



Can aquaculture benefit the extreme poor? A case study of landless and socially marginalized Adivasi (ethnic) communities in Bangladesh



Jharendu Pant ^{a,*}, Benoy Kumar Barman ^b, Khondker Murshed-E-Jahan ^b, Benjamin Belton ^b, Malcolm Beveridge ^c

^a WorldFish (Headquarters), Jalan Batu Maung, Batu Maung, 11960 Bayan Lepas, Penang, Malaysia

^b WorldFish, Bangladesh Office, House 22B, Road 7, Block-F, Banani, Dhaka 1213, Bangladesh

^c WorldFish, Zambia Office, Addis Ababa Drive, Plot No: 4186, Longacres, Lusaka, Zambia

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ABSTRACT

The Adivasi Fisheries Project, aimed at diversifying livelihood options for resource-poor Adivasi (ethnic) communities in the North and Northwest of Bangladesh, was implemented during 2007–9. Aquaculture and related technologies were introduced to a total of 3594 resource-poor Adivasi households. Baseline and end-line surveys were applied to assess the changes in their livelihoods following intervention. Household incomes of project participants rose significantly ($p \leq 0.01$), which was attributed to the increased share of aquaculture and related enterprises from 15% in 2007 to nearly 30% in 2009 in terms of annual household incomes. By contrast, the contribution of aquaculture to household incomes remained virtually unchanged ($p > 0.05$) among non-project participants. The monthly frequency of fish, meat and egg consumption increased between 2007 and 2009 ($p \leq 0.01$), confirming improved food and nutrition security among project participants. Although non-project participants also slightly increased their fish consumption, it remained significantly lower ($p \leq 0.01$) than that of the project participants. The results from the present study contradict the prevailing view that aquaculture is inappropriate for landless, socially marginalized and extremely poor communities by demonstrating its relevance to improving livelihoods, provided that a diversified approach is followed and interventions are tailored to needs and capabilities of target households.

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1. Introduction

Ethnic minority communities, commonly known as ‘Adivasi’, are among the most marginalized segments of the population in Bangladesh. There are more than 45 of such communities with distinct cultural identities. However, they may be broadly classified into ‘Adivasi of the Plains’ and ‘Pahari’ or ‘Jumma’ (hill tribes), the former are distributed in the plains of the North and Northeast, while the latter are concentrated in the Chittagong hill tracts (Barkat et al., 2009).

For generations, the Adivasi have practiced a diversified livelihood strategy combining crop and livestock farming, fishing in wetlands (for fish and other aquatic animals, including crustaceans and mollusks), and hunting of small terrestrial animals and birds (Barkat et al., 2009). Unlike the mainstream Bengali population, the Adivasi originally inhabited sparsely populated areas with ready access to natural resources. Despite a strong community leadership system and high

degree of social coherence, Adivasi livelihoods are increasingly in jeopardy due to a combination of social, economic, and ecological factors, which include increasing incidences of land dispossession and eviction from ancestral lands (Barkat et al., 2009; Kapaeng Foundation, 2011); declines in natural fisheries resources, the major source of dietary animal protein, due to overfishing and environmental degradation; and social marginalization and exclusion from a number of social safety net programs (for example, the ‘Amader’ project) (NETZ, 2011). With the increase in landlessness, working as agricultural wage labor or seasonal migration to cities to take up unskilled jobs constitutes the few available livelihood diversification options. As traditional livelihoods are eroding, an increasing majority are trapped in a vicious cycle of poverty which is multidimensional in nature (OPHI, 2011). Over 60% of Adivasi populations in northern and northeastern districts fall below the absolute poverty line, compared to the estimated national average of 39.5% of rural populations living in absolute poverty (IRIN, 2011). The identification and provision of appropriate alternative livelihood options are thus important steps towards reducing vulnerability and increasing resilience in Adivasi communities.

There is growing appreciation of the role of aquaculture in diversification of rural livelihoods. Over 85% of global aquaculture production comes from developing countries in Asia, where aquaculture systems are predominately small scale and family owned, managed and operated

* Corresponding author. Tel.: +60 1 24735606; fax: +60 4 6265530.

E-mail address: j.pant@cgiar.org (J. Pant).

(De Silva and Davy, 2010). Empirical evidence shows that small-scale aquaculture, promoted with due consideration for social, economic and environmental contexts and framed within a shared understanding of livelihood assets and risk management, can substantially improve the livelihoods of poor, vulnerable and marginalized communities, including ethnic minorities (Barman and Little, 2006, 2011; Bhujel et al., 2008; CGIAR, 2007; Haylor and Khemaria, 2007; Hüsken and Holvoet, 2010; Pant et al., 2012). However, it has recently been argued that employment in value chains, servicing forms of commercial aquaculture, may have greater potential to reduce poverty in Bangladesh than the small-scale semi-subsistence or 'quasi-peasant' models that have been widely promoted as poverty alleviation tools in the past (Belton et al., 2012). In addition, conventional approaches, emphasizing the promotion of technology and provision of targeted extension services, have not always been successful in benefiting landless, socially marginalized and extremely poor communities, because these communities are constrained by their limited access to and control over land and water resources and often possess limited human, social and economic capital and struggle to access other development resources, inputs and services for aquaculture (ADB, 2004; Belton and Little, 2011; Lewis, 1997).

These limitations have led some to argue that aquaculture is an inappropriate livelihood option for ultra-poor, socially marginalized people (Lewis, 1997). This paper challenges that view, based on outcomes associated with implementation of the Adivasi Fisheries Project, a food security-focused project aimed at diversifying livelihood options for resource-poor, marginalized Adivasi communities in the North and Northwest of Bangladesh during 2007–9. Rather than adopting a 'one-size-fits-all' approach, the project set out to devise and adapt aquaculture technologies and related enterprise options to match the existing physical and human asset base and social and economic contexts and aspirations of Adivasi communities. Following participatory processes throughout (from mapping and analyzing aquaculture value chains and situation analysis to devising appropriate intervention options, implementation and evaluation of results) the project, this focused on building productive livelihood assets, knowledge and skills, considering the specific needs, resources and capabilities of Adivasi households. The project was the first of its kind to specifically promote aquaculture intervention options for Adivasi communities in Bangladesh. This paper outlines the processes followed in identifying appropriate intervention options and planning and implementing activities. The paper also reports livelihood changes realized by resource-poor Adivasi households following the project intervention and discusses the potential of applying this approach to improving livelihoods in other marginalized communities.

