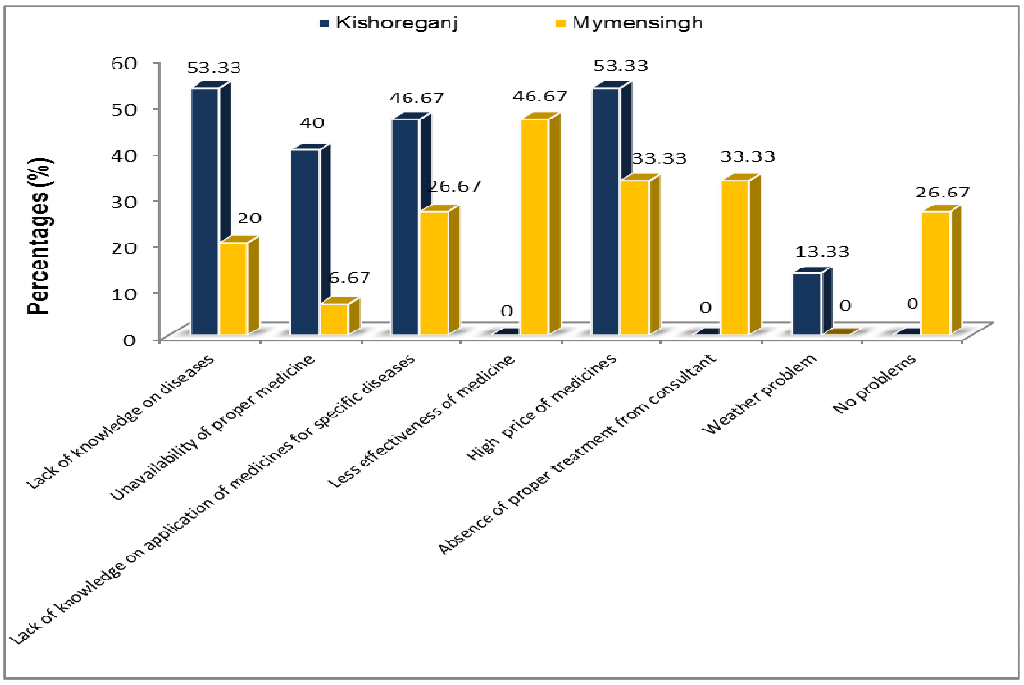

Fig. 5. Problems in control and treatment of fish diseases in Kishoreganj and Mymensingh.

Discussion

Farm boundary is an essential part of a commercial fish farm to secure a successful biosecurity program. Ali *et al.* (2014) observed that majority of the farms 35 (77.8%) in Khartoum, Sudan had a secure boundary fence that was able to stop people and animals entering the farm. In the present study area, it was observed that only few commercial fish farms were surrounded by boundaries. As a result, entrances of wild and pet animals were the most common phenomena which could be sources of pathogens for disease occurrence into the farms. The presence of domestic animals inside a hatchery can be a mechanism for rapid dissemination of infection (Guthrie *et al.* 1999). Grazing of cattle inside the farms were a most common phenomena which might be a major cause of disease transmission into the farm. In addition, a visit of outsiders to the hatchery is a biosecurity risk (FAO 2007). Only a few farms maintained this measure while most farms did not have this facility. Sadler and Goodwin (2007) stated that it is very important to protect the entry of predators or pests into the farms as those could act as carrier of disease to other farms. Birds are major predators or pests in aquaculture farms. There is evidence that birds can transmit bacteria and viruses through their droppings. Birds can also drop fish from one body of water into another. In the present study, some farmers were found trying to control the predatory birds like king fisher, pankouri, herons while most farmers were unable to control this because of large size of the farm. Control of predatory birds was initiated by the hanging polythene in horizontal ropes or net over the ponds. Farmers occasionally used fishing gear like coach (locally called) to kill the snakes and other reptiles. Only a few farms had scope to enter pollutants through the surface run-off of industrial, household, agricultural and poultry farm sources. Horowitz and Horowitz (2003) observed that biosecurity is more easily implemented in

