

**FISH CULTURE IN PONDS AND RICE FIELDS BY POOR ADIVASI (ETHNIC) HOUSEHOLDS IN NORTHWEST BANGLADESH: PERFORMANCES EVALUATION AND LIVELIHOOD ASPECTS****Hossain MA***Professor, Department of Fisheries, University of Rajshahi, Bangladesh**E-mail: mahfaa@yahoo.com***ABSTRACT**

Performances of the poor Adivasi households were evaluated and their livelihoods were studied who culture fish in ponds and rice fields for a period of one year under 12 FFSs (Farmers Field Schools) in Pirganj of Rangpur district and Panchbibi of Joypurhat district, Bangladesh. A questionnaire based survey was designed for a total of 30 ponds (14 from Pirganj and 16 from Panchbibi), 42 rice fields (22 from Pirganj 20 from Panchbibi) and 72 households (36 from each site). Households were selected through stratified random sampling technique. Other than questionnaire based interview, twelve Focus Group Discussions (FGDs) were conducted with pond owners, rice-fish farmers and share croppers. The ponds were found to be used for only food fish production whereas the rice fields were found to be used for both fingerling and food fish production. Households were found capable well to demonstrate their performances in most of the technical issues of fish farming. Fish consumption increased as 13.89-16.67% and income increased as 16.67% in the study areas. Poor Adivasi households (97.22% to 100%) also agreed to continue fish culture in future. Three different types of strategies in sharing the labor, input and benefit were identified for using the multiple owned or leased ponds or rice plots and maximum benefit was found with the leased rice fish plots. Benefit per share was found to be decreased with the increase in share for fish farming in multiple owned ponds or rice fields.

**Key words:** *Adivasi, fish culture, livelihood, pond, rice field*

**INTRODUCTION**

Importance of fish culture to increase the food production, household nutrition, income and employment generation is well documented (ADB, 2005; DoF, 2016). Because of high profit in scientific aquaculture, the rate of adoption of technology-based aquaculture is progressively increasing and aquaculture alone is contributing to more than 50% of the total fish production (DoF, 2016). Most of these aquaculture efforts are being made to improve the fish production only rather than the emphasis on the scale of the poor people's livelihood and thus it is found as a question as to how far poor and disadvantaged peoples are able to take benefit through easy access to the aquatic resources and adoption of appropriate aquaculture technologies. Ethnic minorities live in clusters at different parts of the country and commonly known as "Adivasi" are found vulnerable and far from the main stream development in Bangladesh. Therefore, effective understanding of this community and necessary supports for income generating activities are recommended for their livelihood improvement (Kamal *et al.*, 2003; Barkat *et al.*, 2009). In spite of having some proven aquaculture technologies suitable for ponds and rice plots (Dewan, 1992; Grover *et al.*, 2000; Roy *et al.*, 2002; Frei and Becker, 2005; Hossain *et al.*, 2015; Asadujjaman and Hossain, 2016), some social issues like multiple ownership of the ponds and share cropping complexities of the rice plots make aquaculture difficult while taking decision to use these resources as well as making benefits over the aquaculture technologies by the poor Adivasi communities (Barman, 2007). Moreover, the traditional approaches of technology transfer do not consider the current level of knowledge, capabilities and opportunities of small-scale farmers. The alternative approach like "Farmer Field School (FFS)" can address livelihoods and empower farmers with greater planning, monitoring and decision making in aquaculture activities (Alam and Kamp, 2001). There were

certain constraints in the adoption of technology packages by poor and disadvantaged people in rural sectors and aquaculture in seasonal water bodies was found successful for the tribal people in India through collaborative research (Haylor *et al.*, 2002). Development of farmers committee can play a significant role to improve the knowledge and skills of the tribal farmers and their farming practices in India (Das, 2006). Arguments and evidences mentioned above indicate that integration of the appropriate aquaculture technology with suitable extension approach is found necessary in our research system to improve the livelihood of the poor and disadvantaged people. Present effort evaluated the performances of FFS based poor Adivasi households and studied their livelihood for fish farming in ponds and rice fields of Northwest Bangladesh. The specific objectives in this study were to provide a strategy of using the multiple owned or leased ponds or rice fields; to evaluate the performances in major technical issues; to evaluate the production and economics; and to study the changed livelihood of the poor Adivasi households involved in fish culture in ponds and rice fields.