2. Methodology

2.1. Scoping and diagnostic studies

A pre-project reconnaissance study was carried out by an interdisciplinary team of scientists and development professionals from WorldFish and project partners Caritas (an international NGO) and the Bangladesh Fisheries Research Forum (a consortium of national universities, government and other institutions conducting research on the fisheries sector of Bangladesh) to assess the initial livelihood context of Adivasi communities and identify high-potential interventions. Consultations with Adivasi communities and other key stakeholders were made across the region by the study team. The diagnostic study specifically focused on understanding livelihoods and resource-base contexts, developing criteria for selection of project sites and households, and identifying aquaculture and related livelihood options relevant to the needs of the communities. Partners with experience in implementing development projects in Adivasi communities were also consulted at central and local levels. A total of 42 and 93 stakeholders representing various GOs/NGOs were consulted at district and sub-district levels, respectively, across five districts of the North and Northwest Regions of Bangladesh. The meetings were also attended by representatives of Adivasi communities.

The meetings were followed by stakeholder workshops at Caritas Regional Office, Dinajpur, Northwestern Region, and at Caritas Regional Office, Mymensingh, Northern Region. A project inception workshop was held in Dhaka, where the outcomes of the regional stakeholder consultation workshops were presented.

2.2. Recruitment of project participants and selection of technological options

A census of 5337 Adivasi households was carried out across five districts in North and Northwest Bangladesh in 2007. Over two-thirds of these households, which were categorized as extremely poor based on well-being ranking exercises, were chosen as project participants. In total, 3594 households were selected from 120 communities in twelve sub-districts of Sherpur, Netrakona, Rangpur, Dinajpur and Jaypurhat districts (Fig. 1; Table 1). A total of seven livelihood intervention options in aquaculture production or aquaculture value chains were identified as potentially suitable given the resource base and social and economic contexts identified during the participatory consultation process (Table 1).

Selection of project households was based on income, size of land holdings and food security status. Those households with ownership of or access to assets suitable for fish culture, such as ponds, rice fields and community aquatic resources, were selected for aquaculture production interventions. Landless households without the physical or economic resources were selected for inclusion in upstream and downstream aquaculture-related value chain enterprises, such as fingerling and food–fish trading and pond netting.

2.3. Baseline and end-line surveys

A baseline survey of 657 households, randomly selected from the total project households (3594), was carried out using a structured questionnaire on the asset-base and livelihood portfolios of the participating households. Recent fisheries graduates were hired as enumerators and trained to administer the questionnaire. An end-line survey was conducted upon completion of the project in 2009 of households that had participated in the baseline survey to assess the nature and extent of changes resulting from project interventions. One hundred and forty-eight Adivasi households that had opted not to participate in the project or lived in nearby villages were also surveyed in order to allow for comparisons between intervention and non-intervention households to be made. This group cannot be considered a control in the strictest sense, however, because of the possibility of them being influenced by households participating in the project (see Table 1).

A study of the sustainability of the Adivasi Fisheries Project interventions was carried out in 2012, 30 months after the end of the project. An interdisciplinary team of researchers revisited randomly selected communities in the Northwest Region, Bangladesh. Participatory tools and techniques, including focus group discussions (FGDs) with farmer field school (FFS) members, key informant interviews (KIIs) with community leaders and FFS facilitators, observations, and consultations with other stakeholders were used. Objectives were to assess whether project participants were continuing with aquaculture production and other aquaculture value chain-related activities introduced by the project, whether sustained adoption varied with activities promoted by the project, the causes of any variations in uptake, and likely future outcomes. An ex-post evaluation conducted by the project donor in 2010 provided additional qualitative data on project sustainability.

A participatory process was followed throughout the project's implementation. Project participants were introduced to the potential activities identified through the scoping study and allowed to choose which best matched their resource base and interests. Most households either owning or with access to land decided to practice pond culture or rice–fish culture. Most landless households adopted aquaculture-related enterprises such as food–fish or fingerling trading or pond netting, or

