Fish Fingerling Production in Cages by Ultra-poor Households in the Northwest Region of Bangladesh – Technical and Institutional Issues

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1 INTRODUCTION

Background

Majority of the households in the *Adivasi* communities are poor, landless and they are the most disadvantaged group of people in Bangladesh. They have limited resources of their own to carry out production activities to get earnings for maintaining their normal livelihoods. Most of them mainly depend on seasonal agricultural labour for their income earnings with minimum involvement in other income earning activities. However, both men and women members of the *Adivasi* households are hard working, women can involve directly in agricultural activities with minimum social barriers. Further, there is a strong solidarity among the households in the *Adivasi* communities. Considering their poor economic condition and taking the hard works and solidarity as an advantage it is very important and timely initiative to involve *Adivasi* households in alternative income earning activities to improve their livelihoods.

Many of the landless *Adivasis* live on the embankment of government *khas* ponds or privately owned ponds. Normally the *khas* ponds leased out and lease use the ponds for fish culture although, the households living in the embankments use the ponds for household uses (washing, bathing). In some places there are Settlements of landless poor households (including *Adivasis*) on the dikes of large *khas* ponds established by the Government called '*Adarsha Gram* or *Guccha Gram*'. There is very high potential to involve the poorest households of the *Adarsha Gram* in cage based fingerling production. In some cases the rich private pond owners allow the settlement of the poorest *Adivasi* households in embankments of their ponds as they feel that their presence will be useful for them get agricultural labour, will of importance to get security of their fish in ponds. In most cases *Adivasi* households are trustworthy to the owners of ponds. This 'trustworthiness' work as social capital for the *Adivasi* households to get access for setting up cages in their ponds to get alternative income earning. In hilly and floodplain areas of Bangladesh there is presence of reservoirs, braches of rivers/canals with great scope for cage aquaculture to do fingerling production.

Fish culture in cages is not a new technology however; use of cages for production of fingerling is new in Bangladesh. Bangladesh has huge volume of waterbodies; rivers, irrigation canals, floodplains, *baors* (ox-bow lakes), reservoirs and ponds distributed throughout the country with potential for fish culture in cages. Culture of fish in cages has certain advantages over other aquaculture systems that are of importance to uptake by rural poor even by the extremely poor landless households. The complementarity of the cage technologies especially fingerling production to the grow-out systems where it set up is useful opportunity to get access for setting cages by the non-owners of waterbodies. Getting access to waterbodies with minimum investment even the landless (*Adivasi* and *non-Adivasi*) households can do fingerling production in cages and get income earning.

The European Commission funded Adivasi Fisheries Project is implementing by the WorldFish Center in collaboration with Caritas Bangladesh and the Bangladesh Fisheries Research Forum (BFRF) from January 2007 to December 2009 for 3 years involving the ultra-poor *Adivasi* households in aquaculture and aquaculture related activities. Of different aquaculture

technologies, fingerling production in cages in private/leased ponds close to the homesteads of landless Adivasi households living on the dikes of the ponds for getting extra income was tried. The technology of production of fingerling in cages in ponds/canals is new to the *Adivasi* households although, the earlier on-station and on-farm trials carried out in NFEP farm at Parbatipur and with poor households in different areas of NW Bangladesh showed very encouraging outcomes.

In order to make this technology effective to produce fingerlings by the poor *Adivasi* households, specific knowledge about the use of the technologies in their context and institutional issues related to access to water bodies (belongs to others) the cages set up are important. This action research was designed in order to understand the specific technological and institutional aspects of cage based fingerling production to be carried out by the *Adivasi* households in different areas of NW Bangladesh under the Adivasi Fisheries Project. The purpose of the research was to get the important outcomes to feedback the staff in the field for dissemination to the households involved in fingerling production in cages. The aim is that households can use the technology with greater effectiveness for achieving higher level of fingerling production and income. The outcomes of the research will also be of importance for further promotion of cage based fingerling production to *Adivasi* as well as the non-*Adivasi* poor households in a NW region and in other parts of Bangladesh with having greater potential.

Objectives of the Study

Thus the main objective of this action research is to enhance skills and knowledge of the field staffs working in the project and ultimately the households for effective management of cages for fingerling production to achieve maximum benefits. The specific objectives of the research were:

1. To review in general cage aquaculture and specifics on fingerling production in cages based on available literature

2. To identify potentials and constraints in involving landless *Adivasi* households in fingerling production in cages in ponds

3. To get understanding about the technical factors in brining success to fingerling production in cages by the *Adivasi* households

4. To know about the institutional issues require to use cages for fingerling production and

5. To develop guidelines on best management practices for fingerling production in cages for the *Adivasi* households *in the* project areas.

