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ASSESSING STOCKING DENSITY OF SHING FISH (*Heteropneustes fossilis*) IN HOMESTEAD POND AT TWO DIFFERENT LOCATIONS

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Abstract

An on-farm experiment was conducted at two different locations to assess the effects of three different stocking densities of 500, 600, and 700 shing fish (*Heteropneustes fossilis*) per decimal (1 decimal = 40 m^2) in monoculture system in homestead pond conditions. Nine farmers' ponds were selected in each Sadar upazila of Narsingdi and Gazipur districts for assigning three stocking densities (treatments) with three replications for each. Ponds were prepared and stocked with three week-nursed shing fish fry after proper acclimatization. During the culture period of seven months, fishes were fed with commercial pellet feed (35% crude protein) at 25% of body weight (BW) during the first 15 days of stocking and subsequently the feed amount was reduced to 3-5% BW of standing mass. Among the three stocking densities, 500 fish/decimal resulted in significantly highest ($p<0.05$) average final body weight (58.90±3.58 g), survival (71.53±4.01%), and production (21.64±1.80 kg/decimal) in Narsingdi area. In contrast, there was no significant differences ($p>0.05$) in final weight (33.52±3.15-36.29±3.10 g) and production(10.50±1.86-11.40±1.48 kg/decimal) among the three stocking densities in Gazipur area. The growth rate of shing fish was found biased to female sex. With a male to female sex ratio of 1:1.52, the average weight of male (20.05 g) was lower than that of female (49.25 g). Values of soil organic matter (1.28-1.98%), soil pH (5.5-5.8), water alkalinity (91-110 ppm) and water pH (6.5-7.7) of experimental ponds in Gazipur were lower compared to those in Narsingdi area (organic matter: 1.58-2.45%, soil pH: 6.1-6.4, water alkalinity: 108-132 ppm and water pH: 7.4-9.0). With the findings of the present experiment, the stocking density of 500 fish/decimal may be suggested as an optimum stocking density particularly in Narsingdi area.

Keywords: *Hetropneustes fossilis*, monoculture, stocking density, growth, production.

Introduction

The shing fish, (*Heteropneustes fossilis* Bloch, 1794) locally known as stinging catfish is an indigenous species, which is considered one of the most highly demanded freshwater air breathing fish species in the Indian sub-continent. The fish is very tasty, easily digestible, contain high protein and low fat and is used as patient diet since time vogue in many Asian countries (Puvaneswari *et al.*, 2009). Earlier, the fish was abundant in closed and open water eco-system in Bangladesh, but due to various natural and anthropological causes, abundance of the fishes in natural waters has been declined very rapidly listing it as a threatened species (IUCN, 2000). This has aroused a major concern of producing the fish in captivity through aquaculture not only

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for increasing its availability in market but also for conservation in nature.

With the development of captive breeding and mass seed production technology of the species (Begum *et al*., 2001), pond production of shing fish has been started in Bangladesh and progressing to an entrepreneurial-scale in recent years, but concentrating mostly to a particular region, especially in Mymenshing (DoF, 2014). This might be due to that the shing fish hatcheries are mostly located in this particular region and also the lack of awareness of farmers on appropriate grow-out technology for culturing the fish in diversified homestead pond environment in different parts of the country.

Pond culture in Bangladesh is dominated by polyculture of carps, where only 20% of rural inhabitants operate it in homestead ponds and is characterized by small-scale operations (Belton *et al*., 2011). There are numerous homestead ponds which are not utilized for carp production due to unfavorable ecological conditions, as most of the ponds are seasonal, highly fed with domestic influent and shaded by trees. The research and development question is that could the shing fish be cultured using these un- or underutilized homestead ponds? Because, the primary habitat of shing fish includes ponds, ditches, swamps, and marshes. It is hardy and utilizes atmospheric oxygen for respiration and is amenable to a high stocking rate (Kohinoor *et al*., 2012). The species has also shown diverse potential as an aquaculture candidate, with relatively similar pond management measures as that of carp culture practices (Ayyapaan, 2000; Khan *et al*., 2003). However, there is dearth of knowledge on monoculture of shing fish in homestead seasonal ponds at different locations where carp culture appears not suitable and is not practiced as well. The present on-farm research attempt was, therefore, made to explore the possibility of monoculture of shing fish in homestead ponds at different locations and also to determine production performances at different stocking densities.