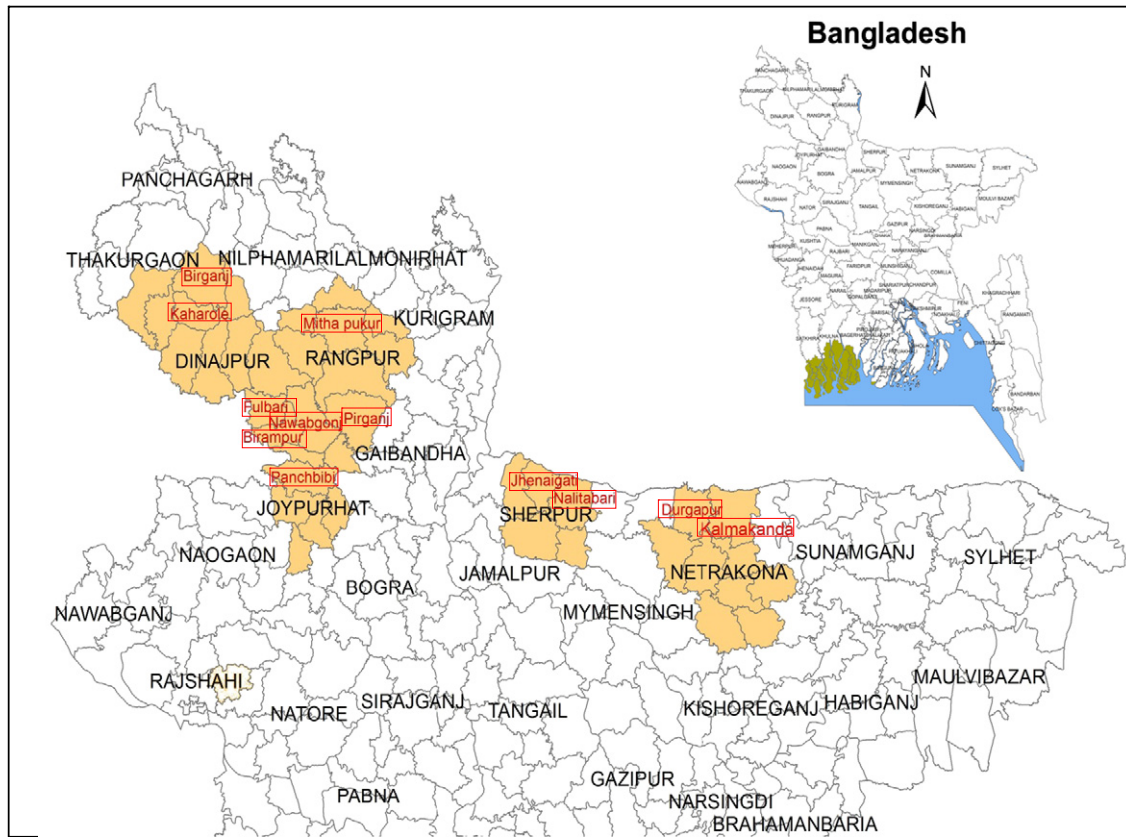


Fig. 1. Map of Bangladesh, showing the geographical coverage of the Adivasi Fisheries Project. The project districts are in orange and sub-districts are denoted by red color fonts.

opted to practice cage aquaculture in private or community ponds with the project’s help to secure access on their behalf. Community-based fisheries management (CBFM) and resources restoration was also chosen as a livelihood option by one group comprising landless and smallholder households (Table 1).

2.4. Farmer field school approach

The farmer field school (FFS) approach, which is effective in developing participatory analyses of problems and their causes and identifying

solutions in a wide range of agricultural interventions (Banu and Bode, 2002; Feder et al., 2004) was chosen to develop capacity and empower Adivasi households to plan, implement, monitor and evaluate livelihood diversification interventions. The FFS methodology adopted by the project was developed following a review of FFSs implemented in project areas by a variety of development institutions, including the Department of Agriculture Extension (DAE), CARE and Rangpur–Dinajpur Rural Service (RDRS). A total of 120 FFSs were formed across the five project districts. Selected project staffs were provided with Training of Trainers (ToT) courses on FFS. In every FFS, participants practicing each activity

Table 1
Value CHAIN-based aquaculture livelihood options of Adivasi households by resource base.

Livelihood options	Selection criteria	Households enrolled (n)	Sample households (n)
Aquaculture			
Pond culture	Pond owners	1238	132
Rice–fish culture ^a	Rice farmers	527	84
Cage culture ^b	Landless ^c households; mainly female members	488	77
Aquaculture VC-related activities			
Food–fish trading	Largely female members of landless households	403	63
Fingerling trading	Landless ^c households	154	42
Pond netting ^d	Male members of landless households	743	77
Community-based fisheries management (CBFM) ^e	Community groups	41	34
Non-project participant	Non-project participants but nonetheless willing to respond to surveys carried out by the project	0	148
Total		3594	657

Notes: n = number of cases.

^a Simultaneous culture of rice and fish in the same area of land.

^b 1 m³ bamboo frame and net covered boxes, submerged in water bodies, used to rear fish or fingerlings.

^c Functionally landless, possessing 0 to 50 decimal (1 decimal = 40.47 m²) land holdings.

^d Variable-sized teams who provide contract pond-harvesting services.

^e Community groups formed to manage access and exploitation of common-property water resources for fish and other aquatic food services.

promoted by the project were chosen to act as 'Lead Entrepreneurs' (LEs), responsible for leading and coordinating FFS sessions, and were provided with two to four days of training. Female FFS members were encouraged to become LEs, and it was made mandatory to have at least one woman LE per FFS. FFS members met fortnightly, and LEs ran sessions while project staff facilitated the process. In addition to regular meetings, farmers took part in exchange visits, field days and result demonstrations organized by the project. The FFS members also participated in rallies during the annual National Fish Week.

2.5. Support for asset development

Because project participants came from landless and marginalized communities, some support was provided for acquiring inputs or building productive assets (e.g., pond excavation or renovation and modification of rice plots for rice–fish culture) to catalyze the adoption process, particularly in the first year. Other than the provision of cash as operating capital for fingerling and food–fish trading, support for asset development was generally provided in kind (Table 2). Efforts were also made to ensure that participants did not become subsidy dependent.

2.6. Analyses of food and nutrition security and sustainability

Food and nutrition security, two of the major indicators of changes in livelihoods of the poor, were assessed from changes in number of meals with major sources of daily energy, including rice, bread and animal-source foods namely, fish, meat and eggs.

Long-term sustainability of the adoption of livelihood options promoted by the project and the factors influencing their retention were assessed using data collected during a rapid post-project appraisal conducted in selected FFS groups in Dinajpur in 2012 and an ex-post project monitoring (Results-Oriented Monitoring, ROM) conducted by the project donor (EU) in late 2010 (Tim, 2010).

2.7. Data sources and analyses

The bulk of data used in the analysis which follows was generated by project baseline and end-line surveys. Additional FGDs, KIs and participant observation were used as sources of qualitative information, as were the post-project sustainability assessments. Data were analyzed using the Statistical Package for the Social Sciences (SPSS 18.0) for Microsoft Windows. The statistical tests generally included measures of central tendency and analyses of variance (ANOVA). The post hoc test, least significant difference (LSD), was performed when ANOVA showed significant differences.

The analytical framework used throughout the paper is based on the sustainable livelihoods approach (SLA) promoted by the Department for International Development (DFID, 2001). The SLA is founded on the principle that increasing access (ownership or rights to use) to

livelihood assets or capital—natural, physical, social, financial and human—is essential to reduce vulnerability and increase adaptive capacity of resource-poor, marginalized communities (DFID, 2001).

