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Study on production performance and economic of mono-sex tilapia culture at marginal farmer's ponds in gopalgonj Bangladesh

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Abstract
The present study was carried to estimate the production performance and economics of mono-sex tilapia (*Oreochromis niloticus* L) at marginal farmer's ponds in Kotalipara Upazilla under Gopalgonj distract, Bangladesh during June to September 2011. The experiment was setup in three treatments each with three replications. Supplementary feed was not given in T_1, but rice bran and mustard oil cake (3:1) were given in T_2 and commercial pellet floating feed in T_3. SGR (%) value (2.58) was recorded in T_3 and the lowest (0.93) in T_1. The survival rates were 90±.20, 90±.20 and 92±0.45 for T_1, T_2 and T_3 respectively. The FCR was 1.95±0.45 and 1.3±0.14 in T_2 and T_3 respectively. The highest production was 9998.56 kg/ha in T_3, followed by T_2 (4270.63 kg/ha) and T_1 (1356.03 kg/ha) respectively. The highest benefit or net return for T_3 Tk. 318069.31/ha and BCR of 1.41 followed by Tk. 115349.00/ha and BCR value of 1.32 in T_2 and Tk. 3845.79/ha and BCR value of 1.02 in T_1.

Keywords: Mono-sex tilapia, Marginal farmer ponds, supplemental feed, production, economics

1. Introduction
The name, "Tilapia" was derived from an African Bushman word simply meaning fish. Fishes belonging to the family Cichlidae is referred to as Tilapias [29]. There are about 100 species; most of them are native to Western African Rivers [2]. Of these, only *Tilapia (Tilapia zillii* and *T. rendak)* and *Oreochromis (0. niloticus, O. mossambicus and O. aureus)* species are in widespread use [15]. Due to their small size and slow growth rate, *T. zillii* and *T. rendali* are rarely cultured but are often used to control weeds in irrigation canals, mostly in some African and Latin American countries. Among *Oreochromis* species *O. niloticus* is familiar for its tolerance to saline and cold water conditions. They have been introduced into a large number of tropical and subtropical countries around the world since the 1960 [26]. Tilapia was first introduced in Bangladesh in 1954. About 80 species of tilapia have been described out of which 10 species are reported to be used for culture [24]. Tilapias have distributed to so many different types of water, to so many different types of culture systems in the world that they have been even labeled as the "aquatic chicken" [23]. They have good resistance to poor water quality and disease, tolerance of a wide range of environmental conditions, ability to convert efficiently the organic and domestic waste into high quality protein rapid growth rate and tasty flavor [4]. The existing strain Nile tilapia (*Oreochromis niloticus* L.) was first introduced into this country by the United Nations International Children Emergency Fund (UNICEF) in 1974 and later by the Bangladesh Fisheries Research Institute (BFRI) from Thailand [14]. Farmed tilapia productions in 2010 exceeded 3.2 million metric tons per annum, surging further ahead of the salmon and catfish industries [10]. Production of tilapia, for home or local consumption and for export, has risen tremendously in the last few decades. The tonnage of worldwide tilapia production (in 2010, about 3 million tons) is second, among fish, only behind to carps. Global production of tilapia was estimated to be 2.5 billion US$ in 2010 [3]. In view of the increasing commercialization and continuing growth of the tilapia industry, the commodity is not only the second most important farmed fish globally, next to carps, but is also described as the most important aquaculture species of the 21st century [28]. The fish is being farmed in about 85 countries worldwide, and about 98% of tilapia produced in these countries is grown outside their original habitats [9]. In INFOFISH Tilapia 2010 Conference it was forecasted that the world's total tilapia production would reach 3.70 million tones by the end 2010.

