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## Present Status and Approaches for the Sustainable Development of Community Based Fish Culture in Seasonal Floodplains of Bangladesh

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**Abstract:** Coordination among the different stakeholders at policy planning, implementation and target beneficiary level, particularly among the agencies responsible for development and management of water resources, agriculture and fisheries, is essential for overall sustainable development. Stocking of larger fingerlings at suitable stocking densities of endemic (rohu, catla, mrigal) and exotic (silver carp, bighead carp, common carp/mirror carp) species should be stocked at varying proportion. Floodplain fish production depends only on the natural fertility of the water bodies. Technological interventions should include the installation of low cost bamboo fencing at water inlet and outlet points and setting of ring culverts for maintaining suitable levels of water for fish culture without hampering the production of rice and other crops in the intervention areas, selective stocking with native and exotic carps, restricted fishing for certain period of time and guarding. It is expected to exert positive influences in enhancing the standing crop and biodiversity of non-stocked species of fishes in the intervention seasonal floodplain. Entry of fish larvae, hatchlings and young fry of wild non-stocked fishes into the seasonal floodplains because of large fence spacing (approximately 1.0 cm), could restrict fishing for certain period, undisturbed habitat and guarding could contribute to higher productivity and enhancement of fish biodiversity in the seasonal floodplains. Proper motivation and effective cooperation of the beneficiaries are extremely important to culture fish in the seasonal floodplains under community based management system. Institutional support and constant vigilance from the Department of Fisheries (DoF) and local administrations are indispensable to ensure the sustainability of fish culture initiatives in the seasonal floodplains. Active participation and involvement of the local community people in all stages of fish culture operation beginning from selection of floodplains, formation of floodplain management committee, planning of fish culture activities, exercise of technical intervention, selective stocking with large fingerlings, guarding, monitoring and supervision, adopting harvesting strategies, marketing and distribution of benefits are extremely essential to ensure sustainability of the program. Mutual trust, sense of respect and good working relationship among the committee members are the basic social elements required for the success of community based fish culture initiatives.

**Key words:** Fish culture, floodplains, water bodies, biodiversity, strategies, sustainability

### INTRODUCTION

The resources for fisheries in Bangladesh are critical to the national economy and livelihoods of millions of poor people. Fish provides a major source of essential dietary nutrients in most households. Due to natural condition and geographical location Bangladesh offers huge fisheries resources with the potential to boost fisheries production. The country's fisheries resources are divided into two major groups such as inland (fresh water) fisheries and marine fisheries. Inland

fisheries occupy an area of 4.58 million hectares (ha) and marine capture covers 1,66,000 km<sup>2</sup>. Fresh water resources are broadly classified into open water fisheries and closed water resources with an area of 4.05 and 0.53 million ha, respectively. The culture fishery includes ponds, ox-bow lakes and coastal shrimp farms. The potential of the inland fishery of Bangladesh is considered to be one of the highest among the inland fisheries of the world. Out of 4,05 million ha of open water fisheries, the flood-plains with an area of 2.8 million ha offer tremendous scope and potential for augmenting fish

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production by adopting the aquaculture-based enhancement techniques (WFC, 2005; DOF, 2005; Rahman, 2010). Haors (large deeply flooded depressions), baors (oxbow lakes) and beels (lakes) are the permanent and semi-permanent standing water bodies in the floodplain, which become inundated during the flooding season and support rich fisheries (Craig *et al.*, 2004). During the rainy season the inundated areas are regarded as seasonal floodplains. Floodplains also contain beels. Beels are part of a riverine complex and are generally formed due to changes in the course of a river, or strengthening of river embankments for flood control (Saha *et al.*, 1990; Saha and Hossain 2002). In simple word, beels are usually deeper depressions in the floodplain (Thompson, 2004).

All these resources offer a unique habitat to support innumerable flora and fish fauna including the crustaceans, molluscs and shellfishes. Inland fisheries production in Bangladesh, as in other exploited floodplain fisheries around the world is strongly related to flood sequence. During the rainy season in extensive river floodplains and deltaic lowlands, floods last several months each year and render the land unavailable for crop production for that period. These water bodies are considerably underutilized in terms of managed aquatic productivity. As open water fisheries resources are still in infancy and offer enough scope for fish production through adoption of fisheries management techniques in a sustainable way. Seasonal floodplains comprise the major share of our open water resources and could contribute significantly in national fish production with a little adoption of fisheries management practices. Sustainable development covers economic, social and environmental goals to meet future challenges. In this regard, community based integrated management of wetlands offers multiple benefits (Vinci *et al.*, 2003). This raises the opportunity to enclose parts of these floodwater areas to produce a crop of specifically stocked aquatic organisms aside from the naturally occurring 'wild' species. The wild species are traditionally fished and remain unaffected by the culture activity. Thereby the overall process results in more high-quality, nutrient-dense food production and offers enhanced farm income for all stakeholders, mainly the poor (Dey and Prein, 2006).

It is estimated that 2.8 million ha of 5.2 million ha of medium and deep flooded areas in the Indo-Gangetic river basin are located in Bangladesh. If 25% of the resources is brought under the community based fish culture systems, 6.7 million people will be directly benefited with the increase in production of fish and other aquatic animals together with associated activities (WFC, 2005). More than one third of the lands in Bangladesh remain under water every year for 4-6 months during monsoon.