3. Aquaculture intervention and changes in livelihood assets

3.1. Land and pond holdings

Land is one of the most critical livelihood assets, not only due to its direct benefit to households but also because it is one of the major indicators of people's sense of social well-being in rural Bangladesh. At the time of project inception in 2007, nearly half of participants were found to be functionally landless (i.e., owning <50 decimals (1 decimal = 40.47 m²) of land) (Table 3). This is considerably higher than the average level of landlessness for the general population in Bangladesh (Hossian and Bayes, 2009; Mainuddin et al., 2011).

Project participants chose technology intervention options largely based on their landholding status. Around two-thirds of the participants in aquaculture value chain-related activities groups (pond-netting groups and fish and fingerling traders) and cage-culture groups possessed <25 decimal. Pond aquaculture and rice–fish farmers were relatively better off, with around half of them owning >100 decimal. Similar trends have been observed by Belton et al. (2012) with respect to pond ownership and by Nabi (2008) with respect to rice–fish culture.

Unlike the general trend of increasing landlessness in Bangladesh (Hossian and Bayes, 2009), the proportion of landless households among the project participants was noted to have declined slightly in 2009, regardless of the intervention group (Table 3). This appeared to be as a result of project participants earning sufficient money to enable them to reclaim land that they had previously mortgaged out to others.

Almost all households in the pond-culture group owned a pond. By contrast, only a small proportion of households engaged in fish trading, fingerling trading or who were members of pond-netting groups owned a pond in 2007, due largely to the fact that most were landless or almost landless. However, by 2009 there was a small increase in pond ownership among landless groups. In addition, a number of households, especially those engaged in food–fish and fingerling trading and pond netting were found to have expanded their asset base by renting ponds for nursing.

3.2. Livestock and poultry

Livestock and poultry are important for resource-poor households since they are readily liquidated as cash, thus serving as an economic 'safety net'. The proportions of households raising cattle/buffalo and sheep/goats in 2007 were estimated at 67% and 45%, respectively (Table 4). Relatively large numbers of pond culture and rice–fish culture group members possessed cattle/buffalo. On average, livestock-raising

Table 2
Support^a provided to Adivasi households for livelihood asset development (US\$/household).

	Support provided	Amount (US\$/household)
Aquaculture		
Pond culture	Renovation of ponds, production inputs (fingerling, fertilizer and feed)	70.6
Rice–fish culture	Construction of ditches, modifying dikes, and fry/fingerling	30.2
Cage culture	Materials for nylon net cages (1 or 2 1-m ³ size cages/HH); construction of cages done by themselves using bamboo for the frame	29.7
Aquaculture VC-related activities		
Food–fish traders	Small amount of cash as seed money to buy food fish, weighing balance	39.7
Fingerling traders	Small amount of cash to buy containers, fingerling, weighing balance	39.7
Pond netting team	Two seine nets (45 m), one for food fish and one for fingerling harvest	29.8
CBFM	Fish fingerling, snails, mussels, crabs, turtle, freshwater eels seed for stocking in the floodplains	30.9

^a Support was provided in kind for asset development except food–fish and fingerling–trading groups, who were provided with cash as operating capital.

Table 3Distribution of households (%) by size of land holdings (decimal) by intervention group. 1 decimal = 40.47 m².

Intervention group	Households (%) by land-holding group									
	2007					2009				
	Landless	<25	25–50	51–100	>100	Landless	<25	25–50	51–100	>100
Aquaculture										
Pond culture	0.0	14.4	10.6	21.2	53.8	0.0	15.2	18.2	16.7	50.0
Rice–fish culture	0.0	11.9	11.9	14.3	61.9	0.0	13.1	10.7	15.5	60.7
Cage culture	2.6	48.1	10.4	15.6	23.4	0.0	46.8	18.2	14.3	20.8
Aquaculture VC-related activities										
Food–fish trading	3.2	60.3	9.5	4.8	22.2	0.0	57.1	12.7	9.5	20.6
Fingerling trading	9.5	66.7	7.1	4.8	11.9	0.0	71.4	2.4	7.1	19.0
Pond netting	5.2	67.5	1.3	6.5	19.5	0.0	61	11.7	2.6	24.7
CBFM	0.0	32.4	17.6	5.9	44.1	0.0	32.4	14.7	8.8	44.1
Non-project participant	2.7	26.4	11.5	14.9	44.6	2.0	27.0	15.5	16.9	38.5
Total	2.4	35.6	9.9	13.1	39.0	0.5	35.2	14.2	12.9	37.3

households owned 2.5 head of cattle/buffalo and 2.2 head of sheep/goats. The proportion of those raising cattle/buffalo and sheep/goats remained relatively unchanged during the project period (Table 4).

Nevertheless, a small increase was noted in the proportion of the households raising pigs and chickens/ducks during 2007–9, indicating that resource-poor Adivasi households were switching to animals that can be raised on the homestead. Unlike cattle/buffalo and sheep/goats, husbandry of which is time consuming because they require special attention, pigs and chickens/ducks can be raised with relatively little effort alongside other livelihood activities, including aquaculture and related enterprises. Pig and poultry rearing therefore represent a good strategy for increasing per-unit returns to labor and diversifying livelihood portfolios.

There was no statistically significant variation ($p > 0.05$) in the proportion of households raising pigs and chickens/ducks among technology intervention groups.

Table 4

Change in livestock holding size (n) by year across intervention groups.

