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INTEGRATED CAGE-CUM-POND CULTURE SYSTEM WITH WALKING CATFISH (*Clarias batrachus*) IN CAGES AND TILAPIA (*Oreochromis niloticus*) IN OPEN PONDS

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ABSTRACT

An experiment was conducted for a period of 97 days at the Fisheries Field Laboratory Complex, Bangladesh Agricultural University, Mymensingh to determine the potential of the cage-cum-pond culture of walking catfish, as well as to assess the economic and environmental benefits of this system. The experiment had two treatments in triplicate. One treatment comprised walking catfish in cage and tilapia in open pond, and the other treatment comprised both walking catfish and tilapia stocked together in open ponds. Ponds of both treatments were stocked with walking catfish and tilapia at a stocking density of 10,000 and 20,000 ha^{-1}, respectively. Fishes in both treatments were fed with commercial pelleted feed (26% crude protein) twice daily at the rate of 10% body weight of walking catfish. All ponds were fertilized with urea and TSP at a rate of 50 $kgha^{-1}$ bi-weekly. Survival of catfish was very low in both treatments ranging from 8.33 to 21.33%. Specific growth rate of catfish was significantly higher (P<0.021) in treatment-2 than in treatment-1 with a value of 2.42 and 1.69 g $fish^{-1}d^{-1}$, respectively. The net yield for catfish of treatment-1 and 2 were 49.67 and 43.45 $kgha^{-1}$, respectively and there was no significant difference between the treatments. The survival rate of tilapia was 65.17 and 71.17% with daily weight gain of 2.31 and 2.22g $fish^{-1}$ in treatment-1 and 2, respectively. Net yield were 817.00 and 790.63 kg ha^{-1}, respectively and there were no significant difference in net yield of tilapia between treatments. Net profit obtained from integrated-cage-cum pond culture (Tk. 24,518 $ha^{-1}97d^{-1}$) was higher than that of open pond (Tk 22,685 $ha^{-1}97d^{-1}$).

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INTRODUCTION

Cage culture of fish and in some cases prawns has developed successfully elsewhere in Asia, Europe and America (Bardach et al. 1972). Until to date aquaculture activity in Bangladesh has concentrated largely on pond culture of Indian and Chinese carps (Karim, 1987). Water bodies in Bangladesh including rivers, irrigation canals, oxbow lakes and haors offer potential sites for cage culture (Golder et al. 1996). Tilapia are widely recognized as one of the most important fish species for farming in wide range of aquaculture systems from single small scale waste feed fish ponds to intensive culture systems (Pullin, 1985). Annual production exceeds 50,000 MT in several Asian countries (Smith and Pullin, 1984). Interest in tilapia culture is also increasing elsewhere in the Indian sub-continent and pacific region countries. Among the wide variety of cultured tilapias the most widely farmed stock is the Nile tilapia (*Oreochromis niloticus*).

The integrated cage-cum-pond culture system is a system in which high valued fish species are fed with artificial diets in cages, and filter-feeding fish species are stocked to utilize natural foods derived from cage wastes. This integrated system has been developed and practiced using combinations of catfish-tilapia (Lin, 1990; and Lin and Diana, 1995) and tilapia-tilapia (Yi et al., 1996; Yi, 1997; and Yi and Lin, 2001) at AIT. In polyculture, ponds are stocked with several species of different feeding habits together. It is impossible to target feeding to only high valued species, because low-valued species consume the feed resulting in economic inefficiency unless an integrated system is adopted. Compared to the nutrient utilization efficiency of about 30% in most intensive culture systems (Beveridge and Phillips, 1993; and Acosta-Nasar et al., 1994), the nutrient utilization efficiency could reach more than 50% in integrated cage-cum-pond systems, resulting in the release of much less nutrients to the surrounding environment (Yi, 1997). In view of the above, the present study has been undertaken with the objectives: a) to assess growth and production of fishes in both cages and ponds; b) to adopt the integrated cage-cum-pond culture system to the local conditions; and c) to assess the economic benefits of this integrated system.

