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PRESENT STATUS OF CARP HATCHERY AND BREEDING OPERATIONS IN BANGLADESH: A REVIEW

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ABSTRACT

Carps are the main species for the aquaculture system in Bangladesh, and the production of these species completely depends on timely and adequate supply of quality seeds. In hatcheries, since middle of nineties, stock deterioration was reported because of poor brood stock management and inbreeding depression and still though both public and private hatcheries and nurseries are producing fish seeds, but there has been a growing concern over the availability of good quality seeds for sustainable fish production. For that reason, the production of quality carp spawns and fingerlings are essential for desired production of fish in Bangladesh. We reviewed the present status of carp hatcheries along with ongoing practices of breeding in different carp hatcheries for sustainable production strategies in this region.

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INTRODUCTION

Bangladesh is one of the world's leading fish producing countries with a total production of 3.684 million mt in the fiscal year 2014-15, contributing 3.69% to the GDP and over 23.12% to the agricultural GDP (FSYB 2015). It is endowed with diversified fisheries resource of which aquaculture is the most important and this aquaculture is mainly carp based. According to Hasan and Ahmed, (2002), three Indian, major carps (rui, catla and mrigel) and three exotic carps (silver, grass and common carps) are the dominant fish species cultured in Bangladesh. However, the availability of fish fry is an essential prerequisite for aquaculture. In past, the rivers of Bangladesh were the major natural source of carp seed production. Due to the destruction of natural habitats and also increased demand, the natural availability of carp seed has largely declined and the aquaculture venture are gradually replaced by the hatchery produced fry since early 80's when artificial fish breeding techniques and low cost hatchery designs have been successfully adapted in Bangladesh (Islam, 1989). So, in recent years, the main sources of carp seed in Bangladesh are spawn produced in government and private hatcheries, and some collected from rivers. In the year 2014, the total carp fry production in Bangladesh was 352010 kg, of which 9207 kg and 342803 kg from 92 public hatcheries and 790 private hatcheries respectively.

What is carp?

Carp are mainly freshwater oily (Food Standards Agency, 2004) fish species under the family Cyprinidae, a very large group of fish primarily originated from Europe and Asia.

Biology of Carp

Cypriniformes mostly have scales and teeth on the inferior pharyngeal bones which may be modified in relation to the diet. Only *Tribolodon* genus under Cyprinidae family can tolerate salt water. Some species are catadromous and they move into brackish water but return to fresh water to spawn. Rest of the cypriniformes live in continental waters and have a wide geographical range (Billard, 1995). Some carp species are able to survive for a few months with practically no oxygen (for example under ice) by metabolizing glycogen to form ethanol and lactic acid (New Scientist, 2017). Somebody think that all cyprinid fishes are carp. On the other and, some consider the family Cyprinidae itself is the carp family. In colloquial use, carp usually refers only to several larger cyprinid species such as *Cyprinus carpio* (common carp), *Labeo rohita* (rohu carp), *Ctenopharyngodon idella* (grass carp), *Hypophthalmichthys molitrix* (silver carp), and *Aristichthys nobilis* (bighead carp).

Carps in Bangladesh

Carps are basically the most important species to aquaculture in Bangladesh (Table 1). In 2001, carp production was estimated as 89% of the total freshwater fish production in the country.

Table 1. Carp species used in hatcheries for seed production in Bangladesh

Major Groups	Common name	Scientific name
Indian Major Carps	Rohu carp	*Labeo rohita*
	Catla carp	*Catla catla*
	Mrigal carp	*Cirrhinus cirrhosus*
	Kalibaush	*Labeo calbasu*
Exotic Carps	Silver carp	*Hypophthalmichthys molitrix*
	Grass carp	*Ctenopharyngodon idella*
	Common Carp	*Cyprinus carpio* var. *communis*
	Mirror carp	*Cyprinus carpio* var. *specularis*
	Bighead carp	*Aristichthys nobilis*
	Black Carp	*Mylopharyngodon piceus*

Carp Hatchery

The term “Carp Hatchery” is considered in broadest sense as a facility where carp fish fry and fingerlings suitable for stocking in growth ponds are produced in artificial manner by the process of induced breeding technique. Induced breeding is a technique whereby ripe brood fishes are stimulated by treating them with inducing agents to breed in captivity. The stimulant promotes a timely release of eggs and milt from ripe breeders. It is now used as a widely accepted means of artificial propagation to overcome constraints in fish seed supply particularly for species that do not breed in captivity.

Carp hatchery region in Bangladesh

The carp hatcheries are distributed in most parts of Bangladesh. They are Mymensingh, Khulna, Satkhira, Bagarhat, Barishal, Jhalukati, Comilla, Chandpur, Chuadanga, Dhaka, Borguna, Faridpur, Madaripur, Kushtia, Magura, Naraial, Pabna, Bogura, Rangpur, Nator, Rajshahi, Jessore and other districts of Bangladesh. Most of the hatcheries are seen Mymensingh, Jessore, Khulna, Rajshahi.

