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R9601 DENSITIES CAGE CULTURE OF COMMON CARP (CYPRINUS CARPIO) IN THE MEGHNA RIVER, BANGLADESH. A COMPARATIVE TRIAL ON FEEDS AND STOCKING

Tapash K. Roy, S.M. Nurun Nabi, Parvez S. Mallick & Mark Ireland
CAGES, CARE-Bangladesh, PO Box 226, Dhaka-1000, Bangladesh

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By : S.M. Nurun Nabi, Tarun Ghosh, Khairul Basher, Anwar Hossen, Ramiz Uddin and Abdur Razzak, CAGES Farm & Training Centre, Bausiaghat, Gazaria, Munshiganj. June 1998

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By: S.M. Nurun Nabi, Tuesday, June 16th, 1998

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By: S.M. Nurun Nabi, A.K.M. Nurul Kabir, Md. Alamgir Rahman

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R9809The techno-economic evaluation of tilapia fry production in cages in Bangladesh

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R9810 Freshwater Prawn Macrobrachium rosenbergii In *Cages:The Effect Of Different* ***Substrates/Structures On Recovery rates &The*** *Effect Of Stocking Density On* ***Growth Performance.***

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R9811 Report on Anabas Koi Rearing in Cage

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R9812 High Density Pangash, Pangasius sutchi Culture in Cage
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Fourth INDIAN FISHERIES FORUM , November 24 - 28, 1996, Cochin

CAGE CULTURE OF COMMON CARP (*CYPRINUS CARPIO*) IN THE MEGHNA RIVER, BANGLADESH. A COMPARATIVE TRIAL ON FEEDS AND STOCKING DENSITIES

Tapash K. Roy, S.M. Nurun Nabi, Parvez S. Mallick & Mark Ireland
CAGES, CARE-Bangladesh, PO Box 226, Dhaka-1000, Bangladesh

ABSTRACT

CARE-Bangladesh's CAGES project aims to develop, innovate and promote cage culture in Bangladesh utilizing the skills and experiences of farmers and other development partners considering the environmental implications. To complement it's extension and training programme project established a trial farm and training centre to adapt and develop appropriate cage management systems. This paper reports on the results obtained from the first trial conducted as part of the process of developing strategies based on learnings. The purpose of this trial was to compare the growth, production and economics of common carp cultured in floating net cage in the Meghna river at density 25, 50 and 100/m3 and fed three different kinds of feed , commercial pellets and farm-made feeds for a period of 100 days. Feed SB results in higher ($p<0.05$) growth compared with Feed A and B. T-test on the data shows that the average growth per fish fed a particular diet is not significant ($p<0.05$) at different densities but the type SB feed results in significantly higher ($p<0.05$) yields at all three densities. Fish recovery decreased with higher stocking densities significantly ($p<0.05$) across all treatments. Feed B had the lowest recovery at all densities and feed SB the highest ($p<0.05$). A negative production also observed at density 100 with Feed A and B. Better growth in Feed SB attributed to it's higher protein contain. The other main reason for poor growth was due to feed loss, due to poor binding properties, physical disturbance by the fish and water flow.

Higher recovery of fish at lower densities may be linked to fish grazing on the net on accumulated periphyton.

Reducing the feed losses will be one of the key factor for economic success of the technology in Bangladesh and in addition will also help minimize the pollution of cage sites.

Key Words : Freshwater aquaculture Common Carp Cage culture Bangladesh

INTRODUCTION

Fisheries contribute about 80% to the nation's animal protein intake of Bangladesh. An estimated 73% of rural households are engaged in some sort of fishing activity and fisheries comprise around 7% of the total employment (around 28 million) in Bangladesh.

Since 1980s, attention was given for development of aquaculture in Bangladesh (Mazid 1995) as production started to decline from inland openwater capture system which accounts for around 50% of the total production. To compensate the loss of natural fish production, both public and private sectors including NGOs took initiatives to boost up aquaculture in the country. This effort able to popularize aquaculture especially pond culture throughout the country which resulted in an increasing trend in aquaculture production. However, the resource-poor people (country's largest and most vulnerable group, do not have any sorts of closed waterbody) missed to join in this development initiative. Aquaculture in the country mainly framed within the waterbodies like ponds, oxbow lakes and coastal shrimp farms. Culture in paddy field also exist in few areas.

The country has vast inland openwater resource which includes rivers, estuaries, floodplains, beels, haors and reservoir covering an estimated area of 4 million ha where cage culture could be adopted and might have an significant impact on aquaculture production, income and employment generation and the nutritional status of the people of Bangladesh (Golder et al. 1996). It offers a good opportunity for resource-poor people often located next to khas (public owned) waterbody to enter and involve in aquaculture. Moreover, problem of conventional disputes regarding fish culture in multi-owned waterbodies could also be overcome (Hasan et al. 1982) by adopting this technology.

CARE-Bangladesh's CAGES project started in September, 1995 to develop, innovate and promote cage culture in Bangladesh utilizing the skills and experiences of farmers and other development partners (Research institutes, universities, development projects and NGOs) considering the environmental implications. The project uses learning approaches which incorporate the knowledge of farmers and enhances life long learning skills in an environment of mutual respect and trust. To complement it's extension and training programme project established a trial farm and training centre in the Meghna river and conducting trials to adapt and develop appropriate cage management systems. This paper reports on the results that obtained from the 1st trial conducted by the project and focused on the reasons of the results and the start of process of developing strategies based on learnings.

Using appropriate stocking densities and feeding strategies are two of the keys to success in aquaculture management. Sodikin (1977) stated that the fish culture in cages could be developed by improving stocking density, feeding methods, selection of species and regulating the culture cycle for maximum profitability. Lack of nutritionally adequate and low-cost feed has always been one of the constrains to the successful practice of cage fish culture in many developing countries (Otubusin 1987). Coche (1979) observed that cost of feeding in intensive cage culture can be account for more than 50% of the production costs.

Recommendations regarding stocking density and feed type for common carp in cage monoculture in Bangladesh are not available. Very little trial work have been carried out so far in Bangladesh . Some of those are Haque (1978), Islam et al. (1978), Hasan et al. (1982) , Alam et al. (1985), Mollah et al. (1987, 1992), FRI (1993) and Golder et al. (1996). None of these studies except FRI (1993) considered common carp to stock in the cages.

We considered common carp to try with as because it is widely used in cage culture in other South-east Asian countries where cage culture is well developed. More importantly, this is the only species that widely available in Bangladesh in earlier enough (March) in the year to take advantage of warm weather generally start to increase from March onward. Commercial fish feeds are costly and also poorly available in rural areas of Bangladesh. Among the three feeds tested in this trial, one was commercial pellets and the other two were farm-made using locally available ingredients. These two feed combinations were chosen because of their familiarity as fish feed to many farming households and also cheap.

The purpose of this trial was to compare the growth, production and economics of common carp cultured in floating net cage at three stocking densities and three different types of feed.

MATERIALS AND METHODS

The trial was conducted in the Meghna river (Meghna-Gumti branch) at Bausia Ghat, Gazaria thana, Munshiganj district (central Bangladesh) where CAGES Trial Farm & Training Centre was set up (Fig. 1). The trial started on 14 June and completed after 100 days of growout period on 22 September, 1996.

Twenty seven floating cages constructed in nine units used for this trial. Each unit consists of three rectangular shape cage-bags (2x1.3x1.9m) placed side by side with a gap in between within a rectangular shape raft (4.75x2.75m) tightened with it's erected hangers. Cage-bag was made from knotless black polyethylene net (mesh 8mm). Iron sinkers were attached with the bottom line of the cage-bag. Raft was made from bamboo, tightening three bamboo together in each of the four sides. Hangers of the raft were made from tree branches (*Ipil ipil*) and framed by bamboo. Cage-bags were hanged in a position that on an average 0.6m remain above the water and 1.3m under the water, created an effective average water volume of 1.68m3 for each cage. Concrete anchors were used to keep the units stationary. At the beginning of the trial units were in the river, placed horizontally somewhat 20m apart from the river bank. After 20 days of growout in the river all the units were shifted to the adjacent creek/floodplain and remained there for the rest of the growout period. The reason for such shifting was to avoid strong current & wave onset along with the monsoon.

Common carp fingerlings were purchased from the local traders and adapted in enclosed conditions in the farm in holding hapas for about ten days before stocking to the trial cages. Fingerlings were stocked at three densities viz., 25/m3, 50/m3 & 100/m3 with nine replicates for each density corresponding to three different types of feed. Fingerlings were stocked randomly in the twenty seven cages. In each cage all fingerlings were weighted at bulk prior to stocking to determine total wt. and av. wt. whereas av. total length was worked out by sampling 30% of the allotted fingerlings at random. Detail data on stocking are given in the Table 1.

Three different types of feed were allocated among the 27 cages in such a way that each of the three densities was replicated three times by each type of feed. Feeds are:

Feed A = Farm-made. Ingredients are 50% rice bran and 50% mustard oil cake. Rice bran were mixed with mustard oil cake soaked overnight in water and presented in dough form.

Feed B = Farm-made. Ingredients are 75% rice bran and 25% chicken viscera. Chicken viscera were minced with an electrical meat blender, mixed with rice bran and presented in dough form.

Feed SB = A commercial feed in pellet form (Saudi-Bangla Fish Feed, Grower).

Feed were supplied in earthen feeding trays (locally called "Shanki") , two in each cage; submerged with "Sikka" (local name, a kind of nylon-made village handicraft) which is tightened with the nylon line crossing over the cage-bag. At feeding time submerged trays were uplifted, allotted feed were placed in the feeding trays and submerged gently to minimize feed wash-out. Feeding started on the one day after stocking @ 10% of the total wt. twice a day and adjusted fortnightly based on sampling. However, after 91 days of growout few modifications were brought in feeding strategy. These were : (i) in feed A and feed B cooked rice water were used instead of freshwater and also flower were added @ 5% of total ingredients at preparation to increase stickiness of the feed, (ii) in all the cages getting feed A and feed B, feed supplied at satiation level rather than body wt. basis. Reasons for these modifications would be describe in the discussion section.

Whenever required the units were repositioned maintaining cage-bag bottom line at least above 0.5m from the soil bed. Each cage-bag and raft cleaned once in a week by brush. Feeding trays were also cleaned whenever required. After the first sampling top of the cage-bags were covered with used knotless nylon nets (6mm mesh) when it was realized that there are chances for fingerlings to jump out specially in heavy windy and/or stormy days when waves reach nearer to the top of the cage-bags.

Growth were monitored fortnightly. At 1st, 2nd and 3rd sampling time all the fishes from a cage were collected by squeezing the cage-bag and then scooping, weighted in bulk and av. wt. was estimated whereas at rest four sampling time 30% of the fishes were scooped at random. To estimate av. total length 30% of the fishes were sampled randomly at all the seven sampling time.

At the end of growout period all the fishes from a cage collected, weighted in bulk; 30% of the fishes measured and restock for other trials.

The analysis of the data was executed by considering the average weight gain per fish per cage observed in the 27 cages during the 100 days interval. The ANOVA was performed using Completely Randomized Design (CRD) with multiple but equal number of observations per cell . Duncan's new multiple range test were applied to investigate the most effective stocking densities as well as the feed types. To assess a particular feed effect on different densities as well as different feeds effect on a particular density 't-test' were applied. To test whether there is any significant differences in fish recovery Proportion test (Z-test) has been used.

RESULTS

Table 1 details the stocking and production details from the trial. Analysis of the data shows that using feed SB results in higher fish production ($p<0.05$) over all densities compared with feeds A and B. T-test on the data shows that the average growth per fish fed a particular diet is not significant ($p<0.05$) at different densities but the type SB feed results in significantly higher ($p<0.05$) yields at all three stocking densities.

Fish recovery decreased with higher stocking densities significantly ($p<0.05$) across all treatments. Feed B had the lowest recovery at all densities and feed SB the highest ($p<0.05$)

Table 1. Stocking and production details of the different treatments

STOCKING	Density 25/m^3			Density 50/m^3			Density 100/m^3		
	Feed A	Feed B	Feed SB	Feed A	Feed B	Feed SB	Feed A	Feed B	Feed SB
Average wt (g)	**13.89 ?2.88**	**16.74 ? 0.27**	**12.46 ? 2.35**	**13.17 ? 5.2**	**7.22 ? 0.5**	**14.44 ?0.6**	**11.55 ? 3.54**	**12.6 ? 4.4**	**10.71 ?2.98**
Average length (cm)	**9.94 ?0.66**	**10.52 ?0.12**	**9.76 ?0.36**	**9.86 ?1.09**	**8.26 ?0.16**	**10.18 ?0.07**	**9.38 ?0.83**	**9.84 ?0.9**	**9.35 ?0.78**
Number/cage	42	42	42	84	84	84	168	168	168
Total wt (kg/m^3)	**0.38 ?0.07**	**0.42 ?0.007**	**0.31 ?0.059**	**0.66 ?0.26**	**0.36 ?0.025**	**0.72 ?0.03**	**1.16 ?0.35**	**1.26 ?0.44**	**1.07 ?0.3**
HARVEST									
Average wt (g)	18.24 ?2.21	20.83 ? 4.34	69.21 ?2.84	14.38 ?1.43	9.62 ?0.38	62.45 ?4.02	11.76 ?7.8	12.94 ?0.83	46.51 ?11.22
Average length (cm)	10.79 ?0.48	11.27 ?0.13	15.89 ?0.38	10.01 ?0.86	8.93 ?0.28	15.67 ?0.28	9.6 ?0.86	9.88 ?0.8	14.06 ?1.17
G. prod (kg/m^3)	0.44 ?0.045	0.51 ? 0.036	1.67 ?0.18	0.67 ?0.22	0.46 ? 0.27	3.06 ?0.14	1.08 ?0.21	1.13 ?0.53	4.4 ?1.18
N. prod (kg/m^3)	0.09 ? 0.027	0.09 ?0.03	1.36 ?0.13	0.008 ?0.055	0.097 ?0.12	2.34 ?0.16	-0.07 ?0.14	-0.1 ?0.1	3.33 ?0.88
Yield/fish (g)	4.35 ?0.67	4.06 ?1.19	56.75 ?5.5	1.21 ?0.87	2.39 ?0.16	48 ?1.69	0.21 ?0.7	0.34 0.54	35.79 ?8.2
Yield/fish/day (g)	0.044 ?0.0067	0.04 ?0.012	0.57 ?0.055	0.0121 ?0.0087	0.024 ?0.0016	0.48 ?0.017	0.002 ?0.007	0.003 ?0.0054	0.35.79 ?0.0082
SGR (%)	0.28	0.22	1.72	0.11	0.29	1.46	0.03	0.03	1.48

Recovery (%)	**97.62 ?2.38**	**99.20 ?1.37**	**96.83 ?1.37**	**92.46 ?3.83**	**95.24 ?2.1**	**98.02 ?2.48**	**92.86 ?4.17**	**84.92 ?15.1**	**94.25 ?2.8**

DISCUSSION

Gross production obtained from this trial was highest at density 100 with Feed SB which is 4.4 kg/m3 (Table I). FRI (1993) reported highest total production of common carp, 3.2 kg/m3 at density 13/m3 with a compounded feed made of fish meal (20%), rice bran (20%), mustard oil cake (40%) and wheat bran (20%) in the Kaptai lake for a growout period of eight months. Golder et al. (1996) reported net production of 3.25kg/m3 for *Pangasius sutchi* at a density of 20/m3 with pelleted Saudi-Bangla fish feed grower cultured in fixed cages in a borrow pit for a period of 120 days. A negative production also observed in our trial in the cages at density 100 with feed A and B.

One of the reasons for the better growth in feed SB is due to it's much higher protein content in comparison to the other two diets, Table 2

Table 2. Proximate analysis of the three diets A, B, and SB given by Bangladesh Agricultural University

Name of sample	Moisture (%)	Protein (%)	Lipid (%)	Ash (%)	Fibre (%)	NFE (%)
Feed A	11.36	19.42	9.59	14.69	19.61	25.33
Feed B	27.36	8.44	9.28	15.18	20.69	19.05
Feed SB	8.92	21.99	11.18	15.52	9.17	33.22

It was recognized during the planning of the trial that the proximate analysis of the diets would vary widely. The trial was to develop a some bench marks for low quality feeds and one of the best feeds available in the open market in Bangladesh. This will help in planning future trials for developing low cost quality feeds based on local ingredients. Though the protein contents of feed A and feed SB are similar 19% and 21% respectively, the growth rates are significantly different. The poor performance of this diet could be due to anti nutritional factors in the mustard oil cake or poor digestibility. Analysis of digestibility was not undertaken for these diets.

The other main reason for the poor growth rates seen in the trial was feed loss from the cages. A large proportion of all feeds were lost due to the poor binding properties and there fore water stability of feeds A and B, water flow through the cages during the time that the cages were set in the river washing fed out of the feeding tray and due to the physical disturbance of the feed by the fish. The latter point was especially a problem in the SB treatments as the fish grew bigger. Table 3 illustrates these points.

Table 3 Percentage of pelleted feed lost from cages with different sized common carp

	River		Flood plain
Average weight of fish (g)	13.63	70.6	58.33
% of feed loss	19.13	59.16	35.32

The level of feed loss obviously greatly effects the economic performance of the system. Reducing the losses will be one of the key factor for success of the technology in Bangladesh. Steps that are taken now to control wastage will in the long term help reduce pollution of cage sites.

The poor growth rate of the fish is also linked to the recovery rate. In feed B the many of the fish showed signs of malnutrition, having wasted bodies and large heads. In treatment B-100 15% of the stock died due to the poor quality of the diet. One of the reasons for the higher recovery of the fish at lower densities many be linked to fish grazing on the net on accumulated periphyton. Given that the area of net is fixed, at lower stocking densities there will be more grazing area per fish.

Conclusion

The development of cage culture in Bangladesh has a long way to go. Currently, there are less than 300 individual cage units operating in the country. To develop low cost feed using locally available ingredients is going to require the combined efforts of different aquaculture development partners.

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R9701

CARE BANGLADESH
CAGES PROJECT

CONSIDERATIONS FOR CAGE DESIGNS
Lessons From One Year's Farm Experience

By

S.M. Nurun Nabi

Presented at workshop on "Cage Aquaculture in Bangladesh", 27-29 April, 1997, Dhaka.

CAGES Farm & Training Centre
Bausiaghat, Gazaria, Munshiganj.

Why cage design is important for cage culture ?

Generally in cage aquaculture, fishes are stocked at higher density in comparison to pond fish culture. To rear plenty of fish in a cage, aquatic environment (specially dissolve oxygen, pH, CO_2, NH_3) of the cage should be friendly to the fish. For ensuring sufficient DO to the fish, water exchange through the cage is required. This is mainly influenced by the size of net mesh i.e. related to cage design.

During the culture period deposition of organic matter (algal growth, feces of fish and feed waste) on cage those after decomposition deteriorate the water quality inside the cage. Moreover, for feeding of fishes, water management, fish growth and health monitoring cages are handled by the operator. How easy will be cage cleaning and handling of fish depends on design of a cage.

Economic viably of fish culture in cage is correlated with the cage design and use of material to construct the cage.

Factors to consider during the design a cage

a) Availability of cage materials at the locality
For the sustainable design to the farmer local resources of cage materials which are more familiar to the farmers could be used. Use of local materials can reduce the transportation cost and easy logistics.

b) Durability of cage materials
To make economic fish cage longevity of materials could be calculated with the price i.e. depreciation cost of cage materials for per crop could be estimated to get the idea about cost effective impute. Different types of materials like net, bamboo, rope etc. are used to construct a cage. Potential effort will be to try to use the impute that are at same durability which will reduce the repairing works during the culture period. These also reduce the risk of fish culture due to cage damage.

c) Purchasing capability of cage operator
Mainly cost of a cage varies with the cage size, type, net type, cage materials, etc. Preliminarily, fry and feeding cost increase with the increment of cage size. Not only cage cost also fry, feeding and maintenance cost should be affordable to the operator. So important to know from operator how much money s/he can invest for this purpose.

d) Net size

Breath varies net to net. Consideration of width may stop waste of net. For example, If any body wants to construct cage having size 2.5x2.5x2.5m from net with 1.5m breath then 0.5m net width will waste from each side wall and bottom of the cage. Therefore, cage size should be depends on net breath rather than preselected size.

e) Size of species

Net mesh should be smaller than the fish size. Other wise fish will escape through the mesh. To culture bigger fish strengthen net could be used for cage. Because during sampling and harvesting hole on cage bag might be produced by the pressure of fish when cage will pull up to agreed the fish.

f) Loose for cage bag

To get uniform spreading of cage bag 20-30% access net required than the actual measurement of cage size except fine mesh net during making .

g) Risk of culture

Disease : Cage bag, feeding tray and inner frame of cage (if used) should be smooth to avoid mechanical injury of fish during movement.

Poaching : To reduce poaching of caged fish layout of the cages might be in cluster form that will help for guarding and may reduce labour cost for this system.

Storm damage : Facing storm strong enough materials could be used. Position of cages (floating) could be free of hitting each other during storm. Top covered cage (floating) could be put under water during storm to avoid wind action on net.

Does profitability depend on cage design ?

In farm site, tilapia fry was reared up to fingerlings in three fixed cages with low cost feeds (rice bran and oil cake individually) at density 250 fry /m3. This trial showed that fry rearing in fixed cage is economically profitable business. If economic analysis was calculated considering floating cages with assumption same production in the both fixed and floating cages then this trial was not economically viable as shown in Table I (Floating cages using bamboo were constructed to culture common carp in the Meghna river.)

Table I : Economic comparison of tilapia fry in between fixed and floating cages

Cage type	Fixed cage	Floating cage
Cage cost*	75	450
Fry cost	62	62
Feed cost	37	37
Total cost	174	549
Total prod (no/cage)	547	547
Total sale(Tk.)	273	273
Profit (Tk.)	99	-274
% of profit on operation cost	56%	-49%

Depreciation cost*

Does design depends on characteristics of water body ?

In the tidal water body, effective water volume of fixed cage varies due to fluctuation of water depth . The variation of effective water volume depends on degree of tide and depth of cage. Fixed cage having two meter depth was installed in the water remaining 0.5m above the water. The average fluctuation of water in the Meghna river was about 0.5m. At this situation variation of effective water volume was 30% . In case of shallow cage , (1m) cage depth had to readjust during high tide and low tide timely. If a top cover is used on the cage and the cage installed in the water during low tide having top of the cage at the water surface which could minimize the variation of water volume. After doing this, during high tide cage is needed to pull up for feeding of fishes which involve addition labour to cage management. Making tubular net opening on the top of cage, normally knotted, feed can be applied to opening in the net (see figure 1). However, tide has no influence on effective water volume of floating cage.

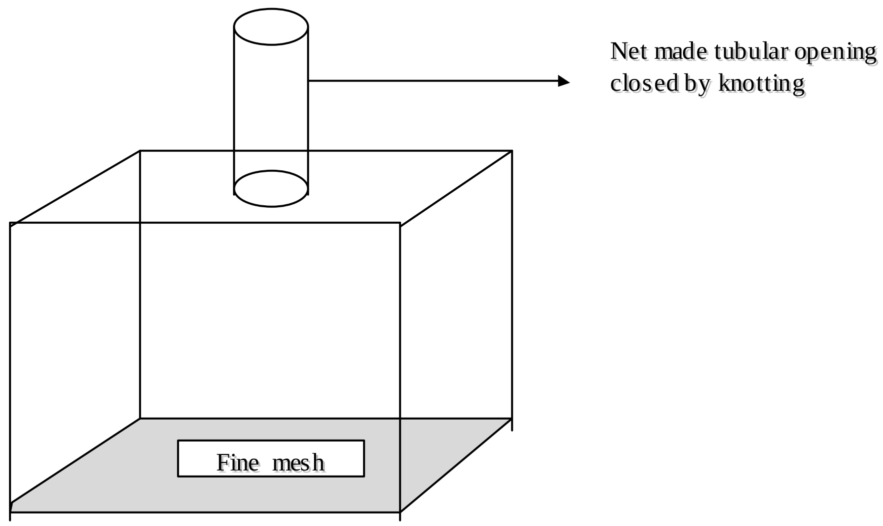


Fig.1 Cage with net made tubular opening on the top and fine mesh at the bottom.

Effective water volume from cage

Effective water volume with uniform cage spreading can be maintained by using box type frame in the inner side of the cage. Extra net is not then needed during the sewing of the bag.

How design helps on cage management ?

Algal deposition on cage bag has been found from water surface to 12" under water in floating cage. These algae had to clean after seven days interval. However, algae growth was not observed on fixed cage. Possible cause might be during low tide algae were destroyed by the sun drying out.

During storm difficult to keep the floating cages stationery and cages hit each other. As a result cages may damage. To keep cages stationery complicated system of anchors is needed. Fixed cages were not affected by the storm.

Sampling of fishes is important to know the growth and required feed ration for the fishes with the increment of fish size. Easy to collect the fish from fixed cage by pulling up the net bag for growth monitoring compared with floating cage. Sampling purpose, at least two person required for both cages but in addition, one boat is needed for floating cage which increase the amount of investment.

In the tidal water body depth of fixed cages is needed to readjust depth with the fluctuation of water level which is hazard to daily management. Using floats at the top of cage with making the loops by rope at the four corners of both top and bottom of cage fitted with poles depth is adjusted automatically with the water level fluctuation. Moreover, 1m3 floating cage using box type frame made of iron rod with loop by rope fiffed with pole worked better than the floating cage without fixed box type frame.

Has any relation with durability of choice of nets ?

Two cages having sizes 4x2x1m and 2x1x1m were made using Indian fine mesh blue net After 3 months some holes were observed on the bigger cage due to shrinkage of net fiber. However, hole was not found in the smaller one. Possible cause might be wind and waves action on cage. Bigger cage had more stress due to higher volume remain above water compared with smaller one. While sampling or cage cleaning or harvesting of fishes one corner of the cage is to be lifted up to gathered the fishes to the other corner. At this moment waters pressure on cage bag. The intensity of water pressure increase with cage size as volume of water is greater.

Can design reduce the impute (misuse of feed) cost ?

Roy *et. al.*(1996) reported feed loss is one of the major constrains to culture fish in cage in Bangladesh. When feed was given to the fish, due to water flow and water agitation produced by the fish during feeding feed waste away through the net. At the beginning feed loss was about 50% and after using fine mesh and deeper bamboo basket cage bag it has been reduced up to 20-30%.

In the stagnant waters it has been observed that farm made feed spreads on round the feeding. So in a similar cage volume there is a more chance of feed loss from rectangular shaped cage than the square. However, in case of flowing water, mainly feed carried out by the water current. Feed loss could be less in rectangular cage if the feed is given at the side of cage where flow comes first and if the cage length set to the water flow.

To minimize the feed loss an another potential option might be use of double Decker cage i.e. comparatively smaller one cage should be put in the bigger cage. Fishes should be stocked in both cages and feed will be applied in the inner cage only. Lost feed from inner cage will be eaten by fishes of bigger cage.

Is the Design friendly to the environment ?

Potential impacts of cage culture on environment might be --

Enrichment of nutrient : Cage fishes are mainly depend on supplementary feed. Generally industrial quality feeds are widely used where peoples has taken it as a profession specially in Philippines, Indonesia and Thailand. Feed loss from cages at first could increase the productivity of local environment and continuos addition of nutrient to the waters might occur pollution. So, feed loss should be reduced significantly using appropriate cage design.

Siltation : In the flowing waters dissolve solids are carried out by the current. Cages may disrupt the velocity which would help the solids to settle down on the bottom which may bring the change of characteristics of the habitat. Rate of siltation depends on mesh size and areas acquired by cage.

Escapee from cage : Exotic fish species may escaped from cage and entered into the local stock which may affect the local stock. Therefore, for exotic fish cage design should be created carefully

Fishes were fed slowly in sprinkle method with Saudi-Bangla fish feed and feed loss was estimated. The result showed that slow feeding to the fish with pelleted feed in sprinkle method can be reduced feed loss up to zero.

Can design increase the natural food for fish ?

In intensive cage culture feed cost greatly influence the total investment (about 60% of the total investment). But feed cost also varies with the quality of a feed. Culturing tilapia with industrial pellets cost are shown Table II. Feed cost could be reduced using different substrates such as bamboo, tree branches, plastic bottles etc. in the cage to grow periphyton on it for grazing by the fish.

Table II Expenditure of tilapia culture in floating cage with commercial pellets for different periods

Duration (Days)	**124**		**141**		**156**		**169**	
Impute	Cost (Tk)	% on total investment	Cost (Tk)	% on total investment	Cost (Tk)	% on total investment	Cost (Tk)	% on total investment
Cage cost	725	16	725	12	725	9	725	7
Cage depreciation	167	4	167	3	167	2	167	2
Seed	783	17	783	13	783	10	783	8
Feed	3066	67	4390	74	6143	80	8522	85
Total invest	4573	100	5897	100	7651	100	10030	100
Investment/cycle	4015	88	5339	91	7092	93	9471	94

Does design reduce the risk of culture ?

Generally bigger cages have more risk of economical loss than the smaller cage. Bigger cage one may have more fishes than smaller one, if the fishes are stocked at same rate. Sometimes crab may cut the cage bag. Therefore, fishes might be escaped through the cage hole. In Philippines, usually farmers stock 5% red tilapia together with culturing fish in each cage to get some idea whether fishes escaped or not through the hole. If all red tilapia were found in the cage it is considered that fishes are not escaped. Stopping the crab, one of the potential option might be using inverted funnel of earthen ware to save the fixed cages from net cutting by the crab.

