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FEASIBILITY OF SMALL-SCALE CAGE CULTURE OF NILE-TILAPIA (*OREOCHROMIS NILOTICUS*) AS AN ADDITIONAL INCOME SOURCE FOR RURAL WOMEN IN BANGLADESH[1]

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Abstract: Trial on tilapia, (*Oreochromis niloticus)* culture in low cost bamboo framed one cubic meter net cages was performed in six villages of Matlab upzila, Chandpur from July to November 2005. In total 20 poor women were selected through an NGO. They were provided with two days training on culture and management, cage materials, tilapia fries (250 per cage) and fish food for one month. The women used kitchen wastes and plant supplements as tilapia's food. After 120 days of stocking, the results showed that the final production of fishes in cages under two cycle varied from 64.9 kg to 142.93 kg. Considering the nine ponds in six villages the maximum production was observed in the pond at Gozra village (average production 47.64 ± 0.32 kg) where three cages were installed followed by the pond at village Pachani (average production 42.52 ± 0.50 kg) for two cages. The lowest production was found in two ponds at village Balurchar (18.02 ± 0.59 kg). The production was significantly varied among cages (F=42.723, *P*≤ 0.00) and as well as among villages (F=-57.140, *P*≤ 0.00). This was due to the variation of survival (F= 10.989, *P*≤ 0.00) and daily growth (F= 28.259; *P*≤ 0.00) of fish in cages. Pond size, management effort and public interest can differ village to village. These factors alone or collectively influence upon the specific growth rate, harvested fish number and production of fishes in cages. In small scale pond cage tilapia culture, the loss of production was due to the poor management practice by the owner. It is evident from the study that tilapia culture in cages is a suitable technology for an additional income source for rural women for the improvement of their livelihoods and household nutrition in these villages.

mvi-ms‡¶c : Pv`ci †Rjvi gZje Dc‡Rjvi 6wU Mv‡g 2005 mv‡ji RjvB - b‡f¤i gvm chš ci×¶vgjKfv‡e Kg Li‡P 1 NbwgUvi AvKv‡ii ev‡ki KvVv‡gvi LvPvq †Zjwcqv PvI Kiv n‡qwQj| Gi Rb¨ GKwU GbwRI Gi gva¨‡g †gvU 20 Rb Mixe gwnjv wbevPb K‡i Zv‡`i †Zjwcqv PvI I e¨e¯vcbvi Dci 2 w`‡bi cwk¶Ymn †Zjwcqvi †cvbv Ges 1 gv‡mi gv‡Qi Lv`¨ webvg‡j¨ c`vb Kiv n‡qwQj| gwnjviv †Zjwcqvi Lvevi wn‡m‡e ivbv N‡ii I ZwiZiKvixi eR¨ Askwe‡kl e¨envi Ki‡Zb| LvPvcwZ 250wU †cvbv gR‡`i ci †`Lv †M‡Q †h, `B P‡µ gv‡Qi cKi cwZ Drcv`b wQj 64.9 †KwR n‡Z 142.93 †KwR| 6wU Mv‡gi 9wU cKi we‡ePbv Ki‡j †`Lv hvq †h, MRiv Mv‡gi GKwU cK‡i me‡P‡q †ekx †Zjwcqv gv‡Qi Drcv`b nq (Mo Drcv`b 47.64 ± 0.32 †KwR), †hLv‡b 3wU LvPv wQj| Ab¨w`‡K Gi †P‡q Kg Drcv`b wQj cvPAwb Mv‡gi cKi¸wj‡Z (Mo Drcv`b 42.52 †KwR ± 0.50), †hLv‡b 2 wU LvPv wQj| me†P‡q Kg Drcv`b cvIqv †M‡Q evjPi Mv‡gi (18.02 †KwR ± 0.59) `wU cKi| LvPv Ae¨e¯vcbvi Kvi‡b †Kvb †Kvb LvPvq GB †jvKmwb n‡q‡Q| GUv ¯úófv‡e †`Lv hvq †h, Mvgxb gwnjv‡`i Rxebgvb Dbqb I cwiev‡ii cwói Pwn`v ‡gUv‡Z, evowZ Av‡qi Drm wn‡m‡e LvPvq †Zjwcqv gvQ PvI chw³ GB Mvg¸wj‡Z †ek mvdj¨ †`wL‡q‡Q|