**MATERIALS AND METHODS**

The study was conducted for a period of one year (2008) with 12 FFSs of the Adivasi households in Pirganj of Rangpur district and Panchbibi of Joypurhat district, Bangladesh (Fig. 1). After completion of the exposure visits to the study areas, a questionnaire based survey was designed for a total of 30 ponds (14 from Pirganj and 16 from Panchbibi), 42 rice fields (22 from Pirganj and 20 from Panchbibi) and 72 households (36 from each site).

Poor Adivasi households were selected through stratified random sampling technique. Of the total number of households (with homestead land of 0.51 to 0.57 ha) selected, 100% Adivasis were Uraon in Pirganj whereas four types of Adivasis were found as Uraon (44.4%), Santal

(22.2%), Pahan (16.7%) and Mahato (16.7%) in Panchbibi. With major occupation in agriculture, they had no (63.89 to 83.33%) or very little (2.78 to 11.11%) training to increase the farm production and income. Among the selected ponds, 37.5% were multiple owned. Rice fields were under single owned (>70%), multiple owned (22.73% in Pirganj and 15% in Panchbibi) and leased (about 5% in both the sites) systems. Mean area of ponds and rice fields varied from 0.06±0.03 ha (Pirganj) to 0.05±0.05 ha (Panchbibi) and from 0.14± 0.11 ha (Pirganj) to 0.08±0.05 ha (Panchbibi), respectively.

Adivasi households were provided with necessary training and field facilities from FFS. For data collection from the selected Adivasi households, a standard questionnaire was

purposely developed, pre-tested and finalized. The questionnaire consisted of both quantitative and qualitative information. A total of twelve Focus Group Discussions (FGDs) were conducted with pond owners, rice-fish farmers and share croppers. Thus the data obtained was cross-checked with the key informants. Fish production data was taken in terms of yield (Fish biomass at harvest - fish biomass at stock) and was expressed as kg/ha. Data on economics of fish farming was taken in terms of total cost (Fixed and variable cost in BDT ha<sup>-1</sup>, Bangladesh Taka) and net benefit (BDT ha<sup>-1</sup> from total income of fish sale - total cost). Collected data was stored in MS Access and analyzed using SPSS (Statistical Package for the Social Sciences) program.