2 LITERATURE REVIEW

In 1991-1992, the DFID funded Northwest Fisheries Extension Project of DoF in collaboration with CARE started cage culture in the NW region of Bangladesh. The target groups were women, the technology showed some initial success but because of several reasons not sustained for longer period. The following were the major constraints for poor success and less sustainability of the foodfish production in cages, some projections on how to overcome such constraints to make cage fish production a success also included in this review: (1) It is important to get cage materials of low cost and the with minimum investment the cage can be made (earlier time cage materials were mainly produce outside Bangladesh and were imported having very high price, however, cage materials now produce in Bangladesh, are cheaper and even with an investment of Taka 300-400 using local materials (mainly bamboo frame and use of used water bottle as float a cage of $1m^3$ size can be build). (2) The second most important component to get success in the foodfish production from cages is to get supply of quality fingerlings of fish species suitable for the cages (Nile tilapia, silver carp, bighead carp, grass carp etc). In most cases in earlier times when it was tried fingerlings of large size of suitable species were not available, it required to get supply of fingerling from long distance sources with high price (e.g. during recent visit to Sunamgonj it came out that the NGO Intercoperation has promoted cage by the beneficiaries in a river to produce foodfish of monosex tilapia – those farmers subjected to huge lose initially due almost total mortality of the fingerlings due to long distance transportations stress). However if the supply of good size fingerlings came from local sources (rice fields, cages – from farmers producing fingerlings using DS approach) such problems can be easily reduced. Other important constraints in low level of success or less benefits from food fish production in cages is problems in feed supply. For poor farmers it is very difficult to buy feeds of good quality to feed the fish on regular basis. However, the cost of the feeds now can be reduced using cages in ponds or water bodies with productive waters and also shifting the use of cages from foodfish to fingerling production which requires less time and for species like tilapia and silver carp in productive ponds required very limited supply of feed from outside (because they can use the natural feeds presence in the pond very effectively).

Silver carp is one of the major species cultured both in perennial and seasonal ponds in Bangladesh. The Nile tilapia (*Oreochromis niloticus*) is found to be popular to people with higher performance almost similar to silver carp is the most suitable species for culture in seasonal ponds in polyculture with other species (Barman et al 2000). Earlier trials on fingerling production of silver carp and tilapia in cages showed good outcomes in terms of production and uses. Breeding of Nile tilapia in *hapas* in ponds and nursing of swim-up fry in *hapas* in ponds in on-farm trials with the poorest farming households in NW Bangladesh also showed encouraging outcomes (Barman 2000). Cage farmers used silver carp and tilapia mainly for fingerling production in their cages. Farmers use silver carp and tilapia due to higher efficiencies of fish to use natural feeds produce in ponds through fertilization with less or no requirement of supplementary feeds from outside. Further there are higher demands of silver carp and tilapia to farmers for grow-out to foodfish especially in seasonal systems. Integrating fish with rice cultivation has an enormous potential in Bangladesh (Barman *et al*, 2006). Fish in this system are mostly considered as an incremental benefit with little marginal investment cost. One of the

important elements to bring success in rice fish culture is to make availability of quality fingerlings to farmers. In this case large size quality fingerlings produce in cages in ponds can be the useful to get success in rice fish culture.

In a country like Bangladesh where land is scarce, effort should be taken to increase production through integration of various production systems like animal-cum-fish, rice-cum-fish culture or cages for efficient utilization of available resources and maximization of production of diversified products, from a minimum area, which will increase the income of the farmers and would enhance food production. Schmittou *et al.* (1998) described that world aquaculture production is increasing at an average annual rate of over 10%, while fish production from world capture appears to be stabilized. The aquaculture production could increase at a great rate by accelerating production intensity, increasing the area of conventional aquacultures. Conventional aquacultures in inland and coastal ponds are becoming more intensive, but increasing pond area is capital intensive and high competitive with other land uses. In this case fish production in cages can be the affordable means of fish production. It has increased technical ecological, social and economic advantages over capture fisheries and the conventional aquaculture production.
Salam *et al,* (2004) described the cage culture potential in open water in rainy season to improve the livelihood of poor and marginal farmers in Bhaluka Upazilla, Mymensingh, using GIS as a tool. The study identified 2,755 ha very suitable and 59,113 ha moderately suitable seasonal waterbodies at the Bhaluka Upazilla with cage culture potential. Cage aquaculture is playing an increasingly important role in the world foodfish, not only for its high market value for marine species, such as salmon, but also for the more ubiquitous carps and tilapias. Moreover, there is growing awareness that the possibilities offered by cage aquaculture have only begun to be explored. Cage can provide low-cost alternative to conventional land-based nurseries and may be employed in culturing even, fast-swimming, pelagic species he opined (Beveridge, 1991).