Materials and Methods

Pond selection and preparation

The on-farm experiment was simultaneously conducted in nine farmers' ponds at different upazilas in Narsingdi (Sadar, Shibpur and Palash) and Gazipur (Sadar) districts of Bangladesh. The average area of pond in Narsingdi was 25.6 decimal, ranging from 12 to 37 decimal, and that of pond in Gazipur was 24.5 decimal, ranging from 16 to 38 decimal. Selected ponds were either dried fully or partially, depending on the prevailing conditions. Partially dried ponds were treated with rotenone (at the rate of 25-35 g/decimal for 30 cm of water depth). After full drying or 5-7 days of rotenone application, ponds were treated with lime (at the rate of 1 kg/decimal). Ponds were refilled with water from adjacent surface or underground source and fertilized with urea (at the rate of 100 g/decimal) and TSP (50 g/decimal). The ponds were left for 5-7 days to allow stabilization of pond water's primary productivity.

Experimental design

The experiment was conducted using a completely randomized block design with nine ponds at each selected research location. In each location, the experimental treatments were three different stocking densities of

500 (T_1), 600 (T_2) and 700 (T_3) shing fish per decimal. Each treatment had with three replications. As it was not possible to have homestead ponds of similar size, replicate ponds were assigned to each treatment so that the average pond area for all treatments could be more or less similar (Table 1).

Fish stocking

Hatchery bred 3-week nursed shing fry (4-5 cm; 0.5-0.9 g) were collected and transported to pond sites using oxygenated polythene bag. Prior to release the fish into the pond, according to the experimental design (Table 1), they were acclimatized to pond water. The length (cm) and weight of fish fingerlings were measured and recorded for estimating initial stocking biomass and to adjusting initial feeding rate.

Post stocking management

After stocking, fishes were fed with commercial pellet feed (35% crude protein) at 25% of body weight (BW) during the first 15 days of stocking and subsequently the feed amount was reduced to 3-5% BW of standing mass (Table 2). The feeding was done twice daily at dawn and dusk. Water temperature (°C), pH and dissolved oxygen (DO) (mg/L) were monitored at weekly interval using thermometer, portable DO meter (Lutron DO 5519) and pH meter (Hanna HI-8429), respectively. Water alkalinity (mg/l) and ammonia (mg/L) were measured fortnightly using water analysis kit (HACH FF-2) at pond site. Pond soil quality, at preparation and at harvest, were analyzed using soil analysis kit (HACH NPS-1) and in Soil Science Laboratory, BSMRAU.

Fish sampling (n ≈ 10-25) was done at fortnightly intervals for measuring individual total length (cm) and weight (g) to assess the growth increment and adjust feeding rate. After seven months of rearing, all fishes were harvested through repeated netting followed by

Table 1. Experimental design and stocking protocol in two locations

Treatment	Narsingdi			Gazipur		
	Stocking rate/ decimal	Replicate pond area (decimal)	Total fish stocked	Stocking rate /decimal	Replicate pond area (decimal)	Total fish stocked
T_1	500	R1: 30 R2: 20 R3: 30 Av. 26.67	40,000	500	R1: 35 R2: 23 R3: 16 Av. 24.67	37,000
T_2	600	R1: 20 R2: 35 R3: 23 Av. 26.00	46,800	600	R1: 38 R2: 16 R3: 19 Av. 24.33	43,800
T_3	700	R1: 30 R2: 37 R3: 12 Av. 26.33	55,300	700	R1: 34 R2: 22 R3: 20 Av. 25.33	53,200

Av.= Average

Table 2. Supplemental feeding rate of shing fishes in different treatments

Feeding duration	Type of feed	Feeding rate (@ % body weight)
1st 15 days	Nursery-I	25
2nd 15 days	Nursery-II	20
3rd 30 days	Starter-I	10-12
4h 30 days	Starter-II	7-8
5th 30 days	Starter-III	6
6th 30 days	Grower	3-5

pond drying. While total number of recovered fishes were estimated by counting fishes of 1 kg for 10 times and averaging the values. All harvested fishes were weighed for estimating total production rate. The number of male and female was also estimated through visual examination in randomly sampled (n≈100) fish at harvest.

The survival rate (SR), specific growth rate (SGR) and food conversion ratio (FCR) were determined at final harvest by using the following formula:

$$SR=\frac{\text{Total number of fish at harvest}}{\text{Total number of stock}}\times 100$$

$$SGR\ (\%\ per\ day)=\frac{\text{ln final body weight(g)-ln initial body weight(g)}}{\text{Culture period (days)}}\times 100$$

$$FCR=\frac{\text{Total amount of feed fed(dry weight)}}{\text{Total live weight of fish}}\times 100$$

All the data collected during experiment and at harvest were recorded and compiled in computer spreadsheet. Data were analyzed using the statistical packages (SPSS) for one-way ANOVA at the significance level of 0.05%.