Common carp was cultured in floating cages. On the top of the cage was open. During windy day waves reach near to the top of the cage . At this moment fishes jumped out from the cage (see Table III). Moreover, During storm waves goes over the cage which increase the fish loss. The cages were covered by nylon net to protect the fish. From fixed cages fishes were escaped due to sudden raising of water level more than the regular high tide. Experiencing of fish loss from fixed cage during tidal effect cages were covered by the net. Top cover was sewed with all the top line of the cage except 0.5m to fed the fish and collect the fishes during sampling. Space for feed application were open and closed by plastic line after 4" interval.

Table III: Losses in common carp culture for a period of 100 days

	Range
Average weight (g)	7-17
Escaped by jumping (%)	0.79-5.36
Escape through net hole (%)	0-7.54
Mortality by malnutrition (%)	0-2.98
Total cultural loss (%)	0.79-15

Note : n=9

Both fixed and floating cages have some advantages and some disadvantages (Table IV).

Table IV Advantages and disadvantages of fixed and floating cages

Fixed cage	Floating cage
Advantage	
a. Cost per unit is less than the floating cage.	a. Cage depth remains constraints with the fluctuation of water level.
b. A little algal deposition occurred on cage bag.	b. Cages could be set up in the deeper water bodies.
c. Cages are not affected by the storm.	c. In the tidal water bodies effective cage depth is higher.
d. Cage management (cleaning, shifting and sampling) are easy.	d. Fish could graze on the cage bag.
e. Cage bag spreads properly due to bindings of four bottom corners with poles.	e. Cage bag of floating cage with box type frame was spreaded uniformly.
f. Easy to construct compared with floating cage.	
Disadvantage	
a. Cage depth varies with the fluctuation of water level.	a. Cost per unit is higher than the fixed cage.
b. In the deeper flowing waters cage could not be set.	b. Algal deposition on cage bag affect the water exchange through the net.
	c. There is a chance of damage of cages through moving and hitting each other.
	d. Due to water flow cage bag does not spread properly which reduce the effective cage volume.
	f. Cage management i.e. cage cleaning, shifting and sampling are not easy.
	g. Extra paint is needed to protect iron frame from rust.

Cage design is important to keep the fish good condition in cage. Profit margin of fish culture in cages is influence by the cage design. Each cage design and cage materials have some risk in terms of durability, cage management and suitability to the water body. Purchasing capability may varies farmer to farmer. Every people may have his own budget for culture fish. Successful cage design depends on considering farmers budget using cost effective cage materials (in terms of durability, cage management, save in the storm) in respect to water body that are friendly to the environment.

At this moment, it could be concluded that fixed cages would be suitable with modification in respect to water bodies in Bangladesh specially in the flood plains where having shallow waters. Moreover, 1m3 floating cage with fixed frame also suitable (interms of cage management) for cage culture in our country.

Reference

T. K. Roy, S.M. Nurun Nabi, P. S. Mallick and M. Ireland, 1996. Cage culture of common carp (*Cyprinus carpio*) in the Meghna river. A comparative trial on feeds and stocking densities. Presented at *Fourth Indian Fisheries Forum*, November 24-28, 1996.

Appendix I: Recommendations generated based on this paper from workshop

1. Dr. Arshad commented that if the top of the cage remained under water fish may face respiratory problem especially fish without air breathing organ.
2. Effect of mesh size on production could be workout.
3. Suitable cage size (in terms of production and management) could be determined in Bangladesh context.
4. Dr. Halder assumed that fish movement might be disrupted and disease may appear in the $1m^3$ sized cage.
5. Potentiality of bamboo and plastic fibre made cage could be tested.
6. Mr. Saymol stated that a hapa could be set in a cage and fry could be reared in the hapa. After a month fries could be released in the cage.
7. Some one asked that what would be stocking size and density for cage culture.
8. Malnutrition problem might be appeared in case of double decker cage.

R9702

CARE BANGLADESH
CAGES PROJECT

Individual Cage Operation (FT03/96-II)

Intensive Tilapia Culture In Cage

By

SM Nurun Nabi and *Naseem Ahmed Aleem*

September, 1997

CAGES Farm & Training Centre
Bausiaghat, Gazaria, Munshigan

Title
Intensive Tilapia culture in cage

Objectives

?? To gain practical experience on cage culture.

?? To asses Tilapia growth with commercial pellets in cage.

?? To asses the durability of the cage materials.

?? To see the profitability of caged fish rearing.

Significance
CAGES staff had no practical experience on cage aquaculture before start the farm trials. Therefore, CAGES feels that each aquaculturist of the project should gain practical experience on it especially on cage management from self managed cage.

From first two farm trials (TF01/96 and FT05/96), CAGES experienced with poor fish growth with low quality feeds (in terms protein content, binding properties and feeds composed of two ingredients). However, comparatively better growth was found in the first trial with commercial pellets (Saudi-Bangla Fish Feed, Grower). These two trials were not economically viable. Reason were poor quality of feed, feed loss during feeding of fish and less density (range 25/m3- 100/m3). Therefore, it was important to evaluate the fish growth with quality feed staff at higher density reducing feed loss using appropriate feeding technique.

Tilapia fish is widely available in ponds all over the country (M. Ireland *et. al.*, 1996). It can breed naturally in ponds and open waters which could offer the farmers to stock their cages at less cost. In Bangladesh, no body studied on Tilapia at higher densities with commercial pellets in cage.

The trial was conducted on 30 December '97 to 17 June '97 for a period of 169 days. This report will describe the results which was obtained from the experiment.

Methods and Materials
Study area
The experiment was carried out in the Meghna-Gomti tidal river to the west bank of the river at Bausiaghat under Gazaria thana and district of Munshiganj.

Experimental facilities
A 2x1.3x1.9m sized cage having 4.4m3 effective water volume was used in this experiment (see figure I). The cage bag was made of knotholess black polyethylene net with 8 mm mesh. It was stitched by tire cord and plastic line. Top of the cage was covered by the same net. A platform, made of fine mesh net was laid on the bottom to protect the sinking of feeds through net mesh. And a rectangular frame (1.8x1.2m) made of plastic pipe having sand in the inner side was fixed on the cage bottom to spread the cage bag properly. Four floats (buoy) were fixed with the top four corners of the cage by rope. Loops were made by plastic rope at the top and bottom four corners and was fitted with four bamboo poles. Therefore, the cage depth was adjusted with the water level automatically.

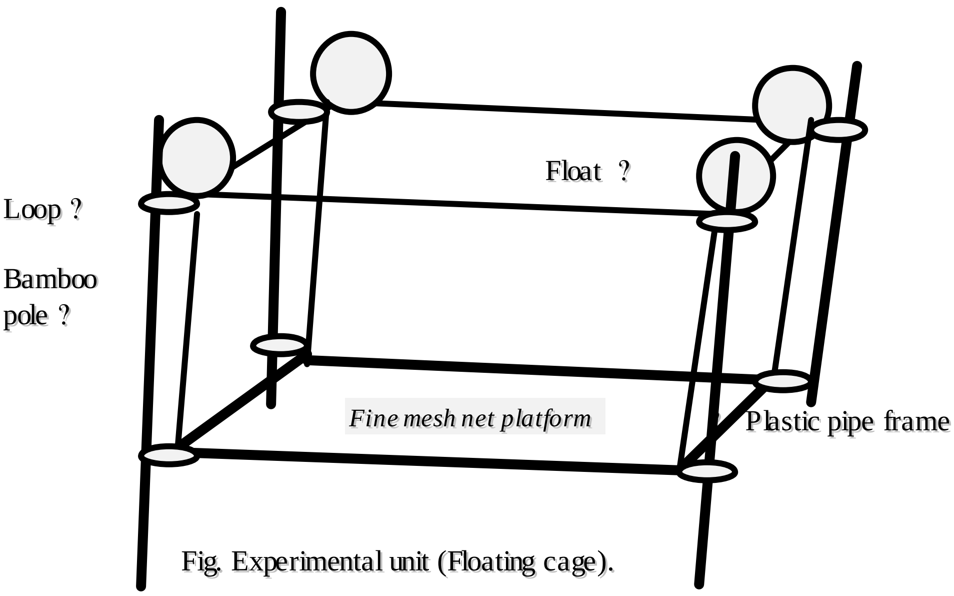


Fig. Experimental unit (Floating cage).

Fingerlings collection
Fingerlings were collected from Fisheries Research Institute (FRI) on 27 June '96 for FT05/96 trial. Left over fingerlings were used in this trial. During holding in hapa fish were fed with farm made feed (50% Mustard oil cake + 50% rice bran). Therefore, fish fries were remain under nutritional stress for long time.

Fingerlings stocking
The fingerlings were stocked in the cage on 31 December '96 at density 350 fish/m3 without replication. The average weight of fries was 10.09g (? 3.43).

Feed and feeding of fish
The commercial pellets named Saudi-Bangla fish feed (grower, about 22% protein content) were fed to the fish. Feed was applied slowly through sprinkle method on the top of the cage. Feeding frequency were 2-3 times in a day at morning, before noon and afternoon. Feed was given to fish at satiation level. Satiation level was adjusted on an average after 10 days interval.

Cage management
Faeces of fish were cleaned by agitating the net after 7-10 days interval. Cage bag spreading and cage hole were checked by dipping in the water at same time.

Growth monitoring
During stocking bulk weight of fish was taken and average weight of fish had been calculated. Standard deviation was measured from group averages of fish (each bulk weight/no of fish). Sampling of fish for estimating the growth was not done to avoid stress on fish due to sampling (Bolivar, 1994). When fish reached at harvesting size after 124 days to stocking, about 20% fish were weighed average weight was

estimated. To monitor the profitability of the system, the trial was continued for longer period. For the rest trial period, all the fish were weighed and averaged.

Harvesting

The experiment were terminated on 17 June '97. Fish were sold to fish trader at whole sale rate and to CARE- staff at retail rate. Two hundred twenty two fish (male-75, female-150) were kept in the holding cage as brood stock.

Economic analysis

Fish price of whole sale to fish trader was used. Actual price of cage materials, fish seed and feed were also used during purchase before trial set up and during the trial. Depreciation cost of cage materials has been estimated based on training experience in Philippines and farm experience.

Feed waste collection

Before feeding of fish a polyester cloth made hapa was set engulfing the cage. Then feed was applied in the cage. After completion of feeding hapa was lifted and checked.

Environmental monitoring

For this trial oxygen and temperature has been collected and analyzed.

Dissolved oxygen

DO reading has been taken from location within farm at three different depths such as surface (< 30 cm), middle (30-100 cm) and bottom(>100 cm) at 0700 hr. and 1500 hr. daily by digital oxygen meter (model no. OXI 92, D812 Weilheim). The daily oxygen data from different depth and time were averaged. Then 15 days data were averaged again.

Temperature

Temperature reading has been recorded at different depths (surface, middle and bottom) of within farm site at 0600 and 1500 hr. twice in a day by digital meter. During average same procedure of analysis of DO data was followed.

Production calculation

Specific growth rate, fish recovery rate, net production and food conversion ratio were obtained from the following formula.

$$\text{Specific growth rate} = \frac{\ln(\text{Final body wt}/\text{Initial body wt})}{\text{Duration of time (days)}} \times 100$$

$$\text{Fish recovery rate} = \frac{\text{No of fish at the harvesting}}{\text{No of fish at the stocking}} \times 100$$

Net production = Final wt at the harvesting - Initial wt at the stocking

Feed given

Food conversion ratio = ---------------------

Weight gain of fish

Results and Discussion

Water quality

At the start, temperature was comparatively lower due to the season and increased gradually with the changing of season. DO was within suitable ranges to fish culture during the experiment (Table I).

Table I: Fortnight average of DO and Temperature

Duration (days)	15	30	45	60	75	90	105	120	135	150	169
Parameter											
Oxygen (mg/l)											
Average	8.46	9.00	11.61						7.75	7.32	6.49
sd	0.58	0.70	0.97						0.44	0.65	0.45
Temperature (oc)											
Average	21.60	20.00				27.46	26.87	27.86	29.42	29.56	29.53
sd	0.58	0.67				0.63	0.55	0.97	0.92	0.91	0.60

Note: Blank box indicates data were not collected due to disturbance of instruments.

Fish Growth

Net production was obtained 61.31 kg/m3 from the trial (see Table II). Mortality was negligible (1.36%) in this study. Fish growth was satisfactory (SGR 1.71%-1.84%) during the trial. Main reason might be use of good quality of feed (appendix I) and reduction of feed loss up to zero. SGR was decreased with the increasing of fish size except 3rd sampling. Reason might be stress on fish due to counting and sorting before 7 days to 2nd sampling. Fish were stressed again during video recording between 1st and 2nd sampling. FCR increased with the increasing of fish size. Possible cause might be maturation of fish. During maturation of fish energy may used for gonadal development.

Table II: Productivity during the experiment

	Stocking	1st sampling	2nd sampling	3rd sampling	Harvesting
Duration (day)	0	124	141	156	169
Average wt (g)	10.09	99.10	115.93	156.27	187.82
s.d	?3.43	?17.32	?17.23	?17.46	?16.71
Number/cage	1540	1519	1519	1519	1519
Number/m3	350	345	345	345	345
Biomass(Kg/cage)	15.54	150.53	176.10	237.38	285.30
Biomass(Kg/m3)	3.53	34.21	40.02	53.95	64.84
Net prod (Kg/cage)	0.00	134.99	160.56	221.84	269.76
Net prod (Kg/m3)	0.00	30.68	36.49	50.42	61.31
SGR (%)	0.00	1.84	1.73	1.76	1.73
Recovery rate(%)	100.00	98.64	98.64	98.64	98.64
FCR	0.00	1.42	1.71	1.73	1.97

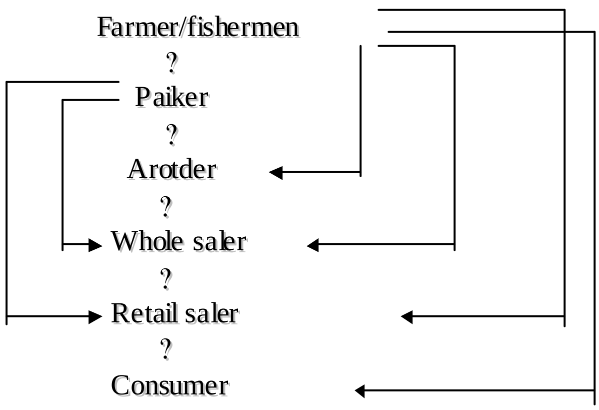
Economic Analysis

Economic analysis showed that feed cost was the major invest for the system. Feed cost increased significantly with the longer period of culture (Table III).

Table III Proportional cost of intensive Tilapia culture in cage for 169 days

Duration (Days)	**124**		**141**		**156**		**169**	
Impute	Cost (Tk)	% on total investment	Cost (Tk)	% on total investment	Cost (Tk)	% on total investment	Cost (Tk)	% on total investment
Cage cost	725	16	725	12	725	9	725	7
Cage depreciation	167	4	167	3	167	2	167	2
Seed	783	17	783	13	783	10	783	8
Feed	3066	67	4390	74	6143	80	8522	85
Total invest	4573	100	5897	100	7651	100	10030	100
Investment/cycle	4015	88	5339	91	7092	93	9471	94

Profitability gradually declined with the longer period of the experiment (see Table IV). Profit margin may depends on marketing system. In Bangladesh, marketing chain (personal observation) are to:



Note: Arrow indicates fish selling at different steps of marketing system.

To increase the profit of the system, fish selling chain could be shorter. From Table I V, it has been found that the system was more profitable up to 124 days than longer period.

Table IV Profitability of Tilapia fattening for a 124 days of grow out periods at different fish price

Duration (Days)	**124**			**141**			**156**			**169**		
Fish price (Tk/Kg)	60	50	46	60	50	46	60	50	46	60	50	46
Total sale	9258	7715	6925	10566	8805	8101	14243	11869	10919	17118	14265	13124
Benefit	4684	3142	2351	4669	2908	2203	6592	4218	3268	7088	4235	3094
Per cycle benefit	5243	3700	2910	5227	3466	2762	7151	4777	3827	7647	4794	3652
Return on total investment (%)	102	69	51	79	49	37	86	55	43	71	42	31
Return on per cycle investment (%)	131	92	72	98	65	52	101	67	54	81	51	39

Note: Fish were sold to CARE-staff and Paiker at different prices (46 Tk/Kg-60 Tk/Kg). Therefore, profitability estimated with that prices without considering price variation with the increasing of fish sizes.

Evaluation of feeding technique

Feed loss during feeding of fish was estimated. The result showed that slow feeding through sprinkle method reduced feed loss up to zero.

At the beginning feed distribution time was 15 minutes for each feeding frequency. Feed distribution time gradually increased with the increasing of the fish size. At last 2 hours required for each feeding frequency which include higher labour cost for feeding of fishes. Feed distribution time per cage could be reduced to apply feed in the two cages at the same time by a person using two hands for two different cages (which are set side by side).

General observation
Bargining for fish price with the Paiker was in favour of CAGES Farm. Fish were shown to the Paikers lifting the cage. When price was less fish were restocked in the cage. Uncertainty of selling did not effect on the price. In pond fish culture, to catch fish from pond to show the Paiker, extra invest is needed. Normally farmer had to sale fish after harvesting though price was less (personal observation).

During 1st sampling, fish were sorted into two groups that are below 50g and above 100g based on eye estimation. About 16% fish were found under 50g group and rest were under above 100g group.

During the experiment the cage was not needed to repair. Actual durability of cage materials might be similar to assuming durability (see appendix II).

Conclusion
Water quality was in favour of fish though at the beginning temperature was comparatively low. Fish growth was satisfactory. Reason could be good quality of feed. Slow feeding through sprinkle method reduced Feed loss up to zero. Profitability decreased with the longer period of culture. Profit margin could increase by reduction of length of marketing chain.

Reference
M. Ireland, T.K. Roy, S.M. Nurun Nabi, M.A. Rahman, S.M.Z. Huque and N.A. Aleem., 1996. Are Tilapia breed in the open waters of Bangladesh ? The results of a preliminary countrywide survey. *Presented at Fourth Asian Fisheries Society, Indian Branch*, Kochi, Kerala.

R.B. Bolivar, H.L. Bolivar and A.E. Eknath., 1994. Effect of sampling frequency on the growth and survival of Nile Tilapia *Oreochromis niloticus* in Hapas. *Asian Fisheries Science* **7**: 129-133. Manila, Philippines.

Appendix I: Proximate composition analysis of commercial pellets

Sample	Moisture (%)	Protein (%)	Lipid (%)	Ash (%)	Fibre (%)	NFE (%)
SB	8.92	21.99	11.18	15.52	9.17	33.22

SB = Saudi-Bangla Fish Feed, Grower.

Appendix II: Cage construction cost.

Item	**Quantity**	**Price**	***Total cost (Tk)***	***Longevity (years)***	***Cost/cycle (Tk)***
Black polyethylene net	11.5m	40/m	460.00	3.00	78.67
Bamboo	2	50/p	100.00	1.50	33.33
Nylon rope	150g	85/Kg	12.75	1.00	6.38
Tire cord	20g	150/Kg	3.00	2.00	0.75
Iron sinker	22p	0.8/p	17.60	2.00	4.40
Fine mesh net	2m	22/m	44.00	2.00	11.00
Float	4p	10/p	40.00	1.00	20.00
Plastic pipe	2p	18/p	36.00	3.00	6.00
Plastic angle	4p	3/p	12.00	1.00	6.00
Total			**725.35**		**166.53**

R9703

CARE BANGLADESH
CAGES PROJECT

REPORT ON INDIVIDUAL CAGE OPERATION (FT03/96-I)

The evaluation of Tilapia growth with hotel kitchen waste in fixed cage

BY

S.M. Nurun Nabi
Tarun Ghosh
Khairul Basher
Md. Nruzzaman
Md. Ramiz Uddin
Abdur Razzak

October, 1997

CAGES Farm & Training Centre
Bausiaghat, Gazaria, Munshiganj.

Title
The evaluation of Tilapia growth with hotel kitchen waste in fixed cage.

Objectives

?? To gain practical experience on cage culture.

?? To asses Tilapia growth with hotel kitchen waste at different sized fish stocking in cage during the winter season.

?? To asses whether different sized fish stocking helps partial harvesting or not.

?? To see the economic viability of the system.

Significance
CAGES staff had no practical experience on cage aquaculture before start the farm trials. Therefore, CAGES feels that each aquaculturist of the project should gain practical experience on it especially on cage management from self managed cage.

From first two farm trials (TF01/96 and FT05/96), CAGES experienced with poor fish growth with low quality feeds (in terms protein content, binding properties and feeds composed of two ingredients). However, comparatively better growth was found in the first trial with commercial pellets (Saudi-Bangla Fish Feed, Grower). These two trials were not economically viable. Reason were poor quality of feed, feed loss during feeding of fish and less density (range 25/m3- 100/m3). Though comparatively better growth was found in the 1st farm trial (FT01/96) with commercial pellets. But industrial feeds are not widely available all over the country and also costly. Therefore, it was important to find out the nontraditional low cost quality feed for caged fish.

Generally slow growth is found during winter season. This trial was also aimed to evaluate the potentiality of fish culture during winter season using quality fish feed at higher density.

Tilapia fish is widely available in ponds all over the country (M. Ireland *et al.*, 1996). It can breed naturally in ponds and open waters which could offer the farmers to stock their cages at less cost. In Bangladesh, no body reared Tilapia in winter season at higher densities using hotel kitchen waste as feed in cage.

The trial was conducted on 23 August '96 to 25 January '97 for a period of 156 days. This report will describe the results which was obtained from the experiment.

Methods and Materials

Study area
The experiment was carried out in the Meghna-Gomti tidal river to the west bank of the river at Bausiaghat under Gazaria thana and district of Munshiganj.

Experimental facilities
A 1.72x0.75x1m sized fixed cage having 0.8m3 effective water volume was used in this experiment (see figure I). The cage bag was made of knotless black polyethylene net with 8 mm mesh. It was stitched by tire cord and plastic line. The top and bottom four corners and were fastened with four bamboo poles.

Fingerlings collection

Local Tilapia have been purchased on 28 July '96 from fry trader in Daudkandi area and these fingerlings were transported up to farm site by trader carried in aluminum patil. Before stocking in the cage fries were kept in a holding hapa. Fries were fed with farm made feed (50% mustard oil cake + 50% rice bran) during the holding period.

Fingerlings stocking
The fingerlings were stocked in the cage on 23 August '96 at density 400 fish/m3 without replication. Three different sized fries (size A=23.73g, B=11.51g and C=5.0g) were stocked with ratio A: B: C :: 1: 1.5: 3 to facilitate partial harvesting for longer periods of time.

Feed collection and feeding of fish
The hotel kitchen waste was collected daily from a nearby hotel situated at Basiaghat. After collection of kitchen waste, spiny bones were removed to avoid fish injury. Feed was applied in a plastic bucket (8 litre capacity) which was suspended in the middle water of the cages hanged by rope. Feeding frequency were 2 times in a day at morning and afternoon. Feed was given to fish at satiation level.

Cage management
Left over feeds and bones were removed daily from bucket at evening . Cage was shifted from one place to another place with the fluctuation of water level due to season. Due to sudden tidal surge on 29 October '96, water went over the cage and some fish were escape from cage. With the experience of fish loss during tidal surge , the top of the cage was covered by nylon net (mesh 5mm).

Growth monitoring
During stocking bulk weight of fish was taken and average weight of fish had been calculated for each size group. Sampling of fish for estimating the growth was not done to avoid stress on fish due to sampling (Bolivar, 1994). During partial harvesting bulk weight also taken and averaged.

Harvesting
The partial harvesting started on 15 December '96 and completed on 25 January '97. Fish were not sold to fish trader, consumed mainly by the CAGES Farm staff (as agreement before the trial start).

Economic analysis
Fish price was estimated by market visit at Daudkandi and Bausiaghat. Actual price of cage materials, fish seed and feed were also used during purchase before trial set up and during the trial. Depreciation cost of cage materials has been estimated based on training experience in Philippines and farm experience.

Environmental monitoring
For this trial oxygen and temperature has been collected and analyzed.

Dissolved oxygen
DO reading has been taken from within farm location at three different depths such as surface (< 30 cm), middle (30-100 cm) and bottom(>100 cm) at 0700 hr. and 1500 hr. daily by digital oxygen meter (model no. OXI 92, D812 Weilheim). The daily oxygen data from different depth and time were averaged. Then 7 days data were averaged again.
Temperature
Temperature reading has been recorded at different depths (surface, middle and bottom) of within farm site at 0600 and 1500 hrs. twice in a day by digital meter. During average same procedure of analysis of oxygen data was followed.

Production calculation

Fish recovery rate and net production were obtained from the following formula.

$$\text{Fish recovery rate} = \frac{\text{No of fish at the harvesting}}{\text{No of fish at the stocking}} \times 100$$

Net production = Final wt at the harvesting - Initial wt at the stocking

Results and Discussion

Water Quality

The water temperature fluctuate from 23 August to end of October and gradually declined from early November to end of January (see Fig. I). Oxygen also fluctuate up to middle of November and then moderately increased with the season. DO quantity increased with the decreasing of temperature except middle of November.

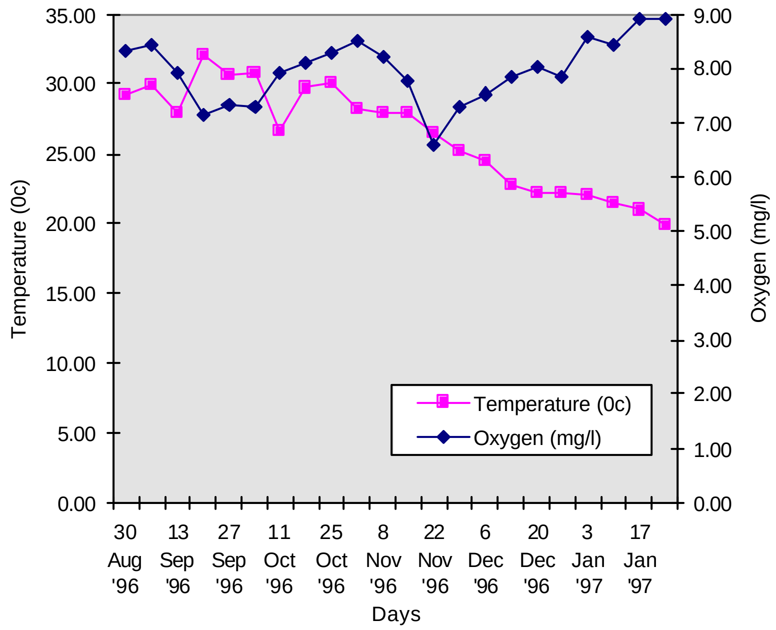


Figure I: Weekly average of DO and Temperature through out the trial.

Fish Growth

The net production and gross production were obtained 11.93 kg/m3 and 16 kg/m3 respectively. The recovery rate was found 73.49%. Due to tidal surge (sudden raising of water level) on 29 October '96 about 24% fish were escaped from cage which strongly effect the recovery rate.

Economic analysis
The economic analysis showed that Tilapia rearing with kitchen waste in winter season was economically viable. The return on total investment was obtained 50.5% (see appendix I).

General Observation

Partial harvesting
The harvesting was started from 15 December'96 to end of the trial (see Table I). Different sized stocking might be facilitated partial harvesting for longer period of time.

Table I: Partial harvesting during the trial periods

Date	Number	Average wt (g)	Total wt (kg)
15.12.96	9	147.78	1.33
20.12.96	8	92.50	0.74
24.12.96	8	61.25	0.49
27.12.96	26	65.77	1.71
29.12.96	30	68.00	2.04
30.12.96	3	76.67	0.23
04.01.97	13	86.92	1.13
07.01.97	2	115.00	0.23
09.01.97	6	85.00	0.51
11.01.97	10	65.00	0.65
14.01.96	3	73.33	0.22
15.01.97	2	110.00	0.22
17.01.97	8	65.00	0.52
25.01.97	116	28.15	3.265
Total	244	54.45	13.285

Fish injury
Few fish were injured during feeding of fish by spiny bones (which were in the hotel kitchen waste). As a result, secondary infection has been found on fish body and fish died. After careful removal of all the spiny bones especially fish bones, fish injury was stopped.

Conclusion
During the winter season temperature was not recorded below 20?c and DO was within suitable ranges to fish culture. Fish growth with hotel kitchen waste was satisfactory. Stocking of different sized fish could facilitate partial harvesting for longer periods of time. The economic analysis showed that Tilapia growing with hotel kitchen waste was profitable business.

Recommendation

Tilapia fish could be reared with quality feed (pellets having about 30% protein content) in winter season which may increase the length of culture period. Another fish culture cycle could be September-March which may help to get higher price of the crop (in the month of April-June, generally fish price is comparatively higher, personal observation).