Common hatchery operations

In Bangladesh, most intensive hatchery and nursery activities take place during June-December, although nursery activities often extend up to February. Generally, during or after February, farmers begin their pond preparation to start the new cycle of breeding and rearing. On average, the duration of the hatching cycle in hatcheries are about five days and the number of cycles per year (June-December) are about 30. The hatchery cycle generally starts from the day when the broodstock are brought to the hatchery from the brood pond until the larvae absorb the yolk sac and the fry are transferred to the rearing pond or cement cistern from the hatching jar. Nursery rearing of carp fry and fingerlings is generally carried out in three stages: a) early fry raising (spawn-early fry), b) fry raising (early fry-fry), and c) fingerling raising (fry-fingerling). The duration of the nursery cycle varies depending on the stage of rearing. The duration of the early fry-raising cycle varies between six to eight days that of fry raising varies between 20-30 days, and that of fingerling raising between 90-100 days. On average, the total number of nursery cycles per year was 8-12. During early fry raising, spawn are raised up to 0.5-1.0 cm size; during fry raising, the fry are grown from 1.0 to 3.0 cm; while size ranges in fingerling raising vary widely between 3-15 cm.

Most hatchery and nursery owners have their own broodstock and nursery ponds. Many of the nursery owners also lease ponds from villagers. The study did not reveal any major difference in the number of ponds owned by the hatchery and nursery owners in these two regions. On average, the hatcheries had eight ponds with a total pond area of 2.06 ha, and the nurseries had, on average, seven ponds with a total pond area of 1.88 ha. Combined hatcheries and nurseries were larger, with an average of 10.5 ponds and an area of 6.74 ha. Nevertheless, there was a large variation in total area between different hatcheries and nurseries. The maximum nursing pond area was 17.8 ha, and the minimum was only 0.06 ha. Forty-two percent of the nurseries sampled had a pond area of less than 1 ha. For hatcheries, the average area of ponds was 2.23 ha, with a minimum of 0.13 ha and a maximum of 9.93 ha. Forty-five percent of hatcheries had an area of less than 1 ha. For the combined hatcheries and nurseries, the average size was greater, with an average pond area of 6.74 ha. The maximum farm size was 43.71 ha, and the minimum was 0.82 ha.

The nursery owners were interviewed about their most likely sources of spawn and the hatchery owners about the sources of their broodstock. The source of spawn for nurseries was mainly from hatcheries (72.6 %); followed by wild caught (e.g., river - 13.7%), own grown (12.6%) and other farmers (0.5%) (Table 4). Similarly, the source of broodstock for the hatcheries was mainly from other farmers' ponds (41.3%), followed by own grown (16.3%), wild caught (16.3%), traders (11.5%), government and private hatcheries and other sources.

Induced breeding practices

The knowledge of artificial breeding is a key aspect as it permits intensive production of a given species in controlled conditions. This allows continue production of juveniles for restocking natural or artificial water bodies (Montchowui et al., 2011). When some stimulants, hormones or pituitary extracts are injected in the brood fishes causing fish to spawn in the controlled condition out of natural environment is called induced breeding or artificial reproduction (Bhuiyan and Aktar, 2011; Bhuiyan et al. 2008) which is a common practice in our country since 1967 (Ali, 1967). Only a proper induced breeding and fry rearing technique can ensure a steady supply of quality fish seeds.

At first Bangladesh started aquaculture practices with natural seed but now it is almost entirely (99.55%) replaced by hatchery produced seed. Since 1975, Bangladesh has successfully adapted artificial fish breeding techniques and low cost hatchery designs. Along with the three Indian major carps, few other major and minor carps and catfishes have been successfully bred in hatcheries. Up to now, 14 endemic finfish species are used in hatcheries for seed production. Among them catla, rohu, mrigal, calbasu and Asian catfishes (Deshi magur and shing) are main (Sarder, 2007).

Table 2. Hormone treatment to the carp broodstock

Species	**Sex**	**1st dose (for each kg)**	**Interval (hours)**	**2nd dose (for each kg)**	**Ovulation** (hours after 2nd dose)
Rui	Female	PG 2 mg	6.0	PG 6 mg	4-6
	Male	-	-	PG 2 mg	
Catla	Female	PG 1-2 mg	6.0	PG 5-6 mg	5-6
	Male	-	-	PG 1-2 mg	
Mrigal	Female	PG 1-1.5 mg	6.0	PG 5-6 mg	4-6
	Male	-	-	PG 1-1.5 mg	
Calbasu	Female	PG 1-1.5 mg	6.0	PG 4-5 mg	5-6
	Male	-	-	PG 1.5-2 mg	
Silver carp	Female	PG 2 mg HCG 200-250 IU	6.0-9.0 9.0-12	PG 6 mg HCG 500 IU+ PG 3 mg	6-8
	Male	-		PG 2 mg	
Grass carp	Female	PG 1.5- 2.0 mg	6.8-8.0	PG 4-6 mg	5-7
	Male			PG 2 mg	
Bighead carp	Female	PG 2 mg HCG 200-250 IU	6.0-9.0 9.0-12	PG 6 mg HCG 500 IU+ PG 3 mg	6-8
	Male	-		PG 2 mg	
Common carp/ Mirror carp	Female	PG 1 mg	6	PG 4mg	6
	Male	-	-	PG 2 mg	

Table 3. Number of hatcheries in Bangladesh

Year	**No of Hatcheris**	**Year**	**No of Hatcheries**
2001	631	2006	764
2002	738	2007	860
2003	696	2008	873
2004	756	2009	854
2005	731	2010	931
2015	964	2011	937

Source: FRSS, DoF (2016)

It is observed in Bangladesh that major carp seed collection in the natural water bodies (i.e. rivers and their tributaries) reduced from 100% in 1960-1970, to 80-60% in 1985-1989 to currently 1% due to degradation of aquatic habitat.