The main culture industries are in the Far East but tilapias are increasingly being farmed in the Caribbean, Latin America and recently, in temperate countries where warm water through artificial means (thermal effluents or geothermal springs) are also available

Supplementary feed is the most for fish culture to get high production. Feed cost generally constitutes the highest single operating cost in semi intensive farming operation [27]. Increased natural food produced in fish ponds through fertilization reduces the use of supplementary feeds that ultimately reduces the feed costs. In Bangladesh some relatively cheap indigenous agricultural by-products, such as, rice bran, wheat bran, mustard oilcake are being used for aquaculture. For proper growth of fish, animal protein supplement, growth promoting vitamins and micronutrients are essential. In recent years pelleted (floading) commercial fish feeds have been marketed by different industries. These feeds are mainly used by medium to large farmers in commercial fish farms. For marginal resource poor farmers it is important to improve the traditional fish culture system. Mono-sex tilapia is omnivorous and its production can be increased through partial feed supplementation. The present study was conducted to see the production performance and economics of mono-sex tilapia culture under different feeding strategies in marginal farmer ponds.

2. Materials and methods

2.1 Experimental site and pond facilities

The experiment was carried out for a period of 120 days from June to September 2011, in nine experimental ponds have been located in nine villages in Kotalipara Upazilla under Gopalgonj distract. The ponds were same in size (30±0.15 dec.) and similar in shape and depth.

2.2 Pond preparation

The ponds were drained out completely and aquatic weeds were removed manually. Liming was done in all ponds at the rate of 1 kg/decimal. Four days after liming the ponds were manured with cow dung at the rate of 2 kg/decimal. One week after liming the ponds were filled with water and fertilized with urea and TSP at the rate of 100 gm/decimal and 50 gm/decimal respectively. TSP was soaked overnight, then urea and TSP were dissolved together and spread manually on pond water surface at sunny day (10-11 am).

2.3 Collection of experimental fish and stocking

All the tilapia fingerlings with mean initial weight of 10 ± 0.25 gm were collected from Genetic hatchery, Avaynagar Jessore and were stocked at a rate of 200/dec (49400/ha).

2.4 Experimental design

The experiment was carried out with three treatments (T_1, T_2 and T_3) each with three replications.

2.5 Feeding

Fertilization was done weekly in the ponds of all treatments at the same rate (cow dung, 2 kg/dec; urea, 100g /dec and TSP, 50 g/dec). Supplemental feeds were given in treatment-2 (T_2) (rice bran: mustard oilcake; 3:1) and in treatment-3 (T_3) (commercial pellet floating feed Nourish containing 30% protein). The feed was applied at the rate of 10% of the body weight of fishes at the beginning of the experiment, then it was reduced to 7% after one month and 3% after two months. Feed was applied twice a day, half in the morning (9.00 am) and the rest in the afternoon (4.00 pm). The supplementary feeds, such as rice bran and mustard oilcake were given to the fish in dough form. For this purpose, mustard oilcake was soaked overnight, mixed with rice bran and small balls were made. The feeds were gently thrown over the ponds water on a particular site of the ponds regularly.

2.6 Sampling

Five percent of the total fish were sampled fortnightly by a cast net to monitor the fish growth and to adjust feeding rates. The weight of fish during sampling was measured by using a portable digital balance.

2.7 Water quality parameters

The water quality parameters such as air temperature, water temperature, dissolved oxygen (DO), water pH, soil pH, ammonia, transparency and total alkalinity were recorded fortnightly. The temperature and dissolved oxygen of the ponds were determined by a DO meter. Secchi disc visibility was measured using a Secchi disc at the time of water sampling. The water pH was recorded by a pH meter.

2.8 Statistical analysis

Computer analysis of the data was done by using MS excel, SPSS (Statistical Package for Social Science) version-20. Significance was assigned at 0.05% level.

2.9 Economic analysis

An economic analysis was carried to estimate the net profit from different treatments. The analysis was based on local market prices for harvested fish and all other items. The costs of fingerlings, fertilizer and supplemental feeds are shown in Table 3. The cost of leasing ponds was not included in the total cost. An additional 7.5% on total cost was included as operational cost [1]. The net return was measured by deducting the gross cost from the gross return per decimal. The benefit cost ratio was also measured as a ratio of net benefit to gross cost.

3. Results

3.1 Water quality parameters

The water quality parameters measured during the experimental period is presented in Table 1.

Table 1: Water quality parameters during the present study.