The DIFD supported CARE-CAGES project tried to promote cage culture in a range of systems throughout Bangladesh with resource-poor farmers within their social, economic and institutional context. The project implemented in Barisal, Comilla, Jessore, Dhaka, Natore, Sylhet and the Chittagong Hill Tracts areas of Bangladesh. The target groups were mainly resource poor landless women (McAndrew, 2002). Although, the technology of foodfish production in cages in rivers flourished in some parts of the country showing very high potential for its promotion, the limitations may be on the use of the technology successfully by the poor. Because most cases the users are now the better off people. So, if we want to include the poorest people to get benefits directly from cage aquaculture, the use of small size cages with quick turnover period and low cost involvement will be important and in that case the use of cages for fingerling production can be the useful technology.
McAndrew *et al.* (2000) reported about the small scale cage culture promoted under the CAGE CAGES project in Bangladesh that had advantages for the poor groups. They observed that for small scale cage culture ownership of water bodies not always required**.** If the access to water bodies ensured, the poor landless groups could operate small scale cage aquaculture practices and get benefits from it. To produce table fish in cages require a relatively longer period of time from stocking to harvest which was found to be difficult poor farmers involved in cage culture. Difficulties of farmers to obtain credit and their less interest to borrow credit for cage culture were observed. They suggested that the risk of cage culture can be minimized through use of alternative approaches like nursing of fry to fingerling in cages to get return with a short period,

holding/fattening of fish in cages, over-wintering of fry in cages during winter to get return earlier in the season when the demand of fingerling very high. The participation of the resource-poor households in cage culture may be encouraged through these alternative production strategies in a more effective and sustainable way.

Bulcock *et al.* (2000) conducted an on-farm trials and social surveys of CARE CAGES project. Trials initially encompassed a wide range of topics and from the assessment of the performance. Key research topics were identified which included the culture of indigenous fish species, the performance of the various strains of Nile tilapia available for cage culture, the suitability of various materials for cage culture, *hapa* breeding of tilapia and nursery rearing of fry. The outcome has been the identification of appropriate options for CAGES beneficiaries. Risk avoidance has been identified as a major influence on choices by cage operators; this has directed research efforts towards strategies that minimize these risks.

Hambrey *et al.* (2001) carried out a study on social issues of cage culture in freshwater in Bangladesh in CARE CAGES project. He observed that small-scale cage culture is particularly suited to poverty alleviation in Bangladesh. It rates highly against a range of criteria and most significantly there are increasing signs of secondary adoption. It is not a single system technology, but a flexible package which can be adapted to the needs, capacity and resources of poor people. He opined that can generate income, nutrition and social benefits as required.

Naser (2002) reported that cage culture could bring bright future to rural poor of Bangladesh. The performance of cage culture of the beneficiaries of POSD a partner NGO of CARE-CAGES project located at Rajshahi was evaluated. It came out that beneficiaries using one cage produce Nile tilapia in a cage for 2-3 cycles in a year getting technical and financial (credit) support from the NGO with success and got benefits. Farmer earned more income from fish culture in cages than they earn from their small rice plot. One of the major problems they identified was the lack of Nile tilapia fingerling to culture fish in cages. Naser and Khatun (2007) developed a simple handbook on culture of fish in cages using questions and answers with explanations on tilapia culture technology in cages. It explained on how cages can be used in large closed water bodies (e.g. beels). The contents of the handbook includes: site selection, cage construction, rearing techniques and the economics.

Costa *et al.* (2006) evaluated the DFID funded DOF project Northwest Fisheries Extension Project (NFEP) activities in light of the successful efforts of CARE-CAGES through TROPECA project cages. Field investigation and primary data were collected from rural communities of Chirirbander in Dinajpur District and Puthia in Rajshahi District. It came out that some beneficiaries of the projects continuing fish culture in cages at Pothia.

Campbell (1985) reported on large scale commercial cage culture of Nile tilapia (*Oreochromis niloticus)* in the Ivory Coast over a one year period together with efficient techniques on rearing large numbers of fry and fingerlings. Fry production from ponds was 4083 kg of fish averaging 1.7 g. A total of 30.7 MT of fish with mean weight of 14 g were produced in 110 cages (3 m^3 cages) that is 93 kg fingerling produce per m^3 cages. Using 8500 m^3 of rearing cages, over 200 MT was harvested (23.53kg fish produce per m^3). The survival of fingerling in cages was 87% and in rearing cages it was 89%. Using pelleted feed with 28% protein, food conversions were 1.75 with fish to 14 g mean weight, and 2.23 to harvest.

Natarajan *et al*., (1979) from Allahabad, India Carrie out research on raising quality fish seed in floating nurseries in cages and raising fish of marketable size in cages are reported as success. In

which carp were reared from spawn to fry stages and rear carp fry in floating nurseries (cages) in lentic waters to fingerling stage.

Amarasinghe et *al*., (2002) reported that the reservoir fisheries of Sri Lanka are almost entirely dependent on the alien cichlid species, most notably Mozambique tilapia (*Oreochromis mossambicus)* and Nile tilapia (*O. niloticus)* fish stock. Community-based cage aquaculture to rear fish fry to fingerling is a recent development in some perennial reservoirs of Sri Lanka. Fingerlings produced were used to stock in seasonal reservoirs to develop enhanced culture fisheries. Average daily growth and survival rates of fish fingerlings reared in floating net cages with feed based on fish meal from local small cyprinids showed better performance than those fed with rice bran. Their performance was more or less similar to those in cages with commercial feed. Small indigenous cyprinid e.g. *Amblypharyngodon melettinus*, Puntius *filamentous,* P. *chola* and *P. dorsalis*, which occur in high abundance in all perennial reservoirs of the country, are not exploited. They suggested to use these small cyprinid fish in perennial reservoirs of Sri Lanka to prepare fish meal as the source of animal protein for aquaculture feeds.

