DISEASE INCIDENCE IN FISH HATCHERIES AND NURSERIES OF NORTH-CENTRAL REGION OF BANGLADESH

M. Phil. Thesis

SUBMITTED BY

SAMIMA NASRIN

EXAMINATION ROLL NO. 05

REGISTRATION NO. 283 (SESSION 2009-2010)

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DEPARTMENT OF ZOOLOGY
UNIVERSITY OF DHAKA
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DISEASE INCIDENCE IN FISH HATCHERIES AND NURSERIES OF NORTH-CENTRAL REGION OF BANGLADESH

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Submitted in Accordance with the Requirements of the University of Dhaka Bangladesh in Partial Fulfillment for the Degree of Masters of Philosophy in Zoology (Fisheries)

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DECLARATION

This is to certify that the thesis entitled **"DISEASE INCIDENCE IN FISH HATCHERIES AND NURSERIES OF NORTH-CENTRAL REGION OF BANGLADESH"** in fulfillment of the requirements for the award of the degree of Masters of Philosophy in Zoology (Fisheries) carried out by Samima Nasrin M.Phil, bearing Registration No. 283/ 2009-2010 under our guidance and supervision and that no part of the thesis has been submitted for any other degree.

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MY PARENTS

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ABSTRACT

The study documented the disease incidences and the operation and management practices in fish hatcheries and nurseries in five upazilas of Mymensingh and Gazipur Districts. A two step data collection scheme was followed: initially a Preliminary Survey of 50 fish farms, both nurseries and hatcheries, based on interview of fish farmers and subsequently, a year round monitoring of fish farms by paying quarterly field visits. During monitoring phase a total of 10 hatcheries and nurseries, two from each selected upazila, were sampled for water quality and documenting disease incidences. In addition, farm operation and management practices were also monitored.

The water quality monitoring was limited to parameters pertinent to aquaculture. The pH values in nursery and stock ponds varied from 4.5 to 10.6 with an average of 7.57 ± 1.25. Dissolved oxygen levels varied from 3.1 to 12.0 mg/l (average: 5.91 ±2.49 mg/l). Alkalinity and hardness levels fluctuated between 21.0-160 mg/l and 31.0 – 150 mg/l (average: 33.67 ± 24.43 mg/l and 45.41 ± 22.12mg/l), respectively. The ammonia and nitrite levels varied from 0.2 to 3.0 (average: 1.06±0.89) mg/l and 0.01 to 0.6 (average: o.13±0.14) mg/l, respectively. The observed low pH and dissolved oxygen levels recorded in some farms are far below the recommended levels for fish culture. Similarly, high levels of ammonia and nitrite concentrations are far above the recommended levels. Water quality parameters showed strong variations between individual farms, could be related to farm management activities practiced in individual fish farms. The seasonal variations were also observed in water quality parameters. Both dissolved oxygen and pH measured low during October-March period. Higher levels of nitrite and ammonia were recorded during October-March and April-June periods, respectively. Low pH and high levels of ammonia and nitrite are toxic to fish. Low oxygen concentrations and low pH and high levels of ammonia and nitrite recorded in the present study are likely to adversely affect the survival, growth and immunity of fish resulting in increased disease burden on fish. Water quality also varied between different sampling areas.

Nine different types of disease symptoms were observed affecting all species (7-9 species) of fish cultured in both in nursery and stock ponds. However, carps and Thai pangas were observed more susceptible to diseases. Depending on seasons, disease incidences were observed in 0-42% sampled fish farms. Highest disease incidences were observed during April-June and October-December periods in 33% sampled ponds, in each case. Of the sampled upazila, disease incidences were comparatively higher in fish farms in Kapasia upazila. In 25% sampled ponds disease affected less than 25% fish population in April-June period, while 50% and 75 % fishes were affected by disease in 8% ponds, in each case. Disease caused fish mortalities in 0-25% affected nursery ponds and 0--42% affected stock ponds. Less than 25% fish mortalities was observed in 25% ponds and up to 75% mortalities caused in only 8% nursery ponds. In case of stock ponds, upto 25% fish mortalities were observed in 58 % affected ponds, while up to 50 % fish mortalities occurred in 11% ponds. Various medicines and chemicals are used in treating fish disease in farms. More than one treatment methods are used in most fish farms. About 25% fish farms used medicine bought from market, about 4.5% farms used common salt, about 7.9%

farms used potassium permanganate and less than 1% farmers used herbal medicine, while about 52% farmers used lime in case of disease outbreak.

Overall, the stocking density in nursery ponds ranged from 20-200000 fry-fingerlings/decimal with an average of 14133±42880 fry-fingerlings/decimal and that of stock pond varied from 6-9000 fingerlings/decimal with an average of about 1341±1839 fingerlings/decimal pond area. Depending on seasons, 55-86% fish farms fed packed feed to fish, while in stock ponds packed feed was used by 14-58% fish farms. The rest of the farms used feed prepared on farm using locally available ingredients. In average, about 515 g feed/decimal was supplied to nursery ponds. High rate of feeding was done during January-March and low rate of feeding was done during October-December. Similarly, about 500g feed/decimal was supplied to stock ponds. In case of nursery ponds, depending on seasons, 33-83% farms fed more than once in a day, while 17-58% farms fed once a day. More frequent feeding was done during April-June period. In case of stock ponds, depending on seasons, more frequent feeding (50-75% ponds) was done during July-September and April-June periods. Water exchanges are done once in a quarter in 50-80% nursery ponds. However, in some nursery ponds water exchanges are done 2-3 times in a quarter. Almost a similar trend in water exchanges were also observed in case of stock ponds. Water exchanges are done more frequently during April-June and October-December periods.

Liming of ponds was a regular activity in the fish farms under the study. Depending on seasons, 77-100% sampled fish farms used lime in their farms. Of these, 18-54% ponds were limed once in a quarter, while 17-52% pond applied lime more than three times in a quarter. Overall average rate of liming in nursery ponds accounted to 300.26±274g/decimal and that for stock ponds was 314.22 ±257g/decimal pond area. Higher rate of liming (423g/decimal) was done during January-March period, while lower rate of liming was done in October-December period. However, 75-92% farms used lime at the rate below 500g/decimal and 8-25% farms used lime at the rate of up to 1000g/ decimal pond area.

Of the nine species of fish examined, only six species were found infected with metazoan parasites. *Histiostrongylus coronatus* was found in *Anabas testudineus* with a prevalence of 9% and intensity of 100, *Pangasius spp.* was found infected with *Argulus sp,. with* a prevalence of 25% and an intensity of 0.25. *Clinostomum piscidium* was isolated from *Labeo rohita* with a prevalence of 20% and an intensity index of 0.5, *Heteropneustes fossilis* was found infected with *Aurgulus* sp. with *a* prevalence of 14.28% and an intensity index of 100. *Puntius spp* was found to be infected with a Digenian parasite with a prevalence of 16.66% and intensity 0.5, *Labeo gonius.* was found infected with a *Clinostomum complanatum* parasite with a prevalence of 50.00% and an intensity 100. The prevalence of parasites was more in October-December period.

It appears from the study that poor water quality and lack of undertaking proper prophylactic measures are linked to observed disease incidences in the fish farms. The final conclusion drawn from the present study is that poor farm management and lack of awareness about disease control among fish farmers are underlying causes for disease outbreaks in fish ponds. It is suggest to develop a guideline on improved fish farm

management with emphasis on disease management issues and create awareness among fishers about controlling of fish diseases.

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INTRODUCTION

1 INTRODUCTION

1.1 Importance of Fish and Fisheries in Bangladesh

Fish and fisheries play an important role in the nutrition, economy and cultural life of the people of Bangladesh. Fish is second to our staple food and Bangladesh is the fourth highest among the freshwater fish producing countries in the world (DoF, 2012). The country is vested with huge water resources in the form of rivers, tributaries, canals, beels, ox-bow lakes, floodplains and pond and the country produces about 32.62 lakh mt fish annually. The total inland capture fisheries of Bangladesh occupies an estimated area of 47.04 lakh hac. and marine capture fisheries covers an area of 166000 sq.km. Of the total fish production in the country, about 82% comes from inland fisheries. Marine fisheries covers or exclusive economic zone 166000 sq. km (FRSS, 2012). There are about 260 species of freshwater fish and 25 species of freshwater shrimp. There 475 species finfish and 36 species shrimp species in marine waters (Chandra 1983).

Although the production from capture fisheries of the country show an increasing tendency, however, per capita consumption has fallen from 33g to18g capita/day in recent years, because of ever increasing population of the country (BBS, 2012). Therefore . Bangladesh is desperately trying to boost up her fish production. Convincing evidences now suggests that the inland open water fisheries is over exploited. In fact , fish production from most water bodies have declined and the trend is continuing further and might be irreversibly detrimental sustainability of the resource . In this backdrop, the only option is to increase the country's fish production through culture fisheries. A number of culture technologies have been developed over the last few decades and were disseminated and promoted throughout the country (BFRI 2012). As a result, the contribution of culture fisheries has increased to a great extent during the last thirty years and show an ever increasing trend (DoF, 2012). Presently, production from culture fisheries amounts to18.60 lakh mt which is about 54.54% of the inland water total production (FRSS, 2012). This necessitated the development and promotion of hatcheries and nurseries for seed production, both at the government as well as at the private level. Aquaculture technologies for commercial purposes of carps, catfishes, pangus, koi, shing, magur, and tilapia fish have been developed and quality hatchlings and fingerlings of those fishes are produced in the country. 1.08% of total fish hatchlings were produced in the government FSMFs and 98.33% in the private fish hatcheries (DoF, 2012).

Fish contains 16-21% protein on wet weight basis and supplies about 60% of animal protein consumed by people (DoF, 2012). Fish proteins are easily digestible and contain most essential amino acids (Nilson, 1946).

Fisheries sector contributes 4.43% to country; s GDP and 22.21% to country's agricultural GDP, foreign exchange of about 2.46% country's GDP. Bangladesh earned BDT 4770400 lakh by exporting 92479 mt of fish and fisheries products (DoF 2011-2012). About 1.4 million people full time professional fishermen and over 11 million part time or occational fishermen and a low percentage of fish pond farmers (Haque, 1996).

At present, there are 845 private fish seed multiplication centers and fish nurseries and 76 Government fish hatcheries in the country. The production of hatchling of private hatchery (181) 180203 Kg in Dhaka division. Fish hatcheries 90% contributed inland fisheries. (DoF, 2012).

1.2 Fish Diseases: Implications for Aquaculture in Bangladesh

Disease outbreaks have long been recognized as a significant constraint to aquaculture production and economic viability and thus pose a threat to sustainability of fish farming. A wide range of pathogens (viruses, bacteria, parasites etc), environmental factors (water quality, etc) and even husbandry factors cause heavy losses in aquaculture facilities. The impacts of fish diseases on mortality, growth, resistance to other stressing factors, and susceptibility to predation, marketability and profitability are well documented (Sarig 1971; Humphrey and Langdon 1985; Brown 1993; SEAFDEC, 1999, Noga 2000, Mazid and Banu, 2002, Mohan and Batta, 2002). Disease outbreaks not only affect the large commercial, but also small scale fish farming and open water capture fisheries around the globe (Chinabut, 2002).

Outbreaks of fish diseases and its impacts on fish productions and economic losses in South and South-east Asian countries have been reviewed by SEAFDEC (1999), and Mohan and Batta (2002). Invariably, fish diseases affect the inland capture fisheries as well as fish farming in the region in varying degrees. In India, diseases caused production and economic loss in both capture and culture fisheries (Das, 2002). Losses due to disease and other problems were estimated to range from a low of 5% in a nursery system to a high of 79.4% in a state hatchery in Laos. Losses incurred by fishers practising capture fishing in natural waters and reservoirs were 49% and 74%, respectively (Reantaso *et a*l., 2002). Disease outbreaks in Thailand during 2001 caused 20-100% mortalities in fish frams and an estimated loss of 4.3 million USD for the whole country (Chinabut, 2002). Disease affected 81.4% of the surveyed farms in different provinces of Vietnam and incurred losses (Phan Thi van *et al.,* 2002). Kanchankhan *et al. (*2002) also reported huge losses in farmed fishes in four provinces of Thailand.

Incidences of dieses in fish farms and its consequent economic loss are often reported in Bangladesh. The economic loss due to EUS was estimated at 118.3 million Taka (US$ 3.4 million; 1US$=35 Taka) during 1988-89 in Bangladesh and in the next year the disease occurred with lower severity, and the economic loss

was estimated at 88.2 million Taka (US$2.2 million). Fish price dropped to 25-40% of the pre-disease level during the first outbreak (Barua 1994).

Another study (Hossain *et al.,*1994a) reported a loss of 61% of carp fry in nurseries of the greater Mymensingh District were infected. Ahmed and Begum (1978) also observed mass mortality in hatchery conditions. Hasan and Ahmed (2002) reported that in most hatcheries and nurseries (66%), diseases caused partial loss of fry and fingerlings; only 7% of hatcheries and nurseries reported total loss of their stock, while 27% of the farmers reported no loss due to disease. The economic loss due to disease was about 7.6% of the profit. An estimate made by Brown and Brooke (2002) for Bangladesh showed that about 6% surveyed fish farms incurred complete loss , while others incurred losses at varying degrees. Average losses were estimated to be 3% of on farm income and equal to around USD 31/farm.

Scrutiny of relevant literature and those mentioned above reveals that disease contributes to the fish fish mortality and economic loss in farmed fishes in Bangladesh, especially incidences of diseases in fish farms, particularly hatcheries and nurseries, is considered as a constraint for aquaculture development in Bangladesh.

1.3 State of Fish Disease Researches in Bangladesh

Researches into the disease management have not been a priority in Bangladesh as it is done for intensification of aquaculture. In fact, there is a paucity of researches in disease incidences, particularly in hatchery and nursery conditions. Most researches are basic in nature, having little practical implications. Nevertheless, researches into the disease incidences covered a wide range of areas. A brief account of researches done into the fish disease in Bangladesh is given below:

A number of studies based on interviews of fish farmers documented fish mortality, disease type and pattern, loss in fish production. Notable of them are Hasan and Ahmed (2002), Hossain *et al. (*1994a), Faruk et al. (2004), Mazid and Banu (2002), Ahmed and Banu (2001), Brown and Brooks (2002), Mohan and Bhatta (2002). Based on fish farm monitoring, more comprehensive studies were made by Chandra *et al.* (1996), Hossain *et al.* (1994b), Ahmed and Begum(1978), Faruk *et al.* (2008). The authors recorded various fish diseases in fish farms and its pattern of occurrences, and identified causative agents, etc.

Aspects of fish health care and aspects of disease treatment have been studied by Mazid (2001), Mazid (2002), Hasan and Ahmed (2002) Rahman *et al.* (2005). The authors documented the disease control measures practiced in fish farms and suggested remedies for controlling disease outbreaks. Socio-economic impacts of disease incidences in fish farms have been studied to some extent by Mustafa *et al.* (2001) , Mazid and Banu (2002), Mohan and Batta (2002) Faruk *et al*. (2004). The authors estimated the production and financial loss and problems in the marketability of diseased fish.

Investigations into the parasitic infestation in nursery ponds were done only in few cases. Studies on the protozoan parasitic diseases in nursery were done by

Hossain et al. (1994b) and Chandra *et al.* (1996), while Ahmed and Banu(2001) studied the microbial diseases of fish in hatcheries. Rahman *et al.*(1998 a. 1998b) studied the impact of infestation on nutrition, metabolism and reproduction of fish.

Majority of researches done into the diseases of fish in Bangladesh relate to study of parasitic infestations. Early works in fish diseases concentrated solely on the exploration of the parasite fauna in fish. However, later other aspects of parasitic infestations were investigated. The important early works carried on fish parasite in Bangladesh include Rahman and Ali (1967), Rahman (1968, 1971), Bashirullah and Hafizuddin(1971,1973,), Bashirullah and Elahi (1972), , Ahmed and Begum (1978), Chandra(1983), Chowdhury *et al.* (1986), Rahman (1989), Khanum *et al.* (1990), Nahida (1993), Khanum and Begum(1990,1992,1996). Their works mainly concentrated on the helminth, acanthocephalan parasites, and crustacean parasites to some extent. More recent studies were done by Banu *et al.* (1993), Banu *et al.* (1997), Hossain *et al*.(1994a, b), Rahman (1995), Hafizuddin and Shahabuddin (1996), Akhter *et al*. (1997), Rahman *et al*. (1998a,b), Parween and Rahman (2000), Banu and Khan (2004), Rahman and Parween (2001), Alam *et al*. (2006), Chandra (2006), Akter *et al*. (2007), Bhuiyan *et al*. (2007), Afsharnasab *et al*. (2009), Mofassalin *et al*. (2012), and Uddin *et al*. (2012). In addition to taxonomic identification of fish the later studies also studied the biology, morphometry of paarsites, prevalence and other indicators of parasitic infestations. Studies were almost confined to freshwater fish, while few authors focused on marine fishes and shellfishes.

1.4 Problem Statement and Scope for Work

As emerged from the discussion in the foregoing sections that disease incidences pose a threat to successful operation of hatcheries and nurseries affecting its profitability. Diseases in hatchery and nursery cause fry and fingerling mortalities and also lead to failure in producing quality seeds for aquaculture. This is emerging as an issue of great concern in Bangladesh as intensification of aquaculture is in progress in the country. Convincing evidences now suggest that disease incidences in hatchery and nursery still remain as a threat to profitability of fish farms. Many studies have strongly suggested to give due emphasis on the control of diseases in fish farms, particularly in hatcheries and nurseries (Ahmed, 1997, Mazid and Banu, 2002, Boanandad-Reantaso, 2005 and Faruk *et al.*, 2008). Unfortunately, little has been done to address the issue. One of the constraints to this end relate to paucity of adequate information on the disease conditions in hatcheries and nurseries, particularly relating to operation and management of hatcheries and nurseries, incidences of diseases and its pattern. Therefore, documenting the operational and management practices, pattern in incidences of various diseases, parasitic infestations, treatment and performances of different treatment methods, etc. are probably of worthwhile.

At present, there are 861 fish hatcheries and 10450 nurseries in the private sector, while Government operates total of 81 hatcheries and 124 fish nurseries in the country. The total production of hatchlings and fingerlings in Bangladesh amounts to 69080 kg and 99875 lakh annually, respectively. Production from nurseries meets about 90/% of the fingerling requirements of for aquaculture in the country (DoF, 2012).

Poor management is probably a pivotal cause for prevailing disease conditions in hatcheries and nurseries in Bangladesh (Hasan and Ahmed, 2002; Faruk *et al.*, 2008). Stocking densities (Sniesziko, 1971, Mazid and Banu, 2002 Mohan and Batta, 2002), feeding regimes (Mazid and banu, 2002 and Hasan and Ahmed 2002), etc. many influence the occurrence and incidences of diseases in fish farms. Therefore, it is important to document the above aspects of management practices in order to understand the farm situation and formulate options for disease control.

Environmental degradation, particularly that of water, is linked to occurrence and intensities of diseases in fish farms. Some authors have indicated the degrading water quality in fish farms arising from farm management practices (Chinabut, 2002; Gupta and Shukle, 2006; Okoh, 2007.) is probably linked to disease incidences. However, water quality parameters determination in relation to disease occurrences in hatchery and nursery has rarely been investigated. Therefore, it is important to characterize the prevailing water quality of fish farms under different management regimes. Equally important to document the types and pattern of occurrences of diseases and curative treatments they undertake and evaluation of its efficacy. Detail information on disease type and its pattern is not well document and warrants for further investigation. These information are very much needed for designing control measures for disease management.

Parasitic infestation of farmed fish causes mortality, reduced growth, poor nutritional quality of fish (Cheng, 1964; Scholz, 1999: Woo, 2006) and pose a risk of disease transmission to human (Gupta, 1953). Some authors studied parasitic infestation in farm fishes, including also nurseries and recorded occurrence of various parasites in fish, ranging from protozoa to crustacea through helminth parasites. However, such data are very localized and do not represent wide areas to draw a common conclusions. Therefore, investigation into the type and intensity of parasitic infestation under different management regimes is important.

As stated above that a wide range of issues relating to disease incidences in hatcheries and nurseries needs to be investigated in order to be able to formulate a pragmatic disease control scheme. Of importance, documentation of hatchery/nursery operation and management practices including stocking densities, liming, fertilization, feeding regime, disease treatment, etc. and disease incidences with particular emphasis on type and pattern, intensities, loss and damages caused, and characterization of water quality of the production systems.

1.5 Objectives of the Study

The overall objective of the study was to carry out a survey on the occurrence of fish diseases in the nursery and hatchery of the country to understand the ground situation which will help to form the basis for the development of a guideline for fish disease control in hatcheries and nurseries in the country. However, the specific objectives of the study were to-

- document the occurrences and incidences of fish diseases in hatchery and nursery.

- document the operational and management practices that contribute to the incidences of fish diseases
- monitor water quality factors that influence the disease incidences in culture systems
- investigate the aspects of parasitic infestation of fishes in hatchery and nursery conditions
- put forward a set of recommendations based on the findings of the study for fish health management in nurseries and hatcheries in Bangladesh.

CHAPTER-2
REVIEW OF LITERATURE

LITERATURE REVIEW

This section reviews and compiles available literatures pertinent to the study from home and abroad, with major focus literatutres on Bangladesh fishes. However, in some acses, lieratures on fishes from other countries were also considered which were felt important to the understanding of the present study.

James (1939) reported some new trematodes of the family Allcreadiidae with the genus *Macroecithus* from the fish Tyosen III.

Gupta (1953) studied the trematode parasites of freshwater fishes of India and reported a large number of trematode species, of which many species were new records for India.

Cheng (1964) described the genus *Ergasilus* possessing at least 12 spp. In freshwater bodies which were parasitic on the gill fiaments of fishes.

Rahman and Ali (1966) worked on the occurrence of a spiny headed worm and reported the species, *Pallisentis nandai* in *Nandus nandus* from ponds in Chandpur.

Kulkarni (1969) studied the monogenetic trematodes of fishes found in Hyderabad and Andra Pradesh of India and reported a large number of trematodes and may of which were first records from Indian waters.

Roberts (1969) studied on *Ergasilus arthrosis* (copepod: cyclopida) and taxonomic status of *Ergasilus versicolor* (Wilson, 1911), *E. elegans* (Wilson, 1936), and *Ergasilus celestas* (Mueler, 1936) from North American fishes.

Roberts (1970) prepared aRevision on *Ergasilus* (copepod: cyclopoida) and prepared key to North American species.

Hafizuddin (1971) studied the helminth fauna of some freshwater fishes of Dacca. He observed *Pallisentis nandai* from the liver and intestine of *Nandus nandus* (Hamilton).

Bashirullah (1973a) worked on the helminth fauna of certain marine and fresh water fish of Bangladesh including *Notopterus notopterus , Puntius sarana, P. sophere, Mystus spp., Rita rita, Clupisome sp. , Wallago attu,Glossobius giuris , Channa spp.,Heteropneustes fossilis, C. fasciatus, Xenentodon cancila and Nandus nandus* .

Bashirullah (1973b) reported some helminth parasites, including *Pallisentis nagpurensis* in *Channa striatus* and *Gnostoma spinigerum and Channa marulius*.

Ahmed and Begum (1978) studied the distribution of some endoparasitic helminthes in six fresh water fishes of Dacca and Barisal.

Chowdhury *et al.* (1982) observed the incidence of *Diphyllobothrium larvae* and Pallisentis *nandai* in *Nandus nandus*.

Hoq (1983) studied on gill inhibiting monogenetic trematodes of some fresh water fishes of Bangladesh and observed high prevalence.

Chandra (1985) recorded the incidence and intensity of infestation of an acanthocephalan worm *Pallisentis ophiocephali* on a freshwater fish, *Channa punctatus*.

Zaman *et al.* (1985) investigated the occurrence of *Procamallanus malaccensis* in *Clarius batrachus* and *C. macrocephalus* from Khedha and Kerak, Malaysia.

Zaman *et al.* (1986) observed the effects of lengths (=Age) of *Clarius batrachus* and *C. macrocephalus*, on the abundance of parasites from Khedha and Kerak, Malaysia. Among 22 collected species only 12 were common in both fish. The number of the parasites increased with age and then decined in the largest size group.

Byrnes (1986) studied some *Ergasilids* (copepod) parasitic on four species of Australian bream *A. canthopagrus*.

Akhtar *et al.* (1989) observed the helminth infection in relation to seasons and body length of *Xenontodon cancila*. One acanthocephalan Pallisentis *ophiocephali* and three nematode sp.-encysted *Scaridoid larvae*, *Metaquempera bagarii* and *Camellanus gaboes* were found available in Xenontodon *cancila*. They found that the intermediate length group was more infected than the smaller and larger size groups.

Talukder (1989) recorded the seasonal infestation of helminth parasites with special reference to acanthocephalan, namely *Pallisentis nandai* in *Nandus nandus* in relation to some of its biological aspects.

Akhter *et al.* (1990) described the incidence of helminth parasites in *Xenontodon cancila* in relation to food items, among the food items found in the stomach of *Xenontodon cancila* 17.6% were arthropods, 22.5% were vegetative matters and 30.6% were small fishes.

Zaman *et al.* (1992) observed the occurrence of *Procamallanus heteropneustes* in *Heteropneustes fossilis*. They observed that the overall prevalence and intensity were 20.9% and 1.9 %, respectively and the male fish was found more infected than the female.

Khanum *et al.* (1992) recorded the correlations of sizes of *Heteropneustes fossilis* with the rate of heminth infection. They observed that the first intermediate size group had the highest prevalence of infestation and the second intermediate size group had the highest intensity of helminthes.

Suchada Kaentip (1992) studied on helminth fauna in climbing perch, *Anabas testudineus* from natural water resources and identified 5 species of digenia, 7 species of nematode, and 1 of acanthocephalan parasite.

Nahida (1993) investigated the helminth parasites and histopathology of infested organs in *Nandus nandus*. She found four trematodes, namely *Coitocaecum orthorchis*, *Opegaster sp*., *Podocotyle atomon*, *Helipegus sp*., two nematodes: *Hnothostoma spinigerum*, procaecum *sp*., one cestode: *Bothriocephalus sp*., and one acanthocephala: *Pallisentis nandai* from the host fish. She also found that the female hosts were more infested than the male hosts, the prevalence and intensity was highest n summer and lowest in winter season. The largest length group and weight group showed the highest prevalence and intensity.

Sarker (1993) studied the helminth parasites and histopathological disorders in Colisa *fasciatius and Xenentedon. cancila.* In *C. fasciatius* she found 3 trematodes: *Indoderogens sp*., *Macrolecithus* sp., *Clinostomum* sp., 2 cestode: *Paradilepis scolecina*, *Pseudophylidian larvae*, 2 nematodes: *Cosmoxynemoides* sp., and Ascaridian *larvae*, 2 acanthocephala: *Pallisentis* sp. and *Acanthosentis indicus*. The highest percentage was found in summer and the male fish was more infested than the female.

Akhtar (1995) studied on helminth parasites and their associated histopathology in *Anabus testudineus*. She identified 1 trematode (Neopecoelina *saharanpurensis*) and 6 nematodes (*Metaquimperia madhui*, *Ascaridian larva*, Contracaecum *sp*., *Zeylanema anabantis*, *Z. bidigitalis*, *Z. pearse* and *Gnathostoma spinigerum*) in different organs of the fish.

Khanum *et al.* (1996) reported the endoparasite community of two species of genus Ompok: *O. binaculatus* which harboured 5 digenian (*Allcreadium mahaseri*, *Pleurogenes pabdai*, *Isoparchis hyopselobagri*, *Phyllodistomum folium*, *Gonocreca crassa*), *Caryophyllidean larvae* , 7 nematode (*Capillaria sp*.,*Eustrongylides tubifex*, *Contracaecum sp*., *Spirocamallanus mysti*, *S. alii*, *Procamallanus heteropneustes* and *Gnathostoma spinigerum* and 1 acanthocephalan (Pallisentis gabos) parasites. *Ompok pabda* also harboured 8 species of helminthes including *L.hypselobagri*, *P. Pabdai*, *P. attu*, *Contracaecum sp*., *S. mystii*, *P. heteropneustus*, *G. spinigerum* and *P. gabos.*

Chinabut (2002) studied the catfish cultured in Thailand is a hybrid of the male African catfish, *Clarias gariepinus* and the female of the native catfish *C. macrocephalus.* A severe outbreak of catfish jaundice was reported in the summer of 1992 that caused 20-100% mortality. The economic loss due to this disease was estimated at US$360- 1,800/farm or US$4.3-21.3 million for the whole country. Research indicated that rancid chicken offal was the cause of this disease. Recommendations based on research resulted in improved fish health and reduced economic loss due to disease.

Chinabut *et al*. (2002) studied the socio-economic impact of disease on small-scale freshwater aquaculture in northeast, central and southern Thailand using questionnaires. A total of 74 farmers from nine provinces were interviewed. The species cultured were ornamental fishes, such as angelfish, goldfish and guppies, and food fishes such as catfish, snakehead, carp and tilapia. It was found that disease problems had an impact in reducing production, which, in turn, caused a decline in income and increased debt. Flooding was also one of the major problems causing serious losses.

Mazid and Banu (2002) investigated the disease incidences and corresponding financial losses in fishes. Indiscriminate and unplanned use of feed and fertilizer, with subsequent effects on water quality in pond ecosystem increases stress to fish and accelerates susceptibility to pathogens. The effects of disease in improved culture systems are significant; however, proper systematic information on disease outbreaks is not yet available. The most obvious effect of the occurrence of disease is mortality, followed by economic losses. Mass mortalities of carp fry and fingerlings due to protozoan and metazoan parasites are frequently reported. In Bangladesh, outbreaks of disease in shrimp caused by white spot syndrome virus (WSSV) (reported as systemic epidermal and mesodermal baculovirus – SEMBV) alone caused a 44.4% production loss in 1996; although the incidence of outbreaks has reduced considerably since then. It is obvious that disease outbreaks in fish and shrimp culture systems have a great impact on low income groups.

Mohan and Bhatta (2002) assessed the socio-economic impacts of disease and stated that rural aquaculture is vital in order to implement primary health care. They said rural aquaculture includes culture-based capture fisheries, trapping systems, traditional fish farming in family ponds and modified extensive or semi-intensive culture systems. The impact of disease may differ in each of these systems. They opined that mechanisms for assessing the impacts of disease in different culture systems should be based on well thought-out protocols. More often, the concept of socio-economic impact assessment is lost when assessments are carried out for only those epizootic diseases that result in total mortality and crop loss.Thier paper examined the health problems in aquaculture, constraints to implementation of adequate health management in different aquaculture systems, and protocols for quantification and assessment of health-related losses, and attempts to define health management costs. The socio-economic impact of epizootic ulcerative syndrome (EUS) and white-spot disease on rural aquaculture was examined in detail using primary and secondary information. Four case studies from different rural aquaculture systems looked into the socioeconomic impact of disease.

Brown and Brooks (2002) surveyed the fish disease in 257 farmers from six districts in Bangladesh during September 1999. The farmers were interviewed selected from a general baseline study of 2,500 farmers .The interviewed farmers were capable of identifying, at most, nine major causes of fish death in their ponds. The most common causes of death were a "red spot" disease referred to as EUS (epizootic ulcerative syndrome), “fin/gill rot,” “air gulping” and “cotton fungus.” No laboratory diagnosis of these diseases was possible. In terms of constraints to production, the majority of farmers did not think that fish disease

was important. Rather, they identified issues such as “lack of personal knowledge of fish pond management,”“credit and financial problems” and “fry/fingerling supply” as being more important. The effect of fish disease on the farmers' ponds and livelihoods was limited. Fish seldom died off all at once, and 47% of farmers were able to either eat or sell the dead fish. Most farmers turned to other farmers for advice when disease occurred in their ponds but had a limited range of treatments, with potassium permanganate being the most popular (although most farmers simply harvested all the fish). In terms of financial loss, only 4% of the farmers said fish disease losses were “big and unacceptable.” Average Losses were stimated as 3% of total “on-farm” income, and equal to around US$31 per year.