Parameters	Treatments		
	T_1	T_2	T_3
Air temperature (^{0}C)	30.1±2.15	30.1±1.45	31±2.82
Water temperature (^{0}C)	29.25±1.40	29.25±1.00	29±1.41
Water pH	8.50±0.25	8.45±0.20	7.70±0.25
Soil pH	6.10±0.70	6.6±0.07	5.75±0.07
DO (ml/L)	4.90±0.60	4.95±0.38	3.85±0.21
Ammonia	00	0.25±0.10	0.50±0.25
Transparency	30±0.45	29±0.25	27.5±0.34
Total alkalinity	200.5±1.41	201.5±1.35	205±7.51

3.2 Growth and production performances

The growth performance of mono-sex tilapia in terms of initial weight, final weight, weight gain, % of weight gain, specific growth rate, feed conversion ratio, survival rate and total production is shown in Table 2. Mean weight gain of Mono-sex tilapia in different treatments were ranged between 30.5±3.72 and 220±1.13 g and there was a significant variation (p<0.05) among the treatments (Table 2). The mean

weight gain was significantly higher ($p<0.05$) in T_3 (220±1.13 g) than in T_1 (30.5±3.72 g) and T_2 (95±2.60 g). Significantly highest ($p<0.05$) SGR value (2.58) was recorded in T_3 and the lowest (0.93) in T_1 (Table 2). The FCR was 1.95±0.45 and 1.3±0.14 in T_2 and T_3 respectively. The survival rate ranged between 90 to 92% and there was no significant difference ($p>0.05$) among the treatments. The production of tilapia in terms of kg/ha/4 months was highest (9998.56 kg) in T_3, followed by T_2 (4270.63 kg) and T_1 (1356.03 kg) and they were significantly ($p<0.05$) different (Table 2). A simple economic analysis showed that T_3 generated the highest benefit or net return of Tk. 318069.31/ha/4 months and Benefit Cost Ratio (BCR) of 1.41 followed by Tk. 115349.00/ha/4 months and BCR value of 1.32 in T_2 and Tk. 3845.79/ha/4 months and BCR value of 1.02 in T_1 (Table 3).

Table 2: Growth and production of mono-sex tilapia were observed in different treatments during the experimental period.

Parameters	Treatments		
	T_1	T_2	T_3
Ponds area (Dec.)	30±0.15	30±0.15	30±0.15
Stocking densities (No./dec.)	200	200	200
Initial weight (gm)	10±0.25	10±0.25	10±0.25
Culture duration (days)	120	120	120
Final weight (gm)	30.5±3.72	95±2.60	220±1.13
Weight gain (gm)	20.50±3.47	85.±2.05	210±0.88
% Weight gain	205	850	2100
FCR	00	1.95±0.45	1.3±0.14
SGR (%)	0.93	1.88	2.58
Survival rate (%)	90±.20	91±0.58	92±0.45
Production (Kg/Dec)	5.49	17.29	40.48
Production (Kg/ha)	1356.03	4270.63	9998.56

Table 3: Economic analysis of Mono-sex tilapia (*O. niloticus*) production in ponds reared for 4 months.

Components	Treatments		
	T_1	T_2	T_3
Expenditure (Tk/dec.)			
Fingerlings cost	400.00	400.00	400.00
Feed cost	--	758.60	2368.08
Lime cost (15 Tk/kg)	41.25	41.25	41.25
Cow dung	20.00	20.00	20.00
Urea	20.00	20.00	20.00
TSP	45.00	45.00	45.00
Medicine	50.00	50.00	50.00
Operational cost	43.22	100.11	220.82
Total expenditures (Tk/dec.)	619.47	1434.96	3165.07
Income			
Gross return (Tk/dec.)	603.90	1901.90	4452.80
Net return (Tk/dec.)	15.57	467	1287.73
Net return (Tk/ha)	3845.79	115349.00	318069.31
BCR (Benefit Cost Ratio)	1.02	1.32	1.41

Sale price of tilapia = Taka 110.00/ kg.
Ready feed= Taka 22.50/ kg.
Commercial feed= Taka 45.00/ kg.
Leasing cost for pond is not included.
Operational cost is considered as 7.5% of total cost [1].

