J. Bangladesh Agril. Univ. 9(2): 319–326, 2011 **ISSN 1810-3030**

Assessing livelihood impacts of cage based fish fingerlings production on *Adivasi* households in north-east and north-west Bangladesh

N. Gupta and M. M. Haque
Department of Aquaculture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh.
Email: nipa_hstu@yahoo.com

Abstract

In Bangladesh, *Adivasi*, the indigenous people are of the poorest sections of the society due to their vulnerable livelihoods with lack of resources. Cage based fish fingerling production (CBFFP) was promoted with *Adivasi* households in the north-east and north-west regions of Bangladesh. A structured questionnaire based survey was conducted with a sample size of 150 CBFFP adopting households to assess the livelihood impacts of CBFFP on the *Adivasi* households. Geographically, the study represents Sherpur and Netrakona districts from north-east and Dinajpur, Rangpur, and Joypurhat districts from north-west regions of Bangladesh. In terms of socio-economic characteristics, the average household size of *Adivasi* households was 4.21± 1.28 with day labour (40%) based primary occupation. Majority (64%) of households heads were found illiterate and the remaining with low level education attainment. Most of the *Adivasi* households depended on a single person's (household head) income. The average size of ponds in which the cages were set was about 1.2±1.4 hectare with the depth of 1.5-3 m. The cage provided with *Adivasi* farmer was of 1 m^3 in size and made of locally available materials, mainly bamboo made frame, net and plastic bottles as floats. The average cost of a cage construction was about BDT 400±85.2 (USD 5.71±1.2). The fry of tilapia (*Oreochromis niloticus*), silver carp (*Hypophthalmichthys molitrix*), rui (*Labeo rohita*), mrigal (*Cirrhinus cirrhosus*), bighead carp (*Aristichthys nobilis*), common carp (*Cyprinus carpio*), Thai sarpunti (*Barbonymus gonionotus*) were stocked in the cages for fingerling production. The average stocking density was about 875±507 fry/cage (about 3.4cm in length). In average, fingerling production cost was about BDT 268±129.2/cage (USD 3.83±1.8/cage) and selling value was about BDT 431±509.1/cage (USD 6.16±7.2/cage). The major impacts of CBFFP include increased household level income (1.7%), use of this income to buy livestock for rearing further. Moreover, CBFFP impacted positively on other aspects of livelihoods such as purchasing food in lean period, saving money and paying credit. The large size fingerlings produced in the cages were used as food fish for household level consumption. The main constrains of *Adivasi* households to adopt CBFFP were poaching of fish from cages and variable access to ponds for cage installation.

Keywords: *Adivasi***,** Socio-economics, Cage culture, Livelihoods, Bangladesh

Introduction

Aquaculture contributes 55% of total inland fish production using only 11% of the total inland water resources (DoF, 2009). Over the last three decades, aquaculture has been developed as the fastest growing food producing sector in the world playing an important role in poverty alleviation. In 2009, the total fish production of Bangladesh was 2.7 million MT of which 2.1 million MT was derived from inland aquaculture (DoF, 2010). Such level of production is also contributing to global production, thus aquaculture production is expected to reach upto 65.1 million MT in 2030 in the world (Verdegem *et al*., 2006).

In the developing countries like Bangladesh, aquaculture practices have subtle relationships with poverty. Now-a-days, in most of the rural areas in the world especially in the Asian countries, poverty and malnutrition are wide spread among rural people under population pressure. It is estimated that about 70% of the population are living in the rural areas (Edward, 2000). Therefore, poverty alleviation should be considered as an important issue of rural development in which the first requirement is to satisfy the basic needs of the poor. For this, it is essential to have an adequate production of food to meet the basic nutritional requirement of the rural poor. In this respect, aquaculture plays a vital role to supply animal protein as well as to contribute to the food security. Furthermore, it provides employment opportunities and generates foreign currency which have broader impacts on social and economic development (Haque, 2007).