Arthur and Subasinghe (2002) studied the introduction of exotic fishes into natural waters, and the culture and stocking of both introduced and indigenous species to enhance production from freshwater artesianal fisheries has often produced significant socio-economic benefits to small-scale rural fishing communities. The introduction of exotic pathogens along with introduced aquatic animals too often resulted in severe socio-economic and/or ecological impacts. In most cases, such impacts can be avoided, if fisheries managers follow internationally accepted procedures (e.g., the protocols of the International Council for the exploration of the Sea, ICES) when importing exotic fish. Enhancement of artesianal fisheries by stocking of hatchery-reared fry of native or well established and widespread troduced fishes (such as the Chinese and major carps in Bangladesh), poses much less threat with regard to pathogen spread. They also observed if brood stock is obtained locally, all pathogens will already be present in the country and most will probably already be widely distributed in natural waters. However, good hatchery management practices, including rigorous screening of broodstock for pathogens and routine disease diagnostics and treatment of fry and fingerlings will do much to reduce the possibility of stocking unhealthy seed (with resulting poor survival and/or production) and the potential for spread of disease into new areas.

Hasan and Ahmed (2002) reported the results of a case study carried out in 180 hatcheries and nurseries in northeastern and southwestern Bangladesh over a 30-day period during August–September 1999. The objective of the survey was to study different aspects of management issues in small-scale carp hatcheries and nurseries, with special reference to their health management. Three Indian major carps (*rohu, catla* and *mrigal*) and three exotic carps (silver, grass and common carp) were the dominant fish species cultured in most hatcheries and nurseries. The study indicated that the major source of spawn for nurseries was hatcheries, while hatchery brood stock were mostly collected from the farmers’ grow-out ponds. In general, hatcheries were more profitable than nurseries. Profitability of nursery operations appeared to be vulnerable, due the high variability in market price of fry and fingerlings. They analyzed the major management problems faced by hatcheries and nurseries were due to disease, drought and flooding. Diseases were less prevalent in hatcheries than in nurseries. The major diseases reported in nurseries were white spot, tail and fin rot, epizootic ulcerative syndrome (EUS), sudden spawn mortality, gill rot, dropsy and malnutrition, while the major diseases reported in hatcheries were sudden spawn mortality and fish lice.

Phan *et al*. (2002) observed that small-scale aquaculture plays an important role in livelihoods in rural areas of Vietnam. The main cultured species are Chinese carps (*Ctenopharyngodon idellus, Hypophthalmichthys molitrix* and *Aristichthys nobilis*), Indian major carps (*Labeo rohita* and *Cirrhinus cirrhosus*), common carp (*Cyprinus carpio*) and tilapia (*Tilapia* spp.). A disease, the causative agent of which has not yet been identified, but known in Vietnam as "red spot disease" (RDS) because of the presenting signs, which are similar to those of epizootic ulcerative syndrome, is causing significant economic loss. This disease is the major constraint to improving output from freshwater aquaculture in Vietnam. The objective of this study was to provide an overview of RDS in Vietnam and the socioeconomic impacts on small-scale fish farming in the north of Vietnam. A total of 145 farmers in Thai Nguyen and Bac Ninh provinces, representing highland and lowland aquaculture systems, were interviewed using a questionnaire provided by the Network of Aquaculture Centres in Asia Pacific (NACA), and the Epi-Info2 software program was used to analyse the data. Findings from the study confirmed that grass carp is the most susceptible species to RSD and, out of 81.4% farmers who had disease problems during the growing cycle, 83.1% had this disease problem. Disease affected 81.4% of farms surveyed. Of these, 83.1% reported that their fish had been affected by RSD, 11.9% by unknown diseases, 4.2% by parasitic diseases and 0.8% by fungal diseases.

Kanchanakhan *et al*.(2002) the socio-economic impact of disease in small-scale coastal finfish aquaculture in the east and south of Thailand was assessed during July-September 1999 using a questionnaire. A total of 136 fish farmers were interviewed. The species cultured in the survey area are barramundi (*Lates calcarifer*) and grouper (*Epinephelus* spp.). The farms surveyed included 102 seabass farms and 34 grouper farms. The farms are located in four provinces: Satun, Pattani, Chanthaburi and Songkhla. Of the farms surveyed, 119 were cage-culture farms, while only four farms were pond-culture systems; five farms were solely hatcheries, while six farms combined hatchery and pond-culture systems. Two of the seabass farms carried out all of the above culture systems. The survey indicatesthat the majority of the problems in grow-out grouper cage culture and seabass cage culture were due to seasonal variations and disease.

Reantaso *et al*. (2002) an aquatic animal health assessment was conducted in August 1999 as part of a framework to develop an aquatic animal health programme in southern Lao PDR. The objectives of the survey were to use a participatory farm/household/community survey to assess the socioeconomic impact of aquatic animal disease and production-related problems on six different small-scale aquaculture practices (i.e., fish pond, rice-fish culture, nursery, community pond, state and private hatchery, and capture fishing in reservoirs and natural waters) in southern Lao and to train livestock and fisheries officers from four provinces in aquatic animal health assessment. A disease exhibiting signs consistent with epizootic ulcerative syndrome (EUS) was recognised by most farmers in most production systems. The other problems recognized were red discoloured patches; deaths with no clinical signs; parasitism by *Lernaea;* and problems related to technical capability, resource availability, the environment and predation. Losses due to disease and other problems were estimated to range from a low of 5% in a nursery system to a high of 79.4% in a state hatchery. Losses incurred by fishers practising capture fishing in natural waters and

reservoirs were 49% and 74%, respectively. EUS-like lesions were reported by a large number of respondents from fish ponds and capture fisheries, as well as from two community ponds. The greatest losses occurred in state hatcheries (US$6,458/yr) followed by reservoirs (average of US$1,028/family/yr), which partly reflects their higher potential production relative to the other systems

Das *et al*. (2002) observed the inland fishery resources of India (e.g., rivers, wetlands, lakes, reservoirs and ponds) had a rich production potential; however, sub-optimal water quality or detrimental ecological conditions had limited their fish production. He said although, in general, reports of fish kills are not properly documented in India, outbreaks of epizootic ulcerative syndrome (EUS) initiated establishment of a disease surveillance and monitoring system for the country. Assessment of disease impacts is hampered by inadequate baseline data on fish production and market intelligence statistics. Thus, an economic evaluation of fish losses is also difficult. In this paper, the results of investigations conducted on these aspects are presented, and the socio-economic impacts of EUS are described through a case study made at three levels viz., the producers, the fish traders and the consumers. The extent of fish and monetary losses suffered as a result of EUS are estimated, the effects on fish consumptionand trade assessed, and the role of the media during disease outbreaks examined.

Bondad-Reantaso and Subasinghe (2005*)* described the various factors, providing specific examples, which had contributed to the current disease problems faced by what is now the fastest growing food-producing sector globally. These include increased globalization of trade and markets; the intensification of fish-farming practices through the movement of broodstock, postlarvae, fry and fingerlings; the introduction of new species for aquaculture development; the expansion of the ornamental fish trade; the enhancement of marine and coastal areas through the stocking of aquatic animals raised in hatcheries; the unanticipated interactions between cultured and wild populations of aquatic animals; poor or lack of effective biosecurity measures; slow awareness on emerging diseases; the misunderstanding include compliance with international codes, and development and implementation of regional guidelines and national aquatic animal health strategies; new diagnostic and therapeutic techniques and new information technology; new biosecurity measures including risk analysis, epidemiology, surveillance, reporting and planning for emergency response to epizootics.

Faruk (2008) examined the status of disease and health management practices in *Pangasius hypophthalmus* in Mymensingh District of Bangladesh during the period from April 2004 to March 2005 using questionnaire interview and participatory rural appraisal tools such as focus group discussion (FGD. The most prevalent symptoms of disease as reported by the farmers were red spot, followed by anal protrusion, tail and fin rot, pop eye, dropsy and gill rot. Other conditions like cotton wool type lesion, ulceration and white spot were also reported but with lower incidences. The study also highlighted health management problems of *P. hypophthalmus* farming which include technical knowledge of farmers on fish health and disease, lack of assistance from government and non-government organizations, unavailability of appropriate therapeutants and lack of knowledge on their application. He suggested proper identification and characterization of

pathogens and for the development of farmer-oriented disease control and health management packages.

Edema *et al.* (2008) conducted a survey of fishes of the Okhuo River between August and November 2004 to determine the abundance and prevalence of parasitic infection by fish types. The fish were collected with gill nets and with hook and line. He also studied ten fish species in nine genera and six families were encountered. The family Cichlidae formed 44.44% of the total number of individuals while the rest were Notopteridae, Characidae, Malapteruridae, Channidae and Anabantidae. Nematode parasites were only recorded. Two nematode parasite species *Procamallanus sp* (50% prevalence) and *Cucullanus barbi* of 33.3% prevalence were observed in the intestine of *Chromiclotiapia guentheri. Spinitectus* sp had 16.7% prevalence in *Parachanna obscura.* The overall parasitic infection rate was 6.94%.

Manjare *et al.* (2010) studied the physico-chemical parameters of Tamadalge water tank in Kolhapur District, Maharashtra. Monthly changes In physical and chemical parameters such as Water Temperature, Transparency, Turbidity, Total Dissolved Solids, pH, Dissolved Oxygen, Free Carbon dioxide, and Total Hardness, Chlorides, Alkalinity, Phosphate and Nitrates were analyzed for a period of one year from 1st January 2009 to 31st December 2009. He said all parameters were within the permissible limits. The results indicated that the tank was non-polluted and could be used for domestic, irrigation and pisciculture purposes.

Phan *et al.* (**2010)** studied residents of the Red River Delta region of northern Vietnam who have a long tradition of eating raw fish. He also studied fish-borne zoonotic trematodes (FZTs) and estimated that paarsite infect ≈1 million persons in Vietnam. It remained uncertain at what stages in the aquaculture production cycle fish become infected with FZTs. Newly hatched fish (fry) from 8 hatcheries and juveniles from 27 nurseries were therefore examined for FZT infection. No FZTs were found in fry from hatcheries. However, when overwintered in ponds, the fish became infected. FZT prevalence was higher in grass carp ($p<0.001$) than in other carp species. Results showed that nurseries were hot spots for FZT infections in fish. The authors staed that sustainable FZT prevention strategies must address aquaculture management practices, particularly in nurseries, to minimize the risk of distributing infected juveniles to grow-out ponds and, subsequently, to markets for human consumption.

Muhibbu-Din (2011) the physicochemical qualities of effluents impacted stream located in Obafemi Awolowo University, ile-ife Nigeria was assessed over the duration of 7 months. Parameters measured included pH, temperature, electrical conductivity, depth, turbidity, biological oxygen demand (BOD), dissolved oxygen, chemical oxygen demand, nitrate, sulphate, acidity, alkalinity, organic matter and carbon levels and these were simultaneously monitored in the receiving stream using standard methods. Unacceptably, high levels of the assayed parameters were observed in many cases for nitrate (0-0.75 mg/L), while dissolved oxygen (3.2-13.6 mg/L) and turbidity (86-97 NTU) for the two sampling points during the study period and are severally outside the compliance levels of the Federal Environmental Protection Agency (FEPA) Guidelines and World Health

Organization (WHO) tolerance limits for domestic uses. The incidences of diseases were also high.

Lutfor Rahman *et al.* (2012) studied the seasonal variations in Turag river water quality parameters with a view to assess the degree of pollution of Turag river water by determining various physico-chemical parameters. Water samples were collected six times per year during wet and dry season at the following three locations: Tongi Railway Bridge, Bishwa Ijtema field and Ashulia. Most of the measured physicochemical parameters exceeded permissible limit of drinking water. The recorded pH ranged from 6.6 to 7.98 and Electrical Conductivity (EC) from 160 to 1107 µs/cm. The recorded dissolve oxygen (DO) varied from 0.11 to 6.8 mg/L and biological oxygen demand (BOD) ranged from 10 to 180 mg/L while chemical oxygen demand ranged from 21 to 220 mg/L and free CO2 value from 5 to 22 mg/L. The concentration ranges of heavy metals and arsenic in ppb were as follows: Zinc (Zn) (0.04 to 0.4), cadmium (Cd) (0.043 to 2), arsenic (As) (1.15 to 4.8), (lead) Pb (2.29 to 18.62) and mercury (Hg) (0.12 to 1.45). Due to the increased values of the parameters pH, DO, BOD, COD and free CO2 water from these locations was not suitable for human consumption without appropriate treatment.

Kavita and Sheela (2012) studied the seasonal variations in physico-chemical parameters of Bharawas pond, Rewari, Haryana. A total of 17 parameters were monitored during the study period. Most of the parameters viz. temperature, transparency, EC, Free CO , DO, Chloride, Carbonate, Bicarbonate, T.alkalinity, 2T.hardness, Calcium, Magnesium, Salinity, TDS and phosphate were badly affected while only pH and nitrate were found within range. It was also observed that the pollutant receiving water body appears as an aquatic desert which is most unsuitable for aquatic biota and for aquaculture.

Phimmachak and Hanthavong (2012 conducted a survey in three provinces of Lao PDR for assessing aquatic animal health based on interview of fishers. The objectives of the study were to (1) identify problems with fish disease in Lao PDR, (2) investigate the source and cause of disease and, (3) determine its effect on aquaculture systems. The interviewed163 fisher families using a questionnaire, and found that 30-40% fish farmes experienced fish disease. They also opined that that the spread of disease depend on many factors associated with culture in hatcheries and nursing and is more of a problem in integrated than in poly-culture systems. In Oudomxay and Vientiane, fish mortality due to disease was high and often associated with imported seed. Disease occurred mainly in the cool months from around December to April and early rainy season from about May to June. Eight major diseases are prevalent, viz. epizootic ulcerative syndrome (EUS) and diseases caused by Lernaea, Epistylis, Trichodinia, Oodinium, Gyrodactylus, Columnaris, and *Edwardsiella tarda*.

Olurin *et al*.(2012) examined one hundred and thirty eight fish specimens of two cichlids, *Sarotherodon galilaeus* and *Tilapia zillii* from River Oshun, south-west Nigeria for helminth parasites. They found forty-five (32.6%) fish specimens had parasitic infection. They recorded two helminth species, a trematode,

Clinostomum tilapiae (metacercaria), and an adult acanthocephalan parasite, *Neoechinorhynchus rutili.*

Omeji (2013) studied *the* prevalence and intensity of infestation brought about by the endoparasites in the fish hosts. Of the eighty (80) *Clarias gariepinus* from earthen pond, 40% fish were not infested while 48 (60%) were infested. They found a total of 62 endo-parasites belonging to two species of nematode (*Eustrongylides* and *Camallanus*), and two species of protozoa (*Hexamita* and *Trypanosoma*) while out of the 80 *Clarias gariepinus* from the concrete, it was observed that 64 (80%) of the fish were not infested while 16 (20%) were infested by endo-parasites and were observed to harbour a total of 24 endo-parasites belonging to two species of nematode (*Eustrongylides* and *Camallanus*) and one species of protozoa (*Hexamita*). It was observed that male fish from the earthen pond had more percentage parasitic infestation (64.29%) than the female fish (57.69%) while in the concrete pond, female fish had more percentage parasitic infestation (22.73%) than the male (16.67%). It was observed that bigger fishes of weight class between 750-849g were more infested than the smaller counterpart (less than149g) from both ponds. In the earthen pond, the highest percentage intensity of infestation (0.83%) was recorded in fish with the weight class between 750-849g while the lowest was recorded in fish with weight class between 250-349g. On the other hand, the highest percentage intensity of infestation (0.42%) was recorded in fish with the weight class between 750- 849g while the lowest was recorded in fish with weight class less than 149g.

CHAPTER-3
METHODOLOGY

3 METHODOLOGY

The purpose of this section is to describe the research activities and its corresponding methodology in documenting the environmental conditions and disease incidences in selected in fish hatcheries and nurseries. The chapter also describes the analytical procedures, and data processing and presentation methods followed.

3.1 Study Area and Study Period

The study was conducted in five selected *upazilas in two districts of* Gazipur District (1 upazila) and Mymensingh District (4 *upazilas*) of the north –central region of Bangladesh . These areas are known to have large number of commercial scale fish hatcheries and nurseries and are also renowned for culture fisheries. The location of the selected hatcheries and nurseries under study are shown in Map 3.1(a,b). The study was carried out during the period January 2012-March 2013.

3.2 Nurseries and hatcheries Sampled for Study

The study populations included the fish nurseries and hatcheries operating within the study area, upon which data collection was based. In fact, data collection was based on the selected fish nurseries and hatcheries of the concerned *upazilas.* Altogether, a total of 50 fish nurseries and hatcheries were selected for background and baseline data collection and of them, a total of 10 fish nurseries and hatcheries were selected for subsequent monitoring. Table 1.a provides information on the Upazila wise distributionof study populations, while Annexure I give the list of individual fish farms.

Table 1.a. Upazila wise distribution of nurseries and hatcheries sampled during monitoring

Area	No. of hatcheries & nurseries sampled for	No. of hatcheries & nurseries selected for	No of ponds (no. of ponds monitored)

	frame survey	monitoring	
Kapasia	9	2	7 (6)**
Mymensingh Sadar	9	2	65 (5)
Trishal	18	2	104 (4)
Fulbaria	7	2	17(4)
Muktagacha	7	2	62 (5)
Total	**50**	**10**	**255 (24)**

** *Figures in parentheses indicate number of ponds sampled for water quality and collecting fish samples*

In total, there were 255 nursery and stock ponds in 10 selected farms, of the them (both hatcheries and nurseries) 24 ponds sampled for water quality and questionnaire based interview.

3.3 Selection of Fish Hatcheries and Nurseries for Monitoring

Initially, the sampling upazilas were selected arbitrarily based on the local accounts of abundance of fish farms within the study area and ease of accessibility. Subsequently, list of all fish hatcheries and nurseries of the selected each individual Upazila was collected by paying visit to concerned upazila Fisheries Offices. All the listed fish farms were then visited to assess the accessibility and suitability for the proposed study. Based on the assessment, a total of 50 fish nurseries and hatcheries were selected for collecting background and baseline data (preliminary survey). From this initially selected fish nurseries and hatcheries, a total of 10 nurseries and hatcheries, two from each selected upazila, was subsequently selected for monitoring of disease incidence and water quality. Information on the selected nurseries and hatcheries given in Table 1.b.

Table 1.b. Upazila wise selected nurseries and hatcheries for monitoring

Si. No.	**Names of Hatchery and Nursery**	**Union**	**Upazila**	**District**
1	Munshi Poultry & Fisheries	Barun	Kapasia	Gazipur
2	Sumaiya Khamar	Raunat, Durgapur	Kapasia	Gazipur
3	Sarkar Hatchery	Raghurampur	Mymensingh Sadar(Shomvogong)	Mymensingh
4	Shapla Hatchery	Raghabpur	Mymensingh Sadar(Shomvogong)	Mymensingh
5	Remi Hatchery	Jayerpar	Trishal	Mymensingh

6	Abdus Salam Hatchery	Bouliapara	Trishal	Mymensingh
7	Billal fisheries	Radhakanai	Fulbaria	Mymensingh
8	Fulbaria Agro Services	Radhakanai	Fulbaria	Mymensingh
9	Sonali Fish Hatchery	Bashati	Muktagacha	Mymensingh
10	Rupali Fish Hatchery	Bashati	Muktagacha	Mymensingh

3.4 Study Design

As indicated above, the study was based on data collection from selected fish hatcheries and nurseries. A two step data collection scheme, initial Preliminary Survey of greater survey population for establishing background and baseline, and subsequent Monitoring of selected farms to document environmental quality and disease incidences from selected hatcheries and nurseries.

3.5 Description of Survey and Monitoring Methods

3.5.1 Preliminary Survey

The purpose of the Preliminary Survey was to collected background and some baseline information on the hatchery and nursery conditions. The survey was conducted on 50 selected fish nurseries and hatcheries by taking interview of fish farm owners/ managers of the respective hatcheries and nurseries and checking of relevant documents, when available .All the fish nurseries and hatcheries were small scale commercial type. The interview was centered on the following subject areas:

Infrastructural facilities: Total area of individual each hatchery and nursery, number and sizes of nursery ponds, total pond areas, etc.

Hatchery production: Fish species stocked, total productions of fry and fingerlings, total income, prices, production period and cycles, etc.

Stocking and feeding: Stocking rate, feed offered, feeding regimes, etc.

Other management activities: Water exchange, perceived water quality, pond drying, source of water, etc.

Incidences and treatment of diseases: Disease or symptoms observed period of occurrences, loss of fish, treatment practices, time and frequency of diseases, etc.

Interview techniques

The interview was carried out by using a structured questionnaire. The questionnaire development procedure followed the methods described by Thrusfield (1995). The questionnaire was designed to record information in a standard format with in-built error checks. The developed questionnaire was field tested prior to actual data collection and was revised when felt necessary. Attempts were made to make wording unambiguous, brief, polite and non-technical. Questionnaires were prepared both in English and Bengali, and the Bengali version was used in the field.

The interview held by prior appointment with farm owners/or managers. The questions were explained to the respondents so that he/she could answer properly. An individual interview lasted for about 2-3 hours.

The questionnaire used for interview is appended in Annexure 2.

3.5.2 Monitoring of Diseases and Water Quality

Once the frame survey was completed and more information accrued, a total of 10 sample hatcheries were selected for subsequent monitoring with a view to observe water quality and diseases incidences and its treatments. The purposes of the monitoring program was to make observations on the incidences of diseases and water quality measurements in order to able to make an assessment of the disease status and water quality status of the fish hatcheries and nurseries in the north – central region of Bangladesh. Details on the monitoring schemes are given below:

Sample size: Twenty four nursery and rearing/ stock pond were selected for monitored from 10 fish hatcheries and nurseries.

Sampling frequency: Once in every 3 months

The following activities were undertaken during monitoring of fish nurseries and hatcheries:

Water quality parameters monitored: Water pH, alkalinity, dissolved Oxygen, hardness, ammonia, nitrite.

Observations on fish behaviour: Prior to sampling fish, where possible observations on fish behavior was made and such. Observations assisted in diagnosis of fish diseases. The symptoms observed included loss of appetite, listlessness, gulping at the water surface, body rubbing, flaring of gill covers (opercula), loss of balance, position in water column, swimming with head up, swimming with head down, spiralling etc.

Inspection of fish: During each visit to the fish farms, some fish from each pond were netted out and examined for any visible symptoms of diseases. Once a fish has been removed, the fish was examined on site for the following:

- Bone deformities haemorrhagic lesions, etc.

- Skin colouration changes- dark, pale, blotchiness, saddleback, presence of sores, necrosis, ulcers, spots, bleeding, loss of scales, changes in texture, etc.
- Eyes: swollen, opaque. Sunken, etc
- Fin rot
- Gills: pale, swollen, filaments fused together, filaments clubbed/swollen, filaments eroded, excess mucus, presence of debris.
- Presence of disease: There are different disease in different hatcheries and nurseries that disease symptoms are identified in different literature, book and hatchery and nursery information.

Interview of fish farmers: In addition to direct observation on fish and fish behavior, fish farmers were also interviewed during each monitoring visit. The interview was conducted following a structured questionnaire. The major questions related to fish diseases and its treatment included the following:

Incidences of disease: Disease signs / symptoms, period of occurrences, frequency and intensity, possible causes, etc.

Treatments employed: Medicine used, other treatments, any management activities for eradication of diseases, consultation of fisheries officer, etc.

Fish mortality or loss: Mortality and damages, severity of mortality and damages, economic losses, etc.

Management practices: Water exchanges, liming and its rates, removal diseased fish, pond diinfection, etc.

The procedures for interview were the same as described for frame survey. As with frame survey both Bangla and English versions of questionnaires were prepared, however Bangla version was used during interview.

A copy of the questionnaire used for conducting interview during monitoring is given in Annexure 3.

3.6 Analytical and Laboratory Procedures

3.6.1 Water quality

The water quality parameters were measured on site using a HACH Kit (FF-2). The methods utilized for individual parameters are mentioned below: The following water quality parameters were measured during each visit to the farms.

Water PH: Measured by using a portable pH meter.

Alkalinity: The alkalinity was determined by phenophtheelein method using digital titrator by using HACH Kit (FF-2 model). .

Hardness: Hardness was determined also by using HACH Kit which employed titratmetric method based on the use of standard EDTA.

Dissolved Oxygen: Dissolved oxygen was measured by HACH's new sensor 6 Dissolved Oxygen Meter and Electroade as an alternative to the Winkler DO method with the Digital Titrator.

Ammonia-N: The Nessler Method was used for ammonia nitrogen measurement by using clor comparator (HACH: FF-2). Interference due to high water hardness is eliminated by adding Rochelle Salt Solution to the sample.

Nitrite-N: Nitrite for test NitriVerR 3 powder pillows (100) method with Colour Comparator Box.

3.6.2 Parasitological Study

As mentioned in forgoing section, some fish samples were taken during each monitoring visit to fish farms for laboratory examination of fish for ascertaining fish disease, and collection and identification of parasites. Total 76 fish specimens were examined for parasites. The fishes were brought alive in polybag in cool box to the laboratory in the Department of Zoology, University of Dhaka. The fishes were subjected to physical examination for disease.

External examination of fish: The external surface of fish, including body and fins, was examined for ecto-parasites under a simple microscope or hand held lens, and body scraps of mucus were also taken for parasitic examinations. . Gills were incised and examined under microscope. Later gill filaments were scrapped off in the laboratory with a blunt end of a scalpel (Cable, 1958) and observed for parasites under Stereoscopic Binocular Microscope (Swift: Stereo Eighty B-4) and any parasite collected was preserved in 70% ethyl- alcohol in separate vials.

Internal examinations (neprosy): Fishes were then dissected to find out the endoparasites of internal organs. The organs were kept in physiological saline (0.7 % Na Cl). The intestinal and stomach parasites were examined by longitudinal incision from posterior to anterior direction Fishes were identified, sexed , measured grouped according to their total length and weight and external observation and internal observation.

After examining the external body surface, the fish were cut open by making an incision through the mid-ventral line of the body. The body cavity, mesenteries, internal organs, etc. were then examined. The entire digestive tract was separated in saline water and cut open into different

portions such as the gills, oesophagus , stomach, intestine, and rectum. The scrapped matter from the mucosal layer and settled substances of these organs were examined under a dissecting microscope. The helminthes or parasites were counted and preserved in 70% alcohol. Later the organs were placed on petridishes and examined under Compound Microscope, if any parasites were sorted and preserved in fixatives 70% ethyl- alcohol in separate vials for identification.

Identification of parasites: The preserved parasites were later identified following: Systema Helminthum, Yamaguti, S. Trmatode (Vol-I, 1958), Nematode (Vol-II, 1961), Crustacea (Vol-IV, 1963).

Identification of host specimen: Identification of host fish was made by using standard references taxonomic books.

Preparation of parasites for microscopic observation: The collected parasites mainly resented there major groups, namely nematode, trematode and crustacea. The parasites were fixed in their respective fixaties, cleared and stained according to the methods suggested by Cable (1953).

The method of fixation adopted for three major groups of parasites during the study were as follows:

Nematode: Nematodes were fixed in glacial acetic acid (G.A.A) and lactophenol.
Trematode: Trematodes were fixed in acetic acid-formalin-alcohol solution (A.F.A) or glacial acetic acid (G.A.A).

Crustacea: Crustacea were fixed in 70% ethyl –alcohol and cleaned in lactophenol.

After identified all parasite preserved in 70% alcohol.

Preparation of slides for microscopic examination: The parasites were removed from 70% alcohol and kept in Lacto-phenol for 24-74hours.

a. Temporary slide preparation: After clearing the parasite by lacto-phenol, borax carmine was used for staining the parasites .Temporary slides were made by mounts in lacto-phenol.

b. Permanent slide preparation: Permanent slides made in Canada balsam by passing through alcoholic gradations and plain series after staining in borax carmine.

3.7 Data Entry and Processing

The filled in questionnaires were checked for validation and missing information. Any abnormality or missing information detected were either excluded or corrected during subsequent visit. Data were regularly fed into computers for subsequent analyses Data were analyzed using STATA VERSION 12.1 and EXCEL programs. Two MS ExcelT spreadsheets were used to enter the collected information. Data were to get the desired outputs. Graphs were prepared also by

using EXCEL software. Data are present either as percent observation or arithmetic mean ± SD.

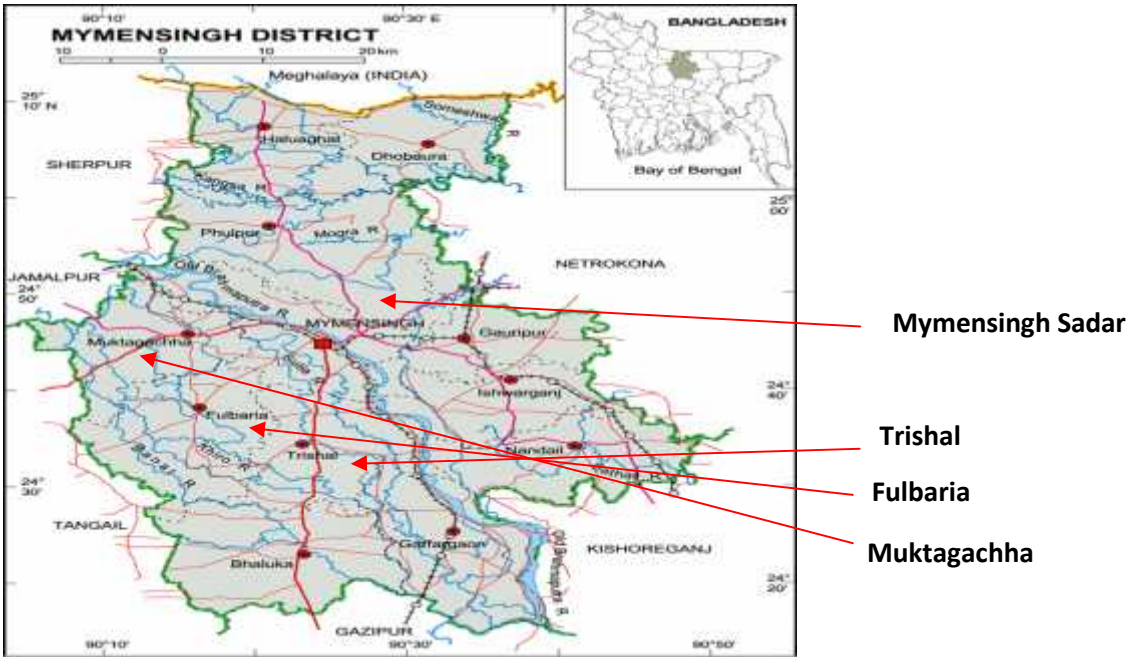

Fig 3.1 (a). Map of Mymensingh District indicating Mymensingh Sadar, Thrishal, Fulbaria and Muktagacha Upazila.