4. Discussion

The rearing experiment of mono-sex tilapia was conducted during June to September when the environmental temperature was very suitable for aquaculture. The surface water temperature of the ponds ranged from 29.25±1.40 to 29±1.41ºC. The conditions are highly suited for raising tilapia between April and October when temperature varies from 25 °C to 35 °C [18]. However, the temperature ranges from 28 °C to 30 °C are optimum for maximum growth of (*Oreochromis niloticus)* [8]. In the present study dissolved oxygen concentration ranged from 3.85±0.21 to 4.90±0.60 mg/l. The favorable range of DO is 4 to 8 mg/L for fish culture [5, 25]. The pH of water in the experimental ponds ranged between 7.70±0.25 to 8.50±0.25 which is considered suitable as suggested by some other authors [7, 22]. Transparency ranged from 27 to 30 cm and the mean values were 30±0.45, 29±0.25 and 27.5±0.34 cm in T_1, T_2 and T_3 respectively. The variation in transparency was due to plankton production and rain induced turbidity. Similar transparency values were recorded by [21, 30].

In the present study, mean weight gain of mono-sex tilapia were 20.50±3.47 g, 85±2.05 g and 210±0.88 g and percent weight gain were 205, 850 and 2100 in T_1, T_2, T_3 respectively. From the study, it is observed that mean weight gain and percent weight gain were significantly higher in T_3 than T_2 and T_1. This is due to utilization of natural foods in the ponds as well as the use of supplementary pelleted floating feed. Lower value of mean weight gain and percent weight gain in T_1 is due to no use of any supplementary feed. About 128 g weight gain of GIFT strain in on-farm ponds for a culture period of 6 months fed rice bran at 5-6% of their body weight [16]. Considering the 3 months culture period in the present study compared to 6 months period by [16], tilapia in the present study performed better. This difference in the growth might be related to feed & fertilizer supplied in the ponds and the time/ season of the experiment. In the present study SGR value of mono-sex tilapia was 0.93%, 1.88% and 2.58% in T_1, T_2 and T_3 respectively. The highest SGR value in T_3 is due to high protein and energy content of the diet compared to other treatments. The higher SGR value obtained 2.03 for tilapia in Honduras using feed and fertilizer [11]. It was observed SGR values of GIFT tilapia ranged from 2.04 to 2.30 fed on formulated diet [17]. The FCR values found in T_2 and T_3 were 1.95±0.45 and 1.3±0.14 respectively. The FCR value of tilapia fed rice bran and commercial tilapia feed as 2.07 and 1.84 [19]. The variation in FCR values might be due to difference in quality of food given. The survival rate of the fishes was high and ranged between 90% and 92%. Similar higher survival of GIFT tilapia was recorded by [17]. The total production of fishes was 1356.03, 4270.63 and 9998.56 kg/ha in T_1, T_2 and T_3 respectively, and varied significantly among the treatments more or less similar [20]. The highest production found in T_3 might be due to high protein quality supplementary pelleted (floating) feed and large quantity of natural food available in the pond during the study period, and this production is more or less similar to the findings [17, 19]. The feeding plus fertilization can increase fish production over that possible with fertilization alone [6]. The tilapia production were 3554.76 kg/ha in treatment receiving supplementary feed than 1510.71 kg/ha in fertilized ponds for 6 months [13]. The yields were ranged from 1274 to 2929 kg/ha/145 days [12]. The difference in total production found by different authors might be due to the variation in productivity of the ponds, variation of rearing season and cultural periods along with other factors. The net return and benefit cost ratio was higher in T_3 where pellet (floating) feed was used. Possibly the feed (rice bran + oil cake) given in T_2 could not fulfil the nutritional requirement of the fishes in that treatment as a result the fish production, net income and benefit cost ratio was lower. As no food was given in T_1 so the production was very low in that treatment.

5. Conclusion

The research study demonstrated that production performance of mono-sex tilapia *(Oreochromis niloticus)* depends on good environmental parameters and feed management. During the study it was found that feeding directly effects on the growth performance of mono-sex tilapia. In the whole study period all water quality parameters were observed and feed management was properly maintained. The present research findings revealed that pellet (floating) feed having nutritional requirements is good for getting high production and net income.

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