The prerequisite of pond based aquaculture is the availability of quality seed in the rural areas of Bangladesh. Availability of quality large size fish fingerlings in time can make considerable impacts on up-taking aquaculture technologies among rural people. Producing large size fingerlings available in the remote places by natural breeding or nursing fry without installation of fish hatcheries, is conceptualized as decentralized fish seed production strategy (Haque, 2007). Among several options of decentralized fish seed production, cage based fish fingerlings production could be an important option to make a sustainable supply of fish seed to remote places (Haque, 2007). Such way of seed production and its availability in remote areas is critical for commercially important and faster growing fish species e.g. tilapia, silver carp etc.

Among the poor, indigenous ethnic minorities living in clusters in different parts of the country are commonly known as *Adivasi*, who are vulnerable and far from the mainstream development in Bangladesh (Kamal *et al.,* 2003). They comprise with 45 distinct communities with an estimated population of 2 million people living in the margin on Bangladesh territory. The increasing trend of population growth and decreasing trend of natural resources have negatively affected *Adivasi's* traditional livelihoods of hunting and gathering of foods from wetlands. Although they are the origin of the country but they are neglected and deprived from the very beginning. However, there is considerable potential to develop underutilized assets including the potential of 'human capital' i.e. develop *Adivasi's* ability to generate an income from their own resources. Decentralized fish fingerlings production in cages could be a practical option for involvement of rural poor for wider social development. With this view of livelihoods improvement of *Adivasi* households, CBFFP was promoted by NGO in ponds in north-east and north-west regions of Bangladesh. In this context, the objective of this study was to assess the impacts of cage based fish fingerlings production on livelihoods of *Adivasi* households.

Materials and Methods

This study was conducted in five (5) districts in north-east and north-west regions of Bangladesh. In north-east, the selected districts were Sherpur and Netrakona and in north-west, the selected districts were Dinajpur, Rangpur and Joypurhat, under this study (Fig. 1). Several villages were selected under these districts for this study. The selected villages have large number of *Adivasi* households who adopted cage farming compared to other villages. A sample size of 150 cage adopting *Adivasi* households was selected randomly from the above districts.

Data were collected through questionnaire survey for three months from July to September, 2009. The questionnaire was designed to characterize cage adopting households with socio-economic characteristics and to get the insights into livelihoods impacts of CBFFP on farming households. The questionnaire was tested initially and finalized after repeated corrections. The collected data were entered into the database software MS-Access and analyzed using SPSS (version 11.5). The findings are presented in tabular and graphical forms.

Results and Discussion

General socio-economic characteristics of Adivasi households

The average *Adivasi* household size was 4.21±1.28, which is very closed to the national average of 4.89 (BBS, 2004). The total number of family members ranged from 1 to 9. Their household income was low reflecting that four-member households cannot meet their basic needs properly. Some of the households were larger indicating that the households had to bear huge maintenance cost with their limited household income.

Fig. 1. Map showing the study area in north-east and north-west Bangladesh

The household head of *Adivasi* households involved in cage based fingerlings production represented a wider age distribution from minimum 19 to maximum 80 years. Average age of the household heads was around 45 (44.57±12.445) years. About 64% of household heads were illiterate, 15.3% had primary and 19.3% had secondary level of education and only 1.3% had higher secondary level of education (Table 1). This indicated lower level of literacy than the national adult literacy level of 54.8% (BANBEIS, 2010) which further suggested that they are poor by lacking of formal education. Learning mother tongue, *Adivasi* children get difficulty in school while teaching is done with mainstream (Bengali) language. In the context of lacking formal education, hands on operation of cage based fingerling production made an appropriate learning path for *Adivasi* people irrespective of gender and age which may be an indicator of sustainable livelihood improvement (Haque *et al*., 2010).