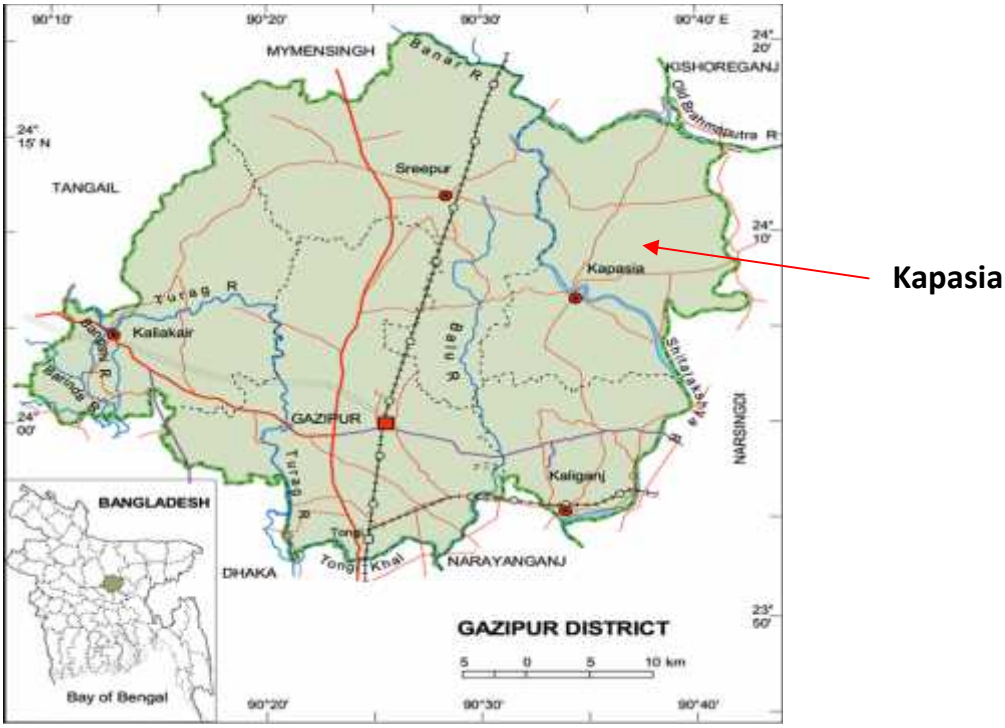

Fig 3.1 (b). Map 0f Gazipur District indicating Kapasia Upazila.

CHAPTER-4

RESULTS AND OBSERVATIONS

4 RESULTS AND OBSERVATIONS

The information collection procedure of this study consisted of two schemes: first, a frame survey which documented the hatchery/nursery conditions, its operation and management highlighting disease incidences employing a structured interview of hatchery/nursery operators of 5 selected upazilas and second, a number of selected nurseries and hatcheries were sampled for documenting the water quality and disease incidences. The results of the two schemes are presented separately.

4.1 Findings of the Preliminary Survey

4.1.1 Physical and infrastructural facilities of nurseries and hatcheries

Land area

The percent distribution of hatcheries/nurseries of the study area by land area is graphically shown in Fig. 1. The land area of the surveyed individual hatcheries/ nurseries varied greatly, ranging from 70 .decimal to 20000.decimal with an average of 1298.86 decimal/hatchery-nursery. The percent distribution of hatcheries/nurseries by land area is graphically shown in Fig. 1. Results show that a 28% hatcheries/nurseries are in the size range of 200-500 decimal size group, followed by 500-1000 size groups and only 6% of the nurseries/hatcheries were in the lowest size group (less than 100 decimal).

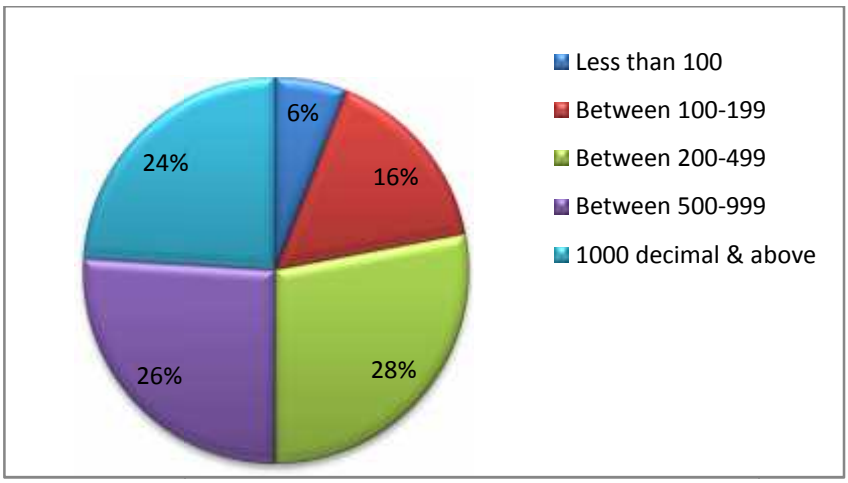

Fig 1. Percent distribution of hatcheries/nurseries by land area of the study area

Time of establishment of hatcheries and nurseries

In general, the age of hatchery/nursery of the study area varied from 1 year to 32 years with an average of 10.24 years. Most hatcheries/nurseries operating within the study were established within 1-10 years, particularly in between 5-10 years. Only 10 % hatcheries/nurseries were established before 15 years (Fig. 2).

However, the age of hatcheries/nurseries varied between the upazilas and again within the upazila. The hatcheries/ nurseries of Fulbaria upazila are comparatively older, (average 19.57 years), followed by Trishal (8.22 years). Age distribution of the studied hatcheries/ nurseries shows that the most hatcheries (44 %) were established 6-10 years back., followed by 5 years (24%), and 15 years (20%). (Table 1b) and (Fig 2) present data on the age and percent distribution of hatcheries and nurseries by age, respectively.

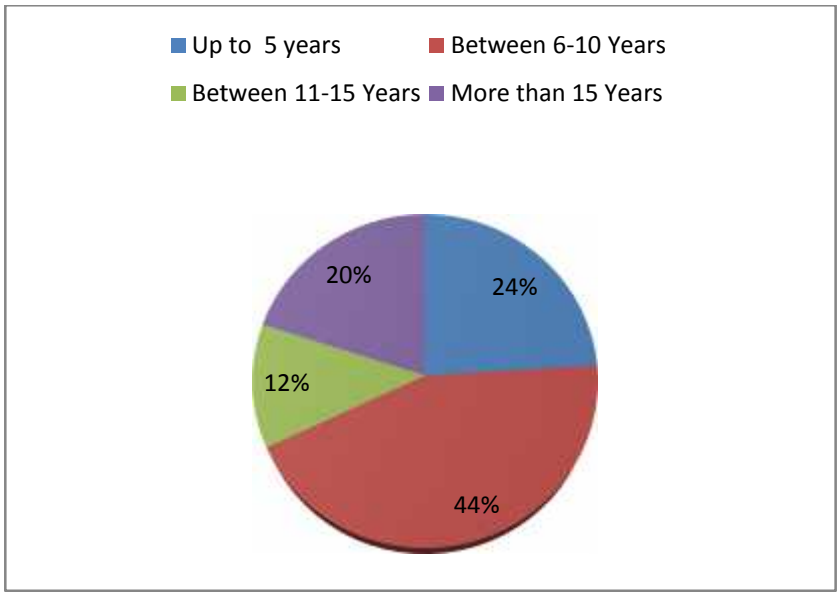

Fig 2. Percent distribution of hatcheries/nurseries of the study area by age of establishment.

Table 1.c. Upazila wise age (in years) distribution of hatcheries nurseries

Upazila	**Mean (yrs)**	**Minimum (yrs)**	**Maximum (yrs)**	**Std. dev.**
Kapasia	7.89	3	12	2.71
Mymensingh Sadar	8.22	1	20	5.54
Trishal	9.89	1	27	6.73
Fulbaria	19.57	6	32	9.24
Muktagacha	7.43	3	20	6.05
Overall average	10.24	1	32	7.23

Hatching, nursing and rearing facilities

It may be mentioned that of the fish farms surveyed, 27 farms were hatchery-cum-nursery with incubating jars for hatching of eggs. The rest 23 farms are exclusively fish nurseries and these farms did not have incubating jars. However, all the hatcheries/nurseries, except one, had nursery and stock ponds. Information on the incubators, nurseries and stock ponds are briefly described below:

Incubators: The total number of incubating jars in 27 hatcheries was 934 with an average of 18.68 incubators/hatchery. Percent distribution of incubators by number is given in Table 2. As can be seen from the results that 33.38 % farms have incubators in the range above 40 incubators, followed by 25.93% hatcheries in the range of 1-10 incubators. Table 3 provides data on the Upazila wise distribution of hatcheries with incubators. In Kapasia there was no hatchery, and as such no incubators. In average, the hatcheries in Mymensigh sadar upazila have highest number of incubators (36.67 incubators/each), followed by Trishal (25.78 incubators/each), and Fulbaria (10.29 incubators/each).

Table 2. Percent distribution of incubators by number in the study area

Range	% incubators	% nursery ponds	% stock ponds
1-10	25.93	79.59	76.00
11- 20	14.81	12.24	10.00
21-30	14.81	0	8.00
31-40	11.11	0	4.00
Above 40	33.38	12.24	2.00
Total	100	100	100

Table 3. Upazila wise information on the mean number of incubators, nursery ponds and stock ponds

Name of Upazila	No. hatchery and average no. of incubators		Average number of nursery ponds		Stock Pond	
	No. farms *N(n)	Mean	*N(n)	Mean	*N (n)	Mean
Kapasia	9 (0)	0	9(9)	2.67	9(9)	1.33
Mymensingh sadar	9 (9)	36.67	9(8)	22.56	9(9)	34.11
Trishal	18 (9)	25.78	18(18)	14.56	18(18)	11.28
Fulbaria	7(3)	10.29	7(7)	6.14	7(7)	4.71
Muktagacha	7(6)	9.71	7(7)	7.14	7(7)	8
Overall	50 (27)	18.68	50 (49)	11.64	50(50)	12.22

**N=Number of fish farms surveyed*

n= Within parentheses number of farms having incubators, nursery pond and stock ponds

Nursery ponds: Only one hatchery of the study area did not have nursery ponds. The rest 49 have 585 nursery ponds. The number of individual nursery ponds varied from 0 to 102 with an average of 11.64 hatchery-nurseries. Table 2 presents data on the percent distribution of nursery ponds by numbers. Majority (80%) of the hatcheries/nurseries had less than 10 nursery ponds, while 12 % hatcheires/nurseries had nursery ponds in the range of 11-20 nursery ponds. and again 12 % hatcheries/nurseries had more than 40 nursery ponds each (Table 2)

As shown in Table 3, the distributions of nursery ponds by number were highly varied within the study area. As can be seen from Table 3 Mymensingh Sadar Upazila had highest number of nursery ponds with an average of 22.56 nursery ponds/nursery, followed by Triahal Upazila (14.56 ponds/nursery).

Stock ponds: All the fish farms surveyed have stock ponds, either for broodstock rearing or for raising fish for markets or for both. The number of stock ponds varied from 1 to 210 stock ponds with an average of 12.22 stock ponds/fish farms Percent distribution of stocks ponds by numbers show that most fish farms (76%) have stock ponds less than 10 stock ponds, while 10% farms have stock ponds in the range of 11-20 stock ponds. Only one fish farm (2%) has stock ponds more than 40.

4.1.2 Information on fry/fingerling production

4.1.2.1 Species/fish groups produced

Information on the species of fry and larvae produced in the hatcheries/nurseries is presented in Table 4. Mainly six groups of fish are used in fry and fingerling production. Some hatcheries produce more than one species of fish. As can be seen from the results (Table 4) 23 hatcheries/nurseries (46%) produce singhi fish (*Heteropneustes fossilis)* fry/fingerlings, followed by climbing perch (21 hatcheries/nurseries), carps (20 hatcheries/nurseries)), pangash (16 hatcheries/hatcheries) and Tilapia (14 hatcheries/nurseries). Only one nursery produces other species along with the above mentioned species.

Table 4. Percent distribution of hatcheries and nurseries by species

Name of fish group/species	N0. 0f hatcheries	% hatcheries
Carp (rui, ctla, silver, mrigel, kalibaus)	20	19.42
Climbing fish (Thai Koi)	21	20.39
Pangash (Thai pangus)	16	15.53
Tilapia (Gift tilapia)	14	13.59

Sjghifish	23	22.34
Pabda	8	7.76
Others	1	0.97
Total	103	100

Yearly production capacity

The annual production targets of fry/fingerling production of individual hatcheries/nurseries vary from less than one lac to more than 10 lac fry/fingerlings. Most hatcheries/nurseries (81.48%) produce more than 10 lac fry/fingerlings per annum, while 3.70% hatcheries/nurseries produce fry/fingerling between 1-5 lac (Table 5).

Table 5. Information on quantity of fry/ fingerling production (in lac) annually

Production capacity (Lac)	**No. fish farms**	**% total farms**
Less than 01 lac	2	7.41
Between 01-05 lac	1	3.70
Between 05-10 lac	2	7.41
More than 10 lac	22	81.48
Total	27	100

Period of hatchery operation

Table 6 provides information on the fry production period highlighting the intensity of production. As evident from the results, during January-March, about 82% hatcheries operate with medium level production intensities. On the other hand, during the same period 11% hatcheries remain operational with low level production intensity, while 7.5% (approx) do not operate during this period.

During April-June, all the hatcheries (100%) operate in a full-swing and produce highest quantity of fry. This period is considered as the peak season of fry production. However, during this period most hatcheries are engaged in carp fry production along with some other species (Table 6)

During July-September, only one hatchery (3.7%) operates at full-swing with maximum outputs, while about 82% farms operate with medium level fry production and the rest of the hatcheries (14%) remain non-operational during the period (Table 6).

During October-December, which is considered as the very lean period for fry production in Bangladesh, only two hatcheries operate with minimum level of production target (Table 6).

Table 6. Fry production intensities in different seasons in hatcheries of the study area

Production level	January-March		April-June		July-September		October-December	
	No. farm	% farm	No. farm	% farm	No. farm	% farm	No. farm	% farm
High level production	0	0	27	100	1	3.70	0	0
Mid level production	22	81.48	0	0	22	81.49	0	0
Low level production	3	11.11	0	0	0	0	2	7.41
Zero level production	2	7.41	0	0	4	14.81	25	92.59
Total	27	100	27	100	27	100	27	100

4.1.3 Occurrence and intensities of fish diseases

4.1.3.1 Seasonality in disease occurrences

In general, most (84%) hatcheries/nurseries of the study area experience disease incidences, however, such occurrences and intensities of fish diseases vary from individual farms to individual farms and also depending on the seasons. Fig. 3 shows the season wise intensities of fish diseases in the hatcheries/nurseries of the study area. Majority of fish farms (52%) experience fish diseases during October-December, followed by January-March (34%). Low intensities of disease occur during the period April-September.

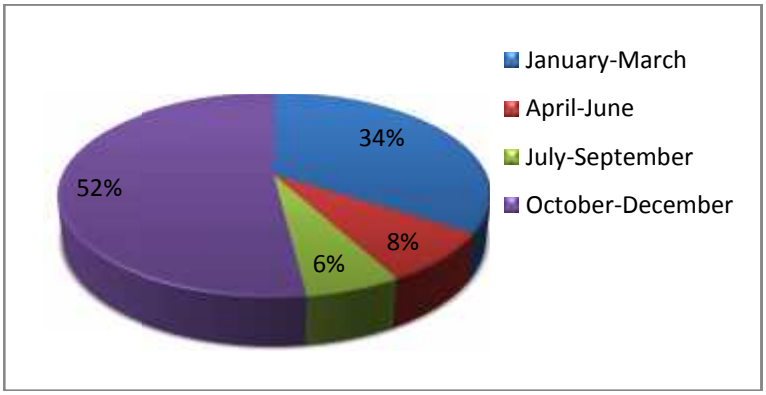

Fig 3. Seasonal occurrence of fish diseases in hatchery/ nursery of the study area

4.1.3.2 Causes for the fish mortality in fish farms

The respondent of each farm asked to name the only one fish disease which causes most fish mortality intheir farms. Out of 15 specific diseases checked with the respondents, 10 different diseases were reported to cause fish mortalities in the sampled hatcheries/nurseries of the study area. However, the relative role contributing to fish mortality varies greatly among fish farms. (Table 7) provides information on the fish mortality caused by different diseases in the hatcheries/nurseries of the study area. Most fish mortalities (38%) are caused by body flukes (*Gyrodactlosis)*, followed by tail and fin rot (24%) and viral disease (8%), while 12% fish mortality is caused by unidentified diseases.

Table 7. Percent fish distribution of fish farms according to occurrences of major diseases in fish hatcheries/nurseries

Name of disease	No. fish farms	% fish farms
Tail and fin rot	12	24
Saprolegniasis	2	4
Gill fluke/ Dactylogyriasis	2	4
Gyrodactyliasis/ Body fluke	19	38
White Spot	2	4
Red Spot	1	2
Tuberculosis	1	2
Argulosis	1	2
Virus	4	8
Unknown	6	12
Total	50	100

4.1.3.3 Trend in changes in the disease incidences

The results on the trend in changes in fish disease incidences compared to the past are graphically shown in Fig. 4. A 48% respondents told that the incidences of fish diseases in their fish farms had decreased compared to 5-10 years back, because of the their increased efforts for disease control, while 34 respondents think that intensities of fish diseases have increased in their farms. According to 18% respondents, there was no changes in the incidences of fish diseases in their farms.

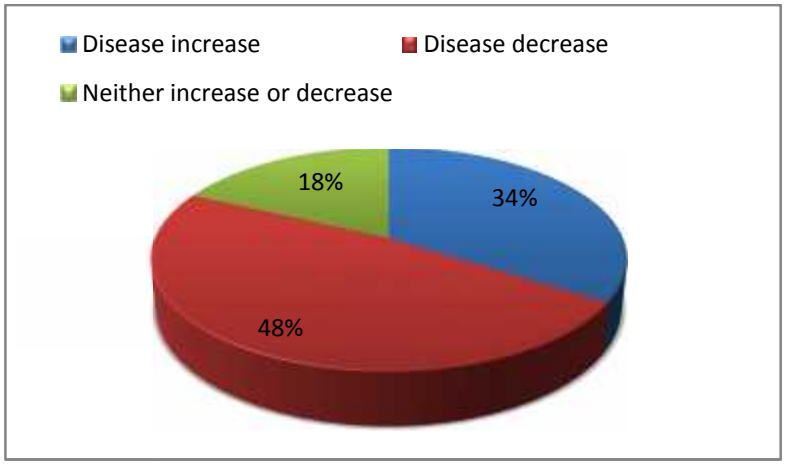

Fig. 4.Trend in changes in the incidences of diseases in hatcheries/nurseries in the study area.

4.1.3.4 Hatchlings/Fry mortality in hatcheries

Table 8. provides on the frequency of disease incidences inhatcheries/nurseries round the year. As can be seen from the results 38% hatycheries/nurseries didn not experiences any disease attack, however, 30% farms experienced diseases within a year. Only 4% farms expereinced diseases up to 4 times within a year.

Table 8. Frequency of disease incidences in hatcery in year

Frequency	No.of. hatchery	% hatchery
0	19	38
1	9	18
2	15	30
3	5	10
4	2	4
Total	50	100

Fry mortality in the hatchery is a great problem in the study area. All hatcheries expereicnes mortality of fries in hachery conditions., however, the intensities of mortality differ greatly between individual hatcheries. The results from interview of nursery operators are given in the Fig. 5). A 22% hatcheries incur more than 75% loss of hatchlings due to various reasons, while 25% and 50% mortalities occur in about 19 % and 18% hatcheries, repectively. However, 75% (50-75%) mortalities occurred only in less than 10% hatcheries.

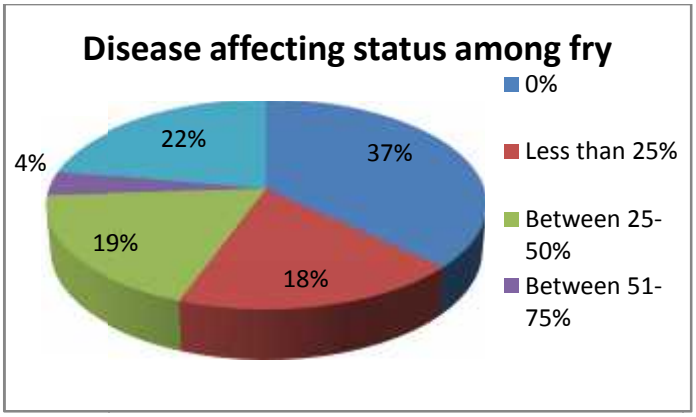

Fig 5. Percent mortality of fish fry in hatchery conditions in fish farms studied

4.1.3.5 Fry/fingerling mortality in nursery ponds

Fry/fingerling mortality in nursery ponds is a great problem in fingerling rising and the intensities of mortality vary greatly among the individual nurseries. The results of interview on the fry-fingerling mortality in nursery ponds of the study area are graphically shown in Fig. 6. As can be seen from the Figure, there were fry/fingerling mortality in 12% farms, while highest mortality (above 75%) occur in 22% farms and the lowest mortality (25%) was observed in 18% farms.

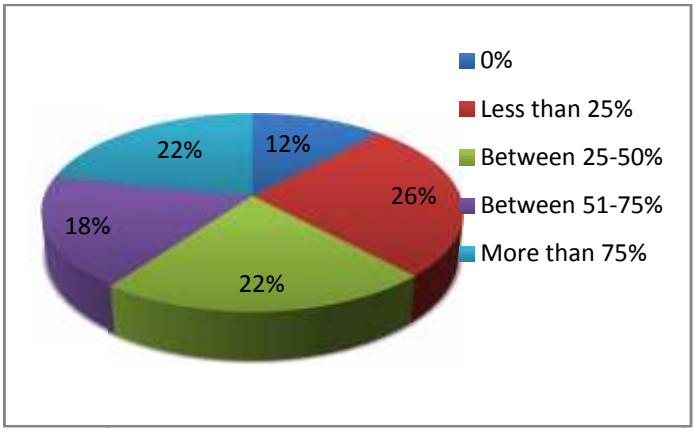

Fig 6. Percent mortality of fish fry-fingerling in nursery pond in fish farms studied

4.1.3.6 Type of diseases occuring in nurseries

Eleven major diseases are reported to cause fish mortality in fish nurseries in the study area, among them tail and fin rot and gyrodatylosis cause fish mortality in

25.57% and 23.08% nurseries, respectively. Mortality caused by Saprolegniasis is found only in 2.57% nurseries, while no diseases is found only in 3.84% farms (Table 9).

Table 9. Major causes for fry/fingerling mortality in fish nurseries

Name of diseases	Number of farms	% farms
No disease attack	3	3.84
Tail and fin rot	20	25.64
Seprolegniasis	2	2.57
Gill fluke/ Dactylogyriasis	3	3.84
Gyrodactyliasis/ Body fluke	18	23.08
Trycodyniasis	3	3.84
White Spot	1	1.29
Red Spot	4	5.13
Tuberculosis	2	2.57
Argulosis	3	3.84
Virus	7	8.98
Unknown	12	15.38
Total	78	100.00

The yearly death among fry in incubators was reported highest (i.e. 8%) in January-March in in pangash fish. The situation of no death among fry in incubators was reported highest (i.e.98%) in both April-June & July-September quarter. (Table 10)

Table 10. Status of death among fry in incubators in hatchery

Fish groups	January-March		April-June		July-September		October-December	
	No.	%	No.	%	No.	%	No.	%
No death	42	84	49	98	49	98	41	82
Carp	3	6	0	0	0	0	3	6
Pangash	4	8	0	0	0	0	2	4
Telapia	0	0	0	0	0	0	1	2
Cat fish	1	2	1	2	1	2	3	6
Total	50	100	50	100	50	100	50	100

The yearly death among fish in nursery ponds was reported highest (i.e.28%) in October-periods.December in fish species of Carp; followed 14% in January-March in same fish species and 10% in the fish species of Pangash in both January-March & October-December (Table 11)

Table 11: Status of death among fish in Nursery pond

Fish groups	**January-March**		**April-June**		**July-September**		**October-December**	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
No death	34	68	46	92	47	94	24	48
Carp	7	14	3	6	1	2	14	28
Pangash	5	10	0	0	0	0	5	10
Telapia	0	0	0	0	0	0	1	2
Cat fish	4	8	1	2	2	4	6	12
Total	50	100	50	100	50	100	50	100

The yearly death among fish in Stock pond was reported highest (i.e.14%) in October-December season in fish species of Carp and Catfish; followed 10% was reported in January-March in fish species of Pangash. Whereas No death condition was reported highest (i.e.96%) for April-June season. Details in (table-12)

Table12. Status of death among fish in stock pond

Fish groups	**January-March**		**April-June**		**July-September**		**October-December**	
	No.	**Percentage**	**No.**	**Percentage**	**No.**	**Percentage**	**No.**	**Percentage**
No death	39	78	48	96	47	94	31	62
Carp	2	4	1	2	0	0	7	14
Climbing Fish (Thai Koi)	1	2	0	0	0	0	0	0
Pangash	5	10	0	0	0	0	4	8
Telapia	0	0	0	0	1	2	1	2
Cat fish	3	6	1	2	2	4	7	14
Total	50	100	50	100	50	100	50	100

4.1.4 .Information on Hatchery and Nursery Management

4.1.4.1 Stocking densities in nursery and stock ponds

Nursery ponds: As per respondents, stocking density in the nursery and stock ponds are highly variable among different nurseries and stocking ponds of the study area. The results on the stocking density are provided in Table 13. The stocking density of nursery ponds ranged from 300 to 20000 with an average density of 6108.16 ± 4024.45 fry./decimal pond area. An analysis of data show that most nurseries (60%) stock fries in the range 1000 to 5000n fry/decimal, followed by 26% nurseries in the range of less than 1000 fry/decimal and 8 % nurseries (range: 10000 & above/fry decimal) .

Table 13. Stocking densities (No./decimal) of fry or fingerling nursery pond and stock pond

Pond type	No. of fry or fingerling stocked			
	Mean	Minimum	Maximum	Std. dev.
Nursery pond	6108.16	300	20000	4024.45
Stock pond	336.70	30	2000	392.62

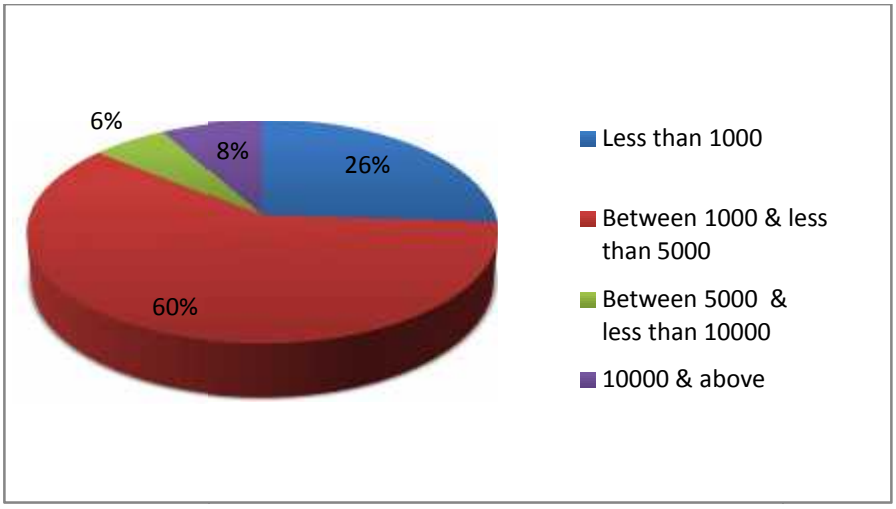

Fig 7. Percent distribution of fish nurseries by number of fry stocked /decimal nursery ponds

Stock ponds: The stocking density of stock ponds ranged from 30 to 2000 fingerlings/decimal with an average density of 336.70 ± 192.62 fingerlings./decimal pond area (Table 13). An analysis of data show that most stock ponds (38%) stock fingerlings in the range of 1000 to 5000 fingerlings/decimal, followed by 32% stock ponds in the range of 5000 to 10000n fingerlings/decimal and 26% stock ponds (range 10000 & above fry decimal) (Fig. 8).

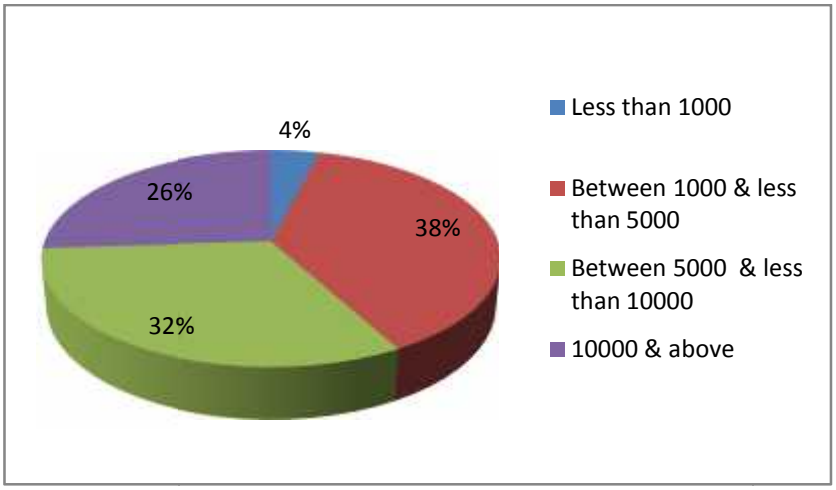

Fig 8. Percent distribution of fish farms by quantity of fingerlings stocked/decimal stock pond

4.1.4.2 Feeding of fry/fingerlings

Type of feed: A 70% nursery ponds used exclusively prepared formulated packed feed, while 30% nurseries fed both formulated feed as well as feed prepared by them by using locally available ingredients like, rice/wheat bran, master seed cake, and others.

Quantity of feed supplied: As per respondent, quantity of feed supplied to nursery ponds varied between 100-20000g feed/ decimal nursery ponds with an average of 1765 ± 3406 g/decimal nursery pond; while in stock pond it ranged between 150-25000g with an average of 5032 ± 4587g/ per decimal. The summary results on feed supply are given in (Table 14).

Table 14. Quantity of feed supplied to nursery and stock ponds

Pond type	Amount of feed(g/decimal)			
	Mean	Minimum	Maximum	Std. dev.
Nursery pond	1765.31	100	20000	3406.42
Stock pond	5032	150	25000	4587.88

Fig 9 and Fig 10 provide data on the percent distribution of farms according to quantity of feed supply in nursery and stock ponds, respectively. Majority of farms (nursery ponds) (58%) supply feed in the range of 1000-5000g/decimal of nursery fond, followed by 500-1000 g/decimal (26% farms). However, lowest (less than 500 g/decimal) and highest amount (5000 g & above/decimal) of feed are supplied in only 4% farms in each case (Fig 9). Similarly, in case of stock ponds, in majority of ponds (50%) feed is supplied in the range of 1000-5000g/decimal stock ponds, while in the lowest number of farms (8%) feed is supplied in the range of less than 1000 g/decimal stock ponds (Fig 10).

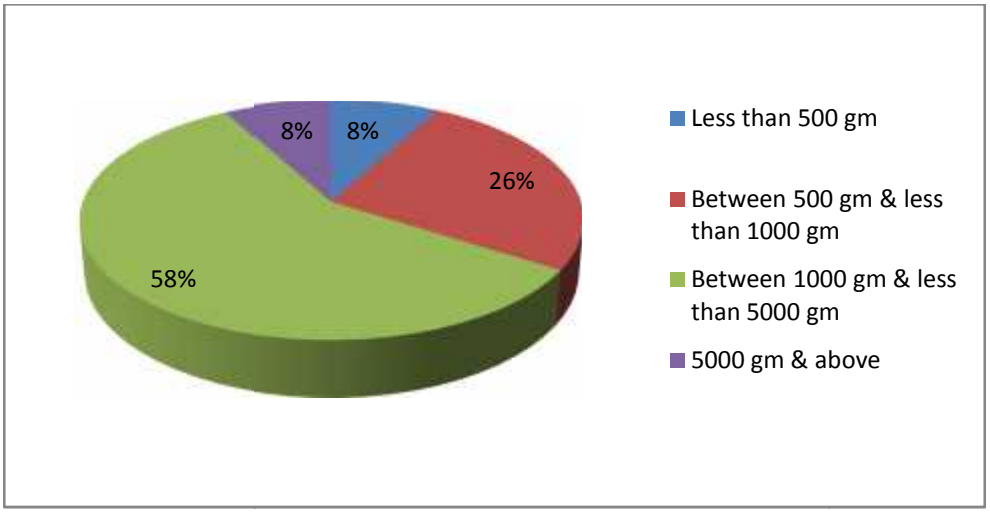

Fig 9. Percent distribution of farms (nursery ponds) by quantity (g/decimal) of feed supplied.