Middendorp *et al.,* (1991a) conducted a study on the feasibility of small-scale *hapa* culture of Nile tilapia (*Oreochromis niloticus*) as an additional income source for rice farmers in northeast Thailand. Besides being a suitable method for managing fish production in village ponds, it may generate additional income for local rice farmers. Fish were fed a commercial feed. Tilapia stocked at initial weight of 50g attained a mean specific growth rate of 1.46% of body weight per day. Market size was attained after an average rearing time of 85 days. He mentioned if smaller fingerlings are stocked, two rearing cycles will be needed to reach market size. In this way, rice farmers may increase their household income by about 20%.

Middendorp *et al.* (1991b) further studied the growth rate, feed conversion and net production of Nile tilapia in nylon hapas of 8 m^3 in Sisaket, north-eastern Thailand. He found that farmers are unaware of more intensive fish farming technologies which is not popular yet. Important prerequisites for their widespread introduction are low capital requirements and simple management techniques. He suggested that a successful introduction of small-scale *hapa* culture in village ponds, guidelines need to be developed for the appropriate technology and management. Their present study sought to develop practical stocking guidelines for hapa culture of Nile tilapia (*Oreochromis niloticus*) by investigating its growth and net production in relation to fish weight at stocking and fish density. They also recorded that a total loss of appetite of fish was observed, and especially among the large fish, mortalities occurred. It is therefore summarized that the low carrying capacity of the *hapa* was related to limiting dissolved oxygen or other adverse water quality conditions caused by clogging of mosquito nets. The projected hapa production parameters were indirectly based on this carrying capacity through the estimation of "safe" and therefore recommendable maximum fish densities.

In an attempt to rear Asian Sea Bass (*Lates calcacarifer*) in illuminating cages in the Philippines it came out that hatchery-produced sea bass fry of different initial sizes (7.2, 13.2, 15.2 mm; 15, 22 and 29 old respectively were stocked at densities between 300 and 1,500 m^{-3} in decreasing order with fish size (Fermin, 2000). Nylon net cages of 1 m^{-3} set in a protected sea cove area were individually lit at 300 lux using incandescent bulb placed at 1 m above water surface. Artificial lights attract wild zooplankton that served as prey to young sea bass. After 42 days of

culture 22-day old sea bass fry with 13.2 mm TL initial size and stocked at 400 m^{-3} showed the highest growth (35.3 mm TL, 535.7 mg BW) and survival rates (64.4%). At a stocking density of 800 m^{-3}, the survival rate was the second highest at 43%. Although day 15- fry at 7.2 mm TL initial size showed higher specific growth rates (11 % day^{-1}) and size at harvest (29-31 mm TL, 346.2-374.4 mg BW), survival rates (11-15 %) were lower than the day 22- and 29-fry (30-64%). Calanoid copepods of the genus *Calanus*, *Paracalanus* and *Acartia* dominated the diet (81-90%) of sea bass at different size groups. Percentage numbers of shooters ranged from 0.5-1.4% of total stocks and were not significantly different among treatments. The present results indicate that sea bass should spend 21 days in the hatchery prior to nursery rearing in illuminated sea cages. Sea cages are inexpensive and found to be more cost-effective than ordinary cage or earthen pond for sea bass fingerling production.

Rearing of common carp (*Cyprinus carpio*) fry to fingerlings in specially fabricated pans was attempted, adopting improved method of manuring (Jayaraj *et al.*1998) in Karnataka, India. Fry of common carp of 0.15 g attained to fingerling size of 6.8 g within 14 days of rearing with 725 survival rate. Better survival and faster growth of fry to fingerlings in attributed to high zooplankton production in pens.

Inslee (1977) in a novel attempt for holding striped bass larvae in cages until swim-up stage found that mean production for a 3 yr period from ponds stocked with fry held in cages was better than other methods. The success of holding cages resulted in a substantial saving in manpower as constant care of fry was not needed. The cage holding method is only one of many facets of striped bass rearing and is only a contributing factor to high production, not a critical factor such as the quantity and quality of food available. This technique would apply to those situations where unsuitable temperature, turbidity or limited facilities make the tank or aquaria method impractical.