Appendix I: Cost-benefit analysis of the trial

	Qty.	**Rate (Tk)**	**Cost (Tk)**
Black polyethylene net	3.25m	40/m	130.00
Tying materials	-	-	15.00
Bamboo poles	2.00	30/p	60.00
Fish seed	332.00	0.45/p	149.40
Top cover net	1m	9/m	9.00
Plastic bucket	1p	25/p	25.00
Total cost (Tk)			388.40
Total fish sale (Tk)			585.00
Total benefit (Tk)			196.60
Return on total investment (%)			50.62

R9704

CARE BAGLADESH
CAGES PROJECT

FEED LOSS MINIMIZATION DURING FEEDING OF CAGED FISH

By

S.M. Nurun Nabi

November, 1997

CAGES Farm & Training Centre
Bausiaghat, Gazaria, Munshiganj

Introduction

In intensive caged fish rearing, supplementary feeds are widely used. Feeds are applied in different techniques such as broadcasting, in the tray or sac and sprinkle method. Some of the applied feeds sink in the water through the cage which may be defined as feed loss/waste. The intensity of feed waste could be related with several factors: cage design, water flow rate, feeding behavior of fish, size of fish, feed form, bindings properties of the feed, feed application rate at a time, mode of feed application, size and type of feeding tray. Waste release to the waters also related with the intensity of the culture pattern and areas which occupied by the cages. CAGES Farm experienced with huge quantities of feed loss (about 40%-60%) during feeding of fish in the first two trials. Which brought the economic loss of those systems. Continuous feed release in the waters occurs eutrophication of the local aquatic system which ultimate result is environmental degradation and raise question on sustainability of the practice (Beveridge *et al*., 1997). Necesity of the waste control from cage is to increase the profit margin of cage culture and to save native aquatic environmental for the sustainability.

CAGES Farm established to develop cage culture technology for the resource poor people in Bangladesh which will be environmentally friendly in the light of CAGES vision. Therefore, the effort was concentrate to minimize monetary loss as well as environmental changes due to feed loss by improving the management system.

Different efforts were followed to minimize the waste from cages. The report will address the preliminary work on feed loss minimization and findings which were drive from the different observations.

Use of feed binder

As binder mar (rice water), flour, mar and flour together were used to increase the binding properties of two feeds: Feed A = 50% rice bran (local) + 50% oil cake, Feed B = 75% rice bran (local) + 25% chicken viscera (chicken viscera was blended by a electrical blender before use). The observations were carried out in the Meghna-Gomti flood plain in the month of October '96. Prepared feeds were tested in a holding cage, made of black polyethylene net. Common carp was reared in the holding cage at density 150 fish/m3 (250/cage). The feeding tray (earthen) was suspended in the water at depth 20 cm to surface. One ball (diameter about 4 cm) of each treatment was given to fish separately at different days. The treatment descriptions are to:

?? Treatment 1: Feed A + mar: Oil cake was soaked over night in mar. Then mixed with rice bran and made in ball form.

?? Treatment 2: Feed B + mar: Rice bran and chicken viscera was mixed with mar and prepared balls.

?? Treatment 3: Feed A + 2% flour: Overnight soaked oil cake, rice bran and flour was mixed with water and made in ball form.

?? Treatment 4: Feed A + 5% flour: Overnight soaked oil cake, rice bran and flour was mixed with water and made in ball form.

?? Treatment 5: Feed A + 10% flour: Overnight soaked oil cake, rice bran and flour was mixed with water and made in ball form.

?? Treatment 6: Feed B + 2% flour: Chicken viscera, rice bran and flour was mixed with water and made in ball form.

?? Treatment 7: Feed B + 5% flour: Chicken viscera, rice bran and flour was mixed with water and made in ball form.

?? Treatment 8: Feed A + mar + 10% flour: Oil cake was soaked over night in mar, then mixed with rice bran and flour and made in ball form.

After feed given in the feeding tray for feeding of fish, solubility of feed was observed as an indicator to assess the feed loss. A scoring system (1-4) was used to evaluate the stability of the feed. The score 1 indicate transparent water in the feeding tray i.e. feed loss stopped, 2 for a little turbid i.e. little amount of feed waste, 3 for turbid and 4 for highly turbid. The higher score indicates higher quantity of feed waste.

The result showed that only use of mar + 10% flour as a binder in feed A could reduce feed waste significantly (see Table I). Reason might be use of higher quantity of flour at T_8 which reduced feed loss significantly. Contribution of the rest of treatments in waste control appeared as insignificant. Due to lack of proper binder at appropriate ratio, rest treatments had poor water stability.

Table I: Qualitative evaluation of different binders at different ratio with farm made feeds

Treatment	Score	Comment
T_1	3	Not effective
T_2	4	Not effective
T_3	3	Not effective
T_4	3	Not effective
T_5	3	Not effective
T_6	4	Not effective
T_7	4	Not effective
T_8	2	Reduced feed loss

Feed dried at room temperature

The feed-A was prepared in ball form with water and mar separately. These were dried over night to increase binding properties of the feed stuff and were applied in the holding cage (which was used for binder test). The observation showed that waste was not controlled significantly (method described previously). Reason could be holding feed for over night could not increase bindings properties of the feed.

Sun drying of the feed

The feed-A which was prepared with water and mar separately and dried in the sun for 1.5 hr. to add to the adhesive characteristic of the feed ingredients. Observation area and site, feed application and analysis method was similar to binder test. The result showed that sun dry could not reduced feed loss significantly. Reason is to be poor bindings properties of feed and sun dry could not increase the stability of the feed in water.

Shade on the cage

From first trial (FT01/96), it has been found that at the beginning common carp took the feed from tray to come at near the surface water and stayed up to finish the feed. With the increasing size, fish did not stayed for longer time, suddenly came to the feed, agitated the water and went back to the deeper part. This behavior may be increase feed loss. Therefore, this observation was taken. The study was conducted in the Meghna-Gomti river from 13 to 26 October '96. The fish was grouped into two sizes (A: 70g and B: 12g) and each size stocked at density 100 fish/m^3 (168 fish/cage) in a shaded and in a unshaded floating cage. Commercial pellets (Saudi-Bangla fish feed) was applied at 9:30 a.m. in the earthen tray @ 4%

body wt. The earthen tray was suspended in the water at 50 cm to surface. The waste was collected after 45 minutes to feeding by a polyester cloth-made hapa. The hapa was set under the cage i.e. the hapa surround the cage. Collected waste was dried in the sun to remove the water and measured by top pan balance (1Kg capacity, grade 5g). The shade was conducted by Chati (bamboo made platform) having black polyethylene sheet on it.

The result showed that dark shade could reduce feed loss from 60% to 40% for bigger size of fish and from 38% to 28% for smaller sized fish (see Table II). It also seemed that the feed loss increased with the increasing of fish size. Dark shade might be reduced restlessness of fish during feeding or created more save environment for feeding of fish.

Table II: The effect of shading on feed loss by the different sized fish

Fish size	**Dark shade Feed loss (%)**	**No shade Feed loss (%)**
Size A	40.5	59.2
Size B	28.1	38.1

Note: n=3.

Use of different feeding tray

The observations were conducted in the Meghna-Gomti river from 26 December '96 to 30 January '96. The deeper bamboo made basket (r = 23 cm, height =25 cm) and fine mesh sac (size75x75x50 cm) as feeding tray were used in this study. The trays were fitted in the black polyethylene net-made cages (size-2x2x2m, water volume-3.45m3, mesh-13mm). Feed was applied @ 5% of body wt. The treatment description of the study were to:

?? T_1: Bamboo made deeper basket + commercial pellets (Saudi-Bangla fish feed) to fed tilapia at density 100 fish/m3 (345fish/cage).

?? T_2: Bamboo made deeper basket + commercial pellets (Saudi-Bangla fish feed) to fed common carp at density 200 fish/m3 (about 700 fish/cage).

?? T_3: Fine mesh sac + commercial pellets (Saudi-Bangla fish feed) to fed common carp at density 200 fish/m3 (about 700 fish/cage).

?? T_4: Fine mesh sac + feed A with 10% cooked flour to fed common carp at density 200 fish/m3 (about 700 fish/cage).

Feed waste collection and analysis method was followed as shading effect observation.

The result showed that fine mesh sac reduced feed loss at 20% with commercial pellets and at 25% with farm made feed (Table III) for common carp. The deeper bamboo basket also reduced waste at 25% and 27% with pellets for tilapia and common carp respectively. Reason might be during feeding of fish, feed might not be fallen from the feeding tray by the water agitation which produced by the fish.

Table III: Measured waste percentage at different trays

Treatment	**% of feed waste**
T_1	25.1
T_2	27.3
T_3	19.2
$\mathbf{T_4}$	21.6

Cooking

Similar method of binder test was followed to evaluate the cooking efficiency. Feed A (50% mustard oil cake + 50% sieved local rice bran) was used with different ratio of cooked flour. The study was conducted from 1 January to 5 January '97 in the Meghna-Gomti river. The treatment description were to:

T_1: Feed A + 5% cooked flour.
T_2: Feed A + 10% cooked flour.
T_3: Feed A + 15% cooked flour.
T_4: Feed A + 20% cooked flour.

Firstly, the flour was mixed with water properly and cooked to make it sticky. Then feed ingredients were mixed with flour and cooked again for a few minutes. Cooked feed remained in the room temperature for 30 minutes to cool down. Feeds was prepared in small ball (diameter about 4 cm) and applied in the cages (2x2x2m) to tilapia fish (density 100 fish/m3). One ball was put to use at a time in a bamboo made basket.

The result showed that use of ? 10% cooked flour with feed-A significantly reduced feed loss during feeding of fish. Cooking increased the stickiness of the flour and higher quantities of flour also increased the bindings characteristics of the feed.

Table IV: Qualitative evaluation of cooking efficiency at varied ratio of flour for farm made feed

Treatment	**Score**	**Comment**
T1	3	Ineffective
T2	2	Effective
T3	2	Effective
T4	1	Effective

Net made platform as feeding tray

The experimentation was conducted in the aquarius with the assumption that if feed waste reduced using net-made platform then it could be incorporated in the tilapia trial (FT05/96) for field test. Two platforms (size 0.9x0.7m), made of Indian fine mesh and black polyethylene net (mesh 8mm) were set in two aquarius (1x0.75x0.75m) having 0.5m water depth with common carp (15 fish/aquarium). Feed A in ball form was applied on the net platform situated in the aquarium and observed the solubility of feed stuff (qualitative evaluation like binder test). The productiveness of net-made platforms to control feed loss appeared as insignificant. Reason might be poor bindings quality of the feed.

Sprinkle method of feeding

The study was conducted in the Meghna-Gomti river on 5 April '97. GIFT tilapia was reared in the top covered floating cage (size-2x1.3x1.9m, water volume-4.4m3) at density 350 fish/m3 (1540 fish/cage). Commercial pellets were fed the fish twice at morning and afternoon at satiation level. Pellets were sprinkled on the middle of the top cover slowly i.e. in "sprinkle method". Fish came at surface and took the feeds. A polyester cloth made hapa was prefixed engulfing the cage. After feeding of fish, hapa was lifted and the waste was collected. But no feed waste was found in the hapa. Therefore, it was seemed that slow feeding through sprinkle method reduced the feed loss up to zero. Reason might be, there was a tough competition among fish for feed due to slow feeding i.e. few number of pellets were available to lot of fish at a time. Another reason might be due to pellet form of feed, it was not dissolved in the water.

Conclusion

The feed waste from cages increases the input cost in caged fish rearing. If a huge quantity of feed released in the aquatic system, environmental degradation may occur. For the sustainability of the cage aquaculture, waste release from cages should be bring at acceptable ranges as has been suggested by the environmentalists.

Following are the techniques could be used to minimize feed loss -

?? Slow feeding through sprinkle method (reduced feed loss from 60% to 0%).
?? Using fine mesh sac (reduced feed loss from 60% to 20% with commercial pellets and from 40% to 25% with farm made feeds).
?? Using deeper bamboo basket (moderately reduced feed loss from 40% to 26% during feeding of fish).
?? Cooked flour as feed binder at ?10% (increased the binding properties of feeds which reduced feed loss significantly).
?? Creating dark shade on the top of the cage (reduced feed loss from 60% to 40% at bigger sized fish and from 38% to 28% for smaller one).

Recommendation

Feed loss could be minimized using formulated pellets with different binders, improving cage design and using appropriate feeding techniques considering fish behavior.

Reference

Beveridge, C M. and Stewart J A. 1997. *Cage culture: limitations in lakes and reservoirs*. FAO/ODA Expert consultation on inland fishery enhancements. 7-11 April 1997, Dhaka.

R9705

CARE BANGLADESH
CAGES PROJECT

CULTURE OF PANGASH *PANGASIUS SUTCHI* IN FLOATING CAGE

BY

S.M. Nurun Nabi

November, 1997

CAGES Farm & Training Centre
Bausiaghat, Gazaria, Munshiganj.

Title
Culture of pangash *Pangasius sutchi* in floating cage.

Objectives
?? To evaluate the growth performance of pangash in cage.
?? To see the economics of the system.

Significance
In cage culture, per kg fish production cost about 25-35 Tk if good quality feed is used. Therefore, species should be chosen for cage aquaculture those has higher market price to increase profit margin. Pangash's market price about 100 Tk-150 Tk/Kg all over the country.

Golder et al. (1996) reported that pangash rearing in cages is economically viable in the northwest parts of Bangladesh using commercial pellets at density 20 fish/m3. Therefore, the present study was conducted to evaluate pangash growth and profitability at higher density (100 fish/m3) to get more profit.

The trial was conducted from 18 October '96 to 21 September '97 for a period of one year. The report will describe the results which was obtained from the experiment.

Methods and Materials
Study area
The experiment was carried out in the Meghna-Gomti river at Bausiaghat under Gazaria thana and district of Munshiganj.

Experimental facilities
Firstly, a fine mesh (Indian blue net) net-made cage (1x1x2m) having 1 m^3 water volume was used in this trial. The cage bag was stitched at a local tailor. Four bottom and top corners of the cage bag was fixed with four bamboo poles by plastic rope. Due to deposition of huge quantity of algae on the cage (inner and out side), water could not exchange through the cage. Moreover, decomposition of dead algae and waste feed, water quality in the cage deteriorated significantly if the cage was not cleaned weekly and cleaning activities was disturbing to fish as it was smaller in size. Therefore, the cage was replaced on 20 May '97 by a floating cage.

The knotholes black polyethylene net (13 mm mesh) with 2m width was used to construct the floating cage. The net was stitched by tire cord with box type $1m^3$ (1x1x1m) iron frame and covered all the sides of the frame by net. Four plastic buoys were fastened by plastic rope with four iron hook which was constructed at four pillar of the iron frame to float the cage. The float was adjusted with the iron hook, as the top of the cage remain about 5 cm above water. The iron frame was painted by coal tar before the net setting to protect developing of rust on it. A fine mesh sac (1x1x0.5m) was fixed on the bottom part of the cage to reduce feed waste from the cage. The cage was remained stationary (horizontally) by a plastic rope-made loop fitted with a bamboo pole.

Fingerling collection
The fingerlings were purchased on 15 October '96 from trader located at Mymensingh (near Fisheries Research Institute) and carried in a oxygenated polyethylene bag up to farm after completion of four

hour's journey. Before stocking fries were kept in a holding hapa fo a period of 3 days and were fed with farm made feed (50% mustard oil cake + 50% rice bran) during the holding period.

Fingerling stocking
The fingerlings were stocked in the cage on 18 October '96 at density 100 fish/m^3 without replication. The average weight of fries was 3.24g.

Feed choosing and feeding of fish
At first, commercial pellets (Saudi-Bangla fish feed, grower) was given to fish @ 5% of body weight, distributed twice in a day at morning and afternoon and continued up to 23 December '96 (1st sampling). After 1st sampling, feed was composed of 50% SB and 50% snail muscle (in dry wt) was used as local resource to reduce feed cost. Feed application time and rate was similar to before sampling and feeds applied directly in the cage bag. From 20 May '97 only SB was given again to fish as SGR was found to less than the past sampling. The feed was allocated twice in a day (time mentioned above) at satiation level.

Cage management
The cage was shifted from one place to another place with the fluctuation of water level. Fine mesh cage had to clean after 10 days interval regularly.

Growth monitoring
All the fish weighed in bulk weight by top pan balance (1Kg capacity, accuracy 5g) during the experiment and averaged. Number of sampling was partially decreased to reduce stress on fish.

Harvesting
The fish were harvested on 21 September '97. Fish were holed to observe fish behavior.

Economic analysis
Actual price of cage materials, seed, and feed were used. The valuation of fish price was done by local market visit. Depreciation cost was estimated based on farm experience. Labour cost for cage management was considered as opportunity cost.

Water quality monitoring
Oxygen and temperature has been recorded and analyzed.

Dissolved oxygen
DO reading has been taken from within farm location at three different depths such as surface (< 30 cm), middle (30-100 cm) and bottom(>100 cm) at 0700 hr. and 1500 hr. daily by digital oxygen meter (model no. OXI 92, D812 Weilheim - up to April '97 and YSI 55 -rest of the tial period). The monthly oxygen data from different depth and time were averaged (calendar month wise).

Temperature
Temperature reading has been recorded at different depths (surface, middle and bottom) of within farm site at 0700 and 1500 hr. twice in a day by digital meter. During average same procedure of analysis of oxygen data was followed.

Production and economics calculation

Fish recovery rate, specific growth rate, food conversion ratio, net production, net profit, return on total investment and return on per cycle investment were obtained from the following formula.

$$\text{Fish recovery rate} = \frac{\text{No of fish at the harvesting}}{\text{No of fish at the stocking}} \times 100$$

$$\text{Specific growth rate} = \frac{\ln(\text{Final body wt/Initial body wt})}{\text{Duration of time (days)}} \times 100$$

$$\text{Food conversion ratio} = \frac{\text{Feed given}}{\text{Weight gain of fish}}$$

Net production = Final wt at the harvesting - Initial wt at the stocking

Net profit = Total sale - Per cycle investment

$$\text{Return on total investment} = \frac{\text{Net profit}}{\text{Total cost}} \times 100$$

$$\text{Return on per cycle investment} = \frac{\text{Total sale- per cycle investment}}{\text{Per cycle investment}} \times 100$$

Results and Discussion

Water Quality

The water temperature range were 20.77 ^{0}c- 30.43 ^{0}c during the experiment (see appendix I). It was seemed that temperature was not growth limiting factor even in the peak winter season. DO range (6.19mg/l-11.61 mg/l) was in favor of fish growth during the trial.

Growth performance

Net production was obtained 70.7 Kg/m3 having average harvested size 740g for a 11 months experimental periods (see Table I) using commercial pellets (22% protein content). Golder *et al.* (1996) reported 470 g final weight of *Pangasius sutch* for similar culture cycle at density 20 fish/m3 fed on commercial pellets with 27% crude protein. The daily weight increment was 2.18 g/fish and SGR was 1.81%. PIU/DTA/BRAC (1997) reported that the daily growth rate and SGR of *Pangasius sutchi* were 1.6g and 1.38 respectively at density 78 fish/m3 with three different commercial pellets (having 22%, 26% and 30% crude protein). In this experiment, it has been also found that better SGR was obtained from feed SB (stocking to 1st sampling = 2.84 and 2nd sampling to harvesting = 1.72) rather than feed 50% SB + 50% snail (1st sampling to 2nd sampling = 0.95).

Table :I Stocking and production detailed during the experiment

	Stocking	1st samp	2nd samp	Harvesting
Date	18 Oct. '96	23 Dec'96	20 May'97	21 Sep'97
Days since stocking	0	66	214	338
Average wt(g)	3.24	21.15	86.29	739.79
Number/m3	100	97	96	96
Biomass (Kg/m3)	0.32	2.05	8.28	71.02
Net prod (Kg/m3)	-	1.74	7.97	70.71
SGR	-	2.84	1.53	1.61
FCR	-	2.17	*1.57	1.81
Recovery rate (%)	100	97	96	96

*Snail was measured at dry matter basis.

Comparatively lower FCR was found in the trial. Reason might be reduction of feed loss during feeding of fish. From 2nd sampling to harvesting, FCR was 1.83 with feed SB. This result could be compared with the FCR of pangash stated by Golder *et al*. (1996) and PIU/DTA/BRAC (1997) though they used feeds those had comparatively higher protein level. Golder et al. mention FCR 2.5 with commercial pellets (27% crude protein) and PIU/DTA/BRAC found FCR 3.4 and 2.6 at density 29 fish/m3 and 41 fish/m3 respectively with similar fish growing cycle (Table II).

Recovery rate was gained 96% which suggested that pangash can survive at comparatively crowed cage situation. PIU/DTA/BRAC reported wide range of recovery rate (13%-64%) at different densities (29-89 fish/m3).

Table II: Growth comparison among different trial with different feeding technique conducted at different places in Bangladesh.

Trial	Density (no/m3)	FCR	SGR	Feeding rate % of body wt.	Feed application
PIU/DTA/BRAC	29	3.4	1.4	4-5	In the feeding tray by pipe
PIU/DTA/BRAC	41	2.6	1.44	4-5	In the feeding tray by pipe
Golder *et al*.	20	2.5	-	Satiation level	In the feeding sac
CARE, 1997	100	1.81	1.61	Satiation level	In sprinkle method

The key variable of this trial might be feeding technique which leads to get better growth compared with the results mentioned by Golder *et al*. (1996) and PIU/DTA/BRAC (1997). This feeding technique effectively stopped feed loss and nutrient leaching. In PIU/DTA/BRAC trial, feed was given by a pipe onto a solid feeding tray on the cage bottom. Therefore, feed loss might be reduced but there was more chances of nutrient leaching during feeding of fish. Both the feed loss and nutrient leaching might be happened in the trial which was conducted by Golder *et al*. as feed was fed in a feeding sac.

It is notable that the cycle was comparatively long (11 month). This longer periods of culture cycle could be reduced by using protein rich quality feed (about 35% crude protein and amino acid balanced diet).

Cage management

Labour input was required mainly for feeding management. At start, about five minutes was needed to feed each feeding time. At the end 30 minutes was needed as fish reach harvesting size.

Economic analysis

The economic analysis showed that pangash fattening in cage was economically viable (TableII). Though feed cost covered about 72 % of the total investment (Tk 2048.00) but average per day feed cost was 6 Taka which is affordable ranges to farmers (CARE-Bangladesh, 1997) and highest feed cost per day was 24 Taka. The participatory research farmers of Noyagaon village expended taka 983-1851 only to purchase fish fry and feed and total cost covered 3023-4432 taka for a crop (Rafique *et al.*, 1997). Therefore, the cost of the system seems to be affordable to farmers. The result also suggest that if a farmer grow pangash in three cages, s/he can earn about 1150 Taka per month but their feed costs rise to greater than 50 Tk per day. The feed cost could be reduced at farmers affordable ranges using partial harvesting technique which could also maximize the fish production. Partially harvested fish selling can provide the fund to continue the cycle. Another potential option might be stocking of fish in three different cages at different periods which could offer the fish selling from older cage and can be source of money to run the rest cages.

Table II: Income of pangash rearing in cage for 11 months

	Cost in Tk	*Cost in $
Cage cost	459.00	10.80
**Cage depreciation	217.00	4.88
Fingerlings	350.00	7.87
Feed	2048.00	46.02
Total cost	2857.00	64.20
Per cycle cost	2615.00	58.76
Total sale	7100.00	159.55
Net profit	4485.00	100.79
Return on total investment (%)	**148.51**	**148.51**
Return on per cycle investment (%)	**171.50**	**171.50**

* 1 $ = 44.5 Tk, ** For detailed cage depreciation see appendix II.

Conclusion

Fish growth was satisfactory (in terms of SGR and growth rate g/day/fish) during the trial. At harvesting, good marketing size (about 750g) was obtained from the trial. Higher recovery rate suggested that pangash could be grown at crowded condition. The length of the cycle could be shorten using good quality feeds and could also increase profit margin. Economics showed that the system was highly profitable and it seems to be potential income generating activity. The trial also suggested that a farmer can rely on pangash fattening for his/her food secuity if 3-4 cages are in operation. However, needed proper prodution planning and management by the cage manager to keep the investment as minimum and to explore optimum profit.

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Appendix I: Monthly average of monitored water quality parameter during the experiment

	Oct'96	Nov	Dec	Jan'97	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep'97
Temperature (^{0}c)												
Average	29.72	26.92	22.89	20.77	-	27.46	27.36	29.49	29.50	29.55	30.43	29.98
s.d	0.96	1.23	1.00	1.02	-	0.63	0.98	0.91	0.50	1.08	0.84	1.10
Oxygen (mg^{-1})												
Average	8.34	7.45	7.74	8.74	11.61	-	-	7.50	6.46	6.30	6.19	-
s.d	0.79	0.98	0.62	0.70	0.97	-	-	0.61	0.45	0.39	0.60	-

Note: Hyphen indicates data was not taken due to mechanical disturbance of instruments.

Appendix II: Cage construction cost

Item	Qty.	Rate (Tk.)	Total cost(Tk.)	Longevity (year)	Cost per cycle (Tk.)
Box type iron frame (1x1x1m)	1	150	150	3	50
Black polyethylene net (mesh 13mm)	4.5	40/m	180	3	60
Fine mesh net (Bangladeshi)	2	22/m	44	2	22
Coal tar	0.25 Kg	18/Kg	4.5	1	4.5
Tire cord thread	o.1 Kg	150/Kg	15	1	15
Bamboo (Thinner)	1	25/p	25	1	25
Float	4	10/p	40	1	40
Total			**458.5**		**216.5**

Appendix III: Proximate composition analysis of commercial pellets

Sample	Moisture (%)	Protein (%)	Lipid (%)	Ash (%)	Fibre (%)	NFE (%)
SB	8.92	21.99	11.18	15.52	9.17	33.22

SB = Saudi-Bangla Fish Feed, Grower.

R9706

CARE BANGLADESH
CAGES PROJECT

REPORT ON INDIVIDUAL CAGE OPERATION (FT03/96-III)

The preliminary study on the durability of cage materials and the growth performance of silver barb in fixed type fine mesh cage

BY

Asma Akhter
S.M. Nurun Nabi

November, 1997

CAGES Farm & Training Centre
Bausiaghat, Gazaria, Munshiganj.

Title
The preliminary study on the durability of cage materials and the growth performance of silver barb in fixed type fine mesh cage.

Objectives
?? To gain practical experience on cage culture.
?? To asses the durability of the cage materials.
?? To asses growth of silver barb.

Significance
CAGES staff had no practical experience on cage aquaculture before start the farm trials. To acquire confidence on cage culture by the project staff, CAGES feels that each aquaculturist of the team should gain practical experience on it especially on cage management from self managed cage.

Before going to practice caged fish rearing, the questions: what are the cage construction materials and equipment's, their durability with the prices (cost-effectiveness), suitable fish species, fish feeds, stocking densities etc. arise to the cage operator. Due to limitation in capacity of the CAGES Farm to find out all the questions at the same time. Different [1]strategies and priorities of work have been established. CAGES decided to operate single cage by the staff for the production of as much as possible answers within as minimum time frame on suitability of construction materials. For the other areas of work scientific trials would be conducted.

In Bangladesh, nets made of various fibres with different mesh having varied prices are available all over the country. Information on longevity and suitability of these net related with cage system are not sufficient. Assumption was behind use of Indian fine mesh nets could reduce feed loss effectively as well as could minimize environmental degradation.

Assumption was also made that silver barb could be good fish for cage culture due to fast growing cultivable species and it's higher demand to the consumer.

The trial was conducted on 18 August '96 to 5 July '97 for a period of 322 days. The report will focus on the observations and results which was produced in the trial.

Methods and Materials
Study area
The experiment was carried out in the Meghna-Gomti flood plain and river at Bausiaghat under Gazaria thana and district of Munshiganj.

Experimental facilities
A 3x2x2m sized fixed cage having 5.8m3 effective water volume was used in this experiment. The cage bag was made of Indian fine mesh net. It was stitched at tailor's shop. A loop was produced at all around the top border of the cage. The plastic rope was passed through the loop and opened at four corners of the cage to fasten it with the poles.The top and bottom four corners and were fastened with four bamboo poles.

[1] Please see research proposal '96

Fingerlings collection
Silver barb have been purchased on 2 August '96 from fry trader in Daudkandi area and these fingerlings were transported up to farm site by trader carried in aluminum patil. Before stocking in the cage, fries were kept in a holding hapa for a periods of 16 days. Fries were fed with farm made feed (50% mustard oil cake + 50% rice bran) during the holding period.

Fingerlings stocking
The fingerlings were stocked in the cage on 18 August '96 at density 75 fry/m3 without replication. The average weight of fries was 2.63g.

Feed preparation and feeding of fish
Farm made feed composed of 50% oil cake + 50% rice bran was applied @ 10% body wt daily, allocated at 8 am and 3 pm. Oil cake was over night socked and mixed with rice bran in the morning. Feed was given to fish in ball form in the earthen tray which was suspended at mid-depth of the cage. The feeding tray was hanged by sickka with the help of plastic rope.

The farm made feed was replaced by commercial pellets (Saudi-Bangla fish feed, about 22% protein content) on November '96 due to poor growth and higher FCR value. Commercial pellets was distributed twice in a day at morning and evening at satiation level of feeding.

Cage management
The cage bag was cleaned at 7 days interval. Fish were gathered by pulling up the cage bag from one side to other side and then cage bag was rubbed by hands in the areas which were free from fish to clean it. Cage was shifted from flood plain to river on 5 October '96 after 48 days of the experiment as water receded . Due to jumping behavior of fish as observed, the cage was covered by nylon net (mesh 0.75") on 24 October '96 after 67 days to stocking to minimize the risk of escapee.

