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Enhancement of fish production in a reservoir after partitioning by dikes through community participation

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Abstract

A reservoir of 70 acres was portioned by dikes into four manageable big ponds to get more production of fishes at Basurhat, Noakhali, Bangladesh under the supervision of local community through a society of 40 people ownership. Pangus (*Pangasius hypophthalmus*) @ 20,000/acre, and then fry and fingerlings of different types of fishes such as catla (*Catla catla*), rohu (*Labeo rohita*), mrigal (*Cirrhina mrigala*), grass carp (*Ctenopharyngodon idella*), bighead (*Aristichthys nobilis*), silver carp (*Hypophthalmichthys molitrix*), common carp (*Cyprinus carpio*) and rajpunti (*Puntius gonionatus*) @ 500/acre were stocked. Feed containing 25% protein was used two times daily and feed was adjusted fortnightly. After 8 months, all the fishes were weighed 0.80-2.10 kg except rajpunti (150-200 g) and tilapia (150-220 g), and a total of 25 ton of fish was harvested which was five times higher than the previous production under signal ownership. The production of fishes were increased after partitioning the lake with dikes due to proper management and control.

Key words: Fish, Lake, Dikes, Community participation

Introduction

Aquaculture practice is gradually blooming in Bangladesh due to decrease of fish in natural habitats like rivers, natural lakes, and other open water bodies (Biswas *et al.* 2003, Habib *et al.* 2003). Therefore, people are assuming aquaculture practice is only the way for fish production to minimize the demand of fish in the country (Molla *et al.* 1990). For this reason, people are very keen to practice aquaculture even converting their paddy field (Habib *et al.* 2003).

The Al-Elahi Agricultural Complex was an agro-complex with aquaculture venture managed by the local people community. The complex was started under single ownership with 100 acres with agriculture crop for rice production with traditional fish culture in 70 acres water area in 2003. Approximately 5 tons of fish was producing every year. This single season crop and traditional fish culture did not provide enough revenue so that the owner gradually switching over to aquaculture with the help of local people through community participation. The complex with the name 'Elahi Aquaculture Farm' started within the agricultural complex covered water area around

70 acres under the management of a group of local 40 people. This 70 acres water area was partitioned with dikes and come under manageable culture system of 24 ponds. The present paper highlighted the aquaculture practice through community participation.

Materials and methods

To manage properly and to facilitate under controlled condition, the 70 acres water area (Elahi Aquaculture Farm) was artitioned by dikes into 24 ponds of which five were nursery, ten for rearing ponds and six for stocking ponds (Table 1). The area of ponds were varied from 1.0 to 8.0 acres. The entire aquaculture farm was divided into Block A, B and C for proper management with supervisor and labourers. Rest of the 30 acres land were used for crop production. There was a small dairy farm inside the complex where about 60 cows are farmed and resulted cow dung was used as organic fertilizer in the ponds and crop field. A community with 40 local people was formed to produce fish through modern aquaculture practice with the technical help of Agro-Based Industries and Technology Development Project II (ATDP-II), Dhaka. The Elahi Aquaculture Complex was found very suitable for fish culture and overall culture and production system were monitored and analysed in the laboratory of Department of Aquaculture, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Table 1. Distribution of supervisors, laborers, ponds and area of ponds

Name of block	A	B	C
Supervisor	1	1	1
Labourer	3-4	3-4	3-4
No. of nursery ponds	2	2	1
Area of nursery ponds	1.5 acres	1.0 acre	1.0 acre
No. rearing ponds	3	3	4
Area of ponds	2.0 acres	2.0 acres	2.0 acres
No. of stocking ponds	2	2	2
Area of stocking ponds	6.0 acres	8.0 acres	8.0 acres

Hand on training

The supervisors, skilled labourers and labourers were trained for different aspects of fish culture managements. They were trained how to measure temperature, transparency (secchi reading), pH, dissolved oxygen, to observe plankton growth, to grow plankton in ponds as live food for fishes, fry weighing, to minimize oxygen deficiency, use of decomposed cow dung etc. A list of optimum ranges of different physico-chemical characteristics were supplied with tolerable and toxic levels (Table 2) so that the farm people could understand the quality of water.