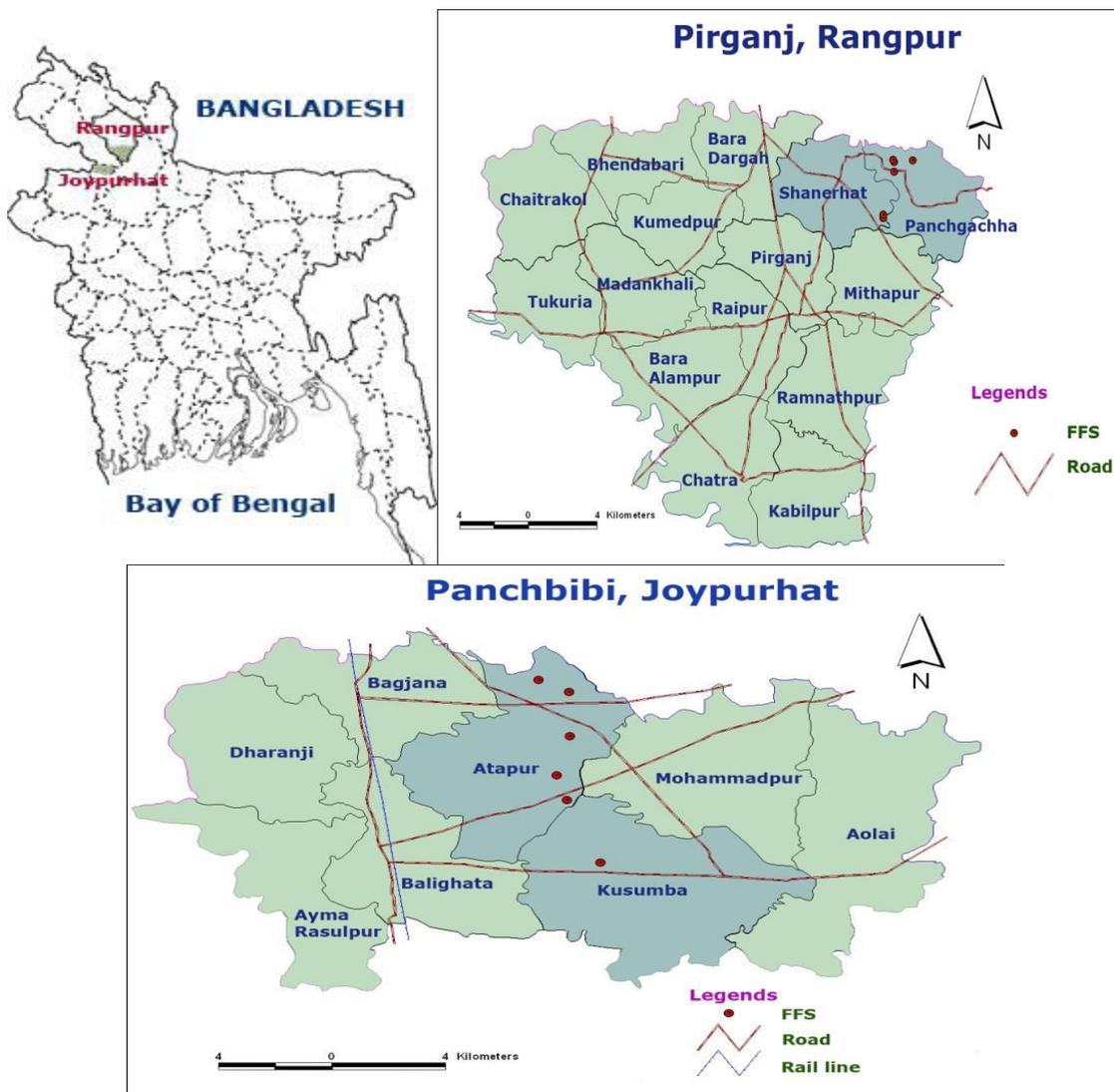


Fig. 1: Map shows the study areas

## RESULTS AND DISCUSSION

### **Strategy for using the multiple owned or leased ponds or rice fields**

Three different types of strategies in sharing the labor, input and benefit were identified for using the multiple owned or leased ponds or rice plots in the study areas (Table 1). Although strategies were different for multiple ownership patterns but these were same for both the study sites. Input and output sharing were found equal for the owners or operators while using the multiple owned rice-fish plots. Among the different strategies, maximum benefit was found for the resource poor Adivasis to use the leased rice fish plots which provided 100% of the fish production/income in addition to the benefit from rice to the operator or lease holder. However, all these agreements or strategies to use the multiple owned or leased ponds or rice fields were made for short term (for a period of 1 to 3 years) basis. Findings indicate that these multiple owned ponds and rice plots have greater potentials if reasonable scope for extension of the culture period is found in the agreements between the owner and operator. On the other hand, there is a risk for getting no access to or causing land degradation of the leased rice fish system while the agreements between the land owner and operator is made for a period of only 1 to 3 years. Actually the sustainable livelihood depends on the increase in production and income with the decrease in environmental pollution. Therefore, it is necessary to develop the long term strategies or agreements between the owner and operator. This statement was strongly supported by ALRD (2003) reporting the leasing period for at least five years for better land management practices. Almost similar assumptions were also made by De Wilde (2000) while working for the development of coastal chars in Southeastern Bangladesh.