Due to continuous movement of the fish around the cage wall, the length of cage bag was segmented by net partition on 25 September '96 and created three chambers to reduce energy loss by the fish. Fish were equally distributed among the chambers. But the partition did not work well due to wind action on it and technical fault during construction (the length of partition was a little higher than the cage width). Therefore, the partition did not stand properly. On 14 November '96 the partition was removed from the cage.

At the start of June '97, the cage bag was replaced by a new one, made of Bangladeshi fine mesh net (size 2x1x1m) having about 2m3 water volume. The top of the cage was covered by the same net.

Growth monitoring
At stocking and harvesting bulk weight of all fish was taken and averaged. During sampling of fish about 15% fish was weighed.

Harvesting
Actually fish were not harvested. On the 5 July '97 all the fish died due oxygen deficiency.

Economic analysis
Fish price was estimated by market visit at Daudkandi and Bausiaghat. Actual price of cage materials, fish seed and feed were used.

Environmental monitoring

For this trial oxygen and temperature has been collected and analyzed.

Dissolved oxygen
DO reading has been taken from within farm location at three different depths such as surface (< 30 cm), middle (30-100 cm) and bottom(>100 cm) at 0700 hr. and 1500 hr. daily by digital oxygen meter (model no. OXI 92, D812 Weilheim). The monthly oxygen data from different depth and time were averaged.

Temperature
Temperature reading has been collected at different depths (surface, middle and bottom) of within farm site at 0700 and 1500 hr. twice in a day by digital meter. The average was made same as DO.

Production calculation

Specific growth rate, fish recovery rate, food conversion ratio and net production were obtained from the following formula.

$$\text{Specific growth rate} = \frac{\ln(\text{Final body wt/Initial body wt})}{\text{Duration of time (days)}} \times 100$$

$$\text{Fish recovery rate} = \frac{\text{No of fish at the harvesting}}{\text{No of fish at the stocking}} \times 100$$

$$\text{Food conversion ratio} = \frac{\text{Food given}}{\text{Wt gain of fish}}$$

Net production = Final wt at the harvesting - Initial wt at the stocking

Results and Discussion

Water Quality
The temperature fluctuated (29.55 ^{0}c-20.77^{0}c) with the season (see appendix I). DO range was 11.6 mg^{-1}-6.3 mg^{-1} during the cycle.

Fish Growth
The net production was gained 0.66g with farm made feed (see Table I). FCR was found to badly higher which indicate poor quality of feed (appendix II) as well as feed loss during the feeding of fish. Use of higher quantity of oil cake (50%) might be restricted the fish growth due to presence of growth inhibitory substances in oil cake. Higher fish mortality was mainly caused by malnutrition which significantly affected the recovery rate. SGR might be influenced by the death of smaller and weak fish.

Table I: Production of silver barb with farm made feed for 83 days

	Stocking	Harvesting
Date	8/18/96	11/9/96
Days since stocking	0	83
Average wt (g)	2.63	7.01

Number/cage	435	257
Biomass (kg/cage)	1.14	1.80
Net production (kg/cage)	0.00	0.66
Recovery rate (%)	100	59
SGR (%)	-	1.18
FCR	-	39.06

Note: 8/18/96 means month/day/year.

Comparatively better growth and recovery rate were found with commercial pellets (see Table II). Before 3rd sampling 65 fish escaped from cage through the opening (for feeding of fish) situated at the top border of the cage during high tide due to lack of knotting. Which affected the recovery rate. Strongly higher FCR values were obtained at 1st sampling. Reason might be feed has been wasted up to 1st sampling. The average weight increment of fish from 3rd sampling to harvesting was about 2g for 52 days in the smaller cage i.e. fish did not grow well. Reason might be productivity of the cage reached at carrying capacity.

Table II: Production of silver barb with commercial pellets for 237 days

	Restocking	1st samp	2nd samp	3rd samp	Harvesting
Date	11/10/96	1/20/97	3/16/97	5/14/97	7/5/97
Days since stocking	0	71	126	185	237
Average wt (g)	7.01	9.39	15.26	50	52.30
Number/cage	257	241	240	174	174
Biomass (kg/cage)	1.80	2.26	3.66	8.7	9.10
Net production (kg/cage)	-	0.46	1.86	6.9	7.30
Recovery rate (%)	-	94	93	68	68
SGR (%)	-	0.41	0.62	1.06	0.85
FCR	-	12.92	4.68	2.48	4.88

Note: In restocking same fish were used.

Economic analysis

The system was not economically viable.

Cage materials durability

The longevity of the net was observed 8 month with a little repairing. Tying materials last about one year. After 7 month of the trial few holes were observed on the cage bag due to shrinkage of net fibres. Possible cause might be wind and waves action on it. Moreover, while sampling or cleaning activities the cage bag had to lifted from one side to another side. At this moment waters pressure on cage bag which caused the shrinkage of net fibres..

General Observation

Larger rectangular sized cage might be enhance the continuous horizontal movement by the fish. This behavior which was shown by the fish might be partially responsible for poor growth due to energy loss in over movement.

Huge algal deposition was observed on the cage bag which had to clean 7 days interval. At the end of the experiment, the cage was not cleaned within 13 days. As a result, all the fish died on 5 July '97 at early morning due to oxygen deficiency.

Conclusion

Temperature and DO fluctuate with the season. Poor fish growth was obtained with farm made feed. Reason might be presence of toxic element in oil cake, poor quality of feed and loss of feed during feeding of fish due to poor binding properties.

Comparatively better FCR was found with commercial pellets. Reason might be better quality of feed. Overall growth was not satisfactory. Fine mesh net-made cage might not be suitable for food fish rearing. Durability of Indian fine mesh net about 8 months and tying materials last about one year long.

Recommendation

Areas for further work are to:

?? Suitable feed (in terms of protein content) for silver barb could be investigated at cage environment.

?? Fry could be rear up to fingerlings in the fine mesh net cage.

Reference

Nurun Nabi, S.M. (1997). Report On Individual Cage Operation (FT03/96-IV).

Appendix I: Monthly average of monitored water quality parameter during the trial

	Aug'96	Sep	Oct	Nov	Dec	Jan'97	Feb	Mar	Apr	May	Jun	Jul
Temperature (^{0}c)												
Average	29.75	30.90	29.91	26.92	22.89	20.77	-	27.46	27.36	29.49	29.50	29.55
s.d (?)	0.82	1.01	1.01	1.23	1.00	1.02	-	0.63	0.98	0.91	0.50	1.08
Oxygen (mg^{-1})												
Average	8.30	7.69	8.03	7.45	7.74	8.74	11.61	-	-	7.50	6.46	6.30
s.d (?)	1.09	1.25	1.20	0.98	0.62	0.70	0.97	-	-	0.61	0.45	0.39

Note: Hyphen indicates data was not taken due to mechanical disturbance of instruments.
Source: Nurun Nabi, S.M. (1997).

Appendix II: Proximate composition analysis of commercial pellets and farm made feed

Sample	Moisture (%)	Protein (%)	Lipid (%)	Ash (%)	Fibre (%)	NFE (%)
Feed A	11.36	19.42	9.59	14.69	19.61	25.33
SB	8.92	21.99	11.18	15.52	9.17	33.22

SB: Saudi-Bangla Fish Feed (Grower), Feed A: 50% Mustard oil cake + 50% Rice bran

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CARE BANGLADESH
CAGES PROJECT

REPORT ON INDIVIDUAL CAGE OPERATION (FT03/96-IV)

The evaluation of growth performance of freshwater prawn *Macrobrachium rosenbergii* in fixed cage

BY

S.M. Nurun Nabi

November, 1997

CAGES Farm & Training Centre
Bausiaghat, Gazaria, Munshiganj.

Title

The evaluation of growth performance of freshwater prawn *Macrobrachium rosenbergii* in fixed cage.

Objectives

?? To gain practical experience on cage culture.

?? To asses prawn growth in cage.

?? To see the economics of the system.

Significance

CAGES staff had no practical experience on cage aquaculture before start the farm trials. Therefore, CAGES feels that each aquaculturist of the project should gain practical experience on it especially on cage management from self managed cage.

In cage culture per kg fish production cost about 25-35 Tk. Therefore, species should be chosen for cage aquaculture those has higher market price to increase profit margin. As a export item prawn's market price comparatively higher (about 200Tk-250Tk/Kg) all over the country. Prawn could be potential for cage culture species especially in the costal belt of Bangladesh where fries are available at the locality.

The trial was conducted on 23 August '96 to 22 August '97 for a period of one year. This trial was not conducted in truly scientific method. The report will describe the results which was obtained from the experiment.

Methods and Materials

Study area

The experiment was carried out in the Meghna-Gomti river adjacent flood plain and Meghna-Gomti river at Bausiaghat under Gazaria thana and district of Munshiganj.

Experimental facilities

The knotholes black polyethylene net (8mm mesh) with 2m width was used to construct the cage bag and stitched by tire cord and plastic line (ball pen refill thickness) with the help of net weaving needle. As a top borderline of cages, plastic line (ball pen thickness) was also used. Four bottom corners of cage bag were fastened by plastic line with bamboo poles to spread the cage properly. Iron sinker also attached on the bottom of cages to sink the cage bag uniformly. The cage size and effective water volume were 1.9x1.9x2m and 2.75m3 respectively.

Fingerlings collection

Prawn fries have been purchased on 4 August '96 from fry trader who collected from fishermen. These fries have been harvested by the fishermen from Megna-Gomti river. Before stocking in the cage fries were kept in a holding hapa. Fries were fed with farm made feed (50% mustard oil cake + 50% rice bran) during the holding period.

Fingerlings stocking

The fingerlings were stocked in the cage on 23 August '96 at density 100 prawn/m3 without replication. The average weight of fries was 7.56g.

Feed choice and feeding of fish
At first, commercial pellets (Saudi-Bangla fish feed, grower) was given to fish @ 5% of body weight, distributed twice in a day at morning and evening and continued up to 1st sampling (16 days) . But most of the feed was uneaten which considered as less attraction to SB by prawn and substituted the feed by 50% SB + 50% snail musscles for next 10 days. From these feeds, prawn chose snail rather than SB (SB was leftover in the feeding tray) and continued for the rest periods of the experiment. After removal of shells musscles were sewed with the help of needle and kept on the cage bottom by plastic rope for feeding of prawn. Feed was applied at satiation level.

Cage management
Left over feeds were removed daily from cage at morning. Cage was shifted from flood plain to the river on 5th October '96 due to water receding.

Growth monitoring
At stocking and harvesting bulk weight of all fries were taken and averaged. During sampling due to handling and attachment on sampling bag (made of mosquito net) by their legs, some legs of prawns were destroyed. Therefore, sampling is partially avoided. During sampling all the prawns were weighed and averaged.

Harvesting
The prawns were harvested on 22 August '97. Prawns were sold to CAGES Farm office owner and CAGES Farm staff.

Modification in the trial
Due to experience of higher cannibalism rate, prawns were graded into two size groups (size A and size B) and kept in two separate cages on 6 January '97 for 162 days to see the intensity of cannibalism with the sizes. After completion of observation on grading effect, prawns were reared together again in a cage. A tetul tree branch about 1.5m long having sub-branches was placed in the cage to produce shelter for prawns during molting. After a month of rearing the Tetul tree branch was replaced by a coconut tree branch and continued for the another month.

Economic analysis
Actual price of cage materials, seed, feed and prawn sale were used.

Environmental monitoring
For this trial oxygen and temperature has been collected and analyzed.

Dissolved oxygen
DO reading has been taken from within farm location at three different depths such as surface (< 30 cm), middle (30-100 cm) and bottom(>100 cm) at 0700 hr. and 1500 hr. daily by digital oxygen meter (model no. OXI 92, D812 Weilheim). The monthly oxygen data from different depth and time were averaged (calendar month wise).

Temperature

Temperature reading has been recorded at different depths (surface, middle and bottom) of within farm site at 0700 and 1500 hr. twice in a day by digital meter. During average same procedure of analysis of oxygen data was followed.

Production calculation
Fish recovery rate, specific growth rate and net production were obtained from the following formula.

$$\text{Fish recovery rate} = \frac{\text{No of fish at the harvesting}}{\text{No of fish at the stocking}} \times 100$$

$$\text{Specific growth rate} = \frac{\ln(\text{Final body wt}/\text{Initial body wt})}{\text{Duration of time (days)}} \times 100$$

Net production = Final wt at the harvesting - Initial wt at the stocking

Results and Discussion

Water Quality
The water temperature gradually declined from August '96 to January '97 except September '96 and then upward trend showed up to August '97 (Table I). DO approximately increased with the declining of temperature round the year.

Table I: Monthly average of monitored water quality parameter over a year

	Aug'96	Sep	Oct	Nov	Dec	Jan'97	Feb	Mar	Apr	May	Jun	Jul	Aug'97
Temperature (^{0}c)													
Average	29.75	30.90	29.91	26.92	22.89	20.77	-	27.46	27.36	29.49	29.50	29.55	30.23
s.d	0.82	1.01	1.01	1.23	1.00	1.02	-	0.63	0.98	0.91	0.50	1.08	0.73
Oxygen (mg^{-1})													
Average	8.30	7.69	8.03	7.45	7.74	8.74	11.61	-	-	7.50	6.46	6.30	6.18
s.d	1.09	1.25	1.20	0.98	0.62	0.70	0.97	-	-	0.61	0.45	0.39	0.59

Note: Hyphen indicates data was not taken due to mechanical disturbance of instruments.

Growth performance
Generally poor growth was obtained from the system. Main reason might be feed was composed of single ingredient which may not balanced in amino acid requirement for prawn. Cannibalism was appeared one of the major constraints to prawn rearing in cage. Which significantly influenced on net production as well as average weight of prawn especially at 4th sampling and harvesting (see Table II). Recovery rate also strongly affected by the cannibalism.

Table II: Productivity of the system for a period of one year.

	Stocking	1st samp	2nd samp	3rd samp	4th samp	Harvesting
Date	8/23/96	9/8/96	1/6/97	6/17/97	7/23/97	8/22/97
Days since stocking	0	16	136	298	334	365
Average wt (g)	7.56	8.57	14.03	37.94	36.25	30.81
Number/cage	275	265	159	68	48	37
Biomass (kg/m3)	0.76	0.83	0.81	2.58	1.74	1.14
Net production (kg/m3)	0.00	0.07	-0.01	1.82	0.98	0.38
Recovery rate (%)	100	96.36	57.82	24.73	17.45	13.45
SRG (%)		0.78	0.45	0.54	0.47	0.38

Note: 8/23/96 means month/day/year

Economic analysis

The economic analysis showed that the trial was not economically viable.

General Observation

The findings on different observation were following.

Grading effect

The result showed that the cannibalism rate increased with the increasing of sizes (Table III). The result also indicated that grading can enhance the growth rate (SGR). From this observation, average weight was obtain 53g at size A which was good marketing size i.e. prawn can grow in cage. Main constraint to rear prawn in cage was found to cannibalism. Therefore, it could be conclude that if the cannibalism was protected, economically viable prawn cage culture could be possible.

Table III: Intensity of cannibalism at different sized prawn for 162 days.

Date	6 January '97		17 June '97	
Days since restocking	0		162	
	Size A	Size B	Size A	Size B
Average wt (g)	20.00	6.43	53.03	23.71
Number/cage	89	70	33	35
Biomass (kg/cage)	1.78	0.45	1.75	0.83
Net production (kg/cage)	-	-	-0.03	0.38
Recovery rate (%)			37.08	50.00
SRG (%)			0.60	0.81

Tetul tree branch as prawn shelter

The recovery rates indicated higher cannibalism during the observation (Table IV). Reason might be use of less quantity of tree branch in per cubic meter cage or structure of branches still leaves the moulting prawns exposed.

Table IV: The evaluation of Tetul tree branch as shelter for prawn

Date	17 June '97	23 July '97
Days since restocking	0	36

Average wt (g)	37.94	36.25
Number/cage	68	48
Recovery rate (%)	100	70.59

Coconut tree branch as prawn shelter
From this observation higher mortality (23%) was obtained for a month prawn rearing cycle (Table V). Reason might be use of less quantity of tree branch in per cubic meter cage.

Table V: The evaluation of coconut tree branch as shelter of moulted prawn

Date	23 July' 97	22 August' 97
Days since restocking	0	31
Average wt (g)	36.25	30.81
Number/cage	48	37
Recovery rate (%)	100	77.08

Feeding behavior
Prawn cosumed less feed in the morning than the evening and they eat the feeds slowly. In daytime, feed intake by prawn has been enhanced by placing floating aquatic weeds in the cage creating dark environment. Prawn brought the feed into mouth by their legs from feeding tray/device. If the feed size comparatively bigger than the mouth size, prawn cut the feed by pinching.

Conclusion
Poor growth was found in this trial. Main reason might be use of single feed ingredient (only musscles) as prawn feed. Cannibalism behavior was appeared one of the major constraints to rear prawn in cage. But prawn can grows in cage condition and reach at good harvesting size (20 no/Kg) over a nine month period. Economic prawn fattening could be possible protecting cannibalism using appropriate cage design and facilitating sufficient shelter in cage. The length of the cycle could be shorten using quality feed (in terms of protein content, amino acid balance in feed ration and appropriate feed form in cage situation).

Recommendation
Further research could be done in the areas are to:

1. Minimization of cannibalism:

?? Cage design could be improved i.e. rough bottom/chambered bottom (like ice cream die) could be designed for prawn rearing.

?? More clumsy shelter could be produced in the cage using substratum (date-palm tree branch, coconut tree branch).

?? Combination of above ideas.

2. Quality feed for prawn:
If the feed remain in the water for longer period of time , feed lost bindings properties as well as lost nutrients. During taking (pinching) of feeds by prawn may increase the losses. About 30% protein content feed in ball form using 20%-30% ata as binder could be used for prawn feeding. Use of 20%-30% ata may significantly reduce the solubility of feeds and feed nutrients. Also may reduce the feed waste during

feeding of prawn in pinching/picking method due to stickiness of feeds. Feeds in the form of crumble could be also tried.

?? Identification of economic good quality prawn feed (in terms of protein content and amino acid balanced diet).

?? Identification of suitable feed form in cage situation.

R9708

CARE BANGLADESH
CAGES PROJECT

Mono-culture Of Common Carp And Local Tilapia In Floating Cages

By

S.M. Nurun Nabi

December, 1997

CAGES Farm & Training Centre
Bausiaghat, Gazaria, Munshigan

Title
Mono-culture of locally available tilapia and common carp in 1 m^3 floating cage

Objective
?? To grow tilapia and common carp up to marketable size for sale
?? To asses growth of both tilapia and common carp at higher density
?? To asses economic viability of the system

Significance
Tilapia fingerlings were purchased on 28 July '96 for trial FT 05/96 and common carp was purchased on 18 April '96 for FT 01/96 trial. Some of those fingerlings remain unused which was under size as food fish for sale. Therefore, main intention was to bring the fish at marketable size and sale which would also give opportunity to get experience of growing both tilapia and common carp in 1m3 floating cages. Moreover, CAGES Farm had no experience with the growth of locally available tilapia and common carp at higher density using commercial pellets as recommended by Schmittou (200 to 500 fish/m^3) (1997).

This report will focus on growth performance of both tilapia and common carp at density 500 fish/m3 with commercial pellets to test the concept of low volume high density fish culture.

Methods and Materials

Study area
The trial was conducted in the Meghan-Gomti river at CAGES Farm and Training Centre.

Cage construction and installation
The knotholes black polyethylene net (13 mm mesh) with 2m width was used to construct each floating cage. The net was stitched by tire cord with box type 1m^3 (1x1x1m) iron frame and covered all the sides of the frame by net. Four plastic buoys were fastened by plastic rope with four iron hook which was constructed at four pillar of each frame to float the cage. The float was adjusted with the iron hook, as the top of the cage remain about 5 cm above water. The iron frame was painted by coal tar before the net setting to protect developing of rust on it. A fine mesh sac (1x1x0.5m) was fixed on the bottom part of the cage to reduce feed waste through the cage. The cages were remained stationary (horizontally) by a plastic rope-made loop fitted with a bamboo pole.

Fingerling collection and stocking
Both the fingerlings were purchased from local fry trader. Fish were holed in hapa more than one year. While holding in the hapa, fish were fed to farm made feed which was composed of 50% oil cake and 50% rice bran. But only common carp was fed to commercial pellets about one before stocking. Therefore, fish were remained under nutritional stress for long time. Tilapia was stocked on 9 May '97 and common carp on 1 June '97 (please see Table I).

Feeding of fish
Commercial pellets (Saudi-Bangla fish feed, grower) was given to fish at satiation level, distributed twice in a day at 9 am and 3:50 pm through slow feeding in sprinkle method.

Cage management
The cage was shifted from one place to another place in accordance with the fluctuation of water level.

Growth monitoring
Bulk weight of all fish were measured at stocking and harvesting by top pan balance (1Kg capacity, accuracy 5g) and averaged. During sampling about 30% fish were weighed and averaged. Number of sampling was partially decreased to reduce stress on fish due to handling of fish.

Harvesting
Tilapia and common carp were harvested on 16 September '97 and 8 September '97 respectively.

Economic analysis
Actual price of cage materials, seed, and feed were used. The valuation of fish price was done by local market visit. Depreciation cost was estimated based on farm experience. Labour cost for cage management was considered as opportunity cost.

Result and Discussion
Specific growth rate of tilapia and common carp were obtained almost similar (see Table I). Though tilapia showed higher SGR (Specific Growth Rate) at 1st sampling and decreased at harvesting. Reason might be maturation of fish. Comparatively higher FCR (Food Conversion Ratio) was found with both species. Reason might be maturation and might be poor quality fries of both the tilapia and common carp but the reasons were not identified separately. During cage cleaning and checking, tilapia hatchlings were found in the cage. Which strongly supported the maturation of tilapia. During sampling, egg was observed in the abdomen of common carp by striping. Maturation has a significant effect on the growth of tilapia and after maturation growth reduced in comparison to immature fish (Legendre *et al*., 1989 and Huchette 1997).

Though stocking day and stocking size was not same, the growth of different fish could be evaluate by SGR. Mainly tilapia mortality was recorded within 7 days to stocking which might be due to inefficient handling of weak fish as tilapia remained under nutritional stress for long time.

Table I: Growth performance of Tilapia and common carp for the different periods of grow-out trial.

Species	Tilapia			Common carp	
	Stocking	1st sampling	Harvesting	Stocking	Harvesting
Date	9 May '97	17 June '97	16 Sep. '97	1 June	8 Sept. '97
Duration	0	39	130	0	100
Average wt (g)	11.30	22.50	59.57	30.26	119.34
Number/m3	500	445	421	500	498
Biomass (kg/m3) Net prod (kg/m3)	5.65 -	10.01 4.36	25.08 19.43	15.13 -	59.43 44.30
SGR	-	1.77	1.28	-	1.37
FCR	-	1.58	2.64	-	2.98
Recovery rate	100	89.00	84.20	100	99.60

The economics analysis showed that both tilapia and common carp rearing were not profitable business. Reason was higher production cost (per/Kg) due to higher FCR value.

Useful information from this trial could be-

- ? ? Maturation may strongly affect the growth of tilapia and common carp.
- ? ? Both tilapia and common carp can survive and grow in the river at very crowded cage situation.
- ? ? Common carp reached at marketing size for a 100 days of culture period if the stocking size is comparatively larger (30g).
- ? ? Tilapia reached at marketable size over a four months grow-out trial.
- ? ? FCR might increase at maturing stage of both tilapia and common carp.

Recommendation

For cage culture, fish selection could be done carefully i.e. healthy fish should be stocked. Age of tilapia could be also considered before stocking and it must not be more than 2.5 months. Suitable protein level in feeds to grow common carp could be worked out in crowed cage condition.

Reference

Legendre, M., Hem, S. and Cisse, A., 1989. Suitability of brackish water tilapia species from Ivory Coast for lagoon aquaculture. II- Growth and rearing methods. Aquatic Living Resource, **2**: 81-89.

H.R. Schmittou, 1997 (Edited by M. Akiyama). High Density Fish Culture In Low Volume Cages. *Published by American Soybean Association*. Vol. AQ41, 78pp.

Huchette, S. 1997. Technical and economical evaluation of periphyton based cage culture of tilapia (*Oreochromis niloticus*) in Bangladesh. A unpublished M Sc Thesis, Institute of Aquaculture, University of Stirling, Scotland.

Appendix I: Proximate analysis (wet matter basis) of Saudi-Bangla fish feed (grower)

Moisture (%)	Protein (%)	Lipid (%)	Ash (%)	Fibre (%)	NFE (%)
8.92	21.99	11.18	15.52	9.17	33.22

R9801

ON-STATION RESEARCH STRATEGY

Submitted by S.M. Nurun Nabi

Why do CAGES need the strategy ?
CAGES has to be developed different cage culture options for the resource poor people of Bangladesh by year 2000. With the limited resources (time, man power and money) CAGES is working to find out the appropriate technological package for farmers. But there are lot of researchable issues and problems addressed by the farmers and CAGES which needed to be solved. At start and the mid age of the project, CAGES analyzed the situation (i.e. Where are we ? How long we have to go to touch the objectives ? Are we going in the right truck ? Who are the user of the technology produced by CAGES ? How shall we achieve the objectives ?) After situation analysis, CAGES need the research strategy to achieve the project goals and objectives with limited resources and to ensure the interest of the beneficiaries.

Objective
To develop small scale sustainable cage culture techniques for resource poor farmers.

Target
A range of alternative options for small scale cage culturists.

Process
CAGES and few farmers know that how to grow fish in cage cost-effectively but both still are not produced enough technical options which can be recommended for cage aquacuture system. CAGES has to be proceed several technical options from zero. The process could be -

Process		Target options
Identification of problems and opportunities	⟶	**1**
Prioritization of problems		**2**
Planing and designing of options		**3**
Experimentation		**4**
Exchange of learnings		**.**
		.
		.
		etc.

Guideline for selecting trial
?? Identifying successful or interesting culture methods/techniques from farmers, validating and testing at on-station.
?? Farmers ability (in terms of knowledge, skill, time and financial capability).
?? Environmental issues (escapees, biodiversity of the ecosystem, nutrient enrichment and siltration).
?? Resource availability.
?? Return on invest.

Process for collecting and disseminating information
?? Discussion with region based TOs, NGO staffs and farmers on their success problems.

?? NGOs and farmers cage site visit.
?? Review the field visit reports.
?? Review the on-farm research reports and socio-economic base line survey reports.
?? Attend in the regional workshop.

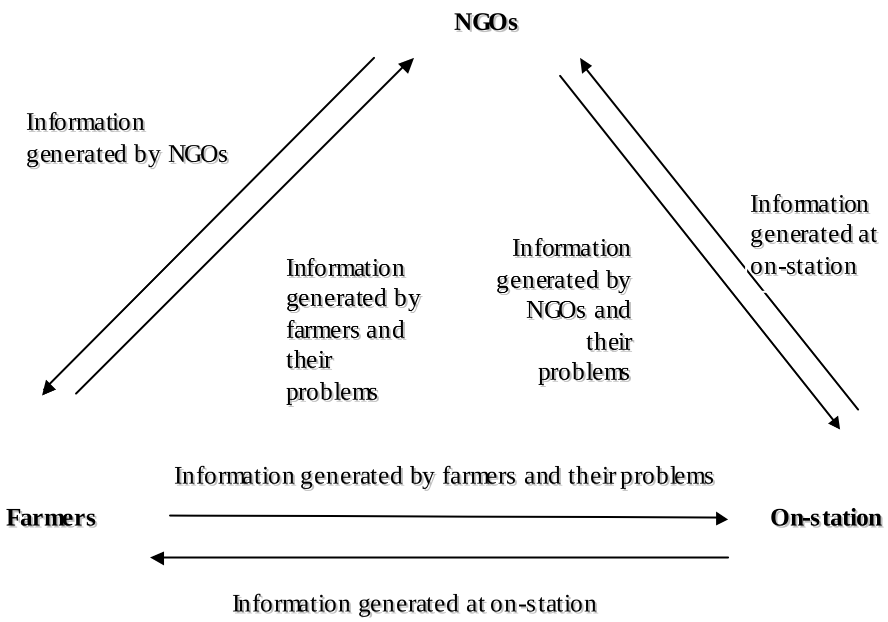

Fig. I: Information collection and dissemination method.

Research strategy thrusts

? ? Feed
? ? Fry rearing
? ? Wild fish/prawn fattening
? ? Disease/risk management

Option for culture system

1. GIFT tilapia fattening with quality feed (price Tk 16/Kg).
2. Pangash fattening with pellets (price < Tk 12/Kg).
3. Calibasu fattening (stocking size-80g) with farm made pellets (price Tk 7/Kg).
4. Thai punti fattening with farm made feed (price Tk 12/Kg) at high density.

5. Grass carp fingerlings nursing (stocking size- 3", harvesting size- 5") with aquatic weeds.
6. Thai punti fingerlings nursing (stocking size- 2.0", harvesting size- 3") with aquatic weeds.
7. Common carp fingerlings nursing (stocking size- 2.5", harvesting size- 4") with low cost farm made feed (price < Tk 6/Kg).
8. GIFT tilapia fingerling nursing with farm made feed (price <Tk 8/Kg, composed of 4 fee ingredients).
9. Local tilapia fingerlings nursing with low cost farm made feed (price <Tk 8/Kg).
10. Pangash fingerling nursing (stocking size- 2", harvesting size-6") with farm made feed (price < Tk 12/Kg).
11. Prawn PL nursing with farm made feed (price < Tk 20/Kg).

