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Competitive Research Grant

Sub-Project Completion Report

on

Study on Quality of Fish Feed, Brood Used and Fingerlings Produced in Commercial Fish Farms of Bangladesh

Project Duration
September 2017 to September 2018

Bangladesh Fisheries Research Forum

Submitted to
Project Implementation Unit-BARC, NATP 2
Bangladesh Agricultural Research Council
Farmgate, Dhaka-1215

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Study on quality of fish feed, brood used and fingerlings produced in commercial fish farms of Bangladesh
Project Implementation Unit
National Agricultural Technology Program-Phase II Project (NATP-2)
Bangladesh Agricultural Research Council (BARC)
New Airport Road, Farmgate, Dhaka – 1215
Bangladesh

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Bangladesh

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Acronyms

AAS	Atomic Absorption Spectrometer
Av.	Average
AOAC	Association of Official Analytical Chemists
BAU	Bangladesh Agricultural University
BDL	Below Detection Limit
Cd	Cadmium
Cu	Copper
%	Percent
Cr	Chromium
DoF	Department Of Fisheries
et al.	Et alia (L), and others
FAO	Food and Agricultural Organization
FRSS	Fisheries Resources Service System
G	Gram
Kg	Kilogram
mg/Kg	Milligram per kg
MS	Masters of Science
Ni	Nickel
N/A	Not applicable (Not provided by manufactures)
Pb	Lead
WHO	World Health Organization
Zn	Zinc

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Executive Summary

In Bangladesh, aquaculture has expanded, diversified, intensified and technologically advanced due to reduction of fish production from natural resources. Quality seed and feed are prime requirements for aquaculture production. Quality of seed depends on the quality of brood used for spawning. Breeding performance depends on the quality of feed and feeding pattern during brood stock management. Therefore, it is necessary to know the quality of fish feed, brood used and fingerlings produced in commercial fish farms of Bangladesh. The present study was focusing on the evaluation of quality of feed (the major ingredients) used in the fish farms, the performance of brood stock and fingerlings of selected Carp, Catfish and Perch farmed in Bangladesh through surveying and conducting several experiments. On the basis of top fish production districts, we divided the whole country into four hubs such as Mymensingh, Jashore, Cumilla and Rajshahi. Data were collected from 300 individual respondents of commercial fish farms located at each hub (75 from each). It has been found that most of the farm owners (91%) are used to use commercial feed instead of homemade feed. Although a considerable number of respondents replied that quality of homemade feed is better than commercial feed and most of the farm owners are using commercial feed instead of homemade feed because of availability and less labor intensive. Moreover, proximate composition of 30 feed of different companies were analyzed. The proximate composition of most of the collected feed samples varied with the declared values of manufacturers. Although most of the farm owners collected fries from private/own hatcheries (69%), a considerable number of grow out farm owners replied that the fries produced in government hatcheries/brood bank, BFRI and river are better than those of private hatcheries in terms of growth performance, disease resistance and survivability. Embryonic and larval development of fish were studied from three different groups of fish (Carp, Catfish and Perch). Several deformities were observed in embryo and larvae of fish collected from the hatcheries where brood stocks were not maintained properly. It is anticipated that quality seed, feed and brood are very essential in order to ensure sustainable and cost effective aquaculture. Therefore, farm owners should be cautious enough in selecting right feed, brood and fingerlings, as well as the appropriate authority should be careful in implementing laws and regulations very strictly in order to ensure the quality of feed, brood and seed.

CRG Sub-Project Completion Report (PCR)

A. Sub-project Description

1. **Title of the CRG sub-project:** Study on quality of fish feed, brood used and fingerlings produced in commercial fish farms of Bangladesh
2. **Implementing organization:** Bangladesh Fisheries Research Forum
3. **Name and full address with phone, cell and E-mail of PI/Co-PI (s):**

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4. **Sub-project budget (Tk):**
   - 4.1 Total: Taka 5000000/= (Taka Fifty Lac Only)
   - 4.2 Revised (if any):
5. **Duration of the sub-project:**
   - 5.1 Start date (based on LoA signed): **12 September 2017**
   - 5.2 End date : **30 September 2018**
6. **Justification of undertaking the sub-project:**

Bangladesh is the land of rivers and is blessed with an extensive biodiversity of fish and fisheries resources. Fisheries play a vital role in nutrition, employment, income generation and foreign exchange earnings. Fisheries sector provides about 60% of the animal protein intake and more than 11% of the total population of the country is directly or indirectly involved in this sector for their livelihoods (DoF, 2013). However, due to the degradation of ecological balance, fish production from natural resources has been declined. Thus aquaculture has expanded, diversified, intensified and technologically advanced in Bangladesh. With the increased intensification and commercialization of aquaculture practice, quality of fish seeds and fish health somehow decreased and became one of the most important issues to aquaculturists (Bondad-Reantaso *et al.,* 2005).

Historically fish farming has been a part time activity of peasant farmer who develop it as an efficient mean of utilizing farm resource to the maximum extent. Indian major Carps, some exotic Carps and Catfishes are the main cultured species for the closed water system and production of these species completely depends on timely and adequate supply of quality seed. Until very recent times, Carp culture in pond remains as the main stay of aquaculture globally including Bangladesh. However, a number of other fish have been added to the species combinations with the expectation of increasing productivity in polyculture pond (Samad *et al.*, 2013). Brood fish is considered as the heart of the hatchery and management of brood stock is the key to quality seed production. Success of induced breeding depends on availability of sufficient number of brood fish. Therefore, broodstock should be maintained scientifically so that mature broods could be obtained during the whole breeding season. Most of the government hatcheries have their own brood stock and around 25 percent recruitments take place in every year. On the other hand, few private hatcheries have their own stock and maintain them more or less scientifically but there are many private hatcheries that do not have the required number of broods. During breeding season, they instantly buy broods from others and produce fry from them to fulfill their target (Sarder, 2002). Moreover, feeds quality is another important issue to maintain good broodstock to get quality seeds.

Quality seed in one of the prime requirements for aquaculture production and business. Quality of seed depends on the quality of brood used for spawning. Breeding performance depends on the quality of feed and feeding pattern during brood stock management. Therefore, it is necessary to know the quality of fish feed, brood used and fingerlings produced in commercial fish farms of Bangladesh. The present study focused on the evaluation of quality of feed (the major ingredients) used in the fish farms, the performance of broodstock and fingerlings of selected Carp, Catfish and Perch farmed in Bangladesh through surveying and conducting several experiments.

7. Sub-project goal:

To provide a comprehensive guideline for enhancing quality seed production using improved quality brood and feed in fish farms and hatcheries of Bangladesh

8. Sub-project objective (s):

1. To evaluate the quality of feed (the major ingredients) used in the fish farms and to assess the performance of broodstock and fingerlings of selected Carp, Catfish and Perch farmed in Bangladesh;

2. To develop a set of principles for the hatchery owners on how to maintain and improve the quality of broodstcok and how to produce fish seed with prime quality that ensure high survival, good growth, and best disease resistance in the grow-out; and

3. To prepare a guideline for the feed producers (manufacturers) and fish feed users (fish farmers & hatchery owners) on using feed ingredients and maintaining quality of feed.

9. Implementing location (s):

Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh.

10. Methedology:

Expt. 1. In depth survey on fish feeds, quality of broodstock & fish seed, their impacts on fish production and Farmers' perception in Bangladesh.

On the basis of top fish production districts, we divided the whole country into four hub, such as Mymensingh (319,421MT), Jashore (1,13,895MT), Cumilla (1,05,726MT) and Rajshahi (46,519MT). Data were collected from 300 individual respondents of commercial fish farms located at Mymensingh, Rajshahi, Jashore and Cumilla (75 from each) regions. Literature review, semi structured questionnaire interview, structured and in-depth interview, and focus group discussions were utilized to assess the current status of commercial fish farms in Bangladesh.

Figure 1. Map of Bangladesh for showing the study areas (Mymensingh, Rajshahi, Cumilla and Jashore).

Expt. 2. Analysis of the proximate compositions and heavy metals of different fish feeds used in the commercial fish farms

Collection and storage of feed samples:

A total of 30 feed (Nursery feed, Hatchery feed, Starter feed, Grower feed and Finisher feed) samples of different feed companies were collected from the study area. All feed samples were collected from feed dealers' shop, retailers and farms. Proximate composition of company feeds were recorded from feed packages and leaflets supplied by respective companies. After collection of feed samples in polythene bags, the samples were kept at 4^{o}C temperature in a refrigerator and later analyzed for proximate composition and heavy metals.

Figure 2. Photographs of feed packages collected from different companies

Proximate composition analysis:

The proximate composition of different commercial and farm-prepared fish feeds used in the commercial fish farms was analyzed in triplicate according to standard procedure given in Association of Official Analytical Chemists (AOAC, 1980).

Moisture

Moisture content was determined by placing an accurately weighed amount (about 2-3g) ground sample in a pre-weighed porcelain crucible in a hot air oven (Gallenkamp, HOTBOX, Model OVB-306) at 105°C for about 24h until a constant weight was obtained. The crucible then transferred to desiccators for cooling and weighed using a sensitive electric balance. The percentage of moisture was calculated using the following equation:

$$\text{Moisture (\%)} = \frac{\text{Original sample weight(g)} - \text{Dried sample weight(g)}}{\text{Original sample weight(g)}} \times 100$$

Ash

Accurately weighed samples (about 2-3 g) were taken in pre-weighing porcelain crucibles and placed in a muffle furnace (Philip Harris Ltd, England), at 550°C for 6 hours. The crucibles were then taken out to cool in a desiccator and weighed using a sensitive electric balance. The percentage of ash was then determined by using following formula:

$$\text{Ash}(\%) = \frac{\text{Weight of crucible with ash}(g) - \text{Weight of empty crucible}(g)}{\text{Weight of sample}(g)} \times 100$$

Crude Protein

Crude protein of the samples was estimated by using Kjeltec2020 digester. A sample of about 0.5g and a blank was estimated in the digestion tube. For digestion 10ml of concentrated sulfuric acid (H_2SO_4) and 1.1g digestion mixture were added in the tube. Then the digestion tubes were set in digestion chamber fixing at 420°C for 45 minutes ensuring water supply, easier gas outlets etc. After digestion the tubes were allowed to cool and 5ml of sodium thiosulphate ($Na_2S_2O_3$) (33%) and 30ml 10N sodium hydroxide (NaOH) solution were added in each tube. Then the distilled extraction was collected with 25ml of boric acid (4%), and then added three drops mixed indicators. In distillation unit from the digestion tube nitrogen in the form of ammonia vapor deposited in the conical flask, the boric acid solution color turned into green. 100 ml extraction was collected. Then it was titrated with standard hydrochloric acid (0.2 N) until the color of the solutions turned into pink. The nitrogen values obtained was converted into percentage of crude protein by multiplying with a factor of 6.25 (for animal source) or 5.87 (for plant source) assuming that protein contains 16% nitrogen or 17% nitrogen, respectively.

$$\text{Nitrogen } (\%) = \frac{\text{Milliequivalent of nitrogen } (0.014) \text{ x titrant value } (\text{ml}) \times \text{strength of HCL}}{\text{Sample weight } (g)} \times 100$$

Crude Protein (%) = Nitrogen (%) × 6.25 or 5.87

Crude Lipid

Crude lipid was determined by extracting a weighed quantity (2-3g) of samples with analytical grade acetone in Ground Joint Soxhlet Apparatus. Extraction was allowed to continue by heating in the electric heater at 70°C temperature until clear acetone (without oil) was seen in siphon, which took about 3 hours. Then the round bottom flask of the apparatus was separated and the extract was transferred to a pre-weighed beaker and left for evaporation of acetone. After the evaporation of acetone, only the lipid was left in the beaker which was later calculated in percentage.

$$\text{Crude Lipid } (\%) = \frac{\text{Weight of beaker with lipid } (g) - \text{Weight of empty beaker } (g)}{\text{Sample weight } (g)} \text{ x } 100$$

Crude fibre

A small amount of finely ground sample (1-2 g) was taken in to a filter crucible and was inserted into the hot extraction until (Hot Extractor, Model-1017). Sufficient amount of pre-heated 0.128M H_2SO_4 was added into the reagent heating system and a few drops of octane were added. The mixture was digested for 30 minutes. Acid was then removed from it by filtering and washing with boiling or distilled warm water. The residues in the flask was boiled with required amount of 0.223M KOH for 30 minutes and then filtered with subsequent washing in boiling distilled water and acetone. The residual content was then dried in an oven at 105°C for a few hours and then ignited in muffle furnace at 500°C for 3 hours. The loss of weight represented the crude fibre. Then percent crude fibre was calculated by the following formula:

$$\text{Crude fibre (\%)} = \frac{\text{Oven dried sample weight (g)} - \text{Ash weight of sample (g)}}{\text{Sample weight (g)}} \times 100$$

Nitrogen free extracts (NFE)

Nitrogen free extract (NFE) which is a soluble carbohydrate was calculated by subtracting the sum of the percentage contents of moisture, lipid, ash, protein and crude fibre from 100.
Nitrogen free extract (NFE) was calculated as:

NFE (%) = {100- (moisture + crude protein + crude lipid + ash + crude fibre) }

Heavy metal analysis:

Some important heavy metal elements (lead, cadmium, copper, chromium, zinc and cadmium) were analyzed in AAS laboratory under the department of Agricultural Chemistry.

Electro-thermal heater digestion

For digestion, exactly 1g of each sample was taken in digestion tube, 10ml of nitric acid and 5ml of Perchloric acid were added. Mixing of those acids, containers were placed in electro-thermal heater at 80°C for 25-30 minutes. After digestion, sample solutions were cooled to room temperature then transferred quantitatively in to acid cleaned 100ml standard volumetric flasks and made up to 100ml with double distilled water and prepared under the same conditions as the calibration standards. Then the digestion was filtered through Whitman filter paper No. 42, and kept in the air tight plastic bottle with proper labeling. Electro thermal digestion was used instead of classical methods because of its shorter time, less acid consumption, and ability to retain volatile compounds in the solutions.

Blank preparation

At each step of the digestion processes of the samples acid blanks (laboratory blank) were done using an identical procedure to ensure that the samples and chemicals used were not contaminated. They contain the same digestion reagents as the real samples with the same acid ratios but without fish sample. After digestion, acid blanks were treated as samples and diluted with the same factor. They were analyzed by atomic absorption spectrophotometry before real samples and their values were subtracted to check the equipment to read only the exact values of heavy metals in real samples. Each set of digested samples had its own acid blank and was corrected by using its blank sample.

Atomic absorption spectroscopy

Flame atomic absorption spectrometer is a very common technique for detecting metals and metalloids in environmental samples. The technique is based on the principle of ground state metals absorbing light at specific wave length. Metal ions in a solution are converted to atomic state by means of a flame. Light of the appropriate wave length is supplied and the amount of light absorbed can be measured against a standard curve. The technique makes use of absorption spectrometry to assess the concentration of an analysis in a sample. It requires a standard with known analytic content to establish the relation between the measured and the analytic concentrations and relies on Beer Lambert's Law (Skoog *et al*., 2005). The sample is converted into atomic vapors by a process known as atomization. The two types of atomizers are continuous and discreet atomizers. In continuous atomizers the sample is fed into the atomizer continuously at a constant rate giving a spectral signal which is constant with time. Atomization methods that are of continuous type are flame, inductively coupled argon plasma and direct current argon plasma. With the discrete atomizers, a measured quantity of a sample is introduced as a plug of liquid or solid. The spectral signal in this case rises to a maximum and then decreases to zero.