Bombeo *et al*. (2002) in the Philippines studied the growth and survival of hatchery-bred Asian catfish, *Clarias macrocephalus*, fry reared at different stocking densities in net cages suspended in tanks and ponds. The stocking densities used were 285, 571 and 1143 fry m^{-3} in tanks and 114, 228 and 457 fry m^{-3} in ponds. Fish were fed a formulated diet throughout the 28-day rearing period. Generally, fish reared in cages in ponds grew faster, with a specific growth rate 10.3-14.6% day^{-1}, than those in cages suspended in tanks (SGR 9.0-11.3% day^{-1}). This could be attributed to the presence of natural zooplankton (copepods and cladocerans) in the pond throughout the culture period, which served as additional food sources for catfish juveniles. In both scenarios, the fish reared at lower densities had significantly higher SGR than fish reared at higher densities. In the pond, the SGR of fish held at 228 and 457 m^{-3} were similar to each other but were significantly lower than those of fish held at 114 m^{-3}. The zooplankton in ponds consisted mostly of copepods and cladocerans, in contrast to tanks, in which rotifers were more predominant. Per cent survival ranged from 85% to 89% in tanks and from 78% to 87% in ponds and did not differ significantly among stocking densities and between rearing systems. In conclusion, catfish nursery in cages suspended in tanks and ponds is density dependent. Catfish fry reared at 285 m^{-3} in tanks and at 114 m^{-3} in ponds had significantly faster growth rates than fish reared at higher densities. However, the desired fingerlings size of 3-4 cm total length for stocking in grow-out culture can still be attained at stocking densities of 457 m^{-3} in nursery pond and 571 m^{-3} in tanks.

Otubusin and Ifili (2000) studied the growth response of catfish (*Clarias gariepinus*) fry in Nigeria. With the mean initial weight, 0.62g stocked at 20 fish per hapa ($0.75m^{-3}$ water capacities) and fed plankton, frozen maggot and 35% pelleted feed under a completely randomized design, replicated twice was studied for six weeks. Fish fed frozen maggot only recorded the best mean final wt. (7.17g); best mean daily weight gain (0.155g/d), best specific growth rate (5.72% per day), best relative weight gain (1003.1%) and best feed conversion ratio (0.32). Frozen maggot was highly recommended for catfish fingerling production in net hapas as a cheaper, more efficient alternative to the scarce and expensive conventional fish feed ingredients.

Zamal (2004), attempted small scale cage culture of grass carp (*Ctenopharyngodon idella*) by using locally available terrestrial grass and aquatic vegetation as fish feed with marginal poor beneficiaries. The experiment was conducted for 6 months. Overall mortality was very low. At the end of six month a significant amount of fish growth was recorded. He concluded that cage culture of grass carp using aquatic vegetable is profitable.

Hossain *et al.,* (1986) conducted an experiment in bamboo made cages in the Brahmaputra River for a six months February - July 1977. Fish species rohu (*Labeo rohita),* mrigal *(Cirrhinus cirrhosus),* magur *(Clarias batrachus),* shing *(Heteropneustes fossilis),* koi *(Anabas testudineus),* shoal *(Channa striatus) and* mossambique tilapia *(Oreochromis mossambicus) were used for stocking*. Mozambique tilapia *showed fast growth rate* (70% by length: 282% by weight) and the grow rate was lowest for magur. The growth rate of rohu was intermediate (50% by length; 165% by weight), for shing and koi the grow rate was very unsatisfactory however the shoal died. Supplementary feeds (24% crude protein and 7.1% fat) were fed to the fish in cages.
Haque *et al.,* (1988) reared Shingi (*Heteropneustes fossilis*) in floating net cages for a period of 180 days. The stocking densities were 25, 50, 75, and 100 fish/m^3 using common supplemental diet. Among the four density groups better production were observed in 75 and 100 fish/m^3.

Tilapia is one of the major cultured species in cages in the Philippines (Baluyut, 1992). The paper also discussed the role of tilapia in the management of inland waterbodies in the Philippines, examining in particular the status of the local cage culture industry, especially in Laguna de Bay. Cage design and construction, operation and management, and also tilapia fry and fingerling production are considered. A case study was presented for the continued utilization of tilapia in the freshwater fisheries development of the country. Cruz and Ridha (1989) examined different production schedules for producing market-size tilapia (*Oreochromis spilurus*) in seawater cages in Kuwait. They observed that the culture of tilapia (*O. spilurus*) in sea cages can be practiced limited time from mid-April to mid-November only due to the high water temperature. They also suggested a necessary to shorten production time by adopting stocking larger fingerlings to extend the marketing period. Several fingerling production schedules were tested using fry spawned in May, August and December. The fish were initially stocked and over wintered in fibreglass tanks for better survival. On 19 April 1988, the fish were transferred to one m^3 net cages at 150 fish $cage^1$ and grown to a market size (> 300 g). Results showed that fish spawned in May (normal and stunted), August and December were harvested in July, August and October and can be marketed for 125, 100 and 60 days, respectively.