Results and Discussion

The production performance of three test stocking densities in two experimental locations is presented in Table 3 and Table 4.

In Narsingdi location, the shing fish attained significantly higher ($p<0.05$) average body weight of 58.90±3.58 g, with the lowest stocking of 500 fish/decimal for 210 days of culture period (Table 3). For the same culture period, the average weight of shing fish in Gazipur location varied from 33.52±3.15 g to 36.29±3.10 g, where the higher value was also for the lowest stocking density (500 fish/ decimal), though not significantly ($p>0.05$) different (Table 4).

In Mymensingh region, with the stocking density of 500 fish/decimal, an average weight gain in shing fish of 69.42 g has been reported (Kohinoor *et al*., 2012). This rate of weight gain was lower than that had been obtained in Narsingdi area (Table 3). This difference might be due to that the culture duration of present trial was six months and that of Kohinoor *et al*. (2012) was eight months.

However, the weight gain of shing fish in Gazipur location was considerably lower, compared to that had been obtained in Narsingdi area during the present study (Table 3) and reported in elsewhere (Khan *et al*., 2003; Kohinoor *et al*., 2012).

With the lowest stocking density, the higher weight gain of shing fish at harvest was the resultant effect of increase in growth at higher rate with the progression of culture period. Though there were differences in growth gain, the increment trend in weight gain in shing fish over the culture period in both locations showed that the higher the stocking density, the lower the gain rate in weight (Fig. 1.a and Fig. 1.b. The SGR (%) value was also significantly higher with the lower stocking density (Table 3 and Table 4). Similar growth trend with different stocking densities of *H. fossilis* has been reported by other researchers (Narejo *et al*., 2005; Khan *et al*., 2003; Kohinoor *et al*., 2012). This growth trend might be due to that the fishes with lower stocking density have lower community feelings among them that influence to consume feed properly. This phenomenon might be absent in the treatments with higher stocking densities.

Likewise the trend in weight increment, survival rate was also found to be negatively influenced by increased stocking densities

Table 3. Values (mean±sd) of different production parameters of shing fish (*H. fossilis*) cultured at different stocking densities in Narsingdi area for 210 days of culture period

Growth parameter	Treatment (stocking density)		
	T_1 (500/decimal)	T_2 (600/decimal)	T_3 (700/decimal)
Initial length (cm)	4.6±0.10	4.6±0.10	4.6±0.10
Final length (cm)	19.98±0.48	17.76±0.36	16.09±0.53
Initial weight (g)	0.71±0.20	0.70±0.22	0.72±0.23
Final weight (g)	58.90±3.58^a	45.06±5.96^b	38.60±6.56^b
Weight gain (g)	58.15±3.22^a	44.36±4.21^b	37.87±6.37^b
SGR (%)	2.05±0.01^a	1.92±0.05^b	1.85±0.08^b
Survival (%)	71.53±4.01^a	62.34±5.08^b	58.67±4.07^b
Production (kg/decimal)	21.64±1.80^a	16.86±1.85^b	15.85±2.05^b
FCR	2.51±0.02^a	2.82±0.06^b	3.18±0.03^b

*Data in same row with no or similar superscript letters are not significantly different ($p>0.05$)

Table 4. Values (mean±sd) of different production parameters of shing fish (*H. fossilis*) cultured at different stocking densities in Gazipur area for 210 days of culture period

Growth parameter	Treatment (stocking density)		
	T_1 (500/decimal)	T_2 (600/decimal)	T_3 (700/decimal)
Initial length (cm)	5.06±0.10	4.99±0.15	4.82±0.04
Final length (cm)	18.10±1.17	17.39±1.02	17.61±0.56
Initial weight (g)	1.12±0.03	1.09±0.03	1.10±0.02
Final weight (g)	36.29±3.10	34.88±2.99	33.52±3.15
Weight gain (g)	35.16±2.16	33.76±2.92	32.41±3.12
SGR (%)	2.90±0.02	2.89±0.03	2.85±0.04
Survival (%)	57.5±4.5^a	50.3±3.3^{ab}	48.5±1.5^b
Production (kg/decimal)	10.50±1.86	10.70±1.26	11.40±1.48
FCR	2.98±0.02^a	3.23±0.05^b	3.88±0.02^c