Figure 3: AAS used for metal analysis

Sample analysis

Analysis of the heavy metal content of the samples was performed with a flame atomic absorption spectrophotometer (Model Shimadzu AA-7000) using acetylene gas as fuel and air as an oxidizer (Figure 3). Digested samples were aspirated into the fuel-rich air acetylene flame and the metal concentrations were determined from the calibration curves obtained from standard solutions. Each determination was based on the average values of three replicate samples.

Expt. 3. Study of the quality of broods and performance of fingerlings of Carp, Catfish and Perch collected from selected fish farms through examination of their larval and embryonic development

The fertilized egg samples were collected to observe the embryonic development under a dissecting microscope. The experiment was conducted with three treatments, each with three replications. Fertilized eggs of Carp, Catfish and Perch were collected from different selected hatcheries based on maintaining broodstock properly, no broodstock, and has broodstock but not good management which treated as Treatment one (T1), Treatment two (T2), and Treatment three (T3), respectively.

The egg samples were collected randomly from each treatment at every 6 hours interval till hatching. Five eggs from each treatment were observed undergoing embryonic development.

Twenty-four hours after fertilization, when hatching of eggs occurred, the larvae samples were collected at every 12 hours and at every 24 hours interval until yolk sack absorption. Five larvae from each of the treatment were collected and immediately put into distilled water for immediate study under microscope.

Developmental stages were observed under a digital microscope (Olympus CX 41). Then their images were snapped using a microscopic camera (Magnus analytics, Model-MIPS) connected between microscope and computer.

11. Results and discussion:

11.1 Farmers' perception on quality of fish feeds, broodstock & fish seed and their impacts on fish production in Bangladesh

Data were collected from 300 individual respondents of commercial fish farms located at Mymensingh, Rajshahi, Jashore and Cumilla (75 from each) regions to know the farm owner's

perception on the quality of feed, brood and fingerlings.

11.1.1 Scenario of use of feed by farms owners

It was found that most of the farm owners are used to use commercial feed instead of homemade feed (Fig. 4). During the study period, users of commercial and homemade feed were recorded 91% and 9% respectively all over the country. Similar trends were recorded in case of Mymensingh, Rajshahi and Jashore regions. Interestingly, in Cumilla region a remarkable number of farm owners (89%) were using both types of feed. Use of manufactured feed in aquaculture has grown rapidly over the last five years in Bangladesh. More than 1 million tons of commercially formulated feeds and 0.3-0.4 million tons of farm-made feeds were produced in 2012 (Mamum-Ur-Rashin *et al*., 2013).

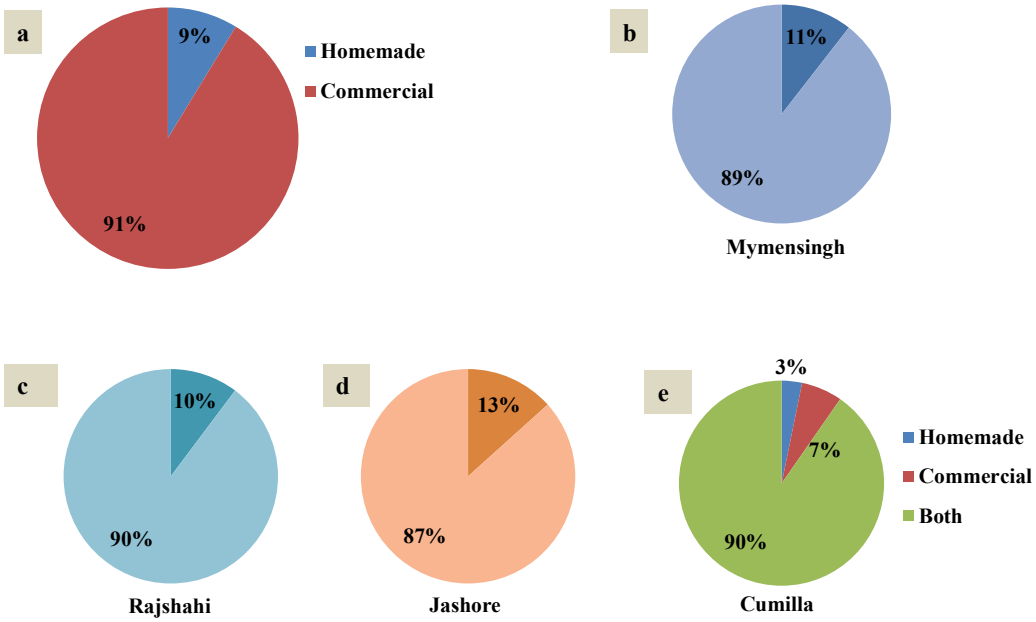

Fig. 4: Scenario of use of feed by farms owners; a) overall country, b) Mymensingh, c) Rajshahi, d) Jessore and e) Comilla region.

11.1.2 Farmers' perception on quality of feed

During the study period, farm owners were asked about the quality of fish feed on the basis of cost, reliability, availability, growth performance, organic origin and labor intensive. A considerable number of respondents replied that the quality of homemade feed is better than commercial feed (Fig. 5a). However, most of the farm owners were using commercial feed instead of homemade feed as because of availability and minimum labor intensive (Fig. 5b). A check list of different fish feeds with their company name used in different regions are presented in Table 1. Around 35 feed companies were found to be involved in supplying fish feed all over the country. The types of feed are variable among different regions of Bangladesh.

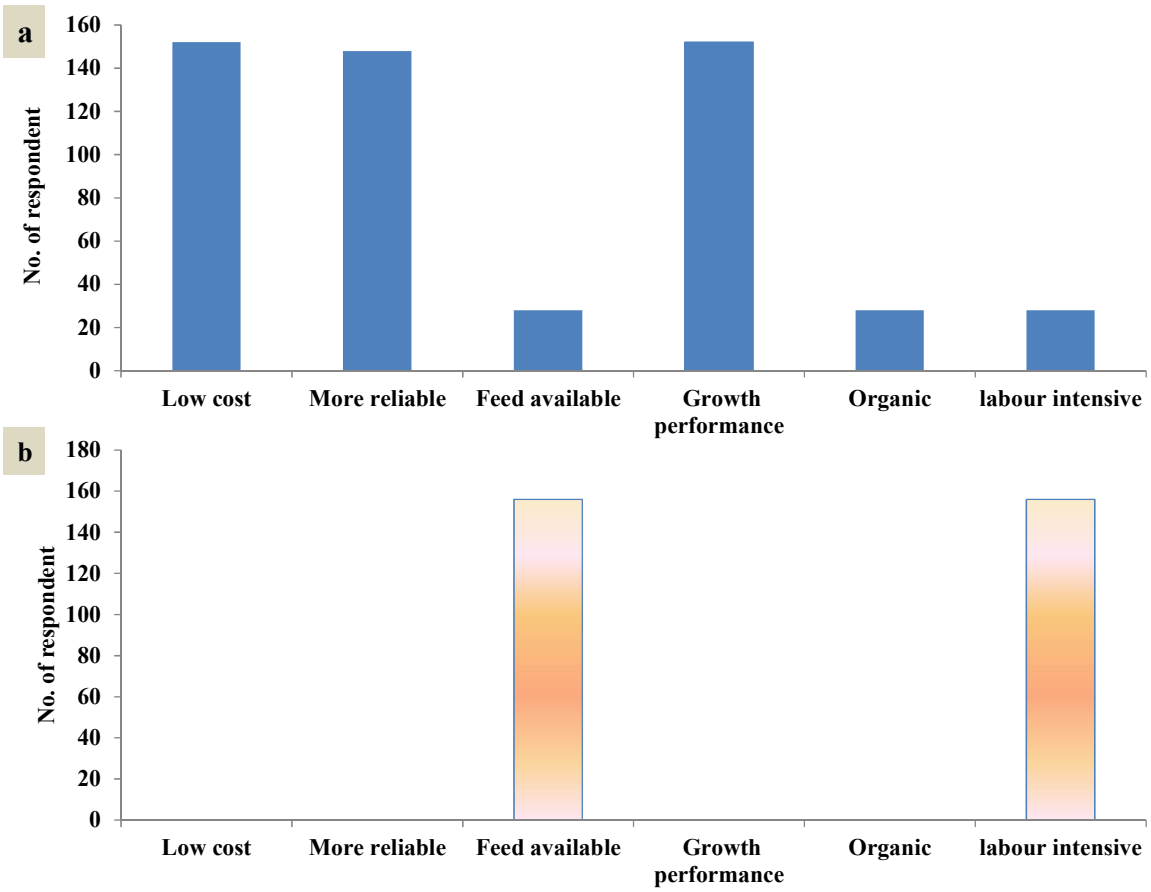

Fig. 5: Farmers' perception on quality of feed; a) homemade feed, b) commercial feed.

Table 1. A Check List of Different Fish Feeds with Their Companies in Different Regions of Bangladesh

SL No.	Name of Companies	Feed Items			
		Mymensingh	Rajshahi	Jashore	Cumilla
1	NOURISH	1. Nursery 2. Nursery-1 3. Koi starter 4. Pangas floating grower 5. Shing, Magur floating starter		1. Pabda, Gulsha starter 2. Pabda, Gulsha grower 3. Koi starter 4. Tilapia grower 5. Carp grower	
2	AFTAB	1. Nursery 2. Nursery-1 3. Koi starter 4. Pangash starter 5. Tilapia starter 6. Shing-magur grower 7. Shing-magur finisher	1. Tilapia grower 2. Carp starter and grower 3. Koi starter 4. Pangash starter 5. Tilapia starter 6. Shing-magur grower 7. Shing-magur finisher	1. Nursery 2. Tilapia starter 3. Pangas starter 4. Tilapia grower 5. Koi grower	
3	QUALITY FEEDS	1. Pabda-Gulsha starter 2. Shing-Magur starter 3. Shing-Magur grower 4. Tilapia grower 5. Pangas grower 6. Tilapia premium starter 7. Tilapia eco starter 8. Nursery -1 9. Nursery-2 10. Pangas starter	1. Pabda-Gulsha starter 2. Shing-Magur starter 3. Shing-Magur grower 4. Tilapia grower 5. Pangas grower6 6. Tilapia premium starter 7. Tilapia eco starter 8. Nursery -1 9. Nursery-2 10. Pangas starter	1. Pabda-Gulsha starter 2. Shing-Magur starter 3. Shing-Magur grower 4. Tilapia grower 5. Pangas grower 6. Tilapia premium starter 7. Tilapia eco starter 8. Nursery -1 9. Nursery-2 10. Pangas starter 11. Carp grower	1. Pabda-Gulsha starter 2. Shing-Magur starter 3. Shing-Magur grower 4. Tilapia grower 5. Pangas grower 6. Tilapia premium starter 7. Tilapia eco starter 8. Nursery -1 9. Nursery-2 10. Pangas starter
4	TAMIM GROUP	1. Tilapia pre-starter 2. Tilapia grower 3. Pangas sinking grower 4. Pangas grower	1. Tilapia pre-starter 2. Tilapia grower 3. Pangas sinking grower 4. Carp grower		
5	KNV	1. Koi starter 2. Koi grower 3. Pangas grower 4. Pangas starter 5. Carp floating grower 6. Carp finisher	1. Koi starter 2. Koi grower 3. Pangas grower 4. Pangas starter 5. Carp grower 6. Carp finisher		1. Koi starter 2. Koi grower 3. Pangas grower 4. Pangas starter 5. Carp grower 6. Carp finisher
6	EON	1. Tiger fish feed	1. Tiger fish feed	1. Tiger fish feed	

		2. Fast grow fish grow	2. Fast grow fish grow	2. Fast grow fish grow	
7	SAUDI-BANGLA	1. Pangas starter 2. Tilapia starter 3. Koi sinking starter 4. Pangas sinking grower 5. Pangas sinking finisher 6. Tilapia sinking grower 7. Tilapia sinking finisher	1. Pangas starter 2. Tilapia starter 3. Koi sinking starter 4. Pangas sinking grower 5. Pangas sinking finisher 6. Tilapia sinking grower 7. Tilapia sinking finisher	1. Pangas starter 2. Tilapia starter 3. Koi sinking starter 4. Pangas sinking grower 5. Pangas sinking finisher 6. Tilapia sinking grower 7. Tilapia sinking finisher	1. Pangas starter 2. Tilapia starter 3. Koi sinking starter 4. Pangas sinking grower 5. Pangas sinking finisher 6. Tilapia sinking grower 7. Tilapia sinking finisher
8	TONGWAY	1. Shing, Magur, Pangas nursery feed 2. Koi starter 3. Shing, Magur starter 4. Pangas grower	1. Shing, magur, Pangas nursery feed 2. Koi starter 3. Shing, magur starter 4. Pangas grower		1. Shing, magur, Pangas nursery feed 2. Koi starter 3. Shing, magur starter 4. Pangas grower
9	MEGA	1. Koi, Shing, Magur, Pabda, Gulsha Pre-starter 2. Tilapia grower 3. Pangas finisher 4. Carp grower 5. Tilapia nursery grower 6. Golda finisher	1. Koi, Shing, magur, Pabda, Gulsha Pre-starter 2. Tilapia grower 3. Pangas finisher 4. Carp grower 5. Tilapia nursery grower 6. Golda finisher	1. Koi, Shing, magur, Pabda, Gulsha Pre-starter 2. Tilapia grower 3. Pangas finisher 4. Carp grower 5. Tilapia nursery grower 6. Golda finisher 7. Carp grower	1. Koi, Shing, magur, Pabda, Gulsha Pre-starter 2. Tilapia grower 3. Pangas finisher 4. Carp grower 5. Tilapia nursery grower 6. Golda finisher
10	PROVITA	1. Pangas starter 2. Tilapia starter 3. Koi grower 4. Tilapia grower 5. Koi finisher	1. Pangas starter 2. Tilapia starter 3. Koi grower 4. Tilapia grower 5. Koi finisher		1. Pangas starter 2. Tilapia starter 3. Koi grower 4. Tilapia grower 5. Koi finisher
11	PARAGON	1. Nursery 2. Tilapia starter 3. Pangas starter 4. Tilapia grower 5. Koi grower	1. Nursery 2. Tilapia starter 3. Pangas starter 4. Tilapia grower 5. Koi grower		1. Nursery 2. Tilapia starter 3. Pangas starter 4. Tilapia grower 5. Koi grower
12	AIT	1. Pangas starter 2. Pangas grower 3. Pangas finisher 4. Shing, Magur starter 5. Koi grower	1. Pangas starter 2. Pangas grower 3. Pangas finisher 4. Shing,Magur starter 5. Koi grower	1. Pangas starter 2. Pangas grower 3. Pangas finisher 4. Shing,Magur starter 5. Koi grower	
13	SMS	1. Tilapia grower 2. Pangas starter	1. Tilapia grower 2. Pangas starter		