Key words: Cage fish culture, Tilapia, production, Chandpur, *Oreochromis niloticus*, women empowerment

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INTRODUCTION

Cage aquaculture is relatively a new technology in Bangladesh. The first attempts on cage culture in Bangladesh were taken in Chandpur Fisheries Research Station (Now Riverine station of Bangladesh Fisheries Research Institute) as a research project in 70's and the next attempt was made in 80's in two lakes of Bangladesh, namely Kaptai lake at Rangamati and Dhanmondi lake at Dhaka (Flexi 1987). All these attempts were failed due to handling the cages by non-experienced farmers. Besides, the unexpected release of exotic tilapia fish (*Oreochromis mossambicus*) in Kaptai Lake from crab cutting cage nets, resulted in the introduction and establishment of tilapia in the lake, which had a negative impression on the cage culture by the farmers and policy makers. Later, the Department of Fisheries (DoF) and North Fisheries Extension Project (NFEP) in conjunction with CARE piloted some cage culture practices in northern districts of Bangladesh between 1991 and 1992. Recently, large scale and remarkable approach was made by the CARE- CAGES project (1998-2002). It was successful initially in establishing small scale cage culture technique in village level but later failed to sustain due to the closure of the project and withdrawal of technical support (Naser 2002). Learning from CARE CAGES project showed that small sized cages were more appropriate for the poor women empowerment in the limited beneficiaries target groups. Later another AFGRP, DFID-UK project called TROPECA studied some of the nutrient balance in freshwater cage pond at Rajshahi from 2002- 2004 (Naser 2006).

CARE's CAGES project was the first aquaculture development project to focus exclusively on cage aquaculture system in Bangladesh, which started in1998 in six regions (Barisal, Comilla, Dhaka, Jessore, Natore and Sylhet) of Bangladesh. The first three years of this project were concerned with the introduction of cage culture with very limited previous experience. The target groups were poor particularly of the women who had ownership problem or access to pond as cages could be set in different water bodies of Bangladesh (McAndrew *et al.* 2000).

From the findings of the TROPECA project it was evident that small scale freshwater cage aquaculture has many advantages over other aquaculture systems and are potentially important in terms of rural poor, landless and/or no-pond owner people (TROPECA 2004). Because the farmers who do not own pond they can culture fish in cages in open water bodies such as rivers, canals, *haor, baor, beels* and others where water remains at least 1.5 m depth for 5-6 months of the year (Naser 2002).

Although various fish species can be cultured in cages, but tilapia is one of the best candidates that suit in small cages as they grow well in average favorable environments with good survival, growth and flexible diets. Tilapia culture in cages may provide interesting perspectives for the development of nutritional and financial security in rural Bangladesh specially for the women. A suitable fish culture method to produce fish in village ponds, may generate additional income for rural women in Bangladesh.

OBJECTIVES

The objectives of the present study are to assess the tilapia fish culture in small scale cages and its sustainability in rural Bangladesh. The technology was transferred through an NGO based activity on the area. Effort has been made to analyze the fate and economy of the technology in terms of household consumption and income from the cages studied in the area.

MATERIAL AND METHODS

Study area: The study was conducted at six villages of Matlab upzila of Chandpur district, from July 2005 to November 2005 (Fig. 1). The area is situated beside the Dhanagoda River, an offshoot from the Meghna River and within the FCD project area. The flood prone area was chosen due to the availability of water in pond throughout the year.

Fig. 1. Map of the study area (The red spot) under Matlab Upazila, Chandpur District.

Selection of the cage culturist: Twenty woman respondents were selected from six villages. Each woman had access to pond water the depth of which was 1.2 m or more for at least six months. They had enthusiasm to culture fish in cages. The women were literate or anyone of their home was literate, could at least keep records of the harvest and other events during culture.