Intervention	Cattle/buffalo		Sheep/goat		Pig		Chicken/duck/pigeon	
	Mean	n	Mean	n	Mean	n	Mean	n
2007								
Aquaculture								
Pond culture	2.7	93	2.6	59	1.5	39	10.4	110
Rice–fish culture	3.2	72	3.4	34	1.5	27	12.3	74
Cage culture	2.0	48	2.2	41	1.1	15	10.8	64
Aquaculture VC-related activities								
Food–fish trading	2.3	36	2.6	25	1.5	19	11.1	57
Fingerling trading	1.9	28	2.3	23	1.3	16	11.3	37
Pond netting	1.9	39	1.6	31	1.4	17	7.1	60
CBFM	2.0	22	1.8	22	1.2	9	6.6	34
Non-project participants	2.8	103	2.2	62	1.6	48	7.6	116
2009								
Aquaculture								
Pond culture	2.9	94	2.6	58	1.7	54	13.0	124
Rice–fish culture	3.4	64	2.7	32	1.8	29	11.3	75
Cage culture	2.0	51	2.5	35	1.5	22	10.3	66
Aquaculture VC-related activities								
Food–fish trading	2.3	32	2.0	21	1.3	19	12.1	54
Fingerling trading	1.8	28	3.0	19	1.7	15	12.1	36
Pond netting	2.0	41	2.6	25	1.8	28	7.7	69
CBFM	2.0	26	1.8	18	1.3	14	8.8	34
Non-project participants	2.6	104	2.6	54	1.8	50	9.4	127

n = number of cases.

3.3. Physical assets

The proportions of households possessing key physical assets in 2007 and 2009 are presented in Table 5. Rickshaws, bicycles and mobile phones were important aquaculture-related livelihood assets, while others included tube wells, sewing machines, radios, televisions and furniture, particularly chairs and cupboards. In general, the proportion of households with these assets increased between 2007 and 2009, although differences among intervention groups were also observed. Interestingly, increases were apparent in the most resource-poor groups, namely fish netting, fish and fingerling trading, and cage culture, most of whose members were either landless or nearly landless.

Bicycles and rickshaws are important livelihood assets of poor households in Bangladesh. A small number of Adivasi households—regardless of technology intervention group—possessed rickshaws in 2007; the figure remained little changed in 2009. Overall, there was some increase in the number of bicycle-owning households during the project period (33.5% in 2007; 38.5% in 2009) (Table 5). Bicycles are the most versatile means of transport in rural Bangladesh, being used to carry people and goods even in remote areas without road links. Fingerling traders and pond-netting groups need to travel for their work, and among these groups the proportion of bicycle-owning households increased notably, reflecting the importance of bicycles as a livelihood asset.

One notable change was in mobile phone ownership. The proportion of households possessing mobile phones was clearly increased in both project intervention and control groups over the project period (Table 5). Although fish and fingerling traders and fish-netting groups were among the poorest, their use of mobile phones increased

Table 5

Changes in proportion (%) of households on ownership of selected physical assets by intervention group.

Intervention group	Households (%)						
	Mobile phone		Bicycle		Rickshaw		n
	2007	2009	2007	2009	2007	2009	
Aquaculture							
Pond culture	28.8	55.3	50.8	50.8	6.1	3.0	132
Rice–fish culture	17.9	46.4	44.0	45.2	3.6	11.9	84
Cage culture	26.0	42.9	9.1	31.2	2.6	13.0	77
Aquaculture VC-related activities							
Food–fish trading	11.9	71.4	50.0	69.0	16.7	14.3	42
Fingerling trading	4.8	25.4	27.0	30.2	11.1	7.9	63
Pond netting	2.6	35.1	26.0	24.7	7.8	9.1	77
CBFM	14.7	17.6	14.7	11.8	8.8	8.8	34
Non-project participants	15.5	30.4	31.1	34.5	8.8	8.8	148
Total	16.9	40.9	33.5	38.2	7.5	8.8	657

n = number of cases.

Table 6
Changes in household incomes (US\$) by intervention group.

	Household (HH) income (US\$)													
	Fish								Total					
	2007				2009				2007			2009		
	Mean	SD	n	% of HH income	Mean	SD	n	% of HH income	Mean	SD	n	Mean	SD	n
Aquaculture														
Pond culture	55.6 ^a	71.6	113	15.4	158.0 ^c	129.2	131	26.2	361.0 ^{bc}	297.7	128	603.8 ^{bc}	424.4	131
Rice–fish culture	45.1 ^a	56.1	66	16.5	143.9 ^{bc}	155.3	82	26.3	273.0 ^a	223.5	79	546.8 ^{abc}	474.4	84
Cage culture	38.8 ^a	39.7	24	12.0	59.1 ^a	66.2	77	11.8	323.4 ^{ab}	140.2	75	500.0 ^{ab}	320.9	77
Aquaculture VC-related activities														
Food–fish trading	117.8 ^b	189.7	20	31.6	319.7 ^d	229.2	62	48.7	372.4 ^{bc}	195.5	63	656.5 ^c	303.1	63
Fingerling trading	34.3 ^a	47.5	13	9.0	291.5 ^d	263.6	41	47.8	379.2 ^{bc}	187.2	41	610.1 ^{abc}	253.8	42
Pond netting	59.7 ^a	75.9	58	14.4	103.8 ^{ab}	99.5	77	19.8	415.8 ^c	199.6	76	524.1 ^{ab}	220.9	77
CBFM	30.8 ^a	34.4	34	8.7	173.6 ^c	79.7	34	31.0	354.7 ^{abc}	197.6	34	560.8 ^{abc}	337.0	34
Non-project participants	47.2 ^a	72.0	90	13.5	68.5 ^a	164.9	82	14.0	348.7 ^b	253.2	143	490.7 ^a	420.7	145

Note: n = number of cases; SD = standard deviation of the mean. Mean values with different superscripted letters denote statistically significant differences ($p \leq 0.01$). In all groups, income from fish in 2007 refers to income from capture fisheries and related activities.

tremendously between 2007 and 2009, possibly because their enterprises required more communication than others.

4. Changes in household income and savings

4.1. Household income

Average annual income of Adivasi households targeted by the intervention was around US\$ 350 in 2007; this number grew significantly ($p \leq 0.01$), reaching over US\$ 570 in 2009. This equates to an inflation-adjusted compound annual growth rate of approximately 8% per annum. Such a substantial increase in income is indicative of the improved livelihood situation of the project participants in general, although their income remained well below the average estimated income of US\$ 1702 for a rural household in Bangladesh in 2010 (BBS, 2011). Increases in total annual income were noted in all the technology intervention groups (Table 6). The change in annual household incomes appears to reflect the successful diversification of livelihood portfolios by Adivasi households.