			3. Koi grower		
14	DE-HEUS /FISHTECH	1. Catfish, Tilapia, Anabus feed 2. Koi grower 3. Koi starter 4. Catfish grower 5. Catfish finisher	1. Catfish, Tilapia, Anabus starter 2. Koi grower 3. Koi starter 4. Catfish grower 5. Catfish finisher		1. Catfish, Tilapia, Anabus starter 2. Koi grower 3. Koi starter 4. Catfish grower 5. Catfish finisher
15	GALAXY	1. Pabda, Gulsha starter 2. Pabda, Gulsha starter 3. Pabda, Gulsha finisher	1. Pabda, Gulsha starter 2. Pabda, Gulsha starter 3. Pabda, Gulsha finisher		1. Pabda, Gulsha starter 2. Pabda, Gulsha starter 3. Pabda, Gulsha finisher
16	RUPOSHI BANGLA	1. Pangas starter 2. Pangas grower 3. Pangas sinking starter 4. Pangas sinking grower 5. Koi floating starter 6. Koi grower 7. Shing, magur starter 8. Pabda, Gulsha starter 9. Tilapia starter and grower	1. Carp starter 2. Pangas grower 3. Pangas sinking starter 4. Pangas sinking grower 5. Koi starter 6. Koi grower 7. Shing, magur starter 8. Pabda, Gulsha starter 9. Tilapia starter and grower	1. Pangas starter 2. 2.Pangas grower 3. Pangas sinking starter 4. Pangas sinking grower 5. Koi starter 6. Koi grower 7. Shing, magur starter 8. Pabda, Gulsha starter 9. Tilapia starter and grower	1. Carp starter 2. Pangas grower 3. Pangas sinking starter 4. Pangas sinking grower 5. Koi starter 6. Koi grower 7. Shing, magur starter 8. Pabda, Gulsha starter 9. Tilapia starter and grower
17	LILY	1. Pangas starter 2. Pangas grower 3. Pabda, Gulsha pre-starter 4. Koi starter 5. Koi grower 6. Tilapia starter 7. Tilapia grower	1. Carp starter 2. Pangas grower 3. Pabda, Gulsha pre-starter 4. Koi starter 5. Koi grower 6. Tilapia starter 7. Tilapia grower		1. Carp starter 2. Pangas grower 3. Pabda, Gulsha pre-starter 4. Koi starter 5. Koi grower 6. Tilapia starter 7. Tilapia grower
18	FEED X	1. Catfish starter 2. Catfish grower 3. Catfish finisher	1. Catfish starter 2. Catfish grower 3. Catfish finisher		1. Catfish starter 2. Catfish grower 3. Catfish finisher
19	ACI	1. Pabda, Gulsha starter 2. Pabda, Gulsha grower	1. Pabda, Gulsha starter 2. Pabda, Gulsha grower	1. Catfish, Tilapia, Anabus starter 2. Koi grower 3. Koi starter 4. Catfish grower 5. Catfish finisher	1. Pabda, Gulsha starter 2. Pabda, Gulsha grower 3. Pangas starter, grower and finisher
20	AGATA	1. Hatchery powder 2. Nursery 1,2 3. Pangas starter, grower, finisher	1. Carp starter and grower 2. Nursery 1,2 3. Pangas starter, grower, finisher	1. Hatchery powder 2. Nursery 1,2 3. Pangas starter, grower, finisher	

		4. Tilapia starter, grower, finisher	4. Tilapia starter, grower, finisher	4. Tilapia starter, grower, finisher 5. Carp starter	
21	AMAN		1. Pabda, Gulsha starter and grower 2. Nursery 1, 2 3. Pangas starter, grower, finisher 4. Tilapia starter, grower, finisher		1. Tiger fish feed 2. Fast grow fish grow
22	AGROHO		1. Catfish, Tilapia, Anabus starter 2. Koi grower 3. Koi starter 4. Catfish grower 5. Catfish floating finisher		
23	BRAC		1. Koi floating starter 2. Koi floating grower 3. Pangas grower 4. Pangas starter 5. Carp floating grower 6. Carp floating finisher		
24	SPECTA			1. Tilapia pre-starter 2. Tilapia grower 3. Pangas sinking grower 4. Carp grower	
25	AHAD			1. Koi starter 2. Koi grower 3. Pangas sinking grower 4. Pangas sinking starter 5. Carp grower 6. Carp finisher	
26	DG			1. Shing, magur, Pangas nursery feed 2. Koi starter 3. Shing,magur starter 4. Pangas grower 5. Carp starter	

27	ARAB FEED			1. Nursery 2. Rui Catla starter 3. Koi starter 4. Pangash starter 5. Tilapia starter 6. Shing-magur grower	
28	VENKIS			1. Pangas sinking starter 2. Tilapia starter 3. Koi grower 4. Tilapia grower 5. Koi finisher	
29	CP			1. Pabda, Gulsha starter 2. Pabda, Gulsha starter 3. Pabda, Gulsha finisher 4. Pangas sinking grower 5. Koi starter 6. Carp grower	1. Tilapia pre-starter 2. Tilapia grower 3. Pangas sinking grower 4. Carp grower
30	AFIL			1. Pangas starter 2. Pangas grower 3. Pabda, Gulsha pre-starter 4. Koi starter 5. Koi grower 6. Tilapia starter 7. Tilapia grower	
31	NEW HOPE			1. Catfish starter 2. Catfish grower 3. Catfish finisher 4. Koi grower 5. Tilapia starter 6. Carp grower	
32	CARE				1. Tilapia grower 2. Carp starter and grower 3. Koi starter 4. Pangash starter 5. Tilapia starter 6. Shing-magur grower 7. Shing-magur finisher
33	NATIONAL				1. Pangas starter 2. Pangas grower

					3. Pangas finisher 4. Shing,Magur starter 5. Koi grower
34	LION				1. Tilapia grower 2. Pangas starter 3. Koi grower
35	TEER				1. Carp starter and grower 2. Nursery 1,2 3. Pangas starter, grower, finisher 4. Tilapia starter, grower, finisher 5. Pabda, Gulsha starter

11.1.3 Farmers' perception on quality of brood

During the study period, we asked to the farms owners about the sources and quality of brood fish used for induced breeding in different hatcheries of Bangladesh. Highest number of respondent used brood fish from their own hatcheries followed by the sources of river, BFRI, government brood bank and other hatcheries (Fig. 6). Interestingly, most of the farms owners replied that the qualities of brood are better in their own hatcheries (Fig. 7). Hossain *et al*. (2016) reported that the main sources of brood of Indian major Carps were world fish center (15%), BFRI (8%), Halda river (19%), Padma river (12%), govt. brood bank (15%), own (23%) and others sources (8%). The main purpose of collecting brood from different sources was to avoid (or reduced) inbreeding and produced quality seed. Preferably 1 to 3 years weighing about 3.5 kg to 8 kg old mature males and females should be collected from the natural sources (rivers, lakes, and reservoirs) as broodstock (Sarder *et al.,* 2002).

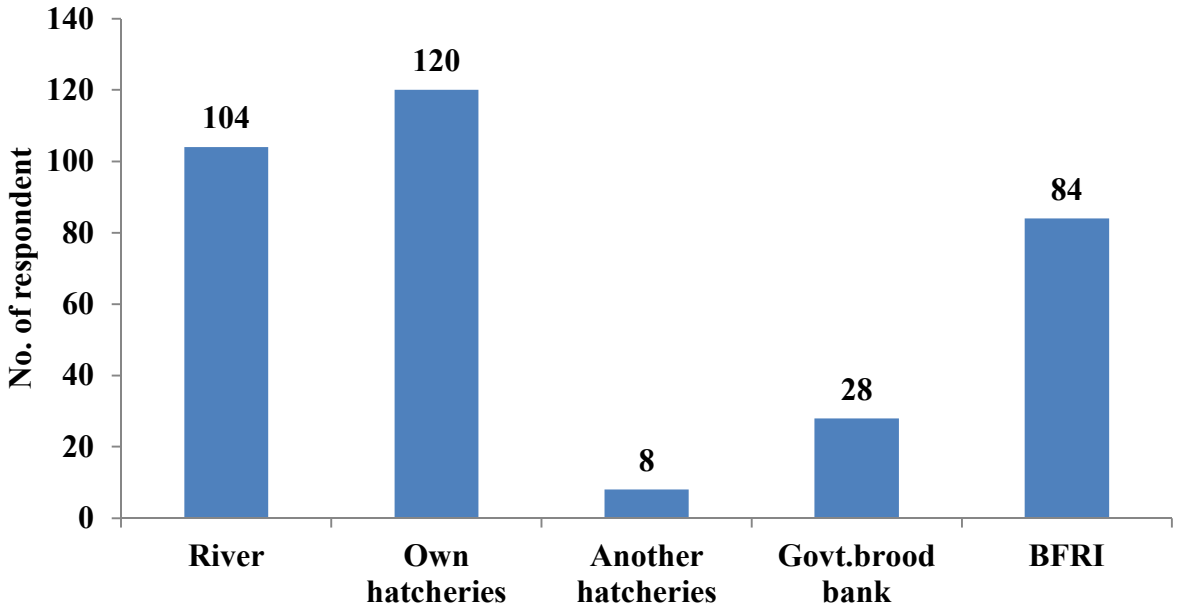

Fig. 6. Sources of brood fish used for induced breeding in different hatcheries of Bangladesh.

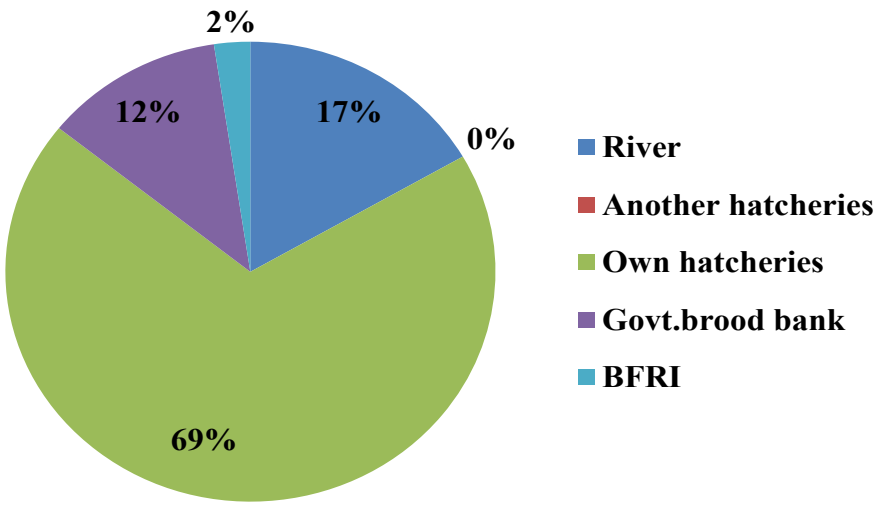

Fig. 7: Responses of farms owners about the quality of brood fish used for induced breeding in different hatcheries of Bangladesh.

11.1.4 Farmers' perception on quality of fries

During the study period, we asked to the farms owners about the sources and quality of fries collected for grow out pond. Highest number of respondent collected fries from private hatcheries followed by government hatcheries, river, brood bank and BFRI (Fig. 8). Asif *et al.* (2014) reported that marketing channel of fish fry and fingerling is start with brood pond and continues with hatchery, nursery, fry and fingerling traders, intermediates, buyer, farmer, then farming pond or rearing pond. Sharif and Abdulla-Al-Asif (2015) showed that channel start with Brood Fish (collection from mainly in Halda and Jamuna River) then hatchling Production, nursery owners, fry production, wholesaler, Retailer and finally end with fish Farmer. Although most of the farms owners were collected fries from private hatcheries, a considerable number of grow out farms owners replied that the fries of government hatcheries, river, brood bank and BFRI are better than private hatcheries in terms of growth performance, disease resistance and survivability (Fig. 9).

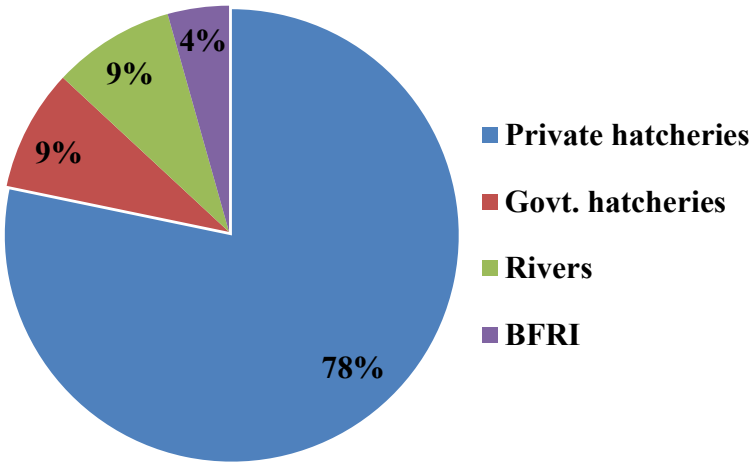

Fig. 8. Sources of fries collected for grow out pond culture in Bangladesh

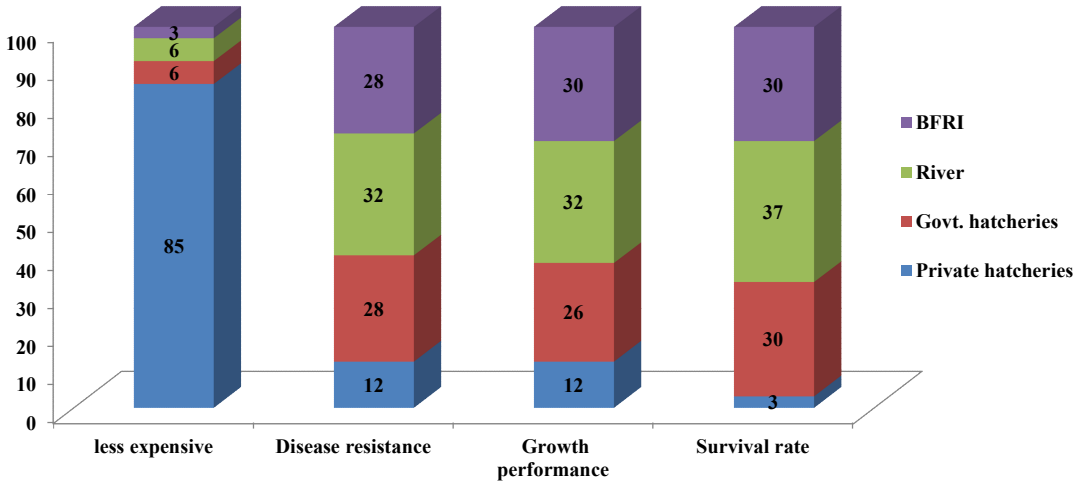

Fig. 9. Responses of farms owners about the quality of fries collected for grow out pond culture in Bangladesh.

11.2 Analysis of the proximate composition and heavy metals of different fish feeds used in the commercial fish farms

11.2.1 Proximate composition of different fish feeds

The results of proximate composition of different feeds analyzed and manufacturers' declaration are shown in Table 2.

Moisture: Moisture is one of the most important components of feed. Result obtained from analysis showed that moisture contents varied between 10.857 to 15.69 % (Table 2). However, manufacturers' declared moisture content of most of the collected feed samples was lower as indicated in the parentheses. Narayon (2016) found 11.1-19.22% moisture, whereas Palash (2015) reported that analyzed mean moisture content of fish feed varied from 7.37 to 18.29%. Lazu (2011) observed 10.59 ± 2.29 to 20.05 ± 0.41% moisture content in feed. On the other hand, Ariyaratne and De Silva (2001) found 5.1-7.1% moisture which is dissimilar to the present investigations. Roy (2002) found that a diet containing 9.8% moisture appears to be more suitable for GIFT Tilapia, and 8-12% moisture for shrimp and prawn. Kawser (2012) found that majority of feed moisture was more than 12%.

Crude protein: Protein is the major growth promoting factor in feed. The protein requirement of fish are influenced by various factors such as fish size, water temperature, feeding rate, availability and quality of natural foods and overall digestible energy content of diet (Satoh, 2000; Wilson, 2000). Protein determines whether feed cost is high and low. Result of analyzed crude protein contents are shown in Table 2. However, manufacturers' declared protein content of most of the collected feed samples was lower as indicated in the parentheses. Wilson (2000) reported that most of the commercial channel Catfish feeds contain 32% crude protein. Boonyaratpalin (1988) estimated the protein requirement for tropical Catfish to be 35-40%, 25-35% and 28-32% for fry, grow-out and broodstock, respectively. Watanabe *et al.* (1990) observed that Catfish production was increased through the use of high amounts of protein (35% or more) in their diet and phase feeding may be more profitable. Kawsar (2012) investigated the quality of some commercial fish feeds where maximum feed samples had lower crude protein (difference 0.05 to 8.05%) than company provided protein value which has similarity comparing with this study on the aspect of differences. Lazu

(2011) observed crude protein content ranged from 22.54 ±1.80 to 30.71 ± 3.84% in different farms which are also lower than this study. Ariyaratne and De Silva (2001) showed 5-12% protein of farm-made aqua feed where in this study company feed has higher protein. The dietary protein requirements of several species of Tilapia have been estimated to be ranged between 20% and 56% (EI-Sayed and Teshima, 1991), where shrimp and prawn need 32-40% (MOFL, 2011).