Table 2. Optimum and toxic levels, and ranges of different physico-chemical properties of water of ponds for aquaculture (Pillay 2004)

Name of properties	Optimum levels	Symptom/effect	Toxic levels
Turbidity by suspended particles	> 20 000 mg/L	Bevavioural reactions Restrict light penetration Limits photosynthesis Destroy benthic communities and fish eggs	Mortality occurs above 175 000 mg/L
Turbidity by phytoplankton	No range	Not harmful to fish	
pH	6.5-9	Desirable growth of fish	6.0-6.5 poor growth 4.0 – Acid death point 11.0- Alkaline death point
Dissolved Oxygen	> 5 mg/L 1.0 mg/L	Good growth Warm water carp can survive	Below 5.0 mg/L not good for shrimp more than few hours 3-4 mg/L Eel, carp and tilapia can tolerate Optimum level higher than this level
Free carbon dioxide	0 mg/L 5-10 mg/L	In the afternoon At daybreak	No ill effect on fish No ill effect on fish
Un-ionized ammonia-N	0.6-2.0 mg/L	Tolerable conc. 0.10 mg/L	Fish die
Nitrite-N	< 0.1 mg/L	Tolerable level	Fish survive
Nitrate-N	< 100 mg/L	Tolerable level	Fish survive
Un-ionized H_2S	Normal level	Untolerable	Very toxic
Ortho-Phosphate	45-100 mg/L	Tolerable	Not toxic
Phytoplankton bloom	Harmful phytoplankton Beneficial phytoplankton	Untolerable Good live food for fish	Toxic to fish Nutritionally rich health food
Pesticides (Insecticides)	5-100 mg/L	Extremely toxic to fish	Acute toxic level

Preparation of stocking ponds

Ponds were prepared with lime after drying. In respect to pH of pond bottom soil, it was suggested to apply 500g lime/dec.. However, according to the content of organic carbon and total N, 2kg/dec. cow dung and 1.5 kg/33 dec. urea were used in bottom soil and advised to use this doses fornightly during whole culture period. Then all the stocking ponds were filled with underground water. P:K at the ratio of 1.5: 0.75 kg/33 dec. were administrated monthly. Depending on water quality then N:P:K was administrated weekly at the ratio of 3.0:1.50:0.75.

Physico-chemical properties analyses of pond water and bottom soil

Water and soil samples were collected from ponds for analyses. Different physico-chemical properties of water were analysed following the standard methods (Clesceri *et al.*

1989). For convenience, samples were collected from nine locations of three blocks of the farm. The physico-chemical properties of water samples were analysed in site. On the other hand, soil samples were carried to the laboratory for process before analyses of chemical properties.

Water colour of ponds was recorded by eye estimation. Temperature of pond water was determined by centigrade thermometer. Turbidity (Transparency) was measured by turbidity meter. pH of water was measured by a digital pH meter (HANNA instruments, Model: HI 8314). Electric conductivity of water was analysed by conductivity meter after some chemical treatment. Dissolved oxygen was measured by digital oxygen meter (HANNA Instruments Model: HI-9142). Alkalinity of water was estimated using alkalinity meter after chemical treatment. Nitrate-N (ppm) was determined after filtering 100 ml water through glass microfilter paper using Nitrogen-5 powder pillow and then direct reading using Spectrophotometer, DR 2010. Similarly Phosphate-P (ppm) was determined from filtered water using reagent pillow Phosver-3 and then direct reading using Spectrophotometer, DR 2010.

Collection and identification of plankton

For collection of plankton, 10 litres of water from each location of farm was filtered through consecutive three nets of different mesh sizes (10, 30 and 120 µm). The collected plankton samples were preserved in 6% buffered formalin. These samples identified using Sedwich Rafter Counting Chamber under microscope with the help of keys given by Ward and Whipple (1959), Whitford and Schumacher (1973) and Yamagichi (1992).

Fifty ml of pond water was filtered through 0.45 µm mesh and the filter paper was mashed with 10 ml acetone in 25 ml plastic tube. The tube was wrapped with aluminium foil and brought to the laboratory and kept in the refrigerator. It was then centrifused at 5000 rpm for five minutes. The supernatant was taken in cuvette and readings at three different wavelengths were taken in spectrophotometer. Then chlorophyll a was estimated using the following formula:

$$\text{Chlorophyll } \underline{a}\ (\mu g/L) = 11.85\ (OD_{664}) - 1.54\ (OD_{647}) - 0.08\ (OD_{630}).$$

Chemical analyses of bottom soil of ponds

Pond bottom soil from nine location of whole site was collected. Texture of bottom soil was determined after treatment dry soil with 5% calgon solution using hydrometer. pH was measured by a digital pH meter (HANNA instruments, Model: HI 8314). Organic carbon was calculated following wet oxidation method. Total N was analysed by Microkjeldahl method. Phosphate-P was determined from filtered water using reagent pillow Phosver-3 and then direct reading using Spectrophotometer, DR 2010.