*Data in same row with no or similar superscript letters are not significantly different ($p>0.05$)

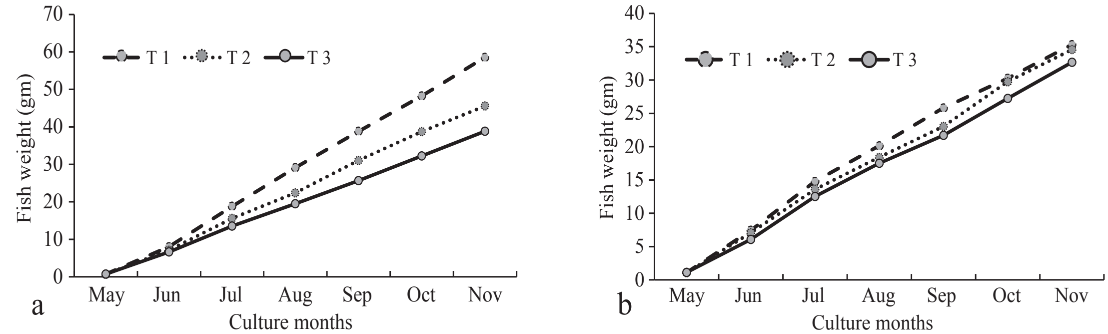

Fig. 1. Monthly growth increment of shing fish at different stocking densities of 500 (T1), 600 (T2) and 700 (T3) per decimal in Narsingdi (a) and Gazipur (b) location.

(Table 3 and Table 4). It might be due to high competition for food and space among the fishes at high stocking density (Narejo *et al*., 2005). In case of walking catfish (*Clarias macrocephalus*), Mollah (1985) reported that the lower density resulted in larger size and higher survival rate. While a survival rate of 98.81% has been recorded in monoculture of *H. fossilis* with the lower stocking density of 160 fish/decimal that of 75.13% has been found 400/decimal (Khan *et al*., 2003).

In both the locations, food conversion ratio (FCR) was found the lowest for T_1 (2.5 at Narsingdi and 2.98 at Gazipur), where the lowest number of fry/fingerlings (500/decimal) was reared (Table 3 and 4). This indicates that the applied feed was utilized more efficiently to gain the live weight of fish with lower stocking density. Kohinoor *et al*. (2012) reported a similar FCR of 2.78 in case of 500 fish/decimal of stocking density of shing rearing. Similar to the present observation of increased FCR with increased stocking density (Table 3 and 4), Narejo *et al*. (2005) and Kohinoor *et al*. (2012) reported an FCR of about 4.0 in shing monoculture in Mymenshing region at a stocking density of 900-1000 fish/decimal.

The production data of shing in Narsingdi (Table 3) showed that the lowest stocking density of 500 fish/decimal resulted in significantly higher ($p<0.05$) yield of 21.64 kg/decimal (5.35 t/ha), while that of 600 and 700 fish/decimal resulted in similar production of 16.86 and 15.85 kg/decimal, respectively . At a same period and similar stocking density, the production rate of 10.5 – 11.40 kg/decimal (2.6 – 2.8 t/ha) was obtained in Gazipur location without any significant differences ($p>0.05$) among the treatments (Table 4). These production rates are comparable to 3 t/h, which has been reported by Khan *et al*. (2003), with a stocking density of 250 shing per decimal, but quite lower than the production rate of 7.5 t/ha at the stocking density of 500 fish/decimal in Mymenshing region (Kohinoor *et al*., 2012). This higher production rate might be due to that the experimental ponds were managed at entrepreneurial level.

While growth rate is biased to either male or female, then sex ratio plays an important role in total yield. Depending on the species, females or males grow faster, and faster growth gives higher output. In the present on-farm trials, the weight of male and female fish was found to vary from 17.46 to 23.67 g and 48.57 to 51.23 g., respectively (Fig. 2). The weight of female fish, in a single batch at stocking and same culture period, was therefore recorded about 106-178% higher than that of male shing fish, indicating that the female population is one of the major factor for production rate in shing aquaculture. Sex ratio different from 1:1 are often found in fish populations both in the wild or held in captivity with sex-specific differences in size, behavior or survival (Hahlbeck, 2004). In natural and in cultured condition, *H. fossilis* is female-biased at a ratio of 2 females : 1 male (Bhatt, 1968). But in the present on-farm trials, the average sex ratio has been recorded as of 1.52 females :1 male (Fig. 3).