Crude lipid: Similarly, there were differences between the analyzed and company declared crude lipid values even though they were not significantly different from the company mentioned values. Lipids are primarily included in formulated diet to maximize their protein sparing effect (Hasan, 2001) by being a source of energy. Razzaque (2017) showed that in Jashore Chachra union feed samples contains lipid varied from 3.08-7.61% where in this study it varied from 4.8 to 7.8%. Razzaque (2017) found Lily finisher feed contains highest lipid where in this study was Mega nursery feed contained highest lipid in feed. Narayon (2016) observed that lipid content varied from 6.67 to 22.95% which has no similarity with present research. Palash (2015) found that the lipid content of Bagerhat fish feed varied between 6.20 and 10.65% whereas in present experiment it was 4.8 to 7.8%. Rana (2014) observed lipid content within 9.13-9.82% for Koi feed and 7.35-8.54% for Pangas feed which was higher than present study. Luquet (2000) stated that dietary lipid levels of 5 to 6% are often used in Tilapia diet which is more or less similar with the present study.

Ash: Result of analyzed ash contents of the collected commercial fish samples were in the range of 8.81-27.04%, while the manufacturer's declaration ranges of 8.00-22.00%. There was a huge difference between companies provided value and analyzed value. Most of the company did not provide actual ash value. Razzaque (2017) found that ash content varied from 6.89-11.91% of freshwater nursery and grower feed. Comparing with that in present study ash content varied from 7.41-27.04% which was very high comparing with the above findings. Narayon (2016) observed the ash content varied from 10.24%-20.99% which is similar with the results of present study. Palash (2015) reported that the ash content of feed of different companies is very high which is also similar with the present work. Bhuiyan (2002) found that the diet containing 11.02% ash appears to be more suitable for Carp polyculture. Roy (2002) reported that a diet containing 12.92% ash appears to be more suitable for GIFT Tilapia. Comparing with these data ideal ash content range for shrimp and prawn is 16-20% (MOFL, 2011) which is more or less similar to the present study.

Crude fibre: Fibre contents of different feeds from all companies under study were significantly higher than the company declared maximum values ($p<0.05$). The analyzed mean crude fibre content of fish feeds varied from 3.8 to 7.8%. Razzaque (2017) reported that fibre content varied from 4.1-7.5% where in present study varied from 3.8% to 7.8%. Razzaque (2017) found Lily feed grower contained highest crude fibre where same lose finisher feed having 7.8% crude fibre. Narayon (2016) found that crude fibre varied from 4.40-7.8% which was almost same with the present study. Palash (2015) reported that fibre content varied among different feeds from 4.05 to 7.60% which is same comparing with current research. Fibre helps in the binding of feed within a certain range where excessive fibre is not recommended. However, it is not desirable to have a fibre content exceeding 10-12% in diets for fish, as the increase in fibre content would consequently results in the decrease of quality of an unusable nutrient in the diet (De Silva and Anderson, 1995). Comparing with this information in this study fibre contents were within satisfactory range during present investigation.

Carbohydrate: Carbohydrate is considered as important composition which has protein sparing effect. The activities of supplying energy by essential carbohydrates seems to have an overall beneficial effect in terms of improving growth and protein utilization of most shrimp and prawn as well as fish. But it was found that there were differences between analyzed value and company provided value. Most of them were found dissimilar percentages from their labeled value. The

analyzed carbohydrate content of fish feeds varied from 22.79 to 41.73%. Most of the feeds contain carbohydrates between the ranges 30 to 35%. Razzaque (2017) reported that carbohydrate content varied from 32.77-47.52% which is almost similar with the present study (22.79 to 41.73%). Narayon (2016) found carbohydrate ranged 18.62-42.25% which is slightly lower than the present study. Palash (2015) reported the carbohydrate range between 26.3-39.04% which is lower than the present findings. Highest carbohydrate was found in Fresh nursery feed (39.04%) where in the present experiment, highest value of carbohydrate found in quality finisher feed. Kawser (2012) found highest 42.21% carbohydrate in Anchor grower feed and lowest 20.03% was in Mega nursery feed which almost agrees with the present findings. Ali *et al.* (2008) stated that the diet containing 13% CHO appears to be more suitable for Nile Tilapia. Bhuiyan (2002) reported that the diet containing 34.53% CHO appears to be more suitable for Carp polyculture. Roy (2002) found that a diet containing 29.18% CHO found more suitable for GIFT Tilapia. From the information of MOFL (2011) ideal carbohydrate content for shrimp and prawn ranged from 22- 30%. Comparing with this information carbohydrate range was 22.79-41.73% found in present work higher than the above recommended values. The assessment of present study showed that lab analyzed data and company given data were not similar. Again, nutrient values of these companies were not in optimum range. As there are not specific rules and regulations for processing and marketing of these feeds, it should be ensured to get high yield from fisheries sector.

Table 2. Proximate composition of different commercial fish feeds available in Bangladesh (% dry matter basis)

SL No.	Company Name	Feed Type	Proximate Composition (%)					
			Moisture	Crude protein	Crude lipid	Ash	Crude fibre	CHO
1	MFL	Koi, Shing, Magur Floating Pre- Starter	11.76 (12.00)*	32.52 (30.00)	6.40 (3.00)	11.63 (18.00)	5.60 (6.00)	32.09 (37.00)
2	MFL	Catfish Floatintg Starter	12.60 (12.00)	33.19 (30.00)	7.30 (3.00)	11.79 (18.00)	5.30 (6.00)	29.82 (37.00)
3	IAFF	Koi Floating Starter	12.78 (11.00)	30.13 (33.00)	5.90 (7.00)	9.05 (18.00)	4.86 (6.00)	37.28 (28.00)
4	RBFL	Koi Floating Pre-Starter	9.56 (11.00)	34.06 (33.00)	6.64 (8.00)	9.69 (12.00)	4.34 (5.00)	35.71 (28.00)
5	QFL	Pabda, Gulsha Floating Starter	9.88 (11.00)	35.53 (36.00)	6.45 (7.00)	9.40 (12.00)	4.43 (2.50)	34.31 (25.00)
6	AIT	Pangas Starter	13.38 (12.00)	30.05 (28.00)	6.36 (7.00)	9.21 (21.00)	5.40 (7.00)	35.60 (33.00)
7	AIT	Pangas Floating Starter	12.12 (12.00)	31.92 (30.00)	6.56 (7.00)	9.66 (20.00)	5.64 (6.00)	34.10 (30.00)
8	Tongue	Shing, Magur Starter	11.34 (12.00)	32.27 (30.00)	5.98 (7.00)	9.44 (20.00)	4.70 (6.00)	36.27 (30.00)
9	IAG	Catfish Pre-starter	12.46 (11.00)	33.78 (35.00)	7.20 (8.00)	8.81 (17.00)	5.20 (4.00)	32.55 (26.00)

SL No.	Company Name	Feed Type	Proximate Composition (%)					
			Moisture	Crude protein	Crude lipid	Ash	Crude fibre	CHO
10	MFL	Tilapia Floating Grower	11.66 (12.00)	30.29 (28.00)	7.26 (3.00)	11.05 (20.00)	4.40 (8.00)	35.34 (37.00)
11	AIT	Pangas Grower	14.80 (12.00)	26.89 (25.00)	5.80 (6.00)	7.41 (13.00)	6.40 (8.00)	38.70 (37.00)
12	IAG	Koi Grower	11.88 (11.00)	30.14 (32.00)	6.90 (6.00)	9.78 (19.00)	4.70	36.60 (34.00)
13	QFL	Pangas Grower	15.69 (11.00)	26.02 (25.00)	6.20 (7.00)	9.50 (12.00)	6.90 (4.50)	35.69 (22.00)
14	QFL	Tilapia Floating Grower	10.55 (10.00)	28.16 (26.00)	5.88 (5.60)	7.98 (10.00)	5.70 (3.20)	41.73 (22.00)
15	SMS	Tilapia Floating Grower	12.07 (12.00)	31.77 (30.00)	5.95 (5.00)	10.90 (17.00)	4.90	34.41 (28.00)
16	MFL	Pangas Floating Finisher	12.25 (12.00)	27.19 (28.00)	6.20 (3.00)	10.95 (22.00)	6.70 (9.00)	36.71 (39.00)
17	MFL	Golda Finisher	13.50 (12.00)	30.20 (38.00)	7.40 (5.00)	11.96	4.80 (5.00)	32.14
18	Tongue	Tilapia Finisher	12.77 (12.00)	28.57 (25.00)	7.80 (5.00)	9.42 (22.00)	5.80 (9.00)	35.64 (40.00)
19	BFL	Pangas Finisher	13.53 (12.00)	26.07 (25.00)	5.77 (4.00)	9.42	6.90 (8.00)	38.31
20	MFL	Tilapia Nursery Grower	13.69 (12.00)	39.44 (35.00)	6.40 (6.00)	13.76 (16.00)	3.80 (5.00)	22.91 (31.00)
21	Tongue	Catfish Nursery	10.85 (12.00)	38.90 (35.00)	6.40 (8.00)	11.66 (18.00)	4.40 (5.00)	27.79 (26.00)
22	QFL	Pabda, Gulsha Floatintg Nursery	11.64 (11.00)	40.32 (40.00)	6.36 (8.00)	8.88 (10.00)	4.20 (3.00)	28.60 (20.00)
23	NFL	Common Floating Nursery	13.11 (12.00)	38.00 (33.00)	6.66 (4.00)	14.57 (8.00)	4.60	23.06

SL No.	Company Name	Feed Type	Proximate Composition (%)					
			Moisture	Crude protein	Crude lipid	Ash	Crude fibre	CHO
24	PFL	Koi, Catfish Hatchery Powder	12.19 (10.00)	33.07 (35.00)	5.70 (5.00)	14.29	6.26 (2.00)	28.49
25	QFL	Tilapia Hatchery	12.41 (10.00)	40.77 (35.00)	6.35 (8.00)	12.73 (10.00)	4.80 (3.50)	22.94
26	RBFL	Tilapia Floating	10.67 (11.00)	30.36 (28.00)	6.44 (5.00)	9.94 (4.00)	4.90 (9.00)	37.69 (38.00)
27	MFL	Catfish feed	12.76 (12.00)	31.33 (32.00)	5.90 (3.00)	12.23	5.80 (10.00)	31.98
28	DH	Floating Grower	12.34 (11.00)	37.13 (35.00)	6.73 (6.00)	9.33 (16.00)	5.60 (5.00)	28.90
29	LF	Carp and mixed feed	13.25 (10.00)	16.37 (20.00)	4.80 (4.00)	27.04 (21.00)	7.80 (6.00)	30.74 (25.00)
30	SMS	Pangas feed	13.84 (10.00)	30.36 (32.00)	6.20 (5.00)	15.45 (17.00)	5.20 (6.00)	28.95

*Figures in the parentheses indicate the proximate composition declared by the company

11.2.2 Heavy metal analysis

The results of heavy metals concentrations (mg/Kg) of different feeds analyzed are shown in Table 3. **Lead (Pb):** Lead compounds may have a variety of hazards within the nervous system both for fishes and for humans causing neurotoxicity (Bondy, 1988). The highest lead content was 0.1798 ± 0.020 mg/kg (Table 3). Assessment showed that most of the samples had lead content lower than the maximum consumption limit (5 mg/kg). This is not very alarming to us. Lead poisoning in humans causes severe dysfunction in the kidney, reproductive system, liver, brain and central nervous system (Martínez-Quintana and PenagosCorzo, 2012). Lead causes loss of neurons' myelin sheaths, reduces numbers of neurons, interferes with neurotransmission and decreases neuronal growth (Rudolph et al., 2004). On the other hand, Shamshad *et al.* (2009) reported that the average lead content in shrimp feed that is mostly used in Bangladesh was 3.58 mg/kg. Adams *et al.* (2017) reported that the highest percentage of feed samples with lead concentrations exceeding the maximum limit (of 30 mg/ kg) were from feed additives belonging to the functional groups of binders and anti-caking agents. This concerned complementary mineral feeds, pre-mixtures, fish meal, manga nous oxide and 'other feed additives'. Most of the branded fish feed in Bangladesh are costly and most free from metal pollution (Shamshad *et al*., 2009). However, feeds those are made locally with available ingredients are cheap but not tested properly to assess the contamination level with different heavy metals. As most of the fish farmers are poor, they typically use local feeds which are often contaminated with different harmful heavy metal like lead.

Cadmium (Cd): Cadmium is a nonessential nutrient may accumulate in the body, particularly in the kidney, liver, and to a lesser extent in the muscle (Li *et al.,* 2005). The highest cadmium content in our feed samples was 0.0266±0.001 mg/kg (Table 3). Shamshad *et al.* (2009) reported that the average cadmium content in shrimp feed that is mostly used in Bangladesh was less than 0.1 mg/kg. Ikem and Egilla (2008) have reported that the average elemental concentration of Cd is 2.37 mg/kg in diet (dry wt.) of fish feed which is double than the acceptable limit. Adamse *et al.* (2017) reported that the presence of elements like cadmium in the aquatic environment originates from natural (volcanic activity, weathering of bedrocks) or from anthropogenic sources such as mining activities, incineration of waste and agricultural use.

Chromium (Cr): Chromium is an essential nutrient. It facilities the action of insulin as well as helps to the metabolism and storage of carbohydrate, fat and protein (Anderson, 1997). But excessive level of chromium in fish feed damages the kidneys, the liver and blood cells through oxidation reactions (Dayan and Paine, 2001). The results obtained from our study were alarming. The highest chromium content was found in our study was 1.0215±0.014 mg/kg (Table 3). The assessment showed that some of the feed samples contain chromium two or three times lower than the maximum chromium consumption level (5 mg/kg). The major concern about chromium is that it has carcinogenic behavior in humans. However, Ikem and Egilla (2008) have reported that the average elemental concentration of Cr is 1.42 mg/kg in diet (dry wt.) of fish feed which is within the acceptable limit and lower than our findings.

Copper (Cu): Copper is an essential element that is carefully regulated by physiological mechanisms in most organisms. Copper is an essential part of several enzymes and is necessary for the synthesis of hemoglobin. However, studies have shown that Cu is highly toxic in aquatic environments and has effects on fish, invertebrates, and amphibians, with all three groups equally sensitive to chronic toxicity. Copper accumulate in many different organs in fish and mollusks. The highest copper concentration measured in fish feeds in this study was 0.3033±0.005 far below the FAO guideline of 100 mg/kg (Table 3). The values found from this study were also lower than that obtained for poultry feed in Pakistan. The concentrations of Cu in the fish samples analyzed ranged from 21.13±1.44 to 23.76±1.41mg/kg. The permissible limit of Cu proposed by WHO and FAO is 30 mg/kg fresh weight of fish. However, there are some reports on high concentration of Cu (575.34±61.86 mg/kg) in prawn from the Buriganga River in Bangladesh.