Anon (1987) reported that the success of cage culture depends on the formulation of fish feed that contains an optimum level of protein and energy necessary for the growth of the fish and is also cheaper. This is also suggested that it is obviously necessary to formulate and manufacture fish feed from locally available ingredients should as the source of essential amino acids, minerals, vitamins, growth promoting substances and energy. It is also reported that low quality feed resulted in a strongly skewed weight distribution, hindered growth rate of fish and resulted in higher mortality from pathogenic bacteria infestation. For formulation of fish feed, ingredients were fishmeal, blood meal, sunflower seed, mustard oil cake, rice bran and wheat flower. It is also reported that residual, lipids of fishmeal are highly digestible for farm animals. It is revealed that fishmeal protein contained all of the ten essential amino acids as well as the eleven dispensable amino acids in sufficient amounts which in conjunction with other necessary nutrient produce balance diet. The balanced diet was prepared at the rate of fishmeal (25%), rice bran (24%) wheat flower (15%), mustard oil cake (15%), sunflower seed (7%) and blood meal (5%). Fastest growth rate was recorded in *Oreochromis mossambicus* (70.4% by length, 65.05% by weight) and lowest growth rate was noted in *Clarias batrachus* (15.20% by length, 65.05% by weight) whereas intermediate growth rate was recorded in *Labeo rohita* (49.65% by length, 65.05% by weight) and the growth rate of *Anabas testudineus* was recorded (27.20% by length, 65% by weight). From the experiment, it was concluded that the prepared feed was suitable for the culture of *Oreochromis mossambicus* in cages for their faster growth rate.

In high density condition disease break may be one of the major constraints in cages (Leong, 1992; Boonyaratpalin *et al.,* 1996). The fry and fingerlings of most species are highly susceptible to infections of protozoans, *Cryptocaryon irritans* and *Trichodina* spp. during the early stages of their introduction to brackish water floating net-cages. These infections present the most serious risk to the industry because of their high pathogenicity and resistance to conventional means of control. Many major groups of bacteria have been reported to cause disease outbreaks in farmed marine finfish's resulting in serious economic losses to the industry. Vibriosis is the commonest of all diseases in sampled fishes.

3 RESEARCH FRAMEWORK AND METHODS

Study Area and sampling:
In the NW region in eight Upazilla the Adivasi Fisheries Project is implementing its activities with the *Adivasis*, several communities with households involve in cage based fingerling production were selected from Birgonj, Kaharole and Fulbari Upazilla of Dinajpur, Mithapukur Upazilla in Rangpur and Pachbibi Upazilla in Jaypurhat districts. Of eight Upazilas under the Adivasi Fisheries Project the above five Upazillas were selected for the study. The different groups of *Adivasis* included in the studies were; Santal, Oraon, Mahato, Pahan. Of the communities with households involved in fingerling production in cages most of them were selected. Information of all the households in of the selected communities wee collected.

The Principal Investigator Dr. Niamul Naser and the Co-Investigator Dr. Benoy Barman were responsible to carry out the study in the northwest region in the above mentioned study areas with the sampled households. The field information for Mithapukur was collected by a hired Research Assistant deputed in the area and for Dinajpur the information were largely collected by the two Research Assistants (Shakil Ahmed and Mahadi Hasan) of the WorldFish Center. The communities selected for the studies are shown below:

Rangpur	**Dinajpur**	**Jaypurhat**
Mithapukur Binodpur, Sakhipur, Ramasharpara 1, Ramasharpara 2, Chotto Hazratpur, Rasulpur, Vagabatpur, Ratiabajitpur, Emadpur, Khuddunurpur, Girai, Boldipukur 1, Latkrishnapur, Baldipukur	**Birgonj** Tulshipur Nagri Sagri & Bochapukur **Kaharole** Tarala, Tarapur, Biroli **Fulbari** Panal, Basudebpur, Chakmathura,, Amara, Sreerampur, Radhanagar1 Radhanagar 2	**Pachbibi** Bajitpur, Kalandapur, Bimnagar Jarkapara, Patharghata, Kadampukur Urani, Krishnapur, Belpukurelpukur Dautpur & Durail

All Adivasi households in the communities involved in fingerling production in cages the selected Upazila of the selected communities were surveyed to collect information on fish culture in cages in ponds. A research assistant was involved for 10 months in collection of information from the households from the communities of Mithapukur Upazila. .Two Research Assistants of WorldFish Center involved in the implementation of other activities also play role for collection of information from the cage households of Birgonj, Kaharole, Fulbari and Pachbibi. The Assistant Field Officers of Caritas Bangladesh in of the respective Upazillas provided necessary assistance during collection of information from the households. The specific location of the communities with cages identified during initial visit in the project areas by the research team. Both small and large size ponds were used to set up cages by the households for fingerling production.

Survey of households

Scoping visits by the PI and co-investigator for these activities initially made several scoping visits with RA to setup the research in time with great effectiveness. The PI provided necessary training to the RA to carry out the above activities in the field. During the study period the PI made frequent field visits during PRA studies. The RA carried out the activities on site based at their workings areas.

Stakeholder analysis, Focus Group Discussion (FGD), Key Informant Interview (e.g. pond owners, DoF, Land Department Officials), Semi-structured questionnaire survey interview, Structured questionnaire survey: The survey includes the following information: access of *Adivasi* household to waterbodies to set up cages, the suitability of waterbodies for cage culture, attitude of *Adivasi* households on cage culture, cage materials, fish seed and feed, communication, markets for fingerling

Monitoring: collection of information about fry rearing in cages was performed with preferred fish species. Regular monitoring, data collection and advice to the farmers were made as part of implementation of the activities by the project. The researcher of this project with assistance from the RA of the WorldFish Centre and the field officials of Caritas collected information on the technical and institutional aspects in a semi structure format (see questionnaire in Appendix 1). The data collected were entered and analysed. The results are presented based on the primary analysis of the data. The complete analysis of the data of the households is on-going with further checking in the fields. The reports with complete analysis of data and the outcomes will be presented as modified version of the report within short period of time before submission to the WorldFish or to the European Commission.