There was a significant increase ($p \leq 0.01$) in the proportionate contribution of aquaculture or related value-chain activities to the household income in all intervention groups in 2009, reaching 29% (Table 6). Estimated at only around 15% of the total, the same was somewhat low in 2007. However, no such increase was evident in the case of non-project households.

Variations in the contribution of aquaculture or related enterprises to the household incomes by intervention group were also evident in 2009 ($p \leq 0.01$), which was not the case in 2007 ($p > 0.05$). The

proportionate contribution of aquaculture to the income of cage-culture and non-project households remained fairly unchanged. By contrast, aquaculture value-chain groups, particularly those comprising fish and fingerling traders, realized a substantial rise ($p \leq 0.01$) in the relative contribution of these activities to household incomes, confirming its growing relevance to livelihoods. Pond culture and rice–fish culture groups also realized a significantly higher contribution of aquaculture to their household incomes ($p \leq 0.01$) compared to the control group, but it remained lower ($p \leq 0.01$) than that in fish and fingerling trader groups (Table 6).

4.2. Savings

Corresponding to the total annual income (Table 6), Adivasi household savings increased markedly between 2007 and 2009. On average, households were saving only around 9% of the total income in 2007, which was estimated to have increased to 25% in 2009 – an almost three-fold increase (Table 7). All but fingerling-trading groups realized a notable rise in savings over this period. It may have been that fingerling-trading groups substantially increased expenditure on livelihood assets in 2009 compared to 2007, thereby accounting for the relatively low level of savings among these groups (Table 7). Fish-trading and cage-culture groups saved more than 20% of their household incomes, which approximated the savings made by relatively better-off groups (pond culture and rice–fish culture). Both cage-culture and fish-trading activities were largely carried out by female members. The higher savings in these groups indicate that female household members tend to invest more of their incomes in savings,

Table 7
Changes in savings (US\$) of Adivasi households by intervention group.

Intervention group	Savings (US\$)							
	2007				2009			
	Mean	Median	SD	n	Mean	Median	SD	n
Aquaculture								
Pond culture	41.4 ^a	20	57.5	97	194.2 ^{de}	55.6	254.7	113
Rice–fish culture	41.2 ^a	14.6	71.6	67	225.2 ^e	37.2	372.1	65
Cage culture	25.5 ^a	13.7	27.1	55	106.3 ^{abc}	19.3	191.5	65
Aquaculture VC-related activities								
Food–fish trading	19.3 ^a	6.8	29.5	46	155.4 ^{bcde}	41.8	210.8	53
Fingerling trading	20.1 ^a	6.9	42.1	35	26.8 ^a	15.5	34	32
Pond netting	26.3 ^a	14.9	32.9	51	80.8 ^{ab}	34.3	122.3	64
CBFM	29.9 ^a	7.4	63.4	26	229.9 ^{cde}	10.3	680	23
Non-project participants	52.5 ^a	13.7	150.6	109	129.8 ^{abcd}	34.3	224	103

Note: n = number of cases; SD = standard deviation of the mean. Mean values with different superscripted letters denote statistically significant differences ($p \leq 0.01$).

Table 8
Changes in food and nutrition security of Adivasi households, as measured by frequency of meals/month.

Food security	Frequency (times/month)																	
	2007									2009								
	Rice/bread			Fish			Meat and eggs			Rice/bread			Fish			Meat and eggs		
	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n
Aquaculture																		
Pond culture	79.1 ^a	9.9	132	9.6 ^{ab}	5.8	132	6.5 ^a	4.9	122	81.3 ^{ab}	7.6	132	25.2 ^c	14.6	132	10.0 ^a	8.5	122
Rice–fish culture	77.1 ^a	11.5	84	11.5 ^c	7.5	84	6.8 ^a	5	76	81.4 ^{ab}	7.5	84	26.7 ^c	15	84	10.2 ^a	7.9	75
Cage culture	79.5 ^a	9.3	77	10.7 ^{bc}	6.6	77	6.1 ^a	4.2	70	81.9 ^{bc}	6.7	77	22.7 ^{bc}	12.9	77	9.3 ^a	8	72
Aquaculture VC-related activities																		
Food–fish trading	78.8 ^a	9.6	63	9.1 ^{ab}	6.3	63	6.3 ^a	5	56	82.3 ^{bc}	6.5	63	25.4 ^c	14.3	63	9.8 ^a	7.2	55
Fingerling trading	77.5 ^a	9.4	42	12.0 ^c	4.5	42	5.5 ^a	3.8	33	80.4 ^{ab}	8.8	42	16.3 ^a	7.3	42	9.3 ^a	6.9	39
Pond netting	76.8 ^a	11.3	77	12.3 ^c	7.6	77	6.8 ^a	5.1	69	80.1 ^{ab}	8.8	77	24.4 ^c	15.1	77	8.1 ^a	5.1	67
CBFM	77.5 ^a	11.5	34	8.4 ^{ab}	3.7	34	4.4 ^a	1.9	32	79.8 ^{ab}	8.6	34	17.4 ^{ab}	11.8	34	9.5 ^a	7.4	27
Non-project participants	77.3 ^a	11.4	148	7.4 ^a	5.7	147	5.1 ^a	4.6	148	79.6 ^a	9.5	148	18.2 ^{ab}	13.3	147	7.7 ^a	7.6	148

Note: n = number of cases; SD = standard deviation of the mean. Mean values with different superscripted letters denote statistically significant differences (p ≤ 0.01).

as has been observed in communities elsewhere (Chowa, 2006). Pond-netting groups comprised only men, and although their savings had increased by 2009, they were still proportionally well below the savings of cage farmers and fish traders.

5. Food and nutrition security

In general, an average Bangladeshi household from a mainstream community eats three meals a day, but it is not uncommon to find many households, particularly from resource-poor, socially marginalized Adivasi communities, eating less frequently. Rice and/or bread (*roti*) are included in every meal, while inclusion of meat or fish depends on livelihood situation – well-off households consume fish at almost every meal, whereas poor households only occasionally consume fish or meat, primarily due to poor economic access.