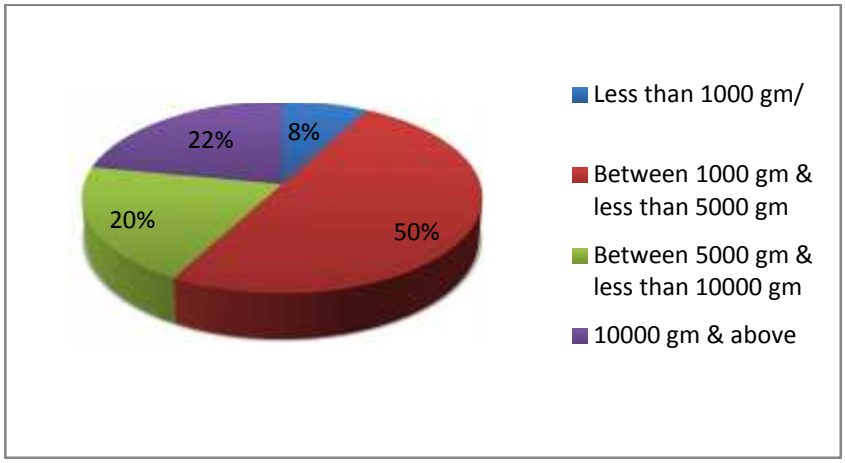

Fig 10. Percent distribution of farms (stock ponds) by quantity (g/decimal) of feed supplied.

Frequency of feeding: Information on the frequency of feed supply to nursery and stock ponds are shown graphically in Fig 11. As evident from the Figure that in 85.71% nurseries feed is supplied more than once in a day, while in 8.16% and 6.12% nurseries fish are fed once a day and once in every 2/3 days, respectively. On the other hand, in case of stock ponds, fish are fed more than once a day in 62% stock ponds, once a day in 34% ponds and once every 2/3 days only in 4% stock ponds (Fig 11).

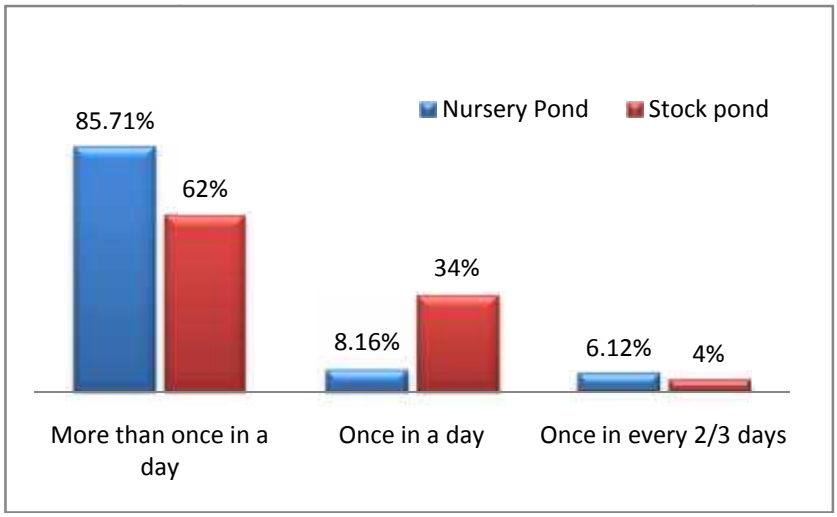

Fig 11. Frequency of feeding fish in nursery and stock ponds

4.1.4.3 Information on feed consumption time by fish

Interview of farm operators revealed that in most nurseries (62%) feed is consumed within a day and as such no or little feed is left uneaten, however, in 32% nursery ponds some feed is left and usually it takes two or more days to finish the feed. The respondent indicated that some feed go waste when it is not consumed within few hours of its application.

4.1.4.4 Cultivation or rearing of other animals other than fish in ponds

As such no other animals are reared nor cultured in nursery ponds. However, occasionally ducks get into the ponds. One the other hand, about 28% farmers intentionally allow their ducks in the stock ponds to forage.

4.1.4.5 Water supply and exchange in nursery ponds

Water exchange: Water in almost all fish farms (98%) under study is exchanged, either regularly or irregularly during the entire nursery operation period.

Sources of water supply: A 96% farms (nursery ponds) use underground water to exchange waters, while only 4% farms use surface waters (Table 15).

Table 15. Sources of water supply in nursery ponds

Source of water	No. of farms	Percentage
Underground water	47	96
Surface water	2	4
Total	49	100

Frequency of water exchange: Fig 12 shows the results on the frequency of water exchanges in the nursery ponds of the study area. In 52% farms water is exchanged once or more times in a month, while in 28% farms water is exchanged once in 2/3 months, in 16% ponds once within six months and only in

2% ponds water is exchanged once in 7-12 months. In case of stock ponds, 48% farms water is exchanged once or more times in a month, while in 26% farms water is exchanged once in 2/3 months, in 18% ponds once within six months and only in 6% ponds water is exchanged once in 7-12 months.

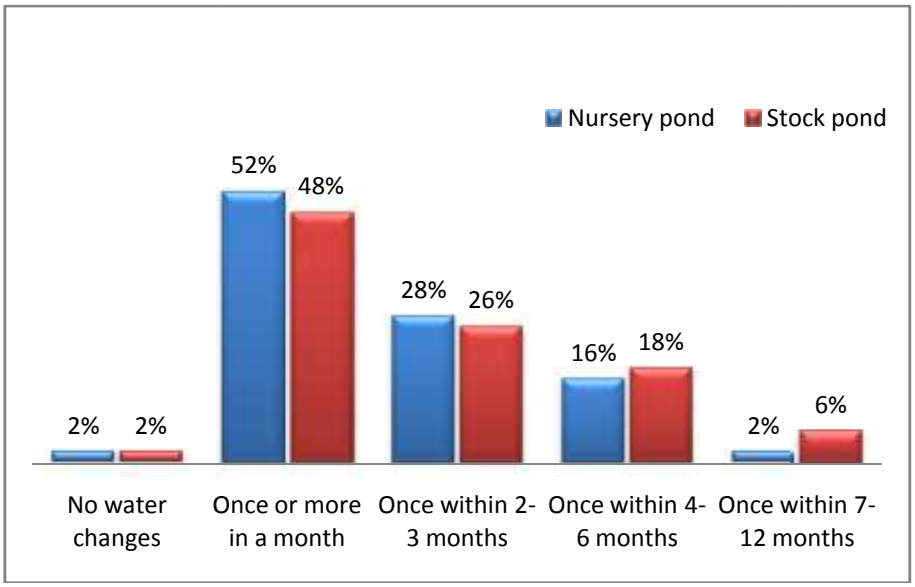

Fig 12. Frequency of water changes in Nursery & stock pond round the year Respondent's perception about water quality

4.1.4.6 Changes in water quality

In response to a question whether water quality of their farms deteriorate during culture period or not, a 94% respondent indicated that water quality deteriorates in their nursery and stock ponds sometimes in their farms. However, they think that this change in water quality is not a major issue as water exchanges are done in most farms.

Indicators of water quality deterioration: The water quality of hatchery/nursery is identified by different indicators by the farmers when it becomes awful. The main causes for water quality deterioration as identified by the respondents are presented in Table 16. As can be seen from Table 14, according to 45.54% respondents deterioration in water quality is recognized by changes in water color, while 32.67% respondents recognize water quality deterioration by bad smell. Fish die is used as an indicator of water quality deterioration only by about 1% respondents.

Table 16. Percent distribution of fish farms by water quality based on some indicators

Indicators of water quality	No. of farmers	% respondents
Discoloration of water	46	45.54
Bad smell	33	32.67
Oxygen depletion as diagnosed by air gulping of fish	9	8.91
Fish die	1	0.99
Floating fish on water	9	8.91
Phytoplankton bloom	3	2.98
Total	101	100.00

41.4.7 Fish disease curative and corrective measures

The interview revealed that 94% farmers undertake curative measures when there are any incidences or outbreak of disease in their farms. When there is a disease incidence farmers undertake various activities and measures. The results on the interview about measures taken by the fish farmers for fish disease treatment are provided in Table 17.

Results show that only 19.73% farmers go to Fisheries Officer if there are any disease incidences in their farms, while 28.96% farmers buy medicine from market without having consultation with Fisheries Officers. A 28.29% farmers use lime in case of disease incidences. The other treatments include use of salt (6.57%), use of potash (11.19%) (Table 17).

Table 17. Type of curative measure disease incidences in fish farms in the study area

Treatment type	No. of farms	% of total farms
Take suggestion from fishery officer	30	19.73
Received treatment from veterinian	7	4.60
Use medicine from market	44	28.96
Use CaCo3 to hatchery /nursery pond	43	28.29
Use Salt	10	6.57
Use Potash	17	11.19
Use Harbal medicine	1	0.66
Total	152	100.00

Prophylactic measures: A 84% farmers do not use any prophylactic treatment to control disease, while the rest 16% farmers think that the use of lime in their farms is a prophylactic measure.

Tendency of using insecticides in fish ponds

The results on the tendency in using pesticides in fish farms are presented in(Fig 13) As per 40% respondents, use of pesticides in their farms have increased, while according to 46% respondents the use of pesticides has decreased in the recent years and 14% respondent think that there is no change in the tendency of using pesticides in there farms.

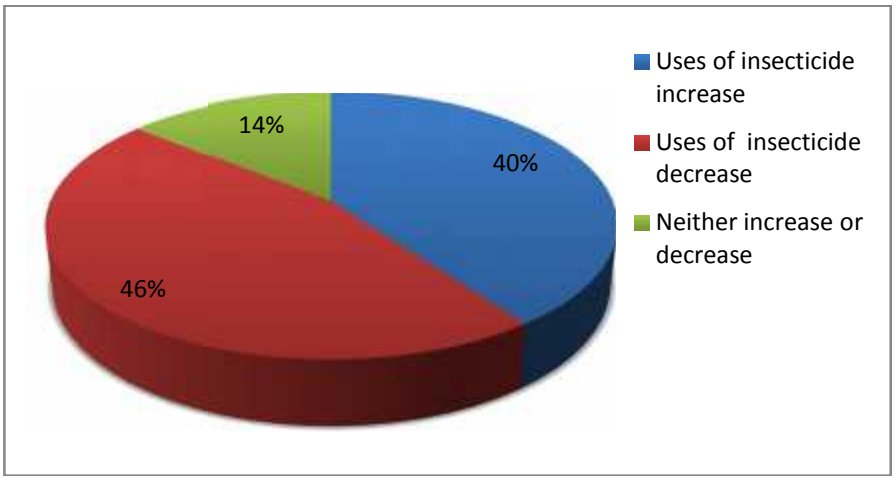

Fig 13. Tendency in changes in using insecticide in stock and nursery ponds

Liming of ponds

4.1.4.8 Frequency of liming ponds

The fish farmers in the study area use lime in different frequencies round the year. Percent distribution of fish farms by frequency of lime use are provided in Table 18. A 30% fish farms use lime once in a month, while 28%, 20% 10% farmers use once in 15 days, once in every 2 months and once in 6 months, respectively.

Table18. Percent distribution of fish farms by frequency of lime use in ponds

Frequency of lime use	Number	Percentage
No use	1	2
Once in week	5	10
Once in 15 days	14	28

Frequency of lime use	Number	Percentage
Once in month	15	30
Once in every two months	10	20
Once in every 6 months	5	10
Total	50	100

Quantity of lime used in ponds: The results on the quantity of lime used in nursery and stock ponds are provided in Table 17. In case of nursery ponds, the application of lime ranges from 100g to 1000g with an average of 895.67g CaCo3/ decimal nursery pond; while in stock pond it is 50g-15000g (mean 988.78gm) /decimal. Pond area.

Table 19. Quantity of lime (CaCo3 / decimal) used in nursery ponds and stock ponds

Pond type	Amount of CaCo3 (g/decimal)			
	Mean	Minimum	Maximum	Std. dev.
Nursery pond	895.67	100	10000	1827.15
Stock pond	988.78	50	15000	2113.11

4.1.4.9 Phytoplankton bloom

Phytoplanktom bloom affects the pond production by their toxic and other actions. Use of feed and fertilizers might influence phytoplankton bloom. About 98% farmers reported that phytoplankton bloom occurs in their farms. High level of phytoplankton bloom occur in hatchery/nursery during April-June (in 60% farms); while the lowest level bloom occurs during October-December (in 2 % ponds) (Fig. 14).

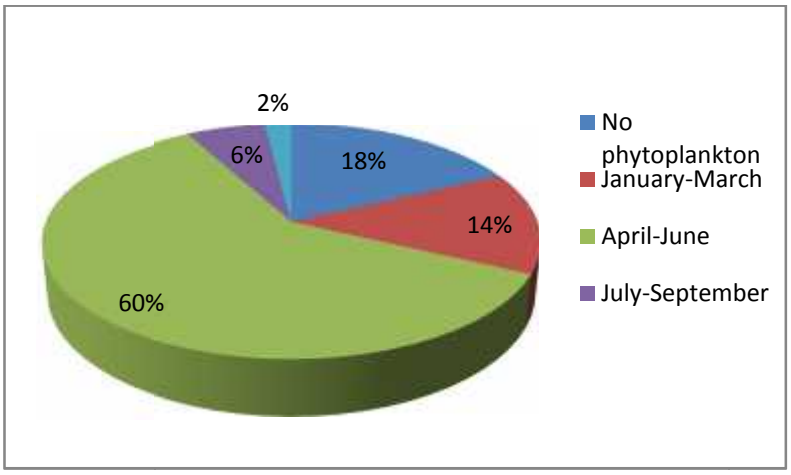

Fig 14. Phytoplakton blooms (% farms) by seasons in nursery and stock ponds

4.2 Results on Fish Farm Monitoring

Once the Preliminary Survey, based on interview of fish farmers was completed, a year round monitoring of fish farms in four different seasons was carried out by visiting individual farms in each season. During this monitoring programme, observations were made on water quality, disease incidences and hatchery management practices. In addition, fish were sampled from the fish farms to study parasitic infestations . The results are described below.

4.2.1 Water quality

4.2.1.1 General observations

Six major water quality parameters, viz. pH, dissolved oxygen (DO), alkalinity, hardness, ammonia, and nitrite which are pertinent to aquaculture and often influenced by aquaculture practices, were monitored.

Measured data from different seasons and different pond types were pooled together to get the overall water quality data for the region and are summarized in Table 20 showing the minimum and maximum values for each parameter, and mean values with standard deviation. Overall, pH varied from 4.5 to 10.6 with an average of 7.57, DO from 3.1 to 12.0 mg/l with an average of 5.91 mg/l, alkalinity from 21.0 to 16 mg/l with an average of 33.67 mg/l, hardness from 31.0 to 150 mg/l with an average of 45.41mg/l, ammonia from 0.2 to 3.0 with a an average of 1,06 mg/l and nitrite from 0.01 to 0.6 mg/l with an average of 0.13 mg/l.

Table 20. Overall data on the measured water quality parameters

Parameters	Mean	Minimum	Maximum	Std. dev.
pH	7.57	4.5	10.6	1.25
DO (mg/l)	5.91	3.1	12	2.49
Alkalinity (mg/l)	33.67	21.0	160	24.43
Hardness (mg/l) as Ca CO_3	45.41	31	150	22.12
Ammonia (mg/l)	1.06	0.2	3	0.89
Nitrite (mg/l)	0.13	0.01	0.6	0.14

n= 22-24

Further, measured data were segregated and summarized data are present separately for nursery and stock ponds provided in Table 21. Overall, the mean values for pH, DO, alkalinity, hardness, ammonia, nitrite were 7.56, 6.13 mg/l, 34.98 mg/l, 44.68 mg/l, 0.75 mg/l, 0.13 mg/l , respectively, in nursery ponds and

that for stock ponds were 7.57, 5.71 mg/l, 32.45 mg/l, 46.09 mg/l, 1.34 mg/l, 0.13 mg/l, respectively.

Table 21. Summary information on the measured water quality data separately for nursery ponds and stock ponds.

Parameters	**Nursery pond**				**Stock pond**			
	Mean	**Min.**	**Max.**	**Std. dev.**	**Mean**	**Min.**	**Max.**	**Std. dev.**
Alkalinity	34.98	21	160	27.42	32.45	21	130	21.49
Ammonia	0.75	0.2	2	0.54	1.34	0.2	3	1.05
DO	6.13	3.2	11.5	2.49	5.71	3.1	12	2.51
Hardness	44.68	31	150	22.10	46.09	31	138	21.50
Nitrite	0.13	0.01	0.5	0.15	0.13	0.01	0.6	0.13
pH	7.56	4.5	10.6	1.33	7.57	4.9	10	1.18

4.2.1.2 Seasonal variations in water quality

In general, water quality of both nursery and stock ponds showed strong seasonal variations, reflecting the dilution of water in rainy season and the operational activities of the fish farms. The seasonal variations in individual water quality parameters are present in Tables 20 to Table 21.The results are present separately for each individual parameters.

Alkalinity: Table 22 presents data on the alkalinity of nursery and stock ponds. Alkalinity values of nursery ponds showed strong seasonal variations. The values varied from 21 to 160 mg/l. The highest alkalinity (60.5 mg/l) was observed in April-June period and lowest value (23.5 mg/l) was observed during October-December period.

The alkalinity of individual stock ponds ranged from 21 to 130 mg/l. As with nursery ponds, in case of stock ponds, the highest alkalinity (53.0 mg/l) was measured during April-June period, however, the lowest values (23.27 mg/l) were noted during October-December period. The extremely high standard deviation both in case of nursery and stock ponds signify the high differences in alkalinity values between the individual ponds in each case.

Table 22. Seasonal variations in alkalinity (mg/l) in both nursery ponds and stock ponds

Observed periods	**Nursery pond**				**Stock pond**			
	Mean	Min.	Max.	Std. dev.	Mean	Min.	Max.	Std. dev.
Apr-Jun,12	60.50	22	160.00	43.97	53.00	22	130	35.64

Jul-Sep,12	26.67	22	32.00	3.06	27.17	21	38	4.84
Oct-Dec,12	23.50	21	28.00	2.07	23.27	21	28	2.20
Jan-Mar,13	25.80	21	33.00	3.68	25.58	23	32	2.68

Ammonia-N: Table 23 presents data on the total ammonia concentrations in four different seasons in nursery and stock ponds of the study area. The total ammonia concentrations in nursery ponds showed little variations with seasons. The mean values for total ammonia concentrations for individual seasons ranged from 0. 68 to 0.82 mg/l in nursery ponds. However, the individual values varied from 0.2 to 2.0 mg/l. The highest (0.82 mg/l) and lowest (0.68 mg/l) mean ammonia concentrations were observed during July-September and January –March periods, respectively.

In case of stock ponds, ammonia concentrations, however, showed wide variations with seasons. The mean values for total ammonia concentrations ranged from 0.95 to 1.91 mg/l in stock ponds. However, the individual values varied from 0.2 to 3.0 mg/l. The highest (1.91mg/l) and lowest (0. 95mg/l) mean ammonia concentrations were observed during July-September and October-December periods, respectively (Table 23).

Table 23. Seasonal variations in ammonia-N concentrations (mg/l) in both nursery and stock ponds

Periods	**Nursery pond**				**Stock pond**			
	Mean	Min.	Max.	Std. dev.	Mean	Min.	Max.	Std. dev.
Apr-Jun, 12	0.73	0.2	1.8	0.50	1.91	0.3	3	1.17
Jul-Sep,12	0.82	0.2	2,0	0.74	1.40	0.2	3	1.18
Oct-Dec,12	0.78	0.2	2.0	0.56	0.95	0.2	2.2	0.71
Jan-Mar,13	0.68	0.2	1.0	0.33	1.1	0.2	3	0.88

Dissolved Oxygen (DO): Seasonal variations in dissolved oxygen contents in nursery and stock ponds of the study area shown in Table 24. The mean values for DO contents in different seasons varied from 3.31 to 7.86 mg/l in nursery ponds. The highest DO content was observed in April-June period and the lowest value was recorded in January-March period.

As in nursery ponds, the DO contents in stock ponds also showed high variations. The mean values for DO contents in different seasons ranged from 3.23 to 6.66 mg/l. The highest Do content was recorded in April-June period, whereas the lowest value was noted during January-March period (Table 24).

Table 24. Seasonal variations in dissolved oxygen (DO) contents (mg/l) in both nursery and stock ponds

Periods	**Nursery pond**	**Stock pond**

	Mean	Min.	Max.	Std. dev.	Mean	Min.	Max.	Std. dev.
Apr-Jun,12	7.86	4.0	11.5	2.44	6.66	4	12	2.51
Jul-Sep,12	6.95	4.5	11.0	2.26	6.98	4.1	11.7	2.30
Oct-dec,12	5.9	4.0	9.0	1.52	6	4	11	2.37
Jan-Mar,13	3.31	3.2	3.5	0.12	3.23	3.1	4	0.25

Hardness: Table 25 provides data on the total hardness contents of nursery and stock ponds in different periods of the year. The hardness levels in nursery ponds showed a strong variation with seasons ranging from 34.0-60.0 mg/l (mean values of seasons) in nursery ponds. The higher hardness values were observed in April-June and the lowest value was found in January-March period.

As can be seen from Table 25, the hardness levels in stock ponds also varied with seasons. The seasonal mean values of hardness varied from 36.75 to 65.67 mg/l water. The highest and lowest mean values in hardness contents were measured in Apruil-June and January-March periods, respectively. The fluctuations in hardness contents among individual ponds were also high during April-June period.

Table 25. Seasonal variations in water hardness (mg/l) in both in nursery and stock ponds

Periods	**Nursery ponds**				**Stock ponds**			
	Mean	Min.	Max.	Std. dev.	Mean	Min.	Max.	Std. dev.
Apr-Jun,12	60	34	150	39.02	65.67	33	138	35.08
Jul-Sep,12	44.58	33	63	10.05	44.08	31	63	9.63
Oct-Dec,12	36.8	32	46	4.19	37.09	34	42	2.34
Jan-Mar,13	34.3	31	47	4.88	36.75	32	40	2.42

Nitrite-N: Table 26 shows the seasonal variations in nitrite contents in nursery and stock ponds of the study area. There were little seasonal variations in nursery ponds. The mean values of nitrite levels in different seasons fluctuating from 0.10 mg/l in April-June period to 0.16 mg/l in October-December.

Similarly, the nitrite concentrations in stock ponds showed little variations between seasons. The seasonal mean values for nitrite in stock ponds fluctuated between 0.09 mg/l and 0.17 mg/l, being maximum during October-December and minimum during July-September periods.

Table 26. Seasonal variations in nitrite-N concentrations (mg/l) in both nursery and stock ponds

Periods	**Nursery pond**				**Stock pond**			
	Mean	Min.	Max.	Std. dev.	Mean	Min.	Max.	Std. dev.
Apr-Jun,12	0.10	0.01	0.5	0.16	0.13	0.01	0.6	0.19

Jul-Sep,12	0.12	0.01	0.4	0.15	0.09	0.01	0.4	0.12
Oct-Dec,12	0.16	0.01	0.5	0.19	0.17	0.01	0.5	0.14
Jan-Mar,13	0.15	0.01	0.3	0.08	0.12	0.01	0.2	0.05

pH: The seasonal variations in pH values both in nursery and stock ponds are shown in Table 27. In nursery ponds, mean pH values ranged from 6.60 in April-June period to 8.15 in October-December period. This variations show no seasonal pattern.

Similarly, pH in stock ponds also did not show any particular pattern with seasons. In this case, pH values varied from 6.54 to 8.28. The lowest value was recorded in October-December, while the highest value was noted during January-march period (Table 27).

Table 27. Seasonal variations in pH values in both nursery and stock ponds

Periods	**Nursery pond**				**Stock pond**			
	Mean	Min.	Max.	Std. dev.	Mean	Min.	Max.	Std. dev.
Apr-Jun,12	6.6	4.9	8.5	1.33	6.54	4.9	8	1.14
Jul-Sep,12	7.86	4.5	10.6	1.52	7.92	6	9.9	0.93
Oct-Dec,12	8.15	7.5	10	0.89	7.55	6	9.5	1.05
Jan-Mar,13	7.78	6.5	9	0.98	8.28	6.5	10	0.92

4.2.1.3 Spatial Variations in water quality

The study areas differ in topography and soil quality, and again aquaculture management practices differ greatly between the sampling upazilas. These are likely to influence the water quality water qualities. The water quality monitoring data were segregated upazila wise both for nursery and stock ponds to demonstrate the variations between the different sampling upazilas. The variations in water qualities among different uazials for individual parameter are described below.

Alkalinity: The alkalinity levels differed greatly in different upazilas. A Upazila wise data on alkalinity levels are presented graphically in Fig. 15. In case of nursery ponds, the alkalinity values of sampling upazilas varied from 24.62 to 53.45mg/l. The highest mean value was recorded in Kpasia upazila (53.45mg/l) and the lowest value was measured in Fulbaria upazila,.

The alkalinity levels in stock ponds in different upazilas also showed strong variations. As with nursery ponds, in case stock ponds, the highest mean level of alkalinity was noted in Kapasia Upazila (47.18mg/l), followed by Muktaghacha upazila (30.16mg/l), while the lowest value was recorded from Fulbaria upazila. However, there was no much variations in the levels of alkalinity between stock and nursery ponds of the same upazila.

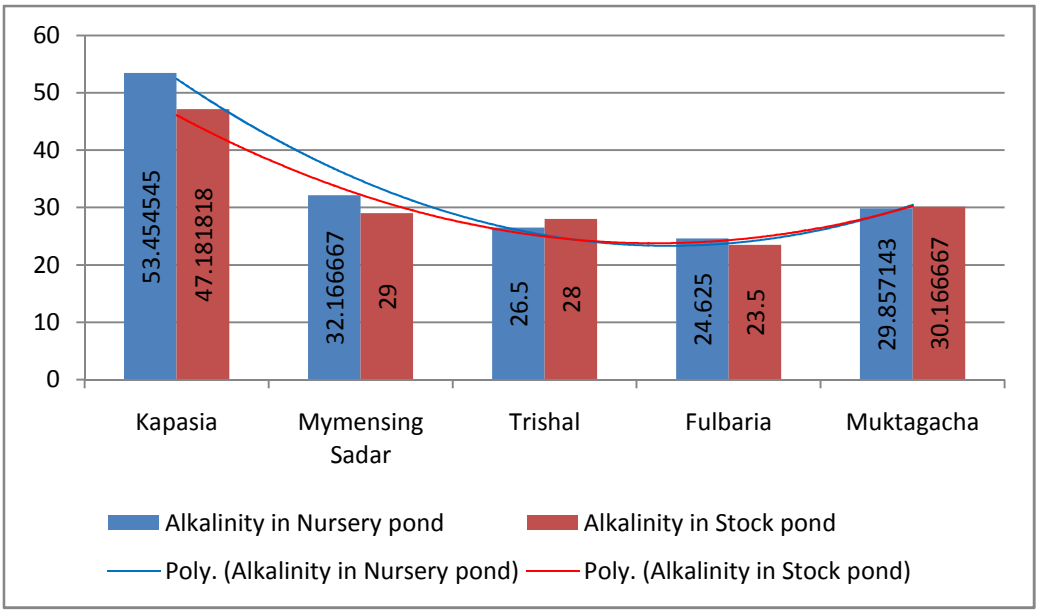

Fig 15. Upazila wise variations in alkalinity levels (mg/l) in nursery and stock ponds

Total ammonia-N: The ammonia concentrations in both nursery and stock ponds varied among sampled upazila. The data on ammonia concentration by upazila are presented in Fig. 16. As evident from the results, the mean ammonia levels for nursery ponds of different upazilas ranged from 0.45 mg/l to0.99 mg/l, the highest being in Kapasia Upazila and the lowest in Mymensingh Sadar upazila.

However, in case of stock ponds, the ammonia concentrations did not vary much between upazilas. The mean levels for different upazilas varied from 0.77mg/l to 2.07mg/l the highest level was observed in Kapasia and Muktagacha upazilas, whereas the lowest level was noted from Mymensingh sadar upazila (Fig . 16).

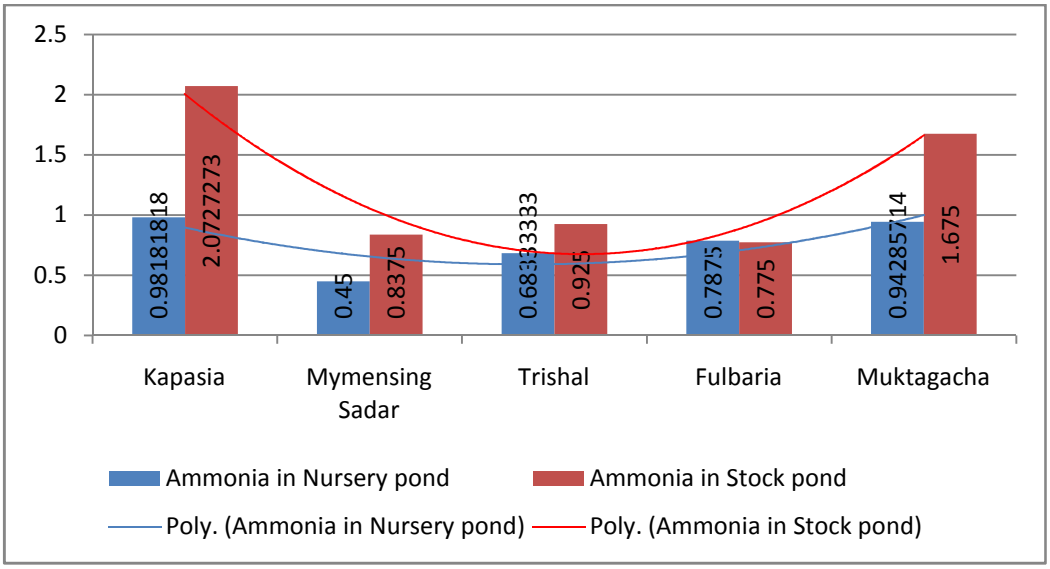

Fig. 16. Upazila wise variations in ammonia-N levels (mg/l) in nursery and stock ponds

Dissolved oxygen (DO): The data on DO contents in nursery and stocks ponds by upazilas are shown graphically in Fig. 17. In general, there were little variations in DO of nursery and stock ponds in different upazilas. In case of nursery ponds, upazila wise mean values od DO content in different upazilas ranged from 5.61mg/l to 6.85mg/l., the highest being noted from Mymensuingh Sadar and lowestfrom Fulbaria Upazila and that of stock ponds varied from 5.11mg/l to 6.55mg/l., highest was recorded from Mymensingh sadar and lowest was noted from Kapasia upazila.