MATERIALS AND METHODS

The study was carried out for a period of 97 days from 24 July to 28 October 2004 in six earthen ponds at the Fisheries Field Laboratory Complex, Bangladesh Agricultural University, Mymensingh, Bangladesh. The experiment was designed with 2 treatments with triplicates. GIFT (genetically improved farmed tilapia) strain of Nile tilapia (*Oreochromis niloticus*) and walking catfish (*Clarias batrachus*) were used for the experiment. In treatment-1, ponds were provided with cages of 1 m^3 $pond^{-1}$; the walking catfish were stocked in the cage and the GIFT fingerlings were stocked in open pond. In treatment–2, both species were stocked in open pond. The stocking density were same in both treatment i.e. tilapia 20,000 ha^{-1} and catfish 10,000 ha^{-1}.

Research design

The fingerlings of catfish were collected from “The Reliance Aquafarm Ltd.” and stocked in cages for the experiment. Fingerlings of walking catfish and GIFT were stocked according to the research design.

Table 1. The design of experiment (Each treatment with triplicates)

Variables	**Treatment–1** (Catfish in Cage and Tilapia in pond)	**Treatment–2** (Both Catfish and Tilapia in pond)
Stocking density	Catfish–$100m^{-3}$ Tilapia–20,000 ha^{-1}	Catfish–10,000 ha^{-1} Tilapia–20,000 ha^{-1}
Feeding	Feed twice in a day in cage as per 10% body wt of catfish	Feed twice in a day in pond as per 10% body wt of catfish
Feed ingredients	Pellet feed (26% crude protein)	Pellet feed (26% crude protein)

Water quality parameters

Water quality parameters such as temperature (°C), transparency (cm), pH, dissolved oxygen (mgl^{-1}), total alkalinity (mgl^{-1}), Phosphate-phosphorus (mgl^{-1}), nitrate nitrogen (mgl^{-1}), ammonia nitrogen (mgl^{-1}) and chlorophyll *a* (μgl^{-1}) were measured at the biweekly.

Growth and production performance

To evaluate the growth performance following growth parameters has been determined.

a) Weight gained = Mean final fish weight – mean initial fish weight

b) Percentage of weight gained =

$$\frac{\text{Mean final fish weight} - \text{mean initial fish weight}}{\text{Mean initial fish weight}} \times 100$$

c) Specific growth rate:

$$\text{Specific Growth Rate (\% day)} = \frac{\text{Log}_e\, W_2 - \text{Log}_e\, W_1}{T2 - T1} \times 100$$

Where,

W_1 = the initial wet body weight (g) at time T_1 (day)

W_2 = the final wet body weight (g) at time of T_2 (day)

d) Survival rate = $\frac{\text{No. of fishes harvested}}{\text{No. of fish stocked}} \times 100$

e) Yield of fishes:

i. Gross Yield = No. of fish caught x Average final weight

ii. Net Yield = No. of fish caught x Average weight gained

RESULTS AND DISCUSSIONS

Water quality parameters

Water quality parameters were analyzed to observe any appreciable changes that might have occurred in response to pond-cum-cage culture. All parameters were more or less within the acceptable range for fish culture during the experimental period. Mean values (±SE) of water quality parameters of different treatments are shown in Table 2.

Growth and Production Performance

The growth performance of walking catfish and tilapia among two treatments in terms of final weight, weight gain, specific growth rate (SGR%) bwd^{-1}), survival rate and total production are shown in Table 3 and 4. Mean final weight of individual walking catfish varied significantly different among the treatments and ranged between 29.22 and 59.22 g. The mean final weight of individual walking catfish (59.22 g) in treatment-2 was significantly higher ($P<0.05$) than the treatment-1. The total weight of walking catfish also significantly different among the treatment-1 and 2 and ranged between 0.482 and 0.619 kg. There are no significant variance of final weight of tilapia among the treatment-1 and 2 and ranged between 65.37 and 69.14 g. The mean final weight of tilapia in treatment-1 (69.14 g) is higher than treatment-2. The total weight of tilapia in treatment-1 and 2 ranged between 8.95 and 9.19 kg, respectively.