Zinc (Zn): The highest concentration of Zn in the fish feed samples was 1.4682±0.037 mg/kg (Table 3). However, 100 mg/kg was the maximum recommended limit by WHO and FAO. The observations on Zn were similar to other studies although, higher than fishes from eastern Taiwan (Huang, 2003), Malaysia but lower than from south west coast of India (Rejomon *et al*., 2010), Indonesia (Agnes and Hamami, 2007) and Iran (Fariba *et al.,* 2009).

\Nickel (Ni): There was no Nickel element in these 30 fish feeds of different companies**.**

Table 3. Heavy metal concentrations (mg/kg) in different fish feeds of different companies.

SL No.	Company Name	Feed Type	Heavy metals (mg/Kg)				
			Pb	Cd	Cr	Cu	Zn
1	MFL	Koi, Shing, Magur Floating Pre-Starter	0.006±0.002	0.0162±0.002	BDL	0.021±0.002	0.741±0.002
2	MFL	Catfish Floatintg Starter	0.080±0.006	0.020±0.002	BDL	0.068±0.003	1.162±0.009

SL No.	Company Name	Feed Type	Heavy metals (mg/Kg)				
			Pb	Cd	Cr	Cu	Zn
3	IAFF	Koi Floating Starter	0.032±0.026	0.019±0.001	BDL	0.128±0.005	1.178±0.003
4	RBFL	Koi Floating Pre-Starter	0.064±0.029	0.023±0.001	0.082±0.005	0.042±0.002	0.698±0.003
5	QFL	Pabda, Gulsha Floating Starter	BDL	0.021±0.003	BDL	0.152±0.042	1.465±0.042
6	AIT	Pangas Starter	BDL	0.019±0.002	BDL	0.045±0.007	0.785±0.007
7	AIT	Pangas Floating Starter	0.133±0.018	0.0266±0.001	0.056±0.032	0.0937±0.002	1.4682±0.037
8	Tongue	Shing, Magur Starter	0.080±0.021	0.021±0.001	BDL	0.040±0.002	1.1103±0.011
9	IAG	Catfish Pre-starter	BDL	0.019±0.002	BDL	0.059±0.003	0.701±0.003
10	MFL	Tilapia Floating Grower	BDL	0.0182±0.001	BDL	0.1021±0.010	0.9435±0.011
11	AIT	Pangas Grower	0.096±0.022	0.0227±0.001	BDL	0.058±0.002	0.749±0.002
12	IAG	Koi Grower	0.112±0.019	0.021±0.002	BDL	0.061±0.001	1.003±0.004
13	QFL	Pangas Grower	BDL	0.0193±0.002	BDL	0.111±0.012	0.665±0.012
14	QFL	Tilapia Floating Grower	0.028±0.016	0.020±0.002	BDL	0.075±0.002	0.722±0.007
15	SMS	Tilapia Floating Grower	BDL	0.020±0.001	BDL	0.025±0.003	0.926±0.008
16	MFL	Pangas Floating Finisher	0.043±0.012	0.022±0.001	BDL	0.038±0.003	0.593±0.001
17	MFL	Golda Finisher	0.091±0.005	0.021±0.001	BDL	0.082±0.001	0.102±0.005
18	Tongue	Tilapia Finisher	0.189±0.020	0.023±0.003	0.768±0.004	0.073±0.002	0.702±0.003
19	BFL	Pangas Finisher	BDL	0.018±0.001	0.039±0.007	0.036±0.029	0.751±0.30
20	MFL	Tilapia Nursery Grower	BDL	0.023±0.001	BDL	0.076±0.000	0.748±0.018
21	Tongue	Catfish Nursery	BDL	0.021±0.101	BDL	0.049±0.001	0.651±0.001
22	QFL	Pabda, Gulsha Floatintg Nursery	0.138±0.011	0.026±0.002	0.026±0.003	0.061±0.001	0.965±0.027
23	NFL	Common Floating Nursery	0.117±0.030	0.021±0.001	BDL	0.3033±0.005	0.7757±0.003

SL No.	Company Name	Feed Type	Heavy metals (mg/Kg)				
			Pb	Cd	Cr	Cu	Zn
24	PFL	Koi, Catfish Hatchery Powder	BDL	0.020±0.003	1.023±0.014	0.0405±0.010	0.7655±0.010
25	QFL	Tilapia Hatchery	0.048±0.016	0.021±0.002	BDL	0.0375±0.002	0.9201±0.023
26	RBFL	Tilapia Floating	0.048±0.003	0.021±0.001	BDL	0.0079±0.005	0.7189±0.023
27	MFL	Catfish feed	0.129±0.011	0.023±0.001	0.033±0.012	0.012±0.002	0.684±0.001
28	DH	Floating Grower	0.048±0.021	0.016±0.002	BDL	0.043±0.004	1.003±0.001
29	LF	Carp and mixed feed	BDL	0.018±0.001	BDL	0.024±0.014	0.802±0.014
30	SMS	Pangas feed	0.080±0.019	0.020±0.002	BDL	0.134±0.002	0.954±0.002

BDL = Below Detection Limit

11.3. Quality of broods and performance of fingerlings of Carp, Catfish and Perch collected from selected fish farms through the study of their larval and embryonic development

Among the different groups of fish, we studied embryonic and larval development of three groups (Carp, Catfish and Perch) of fish.

Embryonic and larval stages Carp - Rohu, *Labeo rohita*

Edema and abnormal development in embryos were observed in T2 and T3 as compared to T1. Several deformities of larvae have been resulted e.g. yolk sac edema, blood clotting, ruptured dorsal and tail fin, twisted tail, inward bent tai, ocular hypertrophy, growth retardation etc. in T2 and T3 as compared to T1 (Fig. 10). Hatching rate (%) was also lower in T2 and T3 compared to T1 (Fig. 11a). On the other hand, percentage of deformities was higher in T2 and T3 compared to T1 (Fig. 11b). Hatching rate was 85-91% and deformed hatchlings were 5-7% for Rui, Catla and Mrigal in the hatcheries located in Jashore region (Hossain *et al.*, 2016).

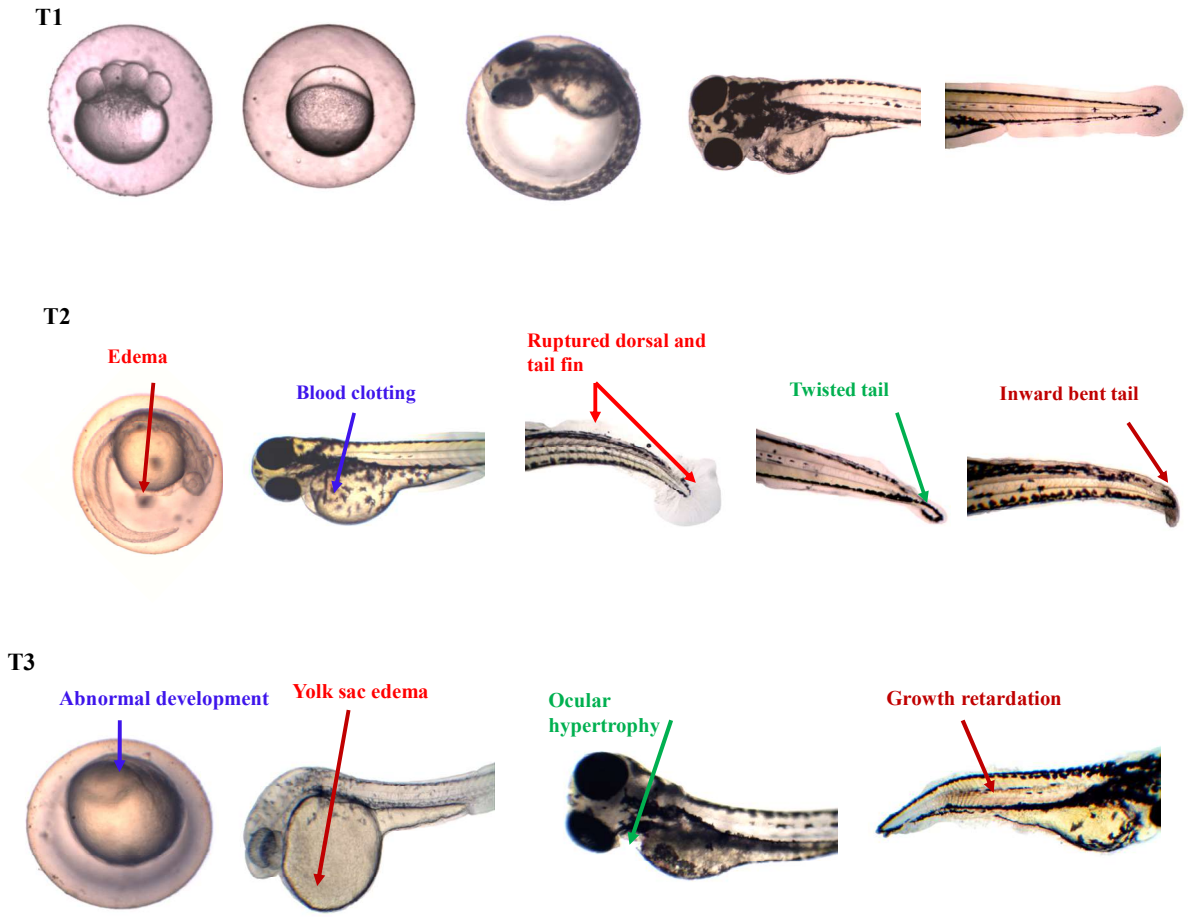

Fig. 10. Embryonic and larval development of a Carp species - Rohu, *Labeo rohita*.

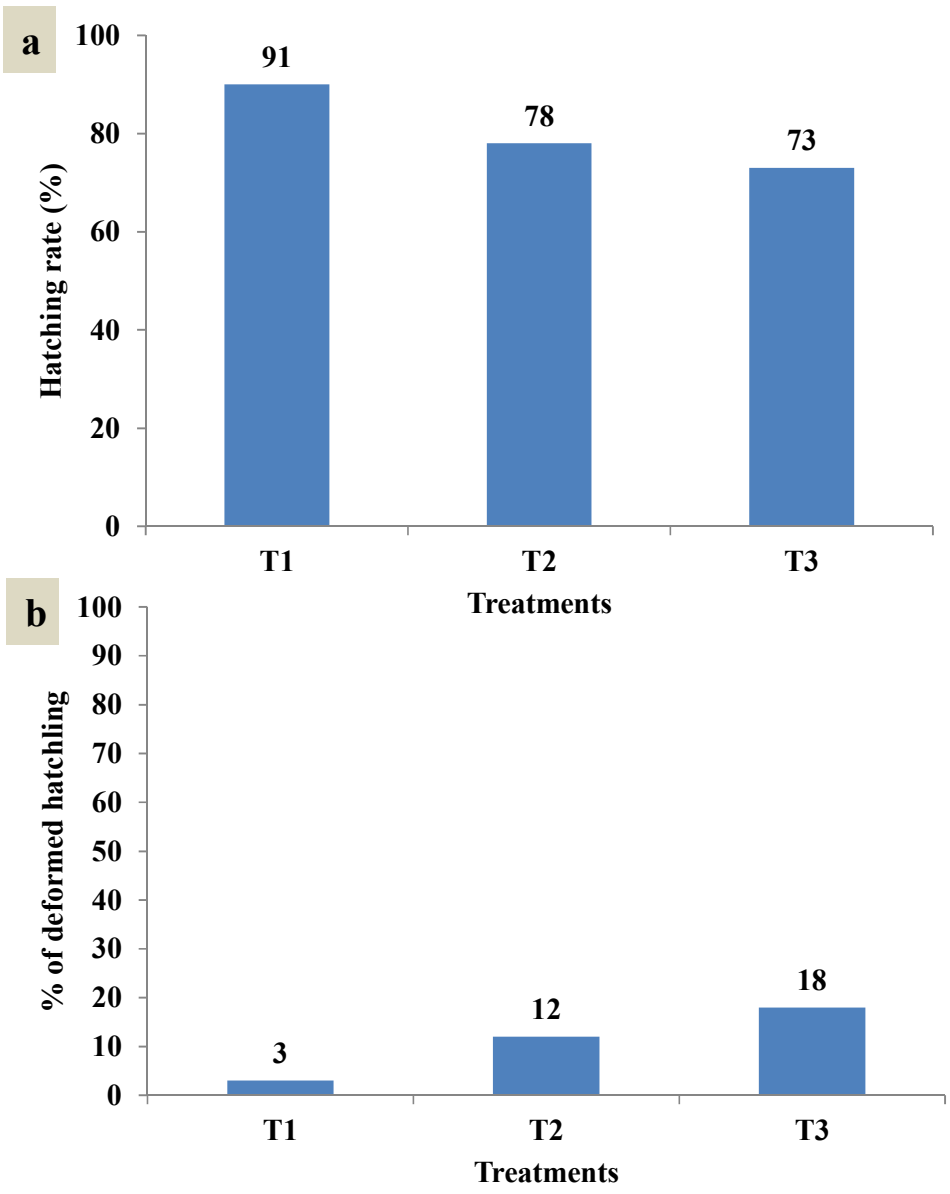

Fig. 11. (a) Hatching rate and (b) deformed hatchling of Rohu (*L. rohita*) collected from hatcheries maintaining brood stock properly (T1), has brood stock but not good management (T2) and no brood stock (T3).

Embryonic and larval stages Catfish-Shing, *Heteropneustes fossilis*

Embryonic stages

Faster embryonic development was observed in T2 and T3 as compared to T1 at 6 h after fertilization (Fig. 12 A) and 12 h after fertilization (Fig. 12 B). Several abnormalities, such as black color and deformed germinal ring of eggs were evident in T2 and T3 compared to T1.

Larval stages

Several deformities of larvae have been resulted e.g. edema (E), abnormal yolk sac (AY), notochord deformity (ND), deformed head (HD), deformed mouth (DM), caudal fin deformity (CD), curved neck

(CN) etc. in T2 and T3 as compared to T1. The deformities were observed at 24h after hatching (Fig. 13), at 36h after hatching (Fig. 14), at 48h after hatching (Fig. 15), at 72h after hatching (Fig. 16) and at 96h after hatching (Fig. 17).

Hatching rate (%) was also lower in T2 and T3 compared to T1 (Fig. 18a). On the other hand, percentage of deformities was higher in T2 and T3 compared to T1 (Fig. 18b).

