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MANAGEMENT PRACTICES IN THE *BEEL* AQUACULTURE SYSTEM AT RAJSHAHI, NORTHWEST BANGLADESH

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Abstract

Open aquatic system such as *beel* is an important freshwater resource for agriculture and aquaculture. This study was conducted (July-December 2014) to describe the *beel* aquaculture management practices in the Hagla *Beel* at Bagmara upazila under Rajshahi district. The *Beel* fish farming area was 20.25 ha and irregular in shape with average depth 1.5 m. During the study period, the measured water quality parameters of the *beel* were within the suitable range for aquaculture. Eight genera of phytoplankton and eight genera of zooplankton were identified from the *beel* water body. Four native and 4 exotic fish species with sizes ranging from 0.15-1.11 kg were stocked for growing in the *beel*. At the end of culture period, the production of fish was 2,622.15 kg/ha and cost-benefit ratio (CBR) was 1:1.42. Environmental problems such as increasing of water temperature and decreasing of water level during summer, and parasitic diseases were some of the risks in *beel* fish farming system. The results of this study should be useful for *beel* aquaculture, and for the farmers and resource manager for harnessing maximum benefits from the *beel* resources in Bangladesh.

Key words: Aquaculture, Hagla *Beel*, Management practice, Northwest Bangladesh

Introduction

Fisheries, as one of the sub-sector of agriculture, is playing significant role in supplying nutrition, employment generation, reducing poverty and earning foreign exchange, and more importantly developing socio-economic conditions in the rural areas of Bangladesh (DoF 2017). Fisheries sector contributes 3.65% to GDP and 23.81% to agricultural production. Bangladesh earns a considerable amount of foreign currencies every year by exporting fish, shrimps and other fisheries products (FRSS 2017). Bangladesh has extensive water bodies that have a high potential for fisheries production and appropriate management of the water bodies can increase the fish production by many folds.

Among all other open water bodies' *beel* is the most productive ecosystem (Ahmed et al. 1991). *Beels* are usually shallow and hold water throughout the year (perennial *beels*) but some *beels* retain water for 4-5 months (seasonal *beel*). *Beels* are usually rich in aquatic vegetation, and surrounded by paddy fields that provide food and shelter for the various species of fish and other aquatic organisms. In open water fisheries sector *beels* are playing a vital role regarding employment generation, animal protein supply, foreign currency and poverty alleviation. Over the last two decades fish production from the *beel* has been decline due to over fishing, siltation and management problems (Middendrop and Balarin 1999). Proper management of the *beel* could significantly contribute to the national fish production. Nowadays, aquaculture is being practiced in the *beel* area in different parts of our country. Still to date there is a lack of research information on *beel* aquaculture management. The present study was conducted to provide information about the aquaculture management practices in the Hagla *Beel* at Rajshahi, the northwest Bangladesh. The

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specific objectives were to determine water quality parameters of the *beel*, document aquaculture management practices and analyze production economics of the *beel* fish farming.

Materials and Methods

Study area

The study site was located in Hagla *Beel* at Bagmara upazila under Rajshahi district, the northwest Bangladesh and the farming activity was observed for a period of 6 months (July-December, 2014). The *beel* was a perennial water body with an area of 20.25 ha, 1.5 m in depth and irregular in shape (Fig.1).

Fig. 1. Map showing the study area (●).

Water quality parameter and plankton population

Water quality parameters, like water temperature were measured by Celcius thermometer and transparency was measured by secchi disk. Dissolved oxygen (DO), free CO_2, pH and alkalinity were measured by water quality test kit (HACH kit FF-2, USA). Plankton population was identified according to Prescott (1964). All the water quality parameters and plankton was collected on monthly basis.

Farming management

Pre-stocking management

Bushes and shrubs were cleaned manually from the embankment and the broken parts of dyke repaired using sand bags. The aquatic weeds namely kochuripana, khudipana, topapana, kolmilata, malancha, kochu were controlled both biologically releasing phytophagus fishes and manually using bamboo and metal devices. The farmers did not use any chemical to control the aquatic weeds.

Fish stocking

Four native fish species (*Labeo rohita, Gibelion catla, Cirrhinus mrigala* and *Notopterus chitala*) and 5 exotic fish species (*Hypophthalmichthys molitrix, Ctenopharyngodon idella, Cyprinus carpio, Aristichthys nobilis* and *Mylopharyngodon piceus*) were stocked in the *beel*. Fingerlings were collected from fry trader of Rajshahi. Initial weight of fingerlings was measured and stocking was done in the early morning (Table 1).