Table 4. Amount of spawn production from natural and hatchery sources in Bangladesh

Year	Spawn Production	
	Natural sources (kg)	Hatchery Sources (kg)
1988	12533	5697
1989	12235	4315
1990	5128	13014
1991	6855	22170
1992	9342	33072
1993	4913	43047
1994	5871	49000
1995	9144	72000
1996	2399	116212
1997	2824	117500
1998	2885	118100
2001	2683	187343
2002	1975	276481
2003	1044	297781
2004	1577	345227
2005	2123	315892
2006	1723	407827
2007	2061	457288
2008	1872	416946
2009	1876	459804
2010	2203	459804

(source: Chowdhury 1999 and FRSS (2014)

Major Issues in carp Hatchery

The major concerns in the carp hatcheries in Bangladesh as follows: i) Hatcheries without broodstock ponds; ii) Main objective is the production of mass seed rather than quality seed; iii) Lack of knowledge on genetic status of hatchery stocks; iv) Lack of knowledge of hatchery and nursery operators; v) Lack of knowledge on effects of openwater stocking on wild stock; vi) Brood stock replacement is from leftover fish; vii) Degradation in genetic quality of seeds due to inbreeding & negative selection and due to hybrid introgression in some major carp species; viii) Genetic drift due to small numbers of parent stocks; ix) Genetic erosion of domesticated stocks.

Table 5. Suitability of various cultivable carps depending on their weight and age

Fish	Weight (kg)	Age (Yr)
Catla	>3.0	3
Rohu	>1.0	2
Mrigal	>1.0	2
Grass Carp	>2.0	2
Silver Carp	>1.5	2
Common Carp	>1.0	1

Means of increasing Carp Fish Production

There are many important factors for increasing carp fish production in a hatchery which is discussed below:

1. Before selecting brood fish for spawning, small size and young fish should be avoided. Although most carps attain first maturity in their 1 to 2 years, there is an optimum age and weight at which they should be selected for induced breeding.
2. The basic input for quality carp fish production in a hatchery depends on the healthy brood fish. Different brood fish strains should be collected from various sources of origin. The fish seeds produced from different strains at a hatchery should then be marked and reared to the size of fingerling. Already to some extent, the gene pools of our indigenous varieties of carps viz : Rohu, Catla & Mrigal have been contaminated. As a result, in near future it is feared that pure seeds of these indigenous carps, endemic to this region shall gradually disappear from the culture system. Lack of quality fish seeds may be one of the primary reasons for the low fish production. In a word, a quality brood fish produces quality seed which increase the carp fish production.
3. Inbreeding depression should be avoided because it contaminates the seed production which will inhibit fish production. It may be avoided by the following ways: i) Hatchery operators should have detailed information's on pedigree of brood stock; ii) Cultured populations should be identified using a proper marking system; iii) Females & males have to be originated from two different lines; iv) Inbreeding in commercial fish farm should be handled carefully or avoided; v) Individual fish with poor constitutional conditions or anatomical abnormalities should be culled.
4. Day by day the quality of seed has deteriorated 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.
5. The government in collaboration with private entrepreneurs should take necessary steps to establish brood banks in different parts of the country. Quality broods from the brood banks should be distributed to the hatcheries as required and its maintenance monitored.
6. Carp fish sanctuaries should be established and monitored in open water bodies as much as possible in order to promote natural recruitment.
7. Catching or killing of broods and fry during breeding season should be banned and in this regard alternate employment for fishermen during breeding season should be arranged.
8. Loss and destruction of breeding and nursery grounds due to construction of flood control dams, roads and embankments and irrigation should be stopped. Inter-departmental co-ordination needs to be developed to minimize the damage to fish habitats.
9. Necessary training on brood stock management, breeding technology, nursery technology, disease control, etc. should be provided to hatchery and nursery operators, farm managers, and fish farmers. Awareness building of private hatchery operators and fish farmers should be further extended.
10. The Government should impose rules strictly to the hatchery operators for maintaining proper protocol of induced breeding, selective breeding, line crossing, hybridization, nursery management etc. so that fish seed production does not contaminate. Government field laboratories should be established for testing the quality of fish of different hatcheries locally and regionally.
11. Trading networks should be developed by the government and other developing partners so the carp fish farmers can get their actual benefit.
12. A live gene bank initially for the IMC (Indian Major Carp, viz. Catla, Rohu, Mrigal etc.) should be established to supply pure strains of these indigenous carps and Govt. may support establishing such facilities.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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