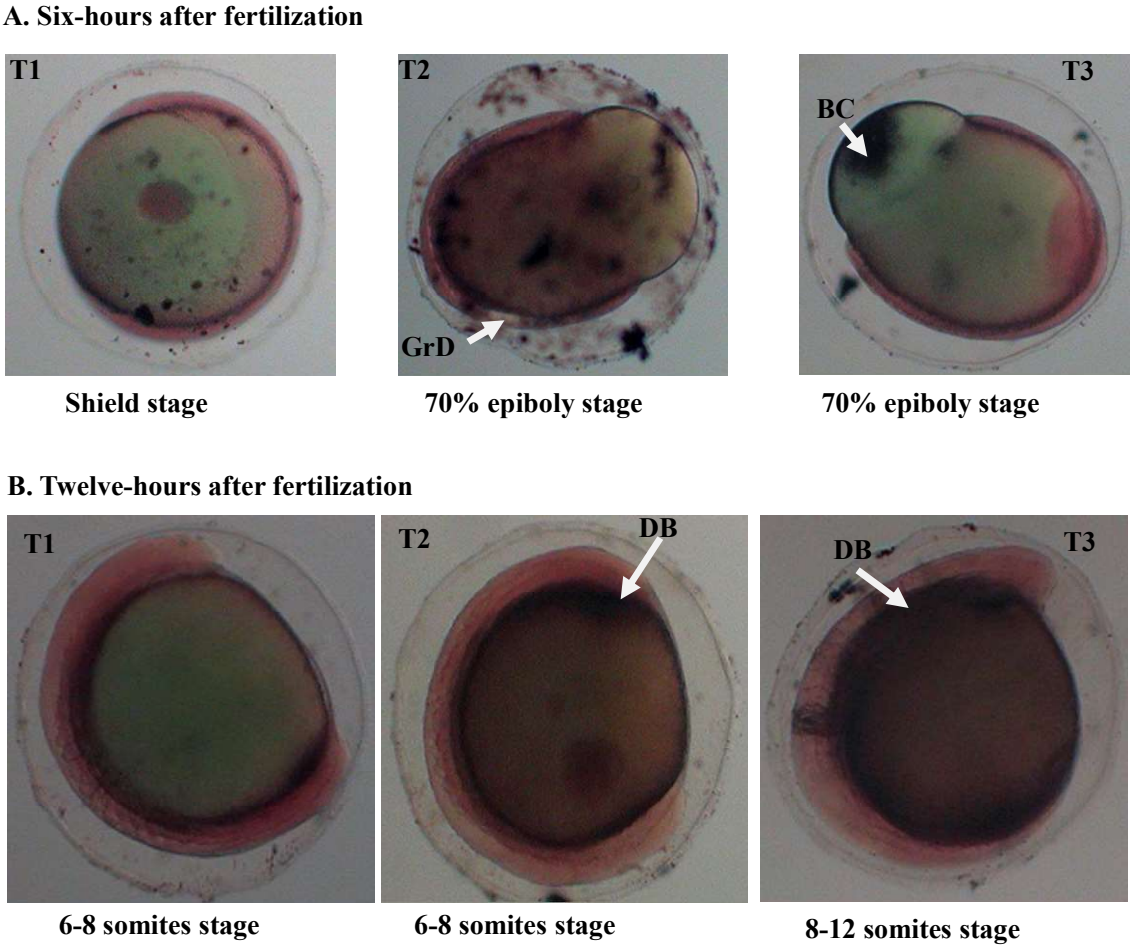

Fig. 12. Embryo at 6h after fertilization (A) and 12h after fertilization (B). GrD- damaged germinal ring; BC- black colour; and DB- dark brown colour in yolk sac.

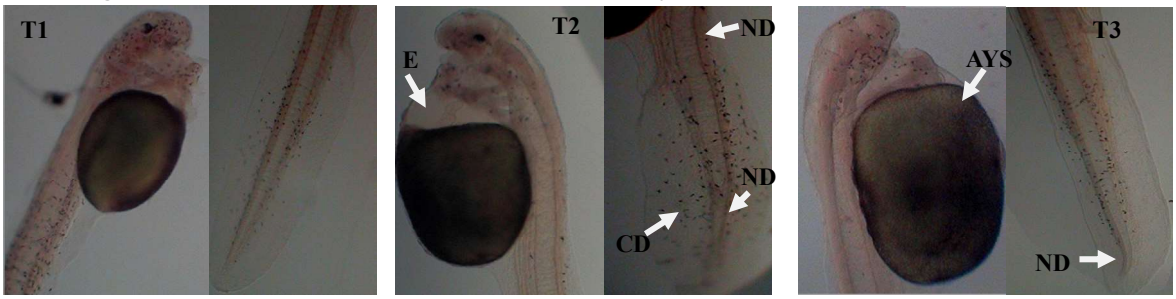

Fig. 13. Larvae at 24h after hatching. E- Edema; ND- notochord deformity; AYS- Abnormal Yolk Sac**.**

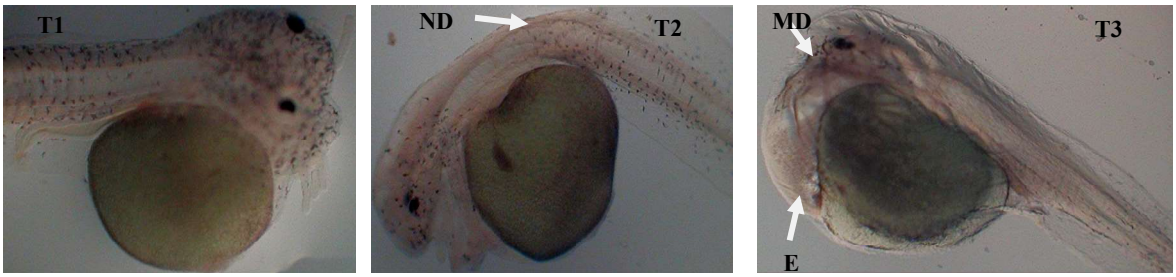

Fig. 14. Larvae at 36h after hatching. E- Edema; ND- notochord deformity; MD- mouth deformity.

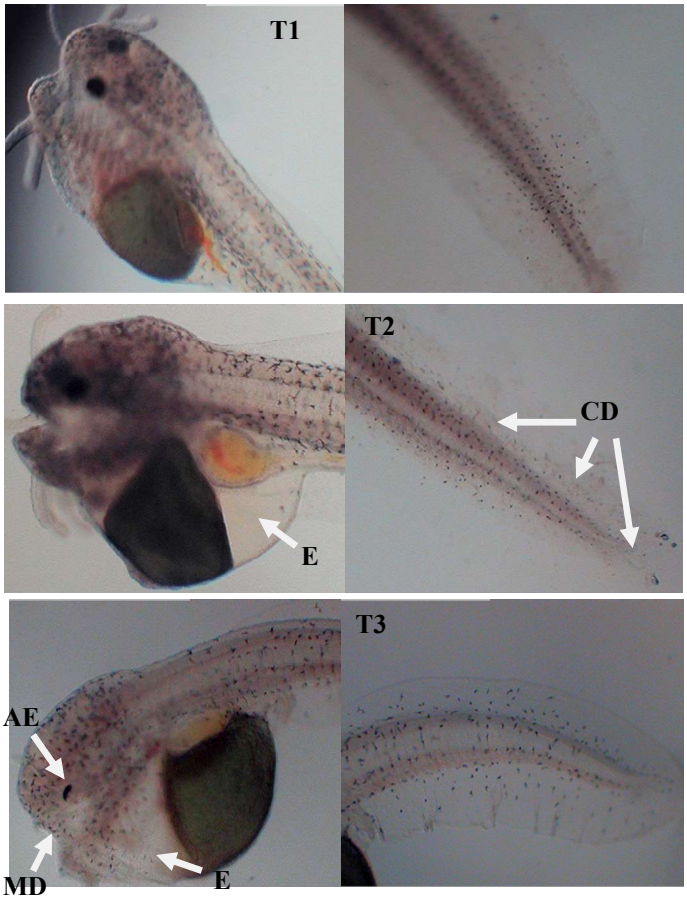

Fig. 15. Larvae at 48h after hatching. E- Edema; CD- caudal fin damaged; MD- mouth deformity; AE- Abnormal Eye formation.

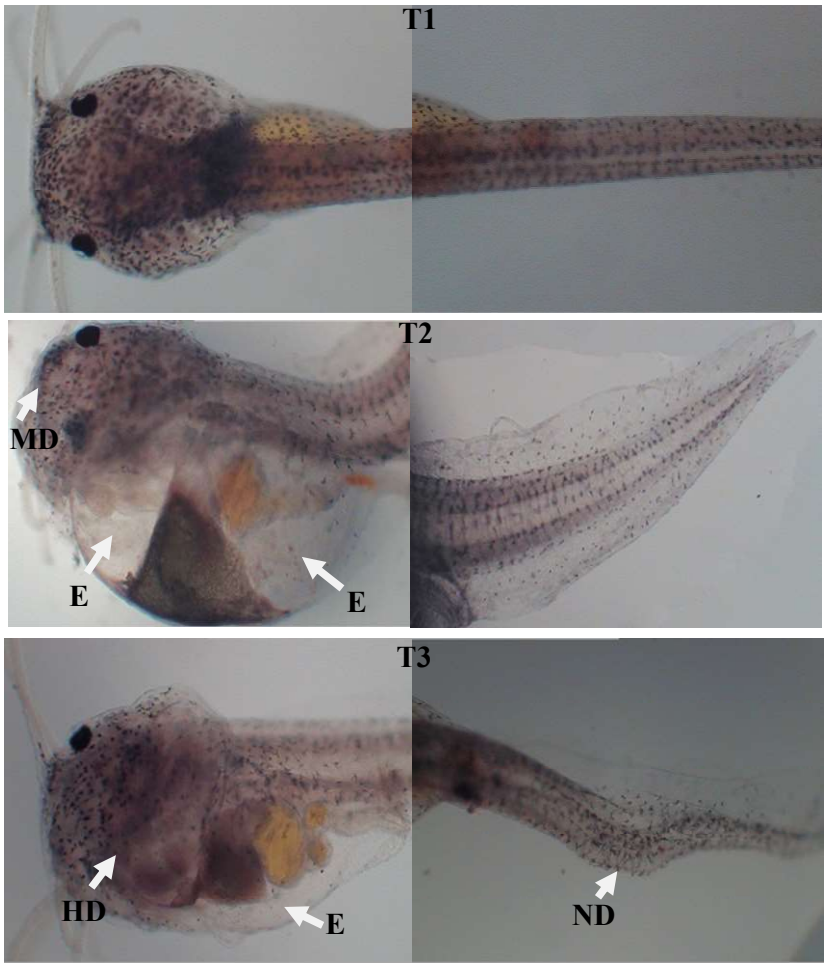

Fig. 16. Larvae at 72h after hatching. E- Edema; MD- mouth deformity; ND- notochord deformity; HD- Head Deformed.

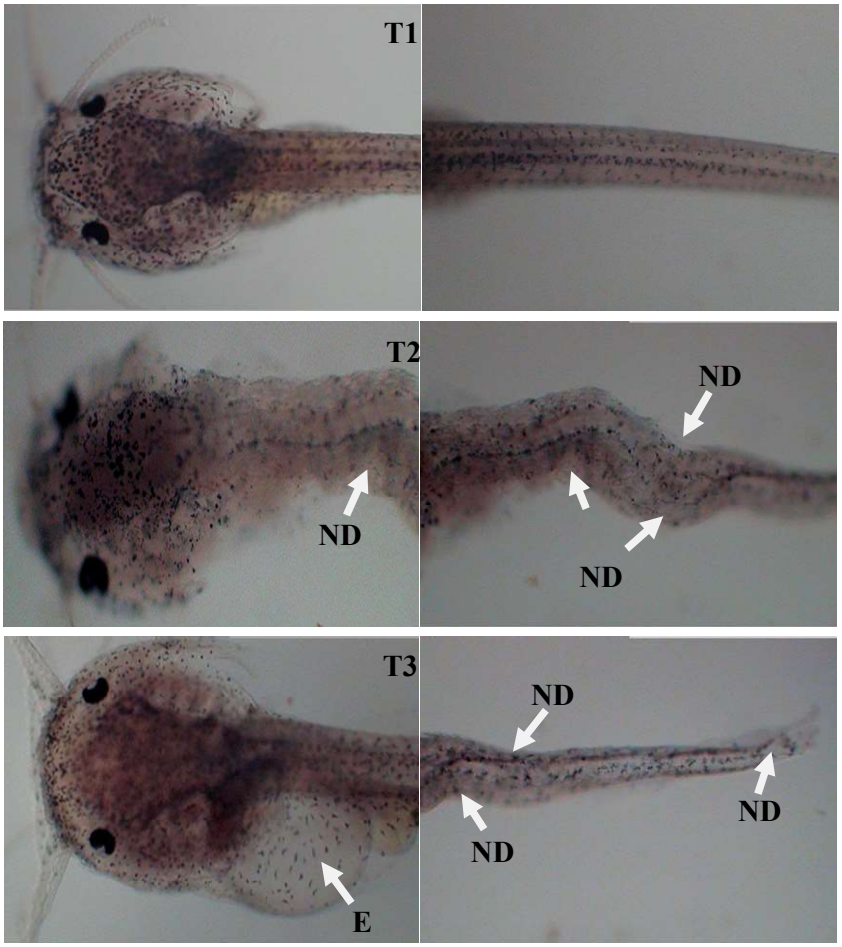

Fig. 17. Larvae at 96h after hatching. E- Edema; ND- notochord deformity.

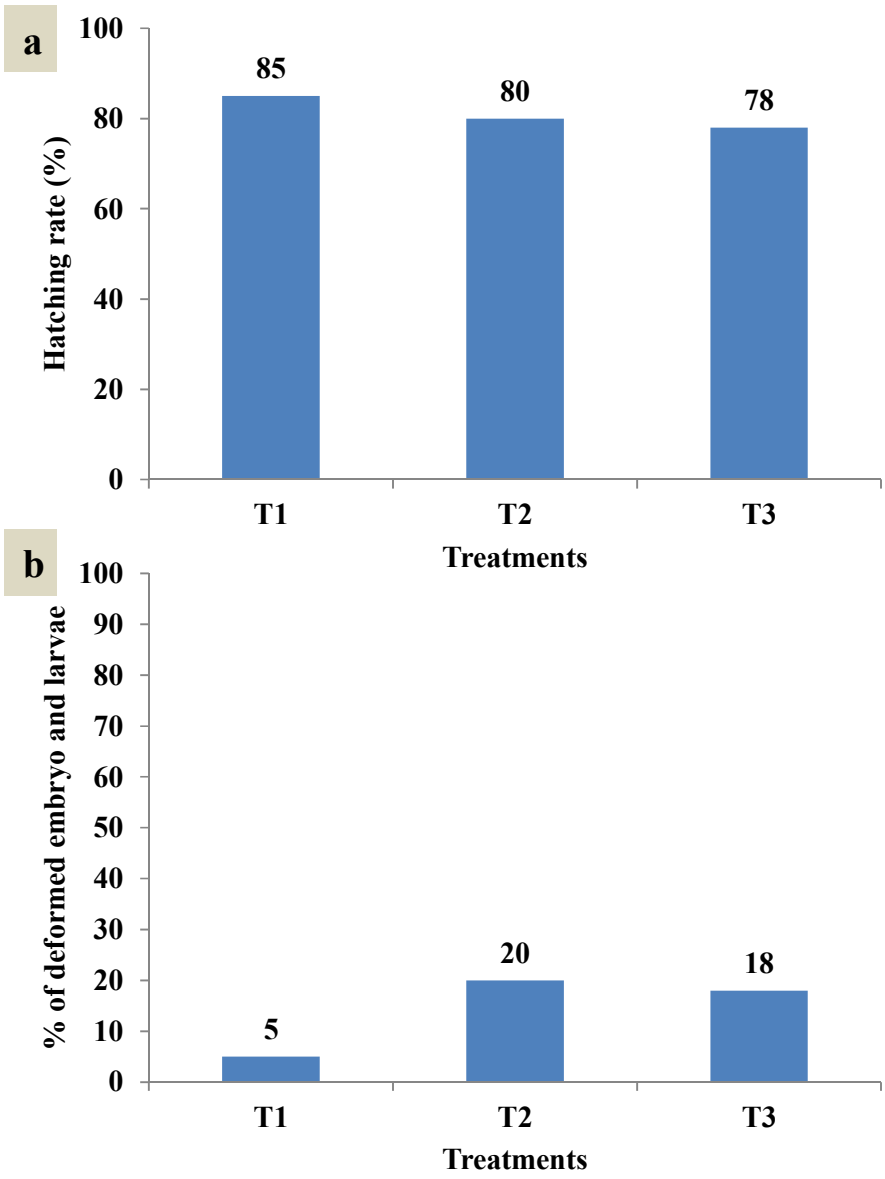

Fig. 18. (a) Hatching rate and (b) deformed hatchling of Shing (*H. fossilis*) collected from hatcheries maintaining brood stock properly (T1), has brood stock but not good management (T2) and no brood stock (T3).