Table 1. Fish species composition, initial weight and stocking density

Fish species	Common name	Initial weight (kg)	Stocking density (fish/ha)
Labeo rohita	Rui	0.16±0.07	300
Gibelion catla	Catla	0.55±0.11	100
Cirrhinus mrigala	Mrigel	0.15±0.02	200
Notopterus chitala	Chitol	1.11±0.45	15
Hypophthalmichthys molitrix	Silver carp	0.23±0.02	400
Ctenopharyngodon idella	Grass carp	0.54±0.09	50
Cyprinus carpio	Common carp	0.32±0.01	200
Aristichthys nobilis	Bighead carp	0.25±0.01	150
Mylopharyngodon piceus	Black carp	0.53±0.0	25

Post-stocking management

The *beels* was monitored regularly and the liming was done at the rate of 62.5 kg/ha/month. Inorganic fertilizer such as urea and TSP were applied at the rate of 267.5 kg/ha/month and 170 kg/ha/month, respectively during the entire culture period (6 months). During the first two months supplementary feeds such as rice bran, wheat bran and mustard oil cake were used while the rest of the study period commercial feeds were provided to the fishes at 2-3% body weight per day.

Fish growth

Fishes were sampled monthly. On each sampling day, individual fish was weighed to determine the fish growth and to adjust the feed ration. Growth and yield of fishes was calculated as follows:

Final weight (g) = Weight of fish at harvest (g).

Weight gain (g) = Mean final weight (g) – Mean initial weight (g)

Fish yield (kg/ha/12 months) = Fish biomass at harvest – Fish biomass at stock

Farming economics

Data on both fixed and variable costs was recorded to determine the total cost (BDT/ha). Total return was determined from the market price of fish sale, expressed as BDT/ha. The net benefit and cost benefit ratio (CBR) was calculated as follows:

Net benefit (BDT/ha) = Total return (BDT/ha) – Total cost (investment) (BDT/ha)

$$CBR = \frac{\text{Net benefit}}{\text{Total investment}}$$

Statistical analysis

Data on water quality parameters and fish growth was subjected to one way ANOVA (Analysis of Variance) with Duncan Multiple Range Test using computer software SPSS (Statistical Package for Social Science, version-20.0) to know the level of significance at $p<0.05$.

Results and Discussion

Water quality parameter

Water quality parameters showed significant monthly variations ($p<0.05$) and their mean values are shown in Table 2. The highest water temperature was recorded in the month of July (28.39°C) and the lowest in the month of December (20.39°C), which was more or less similar to the findings of Ehshan et al. (1996) who found highest water temperature (31°C) in the month of June and the lowest (25°C) in January from Chalan *Beel*, the northwest Bangladesh. In the present study, the highest transparency was recorded as 24.67 cm in August and the lowest was 22.19 cm in October. During the study period, the highest value of DO was 6.07 mg/l in December and the lowest value was 2.98 mg/l in July. The mean DO of the present study was 4.25±1.17 mg/l which was more or less similar with the findings of Rahman and Hassan (1992), who reported 5.0 mg/l DO in a productive water body. The levels of free CO_2 ranged 8.49-10.99 mg/l, where the highest value was recorded in the month of July and lowest in the month of December. The average value of free CO_2 was 9.64±1.05 mg/l. According to DoF (2017) suitable range of free CO_2 is <12 mg/l. During the study period, water pH of the *beel* ranged from 7.10 (August) to 7.82 (November), indicated a slightly alkaline condition but suitable for fish culture. Similar findings were found by Saha et al. (2003) and Islam (2000). Alkalinity of the *beel* fish farming pond ranged from 110.00 to 115.67 mg/l, where the highest value was recorded in the month of July and lowest in the month of November. The average value of total alkalinity was 113.61±2.55 mg/l. Boyd (1998) reported the highest alkalinity level up to 150 mg/l. Alikunhi (1957) reported that total alkalinity more than 100 mg/l should be present in high productive water bodies. On the basis of above facts, it can be accomplished that total alkalinity recorded in the present study was within limit for fish culture.

Table 2. Water quality parameters in the in the Hagla *Beel*

Parameters	Minimum	Maximum	Mean
Water temperature (°C)	19.23	31.50	25.16±3.16
Water transparency (cm)	21.00	26.00	23.48±1.47
Dissolved oxygen (mg/l)	2.53	6.22	4.25±1.17
pH	6.85	7.90	7.42±0.28
CO_2 (mg/l)	8.30	11.50	9.64±1.05
Total alkalinity (mg/l)	109.00	118.00	113.61±2.55

Plankton population

During the study four groups of phytoplankton (Cyanophyceae, Chlorophyceae, Euglenophyceae, Bacillariophyceae) in eight genera and two groups of zooplankton (Rotifera and Crustacea) in eight genera were identified (Table 3). Ahmed et al. (2004) also reported three groups of phytoplankton such as Myxophyceae, Chlorophyceae and Bacllariophyceae from a *beel* ecosystem of Brahmanbaria, Bangladesh.