Adivasi households, regardless of technology intervention, did not necessarily eat three meals per day. In 2007, the monthly frequency of consumption of rice/bread was estimated to be 78, confirming their food insecurity situation. In 2009, there was an overall increase in the number of meals, particularly of rice and bread, where the frequency realized was closer to an average of three meals per day (2.7). No statistically significant differences were noted (p > 0.05) in monthly frequency of cereal/bread consumption between intervention and control groups.

Mean monthly frequency of consumption of fish and meat/eggs by Adivasi households in 2007 was estimated at ten and seven, respectively, which is clearly low compared to rural households in mainstream communities. However, a substantial increase in animal-source food consumption, particularly of fish, was noted in 2009 (p ≤ 0.01). The

average frequency of fish consumption per month among project participants in 2009 was estimated at 24, over twice that estimated during the same period in 2007. Although similar increases were also noted in the non-project households, the frequency of fish consumption was clearly higher among aquaculture and related value-chain intervention groups. It is customary for fish-netting team members to be given some fish free of charge as part of the remuneration from pond owners on the day of fish harvest. This is perhaps the reason for the impressive increase in the frequency of fish consumption among such households in 2009 compared to 2007 (Table 8). Likewise, food–fish-trading group members, who were engaged in selling fish throughout much of the year, would set aside some fish for their family consumption on the day they sold fish. Cage farmers too harvested fish to eat as and when they liked due essentially to increased availability and access to fish.

A substantial increase in fish, meat and egg consumption by Adivasi households confirmed the significance of aquaculture and related technological interventions in improving food and nutrition security. It was also associated with increased annual income (see Table 6), reflecting increased consumption of high-value food.

6. Social and institutional aspects

As elsewhere, one of the major characteristics of deprived and marginalized communities in Bangladesh is their low participation in social organizations. Organizing such communities through the formation and strengthening of community organizations is an effective tool for empowerment.

Table 9
Proportion of Adivasi households (%) with membership(s) in community organization(s) (n = number of cases).

Intervention group	Households (%) with memberships in number of community organizations										
	2007					2009					
	0	1	2	≥3	n	0	1	2	≥3	n	
Aquaculture											
Pond culture	3.0	72.0	18.9	6.1	132	0.0	30.3	59.1	10.6	132	
Rice–fish culture	0.0	63.1	19.0	17.9	84	0.0	32.1	56.0	11.9	84	
Cage culture	3.9	58.4	31.2	6.5	77	0.0	45.5	54.5	0.0	77	
Aquaculture VC-related activities											
Food–fish trading	0.0	71.4	19.0	9.5	83	1.6	49.2	38.1	11.1	63	
Fingerling trading	0.0	92.9	7.1	0.0	42	0.0	52.4	45.2	2.4	42	
Pond netting	3.9	76.6	16.9	2.6	77	0.0	45.5	49.4	5.2	77	
CBFM	0.0	70.6	29.4	0.0	34	0.0	70.6	26.5	2.9	34	
Non-project participants	59.5	39.2	1.4	0.0	148	41.9	43.4	4.1	0.7	148	

Table 10
Sustainability of aquaculture and aquaculture value-chain activities of Adivasi Fisheries Project by FFS group across selected locations.

Intervention group	FFS groups						
	Tarala	Mohammadpur	Birnagar Bashpara	Purba Bajitpur	Aira	Patherghata	Khoirgoni
Aquaculture							
Pond culture	++++	++++	++++	++++	++++	++++	na
Rice–fish culture	na	+++	++++	+	+	+	na
Cage culture	+++	++	++++	++	+++	+	na
Aquaculture VC-related activities							
Food–fish trading	+++	+++	++++	na	+++	na	na
Fingerling trading	+++	na	++++	na	na	na	na
Pond netting	++	++++	++++	++++	na	na	na
CBFM	na	na	na	na	na	na	++++

Notes: +++++ = >90% of FFS members continuing or even expansion of membership, +++ = >75%–≤90% of FFS members continuing; ++ = >50%–≤75% of FFS members continuing; + = >50–100% FFS members have discontinued membership for various reasons; na = not applicable as the practice was not introduced to these communities.

Source: Consultations with farmer field school members, 2012.

An increase in the involvement of Adivasi households in community organizations was evident in 2009. Over two-thirds of households had membership in a single organization in 2007, while a small proportion of households did not belong to any organizations, and over a quarter were attached to two or more. However, a tremendous increase in the proportion of Adivasi households attached to more than one community organization was noted in 2009 (Table 9). With the exception of non-project households, all households had membership in one or more organizations by 2009. Membership ranged from crop, livestock, fish-production and marketing groups to various social and microfinance groups set up by GOs/NGOs working in the area. Farmer field schools set up by the project were one of the community groups of which a large majority of Adivasi households were members.

The low participation of Adivasi households in community organizations is not only caused by poverty but also by social marginalization. Adivasi were discriminated against on the basis of a number of social prejudices; for example, they were labeled as drunkards, nomadic people, etc. (NETZ, 2011). Nevertheless, ensuring their increased participation in social and community organizations was an appropriate way to enable them to raise their voices, thereby increasing their social integration. The increase in participation in community organizations is a strong indication of the indirect contribution of the Adivasi Fisheries Project to empowerment.

7. Sustaining aquaculture interventions in Adivasi communities: opportunities and issues

The above sections clearly show that promotion of aquaculture and related livelihood interventions via the project improved food and nutrition security, augmented household incomes, increased livelihood assets and built social capital, even among the poorest sections of Adivasi communities. However, it is not uncommon for livelihood interventions that are successful during the project support period to ultimately fail after the project support is removed. This is particularly prevalent among resource-poor and marginalized people and occurs for a variety of reasons, including their inability to cope with changing social, economic and ecological contexts. Nevertheless, the overall rate of retention of aquaculture and related livelihood options among Adivasi was found relatively high for activities such as pond–fish culture, pond netting, and food–fish and fingerling trading, in which 80–90% of the project participants were continuing with the activities they had adopted during the project period, while 20–30% of participants had even expanded their enterprises in the years subsequent to the project ending. However, differences in retention of technological options and related interventions were observed, as was also evident across locations (Table 10).