Embryonic and larval stages of Perch-Tilapia, *Oreochromis niloticus*

We studied embryonic (Fig. 19) and larval (Fig. 20) development of a Perch-Tilapia. Interestingly we did not found any abnormalities and deformities of embryo and larvae collected from hatcheries maintaining brood stock properly (T1), has brood stock but not good management (T2) and no brood stock (T3). No distinct differences in hatching rate (%) were also noted among three treatments (Fig. 21).

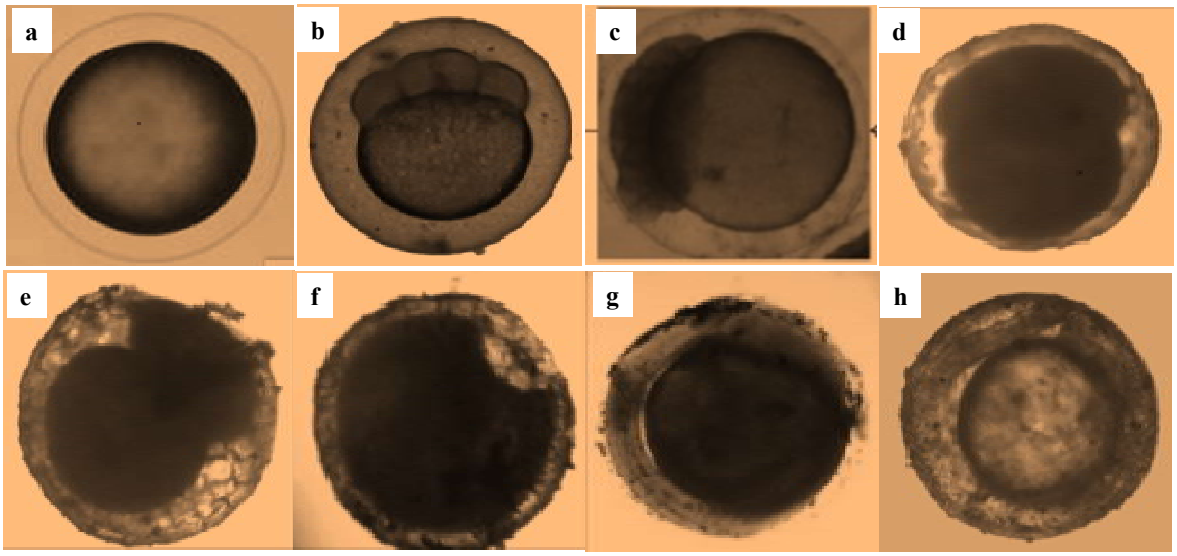

Fig. 19. Embryonic development of Perch-Tilapia ; a) Fertilized egg, b) 4-cell stage, c) multi-cell 3 haf, d) morula stage 4.30 haf, e) Early blastula 5 haf, f) Gastrula 7.30 haf, g) Somite stage 150 haf, h) Just before hatching 20 haf.

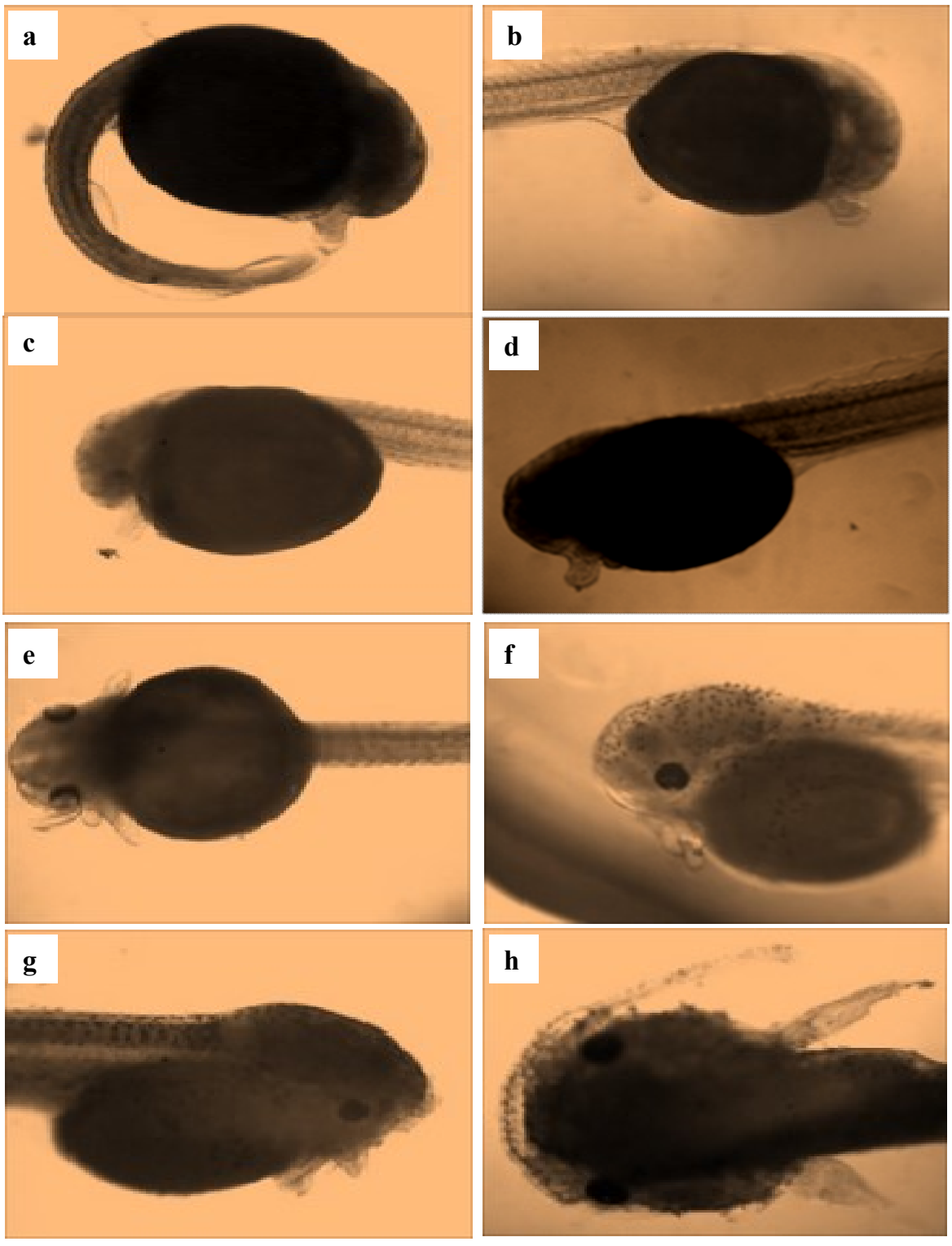

Fig. 20. Larval development of Perch-Tilapia ; a) Newly hatched larva, b) 2h old larva, c) 4h old larva, d) 6h old larva, e) 12h old larva, f) 24h old larva, g) 36h old larva, h) 72h old larva.

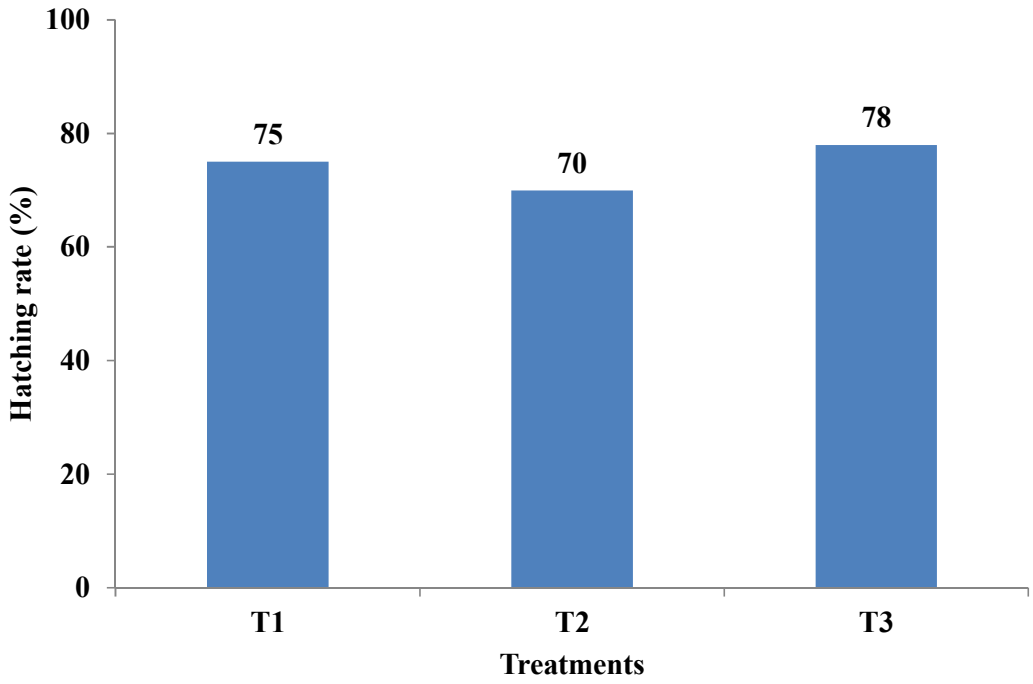

Fig. 21. (a) Hatching rate of Tilapia (*O. niloticus*) collected from hatcheries maintaining brood stock properly (T1), has brood stock but not good management (T2) and no brood stock (T3).

11.4 Principles to improve and maintain the quality of broodstock and fish seed

The following recommendations have been suggested depending on the findings of the present studies:

1. All hatcheries should have their own broodstock units, where breeders of different age groups of the species involved are kept under long term stocking conditions. In the management of a fish broodstock unit the main issues to be considered refer essentially to:
   - stock dimensioning;
   - stock collection;
   - adaptation to captivity and long-term stocking conditions;
   - sexual maturation and spawning according to the production schedule and
   - renewal of the old breeders.
2. Since the quality of seed has deteriorated over the years due to inbreeding, hybridization, negative selection and improper brood stock management, special attention should be paid to improve the quality of seed. In this regard, live brood and cryogenic gene banks need to be established.
3. Parent fish should be collected either from a farm or from the wild. Usually, wild fish are preferred since farmed animals could present some problems such as consanguinity or poor general conditions due to an unhealthy rearing environment. On the other hand, the use of farmed animals gives the possibility to select breeders on the basis of observed characteristics of the animals (fast growth, commercially preferred pigmentation and shape, domestication, etc.).
4. Wild fish have to be conditioned to captivity, which generates stress that will inhibit their sexual maturation for a certain time (latency period). It is safer to consider that new broodstock should be kept in the farm for at least six months before being used as breeders.
5. The main selection criteria to identify adult fish as suitable breeders are not scientifically stated, but follow the common sense. With the advance of genetic studies, more specific criteria will probably become available related to faster growth rate and stronger disease resistance. For the

time being, the following empirical selection criteria for breeders have a proven record to work for hatchery purposes:

- normal body shape and color;
- absence of skeletal deformities;
- overall health status (absence of large wounds, hemorrhages, infections, parasites and necrosis);
- normal behavior such as a quick response to food distribution, fast swimming, controlled buoyancy etc.;
- the largest size within its age group;
- the best growth and food conversion rate within its age group.

6. Feeding broodstock
   - A diet rich in vitamins, poly-unsaturated fatty acids (n-3 PUFA) and other micro-nutrients is essential in obtaining viable eggs and larvae.
   - From a management point of view, a feeding schedule should be prepared at regular intervals based on periodical controls of fish weight.
   - During gametogenesis female fish require feed enriched in sufficient proteins and lipids more than usual to produce the vitellogenin, which is progressively stored as yolk in the oocytes. As the sole source of food for the developing embryo and the early larval stage until feeding on live preys starts, yolk quality and quantity are key factors for a successful reproduction.
7. Necessary training on broodstock management, breeding technology, nursery technology, disease control etc. should be provided to hatchery and nursery operators, farm managers, and fish farmers.
8. Government should ensure supply of adequate high quality of pituitary gland for induced breeding.
9. Formal fry and fingerling trading networks should be developed locally and regionally by the government and other developing partners so that fry and fingerlings producers can get their actual profit.
10. Government and NGO's should come forward to arrange loan system for the commercial fish farmers and also arrange subsidy system.
11. Research institutes should build an institute- industry research partnership with hatchery and nursery operators to improve quality broodstock and produce quality fingerlings.
12. Government should take proper steps to train up the interested people on modern technology of hatchery management.
13. Organized community actions may be encouraged to avoid management problems, thefts and intentional damage of commercial fish farms.
14. Out-of-season spawning
    - When fertilized eggs are required outside the natural spawning period, out-of-season sexual maturation is obtained through environmental phase shifting of the gametogenesis by manipulation of photoperiod and temperature. Different methods can be applied for out of season spawning:
      - ✓ fish are kept under compressed photoperiods and temperatures cycles (the commonest);
      - ✓ fish under constant day length are exposed to brief periods of long or short days;
      - ✓ fish live in different 12-month long natural cycles, but shifted by three months each.
    - The broodstock is divided in four groups including both males and females: three groups are exposed to environmental regimes that are shifted by 3, 6 and 9 months respectively compared to the natural environmental regime, which is left for the fourth group. In this way, the hatchery will have a group of fish ready to spawn on each season: in winter the parent fish exposed to natural environmental conditions, in spring, summer and i autumn the other three groups. Shifting should start when fish are still in the resting phase of their sexual cycle. If breeders are properly managed, eggs produced out of season with shifted cycles do not differ significantly in quality and quantity from the in-season eggs.

- An out of phase maturation unit requires specific facilities:
  - ✓ an independent sector equipped with tanks suitable for long term stocking, where light and water temperature conditions can be set independently from the natural cycle;
  - ✓ a timer-controlled lighting, preferably equipped with a dimmer to avoid abrupt changes in light intensity (and to create a twilight effect);
  - ✓ a water heating/cooling system (usually heater and heat-pump);
  - ✓ a computerized control of temperature and photoperiod.

15. Establishment of Biosecurity: Biosecurity is the establishment and implementation of a system or procedures to prevent the introduction of pathogens into a fish hatchery from outside the facility or into a section of the hatchery from another section in the same hatchery.

11.5 Guideline for the fish feed producers and users for maintaining quality

The study has identified various research, development and policy actions that can be taken to improve the quality of ingredients, together with better formulation and utilization of fish feeds by farmers. The key recommendations are organized around six main areas:

1. Better feed ingredients

- ➢ Improvement in ingredient quality and sustainability of local protein requirements is required, specifically:
- Sustainability of locally-available animal protein sources needs more in-depth understanding, and supplies identified that are sustainable and consistently available.
- Protein digestibility should be understood for different local fish species to allow feed manufacturers to better match dietary ingredients with fish requirements.
- Adulteration in feed value chains and processing should be assessed, and control points identified.
- Improved methods for protein and other chemical measurements should be adopted to detect and avoid adulteration.
- ➢ Increasing production of local raw materials has potential to help reduce feed costs, minimize environmental impacts and provide income for local farmers, specifically:
- Undertake an in-depth study of potential locally-available raw materials to identify sustainable supplies.
- Identify technologies for processing and preservation that ensure maximum utilization of raw materials.
- Collaborate with international research organizations (e.g. CIMMYT, IRRI) to develop local varieties (maize, soybean) and cultivation methods to boost yields.
- Conduct extension activities to promote farming of suitable and competitive local feed ingredients.
- Initiate research on relations between feed ingredients, feed formulation, and the human nutritional values of farmed products.