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R9802

CARE BANGLADESH
CAGES PROJECT

FRESHWATER PRAWN LARVAE REARING IN CAGE

By

SM Nurun Nabi

February, 1998

CAGES Farm & Training Centre
Bausiaghat, Gazaria, Munshigan

Title
Freshwater prawn larvae rearing in cage

Objectives
?? To asses the growth of pawn larvae in cage.
?? To notice the profitability of pawn larvae nursing.

Significance
CAGES Farm conducted a trial on freshwater prawn rearing in cage fed on mainly snails to asses the growth and profitability of the system. This trial was non profitable due to poor growth and cannibalism. Assumption was made that PL (post larvae) nursing with quality pellets (in terms protein) might bring economic success as feed cost remain less and cannibalistic behavior is less at smaller sizes. Moreover, availability of good quality fingerlings for prawn farming is still limiting the country's prawn production which leds to CAGES (Cage Aquaculture For Greater Economic Security) Farm to conduct the trial. This trial will asses the potential of PL rearing in freshwater for resource poor farmers. If the system demonstrate the profit, it could be suggested for the farmers.

The trial was conducted on 30 September '97 to 17 December '97 for a period of 78 days. This report will describe the results which was obtained from the experiment.

Methods and Materials
Study area
The experiment was carried out in the Meghna-Gomti tidal river at Bausiaghat under Gazaria thana and district of Munshiganj.

Experimental unit
A fine mesh net (Indian blue net) was used to construct the cage bag. The size of the cage bag was 2.5x2.5x2m which created an effective 6.25m3 water volume. The walls of the cage bag were stitched by machine (at tailor's house) to form an inverted mosquito net. Both the top and bottom corners were fastened with 4 bamboo poles by plastic rope to fix and spread the cage properly.

Origin of prawn larvae
Prawn larvae (PL_6) were collected from FMS low-cost prawn hatchery. These larvae were carried in 4 aluminum patils (approx. capa. 30 litre) without aeration and were transported over a 1.5 hours journey. The age of these post larvae at stocking was 6 days.

Stocking of larvae
The larvae were stocked in a single cage on 30 September '97 at density 288 PL_6 /m^3 without replication.

Feed formulation and feeding of PL
The feed was composed of oil cake, auto rice bran, broken rice, wheat bran, wheat flour and fish meal which contained about 40% crude protein. The composition of feed ingredients were determined by a spreadsheet program where data of proximate analysis of different ingredients were used (see appendix I-II). Wheat flour was cooked with water (25%-30% of total feed weight) for 15 minutes then was homogeneously mixed with rest ingredients by hands and pelleted by a electrical pelleter with 2mm diameter sieve. Wet pellets were dried in the sun for about 2 hours under a shade, made of transparent

polyethylene sheet to reduce degradation of ultra violet ray sensitive vitamins. Feeds were applied in the earthen tray which was placed on the bottom of the cage by rope. Feed was distributed twice in a day at 9 am and 6 pm. Requirement of feeds of larvae was estimated presence or absence of leftover feeds in the feeding tray i.e. if unused feeds was found in the tray then feed amount was reduced for next days and if feed was not found in the tray then a little amount was increased for the next days. Left over feed was checked before the feeding of larvae and reached at approx. satiation level of feeding.

Cage management
Cage depth was maintained about 1m during low tide. The cage was checked for holes weekly. Four date-palm tree branches were kept on the cage bottom to create shelter for larvae during molting, possibly reducing cannibalism. The tree branches was replaced after one month use.

Growth monitoring
During stocking, the length of 10 larvae were measured by centimeter scale and averaged. The length was measured from the tip of the rostrum to end of the europods. All prawns were counted at stocking and harvesting. Bulk weight was taken by top pan balance (20g accuracy) and averaged at harvesting. Then prawns were graded into two groups passed through a box type 1m3 cage having 10x10mm mesh. The grader (box type cage) was set in the inner side of a fine mesh cage (2.5x2.5x2m) which was set in the water and larvae were released in the grader and kept for 45 minutes and then collected prawns separately. Length of thirty prawns was measured from each group and averaged for group average length and overall average length was estimated from following formula.

No. of larvae in A group x group A average + No. of larvae in B group x group B average
Overall average length = ---
No. of larvae in A group + No. of larvae in B group

About 30 prawns were weighed individually from each group by Ohrous digital balance (0.1g precise) and averaged to see the size variation in the trial.

Harvesting
On 17 December '97 the trial was terminated. Two different sized prawns were holed in two fine mesh cages separately for further growth trial.

Feed sample analysis
Individual feed ingredients were send to Faculty of Fisheries, Bangladesh Agricultural University and proximate composition was analyzed separately. Then proximate analysis of feed was formulated through spreadsheet program using result of single ingredient analysis.

Economic analysis
Actual price of cage materials and feed were during purchase. Depreciation cost of cage materials has been estimated based on farm experience. Price of seeds and prawns were estimated communicated with larvae donor and fishermen who sale prawn fingerlings (wild stock) in the Daudkandi area.

Environmental monitoring
Only temperature data has been collected and analyzed.

Temperature
Temperature reading has been taken from location within farm at surface depth (< 30 cm) at 0700 hr. and 1500 hr. daily by digital meter. The daily data from different time were averaged weekly.

Production and economics calculation

Specific growth rate, fish recovery rate, net production and food conversion ratio were obtained from the following formula.

$$\text{Specific growth rate} = \frac{\ln(\text{Final body wt/Initial body wt})}{\text{Duration of time (days)}} \times 100$$

$$\text{Recovery rate} = \frac{\text{No of prawn at the harvesting}}{\text{No of prawn at the stocking}} \times 100$$

$$\text{Food conversion ratio} = \frac{\text{Feed given}}{\text{Weight gain of prawn}}$$

Net profit = Total sale - Per cycle investment

$$\text{Return on total investment} = \frac{\text{Net profit}}{\text{Total cost}} \times 100$$

$$\text{Return on per cycle investment} = \frac{\text{Total sale- per cycle investment}}{\text{Per cycle investment}} \times 100$$

Results and Discussion

Water quality
At the start, temperature was comparatively higher due to the season and decreased gradually with the changing of season (Table I).

Table I: Temperature (0c) recorded for the trial periods

Weeks	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11
Average	**28**	**29**	**30**	**29**	**28**	**28**	**27**	**26**	**25**	**24**	**22**
s.d. ?	**0.72**	**0.88**	**0.60**	**0.37**	**0.54**	**0.54**	**0.66**	**0.94**	**0.59**	**0.52**	**0.63**

Growth performance
The average length increment was 3.3 cm and SGR 4.3% over a 78 days (Table II). The recovery rate was found to 74% and FCR was calculated 3.8 from the trial which seems to be satisfactory in winter and in a cage situation.

Table II: Productivity of the trial during experiment

	Stocking	Harvesting
Date	9/30/97	12/17/97
Duration (days)	0	78
Average wt (g)	PL_6	0.6
Average length (cm)	0.8	4.1
Number/cage	1800	1330
Number/m^2	288	213
Recovery rate (%)	-	73.9
FCR	-	3.8
SGR (%)	-	4.3

Two distinct sizes, and were appeared after 78 days experimental periods (Table III). The larger prawn (size A) was 24% and smaller prawn (size B) 76% of the total harvest.

Table III: Size variation of prawn larvae over a period of 78 days

	Size A	Size B
Average weight (g)	1.5	0.3
s.d ?	1.10	0.14
Average length (cm)	5.5	3.7
s.d ?	1.15	0.35
Number	314	1016
Percentage	23.6	76.4

Economic Analysis
Economic analysis showed that prawn larvae rearing in cage was a profitable business (Table IV). The profit margin could be increased at higher density.

Table IV: Cost-benefit analysis of the trial

Source of expenditure	Cost (Tk)
Cage depreciation	232
Seed	540
Feed	50
Total investment	1285
Per crop investment	822
Sale	1898
Net profit	1076
Return on total investment (%)	48
Return on per crop investment (%)	131

Conclusion
From this preliminary trial, it could be concluded that prawn larvae could be reared in the cages with higher profit margin within shorter rearing cycle.

Appendix I: Proximate composition analysis (dry matter basis) of farm made pellets

Dry matter (%)	Protein (%)	Lipid (%)	Ash (%	Fibre (%)	NFE (%)
87.6	40	8.5	20.3	6.1	25.2

Appendix II: Ingredients percentage in feed in wet matter basis

Ingredient	Percent
Auto rice bran	4.9
Mustard oil cake	24.8
Broken rice	5.1
Fish meal	47
Flour	10.1
Wheat bran	8.1

Feed cost: Dry matter basis-20Tk/Kg, Wet matter basis-17.8 Tk/Kg.

Appendix III: Cage construction cost

Item	Qty.	Rate (Tk.)	Cost (Tk.)
Net	21m	25/m	525
Making charge			40
Bamboo	2p	50	100
Plastic rope			20
Earthen tray	2p	5	10
Total			695
Cage depreciation			232

Cage life 3 crops with 3 months culture cycle

R9803

NOTES ON KATHA FISHING MONITORING

S.M. Nurun Nabi

A little number of fish (tilapia and common carp) were escaped from CAGES Farm to the Meghna-Gomti river during cage activities. These fish may entered into the local stock and may influence the environment.

At CAGES Farm sites, three kathas[2] were constructed and harvested at different periods by local people. These Kathas were monitored regularly by farm staff during harvesting. The objective of this observation is to see whether escapees from cage entered into the Katha or not.

[2] *Katha* is a device for fish aggregation, made of tree braches.

The information were collected during Katha fishing by interviewing fishermen groups and recorded name of the fish species present in the catches for this study. A total three kathas were monitored at each harvesting time. Up to date, two kathas were harvested three times and the rest was harvested only one time.

The most common species in the catches was prawn (mainly *Macrobrachium rossenbergii*) and followed by snake heads and cat fish. Only tilapia was found in a catch of a Katha (Table I). This big sized two tilapia (about 500 g each) were escaped from a cage about one month before the Katha harvesting. No fish fry was seen in the catches though some fries were escaped. Reason might be escapees might be migrated to other places or predated by predators.

Table I: Fish species found in three kathas at different harvesting periods

Katha owner: Md. Samad Mia, Village: Nutun Chashir Char, Thana: Gazaria		
Katha construction date: 25.9.97		
First harvesting date: 25.11.97	Second Harvesting: 25.2.98	Third harvesting: 15.4.98
Species		
Chana marulia	*Chana marulia*	*Catla catla*
Chana striatus	*Chanda spp*	*Chana marulia*
Chanda spp	*Mastacembelus spp*	*Labeo calbasu*
Labeo calbasu	*Mugil sp*	*Labeo rohita*
Mystus aor	*Mystus aor*	*Mastacembelus spp*
Nandas nandas	Prawn	*Mystus aor*
Oreochromis sp	*Puntius sarana*	Prawn
Prawn	*Wallago sp*	*Puntius sarana*
Puntius spp		
Katha owner: Md.Jamal Mia, Village: Balur Char, Thana: Gazaria		
Katha construction date: 30.12.97		
First harvesting date: 27.02.98	Second harvesting date: 19.4.98	Third harvesting: 5.5.98
Species		
Colisa spp	*Chana marulia*	*Chana marulia*
Chana marulia	*Chanda spp*	*Chanda spp*
Chanda spp	*Mastacembelus spp*	*Nandas nandas*
Nandas nandas	Prawn	Prawn
Mugil sp		*Puntius spp*
Puntius sarana		
Prawn		
Katha owner: Md. Anisur Rahman , Modern Cement Limited. Katha construction date: 5.3.98		
First harvesting date: 20.4.98		
Species		
Chana marulia	Not yet harvested	Not yet harvested
Chana punctatus		
Mystus aor		

Prawn		

R9804

CARE BANGLADESH
CAGES PROJECT

Effect of dietary protein level and feed composition on *Labeo rohita* fingerling rearing in cages

Prepared by S.M. Nurun Nabi

May 1998

CAGES Farm & Training Centre
Bausiaghat, Gazaria, Munshiganj

Title
Effect of dietary protein level and feed composition on *Labeo rohita* fingerling rearing in cages.

Introduction
In Bangladesh, cage materials and commercial pellets are very costly (13 t0 30 Tk/Kg) and low available through out the country. Feeds cost for growing fish in cages ranged 65% to 85% of the total cost (Nabi, 1997) , though the cost depends on the quality and quantity of used feeds and the length of the cycle. The assumption was made by CAGES, as minimum amount of feed and less period are require in nursery option of fish culture, so even if the feed cost is higher, it may be still affordable by the poor of Bangladesh as well as farmers will harvest crops over a shorter period. Moreover, still scarcity of fingerlings in rural areas at proper stocking period a constraints to aquaculture in Bangladesh (Nabi, 1997). Also due to lack of adequate knowledge and skill of farmers in fingerlings transportation, severe fish mortality occurs, as a result, reduces the profit of the cage culture activities (personal communication with Alamgir, Kabir, Suruj, Zia, Shayamol, Rafique and Sarwar of CAGES staff who are working at different project areas). Therefore, it was thought that if farmers rear very tinny fry (<1g) up to fingerlings (about 10g), they could be able to sale as fingerlings to pond owner or this option could be adopted to stock indigenous fingerlings in the baors of Bangladesh which may reduce transportation hazards and expanses.

To achieve above objectives, the CAGES had to be known the suitable feeds (in terms of protein content and price) for Rui fry rearing in cage situation. The aim of the study was to evaluate the effect of different level of protein content and feed composition on growth and yield of fingerling (*Labeo rohita*) rearing in cages.

The trial was conducted from 7 September '97 to 26 October '97 for a period of 50 day. This report will describe the results and recommendation as out put of the trial.

Methods and Materials
Study area
The experiment was carried out in the Meghna-Gomti river to the west bank at Bausiaghat under Gazaria thana and district of Munshiganj nearby Japan-Bangladesh friendship bridge II.

Experimental design
The trial was designed as Table I.

Table I: Treatment description

Treatment description	Replication
T1: 25% animal based protein	**3**
T2: 30% animal based protein	**3**
T3: 35% animal based protein	**3**
Total	**9**

Cage construction

Fine mesh (Indian blue net) net-made 9 cages (dimension 1.5x1.5x2m) having 1.7 m^3 water volume were used in this trial. Each cage bag was stitched at a local tailor as inverted mosquito net. Four bottom and top corners of the cage bag were fixed with four bamboo poles by plastic rope.

Fry collection, conditioning and stocking
The Rui fries were purchased from local trader at Baropara under Daudkandi thana. These were carried in two aluminum patils (capacity of each patil about 75 litres) up to cage site. and conditioned with river water for 30 minutes and thus released into the holding hapa. The fries were holed in the hapa for 7 day before stocking. On 7 September '97, fries were stocked in the cages at density 125 fries/m3.

Feed preparation and feeding of fries
The feed was composed of rice bran, broken rice, mustered oil cake, dry fish, and flour at different ratio. The ingredient composition was led by spread sheet program. The compositions were:

Table II: Feed ingredient composition

Ingredients	T1	T2	T3
Rice bran	**29.63**	**29.44**	**15.63**
Broken rice	**13.8**	**4.96**	**4.93**
Mustard oil cake	**1.23**	**14.12**	**20.53**
Wheat bran	**19.9**	**11.2**	**10.79**
Fish meal	**25.58**	**30.49**	**38.39**
Flour (Atta)	**9.86**	**9.8**	**9.74**
Total	**100**	**100**	**100**
Price (Tk/Kg dry feed)	**12.6**	**13.6**	**15.5**

The feed preparation process for each treatment: flour was cooked for 15 minutes then rest ingredients were homogeneously mixed with cooked flour by hand and pelleted by a electric pelleter with 2 mm diameter sieve. Wet pellets were dried in the sun for about 2 hours under a shade, made of transparent polyethylene sheet to reduce damage of vitamins by ultra violet ray of the sun. Dry pellets were convert into powder form and was made small ball with water. Initially, fries were fed @ 10% of body weight daily and then demand feeding was carried out after 15 days to stocking. The demand of feed for fries was estimated 10 days interval through trial and error method i.e. presence and absence of feeds in the feeding tray limited increasing and decreasing of feed amount. The ration distributed daily 2-3 times in the feeding tray, made of bamboo (inner side covered by polyester cloth) which was suspended in the mid water column by rope.

Feed analysis
Feed pellets were sent to faculty of fisheries, Bangladesh Agricultural University for proximate composition analysis.

Cage management
The water depth in cages was maintained about 0.75 m approximately during the trial. The cages were shifted from one place to another place due to water fluctuation when required.

Termination of the trial
The fries were harvested on 26 October '97 and the trial ended.

Growth monitoring
While stocking, 20 fish were weighed together by digital balance (Ohrous, 0.1g accuracy) and length was measured individually by a centimeter scale and then averaged. During harvesting, batch weight of all fish was taken by top pan balance (capacity 1Kg, accuracy 5g) and length of about 30% fish were measured and averaged. Regular sampling was not performed to avoid stress on fish due to sampling.

Water quality monitoring
To characterize the production of this trial, it was plan to monitor oxygen, pH, temperature, secchi disk visibility and ammonium of the study site. Due to disturbance of oxygen and pH meter only temperature, secchi disk visibility and ammonium data have been collected and analyzed.

Temperature
Temperature reading has been recorded at surface water of within farm site at 0700 and 1500 hr. twice in a day by digital meter and averaged weekly.

Secchi disk visibility
Secchi disk reading was taken from within farm location at 12 p.m. once in a sunny day and analyzed.

Ammonium (NH_4^{++})
Ammonium data has collected from cage mid water once in a week at 9 am by test kit (model Aquaquant® 14423 Ammonium) and recorded.

Production calculation
Net production, fish recovery rate, specific growth rate and food conversion ratio were obtained from the following formula.

Net production = Final wt at the harvesting - Initial wt at the stocking

$$\text{Fish recovery rate} = \frac{\text{No of fish at the harvesting}}{\text{No of fish at the stocking}} \times 100$$

$$\text{Specific growth rate} = \frac{\ln(\text{Final body wt}/\text{Initial body wt})}{\text{Duration of time (days)}} \times 100$$

$$\text{Food conversion ratio} = \frac{\text{Feed given}}{\text{Weight gain of fish}}$$

Result and Discussion
Water quality
Temperature and ammonium levels in water were in favor of fish cultivation (Table III). The secchi disk visibility indicated poor abundance of natural food stuff in the water body.

Table III: Temperature (^{0}c), secchi disk visibility (cm) and ammonium (mgl^{-l}) obtained during the experiment.

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
Temperature (^{0}c)							
Average	**29.97**	**29.39**	**29.63**	**27.84**	**29.12**	**29.74**	**29.24**
s.d. (?)	**0.79**	**0.61**	**0.72**	**0.64**	**0.93**	**0.51**	**0.55**
Secchi disk (cm)							
Maximum	**191**	**185**	**168**	**167**	**124**	**111.6**	**142**
Minimum	**164**	**184**	**97**	**163**	**95.5**	**94**	**90**
Ammonium (mgl^{-1})							
Within cage	**0**	**0**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**

Production
Specific growth rate (SGR): All treatments showed better SGR (see Table IV) but there was no significant difference (p>.05) in SGR among treatments (see appendix I).

Food conversion ratio: Lowest and highest FCR were found at T3 and T1 respectively i.e. FCR increased with the declining of protein level in feed ration. however, there was no significant difference (p>.05) among treatments (see appendix II).

Recovery rate: Comparatively lower recovery rate was obtained from all treatments but highest at T2. Reason might be handling and transportation stress on fish rather than treatment effect. ANOVA of recovery rate showed that no significant difference among treatments (p>.05).

General observation
1. Severe fry mortality was found in the holding hapa after transportation. Reason might be handling and transportation stress on fish.
2. During feeding of fish, due to nutrient leaching quality of feeds (treatments) might be deteriorated which might reduce treatment's effect of the experiment.
3. Fish fries found to graze on cage nets and less response to the supplementary feed. reason might be at early stage of life fries preferred natural food to supplementary feeds.

Table IV: Stocking and productivity of the trial for a period of 50 day

	T1	T2	T3
Stocking			
Average wt (g)	**0.50**	**0.50**	**0.50**
s.d(?)	**0.00**	**0.00**	**0.00**
Average length (cm)	**2.80**	**2.80**	**2.80**
s.d(?)	**0.00**	**0.00**	**0.00**
Number/m3	**125**	**125**	**125**
Biomass (Kg/m3)	**0.06**	**0.06**	**0.06**
Harvesting			
Average wt (g)	**2.64**	**2.66**	**3.42**
s.d(?)	**0.35**	**0.45**	**0.54**
Average length (cm)	**5.46**	**5.86**	**6.52**
s.d(?)	**0.56**	**0.69**	**0.20**
Number/m3	**48**	**53**	**46**
s.d(?)	**10.73**	**13.60**	**16.31**

Net prod (Kg/m3)	**0.10**	**0.11**	**0.14**
s.d(?)	**0.01**	**0.00**	**0.07**
Recovery rate	**38.21**	**42.61**	**37.26**
s.d(?)	**8.61**	**10.90**	**13.08**
SGR	**3.32**	**3.32**	**3.83**
s.d(?)	**0.27**	**0.36**	**0.34**
FCR	**3.26**	**2.92**	**2.68**
s.d(?)	**0.25**	**0.08**	**1.12**

Conclusion and Recommendation

The trial showed that there was no significant difference ($p>0.05$) among SGR, FCR, recovery rate and net production for different treatments. The reason might be poor response to formulated feed which was observed with the fingerlings as smaller size (0.5g) fry was stocked. Another reason might be nutrient leaching from feed during feeding of fish as feed was applied in ball form and remained longer periods in the feeding tray for feeding of fish. The learning from the trial is that the fingerlings rearing in cage is not easy. The trial suggested that to work out the suitable feed in terms of water stability and form of feed with varied protein ratio for fingerlings. In cage system, it could be worthwhile to rear fingerlings (2.5 to 3") up to larger fingerlings (5" to 6").

References

S.M. Nurun Nabi, 1997. Intensive GIFT(Genetically Improved Farmed Tilapia) Tilapia culture in cages. CAGES, CARE Bangladesh, House # 65, Road # 7/A, Dhanmondi, Dhaka.

S.M. Nurun Nabi, 1997. Tilapia fry rearing in cages with locally available low cost feed. Presented at workshop on Aquaculture by CARE Bangladesh, Jessore, Bangladesh.

Appendix I: ANOVA of SGR in Completely Randomized Design (CRD) of different treatments

	T1	T2	T3
R1	3.01	2.90	3.44
R2	3.53	3.51	4.03
R3	3.41	3.55	4.01

SUMMARY				
Groups	Count	Sum	Average	Variance
Column 1	3	9.954098	3.318033	0.073451
Column 2	3	9.965986	3.321995	0.130838

Column 3	3	11.47637	3.825456	0.112489

ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.510966359	2	0.25548318	2.419517398	0.169621899	5.143249382
Within Groups	0.633555716	6	0.105592619			
Total	1.144522075	8				

Appendix II: ANOVA of FCR in Completely Randomized Design (CRD) that obtained at different treatments

	T1	T2	T3
R1	3.07	2.87	3.75
R2	3.16	3.02	1.52
R3	3.54	2.88	2.76

SUMMARY				
Groups	Count	Sum	Average	Variance
Column 1	3	9.766168847	3.255389616	0.061230278
Column 2	3	8.773621837	2.924540612	0.007134669
Column 3	3	8.041149878	2.680383293	1.246359449

ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.499706131	2	0.249853066	0.570126484	0.593352745	5.143249382
Within Groups	2.629448791	6	0.438241465			
Total	3.129154922	8				

Appendix III: ANOVA of recovery rate in Completely Randomized Design (CRD) of different treatments

	T1	T2	T3
R1	48.11	55.19	30.19
R2	33.96	35.85	52.36
R3	32.55	36.79	29.25

SUMMARY

Groups	Count	Sum	Average	Variance
Column 1	3	114.6226415	38.20754717	74.09220363
Column 2	3	127.8301887	42.61006289	118.8886911
Column 3	3	111.7924528	37.26415094	171.1018156

ANOVA						
Source of Variation	**SS**	**df**	**MS**	**F**	**P-value**	**F crit**
Between Groups	48.85091571	2	24.42545785	0.201262986	0.822999752	5.143249382
Within Groups	728.1654207	6	121.3609034			
Total	777.0163364	8				

Appendix IV: ANOVA (single factor) in Completely Randomized Design (CRD) of net production obtained from different treatments

T1	T2	T3
0.11	0.11	0.09
0.10	0.11	0.21
0.09	0.11	0.12

SUMMARY				
Groups	Count	Sum	Average	Variance
Column 1	3	0.299259	0.099753	5.34E-05
Column 2	3	0.332059	0.110686	9.89E-06
Column 3	3	0.415476	0.138492	0.004313

ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.002393	2	0.001197	0.82033	0.484241	5.143249
Within Groups	0.008753	6	0.001459			
Total	0.011146	8				

Appendix V: Proximate composition analysis (dry matter basis) of different treatments

	T1	T2	T3
Protein (%)	25.58	29.60	33.75
s.d. (?)	0.22	0.11	0.49
Lipid (%)	8.55	7.23	9.14
s.d. (?)	0.06	0.12	0.16
Ash (%)	14.22	16.11	16.20
s.d. (?)	0.24	0.39	0.47
Crude fibre (%)	4.69	5.42	5.51
s.d. (?)	0.17	0.19	0.12
NFE (%)	46.96	41.64	35.40
s.d. (?)	0.27	0.73	0.50

R9805

REPORT ON TILAPIA FRY REARING PRACTICE

Prepared By

S.M. Nurun Nabi, Tarun Ghosh, Khairul Basher, Anwar Hossen, Ramiz Uddin and Abdur Razzak, CAGES Farm & Training Centre, Bausiaghat, Gazaria, Munshiganj. June 1998.

After end of "Intensive tilapia (Genetically Improved Farmed Tilapia) culture" trial, fish were reared in a cage as brood stock. At the mid of September '97, some fries were found in a female fish during cage management. These fries were collected and reared in a fine mesh hapa (2x1x1m) with a view to gain experience on fry raising. The estimated umber of fries was about 500. Direct counting was not done to avoid stress on fries. First 20 days of the culture, fries were not fed and allowed them for grazing on nets. Then fries were fed on leftover powder of Saudi-Bangla Fish feed grower and pangash feed in a feeding tray made of bamboo. The feed was distributed twice in a day and applied in both powder and ball form. At the mid December '97 after 3 months length of the cycle, fries reached at stocking size (about 2" to 2.5") and recovered 346 figerlings (direct counting). Thus the practice terminated.

Lessons learnt

?? Tilapia fry can be reared up to fingerlings in the cage condition within 3 months. This culture length could be shorten using good quality feed and culturing in summer.
?? Fry can be reared fed on feeds in ball form at minimum feed waste.
?? Estimated recovery rate was satisfactory (about 70%).
?? Though this cage was not managed scientifically, it's results also demonstrated the potential of fry production and rearing in winter for stocking at the beginning of summer (January) and harvesting in May-June to get higher price of fish.
?? Experience on fry handling.
?? Experience on cage management i.e. cage cleaning, shifting and cage depth maintaining.

R9806

Report On Grass Carp Rearing

By
S.M. Nurun Nabi

Tuesday, June 16, 1998

An APO of CAGES reported that one of participatory research farmer obtained economic and technical success in fattening grass carp fed on grass and water hyacinth in 1997. Therefore, CAGES Farm conducted a preliminary trial on growth performance of grass carp. The aim of this study was to refine the results obtained by the farmer. The trial was designed as following:

Table I: Experimental design

Treatment combination	Replicate
T_1 : Grass carp fed to commercial pellets	**1**
T_2 : Grass carp fed to available grass	**1**
T_3 : Grass carp fed to water hyacinth	**1**
Total	**3**

It was planed to compare grass carp growth between commercial pellets and other feed stuffs. Assumption was that if good harvest obtained from grass and the farmers adopt this technical option at large scale, in the future, good quality grass might be low available or might raise conflict for use of grass between fish culture and cattle rearing. In that situation, commercial pellets could be offered as alternative option if the system is profitable.

The trial was conducted in the Meghna-Gomti rive from 9 September '97 to 6 December '97 over a period of 89 days. This report will state the constraints and potential of grass carp rearing in cages.

Three $1m^3$ box type floating net (black polyethylene with mesh 8mm) cages were used in this trial. The fish was stocked at density 100 fish/ m^3 except T3 (90 fish/ m^3 due shortage of fingerlings). The fish were fed @ 4% of the body weight distributed twice in a day (at morning and afternoon) for T_1 and demand feeding was applied for the rest.

Results and Discussion

Poor growth (Table II) was observed for all treatments and specially negative growth was found at treatment T_3. Reasons might be grass carp might not familiar with eating formulated feeds for T1, soft grass was low available and durba grass (scientific name ?) was supplied to the fish of T2 which might not be edible for the smaller grass carp and water hyacinth might not be good food for grass carp. Another reason might be fish culture in the winter.

Table II: Average weight and recovery rates obtained from the trial over 89 days.