Experimentation: Each participant had one cage of one cubic meter dimension. The cages were constructed with black polyethylene net (8-12mm mesh). Two days training on fish cage construction, management and fish feed preparation were provided to the selected culturist. They were provided with free cage materials, monosex tilapia (*O. niloticus*) fries and fish feed. Tilapia fingerlings (12.5 mm in average length and 20.5 g in average weight) were bought from the Lakshmipur hatchery and transported to the farmers in oxygenated plastic bags. Two hundred fifty fingerlings were stocked in each cage in July 2005.

Fish feed was prepared from locally available ingredients. Feed supplied home made feed of rice barn (30%), mustered oil cake (20%), molasses (10%), kitchen wastes (20%) and fish meal/dry fish powder (20%). The dough was made small ball like shape to feed the fish three times a day until satiation. Rearing time (t) was defined as the number of days the fish were feed for 120 days in each village.

The fish were batch-weighed and counted at stocking and at harvest, and mean initial weight (W_0) and mean final weight (W_t) were calculated. After 120 days (for first one cycle) final harvesting was done and the length and weight of 20% of fishes were taken. A digital weight machine (Denver Instrument, XP-300) and a measuring scale filled to a wooden board were used for taking weight and length data of the harvested fishes.

Performance measurement: Growth per-day, specific growth rate (SGR) and survival rate were obtained from the formula suggested by Goddard (1996):

Economic analysis: Actual cost of cage materials, fish fry /fingerling and feed were used (Table 1). The price of total harvested fish value was estimated by the sale price at pond site. Labour cost for the cage management was not considered as the owners were taking care of their own cages.

The economic analysis was done by the following formula:

a. Net profit = Total sale – Per cycle investment

b. Return on total investment (%) $= \frac{\text{Net Profit}}{\text{Total cost}} x100$

$$\text{c. Return on per cycle investment (\%)} = \frac{\text{Total sale per cycle investment}}{\text{Per cycle investment}} x100$$

Data analysis: Statistical analysis was performed using the SPSS statistical software (version 12 for Windows ™ (SPSS 2003) Significance was set at $P \leq 0.00$. The average values are provided with standard error. The comparisons among the ponds or villages performed by ANOVA (Zar 1996).

RESULTS AND DISCUSSION

Growth performance of tilapia: The average weight of fish (Table 1) varied from 80.9g to 202.6g. Considering the six villages the average growth performance was satisfactory at Gozra ($\bar{x}$ =201.3g) and among cages of the same village, the best performance was observed in cage no. 20 ($\bar{x}$ = 202.6 g). The second to the highest average growth was observed in the village Pachani ($\bar{x}$ = 179g), considering two cages in that village, cage no.17 showed the best growth ($\bar{x}$ =183g) of fish. The lowest growth performance were observed in the village Boliakandi ($\bar{x}$ = 103.1g) and the fishes in cage no. 8 was observed the lowest growth ($\bar{x}$ = 81g), which is also true for all cages installed in different villages at Matlab. The reason for the lowest growth may be the poor management of cages and irregular feeding to the fishes.

Survival, growth/day and SGR in cages: The lowest survival rate (70%) was observed in the cage no.10 (Table 1) where daily growth rate was 0.89g and SGR was 4.11%. The lowest growth per day was observed in cage no. 8 (0.66g) and survival rate was 72% and SGR (3.82%) was lower than cage 10. The similar and highest survival rate was reported in the cages no. 4, 16 &18 (96%) respectively but growth per day was different (1.14%, 1.43% and 1.63% respectively). The reason for different growth/day might be due to irregular feeding to the cage fishes. Further, the highest growth/day was observed in cage no. 20 (1.67). The better SGR was recorded in cages number 3 (4.43%), 17 (4.35%), 19 (4.39%) and 20 (4.55%) among 20 cages. These were corresponded with the growth mentioned in the same table.