A comparison between the average daily weight gain (ADWG) (Figure 4) and the resultant production rate (Fig. 5) of cultured shing fish in Narsingdi and Gazipur area indicated that Narsingdi area may be comparatively suitable for shing monoculture. Though it might not be a conclusive remark on the differences in growth and production performances of shing fish in two experimental locations, a few reasons might have resulted in the lower production in Gazipur area. At early days of culture period, all ponds in Gazipur location were affected by disease. Though fish mortality was controlled, treating the fish with *Eromycine* at the rate of 2 mg/kg of feed that might be led to low survival rate. Though not sure, antibiotic might cause also the lower growth rate, because a number of deformed fishes were recovered at harvest from the antibiotic treated ponds. However, use of any safe/recommended antibiotic, its dose in disease control and effect on growth of fish requires in-depth scientific investigation.

In addition to disease caused mortality, soil and water quality might have effects on differences in growth and production rates of shing fish between two experimental locations. Though variations in different water and soil quality parameters in experimental ponds in each location were similar and within the acceptable range for shing farming (Kohinoor

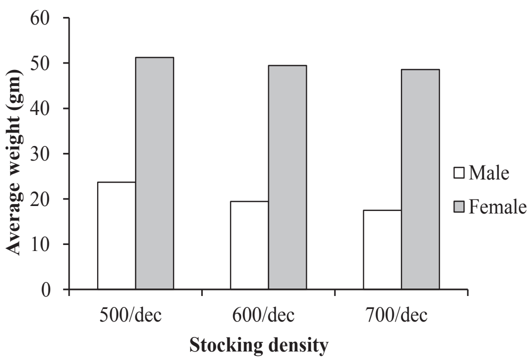

Fig. 2. Average weight variation in male and female shing fish in experimental ponds under different stocking densities.

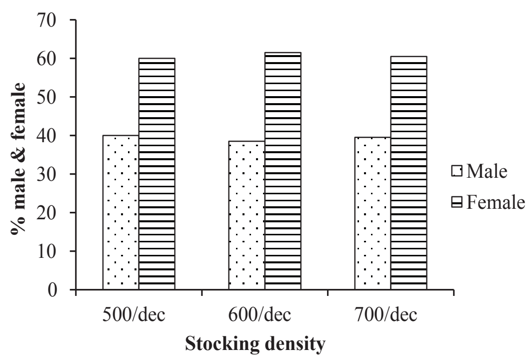

Fig. 3. Percent of male-female of shing fish in experimental ponds under different stocking densities.

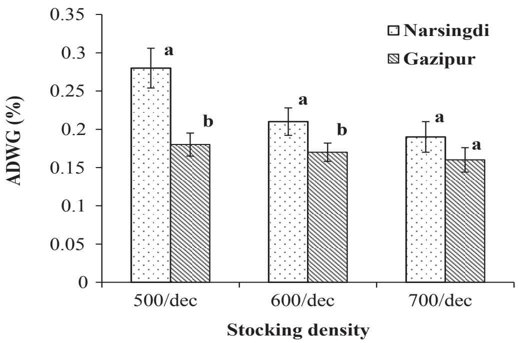

Fig. 4. Location-wise comparison in average daily weight gain (ADWG) of shing fish in experimental ponds under different stocking densities.

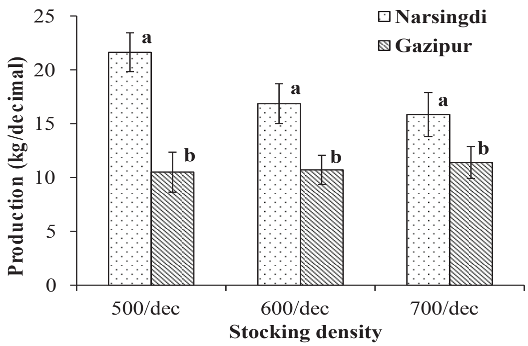

Fig. 5. Location-wise comparison production of shing fish in experimental ponds under different stocking densities.

et al., 2012), there were differences in water alkalinity and soil pH (Table 5 and Table 6).