Daily weight gain ($gfish^{-1}day^{-1}$)

The daily weight gains of walking catfish in treatment-1 and 2 were between 1.69 and 2.42 $gfish^{-1}day^{-1}$. Among the treatments the mean weight gain of walking catfish was significantly higher ($P<0.05$) in treatment-2 (2.42 g) than in treatment-1. There is no significant difference of daily weight gain of tilapia between treatment-1 and 2. The daily weight gain among the treatment-1 and 2 were 2.31 and 2.22 $gfish^{-1}day^{-1}$, respectively. The final mean weight of walking catfish gained in open pond was 59.22±6.46 g within 3 months, which is more or less similar to the Hossain et al. (2001). They reported that for 8 months culture period the walking catfish weight gained was 80.52 g.

Table 2. Mean (±SE) values of water quality parameters as recorded bi-weekly from all the ponds under each treatment. Values are means of 8 sampling dates and three ponds, (N=21). The range of observed values is given in parentheses.

Parameters		Treatment 1	Treatment 2	ANOVA
Temperature (°C)	Mean ± SE	28.09 ± 0.55	28.50 ± 0.65	NS
	Min – Max	25.0 – 34.5	25.0 – 37.6	
Transparency (cm)	Mean ± SE	26.57 ± 1.45	26.61 ± 1.58	NS
	Min – Max	21 – 50	15 – 48	
Dissolved oxygen (mgl^{-1})	Mean ± SE	5.37 ± 0.19	5.42 ± 0.20	NS
	Min – Max	3.5 – 7.1	3.9 – 8.7	
pH	Mean ± SE	7.18 ± 0.87	7.38 ± 0.16	NS
	Min – Max	6.51 – 8.31	6.58 – 9.82	
Total Alkalinity (mgl^{-1})	Mean ± SE	122.59 ± 4.55	127.19 ± 4.58	NS
	Min – Max	72 – 166	64 – 162	
Chlorophyll *a* (μml^{-1})	Mean ± SE	84.09 ± 8.24	93.39 ± 9.83	NS
	Min – Max	10.71 – 164.22	14.3 – 249.9	
NH_3-N (mgl^{-1})	Mean ± SE	0.07 ± 0.01	0.07 ± 0.01	NS
	Min – Max	0.01 – 0.21	0.01 – 0.20	
NO_3-N (mgl^{-1})	Mean ± SE	0.27 ± 0.04	0.23 ± 0.04	NS
	Min – Max	0.1 – 0.7	0.0 – 0.7	
PO_4-P (mgl^{-1})	Mean ± SE	0.28 ± 0.06	0.18 ± 0.02	NS
	Min – Max	0.01 – 1.67	0.03 – 0.38	

NS: not significant

Survival rate (%)

The survival rate of walking catfish is low and ranging from 8.33 to 21.33% with the significant difference among the treatments. The survival of walking catfish is very low in treatment-2 i.e. in the open pond (8.33%) compared to treatment-1 (21.33%) of cages. Hossain et al. (2001) reported that the survival rate of *Clarias batrachus* in mini earthen pond was high (84.58%) in lower densities (160 dec^{-1}) compared to high densities (240 and 360 dec^{-1}). The survival rate of catfish was 73.33 and 68.75%, respectively. The survival rate of catfish is found lower than Hossain et al. (2001). This might be due to some catfish may have escaped from the pond and the stocked fingerlings were smaller size (average 5.67 and 5.63 g, respectively), which may be cause of low survival rate. In case of tilapia, survival rate of was higher (71.17%) in treatment-2 than treatment-1 (65%). There is no significant difference between the treatments. The survival rate of present study was within results of Rakibullah (2004) and Farzana (2004).

Production of fish ($kgha^{-1}$)

Fish production, total gross yield and net yield in the ponds over the experimental period have been shown in Table 4 and 5. Gross and net yield of walking catfish in treatment-1 was 61.86 and 49.67 kg ha^{-1} and in treatment-2 was 48.21 kg and 43.45 $kgha^{-1}$, respectively without significant difference. Simultaneously, gross yield of tilapia in treatment-1 was 911.8 and 817.0 $kgha^{-1}$ and in tresatment-2 was 790.6 and 894.6 $kgha^{-1}$, respectively. There is no significant difference among the treatments.