Table 3. Identified phytoplankton and zooplankton genera in the Hagla *Beel* fish farming

Plankton	Genera	Class
Phytoplankton	*Nostoc*	Cyanophyceae
	Microcystis	Cyanophyceae
	Anabaena	Cyanophyceae
	Volvox	Chlorophyceae
	Chlorella	Chlorophyceae
	Spirogyra	Chlorophyceae
	Euglena	Euglenophyceae
	Navicula	Bacillariophyceae
Zooplankton	*Keratella*	Rotifera
	Branchionus	Rotifera
	Nauplius	Crustacea
	Diphanosoma	Crustacea
	Daphnia	Crustacea
	Moina	Crustacea
	Cyclops	Crustacea
	Diaptonus	Crustacea

Six genera of aquatic weeds floating, sub-merged and spreading were recorded in the *beel* during the study period (Table 4). Limited growth of aquatic plants is useful in maintaining water quality and serve as shelter and substrate for food organism in water body (Pillay 1990). On the other hand excess aquatic weeds used up the nutrients elements in the water body and decrease the productivity (Islam 1998). Therefore, the present study area was more or less hazard free from aquatic weeds.

Table 4. List of aquatic weeds found in the *beel* during the study period

Sl. No.	Local name	Type	Scientific name	Family
1	Kochuripana	Floating	*Eichhornia* sp.	Pontederiaceae
2	Topa pana	Floating	*Pistia* sp.	Anaceae
3	Khudipana	Floating	*Lemna* sp.	Lemnaceae
4	Kachu	Emergent	*Colocasia* sp.	Anaceae
5	Kolmilata	Spreading	*Ipomoea* sp.	Convolvulaceae
6	Helencha	Spreading	*Enhydra sp.*	Compositae

Fish health management

Parasitic diseases (Fig. 2) were more prominent during the winter months that hampered the fish production in the *beel* Hagla. The farmer used different types of chemicals (Calsium carbonate, Malakhite green, Potassium permanganate) to control parasitic diseases. Bauer (1961) reported that parasites can affect fish population by causing mortality, reduction in growth, weight loss and suppression of reproduction activity.

Fig. 2. Showing parasitic infestation in cultured fishes of the *beel.*

Fish yields

Table 4 represents the mean final weight and mean weight gain of cultured fishes during the study period. Highest final weight was obtained in *C. idella* (3.11 kg) and lowest from *H. molitrix* (1.28 kg). The highest yield was recorded in *H. molitrix* (492.15 kg/ha) and the lowest in *M. piceus* (52.75 kg/ha). Total fish production for the six months culture periods was 2622.15 kg/ha. Chandra et al. (2010) recorded 2920.43 kg/ha fish production in *beel* aquaculture from Daudkandi, Cumilla, Bangladesh which is higher than the production of present study. The parasitic infection could be linked with the lower fish production in the present study as compared to the earlier study.

Table 5. Production in the Hagla *Beel* fish farming pond

Fish species	Mean final weight (kg)	Mean weight gain (kg)	Total production (kg/ha)
Labeo rohita	1.55	1.39	465.5
Gibelion catla	2.16	1.61	216.25
Cirhinus mrigala	2.23	2.08	446.25
Hypophthalmichthys molitrix	1.28	1.05	492.15
Ctenopharyngodon idella	3.11	2.5	155.5
Aristichthys nobilis	2.12	1.87	318.75
Mylopharyngodon piceus	2.11	1.5	52.75
Cyprinus carpio	2.53	2.21	442.75
Notopterus chitala	2.15	1.04	32.25
	Total production		2622.15

Cost-benefit analysis

Cost of fishes, feeds, fertilizers, insecticides and labors for different operations were the main variable costs, while land lease cost was considered as fixed cost. The cost of this culture system was BDT 235,120.50/ha, income was BDT 498,180.75/ha and return was BDT 302,390.25/ha. The calculated CBR was 1: 1.44 that means 1.44 BDT return comes from 1 BDT investment. According to Chandra et al. (2010) the cost of fish production, total return and net income were BDT 115,308.55, BDT 176,385.49 and BDT 61,076.94/ ha, respectively, and CBR was 1:1.53, which is more or less similar with the present findings.

Conclusion

The findings of the present study clearly indicated that fish culture in *beel* is profitable. A further comprehensive research is necessary for the development *beel* aquaculture in Bangladesh.

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