Collection and analysis of artificial feed

Commercial feed was analysed for proximate composition such as moisture, crude protein, crude lipids, crude fibre and nitrogen free extract in the laboratory using methods given by Horwitz (1984).

Release of fry in ponds

The spawn was collected from the local hatchery and released in nursery ponds. The nursery reared fish fry (3-8 mg/fish) of Thai Pangus (*Pangasius hypophthalmus*) @ 20,000/acre, and then fry and fingerlings @ 500/acre of different types of fishes such as catla (*Catla catla*), rohu (*Labeo rohita*), mrigal (*Cirrhina mrigala*), grass carp (*Ctenopharyngodon idella*), bighead (*Aristichthys nobilis*), silver carp (*Hypophthalmichthys molitrix*), common carp (*Cyprinus carpio*) and rajpunti (*Puntius gonionatus*) were stocked on the middle of May 2006. Artificial feed was used twice daily in these ponds.

Results and discussions

Overall water and bottom soil properties, and plankton population of ponds

Physico-chemical properties of water of Elahi Aquaculture Farm are presented in Table 3. Most of the ponds were turbid and very few ponds contained little amount phytoplankton. Only nursery ponds were greenish in colour. Temperature was ranged from 27.60 to 28.10°C during the study period. It was observed that the smell of decomposed feed was coming out from some ponds otherwise the pond were almost free from any other odours. Turbidity ranged from 10 to 58 cm. Electric conductivity was ranged from 201 to 398 μhos/sec which indicates good ionic exchange among different chemical factors and favorers good water quality for culture which agrees with the findings of Habib *et al.* (1991). pH of water was found within the alkaline which was favourable for fish culture. Usually there is direct relation among pH, electric conductivity and alkalinity which almost agrees with results of Habib *et al.* (1988). Dissolved oxygen, Nitrate-N and phosphate-P were within the suitable ranges of ponds of good quality water. It was found that chlorophyll-a content was ranged from 14.28 to 26.18μg/L which was very low in all the ponds and not good for fish culture if fish depend on natural food of ponds. However, artificial feed was used to feed fish.

Table 3. Average physico-chemical properties of water from different locations

Parameters	L1	L2	L3	L4	L5	L6
Temperature (°C)	27.8	27.6	28	28.1	28	27.9
Turbidity (cm)	13	43	15	10	58	45
pH	7.7	7.4	6.9	7.5	7.2	7.1
Electric conductivity (μhos/sec)	398	193	201	284	235	225
Alkalinity (ppm)	132	95	105	135	85	60
Dissolved oxygen (ppm)	3.5-5.5	5.8-6.0	3.5-5.5	5.5-6.5	3.5-4.0	2.5-3.0

NO_3-N (ppm)	3.2	2.7	2.2	2.4	1.0	1.8
PO_4-P (ppm)	0.23	0.77	0.34	0.34	2.80	0.57
Chlorophyll a (µg/L)	26.18	10.71	15.47	20.23	14.28	18.25

L1 = Location 1, L2 = Location 2, L3 = Location 3, L4 = Location 4, L5 = Location 5, L6 = Location 6.

Pond bottom soil was analysed for texture, pH, total N and Phosphate-P during culture (Table 4). Soil texture was found sandy clay which is suitable for fish culture (Habib *et al.* 1987). It was found that pH ranged from 6.7 to 7.5 which indicate that the water was almost alkaline in nature and favourable for fish culture. Organic carbon (0.40 to 0.67%), total N (0.25 to 0.35%) and available P (Phosphate-P) (10 to 12 ppm) were almost within the suitable for good quality water of pond. Among the phytoplankton, the blue-green algae such as *Microcystis* an *Anabaena* were found dominant but available in poor amount in all the ponds.