The soil pH in ponds in Gazipur location (Table 6) was found acidic (5.5 – 5.8) that might have resulted in the comparatively low concentration of water alkalinity of 91-110 mg/L than that of 108 – 134 mg/L) in ponds of Narsingdi area. Total alkalinity levels for natural waters may range from less than 5 mg/L to more than 500 mg/L , although most suitable range for fish culture is 102-123 (Boyd, 1982; Kohinoor *et al*., 2012). The organic matter content of 1.28 – 1.98% was also lower in experimental ponds' soil in Gazipur area than that of 1.58 – 2.35% in Narsingdi area (Table 6). Therefore, the combined effects of lower levels of water and soil pH along with that of soil organic matter and water alkalinity in experimental ponds in Gazipur locations might have influenced immensely on the maintenance of a better healthy aquatic environment and thereby the primary and secondary productivity. Growth, feed efficiency and food consumption of fish are normally governed by a few environmental factors of which pH led water buffering system is of prime concern (Boyd, 1982).

A simple analysis of benefit cost ratio (BCR) was performed for each location. The operational costs included only the cost of fingerlings, feed, fertilizers/lime and others (pond preparation/medicine) excluding

Table 5. Values (mean and range) of different water quality parameters in shing cultured ponds during experimental period in two locations

Parameters	Narsingdi		Gazipur	
	Mean	Range	Mean	Range
Temperature (°C)	30.5	22.21 - 32.9	29.92	23.5 - 31.5
pH	7.8	7.4 - 9.0	7.05	6.50 - 7.7
Dissolve Oxygen (mg/l)	8.3	7.1 - 9.5	6.37	3.4 - 8.9
Ammonia (mg/l)	0.25	0.1 - 0.6	0.21	0.001 - 1.5
Alkalinity (mg/l)	121.2	108.3 - 133.8	100.31	90.8 – 110.0

Table 6. Values (mean ± sd) of different soil quality parameters in shing fish cultured ponds in two experimental locations

Parameters	Narsingdi		Gazipur	
	At preparation	At harvest	At preparation	At harvest
pH	6.1±1.1	6.4±0.05	5.5±0.41	5.8±0.48
Organic matter (%)	1.58±0.16	2.45±0.14	1.28±0.12	1.98±0.16
Total Nitrogen (%)	0.17± 0.03	0.18±0.01	0.07 ±0.01	0.08 ±0.03
Phosphorus (µg/gm)	1.3±0.02	1.4±0.001	2.21±0.31	6.0±1.85
Potassium(mg/100gm)	0.26±0.002	0.31±0.02	0.08±0.02	0.22±0.01

the labor cost for feeding, guarding and harvesting, as these services were provided by the farmers. The cost and income analysis of shing farming at different stocking densities in Nanrshingdi and Gazipur locations is presented in Table 7 and 8, respectively. In both the locations, the shing monoculture at the stocking density of 500/decimal resulted in the highest net return, but it was double in Narsingdi than in Gazipur location.

Conclusion

The results of the study revealed that monoculture of shing fish could be practiced in homestead pond with a stocking density of 500 fish/decimal. The density effects are clearly observed in Narshindi but not in Gazipur. Though a stoking density of 500 fish/decimal has resulted in higher growth and profitability compared to that of 600

Table 7. Cost and benefit of shing fish farming at different stocking densities in Nanrsingdi

Treatment	Cost in (Tk/decimal)				Gross benefit (Tk/decimal)	Net benefit (Tk/decimal)	BCR
	Seed	Feed	Others	Total cost			
T_1 (500/decimal)	1250.00	2444.35	50.00	3994.35	8656.00 (21.64 kg @ Tk. 400)	4396.25	2.16
T_2 (600/decimal)	1500.00	2983.75	50.00	4283.75	6744.00 (16.86 kg @ Tk. 400)	2314.65	1.57
T_3 (700/decimal)	1750.00	2674.10	50.00	4454.10	6340.00 (15.85 kg @ Tk. 400)	1837.9	1.42

Table 8. Cost and benefit of shing farming at different stocking densities in Gazipur

Treatment	Cost in (Tk/decimal)				Gross benefit (Tk/decimal)	Net benefit (Tk/decimal)	BCR
	Seed	Feed	Others	Total cost			
T_1 (500/decimal)	1375	1290.24	54.15	2719.39	4725 (10.50 kg@ Tk. 450)	2005.7	1.74
T_2 (600/decimal)	1650	1427.81	58.16	3131.96	4815 (10.70 kg @ Tk. 400)	1679.03	1.54
T_3 (700/decimal)	1925	1740.1	35.1	3719.24	5130 (11.40 kg@ Tk. 400)	1429.8	1.38

and 700 fish/decimal, stocking densities lower than 500/decimal may be tested for further economic return under homestead pond culture conditions. Further research is required for development of location-specific shing monoculture covering wider agro-ecological zones. The feasibility of producing a monosex (all female) population of shing fish also demands scientific investigation.

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