These inundated floodplains are rich in nutrients and natural fish food and thus are excellent feeding, breeding and nursery grounds for fish and other aquatic organisms (De Graaf, 2003; De Graaf and Martin, 2003). Das (2002) also reported that the floodplains are extremely rich in nutrients being reflected by rich in organic carbon and high levels of available nitrogen and phosphorus in the soil system. This is reflected in higher biological productivity offering tremendous scope for augmenting culture and capture fisheries.

Floodplains in Bangladesh have different types of resources involving different types of stakeholders (professional and subsistence fisher, rice producer, leaseholder, farm laborers, irrigation pump owners, etc.) (Islam and Dickson, 2007). There are over 12000 public water bodies (Ahmed and Dickson, 2007) including 6034 floodplains. Of these floodplains, 3400 are perennial and 2634 are seasonal (Rahman, 2005; Bernaeseck *et al.*, 1992). Floodplains under private ownership provide a common pool resource during the flood season and are now under extreme pressure from exploitation due to indiscriminate fishing by different users. Many floodplains under public ownership are leased to fisher groups to establish their fishing rights although there is hardly any initiative to protect or enhance the fish stock.

There are innumerable numbers of private seasonal floodplains including beels in Bangladesh which are highly potential water bodies for practicing culture-based fisheries for many reasons. It has been mentioned earlier that these floodplains are very rich in nutrients and natural fish food organisms to allow the stocked fishes to grow faster. Again the seasonal floodplains support higher stocking densities by virtue of their higher natural productivity. Moreover the connection with canals and spillways permits entry of natural fish stocks. Apart from these, floodplains in Bangladesh are considered common property resource. Water and land use in such areas are subject to conflict between multiple resources users (Payne, 1997). Therefore, a holistic management policy with a provision of incorporating all uses could maximize the benefits from the floodplains in sustainable way as effective and efficient management of aquatic resources hold the key to sustainable and environmental friendly fisheries enhancement in floodplains.

#### **FISHERIES PRODUCTION IN BANGLADESH**

The total fish production including inland and marine resources is estimated at 2.7 mt in Bangladesh (DOF, 2010.). About 81% of the fish production (2.19 mt) comes from the inland fresh water resources and the remaining from marine resources (0.5 mt). According to the Fisheries Resource Survey System (FRSS) of Department

of Fisheries (DoF), Bangladesh, the contribution of open water fisheries and closed water resources to fish production is over 1.12 mt (41%) and 1.06 mt (39%), respectively (DOF, 2010). Fish production from different water resources along with their contributions are shown in Table 1 and Fig. 1, respectively.

Floodplains offer immense opportunity to the rural people for fishing for food as well as income (Das, 2002; Pathak *et al.*, 1989). In 1998-99 floodplain fish production was 0.41 mt which reached to 0.82 mt in 2009-2010 accounting for 77% of fish production from inland open waters (DOF, 2010). Considering the natural productivity of the floodplain water bodies, it is obvious that fish production could be increased substantially through extensive aquaculture, adopting a co-management approach.

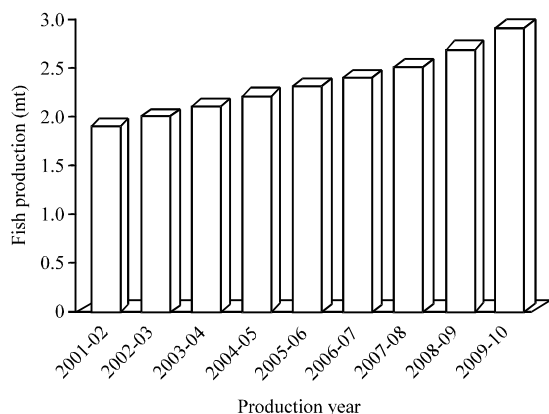


Fig. 1: Fish production of Bangladesh in recent years

Table 1: Total area, capture fisheries and culture fisheries production from different water resources of Bangladesh for the year 2008-2009

Sector of fisheries	Water area (ha)	Total catch (mt)	Catch/Area (kg ha <sup>-1</sup> )
<b>Inland fisheries</b>			
<b>Capture</b>			
River and estuaries	853863	138160	162
Sundarbans	177700	18462	104
Beel	114161	79200	694
Kaptai lake	68800	8590	125
Floodplain	2832792	879513	310
Total inland capture fisheries	4047316	1123925	(41.61%)
<b>Culture fisheries</b>			
Pond and ditch	305025	912178	2991
Boar (Ox-bow lakes)	5488	5038	918
Shrimp/Prawn farm	217877	145585	668
Total inland culture fisheries	528390	1062801	(39.34%)
Total inland fisheries (Capture+Culture)	4575706	2186726	(80.95%)
<b>Marine fisheries</b>			
Industrial fisheries (trawl)		35429	
Artisanal		479215	
Marine total		514644	(19.05%)
Country's total fisheries production		2701370	(100%)

DOF (2007)