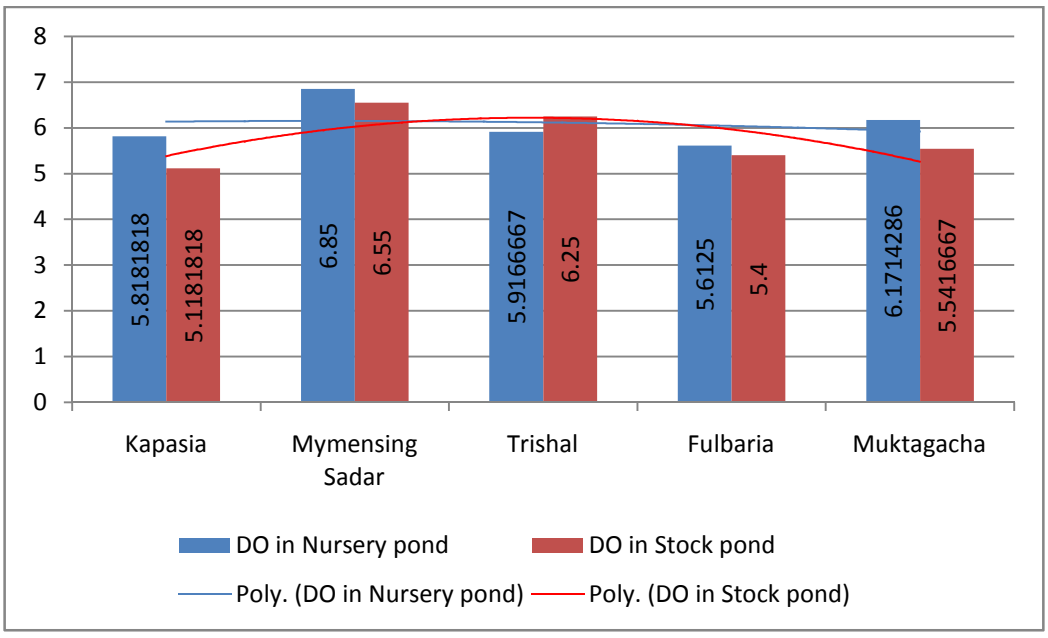

Fig 17. Upazila wise variations in dissolved oxygen levels (mg/l) in nursery and stock ponds

Total Hardness: In general, the hardness levels in both nursery and stock ponds varied slightly among upazilas. The data on hardness by sampling upazilas for both nursery and stock pond are presented in Fig. 18. The hardness levels fluctuated from 34.25mg/l to 51.00mg/l, the highest mean level of hardness, in case of nursery ponds, was found in Kapasia upazila and the lowest level was found in Fulbaria uipazila. In case of stock ponds, the levels varied from 35.00mg/l to 54.37mg/l, again the highest concentration was noted from Mymensingh Sadar upazita, the lowest mean level of hardness from Fulbaria upazila.

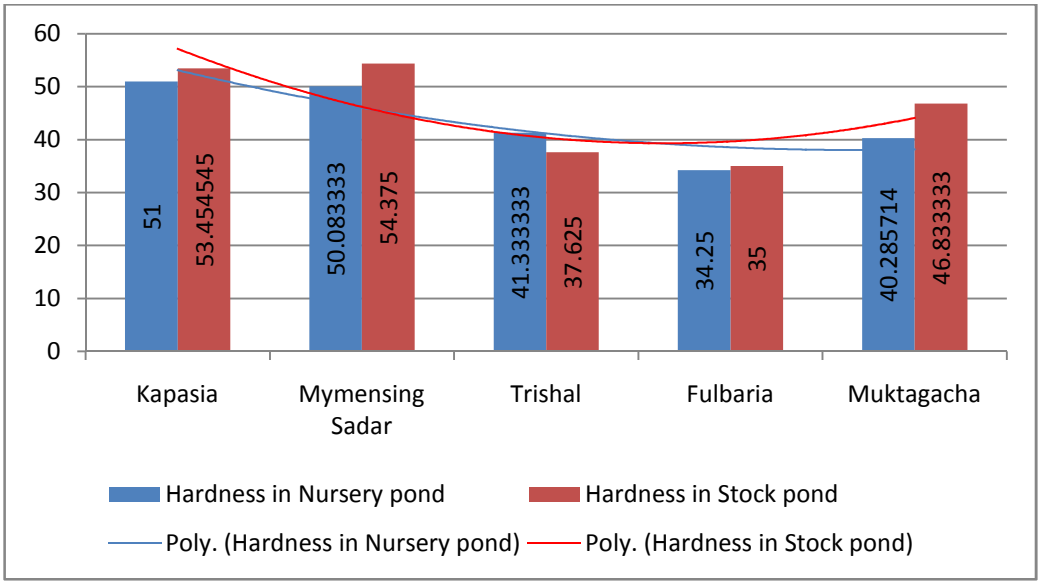

Fig 18. Upazila wise variations in hardness levels (mg/l) in nursery and stock ponds

Nitrite-N: In general, the nitrite levels in both nursery and stock ponds varied moderately between upazilas. The data on nitrite concentrations by sampling upazilas for both nursery and stock pond are presented in Fig. 19. The nitrite levels fluctuated from 0.11mg/l to 0.19mg/l, the highest mean level of nitrite in nursery ponds was found in Fulbaria upazila and the lowest level was found in Trishal uipazila. In case of stock ponds, the levels varied from 0.04mg/l to 0.16mg/l, again the highest concentration was noted from Trishal upazila, the lowest mean level of nitrite was recorded from Mymdarensing sadar upazila. In general, the nitrite levels were comparatively higher in stock ponds. (Fig. 19).

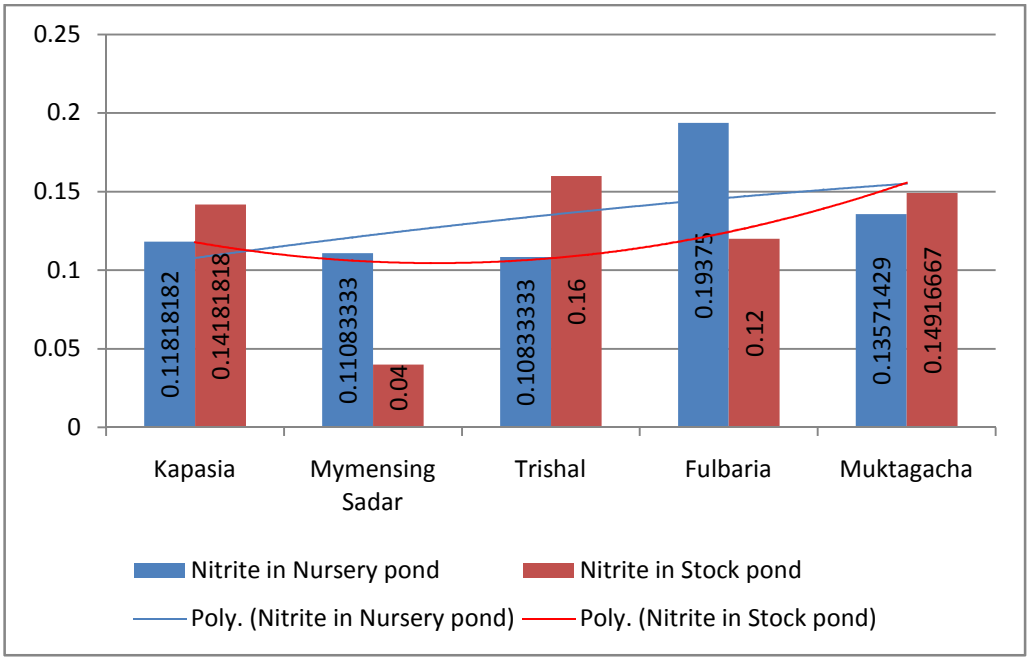

Fig 19. Upazila wise data on the nitrite concentrations (mg/l) for nursery and stock ponds.

pH: The pH values in nursery and stock ponds did not show much variations between upazilas. In case of nursery ponds, the levels varied from 6.43 to 8.24mg/l among the sampling upazila. The results on pH levels showing variations among upazilas are presented in Fig. 20. The highest pH value was observed in nursery ponds of Kapasia upazila, whereas lowest value was noted in Trishal upazila.

In case of stock ponds, the mean pH values fluctuated from 7.16 to 7.95mg between upazilas, but showed no particular pattern. The highest pH levels was measured in Kapasia Upazila and that was measured lowest in Trishal upazila.

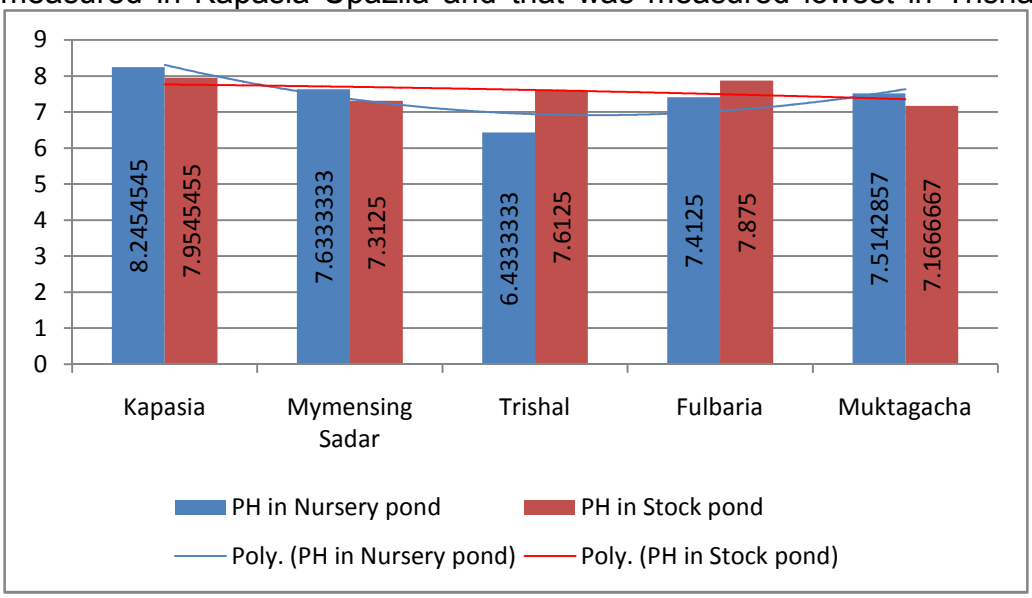

Fig 20. Upazila wise data on pH levels in nursery and stock ponds of the study area.

4.2.2 Occurrences and incidences of diseases

4.2.2.1 Occurrences of diseases

Information on the occurrence of diseases in nursery and stock ponds are provided in Fig. 21 and Fig. 22, respectively. As shown in Fig. 21 that diseases were observed in 17-42% nursery ponds depending on seasons. Highest incidences of disease were found in April-June period and lowest incidence was observed during October-December period. Of the sampled nursery ponds, in average, about 23% nursery ponds were attacked by disease. In case of stock ponds, depending on seasons, diseases occurred in 8- 67% stock ponds . The highest occurrences of disease were observed in April-June quarter and the lowest in January-March period (Fig. 22).

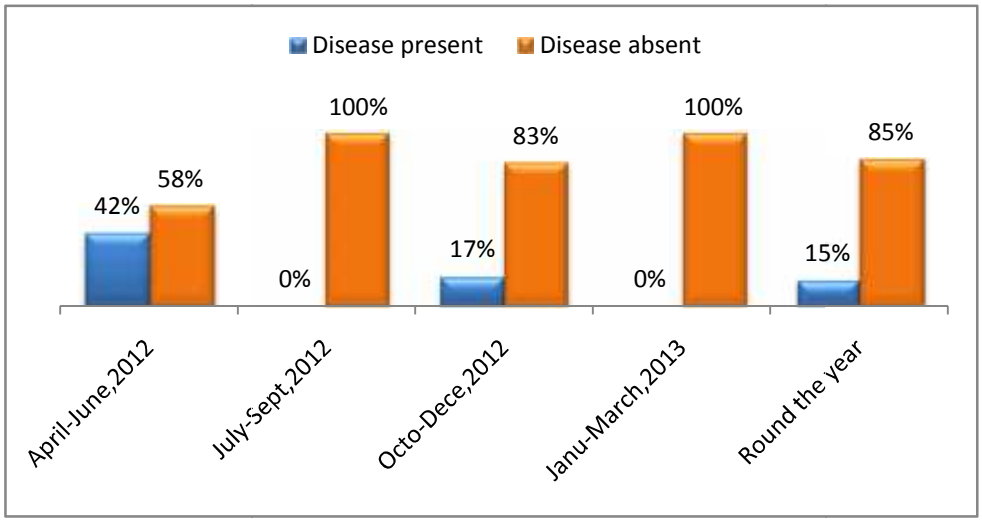

Fig 21. Percent distribution of nursery ponds according to occurrences of disease in different periods of the year

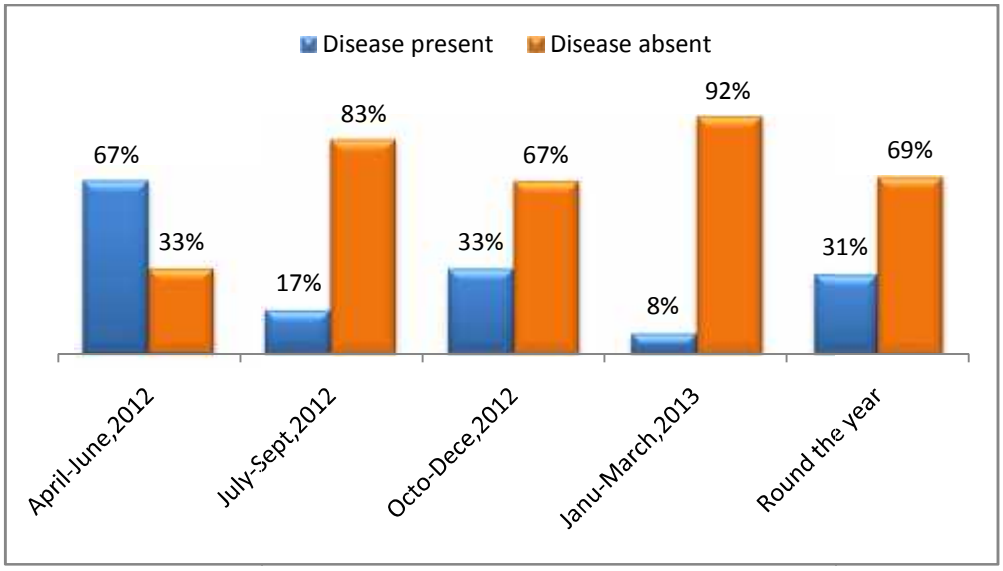

Fig. 22. Percent distribution of stock ponds according to occurrences of disease in different periods of the year

Spatial variations in incidences of disease

The occurrences in fish diseases in sampled farms showed strong variation among the sampling upazilas. Fig 23.shows the percent occurrences of fish diseases in different upazilas of the study area. It is evident from the results that the highest (43%) incidence of disease was observed in Kapasia Upazila and the lowest (5%) incidences were noted in Fulbaria Upazila.

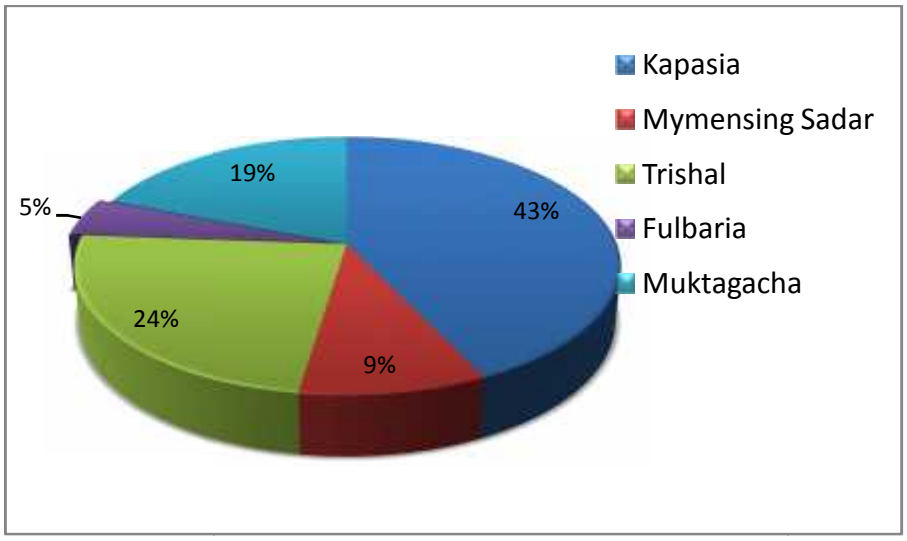

Fig. 23. Percent incidences of disease in different sampling upazilas

Species/groups affected by disease

Only few group/species of fish were raised/cultured in the sampled farms, more precisely in sampled ponds, and of them, almost all species of fish suffered from diseases. Table 28 provides data on disease occurrences in different farms (nursery ponds) by fish species (groups). Carps were found more susceptible to disease during period of April-June period. Thai ko was unaffected by disease throughout the year. However, in case of stock ponds, climbing perch was most affected during April-June period, followed by Thai pangas (Table 29).

Table 28. Occurrences of disease by fish species in nursery pond in different periods of the year.

Fish species/ groups	**Apr-Jun,2012**		**Jul-Sep,2012**		**Oct-Dec,2012**		**Jan-Mar,2013**	
	Disease Present	Disease Absent	Disease Present	Disease Absent	Disease Present	Disease Absent	Disease Present	Disease Absent
Carp(Rui, *catla,* silver carp, mrigel, Carpio)	3	3	0	6	1	6	0	4
Climbing perch (Thai Koi)	0	2	0	2	0	2	0	1
Pangash(Thai pangas)	0	2	0	2	1	0	0	1
Telapia(gift tilapia)	1	0	0	1	0	1	0	3
Stinging cat fish(singhi)	1	0	0	1	0	1	0	1
Total	5	7	0	12	2	10	0	10

Table 29. Occurrences of disease by fish species in stocks pond in different periods of the year.

Fish species /groups	**Apr-Jun,2012**		**Jul-Sep,2012**		**Oct-Dec,2012**		**Jan-Mar,2013**	
	Disease Present	Disease Absent	Disease Present	Disease Absent	Disease Present	Disease Absent	Disease Present	Disease Absent
Carp(Rui, *catla,* silver	1	1	1	3	1	3	0	6

carp, mrigel, Carpio)								
Climbing Fish (Thai Koi)	3	0	0	2	0	1	0	0
Pangash(Thai pangas)	2	1	0	3	1	0	1	2
Telapia(gift tilapia)	1	0	0	2	1	1	0	2
Stinging cat fish (Shingi)	0	1	1	0	0	1	0	1
Gonia	1	1	0	0	0	0	0	0
Total	8	4	2	10	3	6	1	11

Disease types and its intensities

During the study period, eight specific diseases, viz. dropsy, taril and fin rot, white spot, red spot, unknown, poor water quality, Gyrodactyliasis/ body fluke, Argulosis were observed in different periods, both in nursery and stock ponds. In addition, an unknown disease and diseases caused by poor water were also found to occur. Table 30 presents' data by number of fish farms by disease types in different periods. Dropsy and tail and fin rot found to occur in majority of fish species. White spot disease mainly found in pangas fish. Diseases of unknown aetiology were also observed to occur in a number of species.

Table 30 provides data on the seasonal occurrences of different diseases in nursery ponds. Dropsy, red spot, tail and fin rot and poor water quality was found to occur throughout the year, except April- June period in nursery pond. White spot disease was observed during October-December period in nursery ponds but in low intensities.

Table 30. Different disease type s affecting different fish species

Disease type	Fish species					
	Carp	Climbing Fish (Thai Koi)	Pangash	Telapia	Cat fish	Other fish
Dropsy	0	1	1	2	1	0
Tail and fin rot	2	0	1	1	0	0
Gyrodactyliasis/ Body fluke	0	0	1	0	0	0
White Spot	1	0	3	1	1	0
Red Spot	0	0	2	1	1	1
Argulosis	0	1	0	0	0	0
Viral disease	1	0	0	0	0	0
Unknown	2	2	1	0	0	0

Poor water quality	2	0	1	0	0	0

In addition, tail and fin rot, red spot, white Spot, an unknown disease and diseases caused by poor water were also found to occur. Table 31 presents data on Present distribution of ponds by disease types in different periods. Dropsy, Gyrodactyliasis/ body fluke and poor water quality was found to occur throughout the year, except April- June period in stock pond. Viral disease appeared in October-December period in nursery ponds but in low intensities.

Table 31. Seasonal occurrences of different diseases in nursery ponds in different seasons ponds

Name of disease	Apr-Jun,2012	Jul-Sep,2012	Oct-Dec,2012	Jan-Mar,2013
No disease	7	12	10	10
Dropsy	2	0	0	0
Tail and fin rot	1	0	0	0
Gyrodactyliasis/ Body fluke	0	0	0	0
White Spot	0	0	1	0
Red Spot	2	0	0	0
Argulosis	0	0	1	0
Virus	0	0	0	0
Unknown	1	0	1	0
Poor water quality	1	0	0	0

In case of stock ponds, a total of seven disease types, viz. tail and fin rot , red spot, white Spot, an unknown disease and diseases caused by poor water were found to occur. (Table 32) presents data on Present distribution of ponds by disease types in different periods. Dropsy, Gyrodactyliasis/ body fluke and poor water quality was found to occur throughout the year, except April- June period in

stock pond. Virus October-December periods during in nursery ponds but in low intensities.

Table 32. Seasonal occurrence of different diseases in stock ponds of the study area

Name of disease	Apl-Jun,2012	Jul-Sep,2012	Oct-Dec,2012	Jan-Mar,2013
No disease	4	10	6	11
Dropsy	3	0	0	0
Tail and fin rot	1	1	1	0
Gyrodactyliasis/ Body fluke	1	0	0	0
White Spot	0	1	3	1
Red Spot	1	0	1	0
Argulosis	1	0	0	0
Virus	0	0	1	0
Unknown	1	0	0	1
Poor water quality	1	0	0	0

Table 33. Frequency of disease incidences in nursery and stock ponds in different seasons

Frequency	Apr-Jun,2012		Jul-Sep,2012		Oct-Dec,2012		Jan-Mar,2013		Round the period	
	Nursery Pond	Stock Pond	Nursery Pond	Stock Pond	Nursery Pond	Stock Pond	Nursery Pond	Stock Pond	Nursery Pond	Stock Pond
No disease	7	4	12	10	10	6	10	11	39	31
Once in a season	5	5	0	2	2	3	0	1	7	11
Twice in season	0	2	0	0	0	0	0	0	0	2
Thrice in season	0	1	0	0	0	0	0	0	0	1

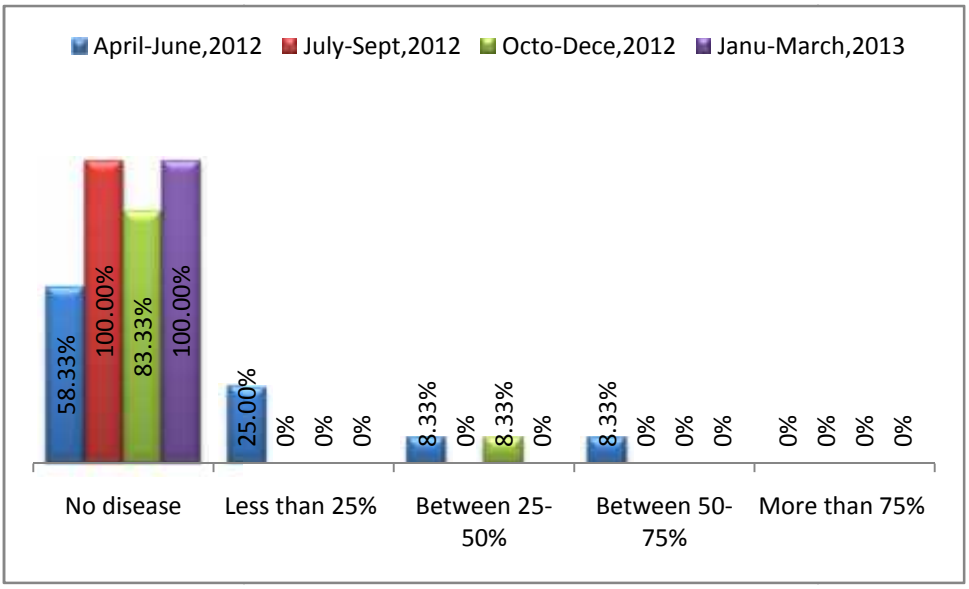

Fig. 24. Percent intensities of ish diseases in different seasons in nursery pond+

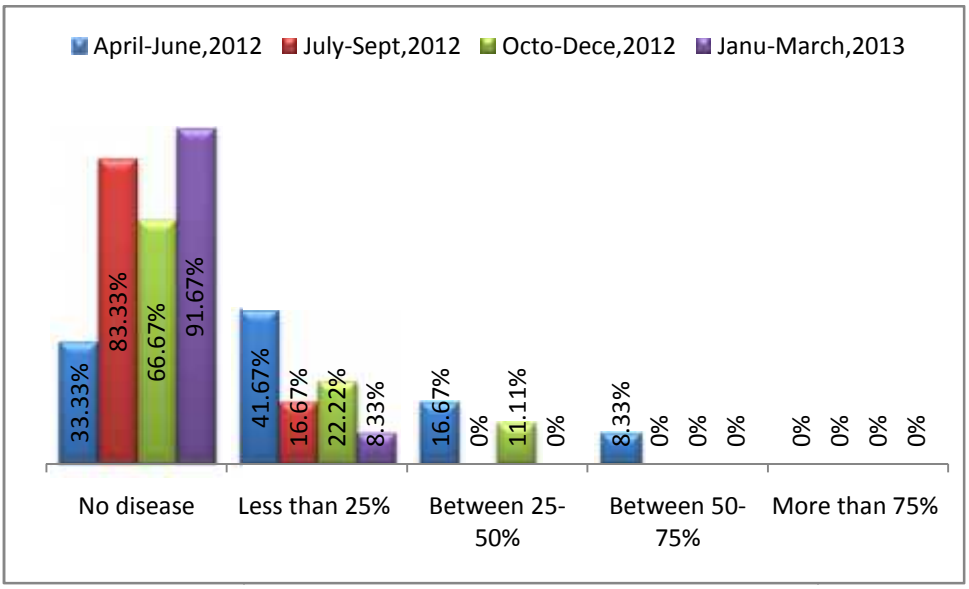

Fig. 25. Intensities of disease affecting fish population (%) in different seasons in stock ponds.

Fish Mortalities caused by diseases

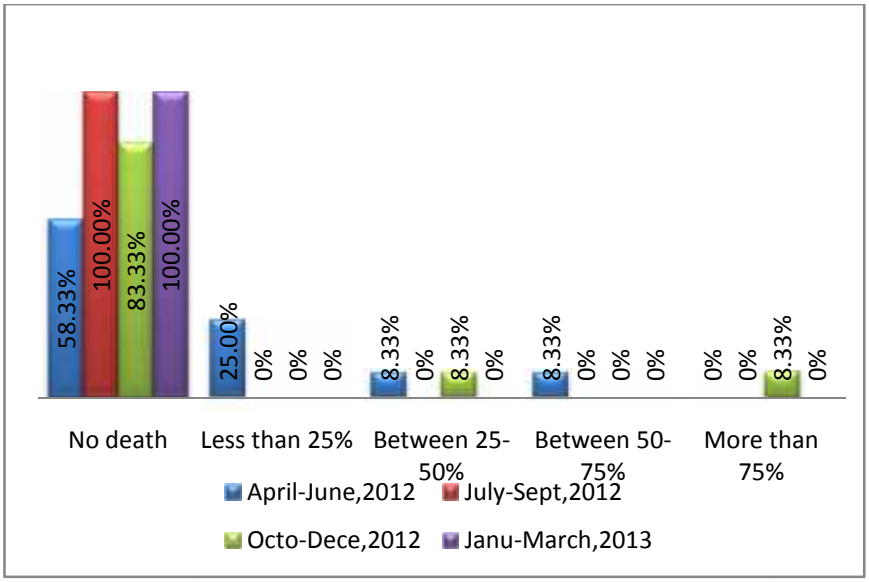

Fig. 26. Percent mortalities of fish in nursery ponds in different periods of the year

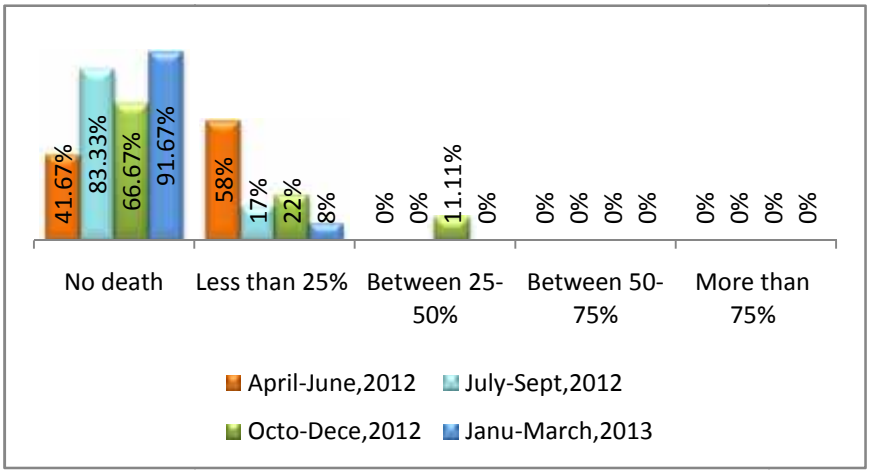

Fig. 27. Percent mortalities of ifsh in stock ponds in different periods of the year

Percent mortalities of fish caused due to disease in nursery and stock ponds are provided in Fig. 26 and Fig. 27, respectively. No fish mortalities in 58.33% fish mortalities due to tail and fin rot, unknown causes probably due to red Spot, malnutrition, Other disease caused mortality in 8.33% nursery pond during April-June, October-December periods were disease mortality white Spot and unknown (8.33%), July-September and January-March were not mortality in nursery pond October-December periods, respectively. (table 34).

Information on the percent stock ponds affected by fish mortalities by different diseases in different periods of the year is given in (Table 35).

Table 34. Percent distribution of nursery ponds by disease type causing fish mortalities in different seasons

Name of Diseases	Apri-Jun,2012		Jul-Sep,2012		Oct-Dec,2012		Jan-Mar,2013	
	Number of ponds	% of ponds	Number of ponds	% of ponds	Number of ponds	% of ponds	Number of ponds	% of ponds
Dropsy	0	0	0	0	0	0	0	0
Tail and fin rot	1	8.33	0	0	0	0	0	0
Malnutrition	1	8.33	0	0	0	0	0	0
White Spot	0	0	0	0	1	8.33	0	0
Red Spot	1	8.33	0	0	0	0	0	0
Unknown	1	8.33	0	0	1	8.33	0	0
Other disease	1	8.33	0	0	0	0	0	0
No disease for death	7	58.33	12	100	10	83.33	10	100
Total	12	100	12	100	12	100	10	100

Table 35. Percent distribution of stock ponds by disease type causing fish mortalities in different seasons

Name of Diseases	Apr-Jun,2012		Jul-Sep,2012		Oct-Dec,2012		Jan-Mar,2013	
	Number of ponds	% of ponds	Number of ponds	% of ponds	Number of ponds	% of ponds	Number of ponds	% of ponds
Dropsy	2	16.67	0	0	0	0	0	0
Tail and fin rot	0	0	1	8.33	2	22.22	0	0
Malnutrition	1	8.33	0	0	0	0	0	0
White Spot	0	0	1	8.33	0	0	0	0
Red Spot	0	0	0	0	1	11.11	0	0
Unknown	2	16.67	0	0	0	0	1	8.33
Other disease	2	16.67	0	0	0	0	0	0
No disease for death	5	41.67	10	83.33	6	66.67	11	91.67
Total	12	100	12	100	9	100	12	100

Disease treatment measures taken by the fish farmers

When there was any outbreak of disease, 50% farmers did not consult Fisheries Officer or equivalent person, and they treated fish from their past experiences, while 20.83% consulted Fisheries Officer or equivalent persons, another 20.3% farmers consulted other farms, while 8.34% farms took suggestions from experienced persons including local veterinary doctor.