	T1	T2	T3
Stocking			
Average weight (g)	**6.10**	**7.10**	**6.00**
Average length (cm)	**7.87**	**8.95**	**7.50**

Number/cage	**100**	**100**	**90**
Harvesting			
Average weight (g)	**11.31**	**11.29**	**5.23**
Average length (cm)	**10.10**	**9.53**	**7.03**
Recovery rate (%)	**99**	**62**	**24**

Possible reasons for good results of grass carp with grass gained by farmer:
?? Stocking of larger fish
?? Might be use of good quality huge grass
?? Summer culture cycle
?? Might be social pressure

Recommendations
Further study could be conducted stocking larger grass carp (about 20 g) in summer fed on soft grass and aquatic weeds based on their choice.
R9806

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?? Summer culture cycle

?? Might be social pressure

Recommendations

Further study could be conducted stocking larger grass carp (about 20 g) in summer fed on soft grass and aquatic weeds based on their choice.

R9807

CARE BANGLADESH

CAGES PROJECT

The potential of Triple Super Phosphate (TSP) as a phosphorus source in formulated fish feed in Bangladesh

Prepared by S.M. Nurun Nabi
July 1998

CAGES Farm & Training Centre
Bausiaghat, Gazaria, Munshiganj

Title
The potential of Triple Super Phosphate (TSP) as a phosphorus source in formulated fish feed in Bangladesh.

Experimental objectives

?? To determine whether TSP can be used as phosphorus source in fish feed
?? To evaluate whether TSP has any toxic effect to fish

Significance
In the past two trials (FT 01/96 and FT 05/96), CAGES Farm experienced with poor fish growth with low cost feeds. The reasons were less quantity of animal protein and phosphorus content in feed stuffs. Due to lack of dietary phosphorus, primarily disrupts formation of skeleton as well as prohibits development of muscles in fish body. Though fish can assimilate required phosphorus from water body through gills if the environment rich with phosphorus. Generally, less quantity phosphorus remain in the open water which may not enough for normal growth of fish. An investigation of TSP as alternative phosphorus source in fish feed was done in Asian Institute of Thailand and found no toxic effect on fish. In Bangladesh, farmers are using TSP widely for agriculture purposes even for fish pond fertilization. Still no body investigated toxicity of Bangladesh's TSP on fish. If Bangladeshi TSP is free from any toxic effect on fish it could be recommended to the farmers for fish diet as alternative phosphorus source as TSP is widely available at the rural level and well familiar to them.

This paper will asses the potential of TSP as phosphorus source in fish feeds.

Methods and Materials

Study site
This trial was conducted from 19 July 97 to 15 November '97 for a 120 day periods in the Meghna-Gomti river to the west bank located at Bausiaghat under Gazaria Thana and district of Munshiganj adjacent to Japan-Bangladesh friendship bridge.

Experimental design
The trial design is designed on spreadsheet program and shown in Table I.

Table I: Treatment structure of the experiment

Definition of treatment	Replicate
T_1 : Rice bran 38.6% + Oil cake 10.4% + wheat bran 13.7% + Flour 9.8% + DCP 1.8% + fish meal 25.5%	3
T_2 : Rice bran 44.8% + Oil cake 10.4% + wheat bran 9.4% + Flour 9.8% + TSP 0% + fish meal 25.5%	2
T_3 : Rice bran 41.7% + Oil cake 10.4% + wheat bran 11.6% + Flour 9.8% + TSP 0.9% + fish meal 25.5%	2
T_4 : Rice bran 35.4% + Oil cake 10.4% + wheat bran 16.1% + Flour 9.8% + TSP 2.7% + fish meal 25.6%	2
T_5 : Rice bran 29.3% + Oil cake 10.4% + wheat bran 20.6% + Flour 9.8% + TSP 4.5% + fish meal 25.6%	2
T_6 : Rice bran 22.6% + Oil cake 10.4% + wheat bran 25.1% + Flour 9.9% + TSP 6.3% +	2

fish meal 25.7%	
Total	**13**

Cage construction

Thirteen 1m3 sized floating cages, made of knotholes black polyethylene net having 8 m.m. mesh with box type iron frame were used in this trial. The cage bag were stitched with iron frame by tire cord. Four floats were bounded at four top corners. At the top of the cages were remain net cover fitted with iron frame which act as door to collect fish during sampling.

Experimental fish and stocking in the cage

Genetically Improved Farmed Tilapia (GIFT) has been purchased on 28 May '97 from Fisheries Research Institute (FRI), Mymensingh and transported in the oxygen bag and carried by jeep up to trial site. These fries were conditioned before holed in the hapa and reared in this hapa before stocking in the cage. The fish were stocked on 19 July '97 at the morning at density $50/m^3$.

Experimental diets and feeding of fish

The feed were composed of rice bran, mustered oil cake, wheat bran, dry fish, flour, TSP and DCP as per treatment structure and this was led by spread sheet program. The feed preparation process for each treatment: flour was cooked for 15 minutes then rest ingredients were homogeneously mixed with cooked flour by hand and pelleted by a electric pelleter with 2 mm diameter sieve. Wet pellets were dried in the sun for about 2 hours under a shade, made of transparent polyethylene sheet to reduce damage of vitamins by ultra violet ray of the sun. The pellets size was increased with the increase of fish size. The fries were fed at satiation level of feeding. The demand of fries for feeds was estimated on an average 10 days interval. The feed ration distributed twice in a day at 08:30 and 15:00 hr. spreading slowly on the top centre of the cage i.e. through sprinkle method.

Feed analysis

Feed pellets were sent to faculty of fisheries, Bangladesh Agricultural University for proximate composition and phosphorus content analysis.

Cage management

The cages were shifted from one place to another place with the water fluctuation.

Growth monitoring

While stocking and harvesting, all fish were weighed and measure individually by digital balance (Ohrous, 0.1g accuracy) and a centimeter scale respectively. During sampling 30% fish were weighed and measured at same procedure and averaged.

Termination of the trial

The fish were harvested on 15 November '97 and thus the trial ended.

Water quality monitoring

The plan was to monitor oxygen, pH, temperature and ammonium of the study site. Due to disturbance of oxygen and pH meter only temperature, sect disk visibility and ammonium data have been recorded and analyzed.

Temperature

Temperature has been measured at surface water from within farm site at 0700 and 1500 hr. twice in a day by digital meter and averaged weekly.

Ammonium (NH_4^{++})

Ammonium data has been collected from cage mid water once in a week at 9 am by test kit (model Aquaquant® 14423 Ammonium) and recorded.

Analytical methods

Net production, specific growth rate (SGR) and food conversion ratio (FCR), fish recovery rate and hepatosomatic index were obtained from the following formulae.

Net production = Final wt at the harvesting - Initial wt at the stocking

$$\text{Specific growth rate} = \frac{\ln(\text{Final body wt}) - \ln(\text{Initial body wt})}{\text{Duration of time (days)}} \times 100$$

$$\text{Food conversion ratio} = \frac{\text{Feed given}}{\text{Weight gain of fish}}$$

$$\text{Fish recovery rate} = \frac{\text{No of fish at the harvesting}}{\text{No of fish at the stocking}} \times 100$$

$$\text{Hepatosomatic index} = \frac{\text{Liver weight}}{\text{Fish body weight}} \times 100$$

Statistical analysis

Regression analysis has been performed between yield and phosphorus content in feeds. t-Test has been also conducted on treatments against control (T_1).

Results and Discussion

Water quality

Temperature and ammonium ranges were remain in favour of fish during the experimental period (Table II).

Table II: Temperature and ammonium recorded during the trial period

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16	Week 17
Temperature (^{0}c)																	
Mean s.d. (?)	**29.0 0.9**	**31.0 0.7**	**30.5 0.5**	**29.6 0.6**	**30.3 0.7**	**31.2 0.7**	**30.8 1.3**	**30.0 0.8**	**29.4 0.6**	**29.6 0.7**	**27.8 0.7**	**28.9 0.9**	**29.9 0.5**	**29.4 0.5**	**28.2 0.7**	**27.5 0.5**	**27.8 0.6**
Ammonium																	

(mg/l)																	
Out side of cage	**0**	**0**	**0**	**0.2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.2**	**0**	**0**	**0**
Within cage	**0**	**0**	**0.2**	**0.2**	**0.2**	**0**	**0**	**0**	**0**	**0**	**0**	**0.2**	**0.2**	**0.2**	**0**	**0**	**0**

Growth performance

Effect of Phosphorus

The regression of yield on different Phosphorus content in feeds showed that the yield decreased with the increase of Phosphorus level and regression coefficient was estimated 4.183. This meant that 1% increase of Phosphorus content in feeds can decrease about 0.12 Kg yield. The regression equation could be expressed as follow:

Yield in Kg = 4.18235 - 0.1195 X (% of Phosphorus content in feeds)

The reason for negative regression might be due to use of higher Phosphorus content in feeds than the requirement for tilapia fish. The available dietary Phosphorus requirement for juvenile tilapia is about 46% (Haylor *et. al.*, 1988). The trial was designed with Phosphorus level as 1.45%, 0.9%, 1.1%, 1.6%,2.4% and 2.5% for T_1 ,T_2 , T_3 , T_4 , T_5 , T_6 respectively. Moreover, results of Phosphorus content analysis suggested use of higher Phosphorus level in feeds (appendix II).

Hepatosomatic index

t-Test on hepatosomatic index indicates no significant difference ($p > 0.05$) between control (T1) and other treatments. This results suggested that no toxic effect of Bangladeshi TSP on fish body.

The specific growth rate and food conversion ratio were obtained almost similar for the different treatments (Table III). The recovery rate was gained from 96% to 97% at different treatments.

Table III: Mean weight, mean length, gross production, net production, SGR, FCR, recovery rate and hepatosomatic index for the trial periods.

	T_1	T_2	T_3	T_4	T_5	T_6
Stocking						
Mean weight (g)	**3.41**	**3.38**	**3.45**	**3.44**	**3.41**	**3.50**
s.d (?)	**0.07**	**0.12**	**0.09**	**0.06**	**0.12**	**0.11**
Mean length (cm)	**5.96**	**5.95**	**5.97**	**5.99**	**5.96**	**6.02**
s.d (?)	**0.05**	**0.08**	**0.05**	**0.03**	**0.11**	**0.05**
Number/ m^3	**50**	**50**	**50**	**50**	**50**	**50**
Biomass (Kg/m^3)	**0.18**	**0.18**	**0.18**	**0.18**	**0.18**	**0.18**
s.d (?)	**0.00**	**0.01**	**0.00**	**0.00**	**0.01**	**0.01**
Harvesting						
Mean wt (g)	**83.55**	**83.98**	**81.25**	**86.08**	**82.61**	**75.79**
s.d (?)	**7.92**	**7.36**	**1.44**	**9.86**	**7.65**	**4.48**
Mean length (cm)	**16.81**	**16.81**	**16.77**	**17.02**	**16.80**	**16.29**
s.d (?)	**0.47**	**0.35**	**0.00**	**0.61**	**0.60**	**0.33**
Gross production (Kg/m^3)	**4.20**	**4.24**	**4.06**	**4.39**	**4.18**	**3.82**
s.d (?)	**0.36**	**0.43**	**0.30**	**0.50**	**0.56**	**0.07**

Net production (Kg/m^3) s.d (?)	**4.02** **0.36**	**4.07** **0.42**	**3.89** **0.30**	**4.21** **0.50**	**4.00** **0.56**	**3.64** **0.07**
SGR s.d (?)	**2.66** **0.07**	**2.68** **0.04**	**2.63** **0.01**	**2.68** **0.08**	**2.66** **0.05**	**2.56** **0.08**
FCR s.d (?)	**2.09** **0.21**	**2.02** **0.00**	**2.12** **0.12**	**2.03** **0.01**	**2.15** **0.00**	**2.16** **0.14**
Recovery rate (%) s.d (?)	**96.79** **5.55**	**97.12** **1.36**	**96.15** **5.44**	**98.08** **0.00**	**97.12** **4.08**	**96.15** **5.44**
Hepatosomatic index s.d (?)	**1.45** **0.17**	**1.82** **0.08**	**1.91** **0.14**	**1.97** **0.11**	**1.75** **0.13**	**1.64** **0.11**

Conclusion

Two rich Phosphorus source fish meal and rice bran were used in this experiment. The Phosphorus content was higher at each treatment than the suitable range for tilapia fish rearing. The trial suggested that if fish meal along with rice bran is used in the feed, then extra TSP was not needed in the feed ration to increase the phosphorus level. The Bangladeshi TSP is not toxic for fish.

Reference

Haylor, G.S., Beveridge, M.C.M. and K. Jauncey (1988). Phosphorus nutrition of juvenile Oreochromis niloticus p. 341-345. In: R.S.V. Pullin. T. Bhukaswan, K. Tonguthai and J.L. Maclean (eds), The second International Symposium on tilapia in Aquaculture. ICLARM Conference proceedings 15, 623p. Department of Fisheries, Bangkok, Thailand and ICLARM, Manila, Philippines.

Appendix I: Proximate composition (dry matter basis) and phosphorus analysis of different treatments

	T_1	T_2	T_3	T_4	T_5	T_6
Protein (%)	**27.68**	**28.20**	**28.49**	**27.43**	**27.43**	**27.54**
s.d. (?)	**0.33**	**0.50**	**0.28**	**0.43**	**0.29**	**0.27**
Lipid (%)	**10.75**	**11.62**	**13.22**	**12.26**	**11.40**	**10.50**
s.d. (?)	**0.19**	**0.11**	**0.16**	**0.09**	**0.06**	**0.07**
Ash (%)	**16.04**	**16.31**	**14.67**	**17.34**	**18.95**	**19.54**
s.d. (?)	**0.91**	**0.49**	**0.44**	**0.51**	**0.20**	**0.16**
Crude fibre (%)	**6.18**	**6.25**	**6.23**	**5.70**	**5.08**	**5.90**
s.d. (?)	**0.18**	**0.18**	**0.16**	**0.16**	**0.21**	**0.14**
NFE (%)	**39.34**	**37.61**	**37.38**	**37.28**	**37.14**	**36.52**
s.d. (?)	**1.32**	**0.84**	**0.56**	**0.10**	**0.51**	**0.62**
Phosphorus (%)	**2.0**	**1.17**	**1.17**	**1.61**	**2.40**	**2.24**

NFE = Nitrogen Free Extract

Appendix II: Regression of yield on Phosphorus content in feeds

Treatment	T1	T2	T3	T4	T5	T6
Yield (Kg)	**4.0204**	**4.0683**	**3.88525**	**4.21125**	**4.0028**	**3.64065**
Phosphorus (%)	**2**	**1.17**	**1.17**	**1.61**	**2.4**	**2.24**

Multiple R	0.328736668
R Square	**0.108067797**
Adjusted R Square	**-0.114915254**
Standard Error	**0.204267048**
Observations	**6**

ANOVA

	df	SS	MS	F	Significance F
Regression	**1**	**0.02022186**	**0.02022186**	**0.48464579**	**0.52465792**
Residual	**4**	**0.16690011**	**0.04172503**		
Total	**5**	**0.18712197**			

	Coefficients	**Standard Error**	**t Stat**	**P-value**	**Lower 95%**	**Upper 95%**	**Lower 95.000%**	**Upper 95.000%**
Intercept	**4.18235334**	**0.314229605**	**13.309864**	**0.0001842**	**3.3099103**	**5.0547964**	**3.3099103**	**5.0547964**
X Variable 1	**-0.1194967**	**0.17165**	**-0.696165**	**0.5246579**	**-0.5960744**	**0.3570809**	**-.5960744**	**0.357081**

Appendix III: Cage and treatment wise average weight for the experiment.

		Stocking	1st samp	2nd samp	3rd samp	4th samp	5th samp.	6th samp.	7th samp.	Harvesting
DCP-I	**Cage-I**	**3.49**	**6.69**	**11.75**	**16.24**	**29.63**	**44.12**	**50.94**	**80.48**	**88.26**
DCP-II	**Cage-IV**	**3.39**	**7.12**	**11.56**	**18.82**	**30.10**	**50.06**	**68.01**	**71.43**	**87.98**
DCP-III	**Cage-XIII**	**3.35**	**6.51**	**10.83**	**17.05**	**25.94**	**33.69**	**51.94**	**54.96**	**74.40**
T_1 average		**3.41**	**6.77**	**11.38**	**17.37**	**28.56**	**42.62**	**56.96**	**68.96**	**83.55**
s.d (?)		**0.07**	**0.31**	**0.49**	**1.32**	**2.28**	**8.29**	**9.58**	**12.94**	**7.92**
TSP-0%-I	**Cage-II**	**3.46**	**7.08**	**11.83**	**18.10**	**29.96**	**44.47**	**63.92**	**74.84**	**89.19**
TSP-0%-II	**Cage-XII**	**3.29**	**5.73**	**9.97**	**16.35**	**25.59**	**33.34**	**53.31**	**70.80**	**78.78**
T_2 average		**3.38**	**6.41**	**10.90**	**17.23**	**27.78**	**38.91**	**58.62**	**72.82**	**83.98**
s.d (?)		**0.12**	**0.95**	**1.32**	**1.24**	**3.09**	**7.87**	**7.50**	**2.86**	**7.36**
TSP-1%-I	**Cage-III**	**3.51**	**6.14**	**10.00**	**18.24**	**27.37**	**42.41**	**50.59**	**76.37**	**82.27**
TSP-1%-II	**Cage-XI**	**3.38**	**6.67**	**11.28**	**16.71**	**29.77**	**41.06**	**50.12**	**69.40**	**80.23**
T_3 average		**3.45**	**6.41**	**10.64**	**17.48**	**28.57**	**41.74**	**50.36**	**72.89**	**81.25**
s.d (?)		**0.09**	**0.37**	**0.91**	**1.08**	**1.70**	**0.95**	**0.33**	**4.93**	**1.44**
TSP-3%-I	**Cage-V**	**3.48**	**6.81**	**11.48**	**17.44**	**27.22**	**44.87**	**64.62**	**93.34**	**93.05**
TSP-3%-II	**Cage-X**	**3.40**	**6.23**	**10.05**	**16.11**	**23.95**	**33.81**	**60.15**	**72.16**	**79.11**
T_4 average		**3.44**	**6.52**	**10.77**	**16.78**	**25.59**	**39.34**	**62.39**	**82.75**	**86.08**
s.d (?)		**0.06**	**0.41**	**1.01**	**0.94**	**2.31**	**7.82**	**3.16**	**14.98**	**9.86**
TSP-5%-I	**Cage-VI**	**3.49**	**6.82**	**11.36**	**20.13**	**32.41**	**45.83**	**66.92**	**79.79**	**88.02**
TSP-5%-II	**Cage-IX**	**3.32**	**6.17**	**10.62**	**16.78**	**28.94**	**39.72**	**54.95**	**56.15**	**77.20**
T_5 average		**3.41**	**6.50**	**10.99**	**18.46**	**30.68**	**42.78**	**60.94**	**67.97**	**82.61**
s.d (?)		**0.12**	**0.46**	**0.52**	**2.37**	**2.45**	**4.32**	**8.46**	**16.72**	**7.65**
TSP-7%-I	**Cage-VII**	**3.42**	**6.69**	**12.01**	**19.30**	**24.67**	**41.05**	**61.30**	**77.59**	**78.96**
TSP-7%-II	**Cage-VIII**	**3.58**	**6.68**	**11.23**	**15.74**	**26.27**	**31.90**	**59.30**	**60.33**	**72.63**
T_6 average		**3.50**	**6.69**	**11.62**	**17.52**	**25.47**	**36.48**	**60.30**	**68.96**	**75.79**
s.d (?)		**0.11**	**0.01**	**0.55**	**2.52**	**1.13**	**6.47**	**1.41**	**12.20**	**4.48**

Appendix IV: Cage and treatment wise average length for the experiment.

		Stocking	1st samp.	2nd samp.	3rd samp.	4th samp.	5th samp.	6th samp.	7th samp.	Harvesting
	Date	**7/19/97**	**8/2/97**	**8/17/97**	**9/1/97**	**9/16/97**	**10/1/97**	**10/20/97**	**10/31/97**	**11/15/97**
DCP-I	**Cage-I**	**6.03**	**7.38**	**8.98**	**10.04**	**12.1**	**13.57**	**14.46**	**16.15**	**17.02**
DCP-II	**Cage-IV**	**5.94**	**7.52**	**8.77**	**10.38**	**12.13**	**14.24**	**15.63**	**15.81**	**17.17**
DCP-III	**Cage-XIII**	**5.93**	**7.3**	**8.85**	**10.15**	**11.49**	**12.56**	**14.75**	**14.88**	**16.30**
T_1 average		**5.96**	**7.40**	**8.87**	**10.19**	**11.91**	**13.46**	**14.95**	**15.61**	**16.81**
s.d (?)		**0.05**	**0.11**	**0.11**	**0.17**	**0.36**	**0.85**	**0.61**	**0.66**	**0.47**
TSP-0%-I	**Cage-II**	**6.01**	**7.5**	**9.04**	**10.25**	**12.01**	**13.39**	**15.38**	**16.24**	**17.05**
TSP-0%-II	**Cage-XII**	**5.90**	**6.99**	**8.51**	**9.9**	**11.68**	**12.68**	**14.57**	**16.04**	**16.56**
T_2 average		**5.95**	**7.25**	**8.78**	**10.08**	**11.85**	**13.04**	**14.98**	**16.14**	**16.81**
s.d (?)		**0.08**	**0.36**	**0.37**	**0.25**	**0.23**	**0.50**	**0.57**	**0.14**	**0.35**
TSP-1%-I	**Cage-III**	**6.00**	**7.18**	**8.53**	**10.29**	**11.78**	**13.41**	**14.33**	**16.25**	**16.77**
TSP-1%-II	**Cage-XI**	**5.93**	**7.46**	**8.92**	**9.98**	**12.14**	**13.09**	**14.40**	**15.74**	**16.76**
T_3 average		**5.97**	**7.32**	**8.73**	**10.14**	**11.96**	**13.25**	**14.37**	**16.00**	**16.77**
s.d (?)		**0.05**	**0.20**	**0.28**	**0.22**	**0.25**	**0.23**	**0.05**	**0.36**	**0.00**
TSP-3%-I	**Cage-V**	**6.01**	**7.49**	**8.81**	**10.04**	**11.8**	**13.53**	**15.42**	**17.33**	**17.45**
TSP-3%-II	**Cage-X**	**5.97**	**7.18**	**8.49**	**9.82**	**11.14**	**12.71**	**15.32**	**15.98**	**16.59**
T_4 average		**5.99**	**7.34**	**8.65**	**9.93**	**11.47**	**13.12**	**15.37**	**16.66**	**17.02**
s.d (?)		**0.03**	**0.22**	**0.23**	**0.16**	**0.47**	**0.58**	**0.07**	**0.95**	**0.61**
TSP-5%-I	**Cage-VI**	**6.04**	**7.47**	**8.91**	**10.59**	**12.41**	**13.8**	**15.75**	**16.46**	**17.22**
TSP-5%-II	**Cage-IX**	**5.88**	**7.21**	**8.67**	**10.01**	**11.5**	**13.03**	**14.56**	**14.95**	**16.38**
T_5 average		**5.96**	**7.34**	**8.79**	**10.30**	**11.96**	**13.42**	**15.16**	**15.71**	**16.80**
s.d (?)		**0.11**	**0.18**	**0.17**	**0.41**	**0.64**	**0.54**	**0.84**	**1.07**	**0.60**

TSP-7%-I	**Cage-VII**	**5.98**	**7.48**	**9.04**	**10.48**	**11.63**	**13.29**	**14.92**	**16.36**	**16.53**
TSP-7%-II	**Cage-VIII**	**6.06**	**7.46**	**8.88**	**9.95**	**11.52**	**12.37**	**14.99**	**15.11**	**16.06**
T_6 average		**6.02**	**7.47**	**8.96**	**10.22**	**11.58**	**12.83**	**14.96**	**15.73**	**16.29**
s.d (?)		**0.05**	**0.01**	**0.11**	**0.37**	**0.08**	**0.65**	**0.05**	**0.88**	**0.33**

Appendix V: Hepatosomatic index of different treatments for the experiment.

	T1	T2	T3	T4	T5	T6
R_1	**1.90**	**1.42**	**1.50**	**2.02**	**1.91**	**1.72**
R_2	**1.31**	**1.48**	**2.37**	**1.69**	**1.71**	**1.82**
R_3	**1.44**	**2.38**	**2.16**	**2.26**	**1.36**	**1.61**
R_4	**1.85**	**2.34**	**1.63**	**2.45**	**2.33**	**1.64**
R_5	**1.53**	**1.52**	**2.19**	**1.41**	**1.66**	**1.66**
R_6	**1.22**	**1.74**	**1.63**	**2.02**	**1.52**	**1.40**
R_7	**1.29**					
R_8	**1.31**					
R_9	**1.17**					
Average	**1.45**	**1.82**	**1.91**	**1.97**	**1.75**	**1.64**
s.d (?)	**0.3**	**0.4**	**0.4**	**0.4**	**0.3**	**0.1**

Appendix III: ANOVA on hepatosomatic index.

SUMMARY		

Groups	Count	Sum	Average	Variance
Column 1	9	13.01034	1.44559	0.0711
Column 2	6	10.89037	1.81506	0.1929
Column 3	6	11.48278	1.9138	0.1363
Column 4	6	11.84021	1.97337	0.1432
Column 5	6	10.48233	1.74706	0.1165
Column 6	6	9.862736	1.64379	0.0192

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	1.375546	5	0.27511	2.5154	0.049	2.5026
Within Groups	3.60919	33	0.10937			
Total	4.984736	38				

R9808

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POTENTIAL OF HIGH DENSITY FISH CULTURE IN SMALL CAGES IN BANGLADESH[1]

Prepared By

S.M. Nurun Nabi, A.K.M. Nurul Kabir, Md. Alamgir Rahman

CARE Bangladesh, CAGES Project, House # 66, Road # 7/A, Dhanmondi, Dhaka-1209.

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1. INTRODUCTION

Bangladesh has vast water resources in the form of beel, flood plain, canal, river, estuary, lake (Kaptai), haor, boar covering 4,05,000 hectors (Ali, 1990) where other aquaculture development is impractical. Cage aquaculture could be a potential option for resource poor people to increase the fish intake and household income.

Intensive fish culture in low volume cages (1 to 4 m3) at high densities (stocking densities and carrying capacities are 200 to 500 fish and 200 Kg/m3 of cage respectively) is known as high density fish culture in low volume cages (Schmittou, 1997). The low volume cages have better water exchange characteristics which increases the carrying capacity of the cages. To grow fish at high densities, protein rich (about 30% protein) water stable (about 10 minutes) floating or sinking pelleted feeds are required.

The cage materials and commercial fish feeds are costly in Bangladesh. To obtain satisfactory economic viable production from cages, the degree of intensity in cage culture needs to be increased. The existing experimental extensive cage culture system is not an economically viable alternative, and does not produce enough return on the farmers labour to make cage culture an activity, farmers can rely on.(Huchette, 1997). To obtain adequate profit and production from cages, LVHD (Low Volume High Density) fish culture is required. This is a proven production system in China (Schmittou, 1997), and this technology could be adopted for Bangladesh.

This paper will focus on the lessons learned and the potential of high density fish culture in low volume cages conducted at different project areas by CAGES, CARE Bangladesh.

2. METHODS AND MATERIALS

At CAGES trial farm located at Bausiaghat under district of Munshigonj, GIFT tilapia and Pangash were reared at density 350 fish/m^3 and 100 fish/m^3 in the Meghna-Gomti river using 2x1.3x1.9m and 1x1x1m floating cages respectively. Also the GIFT tilapia were grown at Comilla in a $1m^3$ (1x1x1m) floating cage in the pond at density 350 fish/m^3. In the Baluhar baor located at Jessore, common carp and silver barb were cultivated in the $1m^3$ (1x1x1m) fixed cages at densities 300 fish/m^3 and 225 fish/m^3 respectively. The knotless 8mm black polyethylene net with 2m width was used to construct all the cages except pangash cage (same net with 13mm mesh). For the $1m^3$ cages, the net was stitched by tire cord with box type $1m^3$ (1x1x1m) iron frame and covering all the sides. Four plastic buoys were fastened by plastic rope to four iron hooks at the upper four corners of the iron frame to float the cage. The float was adjusted with the iron hook, so the top of the cage remained about 5 cm above the water surface. The $1m^3$ fixed cages used at Jessore were suspended in the water hanging from bamboo frame by rope. All the iron frame of $1m^3$ cages were painted by coal tar before the net setting to protect against rusting. A fine mesh/polyethylene platform was fixed on the bottom of all the cages to reduce feed waste from the cage.

The 2x1.3x1.9m sized cage having $4.4m^3$ effective water volume also was stitched by tire cord and plastic line. Top of the cage was covered by the same net. A rectangular frame (1.8x1.2m) made of plastic pipe having sand in the inner side was fixed on the cage bottom to spread the cage bag properly. Four floats (buoy) were fixed with the top four corners of the cage by rope. Loops were made by plastic rope at the top and bottom four corners and was fitted with four bamboo poles. Therefore, the cage depth was adjusted with the water level automatically.
Fingerlings were purchased from local fry traders of each region except GIFT tilapia. GIFT tilapia purchased from Fisheries Research Institute (FRI), Mymensingh.

Commercial pellets (Saudi-Bangla Fish Feed, grower) was used to fed GIFT and Pangash at CAGES farm. Common carp and silverbarb were fed on pellets having 22% and 30% protein content. Only farm made pellets with 25% protein content were used in Comilla for GIFT tilapia. The feed was composed of rice bran (40%), broken rice (16%), mustard oil cake (16%), dry fish (16%), molasses (10%) and triple super phosphate (2%). The feed preparation process is: Molasses was cooked for 15 minutes then rest ingredients were homogeneously mixed with cooked molasses by hands and pelleted by a hand pelleter with 3mm diameter sieve. Wet pellets were dried in the sun for about 2 hours under a shade, made of transparent polyethylene sheet to save the vitamins remain in feeds from ultra violet ray presence in the sun light. Feeds have been distributed daily 2-3 times through sprinkle method i.e. slowly spreading on the top of the cages at approx. satiation level except Comilla (5% of the body weight).