## FACTORS INFLUENCING THE FLOODPLAIN FISHERIES

Around the world the floodplain fisheries are influenced by management of the fishery and the state of the environment. Human uses directly modify the form and function of the floodplain and river channels in many cases. These leave an impact on the quantity and timing of river flows and indirectly influence the erosion deposition processes required to maintain the floodplain and the diversity of channel habitats. These processes alter the fishery by influencing the overall abundance of the fish community and the species composition of the fish assemblages present. Fish assemblages of floodplain rivers respond to heavy fishing pressure by undergoing the fishing-down process (Welcomme, 1999). This means the successive loss of the larger species and individuals from the fish assemblage. One of the few means of effective management appears to be the introduction of co-management systems involving increased control of the fisheries by the fishermen themselves (Welcomme, 2008). Nilsson *et al.* (2005) reported that over half of large river systems of the world have been modified by dams. Floodplains are being modified in a number of ways to respond to human needs for living space, agricultural crops, energy and transportation. One major problem is the changes in siltation rates. These operate on the erosion-deposition cycles to maintain the river channels and floodplains. As a consequence, siltation has increased by about 20% through human activities in recent decades (MEA, 2005). Changes occur within the floodplains as they are converted for agricultural use either as permanently dry land or as seasonally flooded rice fields. MEA (2005) estimated that between 56 and 65% of wetlands (mostly floodplains) had been converted for agriculture in Europe and N. America by 1985. Similar figures appeared for Asia which was 27%; S. America 6% and Africa 2%. Certainly the situation has deteriorated still further since 1985 and, with the increasing demand for grain crops worldwide it may be anticipated that the rate of conversion will be accelerated. Many human activities are placing demands on water. Given the pressures on food supplies worldwide, the increasing industrialization of large sectors of the globe and rising living standards in many countries these estimates may prove conservative (Welcomme, 2008). The impacts of dams on aquatic habitats have been summarized by WCD (2000). Water may be abstracted directly from the river, especially for domestic water supply and small scale irrigation schemes. Individual abstractions may not be serious but cumulatively can cause severe depletion of the water especially at drawdown when the amount of water in the river channels is limited.

The major causes responsible for low level of production from the country's open water systems of Bangladesh. These are- lack of policies and plan for development and conservation of water bodies, weak enforcement of existing regulations for conservation of fisheries resources, lack of appropriate development efforts and mitigating measures for improvement of the degraded habitats, lack of information about the stock by species and by location, lack of capacity and initiative for assessment of environment and its impact on aquatic resources, lack of understanding of the socio-economic aspects of the fishing community and the conditions that lead them to irresponsible fishing practices, environmental pollution causing degradation and depletion of resources and lack of awareness and mechanism for community participation in the management of common property open water fisheries resources (Mazid, 2002). In Bangladesh, floodplain fisheries, particularly the inland open water fisheries, have been affected seriously due to the Flood Control, Drainage and Irrigation (FCDI) Project which led the serious consequences causing reductions in fish production i.e. reducing catch per unit area, biodiversity and livelihood of poor fishers (Craig *et al.*, 2004; Ali and Alam, 2005). Historically, inland open water was the major source of fish production in the country, which contributed about 90% of country's fish production in the 1960's. But due to manmade causes, such as destruction of natural habitat by water pollution through agricultural and industrial intensification, over-fishing in the absence of fisheries management and conservation measures, implementation of flood control and drainage projects, fish production in the inland open water, particularly in the rivers and seasonal floodplains, has declined significantly during the last four decades (Ali, 1995; Mazid and Hossain, 1995; Shelly, 2004). The degradation of floodplains resulting from human interferences due to construction of roads, embankments, deforestation, encroachment for agricultural production, indiscriminate use of pesticides and natural causes such as siltation, drought, cyclone and intrusion of saline water have negative impacts on fish diversity in Bangladesh. On the other hand, the indiscriminate use of different fishing gears, harmful techniques of fishing threatens the biodiversity of the seasonal floodplains. It has been reported that the Chalan Beel fishery is one of the largest, most important watersheds in North Central floodplain in Bangladesh and during 2005-2006 fish production was reduced to 50% of what was in 1982. It was also stated that gradual habitat degradation and over exploitation were the key drivers of biodiversity degradation which were connected to increased siltation rates, construction of flood control embankments and roads, uncontrolled

use of pesticides and chemical fertilizers in the croplands, excessive removal of surface water and extraction of ground water for irrigation, diversion of water courses, unregulated discharge of untreated industrial and aqua farms effluents, fish harvesting by dewatering (Hossain *et al.*, 2009).

## MEASURES FOR MITIGATION

One unique aspect of community based management approach is its decentralized approach to co-management that focuses on collaboration with local government. Reduction of fishing pressure was likely to be a critical part of reviving floodplain fisheries in Bangladesh. Formation of Community Based Organisations (CBOs) is a crucial task, the failure and success of wetland resource management depends on CBO performance and accountability. Welcomme (2008) reported that a range of actions available to mitigate the impacts of human activities on floodplains. These consisted of two essential components, firstly ensuring that flow conditions in the river were sufficient to maintain the floodplain and to fulfill the requirements of the fish and secondly ensuring that the physical structure of the floodplain and its associated rivers was maintained in a condition suitable for fish. Channels connecting floodplain water bodies to the river should be kept open and free of silt and channels those have been sealed or lost should be restored. He also pointed out that the main river channel should be conserved in a healthy state and not over channelized. Connectivity should be maintained with upstream tributaries necessary for movements and breeding of migratory fish species.

**Technical management:** For sustainable management of water bodies and their ecosystems through improved community planning and appropriate management interventions including the establishment of sanctuaries, control of fishing effort, habitat restoration, stocking fingerlings, gear restriction, ban on complete dewatering and other measures are need to be considered.