Fish farmer's udertook various measure for treating fish diseases. Six different treatment measures were taken for treating fish diseases in the sampled fish farms. Sometimes, farmers used more than one measures for the purpose. Table 36 provides data on the type of measures taken to treat fish diseases in fish farms. About 27% farmers used medicine procured from market; about 52% farmers used lime when there were any disease occurrences in their farms.

Table 36. Type of curative measures taken by the fish farmers for controlling diseases

Treatment measures	**No. of farms**	**% farms**
Use medicine from market	41	26.98
Use lime	79	51.98
Use common salt	7	4.60
Use potassium permanganate	12	7.89
Use herbal medicine	1	0.66
Total	141	100.00

4.2.3 Management practices in fish farms

Fish species /groups cultured

Table 36 provides data on the fish species/groups cultured in nursery ponds in different seasons, while the same information on the stock ponds are provided in Table 37. As can be seen from Table 37, a total of five species/groups of fish, namely major carps (rui, catla, *mrigel*), snghifish, *pangas* (*Pangasius sutchi*), tilapia (gift tilapia), Thai koi were raised in nursery ponds. In most nursery ponds (40.00-58.33%) , major carp fingerlings are raised, followed by Telapia (gift Tilapia) (8.33-30.00%), climbing perch (Thai Koi) (10.00-16.67%) , pangas (8.33-16.67%ponds) and shingi fish is raised in 8.33-10.00% nursery ponds. Carps were stocked mostly during October-Decmber (58.33% ponds) and during April-June and July –September (50.00%) nursery ponds.

Table 37. Percent distribution of nursery ponds by fish species/groups cultured in different periods of the year.

Name of fish species	**Apr-Jun,2012**		**Jul-Sep,2012**		**Oct-Dec,2012**		**Jan-Mar,2013**	
	Number of ponds	% ponds	Number of ponds	% ponds	Number of ponds	% ponds	Number of ponds	% ponds
Carp(Rui, *catla,* silver carp, mrigel, Carpio)	6	50.00	6	50.00	7	58.33	4	40.00
Climbing Fish (Thai Koi)	2	16.67	2	16.67	2	16.67	1	10.00
Name of fish species	**Apr-Jun,2012**		**Jul-Sep,2012**		**Oct-Dec,2012**		**Jan-Mar,2013**	
	Number of	% pond	Number of	% pond	Number of	% pond	Number of	% pond

	ponds	s	ponds	s	ponds	s	ponds	s
Pangash(Thai Pangash)	2	16.67	2	16.67	1	8.33	1	10.00
Telapia(Gift Tilapia)	1	8.33	1	8.33	1	8.33	3	30.00
Starting cat fish(Shingi)	1	8.33	1	8.33	1	8.33	1	10.00
Total	12	100	12	100	12	100	10	100

As can be seen from Table 38, total of six species/groups of fish, namely major carps (rui, catla, mrigel), snghifish, pangas (Pangasius sutchi), tilapia (gift tilapia), Thai koi and Gonia were raised in stock ponds. In most stock ponds (16.67-50.00%) major carp fingerlings were raised, followed by Pangash (Thai Pangash) and Climbing perch (Thai Koi) (11.11-25.00%) Telapia(Gift Tilapia) (8.33-22.22%), shingi fish is raised in 8.33-11.11% and Gonia 16.67% stock ponds. Carps were stocked mostly during January-March (50.00% ponds) and during October-December (44.44% ponds) and July-September (33.33% ponds) and April-June (16.67% ponds) in stock ponds.

Table 38. Percent distribution of stock ponds by fish species/groups cultured in different periods of the year.

Name of fish species/group	**Apr-Jun,2012**		**Jul-Sep,2012**		**Oct-Dec,2012**		**Jan-Mar,2013**	
	Number of ponds	% ponds	Number of ponds	% ponds	Number of ponds	% ponds	Number of ponds	% ponds
Carp(Rui, *catla,* silver carp, mrigel, Carpio)	2	16.67	4	33.33	4	44.44	6	50.00
Climbing Fish (Thai Koi)	3	25.00	2	16.67	1	11.11	0	0
Pangash (Thai Pangash)	3	25.00	3	25.00	1	11.11	3	25.00

Telapia(Gift Tilapia)	1	8.33	2	16.67	2	22.22	2	16.67
Starting cat fish(Shingi)	1	8.33	1	8.33	1	11.11	1	8.33
Gonia	2	16.67	0	0	0	0	0	0
Total	12	100	12	100	9	100	12	100

Stocking densities

Overall, the stocking density of fry/fingerlings in nursery ponds varied from 20-200000 with an average of 1413 fry/fingerling/decimal nursery ponds, while that in stock ponds ranged from 6 to 9000 with an average of 1342 (approx) fingerling/decimal (Table 39).

Table 39. Summary statistics on stocking densities of fry/fingerling (number/decimal) in both nursery pond and stock ponds.

Type of pond	**number/decimal**			
	Mean	**Minimum**	**Maximum**	**Std. dev.**
Nursery pond	14133.24	20	200000	42880.68
Stock pond	1341.89	6	9000	1839.63

Nursery ponds: Table 40. Presents data on the stocking densities of fry/fingerlings stocked in different periods of the year. The highest density (above 10000/decimal) was socked in only 33% nursery ponds in April-June period, while 42% and 52% nursery ponds stocked fingerlings between 1000-5000 fingerling/decimal during April-June and January-March periods.

Table 40. Percent distribution of nursery ponds according to stocking densities (number/ decimal) in different seasons

Densities (No./decimal)	**Apr-Jun,2012**		**Jul-Sep,2012**		**Oct-Dec,2012**		**Jan-Mar,2013**	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Less than 500	1	8.33	4	33.33	5	41.67	4	40
Between 500 & Less than 1000	1	8.33	-	-	3	25	-	-
Between 1000 & less than 5000	5	41.67	7	58.34	3	25	5	50
Between 5000 & less	1	8.33	1	8.33	1	8.33	-	-

than 10000								
10000 & above	4	33.34	-	-	-	-	1	10
Total	12	100	12	100	12	100	10	100

Stocking ponds: Information on the stocking densities in stock ponds are given in Table 41. Most ponds (25-50%) were stocked with less than 500 fingerlins/decimal, particularly during April-June and July September periods. However, only about 10% ponds were stocked in the range between 5000 and 10000 fingerlings/decimal stock ponds.

Table 41. Percent distribution of stock ponds according to stocking densities (number/ decimal) in different quarters of the year

Densities (No./decimal)	**AprilJune2012**		**JulySept2012**		**Oct-Dece2012**		**Jan-Mar13**	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Less than 500	6	50	6	50	3	33.33	3	25
Between 500 & Less than 1000	3	25	4	33.33	1	11.11	1	8.33
Between 1000 & less than 5000	3	25	2	16.67	4	44.44	5	41.67
Between 5000 & less than 10000	-	-	-	-	1	11.11	3	25
Total	12	100	12	100	9	100	12	100

Feeding of fish

The farmers mainly used prepared packed feed obtained from markets throughout the year, both in nursery and stock ponds. However, in some farms, feed prepared on farm using locally available ingredients, like rice bran, oil cakes and others were used. Fig. 28 shows the percent distribution of ponds according to the feed type used for feeding fish. As can be seen from Fig. 28 that use of prepared packed feed differed from season to season. Prepared feed was used in 58% ponds in July-September and in 80% ponds during October-December periods.

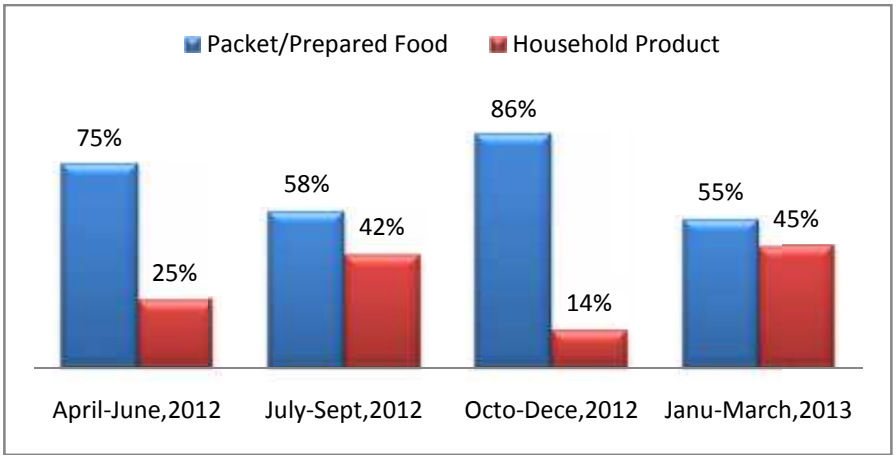

Fig . 28. Percent distribution of nursery and stock ponds in different periods of the year based on type of feed used

Rate of feeding: Information on the quantity of feed supplied to nursery ponds per day in different seasons is given in Table 42. In average, the lowest amount of feed (250 gm/decimal) to nursery ponds during October-December period and highest amount was supplied in January-March (756g/ decimal) with an overall average of 516 g/decimal/day. In case of stock ponds, the average amount of feed supplied was found be lowest in October-Decemeber (239 g/decimal) and highest in January-March(959g/ decimal) with an overall average of 500gm/decimal/day.

Table 42. Quantity of feed (g/decimal/day) supplied in nursery and stock ponds in different seasons

Seasons	**Quantity (g/decimal) of feed supplied in nursery pond**				**Quantity (gm/decimal) of feed supplied in stocking pond**			
	Mean	Min.	Max.	Std. dev.	Mean	Min.	Max.	Std. dev.
Apr-Jun,2012	596.67	100	1500	431.31	433.33	50	1000	338
Jul-Sep,2012	500	100	1000	305.26	304.58	50	750	231.57
Oct-Dec,2012	250	50	600	201.13	238.89	50	800	249.72
Jan-Mar,2013	756	100	3000	899.71	959.17	210	3000	791.67
Round the year	515.65	50	3000	522.98	500.33	50	3000	541.35

The rate of feeding of fish both in nursery and stock ponds varied from pond to pond. The percent distribution of nursery ponds and stock ponds in different seasons are shown in(Table 42 and Table 43, respectively. As can be seen from Table 43, in most nursery ponds fish were fed with less than 1000 g/decimal/day. Only, one pond was fed at the rate of more than 5000g feed/decimal/day. Similarly, most stock ponds were supplied with less than 1000 g feed /decimal/day (Table 44).

Table 43. Percent distribution of nursery ponds according to quantity (g/decimal/day) of feed supplied in nursery ponds in different seasons

Amount of feed/decimal	**Apr-Jun,2012**		**Jul-Sep,2012**		**Oct-Dec,2012**		**Jan-Mar,2013**	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Less than 500 g	5	41.67	6	50	9	75	5	50
Between 500 g & <1000 g	5	41.67	5	41.67	3	25	2	20
Between 1000 g & <5000 g	2	16.67	1	8.33	-	-	2	20
More than 5000 g	-	-	-	-	-	-	1	10
Total	12	100	12	100	12	100	10	100

Table 44. Percent distribution of stock ponds according to quantity (g/decimal/day) of feed supplied in nursery ponds in different seasons

Amount of fish	**Apr-Jun, 2012**		**Jul-Sep,2012**		**Oct-Dec, 2012**		**Jan-Mar,2013**	
	Number	percent	Number	percent	Number	percent	Number	percent
Less than 500 g	7	58.33	8	66.67	7	77.78	2	16.67
Between 500 g & <1000 g	3	25	4	33.33	2	22.22	5	41.67
Between 1000 g & <5000 g	2	16.67	-	-	-	-	4	33.33
More than 5000 g	-	-	-	-	-	-	1	8.33
Total	12	100	12	100	9	100	12	100

Frequency of feeding: Information on the frequency of feeding the fish in nursery and stock ponds are provided in (Fig . 29 and Fig. 30). In general, fish are fed more frequently during during April-June period. It is evident from the (Fig. 29) that in most nursery ponds (34-75%) fish are fed more than once in a day in all seasons, followed by fish fed once a day (17-50% ponds).

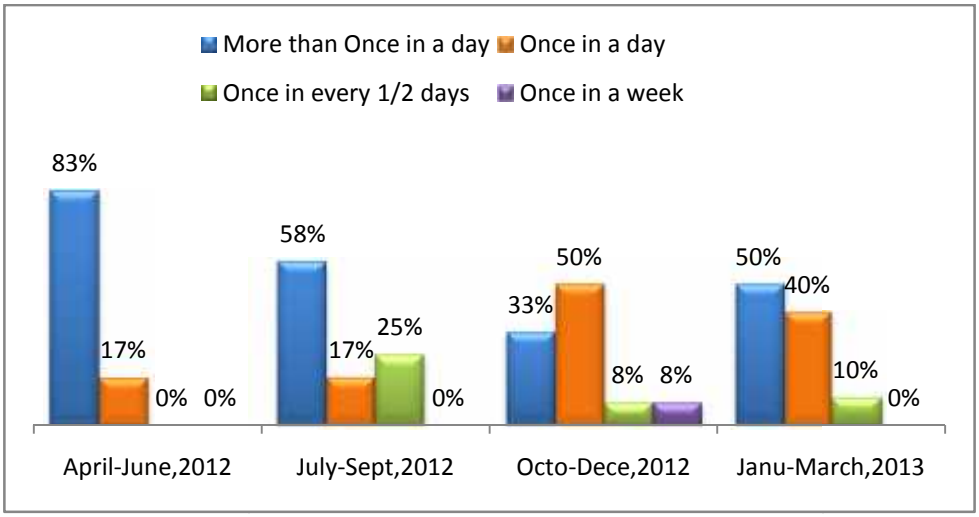

Fig. 29. Frequency of feeding in nursery ponds in different seasons

Similarly, fish in most stock ponds (50-75%) are fed more than once in a day, except October-December period. However, fish are fed once in a day in 8.33-100% stock ponds (Fig. 30), particularly during October-December fish are less frequently fed, once in a day in 100% stock ponds.

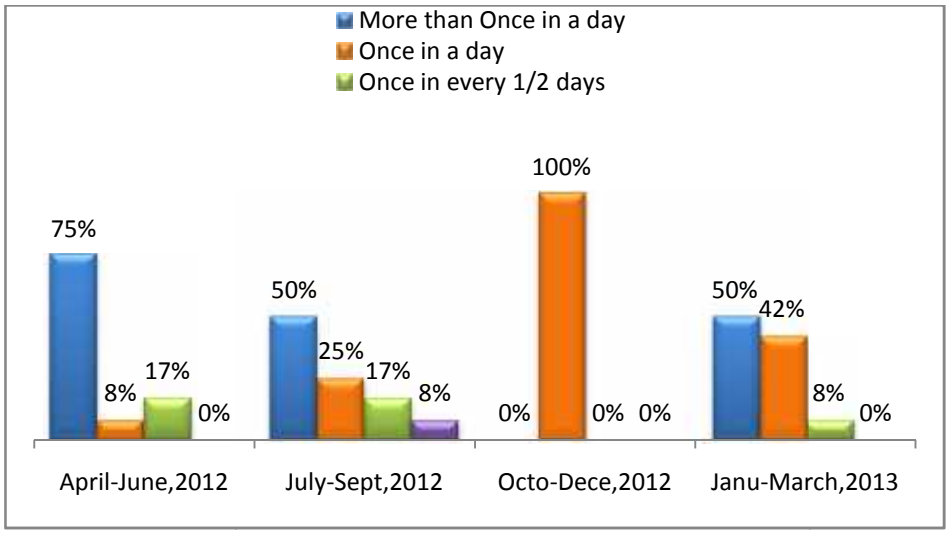

Fig. 30. Frequency of feeding in stock ponds in different seasons

Water exchanges

It is to be mentioned that complete exchanges of water in pond is not done, rather water is added when the level falls low and in some cases some water is pumped out and new water is added to ponds. Table 45 and Table 46 provide data on the frequency of water exchanges /addition in nursery and stock ponds in each quarter of the year. As evident from the Table 45 that most ponds (45to 80%), depending on seasons, water is changed once in a quarter. However, during January-March period in some nursery ponds water is exchanged more than three times.

Table 45. Frequency (times/quarter) of water exchanges in nursery ponds

Frequency of water exchanges	**Apr-Jun,2012**		**Jul-Sep,2012**		**Oct-Dec,2012**		**Jan-Mar,2013**	
	Number	percent	Number	Percent	Number	percent	Number	percent
Once	4	80	4	50	8	66.67	4	44.44
2/3 times	-	-	4	50	1	8.33	-	-
More than 3 times	1	20	-	-	3	25	5	55.56
Total	5	100	8	100	12	100	9	100

Table 46 provides information on water exchanges in stock ponds. As with nursery ponds , in stock ponds water exchanges are done once in a quarter in most ponds (46-86% ponds). Again, in some ponds water is added more than three times particularly during dry period.

Table 46. Frequency (times/quarter) of water exchanges in stock ponds

Frequency of water exchange	**Apr-Jun, 2012**		**Jul-Sep, 2012**		**Oct-Dec,2012**		**Jan-Mar, 2013**	
	Number	percent	Number	Percent	Number	percent	Number	percent
Once	2	66..67	6	85.71	2	22.22	5	45.45
2/3 times	-	-	1	14.29	2	22.22	-	-
More than 3 times	1	33.33	-	-	5	55.56	6	54.55
Total	3	100	7	100	9	100	11	100

Liming of ponds

Frequency of liming: Information on the liming frequency of nursery and stock ponds are shown in Fig. 31. During April- June period, 8% ponds were not limed, while 33% ponds were limed once in a quarter and similarly another 33% ponds were limed more than 2/3 times during the period. During July-September period, all ponds were limed, however, of them 54% ponds were limed once in the quarter and 17% ponds were limed more than 2/3 time during the period.

Similarly, during October-December period, liming was not done in 10% ponds, while 52% ponds received lime more than 2/3 times during the period. On the other hand, 23% ponds were not limed during January-March period, while 45% ponds received more than 2/3 times during the period (Fig . 31).

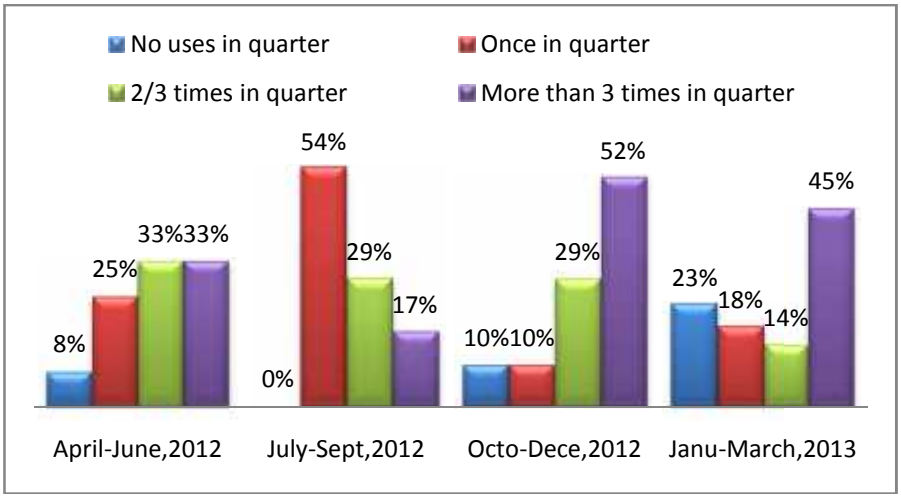

Fig . 31. Frequency of liming of nursery and stock ponds during different periods of the year.

Quantity of lime used in nursery and stock ponds: Summary statistics on the use of lime in nursery and stock ponds are provided in Table 47. Overall, in average, the amount of lime applied in nursery ponds varied from 0 to 1200 g/decimal with an average of 308.26 g/decimal pond area. On the other hand , in stock ponds, the liming rates ranged from 0 to 1200 g/decimal pond area with an average of 314.22 g/decimal.

Table 47. Summarized information on the amount of lime (g/decimal) applied both in sample nursery and stock ponds.

Pond type	**Amount of lime (g/decimal pond)**			
	Mean	**Minimum**	**Maximum**	**Std. dev.**
Nursery pond	308.26	0	1200	273.66
Stock pond	314.22	0	1200	257.50

However, liming rates varied in different seasons. Table 48 provides data on the variations in the amounts of lime used in different seasons in the studied ponds. In nursery ponds, the highest amount (423.0 mg/decimal) lime was used in January-March period, followed by 3316.67 mg/decimal in July-September period. The lowest amount of lime (254.17 g/l) was used during October-December period.

In case of stock of periods, the highest amount of lime (366.67 g/decimal) was used during July/September and lowest amount (261.11 g/decimal) was used during October-December period.

Table 48. Quantity of lime (g/decimal) applied in nursery and stock ponds during different periods of the year.

Seasons	**Nursery ponds**				**Stock ponds**			
	Mean	Min.	Max.	Std. dev.	Mean	Min.	Max.	Std. dev.
April-June	258.33	0	500	176.88	304.17	100	500	157.33
July-Sept	316.67	50	800	247.10	366.67	100	1000	310.67
Octo-Dece	254.17	0	500	123.32	261.11	0	500	165.41
Jan-March	423	0	1200	470.15	311.67	0	1200	344.43

The percent distribution of nursery and stock ponds according to quantity of lime (g/decimal) used during different periods of the year is given in Table 49 and Table 50, respectively. As evident from the results that most of the nursery ponds used lime at the rate less than 500 g/decimal in all seasons (Table 48). Again, in case of stock ponds, a similar trend in lime is also evident from the results (Table 49).

Table 49. Percent distribution of nursery ponds according to quantity (g/decimal) of lime used in different periods of the year.

Amount of lime (g/decimal)	**Apr-Jun, 2012**		**Jul-Sep, 2012**		**Oct-Dec, 2012**		**Jan-Mar, 2013**	
	Number	percent	Number	Percent	Number	percent	Number	percent
Less than 500 g	18	75	18	75	22	91.67	12	60
Between 500 g & <1000 g	6	25	6	25	2	8.33	2	10
More than 1000 g	-	-	-	-	-	-	6	30
Total	24	100	24	100	24	100	20	100

Table 50. Percent distribution of stock ponds according to rate of liming (g/decimal) in different periods of the year.

Amount of lime /decimal	**Apr-Jun,2012**		**Jul-Sep,2012**		**Oct-Dec,2012**		**Jan-Mar,2013**	
	Number	percent	Number	Percent	Number	percent	Number	percent
Less than 500 g/decimal	8	66.67	9	75	7	77.78	8	66.67
Between 500 g & <1000 gm	4	33.33	1	8.33	2	22.22	3	25
More than 1000 g	-	-	2	16.67	-	-	1	8.33
Total	12	100	12	100	9	100	12	100

Phytoplankton blooms

Information on the observed phytoplankton blooms in nursery and stock ponds during different periods of the year is shown graphically in Fig . 32. The high level blooms in nursery and stock ponds were found to occur in 8- 25% ponds studied, the highest being observed in April-June period and lowest in July –September period . Medium level blooms were found to occur in 33- 77% ponds studied, the highest being observed in January-Mach period and lowest in April-June period. Similarly, low level blooms were found to occur in 14- 50% ponds studied. On the other hand, no blooms were noted in 0-14% ponds (Fig . 32).

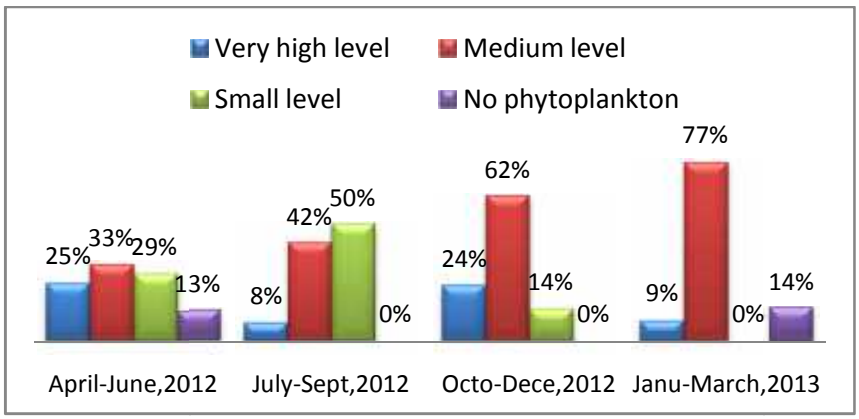

Fig. 32. Observed phytoplankton blooms in sampled nursery and stock ponds

Necropsy results

4.4 Parasitic Infestation

Fish samples belonging to nine species were collected quarterly from nurseries and hatcheries for indentifying metazoan parasites. Of them, only six species were found infected with metazoan parasites. Table 51 shows the names of identified parasites with the intensity of infection and prevalence of their occurrences. Six species of parasites were identified, a single species from each fish species. *Anabas testudineus* was infected with a nematode ,*Histiostrongylus coronatus*, with a prevalence of 9% and intensity of 100, *Pangasius spp.* was infected with a crustacean, *Argulus sp,. with* a prevalence of 25% and an intensity of 0.25, *Labeo rohita* was infected with with *Clinostomum piscidium,* with a prevalence of 20% and an intensity index of 0.5, *Heteropneustes fossilis* was found infected with a *Aurgulas sp. with a prevalence of 14.28% and an intensity index of 100, Puntius spp* was found to be infected with a Digenian spp *prevalence of 16.66% and intensity 0.5, Gonia spp.* was found infected with a *Clinostomum complanatum* parasite with a *prevalence of 50.00% and an intensity 100.*

Table 51. Fish parasites and its observed prevalence in nurseries and stock ponds in the study area.

Name of Fish species	Organs	No. of Fish examined	No. of infected Fish	Prevalence	Total no. of collected parasite	Name of parasite	Intensity
Anabas testudineus	Gill Gut	11	1	9.00	0 1	- *Histiostrongylus coronatus*	100
Pangasius pangasius	Gill Gut	16	4	25.00	1 0	*Argulus spp.*	0.25
Labeo rohita	Gill Gut	10	2	20.00	0 1	- *Clinostomum piscidium*	0.5
Heteropneustes fossilis	Gill Gut	7	1	14.28	1 0	*Aurgulas spp.*	100
Puntius sp.	Gill Gut	12	2	16.66	0 1	Digenian sp.	0.5
Labeo gonius	Gill Gut	2	1	50.00	1 0	*Clinostomum complanatum*	100

Information on the occurrences and prevalence of parasites in different observation periods (seasons) are provided in Table 52.

October-December period was found to be most preferred season for the parasites. Prevalence of infection during this period was comparatively high (23.52%), while low prevalence was observed during July- September period (9.09%).

Table 52. Seasonal variations in the intensity of parasitic infection.

Season	**No of examined fish**	**No of infected fish**	**% of infection**	**No. of parasite**
Apr-Jun,12	25	3	12	1
Jul-Sep,12	22	2	9.09	1
Oct-Dec,12	17	4	23.52	2
Jan-Mar,13	12	2	16.67	2

CHAPTER-5
DISCUSSION

5 DISCUSSIONS

The purpose of this section is to critically discuss and evaluate the results obtained from this study with a view to justify the results and arrive at some conclusions. This section also highlights major findings and its implications in controlling fish diseases in nurseries and hatcheries of Bangladesh. The discussion will concentrate mostly on monitoring results and a final comparison with that obtained from preliminary survey results. Monitoring of fish farms mainly focused on three broad areas of study, viz. water quality, occurrences and incidences of disease, and farm operation and management practices. The discussion will mainly focus on these areas.

5.1 Water Quality

Water quality is linked to the occurrences and incidences of diseases in fish ponds in many ways. Poor water poses stresses to fish leading to reduced immunity and increased growth of bacteria, fungus parasitic to fish (Emerson *et al*. 1975; Ingram, 2001; Okoh, 2007). Therefore, documenting the water quality of fish farms were inevitable to understand the ground situation in disease conditions in fish farms and formulating guidelines for controlling diseases in fish farms.

In general, water quality varied highly depending on the water bodies and sampling seasons as reflected in higher standard deviations. The pH values varied from 4.5 to 10.6 (average: 7.57 ± 1.25) in the sampled fish farms. The pH values less than 6.0 reduce growth, reproduction and immunity of fish, and values below 4.5 may cause death to many fish species (Boyd, 1980). It has been observed that in many ponds pH values were in the range of 4.5 to 5.5 which is unsuitable for fish culture and considered very stressful leading to fish diseases. The observed disease intensities were also high in these fish farms. The observed low pH in fish farms probably originated from decomposition of uneaten feed or from acidsulfate soils (Alabaster and Lyod, 1982) which is prevalent in some areas of the North-central region. Low pH levels in environment enhance the susceptibility of fish to various diseases. (Rand and Petrocelli, 1985). However, organic ligands in may reduce the low pH toxicity. The higher pH levels exceeding 10.0 observed in some ponds probably occurred due to monitoring water quality immediate after liming of ponds.. Liming of ponds increases pH levels (Boyd, 1980).

The dissolved oxygen levels also varied highly between individual ponds and among sampling seasons. The levels varied from 3.1 to 12.0 mg/l (average: 5.91 ± 2.49 mg/l) in the sampled ponds. The lower DO concentrations observed in some ponds is much lower than the level suggested for carp culture (Boyd, 1980). The observed lower DO contents is likely to affect the fish growth and survivality and may lead to increased infections by bacteria, fungi and parasites (Ingram, 2001). The low level of DO contents signify the presence of organic load and its

decomposition. Therefore, the observed low DO contents thus probably resulted from decomposition of uneaten feed and observed phytoplankton bloom.

The alkalinity and hardness levels observed in both nursery and stock ponds are within the range of aquaculture purpose. The levels of alkalinity ranged from 21.0 to 160 mg/l with an average of 33.67 mg/l ± 34.43 mg/l. In case of hardness, the levels varied between 31.0-150 mg/l (average: 45.41 ± 22.12 mg/l). The observed alkalinity and hardness levels are within the range of 20-120 mg/l are suitable for culture of tropical fish (Boyd. 1980). However, exceedingly high values were measured in few ponds only during the April-June period. The reason is not understood. However, it seems the particular pond was probably limed immediate before sampling. There was no appreciable differences in alkalinity and hardness concentrations between nursery and stock ponds.

The total ammonia levels were measured very high in many ponds under stuy. Ammonia concentrations fluctuated between 0.2-3.0 mg/l with an average of 1.06 ±0.89 mg/l. A concentrations of >1.0 mg/l and 0.>05 mg/l unionized ammonia known to have lethal and sub-lethal effects., respectively (Emerson et al., 1975). However, the present case total ammonia was measured which is less toxic. Nonetheless, the observed levels too high for fish ponds and would have adverse impacts on survival, growth and immunity of fish (Alabaster and Lyod, 1980). Ammonia is an intermediary breakdown products of organic molecules, particularly that of proteins (Rand and Petrocelli, 1985). The high levels of ammonia concentrations signify the organic build up in the ponds (Boyd, 1980), probably arising from excessive and uneaten feed. The ammonia level was found appreciably higher in stock ponds than that in nursery ponds. These differences could be related to observed less water exchanges in stock ponds.

Nitrite levels in ponds varied from 0.01 to 0.6 mg/l with an average of 0,13 ± 0.14 mg/l. Nitrite is highly toxic and a concentration of 0.01 mg/l may adversely affect the fish and may predispose fish to disease (Hasan, 1986). While the levels were found near or within the acceptable range for fish culture, in some ponds, the levels were exceedingly high which contributed to higher average concentration. As with ammonia, nitrite is also an intermediary breakdown products of organic matters and results from incomplete breakdown of organic molecules. Therefore, the observed nitrite levels could have been originated from feed used and ammonia excretion from fish itself.