Table 4. Average chemical analyses of soil samples

Parameters	L1	L2	L3	L4	L5	L6
Texture	Sandy clay	Sandy clay	Sandy clay	Sandy clay	Sandy clay	Sandy clay
pH	7.4	7.4	6.7	7.4	7.5	7.5
Organic carbon (%)	0.58	0.47	0.67	0.40	0.58	0.54
Total N (%)	0.27	0.30	0.26	0.35	0.28	0.25
Available P (ppm)	10	11	12	11	10	10

L1 = Location 1, L2 = Location 2, L3 = Location 3, L4 = Location 4, L5 = Location 5, L6 = Location 6.

Feed and feeding

After analysis of proximate composition in the laboratory, it was found that the feed contained 28-29% protein, although the feed bag labeled 30% (Table 5). The actual amount of protein was not found after analysis which indicates that the feed industry sometimes give little bid less amount of protein in feed during preparation which agrees with the observation of Chakraborty *et al.* (2005). The percentage of crude protein, crude lipid, ash and nitrogen free extract (NFE) were varied from one sample of one lot to another. Each sample represented a lot of production so it is assumed that the nutritional quality of feed varied from one lot of production to another. So farm may not get good and uniform growth and good production of fish. Therefore, it is advised that the comer fish farm can manufacture feed through their own effort using fish meal with other locally available ingredients.

Table 5. Proximate composition of commercial feed samples

Sample	Moisture	Crude protein	Crude lipid	Ash	Crude fibre	NFE*
1 (Feb.)	11.43	29.0	7.63	12.20	5.55	35.10
2 (May.)	10.90	28.0	9.03	14.40	5.60	32.00
3 (July)	12.25	28.75	7.76	13.80	6.78	30.55
4 (Sept.)	11.17	29.0	8.02	13.14	6.85	31.75

Production of fishes

Different species of fish spawn were bought first from the nearby hatchery and released in nursery ponds of Elahi Aquaculture Farm inside the Al-Elahi Agricultural Complex. The fry of all the fishes were grown rapidly for first two months though only feed of Pangus was given. Weight of fishes were taken on July and September (Table 6). Increments of weight of fishes were satisfactory but not so promising because all species of fishes were not growing properly. It might be due to feed competition for feeding among fishes, suitability of feed and other related factors (Biswas *et al.* 2003, Habib *et al.* 2003, Jayathi *et al.* 2007). Fishes were first harvested from September and then ended at the end of October. A total of 25 ton of fishes were harvested which was almost five timed higher than the previous year (five ton) which might be due to proper management under controlled condition through partition of lake with dikes, vigilance and activity of community people, use of feed in time. Fishes were weighed 0.80-2.50 kg except rajpunti (150-200 g) and tilapia (150-220g).

Table 6. Average growth of different fish species cultured in the aquaculture farm (arranged according to culture of preference)

Sl. No	Cmmon/Species name	Initial wt. (mg/fish) May 15, 06	Av. wt. (g) on July 19, 06	Av. wt. (kg) on Sept. 24, 06
1	Pungus (*Pungasius sutchi*)	7-8	150-170	1.70-2.50 kg
2	Catla (*Catla catla*)	5-7	100-120	1.80-2.0 kg
3	Rohu (*Labeo rohita*)	4-6	80-90	1.0-1.20 kg
4	Mrigal (*Cirrhina mrigala*)	4-6	60-70	0.80-1.0 kg
5	Silver carp (*Hypophthalmichthyes molitrix*)	5-7	110-120	1.40-1.80 kg
6	Siver barb (*Puntius gonionatus*)	3-4	50-60	150-200 g
7	Mirror carp (*Cyprinus carpio*)	3-4	100-120	1.0-1.50 kg
8	Tilapia (*Oreochromis niloticus*)	4-5	50-70	150-220 g
9	Big head (*Aristhicthys nobilis*)	4-5	130-150	1.30-1.60 kg
10	Kalbaus (*Labeo calbasu*)	4-5	90-110	1.0-1.50 kg
Total production		25 ton		

Production of fishes was increased about 5 times than the past before partition of 70 acres lake with dykes and proper care taken by local community people. It means that the lake was unmanageable at the same time uncontrolled before partition. Usually very big water reservoir is not possible to give diets to the fish properly. Also it is not easy to take proper care. Therefore, if big lake or reservoir is partitioned with dykes then it is easily manageable to give feed and to take proper care by local people specially through community participation, and then the production of fish should be increased in manyfold like the present work.

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