**Community based co-management:** To ensure sustainable and equitable fisheries, community based co-management will be formalized in water bodies where it has already been established through various projects, expanded to other water bodies.

**Community based organizations:** To provide a formal legal recognition of user rights, community based organizations where fishers have a leading role will be facilitated and organized. The type of community based

organization appropriate will vary according to the location, it may be membership based (fishers), an organization representing different stakeholder groups, or a set of volunteers from the community concerned to ensure sustainable fisheries.

#### **FISHERIES CO-MANAGEMENT AND COMMUNITY BASED APPROACH**

Fisheries co-management can be viewed as a set of institutional and organizational arrangements (rights and rules), which define the co-operation among the fisheries administration and relevant fishing communities (Nielsen and Vedsmand, 1999; Nielsen *et al.*, 2004). According to the APFIC (2006), "Fisheries/aquaculture co-management is a partnership approach where government and the fishery/aquaculture resource users share the responsibility and authority for the management of fisheries/aquaculture resources in an area, based on collaboration between themselves and with other stakeholders".

Despite various constraints in management of inland fisheries in Bangladesh, there is a clear potential for co-management in the country but this will only be successful under the necessary preconditions are met. In this regard, it is essential to develop a dynamic partnership between neighboring communities and interest groups as well as the government to support a greater participatory approach, using the capacities and interest of the former complemented by the ability of the later to offer enabling legislation and administration. Hence, co-management and its implementation are in its early stages in the country but may be the key to alternative fisheries resource management in future.

Earlier experience has demonstrated that floodplain where fishery activity is being practiced regularly have better environment in compared to those underutilized from fisheries point of view. Fishery development initiatives through following scientifically based norms may play a pivotal role in conserving the floodplains increased fish production and gainful employment to thousands of people. The seasonal floodplains particularly the beels are regarded as common resources. The active participation of Government, Non-government Organizations (NGOs), organized fishers' groups and other stakeholders are essential for co-management and sustainable development of the fisheries co-management. Delegation of rights to certain user groups regarding utilization and management of floodplain resources may restrict the access of the common mass which may give rise to conflict. Moreover, delegation of rights is generally not successful without collective action (Apu *et al.*, 1999;

Viswanathan, 2003; Ahmed *et al.*, 2004). Bhaumik (2002) reported that whenever there were multiple uses of natural resources, there was competition and conflict among the different users. The main way to conflict resolution should be to attain balance among different uses. Building consensus among stakeholders like co-management with participatory approach on the objectives and levels of use of natural resources is essential for sustainable development.

Various (fisheries co-management) projects in Bangladesh have adopted different community involvement approaches to encourage and support effective and equitable management systems. Beguni *et al.* (2006) reported that in CBFM approach the grass root level peoples' organization formed by the primary resource user groups i.e. the CBOs are playing the vital role for managing the fisheries resources. Hossain *et al.* (2006) reported that there is a positive potential for co-management in Bangladesh but this will only be successful under the ideal conditions. In this regard, it is essential to develop a dynamic partnership between neighboring communities and interest groups and the government to support a greater participatory approach, using the different capacities and interest.

Community Based Fisheries Management (CBFM) is a new tool for the sustainable management of inland fisheries resources. Through this approach, water bodies are operated and managed by the local communities. Several activities like- establishment of sanctuaries, fish habitat restoration, construction of fish friendly structures, stocking of fingerlings, rehabilitation of endangered species and implementation of fish acts and laws etc. have been executed in the CBFM water bodies. As a result, user's right is established in the water bodies by the fishers and other stakeholders residing around the water bodies. On the other hand, fish production and fish biodiversity increase significantly (DOF, 2007).

The role of local community based fisheries management is one of the most interesting and potentially rewarding ones in terms of establishing local responsibility for natural resources, improving the efficiency and accountability of management and creating structures whose economic outputs and social distribution features could offer the potential to be self-sustaining in delivering equitable outcomes. If these are combined with rehabilitation of water bodies to create better access and better habitat for fish stocks, or where low levels of stocks can be enhanced with the addition of new seed these potentials can be even more marked. However, the difficulty of establishing and making operational these systems cannot be underestimated. Otherwise, they confront existing power structures and

have inadequate internal strengths. Time for durable self-sustaining management structures involving poorer groups is also considerable. The requirements for resource management data and the means to apply these in effective management action are also relatively less tested at this stage. The costs for support and information supply and management and the unproven effectiveness of sanctions for non-compliance with management controls are also practical concerns. Notwithstanding these issues, community-based approaches, perhaps if extended to embrace a more complete array of livelihood components in which communities may have a role and represent one of the few means by which these systems might managed (DOF, 2003).

Tripathi *et al.* (1999) reported that group management was an effective tool for enhancement of fish production from the stocking of small beels based on the results of an experiment in three beels of Mymensingh in Bangladesh. DoF (DOF, 2003) reported that stocking activities in beels and oxbow lakes could generate positive financial returns and moderate production costs through floodplain stocking by private entrepreneurs, or in association with government or NGO initiatives.