Table 1. Level of education of household heads of cage adopting *Adivasi* households

Education attainment	Percentage (%) of household heads
Above secondary	1.3
Class VI-X (secondary)	19.3
Class I-V (primary)	15.3
Illiterate	64.0

About 40% of cage adopting farmer's occupations were day labour and agriculture as the main occupations (Table 2) followed by van/rickshaw puller (7%). Hallman *et al*. (2003) stated that engaging in agriculture has been recognized as a primary livelihood strategy of the majority of the households in Bangladesh. In most cases, day labour was also secondary occupation depicting *Adivasi* people worked in the agricultural field living in hardship. Many of them had no secondary occupation (45%) indicating their vulnerable economic status. Only 7% of the households involved themselves in fish culture because they do not have their own ponds. In this context, cage based fish fingerlings production could be a noble opportunity to enhance their income.

Table 2. Category of occupation of household heads of cage adopting *Adivasi* households

Occupation category	Percentage (%) of occupation by different category					
	Day labour	Agriculture	Van/Rickshaw puller	Fishing	Other occupation	None
Primary occupation	40.7	40	7	0	12.3	0
Secondary occupation	29.4	10.7	2	6.8	6.4	44.7

About 66% of *Adivasi* households had no additional earners except household head (Table 3). Most of the *Adivasi* households depended on the income of a single person. It was hard to them to lead their family from the income of a single person where CBFFP was promoted as an important strategy to improve their livelihoods.

Table 3. Number of earners in *Adivasi* households

No. of earner excluding household heads	Percent (%) of households (N=150)
3	2
2	5.3
1	26.3
No earner	66.3

Cage based fish fingerling production in ponds

The average size of ponds in which the cages were installed by *Adivasi* households, was about 1.2±1.4 ha. The larger the pond the better the productivity was evidenced. *Adivasi* households set their cages in five different pond access arrangements including own ponds, multi-ownership ponds, neighbouring

ponds, private ponds (lease holder's ponds) and state-owned (*khas*) ponds. Average number of cages set in each pond was 8±6.1. The size of the cages was about 1m^3 with individual construction cost of BDT 400±85.2 (USD 5.71±1.2). The stocked fry in the cages to produce fingerlings were of tilapia (*Oreochromis niloticus*), silver carp (*Hypophthalmichthys molitrix*), rui (*Labeo rohita*), mrigal (*Cirrhinus cirrhosus*), bighead carp (*Aristichthys nobilis*), common carp (*Cyprinus carpio*) and Thai sarpunti (*Barbonymus gonionotus*). The cost of fingerlings per cage varied due to stocking densities, types of species and source of fry. However, average cost of fingerlings was about USD 3.83±1.8/cage. Most of the *Adivasi* farmers used rice bran, wheat bran and mustard oil cake as supplementary feed for cage reared fingerlings. Hasan *et al*. (1985) observed that the supplementary feed containing rice bran (30%), wheat bran (30%) and fish meal (40%) was the best for Nile tilapia (*Oreochromis nilotica*) production in cages. Most of the farmers supplied feed in the cage one to two times a day early in the morning and late evening. The amount of feed used in one cycle was about 5 to 6 kg /cage and the estimated cost was about BDT 100/cycle/cage (USD 1.43/cycle/cage) (Table 4).

Table 4. General characteristics of cage installed in ponds for fingerling production

Pond/cage characteristics	Value
Average area of pond (ha)	1.2 ±1.4
Average minimum depth of pond (m)	1.5±0.9
Average maximum depth of pond (m)	3±0.9
Average no. of cage set in pond	8±6.1
Average cost of cage construction	BDT 400±85.2 (USD 5.71±1.2)*
Average cost of fingerling production	BDT 268±129.2/cage (USD 3.83±1.8/cage)
Amount of feed used	5-6kg/cage
Cost of feeding	BDT 100/cycle/cage (USD 1.43/cycle/cage)

* 1USD = BDT 69.93

The fingerling production was dominated (70%) by silver carp and tilapia. The amount of fry stocked per cage for first cycle varied from 75 to 2000 fry/cage with an average of 875 fry/cage. During stocking, the average total weight of the fry was 1.5 kg/cage and average length was about 3.4 cm/fry. During second cycle the stocking density varied from 50 to 2000 fry/cage with an average of 889 fry/cage. In the second cycle, the initial average length of the fry was smaller (2.4 cm) than the first cycle (Table 5).