### **Performances of the households in the major technical issues of fish farming**

The ponds were only used for food fish production whereas the rice fields were used for both fingerling and food fish production. A total of ten species namely catla (*Catla catla*), rui (*Labeo rohita*), mrigel (*Cirrhina mrigala*), bata (*Labeo bata*), silver carp (*Hypophthalmichthys molitrix*), bighead carp (*Aristichthys nobilis*), carpio (*Cyprinus carpio*), grass carp (*Ctenopharyngodon idella*), sarputi (*Barbodes gonionotus*) and nitotica/tilapia (*Oreochromis* sp.) were identified for stocking in ponds and rice fields. Silver carp and catla ranked the first position for the maximum ponds used for stocking in Pirganj (45.45%) and Panchbibi (68.75%), respectively. Carpio ranked the first position for its maximum choices for stocking in rice fields (72.73% rice fields in Pirganj 88.24% rice fields in Panchbibi). The initial stocking size of the fishes in rice field varied from 2.75±1.77 cm (carpio) to 12.5±3.54 cm (catla) in Pirganj and 5.2±2.52 cm (carpio) to 13.13±4.58 cm (tilapia) in Panchbibi. Only polyculture of 2 to 9 species in ponds and both

monoculture and polyculture of 2 to 7 species in the rice field were found in the study area. The mean stocking density for table fish production varied from 26903.21±35046.19 individuals ha<sup>-1</sup> (Panchbibi) to 42767.15±41877.98 individuals ha<sup>-1</sup> (Pirganj). The mean stocking density for fish fingerling production in rice fields varied from 1622.87±8498.59 individuals ha<sup>-1</sup> (Panchbibi) to 86934.42±177720.9 individuals ha<sup>-1</sup> (Pirganj). The mean stocking density for table fish production in rice fields varied from 16916.53±16786.07 individuals ha<sup>-1</sup> (Panchbibi) to 33715.8±16850.76 individuals ha<sup>-1</sup> (Pirganj). Fish species selected by the Adivasi households were found almost common for fish farming in ponds and rice fields. Findings agreed with Hossain (2011) and Asadujaman and Hossain (2016) while working on carp polyculture in farmer managed ponds. Present findings on the selection of species in rice fields were also agreed with Dewan (1992), Frei and Becker (2005) and Hossain *et al.* (2015) while working on rice-fish system.

Households were found well capable to demonstrate their performances in most of the technical issues of fish farming in ponds and rice fields (Table 2). Better performances of the households was found for ditch preparation in rice field (81.82% in Pirganj and 90.00% in Panchbibi) as compared to pond preparation (7.14% in Pirganj and 6.25% in Panchbibi). Stocking was found 100% for rice-fish in Pirganj and for pond fish in Panchbibi. Households were found more capable to use fertilizers than supplementary feeds in their ponds and rice fields. Comparatively less application of fertilizers in rice fields (45.45% in Pirganj and 47.06% in Panchbibi) was found than that of ponds (87.5% in Panchbibi and 90.91% in Pirganj). Fish growth observation by the households was found higher in ponds ranging from 63.64% (Pirganj) to 81.25% (Panchbibi) than in rice fields ranging from 37.5% (Pirganj) to 47.06% (Panchbibi). Other than fish production in ponds and rice fields, households were also found capable to grow vegetables through using the dykes of ponds (14.29% in Pirganj and 18.75% in Panchbibi) and rice fields (13.64% in Pirganj and 15.00% in Panchbibi). Ditch area in rice fields were found to be varied in both sites. In Pirganj, there were maximum 22.73% plots with ditch of 5-10% of rice field area whereas in Panchbibi, 40% plots were found with ditch below 5% of rice field area (Table 3). Farmers do not usually follow the ditch preparation technique accordingly in traditional technology transfer process although this ditch has significant role to increase the productivity (Hossain *et al.*, 2015). The overall performances in the major technical issues by the poor Adivasi households can be considered as more or less satisfactory since many of them had little or no experience of fish culture earlier. The success so far found was mainly due to the introduction of FFS approach. The present findings clearly indicate that the multiple owned or share cropped or leased ponds or rice fields can effectively be used if the technology transfer approach is taken accordingly and the statement was more or less supported by Das (2006).