small, intensive and controlled farming systems than in outdoor and large-scale operations. From the biosecurity point of view it is very important to supply contamination free water into the aqua farm. Pietrak *et al*. (2010) reported that ground water sources should be typically disease-free, though sometimes water quality issues must be addressed. In the present study, it was observed that the farmers were very much aware about the water sources and most of the farmers used ground water by using deep tube well and shallow tube well. The results showed that pond water were not exchanged properly during culture period in Kishoreganj and Mymensingh districts. Farmers of Mymensingh compare to Kishoreganj, mostly exchanged water when needed as they had training and better experience in aquaculture that helps to maintain water quality and dissolved oxygen in their ponds. In Kishoreganj, only a few farmers measured water quality parameters while in Mymensingh majority of the farmers measured water quality parameters of their ponds on monthly basis. Parvin (2011) observed that all the commercial fish farmers measured water quality by measuring temperature, dissolved oxygen, transparency, pH, ammonia and alkalinity. Commercial fish farmers were very much aware to maintain water quality properly. But some small scale farmers were found without having water quality measurement kits and hence, they realized about water quality through eye estimation from their own experience. If necessary, they took assistance from the fish feed and medicine company representatives and extension workers who visited the farmer's pond. Proper training and financial assistance would be helpful for these small scale farmers. Faruk *et al*. (2012) mentioned that though some hatchery owners keep the newly collected brood in separate tank, they actually did not maintain proper quarantine procedure. Present study also revealed the similar finding as most of the farmers acclimatized fry before stocking into the ponds but there was no quarantine facility in Kishoreganj or Mymensingh to prevent the susceptibility fish diseases. But regarding health status checking in fish farms, a vast difference between Kishoreganj and Mymensingh was revealed as most of the farmers in Kishoreganj did not monitor fish health condition but in Mymensingh they used to check the health status monthly.

From the biosecurity point of view, removal of the pond bottom wastes after certain period of time is helpful to protect the fish from various diseases. It was observed that in Mymensingh, most of the farmer removed pond bottom waste and dried their culture ponds after two or three cycle of production. On the contrary, only a few farmers in Kishoreganj removed their pond waste because of having larger size of ponds. Again, wearing disinfected clothing and boots by visitors and employees can prevent the horizontal transmission of infection vectors in fish farms (FAO 2007). Additionally, disinfected protective clothing and boots, and the use of footbaths and hand sanitation, are effective personnel biosecurity measures that considerably reduce the transmission of pathogens (Pollard *et al*. 2008). In the present study, it was found that farmers did not provide protective clothing and boots for visitors and their staffs before entering into the farm. Actually, farmers did not follow biosecurity measures due to lack of proper idea and training regarding these issues. Due to lack of proper knowledge, most of the farmers of both districts did not disinfect the equipment like nets, buckets, hapas, plastic bowls and other essential utensils. They did not also disinfect the vehicles and water distribution channel. Pietrak *et al*. (2010) reported that any equipment or vehicle used at aquaculture facilities should be cleaned and thoroughly dried (preferably in direct sunlight) or chemically disinfected before being used in another location. Again, most of the farmers did not disinfect the used plastic baskets, aluminium pots, plastic drums etc. to transport the fishes to the market by transporting vehicles like manual van, pickup truck, lorry etc. Sadler and Goodwin (2007) mentioned that for the best results in killing pathogens, one must clean, disinfect and dry equipment before it is

used elsewhere on or off the farm. Delabbio *et al.* (2004) reported that routine collection of dead fish should be one of the most commonly used biosecurity measures in aquaculture. The disease outbreak was occurred mainly during the winter season in most of the studied farms. Sometimes diseases also occurred in early and late winter. Tail and fin rot disease and EUS were most common diseases both in Kishoreganj and Mymensingh district. Argulosis was also common disease in Kishoreganj. Most of the large farmers opined that searching and collection of the dead or moribund fish after disease outbreak was very difficult, laborious and expensive. Lack of proper assistance on disease control and health management from non-governmental organization (NGOs) and government extension officers were reported in this study. Delabbio *et al*. (2005) reported that fish health specialists and extension agents working on farms must be aware of farmers' perceptions of disease risk and biosecurity to work effectively with them in achieving biosecurity objectives.

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