Pond wise production performance in cages: Production data are presented in Table 1. Considering the nine ponds in six villages the maximum production was observed in pond IX (average production 47.64±0.32 kg) where three cages were used followed the pond VII (average production 42.52±0.50 kg) for two cages. The lowest production was found in pond III and V.

Table 1. Initial average weight, final average weight, growth/day, SGR, survival and mortality rate in cages at six villages of Changarchar, Matlab during 120 days culture period (July 2005- November 2005)

Village name	Pond No.	Cage no.	No. of total harvested fish	Initial Avg. weight (g) of fries	Final average weight (g)/ fish/cage	Growth g/day/ cage	SGR (%)	Survival rate (%)	Total production kg/cage	Average production kg/ pond	Average production kg/village
Rarikandi	**I**	1	220	2.5	143.05	1.17	4.20	88	31.47	32.07± 0.61	32.98± 0.67
		2	235	2.6	145.26	1.19	4.18	94	32.68		
	II	3	230	2	149.9	1.23	4.43	92	34.47	33.88 ± 0.59	
		4	240	2.1	138.76	1.14	4.31	96	33.3		
Balurchar	**III**	5	187	2.5	93.27	0.76	3.77	74.8	**17.44**	**18.02** ± 0.59	21.63± 3.58
		6	195	2.5	95.44	0.77	3.79	78	**18.61**		
	IV	7	205	2.3	140.06	1.15	4.25	82	28.85	28.85	
Boliakandi	**V**	8	180	2	80.95	0.66	3.82	72	**13.9**	**18.56** ±1.88	18.56± 1.88
		9	208	2.1	110.64	0.9	4.09	84.2	**20.62**		
		10	175	2	108.56	0.89	4.11	70	**17.28**		
		11	212	2.5	112.45	0.92	3.96	84.8	22.44		
Palalokdi	**VI**	12	220	3	152.35	1.24	4.11	88	33.51	34.92 ±1.41	35.99± 0.69
		13	232	2.8	156.61	1.28	4.20	92.8	36.33		
	VII	14	226	2.6	147.63	1.21	4.20	90.4	33.36	34.05 ± 0.69	
		15	230	2.5	151.05	1.24	4.25	92	34.74		
Pachani	**VIII**	16	240	3.5	175.09	1.43	4.12	96	**42.02**	**42.52**± 0.50	42.52± 0.50
		17	235	2.8	183.06	1.5	4.35	94	**43.02**		
Gozra	**IX**	18	240	3.5	199.57	1.63	4.25	96	**47.9**	**47.64** ± 0.32	47.64± 0.32
		19	238	3	201.78	1.66	4.39	95.2	**48.02**		
		20	232	2.5	202.64	1.67	92.8	92.8	**47.01**		

Within the six villages a pond wise production values showed that the production in pond II, VI, VII, VIII and IX were more than the average total production (33.28 ±1.31 kg) among all ponds. Whereas ponds I, III, IV and V showed (Table 1) less production than average total production. From the pond production observation where similar rearing time, food ratio and technology were used for nine ponds the production was found to be variable might be due to the low productivity of pond water and the quality of tilapia fingerlings.

Economic analysis: Input costs for one cage are presented in Table 2. The cost for each cage was similar, but the net profit varied within the nine ponds in six villages (Table 3). The loss incurred in pond III and V of village Balurchar and Boliakandi respectively were different from other village's ponds. The pond D of Balurchar, however achieved the minimum net profit of TK 699.5 and of 53% investment return. On the other hand, the cages in pond I,II,VI and VII showed similar types of return on investment (from 70% - 85.2 %). Two ponds from Pachani (pond no. VIII) and Gozra (pond no. IX) showed the maximum return of 125.4% and 152.7% investment.

Table 2. Input costs for one cage at Chengarchar, Matlab in May 2005.