**Table 1: Strategy for using the multiple owned or leased ponds or rice plots**

Ponds/plots	Labor sharing	Input sharing	Benefit/output sharing
Multiple owned ponds (One operator is selected only from the owners)	Operator will contribute 100% labor	Operator will provide 100% input cost	Operator will minus his total input cost from total production/income. Remaining production/income will be distributed equally among the owners.
Multiple owned rice-fish plots	Owners will share equally	Owners will share equally	Owners will share equally
Leased rice-fish plots	Lease holder will provide all the labor	Lease holder will bear all the input cost	Production/income from rice will be distributed equally between land owner and lease holder. Lease holder will get the 100% of fish production/income.

**Table 2: Performances of the households in the major technical issues of fish farming**

Technical issues	Pirganj, Rangpur		Panchbibi, Joypurhat	
	Pond (%)	Rice-Fish (%)	Pond (%)	Rice-fish (%)
Pond preparation or ditch excavation	7.14	81.82	6.25	90
Fish seed stocking	78.57	100	100	85
Supplementary feeding	54.55	31.82	50	58.82
Fertilization	90.91	45.45	87.5	47.06
Liming	-	-	25	-
Growth observation	63.64	37.5	81.25	47.06
Harvesting (Partial)	21.43	4.55	50	35.29
Harvesting (Single)	7.14	13.64	-	35.29
Dyke cropping (Vegetable)	14.29	13.64	18.75	15.0

**Table 3: Ditch area in rice-fish plots**

Ditch area (% of rice plot area)	Pirganj, Rangpur (n=22)		Panchbibi, Joypurhat (n=20)	
	No.	%	No.	%
No ditch	4	18.18	2	10
Below 5%	2	9.09	8	40
5-10%	5	22.73	4	20
10-15%	4	18.18	2	10
15-20%	3	13.64	1	5
20-25%	2	9.09	-	-
25-50%	2	9.09	2	10
50-75%	-	-	1	5

**Table 4: Production and economics of fish farming in ponds**

Ownership type	Fish yield (kg ha <sup>-1</sup> )	Total cost (BDT ha <sup>-1</sup> )	Total income (BDT ha <sup>-1</sup> )
<b>Pirganj (n=9)</b>	<b>1196.71±805.01</b>	<b>30514.14±14750.84</b>	<b>88344.97±59006.84</b>
Multiple owned (n=0)	-	-	-
Single owned (n=9)	1196.71±805.01	30514.14±14750.84	88344.97±59006.84
<b>Panchbibi (n=19)</b>	<b>1246.38±1249.14</b>	<b>36203.36±30983.07</b>	<b>99710.65±99931.36</b>
Multiple owned (n=4)	1216.62±313.35	42080.42±7521.3	97329.76±25068.31
Single owned (n=9)	1259.61±1517.59	33591.33±37333.19	100768.8±121407

**Table 5: Production and economics of fish farming in rice fields**

Ownership type	Fish yield (kg ha <sup>-1</sup> )	Total cost (BDT ha <sup>-1</sup> )	Total income (BDT ha <sup>-1</sup> )
<b>Pirganj (n=16)</b>	<b>296.68±404.03</b>	<b>31212.68±19677.38</b>	<b>103347.7±40627.91</b>
Multiple owned (n=2)	279.41±162.26	47768.92±33092.61	109590.9±3369.24
Single owned (n=13)	220.83±329.8	25675.6±13709.02	96802.65±28450.39
Leased (n=1)	1317.33	70042.13	223946.7
<b>Panchbibi (n=14)</b>	<b>283.12±384.63</b>	<b>73224.07±17798.05</b>	<b>104403.3±47794.13</b>
Multiple owned (n=2)	100.86±90.24	31647.67±7729.62	70521.67±26377.44
Single owned (n=11)	317.05±428.47	38521.99±19919.31	109825.5±51297.77
Leased (n=1)	274.44	34099.72	112522.2