4 RESULTS AND DISCUSSIONS

Farmers face constraints to get supply of fry of silver carp to stock in their cages especially in areas with presence of limited hatcheries and nurseries. The supply of fry of both tilapia and common carp was not available when it requires for stocking in cages by the households. The fry supplied for stocking by fry traders collecting from hatcheries (silver carp) or from other sources (mainly from ponds for tilapia) were not good size, subjected to stress during transportation, were not stocked in proper way (directly stocked in the cages immediately after transportation without conditioning or resting), which results mass mortality immediately after stocking or slowly and continued for few days after stocking. The source of fry of Nile tilapia stocked in cages for fingerling production was largely collected from grow-out ponds with possibility of mixing with others. Although in most cases the fry collected from ponds where the Nile tilapia GIFT strain was stocked by the farmers collecting from known sources. For example tilapia fry collected for stocking by farmers in Tarala at Kaharole in Dinajpur were collected from grow-out ponds of farmers where the GIFT strain of Nile tilapia was introduced from the *hapa f*armer (the *hapa* farmer did fingering production of GIFT supplied from NFEP under a research project few years earlier).

The presence of low level of water in ponds, deterioration of water quality (turbidity) caused problems in fingerling production in cages: Cages set up in ponds with low water level showed poor results and this is further deteriorated due to harvest of fish in ponds (turbid water) or use of water for swimming of children during bathing which makes the water very turbid unsuitable for the fish in cages. In some cases children play with cages in ponds and caused damage. The constraints identified from this research on source of fry, use of methods for stocking to overcome mortality and to get better outcomes in terms of quality of fingerlings are useful to take necessary steps to get an improved supply of fish fry of silver carp and tilapia in a good condition (good health, less stress, proper conditioned). It is important to look at the issues on how to make available the supply of quality fry of tilapia to the cages farmers as per their requirement. This can be done in several ways and the follow-up action research will deal on this important issue as part of meeting the objectives of '**increasing the productivity of the cage fingerling production of the Adivasi households**'.

The important sources of the tilapia fry of good quality will be: (1) Rice farmers of RIU-DSP close to the areas of the cage farmers (e.g. at Tarala, Biroli and Bochapukur the source can be the RIU-DSP farmers of Bochagonj Upazila and similarly for Sree Rampur of Fulbari the source of fingerling can be the RIU-DSP farmers of Mamathapur of Parbatipur Upazila) (2) The local pond owners with good quality GIFT (introduced from know source with having less or no chance to mix with previous feral strains of tilapia can be used as alternative source for the purpose (3) Potential source: re-establishment of hapa based breeding and nursing of tilapia in ponds to supply to cage farmer may be a good option (as the review of the *hapa* based tilapia breeding and seed producers showed that it is because of the less demand of smaller size fry produce in *hapas* – the farmers not continued production although the technology showed very encouraging in terms of getting good numbers of quality fry – so if there will be demand of smaller size fry produce in *hapas* for stocking in cages to grow them up to large size fingerlings this can be the

very important source, on the other hand it can be useful to benefit the poor *hapa* farmers as well in getting extra incomes from their ponds).

Stocking density of fry in cages: Farmers stocked 2 kg of fry of silver carp or tilapia in 1 m^3 cage, it is reported that the numbers of fry for 2 kg of tilapia fry (approx 0.5 inch size) was around 400-500; however the number of silver carp fry of similar size was 10000 to 12000. The number of fry varied largely in cages although the amount kept was the same, when farmers stocked a bit larger size fry the numbers reduced.

*Duration of nursing***:** The duration of nursing of fry in cages were 40—50 days in which the fry become good size for selling to grow-out farmers fro stocking.

*Production cycle***:** In perennial ponds normally it is easier to produce 2-3 cycles for fingerling with higher amount of total fingerlings from individual cage in a season. In Tarala at Kaharole most of the households able to use 3 cycles of fingerling production even the pond was seasonal (contain full volume of water only during monsoon for 5-6 months, in the rest of the period water confined only in the middle part with less volume). Use of cages for several cycles of operations even in the seasonal ponds is very important aspects of increasing the productivity of the cages in fingerling production – also of importance to use cages a very effective means to getting continued earnings of use to mitigate the problems of seasonality in crises of employment and income.

As means of increase the cycle of production of fingerling in cages use of tilapia for fingerling production in cages in ponds with low water levels will be more important rather than silver carp because the resistance capacity of tilapia to turbid water is more as compared to silver carp. The fish can do well even with low volume of water (some farmer carried out fingerling production even setting cages in ponds with <0.3m of water.