Materials	Quantity	Rate (Taka)	Cost (Taka)
Bamboo	1	120	120
Ropes and Threads	4	5	20
Floats	4	5	20
Net	4.5(m)		250
Cement bags	2	5	10
Fries with carrying cost	250	1.5	400
Fish feed			500
Per cycle investment (in Taka)			1320

Table 3. Cost benefits analysis of cages for nine ponds. Total cost (materials, feed, fries etc.) for a cage is TK 1320. The price of fish (tilapia) value estimated in local market (TK 70/kg).

Village name	Pond no.	No. of cage installed	Total sale Taka/ pond	Per cycle investment (TK)	Net profit Taka/ pond	Return of investment (%)	Remarks
Rarikandi	I	2	4,490.5	2640	1,850	70	Profit
	II	2	4,743.9	2640	2,104	80	Profit
Balurchar	III	2	2,523.5	2640	-116.5	-4.4	**Loss**
	IV	1	2,019.5	1320	699.5	53	Marginal profit
Boliakandi	V	4	5,196.8	5280	-83	-1.6	**Loss**
Palalokdi	VI	2	4,888.8	2640	2,249	85.2	Profit
	VII	2	4,767	2640	2,127	80.6	
Pachani	VIII	2	5,950	2640	3,310	125.4	Maximum profit
Gozra	IX	3	10,005.1	3960	6,045	152.7	Maximum profit

Statistically, production significantly varied among cages (F=42.723, $P \leq 0.00$) and as well as among villages (F=-57.140, $P \leq 0.00$). This is due to the variation of survivality (F= 10.989, $P \leq 0.00$) and daily growth (F= 28.259, $P \leq 0.00$) in cages. Pond size, management effort and public interest could vary village to village. These factors in cumulative way influenced the specific growth rate, harvested fish number and production of fishes in cages.

From the survival rate of fish, it was found that mortality was mainly caused during stocking time and seven days after stocking. In the present study the less mortality was observed in cages no. 4, 16 and 18. Similar mortality rate of tilapia in cages were observed by Middendorp and Verreth (1992). The mortality of tilapia was high as 28 to 30% in cages 8 and cage 10. The reason might be due to the inefficient handling of the cages and their maintenance or management.

In the present study, the SGRs of tilapia in cages were higher than those assessed by Middendrop and Verreth (1991) and Duangsawasdi *et al.* (1986). These differences might be for the different feeding levels and good quality of food as well as better pond water quality.

In Bangladesh, fish price varies from region to region. In southern part the price of fish is always high in November 2005, tilapia price at Matlab upazila was Tk. 70 per kg for live harvested fish and Tk. 60-65 per kg for dead fish. Naser (2006) observed similar price for tilapia in Northern districts. Maximum production planning, i.e. cycle may contribute considerably best returns from cage culture. Different production scenarios were observed in six villages. The lower production was obtained from two villages where three ponds were used. In these villages lossess from -4.41% to -1.57% were observed on total investment. However, in the villages Pachani and Gozra maximum profit were gained (125.37% to 152.65% return) on total investment. Good profit was observed from the villages Rarikandi and Palalokdi, which was nearly similar profit (63%) that was summarized by Humbrey *et al.* (2001). The total cost for each cage was the same, however, feed costs were varied from 38% of the total cost per cage. Fingerling costs (30.30%) were next important variable items. Middendrop *et al.* (1992) mentioned that feed costs were the highest (70%) as of total cost per hapa and fingerling cost was about 25% of total cost. They also suggested that feeding cost could be reduced by optimizing the feeding regime and home-mixing of fish feed. In the present study, feed cost was lower than 70%, because farmers were using home made feed more than commercial feed for fishes. Stuart (1999) reported that households managing one cage made low average profit but best average profits were made when three cages were managed by a household. From the present study it was found that the

maximum profit (152.7%) was made from pond I, where three household members with cages were from the same family.

CONCLUSIONS

In view of socioeconomic condition of rural women in Bangladesh, it is expected that women with access to pond will prefer cage culture as a part time fish culture occupation. Therefore, fisheries extension agencies should try to introduce this technology actively which may generate additional income for poor women. Small credit program and bank loan may help in supporting cage culture expansion in the country.

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