#### **SCENARIO FROM BANGLADESH**

Bangladesh has built up a comprehensive experience of community-based management for inland capture fisheries over the last 2 decades, supported by several projects (Government and donor aided). Community based management of resources is a time-driven and successful activity initiated by DoF. Bangladesh is emerging as a country of having positive lessons from community based management of open water. Consultative Group on International Agricultural Research (CGIAR) awarded CGIAR Science Award-2004 to Community Based Fisheries Management Project (CBFM-2) of DoF for its outstanding innovative performance in the field of community-based fisheries management. The establishment of Community Based Organizations (CBOs) and village level sub committees has been recognized as the first and fundamental step in creating sustainable co-management of fisheries resources in decision making process by user's group. Initial work on networking by community-based organizations has been started at regional level. More emphasis has been given to work with community based fisheries management in the inland capture fisheries sub-strategy. Stocking of small and medium sized water bodies by government in association with a local user group is rated highly in terms of employment generation and sustainability but inefficiencies and in some cases

corruption are likely to reduce profitability and wages to labour. This has generally been the experience with co-management initiatives under the new fisheries management policy and this has led some to compare these approaches unfavourably with CBFM initiatives. Constraints to development are however rather few and probably significantly less than those for stocking with CBFM. In particular, real organisational and transactions costs are likely to be lower. Furthermore, government takes on much of the risk, initial investment and organisational costs. Enforcement is likely to be more or less difficult depending on the relationship between government and fishers and particular local circumstances. Sustainability is likely to be relatively high given the resilience of government led institutions. Overall we would rate this activity positively and suggest that different co-management arrangements are worth of greater exploration.

#### **DEPARTMENT OF FISHERIES EXPERIENCES**

Department of Fisheries (DoF), Bangladesh has a long history of involvement in community-based approaches to fisheries management. The important projects undertaken by the government of Bangladesh were Oxbow-lake Project-2 (OLP-2) (1988-1997), Community Based Fisheries Management (CBFM) Project (1995-1999), CBFM 2 (2001-2006), Third Fisheries Project (TFP) (1991-1996), Fourth Fisheries Project (FFP) (1999-2006) and Management of Aquatic Ecosystems through Community Husbandry (MACH) Project (1998-2007). The production and economic performance of floodplain aquaculture projects have been impressive; and they were perceived to have a positive effect on local economies, general livelihood/food security and people's nutritional status and employment opportunities.

In 1988 the Oxbow-lake project 2 (OLP-2) first initiated the co-management system and was successfully implemented in the Oxbow Lakes in the southwest part of Bangladesh. The change in fingerling stocking methods, credit schemes, monitoring by member fishers during stocking, the general willingness of the fishers to produce more fish and cooperation among them had resulted in the effective implementation of the co-management system. The implementation of co-management system at Oxbow Lakes was successful in enhancing the fish production as well as the welfare of the society. Moreover, the adoption of a new technology, like "carp poly-culture technology" by the fishers has been successful in enhancing fish production.

Under the Third Fisheries Project (TFP), 0.1 million hectare of floodplains in the western part of the country,

particularly in major depressions in the Khulna-Narail, Gopalganj-Madaripur and Chalan Beel regions, were stocked in phases, using 6 to 12 cm fingerlings of major carps with a stocking density of 20 to 30 kg ha<sup>-1</sup>. By stocking carp fingerlings at 30 kg ha<sup>-1</sup>, a total incremental production of fish at 300 kg ha<sup>-1</sup>, representing 10 times the weight of stocked fingerlings was obtained (Islam, 1999).

In 1995, Department of Fisheries with five Non Governmental Organizations (NGOs) and International Center for Living Aquatic Resources Management (ICLARM) under a partnership program worked with fishing communities in 19 water bodies in Bangladesh with a view to establish local user management institutions under the Community Based Fisheries Management (CBFM) Project. The Project was designed as an action research project to test and assess alternative models of government-NGO-fisher collaboration for the management of inland fisheries of Bangladesh. The emphasis in the CBFM project was on developing a framework for community-based fisheries management and ensured more sustainable exploitation of open water fisheries resources for future generations (Rahman, 2002).

The second phase of the project, CBFM 2, supported by Department for International Development (DFID) covered 116 water bodies (14 closed beels, 28 floodplains, 8 haor beels, 28 open beels and 38 river sections). It succeeded in the establishment of 130 Community Based Organizations (CBOs) through community development work by 11 partner NGOs (Dickson, 2007).

The Fourth Fisheries Project (1999-2006) had an open water component which was implemented mainly in public lands and advocated stocking of native carp species Rui, Catla and Mrigal with a stocking density of 10 kg (around 1000 fingerlings)/ha/yr. A Floodplain Management Committee was responsible for overall management of the floodplains. The open water fisheries component established 45 Community Based Organizations in 39 water bodies covering about 18,000 ha. Fish catches and biodiversity were increased through establishment of fish sanctuaries and in some sites regular stocking of fish (Rahman, 2002; WorldFish Center, 2007a).

Management of Aquatic Ecosystems through Community Husbandry (MACH) Project (1998-2007) approach for sustainable wetland management initiated the establishment for Resource Management Organizations (RMOs). Since 1998, the Management of Aquatic Ecosystems through Community Husbandry (MACH) project has established 16 Community Based Organizations' representing 110 villages that improved management of about 25,000 ha of wetlands. In

Management of Aquatic Ecosystem through Community Husbandry (MACH) project sites, fish catch increased by 2 to 5 times over baseline catch before intervention, from 58-171-315-390 kg ha<sup>-1</sup> between 2004-2005. Due to the project interventions, 8-10 threatened fish species have re-appeared (WorldFish Center, 2007b).