In the 2nd Phase of this action it is important to look at how to increase the numbers of cycle in fingerling production in cages to get high level of production? Or Does the cage farmers completely aware about the high potential of use of the small cages for a maximum times (using innovation/devices) within a season to get the maximum production and net profits from fingerling production?

Productivity of cages: On the average production is around 10 kg and varied largely among farmers. For some farmers the production of fingerlings was very high even up to 40 kg. So, it is important to find out how the productivity of the cages can be increased from its 10kg average production to maximum level of production.

*Economics of cage fingerling production***:** The economics of the cage fingerlings production depend upon the cycle of cage rearing, i.e. the more fish reared led to more profit. In general it only required around 400-500 for making a cage and other than this to purchase fry 200-300 Taka is required. However, the income from cages on average is Taka 1300 with a maximum of up to Taka 4000.

*Sale of fingerling produces in cages***:** Customers of fingerlings produce in cages are mainly the large pond owners where the cages set up for fingerling production. In addition, the grow-out farmers from the nearby areas purchase the fingerlings for stocking in their ponds. In addition it is the fingerling traders who purchase fingerlings from the farmers for selling to other farmers in the distant communities.

CONCLUSIONS

Management of the pond very important to get good production from cages (cages set in derelict pond or pond with poor management not show good production from cages). Use of quality supplementary feed (boiled rice, wheat bran, rice bran) in cages with tilapia is useful to get higher production. As the productivity in cages largely depends on the management of the ponds – it is very important to have good relations with the pond owners and the households with cages. Access to ponds to set up cages and the attitudes of the owners of the ponds important to get higher income, sometimes the owners want to buy the fingerling with lower price (compared the actual price of fingerling) causing less benefits from use of cages. Both Nile tilapia and Silver carp is the good candidate for fingerling production in cages in ponds, both of the fish can be produce with minimum supply of supplementary feeds as they are the effective user of primary productivity of ponds. Because of the higher demands of large size fingerlings produced from cages – it is important to suggest cage farmers to confine with the production of tilapia and silver carp in cages. It came out that fingerlings produce in cages are stronger than that produce in other systems – useful to long distance transportation with minimum stress. The productivity of cages to produce fingerlings varied largely among the farmers even in the same volume of cages using the similar fish due to variation in several factors. Of the factors the issue of water quality or fertility of water is important. Ponds located in areas with sandy soils with seasonal water availability showed good outcomes in terms of production – because of the regular management such pond water become more fertile that is less turbid water and due to presence of nutrients results the good primary productivity.

RECOMMENDATIONS

As follow up research work ways and means to increase the productivity of the cage fingerling production of the Adivasi households'. It is recommended that sale of fingerling rather than directly use for household consumption to be encouraged to fulfil the objective of fingerling production, to have broader impacts on the fish production and also the more income earnings of the cage farmers. Facilitations of women to involve women actively in fingerling production in cages to get benefits and to consider the gender relations in effective use of the technology to bring equity in benefits from cage based fingerling production within the households

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Appendices

Appendix 1.Households selected for studies on fingerling production in cages in ponds in the study areas

FFS		Village	Household number	Research supervisor
	DINAJPUR	**REGION**	**Total = 206**	**Dr Benoy K Barman**
42	Birgonj	Tulsipur	9	*+ 2 associates from WFC*
47	Birgonj	Nagri Shagri	5	
53	Kaharole	Muhamadpur	7	
54	Kaharole	Tarala	7	
55	Kaharole	Biroli	4	
57	Not done	Saturia	5	
62	Not done	Tongi-Shampur	9	
63	Not done	Horina	4	
64	Not done	Gharua	12	
68	Birampur	Ramchandrapur	5	
70	Not done	Aira	14	
71	Not done	Karampur	4	
72	Not done	Benail	6	
73	Fulbari	Panal	3	
74	Not done	Phukuri	15	
75	Not done	Basudevpur	2	
76	Not done	Chakamathura	8	
78	Not done	Jainty	21	
79	Not done	Amra	8	
80	Fulbari	Sreerampur	18	
82	Fulbari	Radhanagar	40	
	MITHAPUKUR	**REGION**	Total =55	**Dr M Niamul Naser**
84	Mithapukur	Binodpur	7	*+ Ruhina Marjia*
86	Mithapukur	Ramashar Para	9	
88	Mithapukur	Choto Hazratpur	8	
89	Mithapukur	Rasulpur	3	
90	Mithapukur	Vagabatpur	3	
91	Mithapukur	Ratia Bajitpur	6	
92	Mithapukur	Emadpur	1	
93	Mithapukur	Khuddanurpur	5	
94	Mithapukur	Girai	5	
95	Mithapukur	Baldipukur	8	

Does the presence of filamentous algae in ponds is problematic for fingerling production in cages?

Presence of filamentous algae: In some ponds at Mithapukur filamentous algae, which could be a problem for cage set up as well as production of the pond. They algal growth was found to be influenced by nutrients from pond fertilization as well as from the cages.