Table I: Procedure and used materials of trials conducted at different study areas.

Fish species	*GIFT tilapia	*Pangash	*GIFT tilapia	**Silver barb	**Common carp
Study area	CAGES farm	CAGES farm	Comilla	Jessore	Jessore
Water resource Net type	Meghna-Gomti river Black polyethylene	Meghna-Gomti river Black polyethylene	Pond Black polyethylene	Baluhar baor Black polyethylene	Baluhar baor Black polyethylene
Cage dimension	2x1.3x1.9	1x1x1m	1x1x1m	1x1x1m	1x1x1m
Effective water	4.4 m3	1m3	1m3	1m3	1m3

volume					
Culture cycle	31.12.96 to 3.5.97	18.10.96 to 21.9.97	12.8.97 to 3.01.98	4.5.97 to 4.9.97	3.5.97 to 18.9.97
Culture duration (days)	124	338	142	100	100
Stocking densities (no/m3)	350	100	350	225	300
Feed type	SBFF, grower	SBFF, grower	Farm made pellets	Pellets	Pellets
Feeding rate	Satiation level	Satiation level	5% of bd wt.	Satiation level	Satiation level
Feeding frequency (daily)	2-3 times	2 times	2 times	2 times	2 times
Growth monitoring	No sampling	Irregularly	Irregularly	Monthly	Monthly

Note: * indicates trial conducted in a single cage and ** indicates trials with replication.

The cages were cleaned by hand at 10 days intervals, and at this time cages were also checked for damage, by dipping in the water, and any holes repaired. Cages had to be moved with fluctuation of water level.

During stocking and harvesting bulk weights of fish were taken and averaged. Sampling of fish for estimating growth was not carried out at regular intervals to avoid excessive stress on the fish (Bolivar, 1994).

Wholesale fish price, and the actual prices of cage materials, fish seed and feeds were used in economic analysis. Depreciation cost of cage materials has been estimated based on farm experience and assumption. Specific growth rate, fish recovery rate, net production, food conversion ratio, net profit and return on per cycle investment were obtained from the following formula.

$$\text{Specific growth rate} = \frac{\ln(\text{Final body wt}/\text{Initial body wt})}{\text{Duration of time (days)}} \times 100$$

$$\text{Fish recovery rate} = \frac{\text{No of fish at the harvesting}}{\text{No of fish at the stocking}} \times 100$$

Net production = Final wt at the harvesting - Initial wt at the stocking

$$\text{Food conversion ratio} = \frac{\text{Feed given}}{\text{Weight gain of fish}}$$

Net profit = Total sale - Per cycle investment

Total sale- per cycle investment

Return on investment = -- x 100

Per cycle investment

3. RESULTS AND DISCUSSION

3.1. PRODUCTION

Cage production depends on various variable such as feed quality and quantity, species and stocking size of fish, as well as environmental factors. These were not constant in the different study regions. Therefore, it is very difficult to compare and come to concrete conclusion from the production of different fish species, conducted in different geographical locations. However, we may assess the feasibility and potential of this culture system for the poor of Bangladesh. The intensity of the practice depends on the farmers objective. As CAGES is trying to improve the incomes of poor people, so the project carefully assesses technical options that could be affordable by the farmers.

The production ranges gained from 23 Kg to 71 kg/m3 in different trials (Table II) with different species over various length of time. The highest net production was obtained culturing Pangash (70 Kg) for 11 months, followed by GIFT tilapia (50.5 kg) for less than five months. Even, common carp and silverbarb have produced 31 and 23 Kg/m3 over a period of 100 days, which suggests that a good crop can be harvested from flood plains and other water resource's where water exists for up to 4 months, when using quality feeds.

Table II: Stocking, harvesting details and economic analysis of the trials which were conducted at different region with various species

Study area	CAGES farm	CAGES farm	Comilla	Jessore	Jessore
Species	**GIFT tilapia**	**Pangash**	**GIFT tilapia**	**Common carp**	**Silver barb**
Stocking n=4					**n=4**
Average wt (g)	10	3.24	3	17.25	14.11
Number/m^3	350	100	350	300	225
Number/ cage	1540	100	350	300	225
Biomass (Kg/cage)	15.5	0.32	1.05	5.2	3.17
Biomass (Kg/m^3)	3.5	0.32	1.05	5.2	3.17
Harvesting					
Average wt (g)	99.10	739.8	148.24	104.93	110.82
Net prod. (Kg/cage)	135	70.7	50.54	25.31	19.9
Net prod. (Kg/m^3)	30.7	70.7	50.54	25.31	19.9
Net production (Kg/day/m^3)	0.25	0.21	0.36	0.25	0.2
Gross pro. (Kg/cage)	150.5	71	51.58	30.51	23.07
Gross pro. (Kg/m^3)	34.2	71	51.58	30.51	23.07

SGR (%)	1.84	1.61	2.75	1.33	1.68
FCR	1.42	1.81	1.69	2.27	1.95
Recovery rate (%)	98.6	96	99.43	98.5	94
Economics					
Cage cost (Tk)	725	459	573	509	509
Cage depreciation	167	217	165	102	102
Seed	783	350	525	450	270
Feed	3066	2048	644	1549	989
Average feed cost (Tk/day)	25	6	4.5	15	10
Total cost (Tk)	4015	2615	1334	2101	1361
Fish price (Tk/Kg)	46	100	55	55	40
Total sale (Tk)	6925	7100	2835	1678	920
Net profit (Tk)	2910	4485	1501	-423	-441
Return on investment (%)	72	171.5	112.5	-20.13	-32.40

The higher recovery rates (94%-99%) found in all cases indicates that fish can be grown at higher densities in cages at different water bodies, even in the pond. Low FCRs (1.4-2.3) have been gained from all fish species tested. The highest FCR was found in common carp trials (2.3) followed by silverbarb (1.95) even although they were fed on higher protein feeds (30% protein content) than the other fish (22%-23% protein content). The reason might be less feed utilization efficiency of common carp and silverbarb and the results give emphasis on the selection of fish species for profitable cage culture.

Net production was obtained 70.7 Kg/m3 having average harvested size 740g from Pangash trial using commercial pellets (22% protein content). Golder *et al*. (1996) reported 470 g final weight of *Pangasius sutch* for similar culture cycle at density 20 fish/m3 fed on commercial pellets with 27% crude protein. The daily weight increment was 2.18 g/fish and SGR was 1.81%. PIU/DTA/BRAC (1997) reported that the daily growth rate and SGR of *Pangasius sutchi* were 1.6g and 1.38 respectively at density 78 fish/m3 with three different commercial pellets (having 22%, 26% and 30% crude protein). PIU/DTA/BRAC (1997) also found FCR 2.3-3.1 and SGR 1.6%-1.77% culturing common carp at density 103-153 fish/m3 after completion of 115 days similar culture cycle. The FCR of pangash trial could be compared with the FCR of pangash stated by Golder *et al*. (1996) and PIU/DTA/BRAC (1997) though they used feeds those had comparatively higher protein level. Golder et al. mention FCR 2.5 with commercial pellets (27% crude protein) and PIU/DTA/BRAC found FCR 3.4 and 2.6 at density 29 fish/m3 and 41 fish/m3 respectively with similar fish growing cycle.

Growth performance of GIFT tilapia was satisfactory at Comilla and CAGES farm. However, better SGR was found at Comilla. Reason might be presence of natural foods in the pond as water colour remain green throughout the trial.

The key variable of this trial might be feeding technique which leads to get better growth compared with the results mentioned by Golder *et al*. (1996) and PIU/DTA/BRAC (1997). This feeding technique effectively stopped feed loss and nutrient leaching. In PIU/DTA/BRAC trial, feed was given by a pipe onto a solid feeding tray on the cage bottom. Therefore, feed loss might be reduced but there was more chances of nutrient leaching during feeding of fish. Both the feed loss and nutrient leaching might be happened in the trial which was conducted by Golder *et al*. as feed was fed in a feeding sac.

3.2. ECONOMICS

The economic analysis indicates that GIFT tilapia and pangash growing in cages are profitable (Table II) and the systems with common carp and silverbarb are not economically viable alternatives. Results also suggest that economic cage culture depends the choice of fish, use of quality feeds in terms of price and protein content, and farm gate price of fish. The survey carried out revealed that farmers in the project areas can spend 10-20 Tk/day on cage culture activities (CARE 1997). The average daily feed cost were 25, 6, 4.5, 15 and 10 taka for GIFT tilapia at CAGES farm, pangash, GIFT at Comilla, common carp and silverbarb fattening respectively. Therefore, GIFT tilapia (conducted at Comilla) and pangash fattening options seems to be affordable to the farmers spending budgets. Indeed, farmers can afford two cages of GIFT tilapia (based on Comilla trial results), where the highest feed cost/day will reach 40 taka at harvesting. The highest labour return was also obtained from the GIFT tilapia trial at Comilla, followed by GIFT tilapia and pangash at CAGES Farm (see Table III). From personnel observations, these labour returns are higher compared to existing labour rates of each region. Hence, farmers may interested in adopting these better economic options.

Table III: Labour return from practices

Study area	**CAGES farm**	**CAGES farm**	**Comilla**	**Jessore**	**Jessore**
Species	**GIFT tilapia**	**Pangash**	**GIFT tilapia**	**Common carp**	**Silver barb**
Average daily required labour (hours)	1.5	1	0.6	0.5	0.5
Total required labour (hours)	186	338	85.2	50	50
Labour return (Tk/hour)	***15.6***	***13.27***	***17.6***	***-8.46***	***-8.82***
Estimated local labour rate (Tk/hour)	8.75	8.75	7.5	7.5	7.5

4. GENERAL OBSERVATIONS AND COMMENTS:

4.1. ADVANTAGES OF HIGH DENSITY FISH CULTURE IN SMALL CAGES

4.1.1. TECHNICAL

4.1.1.1. Water exchange rate

Though water exchange rate primarily depends on the mesh size of the cage. But square or rectangular low volume cages (1 to 4 m3) have greater water exchange through the cage in comparison to larger cages. This allows turnover of waters, keeping oxygen high, while removing waste (unused feeds, fish excreta, decomposed algae etc.) from the cage. As a result environment in the cage remains healthy for fish at higher densities. The reason for higher water exchange efficiency of low volume cages is higher ratio between lateral surface area and volume (m2:m3). Normally, lateral surface area and volume ratio (m2:m3) reduces with increasing cage size or dimension (Schmitou, 1997).

4.1.1.2. Biology / fish behavior

In low volume cages, fish movement is restricted due to less space in the cage. This may save energy in fish body by reducing unnecessary movement. This will improve FCR values (Table II). Moreover, fighting among fish was not observed even between dominant and weaker fish, avoiding fish injury in crowded conditions. At very crowded condition, feed response by the fish was very strong which assist in estimating the demand for feed. The reason might be high competition for feed among fish.

4.1.2. ECONOMICAL

Cage costs increase with the increase of cage size and decrease per unit production cost which partly influence the profit margin of the practice. However, in small cages total cost of the practice remain affordable to the farmers.

4.1.3. MANAGEMENT

A person can easily handle or operate the cage efficiently even female cage operator (Islam *et. al.*, 1997). Cage management i.e. cage cleaning, cage hole checking, shifting, fish growth and health checking are easier (Nabi, 1997). Moreover, the cage is more secure in storm.

4.1.4. SOCIAL

It's smaller size enable more people to start cage culture in almost any water body. The chance of conflict is reduced between cage operator and fishermen, boatmen or other users as the cage takes up little space and is easily moved. This technology (LVHD fish culture) may have impressive demonstration effect, that could help extension initiatives of cage culture by the extension workers. Installation of small cages in cluster form may assist extension workers to implement group approach in the selected community.

4.2. LIMITATIONS AND POSSIBLE REMEDIES OF THESE LIMITATIONS FOR HIGH DENSITY FISH CULTURE IN SMALL CAGES

4.2.1. TECHNICAL

4.2.1.1 Environmental degradation

Feed waste initially increases the productivity of an ecosystem as it is a nutrient input increasing the production of a natural stock. Environmental degradation occurs when the quantity and quality of feed waste from cages through the intensification of the culture system exceeds threshold levels. Cage culture has long-term impact on environment as has been experienced in Southeast Asian countries, CAGES project has been facilitating awareness among cage culturists about environment. Todate, CAGES Farm (the most established in Bangladesh) reported that no significant impact of cage culture on the environment during monitoring chemical parameters (oxygen and pH) and benthic macro invertebrates. The reason might be very negligible areas are occupied for cage culture compared with the total areas of the water body and the water flow. To ensure the water environment is not degraded, the government or local communities should control the cage number/area covered by the cages in a water body according to the type, area and characteristics of that water body. Schmittou (1997) reported that the use at a rate of 8 Kg feed /hector of open waters/day that released 0.13 Kg phosphorus (P_2O_5) waste would probably be an acceptable threshold for environment. The government of Bangladesh could take similar initiatives in respect to country situation as a precaution. Simple techniques (observing colour, smell, etc) can be adopted to monitor changes in the environment, so action can be taken before damage is done.

4.2.1.2. Escapee

Caged fish may escape from cage to the environment. If exotic predator fish species entered into the environment, local stock will be affected. Therefore, education against the use of exotic predators should be launched by the extension workers, government and researchers.

4.2.1.3. Protein rich feeds

To cultivate LVHD fish culture, protein rich water stable/pelleted feeds are needed to obtain satisfactory production. But quality feeds are not available in many rural areas and animal protein rich feed ingredients such as fish meal is costly and moderately available. Therefore, CAGES had to made effort to formulate low cost (8-12 Tk/Kg) quality feed using locally available feed ingredients and presently facilitating these options through training. Now needed to more simplify the feed formulation process for farmers as a lengthy or a complicated methods of any technology is not well accepted by the farmers. The feeding technique is also important to reduce feed loss from cages during feeding of fish , so profits are maximised. Nabi (1997) reported that slow feeding through sprinkle technique reduced feed loss to zero.

4.2.1.4. Availability suitable fish species

Scarcity of fingerlings in rural areas at proper stocking period still constraints aquaculture in Bangladesh (Nabi, 1997). Up to date, encouraging results have been found in cages with GIFT tilapia, Thai Pangash, African magur, freshwater prawn and silverbarb which may difficult for farmers to obtain. CAGES project has taken an initiative to develop GIFT tilapia fry production techniques for NGOs and farmers. If the techniques are developed and facilitated to the cage farmers through NGOs located at different places of Bangladesh, then it will easy for farmers to buy GIFT tilapia. The linkages among cage operator, fry trader, nurserer and hatchery owner can be significantly improved and NGOs may be able to assist in developing strong linkages among them. Another potential option is wild fish (i.e. Snake headed, Koi, Shing, Magur, etc.) stocking in cage from local stock was thought by CAGES. In this regards, preliminary work has been done with Koi fish and found it's excellent potentiality as cage species.

4.2.2. SOCIAL

As encouraging results are getting from LVHD fish culture, more people may motivated to started cage aquaculture, so the chances of competition for get water access increases. Rich people and the leaders of community may dominate. Therefore, this is time to think how the poor will maintain access to the water resources. The government should create cage aquaculture policy stating clearly who will have water access and how. The NGOs could advocate for the poor to get sustainable water access.

4.2.3. ECONOMIC

As CAGES working for resource poor people, so the target people have budgetary constraints for LVHD fish culture as capital needed higher. Each farmer has his own budget to bear daily cage culture expenditure i.e. mainly feeding cost. CARE (1997) reported most of participants who were lived at different region of project areas have ability to expand 10-20 Tk per day. Therefore, it is recommended that proper production planning is needed before the practice start. The production plan should be based on cage operator's financial ability. For example, if a farmer can spend 20 Taka per day, this will be the factor that will limit the production plan. This feed cost could be estimated fixing or targeting biomass of the cage at harvest. Another option might be partial harvesting from cage which will reduce daily feed cost as well as will add some money into farmers pocket to bear cage expenses.

5. CONCLUSION

Fish growth was satisfactory (in terms of SGR and growth rate g/day/fish) at all regions with different species. After completion of each trial a good harvest was harvested. The economics showed that growing Pangash and GIFT tilapia was profitable and it seems to be potential income generating activity for the poor. Common carp rearing was not economic, reason might be poor genetic strain and higher feed costs.

Primarily, the success of cage culture depends on the selection of fish species, use of low-cost quality feeds especially mode of feeding of caged fish. Moreover, needed proper production planning and management by the cage manager to keep the investment as minimum and to explore optimum profit. For the sustainability of the practice, environmental issues are important to consider by the policy maker experienced from other countries before the problem raise.

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APPENDIX I: CAGE CONSTRUCTION COST AND CAGE DEPRECIATION

Item	Quantity	Cost (Tk)	Longevity (year)	Cost/cycle (Tk)
GIFT cage at CAGES Farm				
Black polyethylene net	11.5m	460.00	3	78.67
Bamboo	2	100.00	1.5	33.33
Nylon rope	150g	12.75	1	6.38
Tire cord	20g	3.00	2	0.75
Iron sinker	22p	17.60	2	4.40
Fine mesh net	2m	44.00	2	11.00
Float	4p	40.00	1	20.00
Plastic pipe	2p	36.00	3	6.00
Plastic angle	4p	12.00	1	6.00
Total		**725.35**		**166.53**
Pangash at CAGES Farm *				
Box type iron frame (1x1x1m)	1no.	150	3	50
Fine mesh net (Bangladeshi)	2m	44	2	22
Black polyethylene net	4.5	180	3	60
Coal tar	0.25 Kg	4.5	1	4.5
Tire cord thread	o.1 Kg	15	1	15
Bamboo (Thinner)	1p	25	1	25
Plastic float	4p	40	1	40
Total		**458.5**		**216.5**
GIFT tilapia cage at Comilla				
Black polyethylene net	4.5m	193.5	3	32.25
Fine mesh net	2m	44	1	22
Box type iron frame (1x1x1m)	1no.	170	3	28.3
Plastic float	4p	40	1	20
Bamboo	1p	75	1	37.5
Thread, needle		30	1	15
Paint		20	1	10
Total		**572.5**		**165.05**
Common carp and silverbarb cage at Jessore *				
Box type iron frame (1x1x1m)	1no.	165	3	18.33
Fine mesh net (Bangladeshi)	2m	44	2	7.33
Black polyethylene net	4.5	180	3	20
Coal tar	0.25 Kg	4.5	1	1.5
Tire cord thread	o.1 Kg	15	1	5
Bamboo	2p	150	1	50
Total		**508.5**		**102.16**

* Cage depreciation has computed considering per year 3 crops.

R9809

CARE BANGLADESH
CAGES PROJECT

The techno-economic evaluation of tilapia fry production in cages in Bangladesh

Prepared By
SM Nurun Nabi
CAGES Farm & Training Centre
Bausiaghat, Gazaria, Munshiganj

July, 1998

Title
The techno-economic evaluation of tilapia fry production in cages in Bangladesh

Objectives
?? To understand the economics of the hapa breeding system.
?? To adapt techniques of breeding tilapia in hapa to enable local seed supply for cages.

Significance
Generally, scarcity of good quality seed during the culture cycle at the locality is one of the major constraints to fish culture in Bangladesh. Moreover, severe mortality of fish fry during transportation is limiting the profit of the aquaculture system.

GIFT (Genetically Improved Farmed Tilapia) introduced in 1994 and disseminated in Bangladesh by Fisheries Research Institute, Mymensingh through DEGITA project (Dissemination of Genetically Improved Farmed Tilapia). Up to date, it's encouraging growth performance compared with locally available tilapia strains, motivated CAGES staff, NGOs staff and farmers to grow in cages as cash crop. However, it's availability strictly limited into research institutes and few NGOs. This leads to CAGES Farm to develop GIFT fry production technique in cages for participants. This tilapia breeding in hapa technique may give farmers sustainable access to the GIFT tilapia fries more easily, as system are small, techniques simple in investment relatively low.

This report will focus on the lessons learnt from the experiment. The trial was conducted from 5 April '98 to 18 May '98 for a period of 44 day in the Meghna-Gomti river.

Methods and Materials

The experiment was carried out in the Meghna-Gomti tidal river at Bausiaghat under Gazaria thana and district of Munshiganj. The experiment was designed as following:

Table I: Treatments, codes and number of replicates

Definition of treatment	Code	Replicate
T_1: Brood density 4/m^2	TB1.1, TB1.2, TB1.3	3
T_2: Brood density 8/m^2	TB2.1, TB2.2, TB2.3	3
Total		**6**

Six fine mesh (1 mm) net (Indian blue net) cages were constructed having dimension 2.5x2.5x2m which created an effective 5.25m3 water volume. The walls of the cage bag were stitched by machine (at a tailor's) to form an inverted mosquito net. Both the top and bottom corners were fastened with 4 bamboo poles by plastic rope to fix and spread the cage properly. After fry collection, fry from each replicate were kept in a separate in a fine mesh cage (1.5x1.5x2m) for counting and rearing purposes.

Fingerlings were collected from Fisheries Research Institute (FRI) on 27 June '96 for an experiment. At the end of that trial, fish were reared as brood stock in a cage with commercial pellets (Saudi-Bangla fish feed grower, about 22% protein content). The broods were stocked in the cage on 5 April '98 at ratio one male for three females.

The commercial pellets Saudi-Bangla fish feed (grower, about 22% protein content) were fed to the brood fish. Feeds were applied in a bamboo basket lined polyester cloth. The basket was suspended in mid-cage by plastic rope. The feed ration was allocated @ 2%-3% of the body weight/day and distributed at 8:30 and 15:30 hr. daily. For fry, farm made feeds, composed of oil cake, auto-milled rice bran, broken rice, wheat bran, wheat flour and fish meal which contained about 40% crude protein. The composition of feed ingredients were determined by a spreadsheet program where data of proximate analysis of different ingredients were used. The ingredients were mixed with water homogeneously by hands and formed ball shape having approximately 1 cm diameter. The feed ball were applied in the 2 earthen trays for cage fry cage. The requirement of feeds for fries was estimated through observation of presence or absence of leftover feeds in the tray i.e. if unused feeds was found in the tray then feed amount was reduced for next days and if feed was not found in the tray then the amount was gradually increased for the next few days. Left over feed was checked before the feeding of fries, so feeding reached approximately satiation levels.

At stocking, brood were weighed and measured individually using a top pan balance (accuracy 20g) and centimeter scale respectively. The collection of free swimming fries were take place weekly from each cage by scoop net. Both the free swimmers and those still in the mouth of the mother were collected biweekly checking mouth of broods and each cage bag properly. This process was continued through out the trial periods. The mouth of the broods was checked biweekly to avoid stress on broods during fry collection. But free swimmers were collected weekly to reduce cannibalism of young fries by older fries. After collection, fries were kept in a aluminum container (about 15 littre capacity) and transferred into the rearing and counting cage. After 5-7 days, all fries were counted directly. The fry collection techniques gradually increased with the time length. The brood stock cages were cleaned during fry collection and the cage was checked for hole at the same time. On 27 May '98, a storm struck the cages and damaged one brood cage from each treatment and all fries of the last collection day (25 May '98) before counting. Therefore, the trial was considered as ended at 18 May '98 to find out the treatment effects more accurately avoiding storm stress on the trial.

All feed ingredients were send to Faculty of Fisheries, Bangladesh Agricultural University separately and proximate composition was analyzed. Using results proximate analysis, feed for fry was formulated through spreadsheet program using result of single ingredient analysis. The previous proximate analysis results of Saudi-Bangla Fish Feed was used.

The price of cage materials and feed were used during purchase. Cage depreciation has been estimated based on farm experience. The rate of GIFT fry was estimated communicated with local fry trader in the Daudkandi area.

Temperature, ammonium and secchi disk data have been collected and analyzed. Temperature reading has been taken from location within farm at surface (< 30 cm) at 0700 hr. and 1500 hr. daily by digital meter. Ammonium has been recorded from cage mid water and out side of cage water at same depth. The secchi disk visibility was measured form within cage site at 12 hr. during sunny day.

t-Test has been performed on fry production of treatments to assess whether any significant difference between treatments in yield or not.

Results and Discussion

Water quality

The temperature was ranged 26.4^0 c to 30.4^0 c and mean was estimated 28^0 c (s.d. ? 1.05) which is suitable for tilapia breeding (Gilbert, ???). The highest secchi disk visibility was 123 cm and the lowest 45 cm including mean 76 cm (s.d. ? 15.7) during the experiment. Ammonium was found in between 0.2 mg^{-1} to 0.0 mg^{-1} from both cage water and out of the cage for the experimental periods.

Production

About 7 day aged fry was obtained 33 thousand for T_1 and 80 thousand for T_2 over the one and half month trial periods which suggested T_2 is strongly superior than the T_1 (Table II). The results of t-Test on production showed significant difference ($p<0.05$) between two treatments. The fecundity of female fish of T_2 (fry number/female/day) was higher (19) than the T_1 (16). The reason might be T_2 created more competitive mating environment in the cages as the total number of female was higher though the ratio of male and female remained same.

The production of fry per day per female was 4 fries obtained by Dr. Guerrero in Philippines's reservoir using 60 to 80 g breeders at density 4/m^2 with sex ratio one male for three females fed on farm made feed having 25% fish meal. In this trial higher fry recovery rates were found. Reason might be use of larger breeders and higher density (forT_2). Similar trial was conducted by NFEP-II in 1997 in the Northwest parts of Bangladesh and obtained 6000-8000 fries/month from 22m^2 hapa using 500 g broods at similar stocking density of T_1 (Babul & Benoy, personal communication). But they faced severe fry mortality after collection. From this trial, good quality healthy fries have harvested. Reason might be improve feeding of fries and good skills on fry collection.

Table II: Trial summary

Stocking	T_1 4 brood/m^2	T_2 8 brood/m^2
Average length of female (cm) s.d. (?)	35 3	35 3
Average weight female (g) s.d. (?)	844 200	819 218
Average length of male (cm) s.d. (?)	39 3	39 2
Average weight of male (g) s.d. (?)	1175 256	1109 212
Average length of male and female (cm) s.d (?)	36 3	36 3
Average weight of male and female (g) s.d. (?)	923 256	888 249
Total Number brood/cage	21	42
Male number/cage	5	10
Female number/cage	16	32
Production		
Total fry number/treatment Fry number/cage/month	33259 7542	79851 18107
Fry number/cage/day	252	605
Fry number/female/month	471	566
Fry number/female/day	16	19

Economics		
Cage cost for brood (Tk.)	2205	2205
Brood cage depreciation (Tk.)	414	414
Cage cost for fry (Tk.)	990	990
Fry cage depreciation (Tk.)	186	186
Brood cost (Tk.)	4361	8390
Feeds cost for broods (Tk.)	1186	2281
Feed cost for fries(Tk.)	41	48
Total cost (Tk.)	6187	11320
Fry price/Thousand (Tk.)	100	100
Fry sale (Tk.)	3326	7985
Brood sale as food fish (Tk.)	4361	8390
Total sale (Tk.)	7686	16375
Net profit (Tk.)	1499	5056
Return on investment (%)	24	45

Note: Estimated price of brood fish 75 Tk/Kg, fry rate 100 Tk./Thousand, Saudi-Bangla fish feed 16 Tk./Kg, farm made feeds for fry 17.8 Tk./Kg. At the end of the trial, biomass of the brood cage considered same as stocking. Fish were not weighed to avoid stress as the cages are using for other purposes.

Gilbert (1997 ?) reported production of 5 fries/female/day using 150 to 250 g brood stock at density 4 broods/m^2 with one male to three females. He also mentioned that fry production gradually decreased with the cycle length and suggested that brood stock could be used up to one year. The reason of higher production of this trial compared with Gilbert's trial could be larger broods and the shorter length of the production system.

This results also suggested that if a farmer produce fry in 2-3 cages for 2 months from early summer (March-April), the production could be enough for ensuring local seed needs for 30 to 40 cage culturists having 1 m^3 50 cage units (Kabir, personal communication).

Economics
Both the treatments made profit. However, T_2 produced more profit than the T_1. The net profit of T_1 and T_2 were 1500 Tk and 5000 Tk within one and half months. This meant that if a farmer produce GIFT fry in three cages, S/he can earn 1000 Tk to 3400 Tk per month if the marketing system in favour of him/her, but higher investment (Tk 6000 to Tk 11000) needed. The survey of farmers opinion on resources which they have for cage culture indicated that they can spend 10 Tk/day on feed (CARE, 1997). However, some farmers also opined that if the profit from cage culture is reliable, they can increase their cage budget. Therefore, if the farmer lacks capital S/he could choose T_2 option and produce fries in a single hapa. This option offers 18000 fries per month and about 1100 Tk as economic return. The return on investment were gained 24% and 45% for T_1 and T_2 respectively. If the production rate is same, it could be gradually increased with the length of the practice as mainly feed cost will increase and other costs will remain almost constant.

It is notable that the fry price strongly influences on the profit margin. The least selling rate of fry to make the system profitable business are 55 Tk/Thous and 37 Tk/Thousand for T_1 and T_2 respectively (Table III). This indicated the dependency of profit on the degree of intensity/scale of the practice.