Table 5. Fry stocking properties of an individual cage

Stocking properties	1st cycle				2nd cycle			
	Min	Max	Mean	STDEV	Min	Max	Mean	STDEV
Total stocked fry (no/cage)	75	2000	875.5	507.7	50	2000	889.3	462.9
Total stocked fry (kg/cage)	1	4	1.6	0.6	1	6	1.2	1
Length of individual fry (cm)	1.27	6.35	3.4	1.0	1	7.6	2.4	1.8

Fingerling production and its impacts on households

The average production of fingerlings per cage was about 13±6.7 kg while the stocking rate of fry was 1.5 kg/cage. Out of total production, 9 kg/cage was sold, 4 kg/cage was consumed and 0.27 kg/cage was given away as gift to relatives and neighbours (Fig. 2). The average selling price of the produced fingerlings was about BDT 431±509.1/cage/household (USD 6.16±7.2/cage/household).

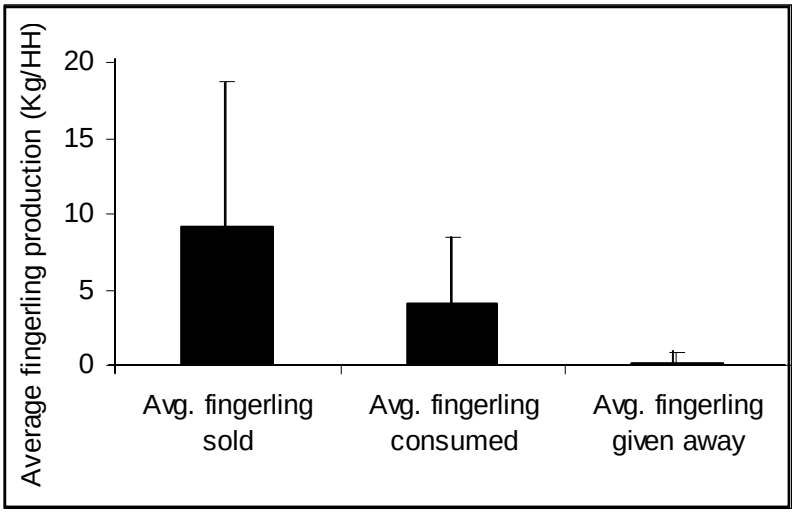

Fig. 2. Use of fish fingerlings produced in CBFFP system (HH-household).

When the size of fingerlings was about 7.62 to 10.16 cm after 3 months of rearing, farmers harvested them and sold through different marketing channels. The produced fingerlings were mostly sold in local markets however, neighbouring farmers and fry traders also got benefit stocking into their ponds and trading the fingerlings, respectively. *Adivasi* farmers harvested their fingerlings at different time mainly when the demand of fish seed was high (Fig. 3).

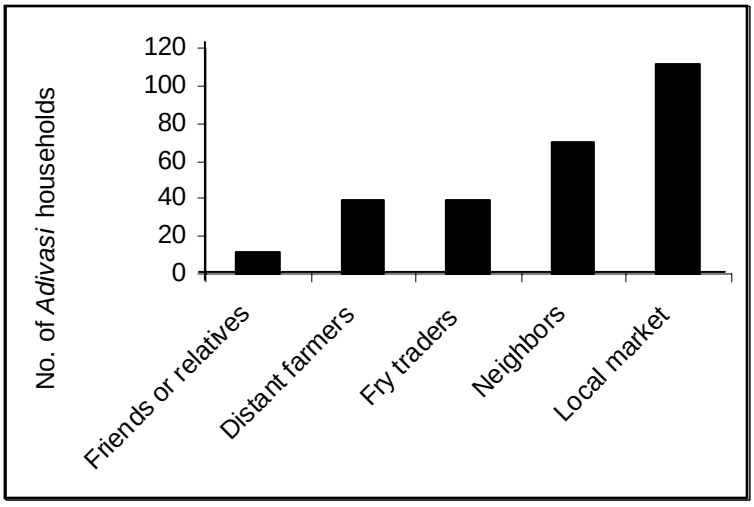

Fig. 3. Fingerlings selling channels used by *Adivasi* households.