The project "Community based fish culture in seasonal floodplains and irrigation systems" (2005-2010) was implemented in Bangladesh by the WorldFish Center in collaboration with Bangladesh Agricultural Research Council (BARC, 2001) and the Department of Fisheries (DOF). It is worthwhile to mention that this project was developed based on the outcomes of the works carried out by the WorldFish Center in Bangladesh and Vietnam (WFC, 2005). The outcomes of the previous works showed very high potential of using the seasonal floodplains for fish culture. It was important to understand more about the productivity and the contribution of aquatic resources to water productivity, technical and institutional aspects in order to bring these vast water resources (2.8 million ha) under fish culture using community based approach. Under this project fish culture program was operated through involvement of local communities (all types of resource users) as per agreed benefit sharing arrangement under the guidance and supervision of Floodplain Management Committee (FMC) and Project Implementation Committee (PIC) (Rahman, 2010; Sheriff *et al.*, 2010). Under this project stocking of large sized (30±4.59-46±5.98 g) fingerlings of carps at varying proportion at the rate of 42±7.23 kg ha<sup>-1</sup> enhanced fish production by 353±201% over the baseline level and 413±52% as compared to non-intervention seasonal floodplains. Non-stocked fish species diversity increased by 23±10% over the baseline abundance and 17±1% as compared to non-intervention seasonal floodplains. The fishes were grown for 5 to 6 months. The project intervention also generated net income ranging from BDT 2677-16279 ha year<sup>-1</sup> with an average of 10491±5424/ha/yr which is nine folds higher than the baseline income (BDT 1176±668 ha year<sup>-1</sup>) (Rahman *et al.*, 2011). Pronounced positive changes were noted in the livestock population, housing condition, sanitation and fish consumption of the beneficiaries after the project intervention. The technological interventions were highly successful in elevating the socio-economic status of the beneficiaries. Effective management of the floodplains, group dynamics and overall supervision and coordination contributed to the success of the research project (Rahman, 2010).

## **EXPERIENCES FROM DAUDKANDI APPROACH**

In recent years, fish culture in seasonal floodplains, by stocking of fingerlings and application of feeds and



fertilizers on a regular basis, was established in Daudkandi, Comilla district, the central part of Bangladesh. These projects were functioning on the principle of company system incorporating some concepts of CBFM. Company's major shares were confined to the landowners of the respective floodplain, local NGO named SHISUK (Shikhya Shastha and Unnayan Karjakram) and a small portion of share was reserved for the local poor people who could afford to buy the share. The company was undertaking semi-intensive fish culture, largely in privately owned closed water bodies. These projects made significant contribution to rural economy in terms of enhance food security and employment generation. Though, these projects were operating successfully but some negative consequences were reported. These projects reduced the open access of the rural poor people to catch fish which affected their food security and livelihood (Gregory *et al.*, 2007; Toufique and Gregory, 2008).

#### **INSTITUTIONAL ARRANGEMENTS IN CBFM APPROACH**

Depending on different socio economical, cultural, environmental factors and accessible natural resources, a wide range of institutional arrangements have been established for different CBFM approaches. The principal features of the Community Based Fisheries Management (CBFM) approach are to organize and motivate fisher community and mobilize them socially to ensure their access to the resources (WorldFish Center, 2007a).

Realizing the limitations of the above approach, a much wider views were incorporated in the subsequent initiatives. Here, the active participation of the local community (such as landowners, landless and fishers) living in the vicinity of the floodplain were involved comprehensively in undertaking all fish culture activities such as, formation of floodplain management committee (FMC), planning, budgeting, fencing, stocking, post stocking management, harvesting and marketing of fish. The floodplain management committees were responsible for directing and guiding the beneficiaries. The enlisted beneficiaries received their financial net benefits as per earlier sharing arrangements. However, the sustainability of the institutional arrangements and ensuring qualitative participation of local resource user groups under CBFM approach in Bangladesh are yet to be determined (Thompson, 2004; Shelly, 2004; Tsai and Ali, 1985, 1987; Ahmed, 1997; Apu and Middendorp, 1997; Hossain and Rahman, 1998; Khan, 1997). Ahmed (1997) made a study on socio-economic and policy issues in the floodplain fisheries and concluded that the tenure

rights of common people to derive benefits from participation in harvesting, resources management and development activities in the floodplains should be recognized and protected. Thompson (2004) reported that, to empowering fishing communities, development of local fisher base organizations like CBOs, co-management for empowering fishing communities and local government support for CBOs or FMCs was important for sustainable management of seasonal floodplains. For fisheries management in seasonal floodplains community based organizations played an important role to improve the resource condition (Dey and Kanagaratnam, 2007). The Floodplain Management Committee (FMC) and Project Implementation Committee (PIC) were the prime requirement for community based fish culture in seasonal floodplains (Rahman, 2010; Sheriff *et al.*, 2010). Active participation and involvement of the local community people in all stages of fish culture operation beginning from selection of floodplains, formation of floodplain management committee, planning of fish culture activities, exercise of technical intervention and distribution of benefits were extremely essential to ensure sustainability of the program. Selection of sincere, honest and devoted floodplain management committee president and members having previous experience and leadership quality was a vital requirement. Mutual trust, sense of respect and good working relationship among the committee members were the basic social elements required for the success of community based fish culture initiatives (Rahman, 2010, Rahman *et al.*, 2008).