Table III: Minimal fry price for profit from the treatments

	T_1	T_2
Total cost (Tk.)	6187	11320
Fry price/Thousand (Tk.)	55	37
Fry sale (Tk.)	1829	2935
Brood sale as food fish (Tk.)	4361	8390
Total sale (Tk.)	6190	11325
Net profit (Tk.)	2	5
Return on investment (%)	0	0

Conclusion

The length of the trial might be shorter to draw concrete conclusion on production and economics of the system. However, it is possible to select better brood stocking density for GIFT tilapia hapa breeding system with the shorter cycle. Both the treatments produced fries effectively and T_2 appeared more productive significantly than the T_1. Economic analysis showed that both the treatments made profit. The net profit of T_1 and T_2 were 1500 Tk and 5000 Tk within one and half months. This meant that if a farmer produce fries in a single hapa as per T_2, S/he will earn about 1100 Tk per month. Even the farmer does not adopt this technique as commercial purposes, if S/he hold 5-6 broods in a hapa from his/her final crop of the last year, S/he could ensure seed needs for own cages.

CAGES Farm is conducting a trial on GIFT fry raising in cages using different density and feeds. If the information are available, sufficient information will be generated on GIFT tilapia breeding and nursing i.e. will fullfil basic needs of cage operators in this regard.

The trial experience suggested that tilapia hapa breeding techniques are simple and easy manageable to the operator. This hapa-based breeding system may afford greater efficiency in the dissemination of GIFT tilapia fry to the farmers.

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Appendix I: Cage costs

Item	Qty.	Rate (Tk.)	Cost (Tk.)
Brood cage			
Net	21m	25/m	525
Making charge	-	-	40
Bamboo	2p	50/p	100
Plastic rope	-	-	20
Bamboo basket	-	-	30
Polyester cloth sac for bamboo basket	-	-	20
Total	-	-	735
[3]Depreciation cost (Tk.)	-	-	138
Fry cage	9m	25/m	225
Bamboo	2.66 p	30/p	80
Plastic rope	-	-	15
Earthen tray	2p	5	10
Total	-	-	330
Depreciation cost (Tk.)	-	-	62

Appendix II: Proximate composition analysis (dry matter basis) of farm made feeds for fries

Dry matter (%)	Protein (%)	Lipid (%)	Ash (%	Fibre (%)	NFE (%)
87.6	40	8.5	20.3	6.1	25.2

Appendix III: Proximate composition analysis of commercial pellets

Sample	Moisture (%)	Protein (%)	Lipid (%)	Ash (%)	Fibre (%)	NFE (%)
SBFF	8.92	21.99	11.18	15.52	9.17	33.22

SBFF means Saudi-Bangla Fish Feed, Grower and NFE means Nitrogen Free Extract.

Appendix IV: Ingredients percentage in fry feeds in wet matter basis

Ingredient	Percent
Auto rice bran	4.9

[3] Cage epreciation has been estimated considering durability 8 months.

Mustard oil cake	24.8
Broken rice	5.1
Fish meal	47
Flour	10.1
Wheat bran	8.1

Feed cost: Dry matter basis-20 Tk/Kg, Wet matter basis-17.8 Tk/Kg.

Appendix V: Treatment wise fry production during the experimental periods

Date	T_1	T_2
4/18/98	5953	9164
4/26/98	2210	12112
5/4/98	8184	21706
5/11/98	9396	12065
5/18/98	7516	24804

Appendix VI: t-Test, Two-Sample Assuming Equal Variances

T_1	T_2
5953	9164
2210	12112
8184	21706
3315	4473
2173	6230
3908	1362
1445	5553
5845	9785
226	9466

Note: First 3 observations are treatment production and rest are cage production.

	Variable 1	Variable 2
Mean	3695.444444	8872.333333
Variance	6460015.278	33778506.25
Observations	9	9
Pooled Variance	20119260.76	
Hypothesized Mean Difference	0	
df	16	
t Stat	-2.448325134	
P(T<=t) one-tail	0.013130312	
t Critical one-tail	1.745884219	
P(T<=t) two-tail	0.026260623	
t Critical two-tail	2.119904821	

R9810

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CAGES PROJECT

Freshwater Prawn *Macrobrachium rosenbergii* In Cages: The Effect Of Different Substrates/Structures On Recovery rates & The Effect Of Stocking Density On Growth Performance

Prepared By
SM Nurun Nabi
CAGES Farm & Training Centre
Bausiaghat, Gazaria, Munshiganj
July, 1998

Titles

Experiment I: The Effect Of Different Substrates/Structures On Cannibalism By Freshwater Prawn *Macrobrachium rosenbergii* In Cages

Experiment II: The Effect Of Stocking Density On Growth Performance Of Freshwater Prawn *Macrobrachium rosenbergii* In Cages

Objectives

?? To assess whether different substrates can reduce cannibalism of prawn or not.

?? To assess the economic viability of different substrates.

?? To assess the suitable stocking density for prawn rearing.

Significance

CAGES Farm conducted the trial in a single cage on freshwater prawn rearing fed on mainly snails to asses the growth and profitability of the system. This trial was non profitable due to poor growth and cannibalism. The assumption was made that if sufficient shelter was present in the cage, cannibalism could be reduced at significant level. Moreover, suitable stocking density for prawn rearing in cages, have not been investigated by CAGES (Cage Aquaculture For Greater Economic Security). These trials will asses the potential of using different substrates in cages to reduce cannibalism by prawn and will identify the suitable stocking density for prawn rearing in freshwater for resource poor farmers.

The trials were conducted from 6 April '98 to 4 June '98 for a period of 60 days. This report will illustrate the results obtained from the experiments.

Methods and Materials

Study area

The experiments were carried out in the Meghna-Gomti river close to the Japan-Bangladesh Friendship Bridge at CAGES Farm & Training Centre.

Experimental Design

Table I: Experiment I

Treatment	Replicate
T_1 : Cage with fine mesh sac	1
T_2 : Cage with fine mesh sac + wooden box	1
T_3 : Cage with fine mesh sac + wooden box + tree branches	1
T_4 : Cage with fine mesh sac + tree branches	1
Total	**4**

Table II: Experiment II

Treatment	Replicate
T_1 : Stocking density 50 prawn/ m^2	1
T_2 : Stocking density 75 prawn/ m^2	1
T_3 : Stocking density 100 prawn/ m^2	1

T_4 : Stocking density 125 prawn/ m^2	1
Total	**4**

Cage and substrates construction
Eight $1m^3$ sized floating cages, made of knotless black polyethylene net having 8 m.m. mesh with a box type iron frame were used in this trial. The cage bag was stitched with iron frame by tire cord. Four floats were attached at the four top corners. At the top of the cages was a net cover fitted over an iron frame that acts as door to collect prawn during sampling. In the experiment I, 1x1x0.25 m fine mesh sac was set on the bottom like inverted mosquito net, 0.95x0.95x0.1m wooden structure (see appendix V and figure II), two date-palm tree branches were used as per treatment structures. For the experiment II, fine mesh sac, wooden structure and two date-palm tree branches were used as shelter on the bottom of the all cages.

Origin of prawn fingerlings
Prawn larvae (PL_6) were collected from FMS low-cost prawn hatchery. These larvae were reared in an experiment and after end of that trial fingerlings were used for these trials. The age of these fingerlings about six months at stocking.

Stocking of prawn fingerlings
The prawn fingerlings were stocked on 6 April '98 at density 50 prawn/m^2 for the trial I and for the trial II stated in the treatment structures without replication.

Feed formulation and feeding
The feed 0% crude protein was composed of oil cake, auto rice bran, broken rice, wheat bran, wheat flour and fish meal . Containing as this needs it in the "fish meal" that contains 40% crude protein. The composition of feed ingredients were determined by a spreadsheet program where data of proximate analysis of different ingredients were used. Wheat flour was cooked with water (25%-30% of total feed weight) for 15 minutes then mixed with rest ingredients by hand and pelleted by a electrical pelleter with 2mm diameter die. Wet pellets were dried in the sun for about 2 hours under a shade, made of transparent polyethylene sheet to reduce degradation of ultra violet ray sensitive vitamins. Feeds were applied in the two earthen trays placed on the bottom of the each cage by rope. Feed was distributed 2-3 times in a day at 9 am, 14 pm and 18 pm. Feed ration was distributed @ 4-5% of the body weight.

Cage management
The cage was checked weekly for holes during cage cleaning activities. The date-palm tree branches were replaced after one month use as it decomposed.

Growth monitoring
While stocking and harvesting, all prawns were weighed and measure individually by digital balance (Ohrous, 0.1g accuracy) and a ruler respectively. During sampling 30% prawns in each cage were weighed and measured using the same procedure and average weight computed.

Termination of the trial
The fish were harvested on 4 June '98 and the trial ended.

Feed sample analysis
Individual feed ingredients were send to Faculty of Fisheries, Bangladesh Agricultural University and proximate composition was analyzed separately. Then proximate analysis of feed was formulated through spreadsheet program using result of single ingredient analysis.

Economic analysis
Actual price of wooden structures and tree branches were used. Depreciation cost of wooden structures have been estimated based on assumption. The economic feasibility for the use of different substrates has been estimated among treatments vs control (T_1).

Environmental monitoring
Only temperature and ammonium data has been collected and analyzed.

Temperature
Temperature reading has been taken from location within farm at surface depth (< 30 cm) at 0700 hr. and 1500 hr. daily by digital meter. The daily data from different times were averaged weekly.

Ammonium (NH_4^{++})
Ammonium data has been collected from cage mid water and out side of cage at same depth once in a week at 9 am by test kit (model Aquaquant® 14423 Ammonium) and recorded.

Production calculation

Net production, food conversion ratio, specific growth rate, recovery rate and return on investment were obtained from the following formula.

Net production = Final wt - Initial wt

$$\text{Food conversion ratio} = \frac{\text{Feed given}}{\text{Weight gain of prawn}}$$

$$\text{Recovery rate} = \frac{\text{No of prawn at the harvesting}}{\text{No of prawn at the stocking}} \times 100$$

$$\text{Specific growth rate} = \frac{\ln(\text{Final body wt}/\text{Initial body wt})}{\text{Duration of time (days)}} \times 100$$

$$\text{Return on per cycle investment} = \frac{\text{Total sale- per cycle investment}}{\text{Per cycle investment}} \times 100$$

Results and Discussion

Water quality

The temperature ranged from 26.4^{0}c to 34^{0}c during the experiment. The ammonium was found <0.2 ppm from within cage and out side of cage for the experimental periods.

Experiment I
The highest recovery rate obtained from T_3 (90%) followed by T_2 (86%) and T_4 (82%) and the lowest was at T_1 (78%) (Table IV and figure) . The reason might be T_3 and T_2 created enough enabling shelter for prawn during molting. The lower FCR was gained at T_3 (3.22) followed by T_2, (3.67) T_4 (3.92) and the highest at T_1 (4.25). The reason might be lower recovery rate of the respective treatments. The SGR was found similar at all treatments.

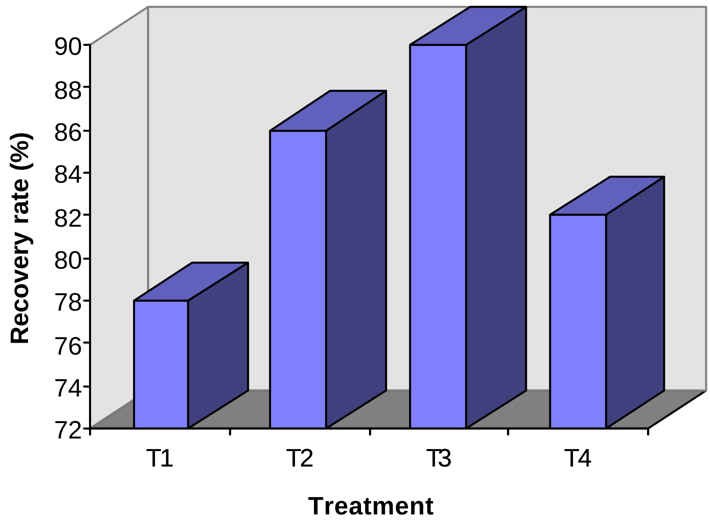


Figure I : The recovery rates of prawns at different substrates in cages for the experimental periods.

Table IV: The growth evolution of the two experimental prawns over a sixty day period

	Experiment I				Experiment II			
	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
Stocking	50/m^2	50/m^2	50/m^2	50/m^2	50/m^2	75/m^2	100/m^2	125/m^2
Average length (cm) s.d. (?)	7.81 0.62	7.86 0.62	7.70 0.73	7.86 0.68	6.34 0.69	6.34 0.63	6.82 5.51	6.08 0.60
Average weight (g) s.d. (?)	3.66 0.89	3.74 0.94	3.61 1.18	3.81 1.07	1.76 0.55	1.91 0.59	1.87 0.63	1.66 0.55
Biomass (Kg/m^2)	0.18	0.19	0.18	0.19	0.09	0.14	0.19	0.21
Harvesting								
Average length (cm) s.d. (?)	10.32 0.87	10.16 0.88	9.98 1.08	10.30 0.88	9.26 1.07	8.66 1.12	8.65 3.67	8.58 0.99
Average weight (g) s.d. (?)	8.67 3.01	8.63 2.37	8.59 3.29	9.03 2.83	6.54 2.63	5.29 2.16	4.87 2.56	5.31 2.35
Number/m^2	39	43	45	41	43	68	87	[4] 61
Net production (Kg/m^2)	0.16	0.18	0.21	0.18	0.19	0.22	0.24	0.12

[4] Cage hole has been found, so prawns might be escaped.

Gross production (Kg/m^2)	0.34	0.37	0.39	0.37	0.28	0.36	0.42	0.32
FCR	4.25	3.67	3.22	3.92	2.23	2.78	3.37	7.29
Recovery rate (%)	78	86	90	82	86	91	87	49
SGR (%)	1.44	1.39	1.44	1.44	2.19	1.69	1.60	1.94

Experiment II
The regression of yield on stocking density was performed for different treatments except T_4. Because prawns might have escaped from T_4 through the cage hole. The regression of weight increment (g/prawn) on different stocking densities showed that weight increment decreased with the increasing of stocking density (appendix I). The regression coefficient of yield (g/prawn) on stocking density was determined -0.0356. This regression coefficient suggested that if the stocking density increase at 100 then the average weight increment will decrease at 3 g/prawn. The equation can be expressed as:

Yield (g/prawn) = 6.395344 -0.0356 X (stocking density)
However, the regression of net production (Kg/m^2) on stocking density indicated that the net production increased for the increasing of stocking density (see appendix II) and the regression coefficient was estimated 0.00087. This result suggested for each increase at 100 prawns/m2 net production will increase by 0.087 Kg. The equation is to :

Net production (Kg/m^2) = 0.1505 + 0.00087 X (stocking density)

The FCRs were gained from 2.2 to 7.3 for different treatments. Reasons might be mortality and escape of prawns during the trial periods. The SGR gradually decreased with the increase of stocking density except T_4. Reason may be prawn grow well at lower densities. Reason for better SGR of T_4 might be escape of smaller prawns through the small hole.

Economics
The economic analysis was performed among treatments against control (T_1) for the experiment I. The results indicated that use of substrates in cages for growing food prawn made losses (see Table V) and the highest loss was estimated from T_3 though the recovery rate of this treatment is highest. However, the highest profit was estimated for T_3, followed by T_2 and T_4 if only the increased production sale as fingerlings. This suggested that substrates could be useful for fingerlings raising as the price of fingerlings is higher.

Table V: Economic feasibility for the use of substrates in different treatments

	T_1	T_2	T_3	T_4
Substrate depreciation (Tk)	0.00	8.88	12.88	4.00
Net production (Kg/m^2)	0.16	0.18	0.21	0.18
Recovery number/m^2	39	43	45	41
[5]Increased net production (Kg/m^2) compared with T_1	-	0.03	0.05	0.02
[6]Increased net production (number/m^2) compared with T_1	-	4	6	2
Economic value of increased production as food prawn(Tk)	-	4.36	7.62	3.72
Economic value of increased production as fingerlings(Tk)	-	20.00	30.00	10.00
Net profit from sale as food prawn(Tk/m^2)	-	-4.51	-5.26	-0.28

[5] Sale price of prawns =150 Tk/Kg
[6] Estimated price of fingerlings = 5 Tk/piece

Net profit from sale as fingerlings (Tk/m^2)	-	11.13	17.13	6.00
Return on investment for sale as fingerlings	-	125	133	150

Conclusion

The different substrates/structures can increase recovery rates using in the cages. The contribution of substrates appeared nonviable in terms of economics for selling prawn as food. However, the systems were profitable for selling prawn as fingerlings. This suggested that substrates could be used for raising larger fingerlings in cages. Considering availability and cheapness, date-palm tree branches could be recommended as prawn shelter for rearing fingerlings in cages though highest return was gained from T_3.

The regression of net production (Kg/m^2) on stocking densities suggested that net production increases with the increasing of stocking densities. However, The regression of weight increment (g/fish) on stocking densities indicated that mean weight of prawn decreases with the increasing of stocking densities. This also suggested that the necessity of choice suitable stocking density for growing prawn in cage. The choice of stocking density could be in respect to objectives of the practice i.e. food or fingerlings production. About 50 prawn/m^2 and 100 prawns/m^2 can be stocked for growing food prawn and large fingerlings respectively.

Appendix I: Regression of yield (weight increment, g/prawn) on different stocking densities

Regression Statistics	
Multiple R	0.948384076
R Square	0.899432355
Adjusted R Square	-3
Standard Error	0.421821813
Observations	1

ANOVA					
	df	SS	MS	F	Significance F
Regression	3	1.591359474	0.530453158	8.943555918	#NUM!
Residual	1	0.177933642	0.177933642		
Total	4	1.769293116			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.000%	Upper 95.000%
Intercept							3.6449E+206	-3.6449E+206
X Variable 1							-1.3325E+140	1.3325E+140
X Variable 2	6.3953444	0.927368644	6.896226797	0.091675229	-5.38794088	18.17862986	-5.38794088	18.17862986
X Variable	-0.0356804	0.011930923	-	0.20543429	-	0.11591574	-0.187276448	0.115915743

3			2.990577857	7	0.187276448	3		

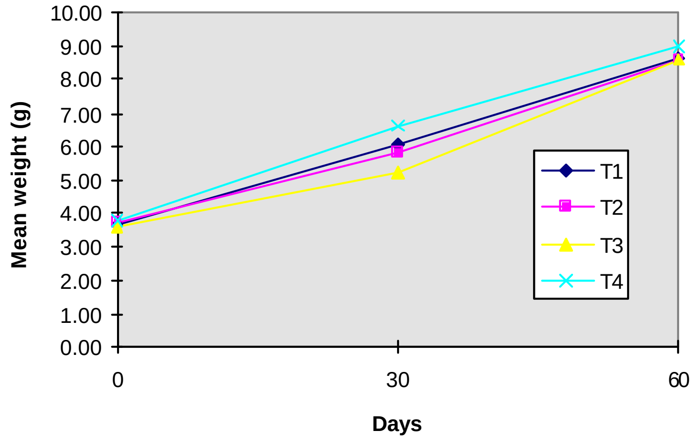
Appendix II: Regression of yield (net production, Kg/m^2)on different stocking densities

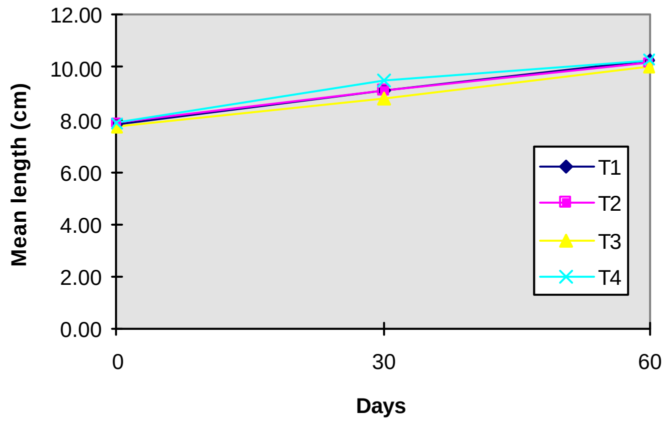
Regression Statistics	
Multiple R	0.999608207
R Square	0.999216568
Adjusted R Square	-3
Standard Error	0.000857321
Observations	1

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.000937445	0.000312482	1275.435374	#NUM!
Residual	1	7.35E-07	7.35E-07		
Total	4	0.00093818			

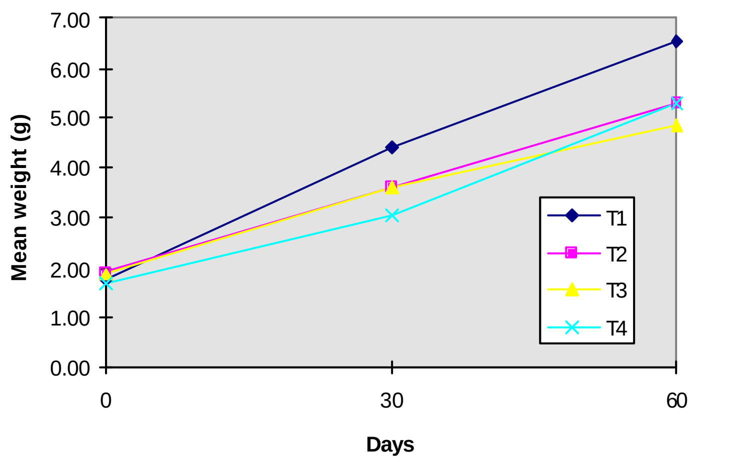
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.000%	Upper 95.000%
Intercept							-8.328E+11	-8.328E+11
X Variable 1							-2272.633	-2272.633
X Variable 2	0.1505	0.001885	79.8225	0.00798	0.1265014	0.174399	0.12650	0.174399
X Variable 3	0.00087	2.425E-05	35.7133	0.01782	0.000558	0.001174	0.0005579	0.001174

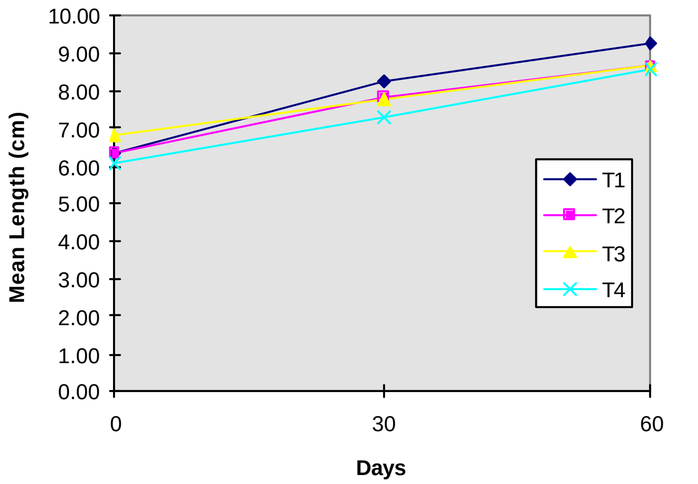
Appendix III: Mean weight and length for the experiment I


Mean weight (g)
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0
30
60
Days
T1
T2
T3
T4


Mean length (cm)
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
30
60
Days
T1
T2
T3
T4

Appendix IV: Mean weight and length for the experiment II





Appendix V: Plan of wooden substrate

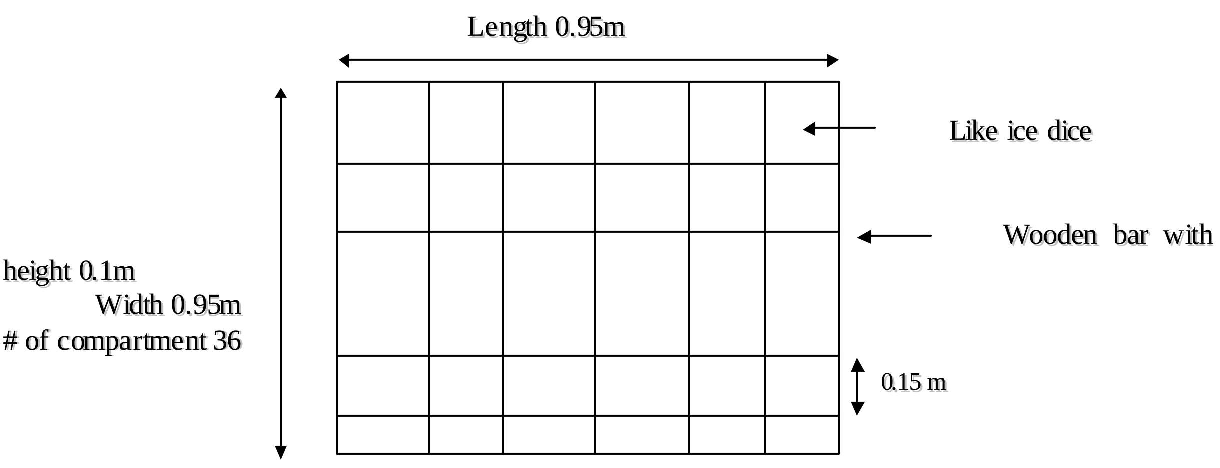


Figure II: Top view of wooden structure/ substrates used for the experiment I.
Appendix VI: Substrate construction costs

	Total costs (Tk)	Durability (month)	Depreciation cost (Tk)
[7]Wooden structure	71	8	8.9
Date-palm tree branches	2	1	4

Appendix VII: Proximate composition analysis (dry matter basis) of farm made pellets

Dry matter (%)	Protein (%)	Lipid (%)	Ash (%	Fibre (%)	NFE (%)
87.6	40	8.5	20.3	6.1	25.2

Appendix VIII: Ingredients percentage in feed[8] in wet matter basis

Ingredient	Percent
Auto rice bran	4.9
Mustard oil cake	24.8
Broken rice	5.1
Fish meal	47
Flour	10.1
Wheat bran	8.1

[7] Two and half orange wooden packets were required for one wooden structure, each packet = 15 Tk, Labour cost = 30 Tk, iron nail = 3 Tk.
[8] Feed cost: Dry matter basis-20Tk/Kg, Wet matter basis-17.8 Tk/Kg.

R9812

High Density Pangash, *Pangasius sutchi* Culture in Cage

S.M. Nurun Nabi

A trial on "culture of pangash in floating cage" was carried out at density 100 fish/m^3 fed on commercial pellets (Saudi-Bangla fish feed grower) at CAGES Farm & Training Center reported in 1997. The trial produced 71Kg fish/m^3 and made net profit about 4500 Tk. (return on per cycle investment 172%) for 11 months.

This trial was conducted to assess the feasibility of high-density pangash culture in cage with quality feed. Total 350 fish were stocked on 25 July '97 having average weight 3.5g in a 1m^3 floating cage made of black polyethylene net (8mm). The bottom part and 0.25m of the 4 side walls were covered by fine mesh bag (1x1x0.25m) to prevent feed loss through the cage during feeding. The cage was replaced on 26 April '98 as total biomass was estimated at about 60Kg (estimated) by a similar cage having 13mm mesh. Large mesh size increased water flow through the cage, allowing increased carrying capacity. The commercial pellets (Saudi-Bangla pangash feed, 30% protein) were fed at satiation level, daily at 9am and 4pm, by sprinkling on the top of the cage slowly. After 15 days to stocking, the cage had to clean up setting the cage. At this time, fish were injured when they scaped against the rough top cover of the cage. As a result, fungal disease appeared on the fish mouth parts caused severe mortality about 64% and healthy fish did not eat the feeds. On 21st August '97, 48 fish estimated total weight 275g were restocked in the cage. Therefore, the density reached at 200 fish/m^3 after mortality and restocking. The 155.6Kg fish were harvested on 6.9.98 over the 407day of experimental period with average weight 1215g. The survival rate was gained 65 of restocking. This survival rate influenced by the disease. The Ulcerative disease appeared on 18.11.97. Firstly, all fish were bathed with mixture of methylene blue and water (0.15ppm) and secondly antibiotic was fed to fish as methylene blue was less effective. When fish attacked by disease, their feeding response reduced dramatically (personal observation). The antibiotic (Tetracycline) was fed to fish to the ratio of 10 to 15 mg for per Kg fish for 20 days. The feeding techniques were: a. required medicine was inserted in the flour ball and fed to infected fish one by one b. antibiotic was mixed with feed ingredients during feed preparation and. The required tetracycline was estimated based on the assumption that the fish will feed at the rate of 4% of their body weight. So each Kg fish will take 40g feeds. Therefore, 40g pelleted feeds contained 10-15mg tetracycline. The feeds spreaded on the top of the cage slowly and the fish ate the feeds at surface.

The fish recovery rate was comparatively less than the previous trial conducted by CAGES. However, the production gained 155.6 Kg which, more than double compared with previous trial (71 Kg). FCR was not estimated due to high mortality found.

Lessons learnt from this trial

? ? The fish grow well at density 198 fish/m3 at reached at average weight 1.2 Kg for 407 days.
? ? The fish attacked by disease during winter at high density/biomass.
? ? Pangash can be cured from Ulcerative disease fed on tetracycline for 15 to 20 days at ratio 10-15mg per Kg fish.
? ? The fish can be injured by the rough black polyethylene net which caused severe mortality. Therefore, the cage could be installed in the water 5 to 7 days prior to the stocking for depositing algae on the net.

- ? ? Feeding behavior of the fish is changed due to handling stress.
- ? ? The carrying capacity of the cage could be increased with the increase of cage mesh size.