Adivasi's main income was generated selling labour daily in agricultural land. Cage farming contributed about 1.7% to their total income which was higher than other agricultural activities such as vegetable, jute, maize, wheat, fruit etc. cultivation (Table 6). This indicates that CBFFP can be introduced at *Adivasi* household level to generate a comparable income.

Table 6. Sources of income and their distribution in cage farming *Adivasi* households

Income source	Mean income (BDT)	Mean income (USD)	STDVE (±) BDT (USD)	Percent of the total income
Day labour	16,072.7	229.6	17720.2 (253.2)	31.4
Rice cultivation	13,541.3	193.5	20799.1 (297.1)	26.5
Service	4,814.0	68.8	19994.0 (285.6)	9.4
Van pulling	3,837.3	54.8	12913.2 (184.5)	7.5
Cattle rearing	3,085.9	44.1	5904.8 (84.4)	6.0
Petty business	2,180.6	31.2	8761.1 (125.2)	4.3
Poultry rearing	1,059.9	15.1	1818.5 (25.9)	2.1
CBFFP	872.3	12.5	939.4 (13.4)	1.7
Fish selling	604.0	8.6	1811.3 (25.9)	1.2
Vegetable cultivation	472.3	6.8	2031.0 (29.0)	0.9
Wheat cultivation	452.2	6.5	2582.9 (36.9)	0.9
Fruit	340.9	4.9	1398.7 (19.9)	0.7
Rice collection	79.3	1.1	572.7 (8.2)	0.2
Jute cultivation	47.3	0.7	368.9 (5.3)	0.1
Maize cultivation	46.7	0.7	571.5 (8.2)	0.1
Shared out land	40.0	0.6	489.9 (6.9)	0.1
Leased out land	14.7	0.2	179.6 (2.6)	0
Potato cultivation	14.4	0.2	176.4 (2.5)	0
Fish fry trading (hatchery produced)	0.47	0.01	0.82 (.01)	0
Others	3,609.3	51.6	14074.4 (201.1)	7.1

As part of diverse livelihood benefits, income from cage culture was re-invested in livestock rearing by the *Adivasi* households. Apart from this, cage culture impacted positively on other aspects of livelihoods such as purchasing food in lean period, saving money, paying credit etc. A substantial proportion of households increased household level fish consumption that they could not catch from the wild sources (Table 7).

Table 7. Household level impacts of cage based fish fingerlings production

Impacts	Number of households	Percent of households
Bought clothing	2	1.3
Bought chicken	1	0.7
Bought duck	1	0.7
Bought chicken and duck	2	1.3
Bought goat	4	2.7
Bought pig	2	1.3
Bought tin for house construction	1	0.7
Bought trees	1	0.7
Increased fish consumption	47	31.3
Constructed toilet facility	1	0.7
General household expenditure	18	12.0
Partial investment for land purpose	2	1.3
Purchased fingerling for stocking own pond	2	1.3
Purchased food (Rice) in lean period (Sep-Oct)	7	4.7
Purchased quality food	1	0.7
Reduced field labouring	1	0.7
Saved money	16	10.7
Spent for agricultural inputs	3	2
Spent for child education	3	2
Paid credit	4	2.7
Could not sell but expected in the following year	31	20.7