The water quality parameters showed appreciable variations within the sampling areas. This probably reflects the soil quality within the areas and different husbandry practices in different sampling areas. Differences in feeding and other practices were observed in different sampling areas. Similarly, differences in feeding regime differed among different seasons. These factors might have contributed to the observed differences to some extent.

It was observed that some ponds were stocked with exceedingly high densities and consequently more feed was applied and frequent feeding was done. The application of more feed probably resulted in the build up of ammonia and nitrite through break down of the organic feed. The high biomass in the culture ponds resulting from high stocking density probably resulted in the excretion of more ammonia and nitrite from metabolic process (Hasan and Ahmed, 2002).

5.2 Occurrences and Incidences of Fish Diseases

Overall, in case of nursery ponds, only 0-42% fish farms experienced various diseases during the study period. Similarly, in case of stock ponds, the disease incidences varied from 8-33% farms. However, the observed disease incidences were highly influenced by seasons which correspond with operational period of the farms. Hasan and Ahmed (2002) mentioned similar, but albeit, higher incidences of fish diseases in hatchery and nursery conditions in the southwest and north-central regions of Bangladesh. However, higher incidences (61%) of disease were recorded by Hossain *et al.* (1994a). These differences among the authors and the present study could be due to improved treatment and farm management now a days..

The incidences of disease, in both cases, were strongly influenced by seasons which corresponded with the intensity of farm operation. High incidences of disease were observed during April-June period that correspond with the peak period of fry production and raising. High density stocking is done during the period. Mazid and Banu (2002) indicated that high density stocking favours the occurrences and incidences of diseases in fish nurseries and hatcheries. Snieszko (1971) made a similar observation in relation to fish diseases in nurseries. The disease incidences also showed variations among the sampling upazilas. Higher incidences of disease were noted in Kapaia upazila. This could be related to poor management practices in the area as reflected in water quality and feeding regime. In fact, management practice influences the incidences of disease incidences in fish farms (Mazid and Banu, 2002).

All the fish species/groups cultured in the sampled fish ponds were attacked by different diseases. However, diseases were prevalent in carps (rui, catla, mrigel, carpio and others) and in pangas fish. In fact, carp fries more susceptible to diseases (Hossain *et al.*,1994a). The higher incidences of disease could be correlated to intensification of pangas culture in the country (DoF, 2003).

A total of nine disease types, viz. dropsy, tail and fin rot, Gyrodactylosis, white spot, red spot, Argulosis, viral disease, disease of unknown etiology, diseases due to poor water quality, etc., were noted to occur in the sampled ponds. Of them, tail and fin rot, Gyrodactylosis and red spot were more prevalent. Diseases like tail and fin rot, dropsy and Gyrodactylosis were also noted by Hasan and Ahmed (2002) in nurseries and hatcheries in Mymensingh areas. Red spot disease noted

by present authors, resemble to some extent to ulcerative syndrome and bacterial and viral septicemia. Many of the symptoms are probably relate to some protozoan diseases. The incidences of disease occurrences were limited to once or twice within the production period. However,several disease attack mentioned by Mazid and Banu (2002) within a single production cycle. .

Results show that intensities of disease attack observed comparatively lower than that was expected. In about 25% nursery ponds less than 25% fish stock were affected by diseases, a 25-50% stocks of about 9% nurseries were affected by disease. However, a 52% stock ponds had less than 25% infection. Hossain *et al.* (1994) reported an infection of 61% carp fry in nurseries of the Mymensingh area.

Results on mortality show that less than 25% mortality in 25% nursery ponds and same mortality rate was observed in 58% stock ponds. Upto 75% fish mortalities were observed in only 9% nursery ponds only. A 100% fish mortalities in nursery ponds were observed by some authors in some particular ponds, particularly due to protozoan disease(Chandra *et al.*,1996). Present study noticed that fish farmers undertake a number of preventive disease treatment activities. These actions probably contribute to less mortality observed by earlier authors.

Fish farmers in the study area use a number of treatment methods, mainly use of medicine, potash, salt and lime in the ponds and they believe that these chemicals helps in controlling diseases. Discussion with local Fisheries Officers (personal communication) revealed that the application of these chemicals help in controlling fish to some extent. Salt, potash (potassium permanganate) have disease curing properties (Hasan, 1986) and Mohan and Batta (2002).

5.3 Operation and Management Practices in Fish farms

Husbandry practices of fish farms is crucial to controlling diseases in farmed fishes (Mazid and Banu, 2002; Hasan and Ahmed (2002). Major approaches in disease control in fish farm is based mainly on the improved husbandry practices. Therefore, documenting the operation and management of fish farms, vis-à-vis husbandry is important befor formulating guidelines for controlling diseases in fish farms.

The stocking densities in nursery ponds varied from 20 to 20000 fries/fingerlings, which is much higher than the recommended level by BFRI (1991). High stocking density favours disease transmission and disease burden. High stocking density also require high feed inputs, which is likely contribute to pollute the water and intense stress on fish (Hasan and Ahmed, 2002; Mazid and Banu, 2002).

Water is added to ponds to compensate the loss time to time, and as such no real exchanges of water is done. This remains a crucial issue in farm management. The build of toxic substances and pathogens remain in the system.

The poor water quality adversely affect the farm production and disease management (Ingram, 1971; Hasan and Ahmed (2002).

Removal of uneaten fish from the ponds is not done at all. However, uneaten feed are sometimes found in the system and got leached into water resulting deterioration in water quality. The increased ammonia and nitrite levels in pond waters was probably caused by leaching of feed (Boyd, 1980). Similarly, in true sense, no prophylactic measure are taken for disease management. All these signify the poor farm management practices taken by the farmers. It appeared that the farmers are ignorant of the improved farm management practices and also they do not understand the economic benefits of disease management in fish farms.

5.4 Parasitic Infestations

In the present study three species of gill parasites and three species of gut parasite were found. These are represented by one species of nematode (*Histiostrongylus coronatus, t*hree species of digenean trematodes (*Clinostomum complanatum, Clinostomum piscidium and an unidentified digenian parasite*) and one genus crustacean (*Argulus* : 2 unidentified species.).

Mofasshalin*et al.*(2012), identified four protozoan species (*Trichodina* sp., *Ichthyophthirius* sp., *Apiosoma* sp. and *Chilodonella* sp.), two monogenean species (*Gyrodactylus* sp. and *Dactylogyrus* sp.), two crustacean (*Argulus* sp. and *Larnaea* sp.), one digenean (*Fellodistomum* sp.) and one nematoda (*Camallanus* sp.) species from three Indian minor carps (*Labeo bata, Labeo gonius* and *Cirrhinus reba*). In the present investigation *Clinostomum piscidium* has been collected from fish *Labeo rohita(gut)and Clinostomum complanatum* has been collected from fish *Labeo gonius* .

Akhtar (1995) examined the parasite prevalence in some fish species and the calculated prevalences were as follows: *Anabas testudineus* (Gut-9.00%), *Pangasius* sp. (Gill-25%), *Labeo rohita* (Gut-20%), *Heteropneustes fossilis* (Gil-14.28%), *Puntius sp.,* (Gut-16.66%), *Labeo gonius* (Gill-50%). However,the observed preevalences in the present study were much less than that were reported by Akhtar et al. (1995).

Prtozoan parasites contribute considerably to fish mortalities in nurseries in Bangladesh. Chandra *et al*. (1996b) isolated 5 *Myxobolus* species that cause fish moratlty in nursery environment. Hasan and Ahmed (2002) also reported *Myxobolus and Henneyguya* sp from carp fingerlings. Hossain *et al*. (1994a) observed highest fish mortalities in nursery caused by *Trichodina , Myxobolus spp. and Dactylogyrus* spp. The present study did not investigate the occurrence of protozoan infestation due logistical problems. Apparently, it appears strongly that some fish mortalities could have been caused by protozoan parasites.

CHAPTER-6

CONCLUSIONS AND RECOMMENDATIONS

6 CONCLUSIONS AND RECOMMENDATIONS

Critical evaluation of the findings of the present study revealed a number facts that might guide the formulation on disease management options for nursery and hatchery in the country. The facts could be summarized as following conclusions drawn from the present study.

1. Depending on seasons, 0-42% of the studied fish farms experienced disease incidences. While in most cases less than 25% fish population suffered from disease in most (42%) affected fish ponds, however, depending on seasons, upto 75% fish population in diseased ponds are affected. Similarly, up to less than 25% (in 25% ponds) and 75% (in 8.33% affected ponds) fish mortalities were observed. This signify that fish disease is still a problem of considerable magnitude in hatchery and nursery operation in the region.

2. Monitoring of water quality of nursery and stock ponds revealed that in some ponds the water quality parameters are awful. Dissolved oxygen and pH levels were recorded as low as 3.1 mg/l and 4.5, respectively. These levels are far below the recommended levels and likely to affect the survival, growth and fish health with disease burden. Similarly, ammonia and nitrite levels were 3.0 mg/l and 0.6 mg/l, repectively. Both ammonia and nitrite are highly toxic to fish and higher levels observed in this study may directly cause fish mortality. The observed levels are far above the recommended levels for fish culture and likely to adversely affect the survival, growth and reduce immunity resulting in increased disease burden. Ammonia and nitrite are intermediary breakdown products of organic matters and excretion products of animals.

3. The degraded water quality observed in the present study signify the build up of organic matters and probably originated from organic inputs, like feeds. Stocking densities recorded in the nursery and stock ponds, in some cases, were far above the recommended rates for the country. High stocking densities enhance the disease transmission and contribute to toxic ammonia build up. All these result from poor farm management and ignorance about improved farm management.

4. It was observed in this study that water is added to ponds to compensate the loss and thus this should not be considered as water exchanges. The present practice is not adequate for improved farm management.

5. Similarly, prophylactic measures are rarely taken for disease management. As documented a number of farms did not take appropriate measures for disease treatment and thus suffered heavy mortalities.

It is clear from the above that occurrences and incidences of disease in the fish farms were primarily linked to poor management of fish farms, in one hand and on the other hand, the ignorance of the farmers about disease management and lack of understanding about the importance of disease management for farm profitability.

Recommendation

On the basis of the above mentioned conclusions and statement a number of recommendations are put forward for the management of fish diseases in hatcheries and nurseries in Bangladesh. The basis for formulating the options for disease management stemmed from the view of "Prevention of disease is always better than cure."

i. There is strong need for developing a "Farmer's Guideline on Operation and Management of Fish Farms" with emphasis on disease management.

ii. Awareness about the need for disease management in farms should be enhanced and practical training on disease management to farmers should be conducted.

iii. Use of disease resistant variety and stocking of disease free healthy seed should be encouraged.

iv. Stocking density should be kept in a reasonable level; if possible monoculture should be encouraged.

v. Adequate water supply and almost complete exchanges from tubewell source should be ensured

vi Fish fry should be treated with 2.5% NaCl for at least 15 minutes before release in ponds. Fry source water should not be released into ponds.

vii. Proper pond preparation, including drying, liming, etc. should be ensured.

viii. All weed fishes must be removed and excluded from the pond prior to fry release.

ix. Proper and adequate liming of pond should be done periodically and when necessary.

x. Contamination of ponds from any sources should avoided

xi. Plankton blooms and growth of other aquatic vegetation should be controlled.

xii. Balanced and uncontaminated feed should be used. Any uneaten feed must be removed from the ponds once the feeding is done.

xiii. Water quality should be monitored periodically and health monitoring of fish should done regularly to check the early incidences of disease in the pond.

xiv. In case of any disease outbreak, nearby Fisheries Offices should be informed and seek their advice for disease treatment.

xv. Prophylactic measures should be taken as when there is risk for disease outbreak.

CHAPTER-7

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7. REFERENCES

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ANNEXURE

ANNEXURE-1

The list of individual fish farms under the study

The list of individual fish hatchery and nursery names and address.

Si. No.	. Names of Hatchery and Nursery	Union	Upazila	District
1	. Munshi Poultry & Fisheries	Barun	Kapasia	Gazipur
2	. Sumaiya Khamar	Raunat, Durgapur	Kapasia	Gazipur
3	Monjur Hossain Nursery	Rounat	Kapasia	Gazipur
4	Lima Enterprize	Targaon	Kapasia	Gazipur
5	samad fakir Nursery	Targaon	Kapasia	Gazipur
6	Ibrahim Nursery	Targaon	Kapasia	Gazipur
7	Ibrahim Nursery	Barun	Kapasia	Gazipur
8	Badal Nursery	Barun	Kapasia	Gazipur
9	Harun Nursery	Barun	Kapasia	Gazipur
10	Four Brothers Hatchery	Char Kuliamari	Mymensingh Sadar(Shomvogong)	Mymensingh
11	Shapla Hatchery	Raghabpur	Mymensingh Sadar(Shomvogong)	Mymensingh
12	Modhumoti hatchery	Raghabpur	Mymensingh Sadar(Shomvogong)	Mymensingh
13	Rohim hatchery	Raghabpur	Mymensingh Sadar(Shomvogong)	Mymensingh
14	Brahmmoputra Hatchery	Char Kuliamari	Mymensingh Sadar(Shomvogong)	Mymensingh
15	Two Brothers Hatchery	Raghurampur	Mymensingh Sadar(Shomvogong)	Mymensingh
16	Sarkar Hatchery	Raghurampur	Mymensingh Sadar(Shomvogong)	Mymensingh
17	Deshbandhu Hatchery	Raghurampur	Mymensingh Sadar(Shomvogong)	Mymensingh
18	Mukti Hatchery	Raghurampur	Mymensingh Sadar(Shomvogong)	Mymensingh

Si. No.	. Names of Hatchery and Nursery	Union	Upazila	District
19	Bhai Bhai Hatchery	Dhala	Trishal	Mymensingh
20	Asia Hatchery	Dhala	Trishal	Mymensingh
21	Mayer Doa Hatchery	Dhala	Trishal	Mymensingh
22	Al-Hera Fish Hatchery	Dhala	Trishal	Mymensingh
23	Sunflower fish Hatchery	Dhala	Trishal	Mymensingh
24	Nirapod Fish Hatchery	Dhala	Trishal	Mymensingh
25	Basir ahmed Hatchery	Dhala	Trishal	Mymensingh
26	Shapla Hatchery	Dhala	Trishal	Mymensingh
27	Remi Hatchery	Jayerpar	Trishal	Mymensingh
28	wahid Fakir Hatchery	Bouliapara	Trishal	Mymensingh
29	Tafazzal Hatchery	Bouliapara	Trishal	Mymensingh
30	Kobbas Ali Hatchery	Bouliapara	Trishal	Mymensingh
31	Jasim Uddin Hatchery	Bouliapara	Trishal	Mymensingh
32	Monira Fish Hatchery	Bouliapara	Trishal	Mymensingh
33	Abdus Salam Hatchery	Bouliapara	Trishal	Mymensingh
34	Rahman Fisheries	Bouliapara	Trishal	Mymensingh
35	Ramjan ali Fisheries	Dhanikhola	Trishal	Mymensingh
36	Salam Bhuiyan Fisheries	Dhanikhola	Trishal	Mymensingh
37	Sarnalata Fisheries	Radhakanai	Fulbaria	Mymensingh
38	Billal fisheries	Radhakanai	Fulbaria	Mymensingh
39	Fulbaria Agro Services	Radhakanai	Fulbaria	Mymensingh
40	Al-Mojib Fish Hatchery	Kushmail	Fulbaria	Mymensingh
41	forman Ali Fisheries	Kushmail	Fulbaria	Mymensingh
42	Shahjahan Nursery	Kushmail	Fulbaria	Mymensingh
43	Shahidul Fish Hatchery	Ward#7, Fulbaria Pourashava	Fulbaria	Mymensingh
44	Moyna Fish	Bashati	Muktagacha	Mymensingh

Si. No.	. Names of Hatchery and Nursery	Union	Upazila	District
	Hatchery			
45	Shapla Fish Hatchery	Bashati	Muktagacha	Mymensingh
46	Nur Fish Hatchery	Bashati	Muktagacha	Mymensingh
47	Sonali Fish Hatchery	Bashati	Muktagacha	Mymensingh
48	Akonda Fish Hatchery	Bashati	Muktagacha	Mymensingh
49	Ferdous Nursery	Satrasia	Muktagacha	Mymensingh
50	Mojnu Nursery	Satrasia	Muktagacha	Mymensingh

ANNEXURE 1

Questionnaire for Fish Hatchery & Nursery Survey on Fish Disease (Preliminary Survey)

মৎস্য রোগ ও রোগতত্ত্ব বিষয়ে মৎস্য হ্যাচারী ও নার্সারী জরিপ

Section 1. Hatchery/Nursery identification

1.1 হ্যাচারী নং (Hatchery ID): ……..... ☐☐

1.2 থানা কোড (Sub District Code): …… ☐

(Kapasia =1, Mymensing Sadar = 2, Trishal = 3, Fulbaria = 4 & Muktagacha = 5)

1.3 হ্যাচারী / নার্সারীর নাম : (Name of Hatchery/ Nursery):

1.4 অবস্থান (Location): Name of Village/ Para:..... ☐

Location (specify): ..... ☐

Name of Union …… ☐

1.5 তথ্য সংগ্রহের তারিখ (Date of data collection/observation/spot check): ……☐☐/☐☐/☐☐

Section 2. খামারের বিবরণ (Description of Hatchery/ Nursery)

2.1. **খামারটিতে কতদিন ধরে মাছ চাষ শুরু হয় ?** .... **বছর** ☐☐ **মাস** ☐☐

[From how many days have you cultivated fish in the Hatchery/ Nursery ?]

2.2 **খামারের আনুমানিক আয়তন (ডেসিমেল)** [Estimated land area of Hatchery/ Nursery]: ... ☐☐☐☐☐

2.3 **আপনার খামারে কতগুলো পুকুর / বোতল আছে?** [How many Pond be present in your Hatchery?]

2.3.1 **রেনু উৎপাদনে বোতলের সংখ্যা** [Number of Bottle / Circulator]..... ☐☐

2.3.2 **নার্সারী পুকুরের সংখ্যা** [Number of nursery Pond]..... ☐☐

2.3.3 **মজুদ পুকুরের সংখ্যা** [Number of reserve Pond]..... ☐☐

2.4. **আপনার খামারে প্রধানত কোন কোন জাতের মাছের পোনা উৎপাদন করা হয় ?**

[What type of chicken fish does your hatchery mainly produce?]

হ্যাঁ [Yes] 1

না [No] 0

2.4.1 **কার্প (রুই ,কাৎলা, মৃগেল, শরপুটি, সিলভার কার্প, কার্ফু)** [Carp] ..... ☐

2.4.2 **থাই কৈ** [Climbing Fish (Thai Koi)] ..... ☐

2.4.3 **পাঙ্গাস** [Pangash] ..... ☐

2.4.4 **তেলাপিয়া** [Telapia] ..... ☐

2.4.5 **শিং/ মাগুর** [Cat fish] ..... ☐

2.4.6 **পাবদা** ..... ☐

2.4.7 **অন্যান্য (নির্দিষ্ট করে লিখুন)** [Others: specify] ..... ☐

2.4.8 **কোন পোনা উৎপাদন করেনা** [Do not product anything] ..... ☐

Skip Note-1: যদি 2.4.8 নং প্রশ্নের **উত্তর 1** হয়, তবে সরাসরি ***2.8-*** এ যান

[If 2.4.8 is 1, skip to question 2.8]

2.5 **আপনার খামারে বাৎসরিক পোনা উৎপাদনের** পরিমান কত**?**..... ☐

[How many chicken fish does your hatchery produce yearly?]

বাৎসরিক **১ লাখের কম** [<1 lac] 1

বাৎসরিক **১ লাখের বেশী কিন্তু ৫ লাখের কম** [1-<5 lacs]..... 2

বাৎসরিক ৫ লাখের বেশী কিন্তু ১০ লাখের কম [5-<10 Lacs] 3

বাৎসরিক ১০ লাখের বেশী [>10 Lacs]..... 4

2.6 আপনার খামারে পোনা উৎপাদনের সময়কাল কোনটি? [What production period does your hatchery produce fry ?]

সর্বাধিক উৎপাদন কাল [Peak Season] 1
মধ্যম উৎপাদন কাল [Mid level production period] 2
কম উৎপাদন কাল [Low level production period] 3
উৎপাদনহীন কাল [Zero level production period] 4

জানুয়ারী - মার্চ [January-March] ..... ☐

এপ্রিল - জুন [April- June] ..... ☐

জুলাই- সেপ্টেম্বর [July-September] ..... ☐

অক্টোবর - ডিসেম্বর [October-December] ..... ☐

27 আপনার খামারে প্রজোনন কাজে ব্যবহৃত মাছের উৎস স্থান কোনটি? ..... ☐

[Which area is the primary source of fish for fertile fry in your hatchery ?]

নিজস্ব খামারের মাছ [Own Farm]: 1
অন্য কারো খামার থেকে [From others Farm]: 2

2.8 আপনার খামারে চাপের পোনা রাখা হয় কিনা ? ..... ☐

[Do you have preserve chicken fish in your hatchery for support off seasonal need?]

হ্যাঁ [Yes] 1
না [No] 0

Section 3. রোগ-বালাই বিষয়ক তথ্যঃ [Fish Disease Information]

3.1 আপনার খামারে বছরের কোন সময়ে রোগের প্রাদুর্ভাব বেশী হয় ? ..... ☐

[When disease occurrence among the fish of your Hatchery /Nursery pond are very high in year ?]

জানুয়ারী - মার্চ [January-March] 1
এপ্রিল - জুন [April- June] 2

জুলাই -সেপ্টেম্বর [July-September] 3
অক্টোবর - ডিসেম্বর [October-December] 4

3.2 আপনার খামারে সাধারণত কোন রোগে বেশী মাছ মারা যায় ? [প্রশ্নপত্রের শেষে কোডলিষ্ট দেখুন] ..... ☐☐

[In which disease are typically active for death of fish in your Hatchery /Nursery ? see code list at the end]

3.3 **আপনার মতে খামারে মাছের রোগ-বালাই প্রতি বছর বাড়ছে নাকি কমছে ?** .....

[what is your thinking about increase/ decrease the disease incidence in your Hatchery /Nursery ?]

1= **রোগ-বালাই বাড়ছে** [disease increase]
2= **রোগ-বালাই কমছে** [disease decrease]
3= **রোগ-বালাই একই রকম আছে** [Neither increase or decrease]
9= **জানেনা** [Don't Know]

3.4 হ্যাচারীতে ডিম বা রেনু পোনার কোন রকম রোগের আক্রমন হয় কিনা? .....

[Have any disease occurred in your Hatchery among fry?]

হ্যাঁ [Yes.....1

না [No] 0

Skip Note-2: যদি 3.4 নং প্রশ্নের **উত্তর** 0 হয়, তবে সরাসরি ***3.7-*** এ যান

[If 3.4 is 0*, skip to question 3.7]*

3.5 উত্তর হ্যাঁ হলে বছরে কি পরিমানে / কতবার আক্রান্ত হয় ?.....

[If Ans. Is yes then how many occurrence are happened in every year?]

3.6 প্রতিবারে গড়ে কি হারে আক্রান্ত হয় ?.....

[Status of occurrence in percent (%) on an average each time]

0= **মোটেও না** [0%]
1= **২৫% এর কম** [Less than 25%]
2= **২৫% এর বেশী কিন্তু ৫০% এর কম** [More than 25% & Less than 50%]
3= **৫০% এর বেশী কিন্তু ৭৫% এর কম** [More than 50% & Less than 75%]
4= **৭৫% এর বেশী** [More than 75%]

3.7 **নার্সারী পুকুরে পোনা মাছে কি কি ধরণের রোগ/ লক্ষন হয়? (এখানে একাধিক উত্তর গ্রহনযোগ্য।)**

[What type of diseases / Symptoms usually occurred in nursery pond among chicken fish? (Multiple answers is acceptable here)]

হ্যাঁ [Yes].....1

না [No].....**0**

3.7.1 **কোন** রোগ হয় **না** [Do not happen anything].....

3.7.2 **পেটফোলা রোগ** [Dropsy].....

3.7.3 **পাখনা ও লেজ পচাঁ রোগ** [Tail and fin rot] .....

3.7.4 **ছত্রাক রোগ** [Seprolegniasis].....

3.7.5 **ইপিজোয়াটিক আলসারেটিভ রোগ** [E U S].....

3.7.6 **ফুলকাপচাঁ রোগ** [Gill fluke/ Dactylogyriasis] .....

3.7.7 শরীর পচাঁ রোগ [Gyrodactyliasis/ Body fluke] ..... ☐

3.7.8 ট্রাইকোডিনিয়াসিস রোগ [Trycodyniasis] ..... ☐

3.7.9 সাদা দাগ রোগ [White Spot] ……..……. ☐

3.7.10 কালো দাগ রোগ [Black Spot] …… ..... ☐

3.7.11 লাল দাগ রোগ [Red Spot]……..... .. ☐

3.7.12 যক্ষা [Tuberculosis]…….. ☐

3.7.13 উকুন/কাঠ পোকা/হাঁসপোকা [Argulosis]…….. ☐

3.7.14 ভাইরাসজনিত [Virus]…….…….. ☐

3.7.15 অজানা [Unknown]…….…….. ☐

3.7.77 অন্যান্য (নির্দিষ্ট করে লিখুন)? [Other (Specify)……..……..……..... ☐

3.8 নার্সারী পুকুরে এ সমস্ত রোগে বছরে কি হারে পোনা মাছের মৃত্যু হয়? ..... ☐

[Yearly Status of death due to diseases occurrence in percent (%) in nursery pond among chicken fish?

0= মোটেও না [0%]

1= ২৫% এর কম [Less than 25%]

2= ২৫% এর বেশী কিন্তু ৫০% এর কম [More than 25% & Less than 50%]

3= ৫০% এর বেশী কিন্তু ৭৫% এর কম [More than 50% & Less than 75%]

4= ৭৫% এর বেশী [More than 75%]

3.9 আপনার খামারে বছরের কোন সময়ে কোন প্রজাতির মাছ বা পোনা মারা যায় কিনা? ..... ☐

[Have any death due to diseases occurrence in Hatchery/Nursery pond among variety of fish / fry?

হ্যাঁ [Yes] 1

না [No] 0

Skip Note-3: যদি 3.9 নং প্রশ্নের উত্তর 0 হয়, তবে সরাসরি ***4.1-*** এ যান

[If 3.9 is 0*, skip to question 4.1]*

3.10 আপনার খামারে বছরের কোন্ সময়ে কোন্ প্রজাতির মাছ বা পোনা সবচেয়ে বেশী মারা যায় ?

[Seasonal Status of death due to diseases occurrence in Hatchery/Nursery pond among variety of fish / fry?

Quarter	পুকুরের ধরণ (Types of Pond)		
	রেনু পোনার বোটল (Bottle / Circulator)	নার্সারী পুকুর (Nursery Pond)	মজুদ পুকুর (Reserve Pond)
জানুয়ারী - মার্চ [January-March]			
এপ্রিল - জুন [April- June]			
জুলাই -সেপ্টেম্বর [July-September]			

অক্টোবর - ডিসেম্বর [October-December]			

কোডঃ

কার্প (রুই ,কাৎলা, মৃগেল, শরপুটি, সিলভার কার্প, কার্ফু) [Carp] 1
থাই কৈ [Climbing Fish (Thai Koi)] 2
পাঙ্গাস [Pangash] 3
তেলাপিয়া [Telapia] 4
শিং/ মাগুর [Cat fish] 5
পাবদা [Pabda] 6
অন্যান্য (নির্দিষ্ট করে লিখুন) [Others: specify] 7

Section 4.খামার ব্যাবস্থাপনা বিষয়ক তথ্যঃ [Information of Hatchery Management]

4.1 খামার ব্যাবস্থাপনায় নিয়োজিত লোকের পদবি ও সংখ্যা [Designation and Number of personnel of Hatchery /Nursery management]

ব্যাবস্থাপক [Manager] ..... ☐☐

চিকিৎসক [Veteranian / Expert for fish disease control] ..... ☐☐

সাধারণ কর্মী [General worker] ..... ☐☐

অন্যান্য (নির্দিষ্ট করে লিখুন) [Others: specify]..... ☐☐

4.2 খামারের প্রতি শতক পানিতে গড়ে কি পরিমান মাছ বা পোনা রাখা হয় ?

[How many fish / fry are reserved per decimal pond in your Hatchery /Nursery ?]

4.2.1 প্রতি শতক নার্সারী পুকুরে পোনা মাছের পরিমান [Quantity of fry per decimal pond] ..... ☐☐☐☐☐☐

4.2.2 প্রতি শতক মজুদ পুকুরে মাছের পরিমান [Quantity of fish per decimal ond]..... ☐☐☐☐☐☐

4.3 খামারের মাছ বা পোনাকে সাধারণত কি ধরনের খাবার দেয়া হয় ? ..... ☐

[What type of feed usually used in your Hatchery /Nursery ?]

প্যাকেটজাত খাবার [Packet / Prepared Feed] 1

ঘরে তৈরী খাবার (কুড়া/ভুষি/খৈল) [Household Product] 2

অন্যান্য (নির্দিষ্ট করে লিখুন)? [Other (Specify).....7

4.4 **খামারের প্রতি শতক পানিতে মাছ বা পোনাকে সাধারণত কি পরিমান খাবার দেয়া হয় ?**

[How much feed per decimal pond usually used in your Hatchery /Nursery ?]

4.4.1 **প্রতি শতক নার্সারী পুকুরে খাবারের পরিমান** [Amount of feed per decimal pond in gm]… ☐☐☐☐

4.4.2 **প্রতি শতক মজুদ পুকুরে খাবারের পরিমান** [Amount of feed per decimal pond in gm]…. ☐☐☐☐

4.5 **খামারের মাছ বা পোনাকে সাধারণত কতদিন পরপর খাবার দেয়া হয় ?**

[How frequently do you usually give feed for fish / chicken fish in your Hatchery /Nursery ?]

4.5.1 **নার্সারী পুকুরে কত ঘনঘন খাবার দেয়া হয়?** [How frequent provide feed to Nursery pond] ..... ☐

4.5.2 **মজুদ পুকুরে কত ঘনঘন খাবার দেয়া হয়?** [How frequent provide feed to reserve pond] ..... ☐

দৈনিক **একাধিকবার** [More than Once in a day] 1
দৈনিক **একবার** [Once in a day] 2
২/১ দিন পর ১ বার [Once in every 1 / 2 days] 3
সপ্তাহে ১ বার [Once in a week] 4
২সপ্তাহে ১ বার [Once in fortnightly] 5
১৫ দিনের বেশী সময়ে ১ বার [Once in more than 15 days] 6

4.6 **খামারের পুকুরে মাছ বা পোনাকে একবার খাবার দিলে সাধারণত কতদিনে তা শেষ হয় ?** ..... ☐

[How many days usually require for finish the food in your Hatchery /Nursery ?]

[Within days] 1
[Within two / more days].....2

4.7 **আপনার খামারে অন্য কোন প্রানী লালন পালন করেন কিনা ?** ..... ☐

[Do you have cultivate the following plants other than fish in your Hatchery /Nursery pond ?]

হ্যাঁ [Yes] 1
না [No] 0

4.8 **খামারে পুকুরের পানি পাল্টানো হয় কিনা ?** ..... ☐

[Do you have change water of your Hatchery /Nursery ?]

হ্যাঁ [Yes] 1
না [No] 0

Skip Note-4: যদি 4.8 নং প্রশ্নের **উত্তর** 0 হয়, তবে সরাসরি ***4.11-*** এ যান

[If Ans. Of ques. 4.8 is 0*, skip to question 4.11]*

4.9 **খামারে পুকুরের পানি সাধারণত কোথা থেকে পাল্টানো হয় ?** ..... ☐

[From where do you usually change water of your Hatchery /Nursery ?]