It has been reported that awareness raising workshops and meetings at the community level were the most important tools to motivate the community people. Before starting the fish culture activities and during the implementation period a series of community level meetings were organized with project beneficiaries, local elites, Union Parishad Chairman and Members, District Fisheries Officer, Senior Upazila Fisheries Officer/Upazila Fisheries Officer, Research Enumerator and project team in each of the intervention sites to find out the intervention tools and management strategies. They also reported that exchange visits were arranged for the beneficiaries of each of the intervention floodplains. There were reciprocal exchanges of visits of the beneficiaries of different floodplains. The beneficiaries had the opportunity to share ideas, exchange views and experiences among themselves. They discussed on various matters relating to formation of the floodplain management committee, planning and implementation process, operating the joint bank account, benefit-sharing arrangement, conflict resolution and future course of action (Rahman, 2010; Sheriff *et al.*, 2010).

## **TECHNOLOGICAL INTERVENTIONS IN CBFM IN SEASONAL FLOODPLAINS**

A number of studies were conducted in the 1980s to test the technical feasibility of culturing fish in seasonally flooded rice fields in India (Roy *et al.*, 1990; Das *et al.*, 1990; Mukhopadhyay *et al.*, 1991), Bangladesh (Ali *et al.*, 1993), Cambodia (Gregory and Guttman, 1996; Guttman, 1999) and Vietnam (Rothuis *et al.*, 1998a, b). These studies showed that fish production could be increased by more than 1000 kg/ha/year by stocking flooded rice fields with fish. Previous study indicated that various natural causes and human activities resulted in considerable degradation in inland aquatic resources. Inland fisheries resources and biodiversity in terms of species, habitats and genetic composition of fish deteriorated alarmingly. Establishment of aquatic sanctuaries and stocking of fingerlings as part of a management program could regenerate natural recruitment and increase fish production in open water systems (Islam and Kaiya, 2005).

Fisheries enhancements, qualitative and quantitative improvement of fisheries can be achieved by exercising specific management options. These options include inlet-outlet management through enclosures, increasing the existing fish stocks (stock enhancement), introduction/transplantation of new fish species (species enhancements), improving the environment (habitat enhancements), changing the exploitation means/norms (management enhancements) and enhancement through new culture systems. The success of stock enhancement of floodplain fisheries depends on- a) the development of a stocking strategy appropriate to the floodplain system (i.e., choice of floodplains with greatest potential, durability of accessible flood land water, species composition, fingerling size at first stocking, stocking density, fingerling supply sources, floodplain management, etc. and b) the development of appropriate institutional arrangements for managing both the stocking programme and the floodplain environment. A key component of this is cost recovery.

Although, the earlier CBFM approach showed promising results for enhancing fish production in the floodplains but in many cases results were poor in terms of yield, fish abundance, biodiversity and overall management of the system. Earlier efforts were mainly centered on formation of CBO, stocking of fish fingerlings, supervision, monitoring, harvesting of fish and distribution of benefits. Technical options on different dimensions of fish culture in the floodplains were obscured. Considering the variation in management

performance and success of technical interventions future research was needed, in order to improve understanding why the technical options was successful at some sites but not in others. However, there is growing evidence from studies worldwide that CBFM can empower communities to enforce responsible management practices which in turn can lead to sustainable harvests and fair access. The availability of information regarding such interventions is still very scarce due to lack of research in this field. In the light of the diverse agro-ecological conditions, climate and environmental change, socio-cultural situation, availability of accessible water resources and their biological productivity, there is a wide scope of research that still needs to be explored for adoption of successful community based co-management systems in Bangladesh.

Seasonal floodplains offer a unique opportunity to enclose parts of the flooded areas to produce a fish crop through stocking of fingerlings along with non-stocked indigenous species without affecting the agriculture activity. Effective utilization of floodwater can result in more production and increased household consumption and income for all stakeholders depending on the system. Research conducted in Bangladesh and Vietnam has demonstrated that community-based fish culture in rice fields could increase yield by about 600 kg/ha/year in shallow flooded areas and up to 1500 kg/ha/year in deep-flooded areas, without reducing the rice yield or wild fish catch (Dey and Prein, 2005, 2006; Dey *et al.*, 2005). Seasonal floodplains being the major share of our open water resources could contribute significantly to national fish production with adoption of locally suitable technical management practices in cost-effective way. A good number of attempts were made to bring the floodplains under community based fisheries management programs for enhancing fish production, rural employment generation and livelihood security of the rural poor's. These initiatives mainly focused on management issues such as, formation of Community Based Organization (CBOs), selective stocking of major carps and harvestings. So far, no comprehensive attempt was made to explore the possibility of exercising technical options to judge its merit for maximizing fish production in seasonal floodplains across the country. Rahman (2010) showed the effectiveness of various technological interventions (fencing, stocking, post-stocking management and harvesting strategies) on fish production, biodiversity and livelihood enhancement of the local communities through undertaking fish culture program in six seasonal floodplains (three experimental sites- Beel Mail, Kalmina Beel and Angrar Beel floodplain;

three control sites-chandpur beel andula beel and painglar Beel floodplain) under community based management approach. The floodplains were located in three major river basins (the Padma, the Teesta and the Brahmaputra) in Bangladesh with community involvement approach where fishers, landless, land owners included as beneficiaries of the floodplains in the form of Community Based Organizations (CBOs). The study was materialized under three broad sub-headings such as (1)-Determination of appropriate technological intervention for increasing fish production in seasonal floodplains (2)-Impact of stocking on fish biodiversity in seasonal floodplains and (3)-Assessment of the livelihood status of beneficiaries involved in culture of fish in seasonal floodplain. After two years of study he concluded that technological interventions in seasonal floodplains brought out remarkable positive changes in enhancing fish production and biodiversity which ensured increased economic return and livelihood improvement of the beneficiaries. These changes were reflected in the acquisition of physical assets of the beneficiaries.