Sustainability of CBFFP

Although there were several positive impacts of CBFFP on *Adivasi* households however, the sustainability of this technology was constrained by some factors. Poaching of fingerlings from the cage even the whole cage was of the main constraints. This discouraged some households to continue CBFFP*.* Cage materials especially cage net was not available in the local market from where other interested farmers can purchase and adopt this technology. However, this constraint could be minimized with little support from local upazila extension office of the Department of Fisheries. Finally, as majority of *Adivasi* households did not have own ponds, accessibility to ponds was found a major hurdle. At the beginning of promotion, the pond owners were not agreed to set the cages in their ponds. They thought that cage culture could affect their pond fish production negatively. This needs a policy level strategy for CBFFP prioritizing access to ponds by *Adivasi* for aquaculture practices (Haque *et al.* 2010).

Conclusion

The cage farming played a considerable role in the uplifting of the socio-economic condition of *Adivasi* households and it also increased the fish consumption of *Adivasi* people*.* From the results of present study, it can be concluded that cage culture could be a complementary option to alleviate the poverty if *Adivasi* households get access to the pond for CBFFP. *Adivasi* people are illiterate thus they are far from the mainstream development of the country. At the school level, applied education for agricultural technologies (e.g. aquaculture) with mother tongue could be incorporated. Major problem of cage culture was accessibility to ponds for cage installation. For this, government and other development organizations should have compulsory components in aquaculture extension to mediate pond access arrangement between *Adivasi* households and large pond owners. In national fisheries policy *Adivasi* people should be prioritized to leasing the state-owned ponds for CBFFP and associated aquaculture enterprises.

References

BANBEIS. 2010. Bangladesh Bureau of Educational Information and Statistics. Ministry of Education. Bangladesh.

BBS. 2004. Bangladesh Bureau of Statistics. Statistics Division. Ministry of planning, Government of the People's Republic of Bangladesh, Dhaka. 673 pp.

DoF (Department of Fisheries). 2009. Fishery and Statistical Yearbook of Bangladesh 2007-2008. Fisheries Resources Survey System, Department of Fisheries, Ministry of Fisheries and Livestock, Matshya Bhaban, Dhaka. 42 pp.

DoF (Department of Fisheries). 2010. Fishery and Statistical Yearbook of Bangladesh 2007-2008. Fisheries Resources Survey System, Department of Fisheries, Ministry of Fisheries and Livestock, Matshya Bhaban, Dhaka. 104pp.

Edwards, P. 2000. Aquaculture, poverty impacts and livelihood. Natural Resource Perspective, ODI, Number 56, June 2000.

Hallman, K., Lewis, D.J. and Begum, S. 2003. An Integrated Economic and Social Analysis to Assess the Impact of Vegetable and Fishpond Technologies on Poverty in Rural Bangladesh. Paper No. 163. Washington, D.C: Food Consumption and Nutrition Division Discussion. International Food Policy Research Institute.

Haque, M.M. 2007. Decentralised Fish Seed Network in Northwest Bangladesh: Impacts on Rural Livelihoods. PhD Thesis. Institute of Aquaculture, University of Stirling, UK. 491 pp.

Haque, M.M., Barman, B.K. and Murshed-e-Jahan, K. 2010. Effectiveness of Different Pond Access Arrangements for Cage Based Fish Fingerling Production by *Adivasi* Households, *Policy Brief,* The WorldFish Center, Bangladesh. 2 pp.

Hasan, M.R., Haque, A.K.M., Islam, M.A. and Tareque, A.K.M. 1985. Studies on the effect of supplemental feed on the growth of Nile tilapia in cages. *Bang. J. Agril. Sci.* **12:** 37-41.

Kamal, M., Samad, M. and Banu, N. 2003. Santal Community in Bangladesh: Problems and Prospects. Dhaka. 80 pp.

Verdegem, M.C.J., Bosma, R.H. and Verreth, J.A.V. 2006. Reducing Water Use for Animal Production through Aquaculture. *Water Resources Development*, **22(1):** 101–113.