Pond-culture groups were continuing to operate in all locations; many households also having expanded the size of their ponds and

intensified the fish-production system through better feeding and management. However, some of those engaged in rice–fish farming had abandoned the practice. Of the five FFS groups visited in 2012 where the project had introduced rice–fish culture technology, one had stopped rice–fish production completely due to flooding and water shortages, and a majority of the group members had discontinued the practice. However, production in another community had expanded by a small number of plots, and in yet another community the number of rice–fish plots remained the same as during the project period. Earlier studies suggest that low adoption and retention of rice–fish technology among marginal farmers in Bangladesh was associated with their low access to resources, technologies, extension and financial services, as well as lack of labor time for rice–fish activities due to their heavy engagement in off-farm jobs for wage earnings (Gupta et al., 1999). Barman and Little (2006) confirmed that resource-poor farmers in areas with high off-farm employment and various other income generating opportunities were relatively less engaged in rice–fish farming. These are possible reason(s) for varying degrees of success in adoption and retention of rice–fish farming among Adivasi households across the locations in this study.

The post-project ROM study carried out for the European Union in 2010 reported that secondary adoption of pond culture and rice–fish culture had occurred in several of the locations visited by the monitoring mission, but that—unsurprisingly—those with access to land or ponds were more likely to become secondary adopters than those without (Tim, 2010).

The rate of retention of aquaculture-related technology options among landless groups was also high. Few who were operating as food–fish and fingerling-trading groups had abandoned the practices, irrespective of location. It was evident that pond-netting teams were continuing in most locations, only a small number in a few locations having discontinued the practice. Of four netting teams visited in 2012, three had expanded by increasing the number of nets and group members, and one had broken up, but with some of the members of the latter joining a mainstream Bengali netting team (Table 10). The EU ROM mission in 2010 concluded that the activity would probably prove sustainable, given that ‘netting is in demand, profitable and a preferable activity to the alternative of daily agricultural labor’. The ROM mission also noted that for all the aquaculture-related enterprises initiated, the beneficiaries were seen to be continuing competently, confidently and profitably. They concluded that there were good prospects for these enterprises to continue, as aquaculture in Bangladesh is expanding rapidly (Tim, 2010).

The sustainability of small-scale cage aquaculture in Bangladesh has been debatable to date given the limited long-term successes of interventions, including the high-profile Cage Aquaculture for Greater Economic Security (CAGES) project run by CARE in the past (Hambrey et al., 2001; McAndrew et al., 2000). Corroborating previous

experiences, retention of cage culture was noted to be relatively low in Adivasi communities in most locations. Maintenance of cages was a major problem in many areas, as nets required for repair were not readily available. In addition, if available, netting could not be purchased in the small quantities needed to make low-volume cages, despite project participants expressing the wish to buy these materials so that they could continue with cage culture. However, despite cages being located in water bodies that were not owned by project participants, access issues were not found to have resulted in rejection of cage technology. Interestingly, in Aira, the number of cages in one of the communities revisited in Dinajpur was found to have dramatically expanded from 14 in 2007 to seventy-two in 2009, which subsequently fell to 55 in 2010 and to only three in 2012 due primarily to difficulty in acquiring materials to renovate the cages. However, in Birnagar Bashpara community in Jaypurhat, the number of households with cages increased from five to 13 between 2007 and 2012. This was made possible by an LE who helped secure netting materials on behalf of the group, indicating a strong group approach with dynamic leadership as key to success. Given the strong community leadership system prevalent among Adivasi communities, sustainability of aquaculture and related technological interventions was also noted to vary with community leaders' willingness and ability to mobilize their community. In general, retention of aquaculture production and associated enterprises was correspondingly high in those areas where community leaders were proactive in mobilizing their communities (for example, Birnagar Bashpara community in Dinajpur). By contrast, expansion was limited in areas where community leaders were more passive in encouraging and mobilizing their communities (Table 10).

It is important to note that the sustainability of the livelihoods of resource-poor Adivasi households depends not only on the continued viability of income-generating activities, but also on continued access to aquatic resources. This was evident for the single community-based fisheries group established under the project, which was revisited in 2012 and was found to be continuing with the management of community aquatic resources for production of culturally significant living aquatic resources (especially crabs, snails and swamp eel) for subsistence consumption (Table 10). However, it proved difficult to secure access to floodplains on behalf of other Adivasi communities while the project was active. Scaling up interventions of this type thus may be problematic.

The ROM mission also concluded that the FFS groups formed under the project had proved sustainable, noting that few had been abandoned since the project ended and that in some cases, new members had participated in the meetings. The ROM mission report (Tim, 2010) stated that 'there is no doubt that beneficiaries find the meetings useful and intend to continue attending and using the meetings to get information to help them improve their activities'. During the follow-up study conducted in 2012, groups continued to exist in name, but discussions regarding aquaculture were found to continue to occur informally, rather than as part of organized sessions. In one community visited, the FFS continued to meet regularly under the dynamic leadership of its LE, who continued to actively promote aquaculture in the community. This indicates the importance of the role played by individual agency in sustaining institutions. However, it may be argued that where formal meetings had ceased to take place the FFS groups had already served their purpose in supporting the establishment of aquaculture and related activities and had been replaced by less formal arrangements.

8. Conclusions

The present paper has reported on the outcomes and sustainability of a development project that promoted aquaculture and related enterprises among Adivasi ethnic minority communities, who comprise some of the poorest and most socially excluded groups in Bangladesh. A key finding of the paper was that, in contrast to conclusions drawn elsewhere, aquaculture and associated enterprises such as pond netting and fingerling and food–fish trading can be adopted and maintained by

the extreme poor, provided that sufficient attention is given to provide a diversity of appropriate options tailored to the specific needs, circumstances and resource base of the groups and households targeted. These interventions resulted in a marked increase in incomes, savings, and frequency of fish consumption among participating households. Income-generating activities initiated as a result of the project were maintained post project in the short and medium term, with good prospects for future sustainability.

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