Table 6: Variation in benefit under different ownerships of pond and rice fields

Fish farming technology & share type	Net benefit (BDT ha <sup>-1</sup> )
<b>Pond fish farming</b>	
Single (01) share	62,504.17
Two (02) share (multiple)	30,365.85
Three (03) share (multiple)	12,938.10
<b>Rice-fish farming</b>	
Single (01) share	70,398.48
Two (02) share (multiple)	25,174.00

Table 7: Change livelihood of the Adivasi households through fish culture (n=36)

Type of change	Pirganj, Rangpur		Panchbibi, Joypurhat	
	No.	%	No.	%
Continue the fish culture in future	35	97.22	36	100
Household crop production increased	11	30.56	19	52.78
Household fish consumption increased	5	13.89	13	16.67
Vegetable consumption increased	11	30.56	19	52.78
Income increased	6	16.67	6	16.67
Homestead improvement	2	5.56	-	-

#### **Production and economics of fish farming in ponds and rice fields**

Production and economics of fish farming in ponds and rice fields are shown in Table 4 to Table 6. Mean fish yield in ponds and rice fields varied from 1196.71 ± 805.01 kg ha<sup>-1</sup> (Pirganj) to 1246.38 ± 1249.14 kg ha<sup>-1</sup> (Panchbibi) and 283.12 ± 384.63 kg ha<sup>-1</sup> (Panchbibi) 296.68 ± 404.03 kg ha<sup>-1</sup> (Pirganj), respectively (Table 4 & Table 5). Comparatively more profit was found with Pirganj site (having no multiple owned pond) than that of Panchbibi site (with multiple owned ponds). Single owned rice fields were found better than that of the multiple owned or leased in terms of production and benefit. Leased rice fields were found better than that of the multiple owned. In case of multi owned ponds, the number of owner or share varied from 2 to 3 and the benefit per share was found to decrease with the increase in share (Table 6). The fish production found from ponds and rice fields was comparatively lower than that of the average national production as reported during that period by DoF (2008). Findings of the present study clearly indicated that differences in management practices along with the different kinds of agreements under different ownership systems affected the production and economics of fish farming in ponds and rice fields. Differences recorded due to the complexities in management of multiple owned ponds or rice fields were reflected by the works of Chowdhury and Moharjan (2001). Present findings also agreed with Kabir and Mondol (2010) who reported that multiple owned ponds affected the intensity of fish farming.

#### **Changed livelihood**

Due to the fish farming efforts in ponds and rice-fields, fish consumption increased as 13.89% to 16.67% and income increased as 16.67% in the study areas. Poor Adivasi households also agreed to continue fish culture (97.22% to 100%) in future (Table 7). Present findings indicated that

FFS based households found the present effort of fish farming in ponds and rice fields as an effective option for the improvement of their livelihood. Actually almost all types of aquacultures have potentials in Bangladesh but aquaculture in ponds and rice fields have greater potentials especially to the resource poor farmers in Bangladesh and Asian countries. Benefits of these technologies were also well documented by Grover *et al.* (2000), Frei and Becker (2005) and Hossain *et al.* (2015). Apart from the technology, extension approach like FFS was also found suitable to involve the poor Adivasi households in fish farming and to ensure the benefits of fish farming for their livelihood improvement. Almost similar assumptions based on the necessity of farmer associations or committees or schools were also made by Das (2006).

#### **CONCLUSION**

Fish culture in ponds and rice fields including the FFS approach played a significant role to improve the livelihood of the poor Adivasi households. Poor households were found well capable to demonstrate their performances in most of the technical issues of fish culture in ponds and rice fields. Potentials of multiple owned ponds and leased rice fields to improve the livelihood of the poor Adivasi households should be explored through conducting further fish farming research under long term agreement between owner and operator.

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