The treatment-1 (walking catfish in cages) shows the better performance in production of both walking catfish and tilapia than treatment-2 (both of the walking catfish and tilapia in open pond). The survival rate of walking catfish was very low in treatment-2, but the net yield of individuals was very high than that of treatment-1. The gross yield of tilapia is higher in treatment-1 than the yield of treatment-2. There is no significant difference between the two treatments.

Table 3. Growth and production performance of walking catfish obtained from two treatments

Variables	**Treatment 1**	**Treatment 2**	**ANOVA**
STOCKING			
Total weight (kg cage or pond^{-1})	0.567 ± 00	0.563 ± 00	NS
Mean weight (gfish^{-1})	5.67 ± 0.26	5.63 ± 0.38	NS
HARVESTING			
Total Weight (kg cage or pond^{-1})	0.619 ±0.07	0.482 ±0.05	*
Mean weight (g fish^{-1})	29.22 ± 0.84	59.22 ± 6.46	*
Daily weight gain (g fish^{-1}day^{-1})	1.69 ± 0.12	2.42 ± 0.18	*
Net yield (kg ha^{-1})	49.67 ± 4.85	43.45 ± 1.24	NS
Gross yield (kg ha^{-1})	61.86 ± 6.81	48.21 ± 0.48	NS
Survival (%)	21.33 ± 5.03	8.33 ± 0.88	*

*P<0.05, NS: not significant

Table 4. Growth and production performance of Tilapia obtained from two treatments

Variables	**Treatment 1**	**Treatment 2**	**ANOVA**
STOCKING			
Total weight (kg cage or pond^{-1})	1.460±00	1.480±00	NS
Mean weight (g fish^{-1})	7.30±0.26	7.4±0.70	NS
HARVESTING			
Total weight (kg cage or pond^{-1})	9.19±1.493	8.95±0.342	NS
Mean weight (g fish^{-1})	69.14±6.91	65.37±16.43	NS
Daily weight gain (g fish $^{-1}$day^{-1})	2.31±0.13	2.22±0.12	NS
Net yield (kg ha^{-1})	817.0±146.2	790.63±42.20	NS
Gross yield (kg ha^{-1})	911.8±149.3	894.6±34.2	NS
Survival (%)	65.17±3.92	71.17±9.67	NS

NS: not significant

Economics analysis

The operation cost, gross income and economics of fish production were given in Table 5. Total cost in treatment-1 and 2 were Tk. 60,867 and 54,000 ha^{-1}, respectively, with significantly highest (P<0.05) in treatment-1. Gross income was Tk. 82,385 in treatment-1 and Tk. 77,085 ha^{-1} for treatment-2 where highest income was obtained in treatment-1 (Tk. 82,385). The net profit in treatment-1 and 2 were Tk. 24,518 and 22,685 ha^{-1}, respectively. There is no significant difference among the treatments.

Table 5. Economic analysis of each treatment

Parameter (Tkha^{-1})	Treatment 1	Treatment 2	ANOVA
Gross Income			
Catfish	18,558±2,042	14,463±145	NS
Tilapia	63,827±10,452	62,622±2395	NS
Total	82,385±8,563	77,085±2,260	NS
Operation Cost			
Total Cost	60,867±296	54,400 ±000	*
Net Profit	24,518 ±8,835	22,685 ±2,260	NS

*P<0.05, NS: not significant

Simple economic analysis showed that net income was higher in treatment-1. The money received by selling the catfish was more than the operational cost of catfish seed, feed, fertilizer etc indicates profit of the culture system. Therefore it can be concluded that both culture system are profitable for fish farmers in Bangladesh with the sustainable view.

CONCLUSION

Cage-cum-pond culture has been successfully practiced in most Asian countries and it may be the appropriate tool for additional fish production in Bangladesh. Cage dissemination, orientation and stocking density of fishes in cages should be perfectly followed to get better quality and quantity of fish. Thus, cage-cum-pond farming can be a good option to increase targeted fish production and create employment opportunities by adding together economic profit for fish farmers of Bangladesh.

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