মাটির গভীর থেকে [Underground water] 1
নদী/খাল/হাওড় [Surface water] 2

4.10 সাধারণত কতদিন পরপর খামারে পুকুরের পানি পাল্টানো হয় ?

[Usually how frequently do you maintain to change water of your Hatchery /Nursery ?]

4.10.1 নার্সারী পুকুরে পানি পাল্টানোর ধরণ [Frequency of water change in days]..... ☐☐☐

4.10.2 মজুদ পুকুরে পানি পাল্টানোর ধরণ [Frequency of water change in days]..... ☐☐☐

4.11 আপনার মতে খামারে পুকুরের পানির গুনাগুন নষ্ট হয় কিনা ? ..... ☐

[Do you think the quality of water of your Hatchery /Nursery fallen in awful?]

হ্যাঁ [Yes] 1
না [No] 0

4.12 আপনি কিভাবে বুঝতে পারেন যে খামারে পুকুরের পানির গুনাগুন নষ্ট হয়েছে ? (একাধিক উত্তর গ্রহনযোগ্য।)

[How do you guess the quality of water of your Hatchery /Nursery fallen in awful?] (Multiple answers is acceptable here)

হ্যাঁ [Yes] 1
না [No] 0

পানির রং পরিবর্তন হলে [when the water of pond discolored] ..... ☐

পানিতে দুর্গন্ধ পেলে [when the water of pond spread bad smell]..... ☐

অন্যান্য (নির্দিষ্ট করে লিখুন) [Others: specify]..... ☐

4.13 আপনার খামারে মাছ বা পোনার রোগ হলে কি ধরণের ব্যাবস্থা / চিকিৎসা গ্রহন করেন ? (একাধিক উত্তর গ্রহনযোগ্য।)

[What type of strategy or treatment do you usually take when disease occurred of your Hatchery /Nursery ?] (Multiple answers is acceptable here)

হ্যাঁ [Yes] 1
না [No] 0

মৎস্য কর্মকর্তার পরামর্শ গ্রহন করি (Take suggestion from fishery officer) ..... ☐

ভেটেরিনিয়ান ডাক্তারের চিকিৎসা গ্রহন করি (received treatment from veterinian)..... ☐

বাজারের দোকান থেকে ঔষধ কিনে ব্যাবহার করি (Use medicine from market)..... ☐

পুকুরে চুনা ব্যাবহার করা হয় (use $CaCo_3$ of Hatchery /Nursery pond) ..... ☐

অন্যান্য (নির্দিষ্ট করে লিখুন) [Others: specify]..... ☐

4.14 **আপনার খামারে/ নার্সারীতে কোন ধরণের প্রতিষেধক ঔষধ ব্যবহার করেন কিনা ?** ..... ☐

[Do you have use any Preventive measure in your hatchery?

হ্যাঁ [Yes] 1
না [No] 0

4.15 **আপনার খামারে ঔষধ/ কীটনাশক ব্যবহার বাড়ছে নাকি কমছে ?** ..... ☐

[what is your thinking about increase/ decrease the use of Insecticide in your Hatchery /Nursery ?]

1= **কীটনাশক ব্যবহার বাড়ছে** [use of Insecticide increase]
2= **কীটনাশক ব্যবহার কমছে** [use of Insecticide decrease]
3= **কীটনাশক ব্যবহার একই রকম আছে** [Neither increase or decrease]
9= **জানেনা** [Don't Know]

4.16 **আপনার খামারের পুকুরে চুন ব্যাবহার করা হয় কিনা ?** ..... ☐

[Do you have use $CaCo_3$ of your Hatchery /Nursery pond ?]

হ্যাঁ [Yes] 1
না [No] 0

Skip Note-5: যদি 4.16 নং প্রশ্নের **উত্তর** 0 হয়, তবে সরাসরি ***4.19-*** এ যান
[If Ans. Of ques. 4.16 is 0*, skip to question 4.19]*

4.17 **আপনার খামারের পুকুরে কতদিন পরপর চুন ব্যাবহার করা হয় ?** ..... ☐

[How frequently do you have use $CaCo_3$ of your Hatchery /Nursery pond ?]

সপ্তাহে ১ বার [Once in week] 1
পনের দিনে ১ বার [Once in 15 days] 2
মাসে ১ বার [Once in month]..... 3
২ মাসে অন্তত ১ বার [Once in every two month] 4
৬ মাসে অন্তত ১ বার [Once in every 6 month] 5

4.18 **খামারের প্রতি শতক পানিতে সাধারণত কি পরিমান চুন দেয়া হয় ?**

[How much $CaCo_3$ per decimal pond usually used in your Hatchery /Nursery ?]

4.18.1 **প্রতি শতক নার্সারী পুকুরে চুনের পরিমান** [Amount of $CaCo_3$ per decimal pond in gm] ☐☐☐☐

4.18.2 **প্রতি শতক মজুদ পুকুরে চুনের পরিমান** [Amount of $CaCo_3$ per decimal pond in gm] ☐☐☐☐

4.**19** **খামারের পুকুরে শৈবালের আধিক্য দেখা দেয় কিনা ?** ..... ☐

[Have any extra phytoplankton of your Hatchery /Nursery pond ?]

হ্যাঁ [Yes] 1
না [No] 0

Skip Note-6: যদি 4.19 নং প্রশ্নের **উত্তর** 0 হয়, তবে সাক্ষাতকার গ্রহন এখানেই শেষ করুন ।
[If Ans. Of ques. 4.19 is 0*, then stop data collection]*

4.20 **খামারের পুকুরে বছরের কোন সময়ে শৈবালের আধিক্য দেখা দেয় ?** .....

[When the phytoplankton of your Hatchery /Nursery pond are very high in year ?]

জানুয়ারী - মার্চ [January-March] 1
এপ্রিল- জুন [April- June] 2

জুলাই -সেপ্টেম্বর [July-September] 3
অক্টোবর - ডিসেম্বর [October-December] 4

Name of Data Collector: **Signature:**
Date:

Continued …

ANNEXURE 2 (b) Code list for disease identification

Code #	রোগ [Disease]	প্রজাতি [Fish Category]	লক্ষন [Symptoms]
01	পেটফোলা রোগ [Dropsy]	রুই জাতীয় মাছ, শিং,মাগুর ও পাঙ্গাস মাছ।	১).মাছের দেহের রং ফ্যাকাশে হয়ে যায় এবং পানি সঞ্চালনের মাধ্যমে পেট ফুলে যায়। ২). মাছ ভারসাম্যহীন ভাবে চলাচল করে এবং পানির ওপর ভেসে থাকে।
02	পাখনা ও লেজ পচাঁ রোগ [Tail and fin rot]	রুই জাতীয় মাছ, শিং,মাগুর ও পাঙ্গাস মাছ।	১).প্রথমিকভাবে পিঠের পাখনা এবং ক্রমান্বয়ে অন্যান্য পাখনা আক্রান্ত হয়।
03	ছত্রাক রোগ [Seprolegniasis]	রুই জাতীয় মাছ এবং অন্যান্য চাষযোগ্য মাছ।	১).আক্রান্ত মাছের ক্ষতস্থানে তুলার ন্যায় ছত্রাক দেখা দেয়।
04	ইপিজোয়াটিক আলসারেটিভ রোগ [E U S]	শোল, গজার, টাকি, পুটি, বাইম, কৈ, মেনি, মৃগেল, কার্ফু এবং তলায় বসবাসকারী মাছ।	১). মাছের মাংসপেশী আক্রান্ত হয়।
05	ফুলকাপচাঁ রোগ [Gill fluke/ Dactylogyriasis]	মৃগেল,শোল, টাকি ও মাগুর জাতীয় মাছ।	১). মাছের শ্বাসরুদ্ধকর পরিস্থিতির সৃষ্টি করে, অস্থিরতার সাথে লাফালাফি করে। ২). ফুলকার উপর স্বচ্ছ ঝিল্লি আবরণ তৈরী কওে এবং কখনও কখনও রক্তক্ষরণ ঘটায়।
06	শরীর পচাঁ রোগ [Gyrodactyliasis/ Body fluke]	মৃগেল,শোল, টাকি ও মাগুর জাতীয় মাছ।	১). চামড়ার উপর ক্ষতের সৃষ্টি করে। ২). মাছ খাবার খেতে অনিহা প্রকাশ করে। ৩). মাছের দেহে অবসন্নতা দেখা দেয় এবং এলোমেলো সাতরাতে থাকে ও লাফাতে থাকে।
07	ট্রাইকোডিনিয়াসিস রোগ [Trycodyniasis]	রুই,মৃগেল ও গ্রাসকার্প	১). ফুলকার ওপর প্রথমে হালকা হলুদ রংয়ের গুটি দেখা দেয় এবং ক্রমান্বয়ে বিক্ষিপ্ত রক্তক্ষরণ সহ প্রচুর ঝিল্লি আবরণ সারা ফুলকায় ছড়িয়ে পড়ে।
08	সাদা দাগ রোগ [White Spot]	রুই জাতীয় মাছ এবং মৃগেল ও রুই মাছের পোনা	১). মাছের পাখনা,কান ও দেহের ওপর সাদা দাগ হয়।

			২). মাছের ক্ষুধামন্দা ও দেহের স্বাভাবিক পিচ্ছিলতা কমে যায় / খসখসে হয়ে যায়। ৩). পোনা মাছের আইশ, পাখনাসহ সারাদেহে ক্ষুদ্র সাদা দাগ দেখা দেয়।
09	কালো দাগ রোগ [Black Spot]	রুই জাতীয় পোনা মাছ	১). রুই, মৃগেল ও কাতলা মাছের পোনার দেহের উপরে ক্ষুদ্র ক্ষুদ্র গোলাকার কালো দাগ দেখা দেয়।
10	ভিটামিনের অভাব এবং অপুষ্টি রোগ	চাষযোগ্য যেকোন মাছ।	১). মাছের অন্ধত্ব ও হাড় বাঁকা হয়ে যায়। ২). মাছের ক্ষুধামন্দা, স্নায়ু দুর্বলতা,রক্তশুন্যতা দেখা দেয় এবং ত্বক ও ফুরকার ওপর ক্ষতের সৃষ্টি হতে পারে।
11	লাল দাগ রোগ [Red Spot]		
12	যক্ষা [Tuberculosis]		
13	উকুন/কাঠ পোকা/হাঁসপোকা [Argulosis]		
14	ভাইরাসজনিত [Virus]		
15	অজানা [Unknown]		

ANNEXURE 3

Questionnaire for Surveillance for Fish Disease among Fish Hatchery & Nursery (Monitoring)

মৎস্য রোগ ও রোগতত্ত্ব বিষয়ে মৎস্য হ্যাচারী ও নার্সারী সার্ভেলেন্স

Section 1. Hatchery/Nursery identification

1.1 রাউন্ড নং (Cycle No.): ..... ☐

এপ্রিল- জুন, ২০১২ [April- June,2012].....1

জুলাই-সেপ্টেম্বর,২০১২ [July-September,2012].....2

অক্টোবর- ডিসেম্বর'১২ [October -December, 2012] 3

জানুয়ারী- মার্চ '১৩ [January -March, 2013] 4

1.2 হ্যাচারী নং (Hatchery ID):..... ..... ☐☐

1.3 থানা কোড (Sub District Code) ..... ☐

(Kapasia = 1, Mymensingh Sadar = 2, Trishal = 3, Fulbaria = 4 & Muktagacha = 5)

1.4 **হ্যাচারী / নার্সারীর নাম :** (Name of Hatchery/ Nursery):

1.5 **অবস্থান** (Located): Name of Village/ Para: .....

Location (specify): .....

Name of Union ……

1.6 **তথ্য সংগ্রহের তারিখ** (Date of data collection/observation/spot check): ☐☐/☐☐/☐☐

Section 2. রোগ-বালাই বিষয়ক ত্রৈ-মাসিক তথ্যঃ [Quarterly Disease Information]

2.1 পুকুরের ধরণ **[Type of Pond]** ..... ☐

ডিম বা রেনু পোনার বোটল [Bottle / Circulator Tank].....1
নার্সারী পুকুর [Nursery Pond].....2
মজুদ পুকুর [Reserve Pond].....3
চাপের পোনার পুকুর [preserve chicken fish] 4

2.2 পুকুরের আইডি নম্বর **[Pond ID]** ..... ☐☐☐☐

2.3 **খামারের পুকুরটিতে বর্তমানে কোন জাতের মাছ / মাছের পোনা আছে ?**..... ☐☐

[What type of Fish / fry are available in your pond at the present?]

কার্প (রুই, কাৎলা, মৃগেল, শরপুটি, সিলভার কার্প, কার্প) [Carp]..... 01

থাই কৈ [Climbing Fish (Thai Koi)] 02

পাঙ্গাস [Pangash]..... 03

তেলাপিয়া [Telapia] 04

শিং/ মাগুর [Cat fish] 05

অন্যান্য (নির্দিষ্ট করে লিখুন) [Others: specify] 77

কোন মাছ / পোনা নাই [Empty] 99

2.4 **খামারের পুকুরটিতে** গত তিন মাসে কোন প্রকার রোগের আক্রমন হয়েছিল কিনা? ..... ☐

[Have any disease occurred in the pond of your Hatchery during last three month ?]

হ্যাঁ [Yes] 1

না [No] 0

Skip Note-1: যদি 2.4 নং প্রশ্নের **উত্তর** 0 হয়, তবে সরাসরি ***2.10-*** এ যান

[If 2.4 is 0*, skip to question 2.10]*

2.5 **খামারের পুকুরটিতে** গত তিন মাসে **কোন কোন ধরণের রোগ/ লক্ষন দেখা দিয়েছিল ? (এখানে একাধিক উত্তর গ্রহনযোগ্য।)**

[What type of diseases/ Symptoms occurred in the pond of your Hatchery during last three months ? (Multiple answers is acceptable)]

হ্যাঁ [Yes].....1

না [No].....**0**

2.5.1 **কোন** রোগ হয়নি [Did not happen anything] ☐

2.5.2 **পেটফোলা রোগ** [Dropsy] ☐

2.5.3 **পাখনা ও লেজ পচাঁ রোগ** [Tail and fin rot] ☐

2.5.4 **ছত্রাক রোগ** [Seprolegniasis] ☐

2.5.5 **ইপিজোয়াটিক আলসারেটিভ রোগ** [E U S] ☐

2.5.6 **ফুলকাপচাঁ রোগ** [Gill fluke/ Dactylogyriasis] ☐

2.5.7 **শরীর পচাঁ রোগ** [Gyrodactyliasis/ Body fluke] ☐

2.5.8 **ট্রাইকোডিনিয়াসিস রোগ** [Trycodyniasis] ☐

2.5.9 **সাদা দাগ রোগ** [White Spot] ……..…… ☐

2.5.10 **কালো দাগ রোগ** [Black Spot] …….. ☐

2.5.11 **লাল দাগ রোগ** [Red Spot]…….. ☐

2.5.12 **যক্ষা** [Tuberculosis]…….. ☐

2.5.13 **উকুন/কাঠ পোকা/হাঁসপোকা** [Argulosis]…….. ☐

2.5.14 **ভাইরাসজনিত** [Virus]…….…….……. ☐

2.5.15 **অজানা** [Unknown]…….…….……. ☐

2.5.77 **অন্যান্য (নির্দিষ্ট করে লিখুন)?** [Other (Specify)……..…….....☐

2.6 **খামারের পুকুরটিতে** গত তিন মাসে কতবার রোগের আক্রমন হয়েছিল **?**……..…….. ☐

[How many occurrence are happened during the last three months?]

2.7 প্রতিবারে গড়ে কি হারে আক্রান্ত হয়েছিল?……..…….. ☐

[Status of diseases occurrence in percent (%) on an average each time]

0= **মোটেও না** [0%]

1= **২৫% এর কম** [Less than 25%]

2= **২৫% এর বেশী কিন্তু ৫০% এর কম** [More than 25% & Less than 50%]

3= **৫০% এর বেশী কিন্তু ৭৫% এর কম** [More than 50% & Less than 75%]

4= **৭৫% এর বেশী** [More than 75%]

2.8 **খামারের পুকুরটিতে এ সমস্ত রোগে** গত তিন মাসে **কি হারে মাছ / মাছের পোনা মারা গিয়েছিল ?** …….☐

[Quarterly Status of death due to diseases occurrence in percent (%) in the pond of your Hatchery]

0= **মোটেও না** [0%]

1= **২৫% এর কম** [Less than 25%]

2= **২৫% এর বেশী কিন্তু ৫০% এর কম** [More than 25% & Less than 50%]

3= **৫০% এর বেশী কিন্তু ৭৫% এর কম** [More than 50% & Less than 75%]

4= **৭৫% এর বেশী** [More than 75%]

Skip Note-2: যদি 2.8 নং প্রশ্নের **উত্তর** 0 হয়, তবে সরাসরি ***2.10-*** এ যান

[If 2.8 is 0*, skip to question 2.10]*

2.9 **খামারের পুকুরটিতে** গত তিন মাসে **কোন রোগে বেশী মাছ / মাছের পোনা মারা গিয়েছিল?** .....☐☐

[প্রশ্নপত্রের শেষে কোডলিষ্ট দেখুন] [In which disease are typically active for death of fish in your Hatchery /Nursery pond during the last three months?] [see code list at the end]

2.10 **আপনার মতে খামারের পুকুরটিতে মাছের রোগ-বালাই আগের তুলনায় বাড়ছে নাকি কমছে ?** .....☐

[what is your thinking about increase/ decrease the disease incidence in your Hatchery /Nursery pond ?]

1= **রোগ-বালাই বাড়ছে** [disease increase]

2= **রোগ-বালাই কমছে** [disease decrease]

3= **রোগ-বালাই একই রকম আছে** [Neither increase or decrease]

9= **জানেনা** [Don't Know]

Section 3.খামার ব্যাবস্থাপনা বিষয়ক তথ্যঃ [Information of Hatchery Management]

3.1 **খামারের পুকুরটিতে (প্রতি শতকে)** গত তিন মাসে **গড়ে কি পরিমান মাছ বা পোনা রাখা ছিল ?** ☐☐☐☐☐☐

[How many fish / fry were reserved per decimal pond in your Hatchery /Nursery pond during the last three months?]

3.2 **খামারের পুকুরটিতে** গত তিন মাসে **মাছ বা পোনাকে সাধারণত কি ধরনের খাবার দেয়া হত ?** ……..…..…..☐

[What type of feed usually used in your Hatchery /Nursery pond during the last three months?]

প্যাকেটজাত খাবার [Packet / Prepared Feed] ……..……..……..1

ঘরে তৈরী খাবার (কুড়া/ভুষি/খৈল) [Household Product] ……..……..2

অন্যান্য (নির্দিষ্ট করে লিখুন)? [Other (Specify)……..…….7

3.3 **খামারের পুকুরটিতে (প্রতি শতকে)**গত তিন মাসে **মাছ বা পোনাকে গড়ে কি পরিমান খাবার দেয়া হত ?** ☐☐☐☐

[How much (**in gm**) feed per decimal pond usually used in your Hatchery /Nursery pond during the last three months?]

3.4 **খামারের পুকুরটিতে** গত তিন মাসে **মাছ বা পোনাকে কতদিন পরপর খাবার দেয়া হত ?** ……..…..☐

[How frequently did you give feed for fish / chicken fish in your Hatchery /Nursery pond during the last three months?]

দৈনিক **একাধিকবার** [More than Once in a day] ……. …..1

দৈনিক **একবার** [Once in a day] ……. …..2

২/১ দিন পর ১ বার [Once in every 1 / 2 days] ……. …..3

সপ্তাহে ১ বার [Once in a week] ……. …..4

২সপ্তাহে ১ বার [Once in fortnightly] ……. …..5

১৫ দিনের বেশী সময়ে ১ বার [Once in more than 15 days] ……. …..6

3.5 **খামারের পুকুরটিতে** গত তিন মাসে **মাছ বা পোনাকে একবার খাবার দিলে কতদিনে তা শেষ হত ?** ……..…..☐

[How many days usually require for finish the food in your Hatchery /Nursery pond during the last three months?]

[Within days] ……..1
[Within two / More days]……..2

3.6 **খামারের পুকুরটিতে** গত তিন মাসে **একবারও পানি পাল্টানো হয়েছিল কিনা ?** ……..…..…..☐

[Do you have change water of your Hatchery /Nursery pond during the last three months?]

হ্যাঁ [Yes] ……. 1
না [No] ……. 0

Skip Note-3: যদি 3.6 নং প্রশ্নের **উত্তর** 0 হয়, তবে সরাসরি ***3.9-*** এ যান

[If 3.6 is 0*, skip to question 3.9]*

3.7 **খামারের পুকুরটিতে** গত তিন মাসে **কতবার পানি পাল্টানো হয়েছিল ?** ..... ☐

[what frequency did you maintain to change water of your Hatchery /Nursery pond during the last three months?]

গত তিন মাসে **একবার** [Once]..... 1
গত তিন মাসে **২/৩ বার** [2/3 times] 2
গত তিন মাসে **৩ বারের বেশী** [More than 3 times] 3

3.8 **খামারের পুকুরটিতে** গত তিন মাসে **কোথা থেকে পানি পাল্টানো হয়েছিল ?** ..... ☐

[From where did you change water of your Hatchery /Nursery pond during the last three months?]

মাটির গভীর থেকে [Underground water] 1
নদী/খাল/হাওড় [Surface water] 2

3.9 **খামারের পুকুরটিতে** গত তিন মাসে **পানির গুনাগুন নষ্ট হয়েছিল কিনা ?** ..... ☐

[Do you think the quality of water of the Hatchery /Nursery pond fallen in awful during the last three months?]

হ্যাঁ [Yes] 1
না [No] 0

Skip Note-4: যদি 3.9 নং প্রশ্নের **উত্তর** 0 হয়, তবে সরাসরি ***3.11-*** এ যান

[If 3.9 is 0*, skip to question 3.11]*

3.10 **আপনি কিভাবে বুঝতে পেরেছিলেন যে পুকরটির পানির গুনাগুন নষ্ট হয়েছিল ? (একাধিক উত্তর গ্রহনযোগ্য।)**

[How did you guess the quality of water of the pond was fallen in awful?] (Multiple answers is acceptable here)

হ্যাঁ [Yes] 1
না [No] 0

পানির রং পরিবর্তন হয়েছিল [water of the pond was discolored] ..... ☐

পানিতে দুর্গন্ধ হয়েছিল [water of the pond spread bad smell]..... ☐

অন্যান্য (নির্দিষ্ট করে লিখুন) [Others: specify]..... ☐

3.11 গত তিন মাসে **খামারের পুকুরটিতে মাছ বা পোনার রোগের জন্য কি ধরণের ব্যাবস্থা / চিকিৎসা গ্রহন করেছিলেন ?**

(একাধিক উত্তর গ্রহনযোগ্য।) [What type of strategy or treatment did you taken during the last three months for fish / chicken fish of the pond ?] (Multiple answers is acceptable here)

হ্যাঁ [Yes] 1
না [No] 0

মৎস্য কর্মকর্তার পরামর্শ গ্রহন করেছি (Taken suggestion from fishery officer) ..... ☐

ভেটেরিনিয়ান ডাক্তারের চিকিৎসা গ্রহন করেছি (Received treatment from veterinian)……..☐

বাজারের দোকান থেকে ঔষধ কিনে ব্যাবহার করেছি (Used medicine from market)…….☐

পুকুরে চুনা ব্যাবহার করেছি (Used $CaCo_3$ of Hatchery /Nursery pond) ……..☐

অন্যান্য (নির্দিষ্ট করে লিখুন) [Others: specify]……..☐

3.12 গত তিন মাসে **খামারের পুকুরটিতে কোন ধরণের প্রতিষেধক ঔষধ ব্যবহার করেছিলেন কিনা ?** ……☐

[Did you have used any Preventive measure in the pond of your hatchery during the last three months ?

হ্যাঁ [Yes] 1
না [No] 0

3.13 গত তিন মাসে **খামারের পুকুরটিতে ঔষধ/ কীটনাশক ব্যবহার বাড়ছে নাকি কমছে ?** ……☐

[Status of the use of Insecticide in the pond of your Hatchery /Nursery during the last three months ?]

1= **কীটনাশক ব্যবহার বাড়ছে** [use of Insecticide increase]
2= **কীটনাশক ব্যবহার কমছে** [use of Insecticide decrease]
3= **কীটনাশক ব্যবহার একই রকম আছে** [Neither increase or decrease]
9= **জানেনা** [Don't Know]

3.14 গত তিন মাসে **খামারের পুকুরটিতে চুন ব্যাবহার করেছিলেন কিনা ?** ……☐

[Did you have used any $CaCo_3$ in the pond of your hatchery during the last three months ?

হ্যাঁ [Yes] 1
না [No] 0

Skip Note-5: যদি 3.14 নং প্রশ্নের **উত্তর** 0 হয়, তবে সরাসরি ***3.17-*** এ যান

[If Ans. Of ques. 3.14 is 0*, skip to question 3.17]*

3.15 **খামারের পুকুরটিতে** গত তিন মাসে **কতবার চুন ব্যাবহার করা হয়েছিল ?** ……☐

[How many times did you use $CaCo_3$ in the pond of your Hatchery /Nursery during the last three months?]

গত তিন মাসে **একবার** [Once]..... 1
গত তিন মাসে **২/৩ বার** [2/3 times] 2
গত তিন মাসে **৩ বারের বেশী** [More than 3 times] 3

3.16 **খামারের পুকুরটিতে (প্রতি শতকে)**গত তিন মাসে **কি পরিমান (গ্রাম) চুন দেয়া হয়েছিল ?** ……☐☐☐☐

[How much (**in gm**) $CaCo_3$ did you use per decimal pond in your Hatchery /Nursery during the last three months?]

3.17 গত তিন মাসে **খামারের পুকুরটিতে কি পরিমান শৈবাল দেখা দিয়েছিল ?** ……☐

[How many extra phytoplankton was found in the pond of your Hatchery /Nursery during the last three months ?]

খুব বেশী [Very large amount] 1
মাঝামাঝি [Medium]..... 2
খুবই কম [Less amount] 3

মোটেও না [Did not anything] 4

Name of Data Collector: **Signature:**

Date:

ANNEXURE -3 (continued)

Code list for disease identification

Code #	রোগ [Disease]	প্রজাতি [Fish Category]	লক্ষন [Symptoms]
01	পেটফোলা রোগ [Dropsy]	রুই জাতীয় মাছ, শিং,মাগুর ও পাঙ্গাস মাছ।	১).মাছের দেহের রং ফ্যাকাশে হয়ে যায় এবং পানি সঞ্চালনের মাধ্যমে পেট ফুলে যায়। ২). মাছ ভারসাম্যহীন ভাবে চলাচল করে এবং পানির ওপর ভেসে থাকে।
02	পাখনা ও লেজ পচাঁ রোগ [Tail and fin rot]	রুই জাতীয় মাছ, শিং,মাগুর ও পাঙ্গাস মাছ।	১).প্রথমিকভাবে পিঠের পাখনা এবং ক্রমান্বয়ে অন্যান্য পাখনা আক্রান্ত হয়।
03	ছত্রাক রোগ [Seprolegniasis]	রুই জাতীয় মাছ এবং অন্যান্য চাষযোগ্য মাছ।	১).আক্রান্ত মাছের ক্ষতস্থানে তুলার ন্যায় ছত্রাক দেখা দেয়।
04	ইপিজোয়াটিক আলসারেটিভ রোগ [E U S]	শোল, গজার, টাকি, পুটি, বাইম, কৈ, মেনি, মৃগেল, কার্ফু এবং তলায় বসবাসকারী মাছ।	১). মাছের মাংসপেশী আক্রান্ত হয়।
05	ফুলকাপচাঁ রোগ [Gill fluke/ Dactylogyriasis]	মৃগেল,শোল, টাকি ও মাগুর জাতীয় মাছ।	১). মাছের শ্বাসরুদ্ধকর পরিস্থিতির সৃষ্টি করে, অস্থিরতার সাথে লাফালাফি করে। ২). ফুলকার উপর স্বচ্ছ ঝিল্লি আবরণ তৈরী কওে এবং কখনও কখনও রক্তক্ষরণ ঘটায়।
06	শরীর পচাঁ রোগ [Gyrodactyliasis/ Body fluke]	মৃগেল,শোল, টাকি ও মাগুর জাতীয় মাছ।	১). চামড়ার উপর ক্ষতের সৃষ্টি করে। ২). মাছ খাবার খেতে অনিহা প্রকাশ করে। ৩). মাছের দেহে অবসন্নতা দেখা দেয় এবং

			এলোমেলো সাতরাতে থাকে ও লাফাতে থাকে।
07	ট্রাইকোডিনিয়াসিস রোগ [Trycodyniasis]	রুই,মৃগেল ও গ্রাসকার্প	১). ফুলকার ওপর প্রথমে হালকা হলুদ রংয়ের গুটি দেখা দেয় এবং ক্রমান্বয়ে বিক্ষিপ্ত রক্তক্ষরণ সহ প্রচুর ঝিল্লি আবরণ সারা ফুলকায় ছড়িয়ে পড়ে।
08	সাদা দাগ রোগ [White Spot]	রুই জাতীয় মাছ এবং মৃগেল ও রুই মাছের পোনা	১). মাছের পাখনা,কান ও দেহের ওপর সাদা দাগ হয়। ২). মাছের ক্ষুধামন্দা ও দেহের স্বাভাবিক পিচ্ছিলতা কমে যায় / খসখসে হয়ে যায়। ৩). পোনা মাছের আইশ, পাখনাসহ সারাদেহে ক্ষুদ্র সাদা দাগ দেখা দেয়।
09	কালো দাগ রোগ [Black Spot]	রুই জাতীয় পোনা মাছ	১). রুই, মৃগেল ও কাতলা মাছের পোনার দেহের উপরে ক্ষুদ্র ক্ষুদ্র গোলাকার কালো দাগ দেখা দেয়।
10	ভিটামিনের অভাব এবং অপুষ্টি রোগ[Malnutrition]	চাষযোগ্য যেকোন মাছ।	১). মাছের অন্ধত্ব ও হাড় বাঁকা হয়ে যায়। ২). মাছের ক্ষুধামন্দা, স্নায়ু দুর্বলতা,রক্তশুন্যতা দেখা দেয় এবং ত্বক ও ফুরকার ওপর ক্ষতের সৃষ্টি হতে পারে।
11	লাল দাগ রোগ [Red Spot]		
12	যক্ষা [Tuberculosis]		
13	উকুন/কাঠ পোকা/হাঁসপোকা [Argulosis]		
14	ভাইরাসজনিত [Virus]		
15	অজানা [Unknown]		

ANNEXURE 3 (continued)

Symptoms of diseases

ANNEXURE- 4

Photoplates

Plate 1.A partial view of Shapla Hatchery in Mymensingh Sadar.

Plate 2. A partial view of Nursery pond .

Plate 3. Partial view of a fish hatchery

Plate 4. A partial view of a hatchery in Muktaghacha

Plate 5. Harvesting of fingerlings from nursery ponds

Photoplates: shows facilities of the sampled nurseries and hatcheries

Plate 6. Examining fish for parasite study

Plate7. Monitoring water quality

Photoplates: Shows some research activities

Plate 8 .Histiostrongylus coronatus molin, (from Yamaguti) 1861;female

Plate 9.Clinostomum piscidium

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Photoplates: Some parasites recorded in the present study

Plate 10.Clinostomum companatum (Redrawn after Braun, 1900)

Plate 11. Argulus sp. (Male viewed from above) (drawn)

Plate 12.Pangasius pangasius

Plate 13. *Anabas testudineus*

Plate 14.Pangasius pangasius

Plate 15. *Heteropneustes fossilis*

Photoplates: shows some infected fish collected from nursery and stock ponds

Fig. Photographs of infected fish.