2. Feed formulation and processing

Feed formulation and processing improvements can contribute to more efficient operation of feed processing plants and better feeds available for farmers, specifically:

- Training should be provided for feed millers on machine selection, improved operations and better maintenance, aimed at supporting improvements in feed quality and profitability of commercial feed milling.
- Through training and other industry promotional activities awareness should be raised about lower energy systems and fuel alternatives (e.g. rice husk boilers) to minimize energy costs and impacts.
- Educational institutions and local service providers should receive training to improve their knowledge and skills on feed mill operations and lift their capacity to better serve industry requirements.

- Commercial feed mills should be better connected to national and international research organizations, education institutes and service providers.
- A mandatory qualification system for machine operators should be developed and implemented, supported by training provided by qualified institutions.
- Assist manufacturing workshops so they build better local feed processing equipment.
- Provide training in good quality feed production to small and village feed millers.
- Provide training on feed nutrition and on how to determine nutrient properties of feed and feed ingredients.
- Identify better village feed production technologies through research.
- Provide training in farm-made feeds (and involve women).
- Investigate the potential for use of premix concentrates for farm-made feeds, and if feasible promote to farmers.
- Pilot improved village feed production technologies and extend them widely.
- Train feed mill nutritionists in quality feed formulation.
- Train producers and local raw material traders in feed formulation
- Encourage wider use of feed formulation software across the feed processing industry.
- Provide better capacity building at local level.
- Ensure that BFRI and DoF have the capacity to provide professional advice on feed formulation.
- Establish better connection of feed formulation software and feed additive companies for knowledge transfer.

3. Better farm-level feed utilization

- Feeding guidelines for major aquaculture species reviewed, upgraded and disseminated to the aquaculture farming community
- Awareness raised on feed quality through the entire feed value chain.
- Feed requirement and feeding systems for different fish species optimized.
- Ecologically efficient methods (e.g. culturing multiple species simultaneously, such as the 80:20 methods) identified through research and disseminated.

4. Improving access of farmers to financial and technical services

- Build partnerships/establish linkages with financial institutions to give farmers access to suitable credit systems, enabling them to purchase better feeds and make use of technical services.
- Undertake research on enabling access to credit and technical services at the local level.
- Establish sustainable business-oriented services for small farmers.

5. Improving collaborations

- Improve communication to avoid duplication and overlapping activities.
- Strengthen Feed Industries Association of Bangladesh (FIAB) as an initiative for making a collaborative agency.
- Collaborate on various activities of different organizations through FIAB and Animal Health Companies Association of Bangladesh (AHCAB).
- Involve government agencies with FIAB for future development of the feed sector.

6. Feed Act and Public Policy

The Feed Act provides an important basis for regulation of aquaculture feeds, but requires stronger implementation, specifically:

- Complete review of Feed Act.
- Complete review of custom regulations for raw material importation and export.

12. Research highlight/findings:

i. Most of the commercial fish farm owners used to use commercial feed instead of homemade feed.

ii. The quality of homemade feed is better than commercial feed.

iii. Manufacturer's declared proximate composition of most of the collected feed samples was either lower or higher.

iv. Brood stock and fries originated in river, govt. hatcheries and BFRI are better than those of private hatcheries in terms of growth performance, disease resistance and survivality.

v. More abnormalities and deformities were observed in embryo and larvae at T2 (no broodstock) and T3 (broodstock with poor management) compared to T1 (broodstock with proper management).

B. Implementation Position

1. Procurement:

Description of equipment and capital items	PP Target		Achievement		Remarks
	Phy (#)	Fin (Tk)	Phy (#)	Fin (Tk)	
(a) Office equipment	1. Laptop 2. Laser printer	80,000	1. Laptop 2. Laser printer	79,800	100% achieved
(b) Lab & field equipment	1. Microscope with camera 2. Electric Balance	480,000	1. Microscope with camera 2. Electric Balance	479,850	100% achieved
(c) Other capital items	-	-	-	-	-

2. Establishment/renovation facilities: N/A

Description of facilities	Newly established		Upgraded/refurbished		Remarks
	PP Target	Achievement	PP Target	Achievement	

3. Training/study tour/ seminar/workshop/conference organized: N/A

Description	Number of participant			Duration (Days/weeks/ months)	Remarks
	Male	Female	Total		
(a) Training					
(b) Workshop					

C. Financial and physical progress (Fig in Tk)

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
A. Contractual staff salary	713532	713532.00	628864	84668.00	100	Late to sign LoA
B. Field research/lab expenses and supplies	2820000	2762314.00	2820400	-58086.00	100	GoB fund Not release
C. Operating expenses	270000	267250.00	269726	-2476.00	100	GoB fund Not release

D. Vehicle hire and fuel, oil & maintenance	300000	292500.00	300000	-7500.00	100	GoB fund Not release
E. Training/workshop /seminar etc.	-	-	-	-	-	-
F. Publications and printing	165000	26946.63	15000	11946.63	10	GoB fund Not release for PCR
G. Miscellaneous	171468	170358.00	169500	858.00	100	Bank charge need
H. Capital expenses	560000	560000.00	559650	350.00	100	Actual RFQ

D. Achievement of Sub-project by objectives:

Specific objectives of the sub-project	**Major technical activities performed in respect of the set objectives**	**Output (i.e. product obtained, visible, measurable)**	**Outcome (short term effect of the research)**
1. To evaluate the quality of feed (the major ingredients) used in the fish farms and to assess the performance of broodstock and fingerlings of selected Carp, Catfish and Perch farmed in Bangladesh	1. Conducted an in-depth survey on - -present status of feed used in commercial fish farms, -the perception of the fish farmers on the feed available in the markets, -quality of broods used in the hatcheries and quality of fish seeds 2. Study the quality of broods and performance of fingerlings of Carp, Catfish and Perch collected from selected fish farms through the study of their larval and embryonic development 3. Analysis of the proximate composition and heavy metals concentrations of different fish feeds used in the commercial fish farms	Survey report, periodical reports, PCR, financial statements, bill and vouchers, best practice guideline etc.	Guidelines prepared for fish feed producers and users
2. To develop a set of principles for the hatchery owners on how to maintain and improve the quality of broodstcok and how to produce fish seed with prime quality that ensure high survival, good growth, and best disease resistance in the grow-out	1. Conducted an in-depth survey 2. Study the quality of broods and performance of fingerlings of Carp, Catfish and Perch collected from selected fish farms through the study of their larval and embryonic development	Half yearly and Annual reports, PCR, etc.	Set of principles to maintain and improve the quality of broodstcok and fish seed

3. To prepare a guideline for the feed producers (manufacturers) and fish feed users (fish farmers & hatchery owners) on using feed ingredients and maintaining quality	1. Conducted an in-depth survey 2. Analysis of the proximate composition and heavy metals concentrations of different fish feeds used in the commercial fish farms	PCR	Guideline for the fish feed producers and users for maintaining quality of feed

E. Materials Development/Publication made under the Sub-project:

Publication	Number of publication		Remarks (e.g. paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Technology bulletin/ booklet/leaflet/flyer etc.			N/A
Journal publication			N/A
Information development			
Thesis	2	2	1. Proximate composition of selected fish feeds used in the commercial fish farms of Bangladesh 2. Study on the quality of fish feed, brood used and fingerlings produced in commercial fish farms in Mymensingh region 3. Present status of the fish farms in the Rajshahi regions of Bangladesh 4. Scenario of the fish hatchery in the Jashore region of Bangladesh

F. Technology/Knowledge generation/Policy Support (as applied):

i. Generation of technology (Commodity & Non-commodity)

N/A

ii. Generation of new knowledge that help in developing more technology in future

N/A

iii. Technology transferred that help increased agricultural productivity and farmers' income

N/A

iv. Policy Support

1. Set of principles to maintain and improve the quality of broodstcok and fish seed
2. Guideline for the fish feed producers and users for maintaining quality

G. Information regarding Desk and Field Monitoring

i) Desk Monitoring [description & output of consultation meeting, monitoring workshops /seminars etc.):

1. Workshop on mid-term review of CRG sub-projects of Fisheries Division, BARC, 10-11 April 2018
2. Annual review workshop on CRG sub-project of Fisheries Division, BARC, 19-20 September 2018

ii) Field Monitoring (time & No. of visit, Team visit and output): Not done

H. Lesson Learned (if any)

N/A

I. Challenges (if any)

1. Lack of willingness of farming community to participate in survey.
2. Collecting accurate information from farm owners due to their tendency of hiding information.
3. Insufficient information available to assess different parameters accurately.

Signature of the Principal Investigator
Date …….
Seal

Counter signature of the Head of the organization/authorized representative
Date ……..
Seal

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Appendices

Appendix I. Survey Questionnaire; Target Group – Fish Farms with Hatchery

A. Location of Hatchery

Name of Hatchery	
Para/Village	
Union	
Upazila	
District	
Division	

B. Owner Information

Name of Owner	
Contact Address	1. Cell Phone: 2. Land Phone: 3. E-mail:
Age group	1. < 25 yrs 2. 25-35 yrs 3. 36-45 yrs 4. 46-60yrs 5. > 60yrs
Religion	1. Muslim 2. Hindu 3. Christian 4. Buddhist 5. Others
Educational Background	1. Illiterate 2. Primary 3. SSC 4. HSC 5. College 6. University 7. Madrassa
Year of Fish Hatchery/ Farming Experience	
Other area of Experiences	
Other occupation	
Is fish hatchery your main earning source	1. Yes 2. No
Type of land	1. Leased Lease value: 2. Own 3. Both

C. Physical facilities of the Hatchery

Hatchery Complex	
Total area of hatchery complex (acres)	
No. and area of brood ponds	
No. and area of Nursery ponds	
No. and area of grow-out ponds	
Hatchery Proper	

Area of the Hatchery Proper	1. Acres: 2. Decimal:
Water source	1. Underground water 2. Canal Water 3. River water 4. Bio-filters 5. Rain water 6. Others
Overhead tank	1. Number: 2. Capacity: 3. Height:
Aeration facilities	1. Water Aeration Tower 2. Pump (No.& Capacity) 3. Paddle Wheel 4. Others
Source of Power	1. Generator- Capacity: HP 2. Electricity
No. of Tanks	1. Circular (No. & Cap.) 2. Brood Holding Tank (No. & Cap.) 3. Incubation jars 4. Hatching Tray 5. Hatching jars 6. Others
Lab facilities	1. Yes 2. No
List of Equipment's	1. Balance 2. DO and pH meter 3. Microscope 4. Sechi-disk 5. Thermometer 6. Others
Office Room	1. Yes 2. No
Store Room (Feed/ warehouse)	1. Yes 2. No
Guard/ Labour Shad	1. Yes 2. No.
Boundary wall	1. Yes 2. No
Transport facilities	1. Van 2. Tractor 3. Mini-Truck
Sanitation facilities	1. Concrete & closed 2. Open

D. Seed of the different species produced in the hatcheries

What are the fish seeds you produce in your hatchery?

Carps –

Catfish –

Perch –

Tilapia -

Eel -

Others –
Please give a brief description about the history of fish hatching in your hatchery (when did you start what).

E. Seed of the different species produced in the hatcheries

From where you collect the brood fish?

1. River
2. Another hatcheries
3. Own hatcheries
4. Govt. brood bank
5. Others sources

How many brood fish in your hatchery now on basis of species and sex?

Which one is best brood among the different collected sources?

How many fries you produce in your hatchery at one season and whom to you sell it?

Among the species which fries are more demanded by the farmers?

Do you interested to exchange brood fish with other hatcheries to reduce inbreeding and increase the quality of fries?

What's the reason behind yes or no?

Do you have got any subsidy to run your hatcheries or receive any loan from any bank?

F. Production, supply and demand scenario

What is the production volume of your hatchery in 2016-2017? Please give a species-wise description.

Do you think, you can sale more than what you produce, or market is saturated and demand is decreasing gradually. Please make species-wise comments.

G. Different feeds used for brood stock management and nursing in the hatcheries

What types of feeds are used for brood stock management?

1. Home made
2. Company feed
3. Both

If homemade than which feed ingredients are used and how to fed?
If company feeds are used than which company feeds for brood stock management?

1.

2.
3.
4.
5.
6.
7.

Which one is better between homemade and company feed for brood stock management and why you think so?

Which one is best company feed you have used for brood stock management and why that company feed is best?

H. Training need

If you want to produce more fish seed than the earlier what will be your training needs on the followings -

Broodstock management
Hatchery facilities
Breeding techniques
First feed/weaning diet
Nursing
Seed transport

I. Gross Profit from the Hatchery

2014
2015
2016

J. Constraints and remedies of the hatchery (as of owner's statement)

Constraints	Remedies
1	
2	
3	
4	
5	

K. How do you evaluate the performance of your hatchery?

1. Very poor
2. Poor
3. Medium
4. Advanced
5. Highly advanced

Name of Respondent:

1. Position
2. Signature with date
3. Mobile number

Interviewed by

1. Name
2. Signature with date

Appendix II. Survey Questionnaire; Target Group –Fish Farms without Hatchery

A. Location of Fish Farm

Name of Farm	
Para/Village	
Union	
Upazila	
District	
Division	
Name of owners	
Address and Contract	Cell Phone: Land Phone: E-mail:
Age group	6. < 25 yrs 7. 25-35 yrs 8. 36-45 yrs 9. 46-60yrs 10. > 60yrs
Religion	6. Muslim 7. Hindu 8. Christian 9. Buddhist 10. Others
Educational Background	8. Illiterate 9. Primary 10. SSC 11. HSC 12. College 13. University 14. Madrassa
Year of Fish trading Experience	
Other area of Experiences	
Other occupation	
Is fish farming your main earning source?	1. Yes 2. No

B. Mode of farming:

How do you farm fish?
1. Intensive
2. Semi-intensive
3. Extensive
4. Super-intensive

What is your fish culture system?
1. Mono culture

2. Poly culture
3. Mixed culture
Which culture system is best?

Where do you collect the fries?

3. Private hatcheries
4. Govt. hatcheries
5. Rivers
6. Others

Which one is best on growth performance you think?

Where do you sale your farm fish?

Are you a member of fish farming group or do the business alone?

What are the peak months of fish farming business?

How many crops you harvest within one year?

Did you receive any subsidy or loan from any bank?

Among the cultured species which one more vulnerable to disease?

C. Seed of the different species udder farming

What are the fish you farm?
Carps –
Catfish –
Tilapia -
Perch –
Eel -
Others –
Please give a brief description about the history of fish farming (when did you start what)

What are the species you think to culture beneficial?

D. Different feeds used for fish farming

What types of feeds are used in your farm?

1. Homemade
2. Company feed
3. Both

If homemade than which feed ingredients are used and how to feed?

If company feeds are used than which company feeds used farming?

1.

2.
3.
4.
5.
6.
7.
8

Which one is better between homemade and company feed farming of fish and why you think so?

Which one is best company feed you have used farming and why that company feed is best?

E. Trade volume, supply and demand scenario

What is your average annual production volume? Please give a species-wise description.

Do you think you can farming more than what you are farming now, or market is saturated and demand is decreasing gradually? Please make species-wise comments.

F. Training need

Do you need any training to improve your fish farming skill? Please describe

G. Gross Profit from the farming

2014
2015
2016

H. Constraints and remedies of the fish farming

Constraints	Remedies
1	
2	
3	
4	

5	

I. How do you evaluate the performance of your fish farming business?

1. Very poor
2. Poor
3. Medium
4. Good
5. Very Good

Name of Respondent:

1. Position
2. Signature with date
3. Mobile number

Interviewed by

1. Name
2. Signature with date

Appendix III. Photo documentation (Res. Work, Monitoring, Training, Field day etc.)


MS Class Test
FM 313 – Aquatic Soil Science
FM 311 – Fish Population Dynamics
FM 411 – Oceanography and Marine Biology
FM 413 – Coastal Zone Manage