This study also demonstrated that seasonal floodplains in Bangladesh hold tremendous potential for obtaining increased supply of fish for meeting the acute shortage of animal protein. If an effective mechanism could be developed for better utilization of these resources on a sustainable basis, then the challenges of quality food, nutrition, rural employment and income generation would be largely met. This ultimately ensured social peace and prosperity among the rural communities. In this regard, introduction of technological management could ensure sustainable fish yields along with the conservation and management of naturally recruiting fish species. Extensive aquaculture practice in the seasonal floodplains could be chosen as an effective tool for increasing fish production and strengthening the rural economy of the country. Therefore, an effective integration of technical, financial, social and human resources are urgently needed for obtaining desirable outputs from seasonal floodplains in terms of food security and better living standards for the rural people. Production of stocked fish (endemic and exotic carps) exhibited pronounced increase from their base level position after technical interventions exercised in the seasonal floodplains. The average baseline fish production of the intervention seasonal floodplains was  $124 \pm 137$  kg/ha/year and after technical interventions it was  $421 \pm 228$  kg/ha/year (Rahman, 2010). The mean fish production as achieved from the floodplains under the project was higher than the national average of

281 kg ha<sup>-1</sup> from the floodplains (DOF, 2010). This was largely due to the implications of community-based management practices including technical interventions of fish culture in the floodplains.

### **COMMUNITY BASED FISH CULTURE IN SEASONAL FLOODPLAINS AND FISH BIODIVERSITY**

In simple word biodiversity means the number and assemblage of different species of organisms in a particular environment. The term fish biodiversity means the totality of fish living in a particular water body. Bangladesh is rich in aquatic fish biodiversity with 260 freshwater fish species where minnows, catfish, eels, perch, gobies, clupeids and 24 species of prawns constitute the major portion (DOF, 2009). Finfish species which are smaller in size are termed as Small Indigenous Species (SIS) or locally known as miscellaneous fishes. These small fishes naturally grow in the inland open water resources, which are easily accessible to rural poor people and still serve as main sources of animal protein as well as micronutrients (Thilsted *et al.*, 1997).

Mamun and Thompson (2004) and reported purposive stocking as one of the ways to enhance fish production in floodplains. There is a concern that the introduction of large scale stocking of carps in open waters might affect the ecosystem and biodiversity leading to an adverse impact on non-stocked indigenous fish (Ali, 1997). It was found that single stocking of carps each year with a density of 3000-4000 fingerlings/ha/year with a rational species composition did not affect yield of indigenous fish. Hossain *et al.* (2000) made a study on biodiversity of fish fauna in three south-western floodplains of Bangladesh with special reference to fish fingerling stocking. After five years' of investigation they found that the stocking program had positive influenced in fish biodiversity in floodplains. A significant loss in aquatic biodiversity has already occurred worldwide (Moyle and William, 1990). Therefore, conservation and maintenance of aquatic biodiversity is a universal concern. A rich diversity of fish fauna is significant to the ecology and sustainable productivity of the floodplains. Degradation of aquatic environment resulting from human interferences and natural causes posed negative implications on fish diversity in Bangladesh. Craig *et al.* (2004) reported that during monsoon the Bangladesh floodplain became integrated into a single biological productive system. About 20 to 30 fish species in the floodplain and tolerant of low levels of oxygen provide the majority of the national freshwater fish production.

All these studies reported the reduction in the production and biodiversity of the floodplains resources and suggested the ways of restoring it without further deterioration as it was linked with the livelihoods of lots of poor and vulnerable people in the country. It is now urgent to consider how to avert the degradation, over exploitation and other causes of reduction of production and biodiversity of the floodplains to restore its situation without further degradation. It is always considered that technological improvement may be an important way to augment fish production in the floodplain with active involvement of people, institutions and approaches in a sustainable way.

Rahman (2010) reported increasing trends of number of fish species over the initial level after technological interventions at the three selected seasonal floodplains in Bangladesh. The study also showed that species diversity exhibited average the species diversity which was noted to be enhanced by  $23\pm 10\%$  in comparison to baseline of the intervention seasonal floodplains and  $17\pm 1\%$  as compared to control floodplains.

### **ECONOMIC PROFITABILITY AND LIVELIHOOD OUTCOMES**

Studies on the management of seasonal floodplain resources and active participation of the stakeholders under different conditions in Bangladesh are of great importance in formulation of optimal strategies for sustainable livelihood development. There is ample scope of research to identify potential and resource in terms of availability and accessibility of the resources as well as sustainability of the possible development approaches. Co-management research should pay particular attention to ensure equitable distribution of the benefits towards different components of the society. Rahman (2010) reported fish culture in all the seasonal floodplains to be profitable under the present set of management arrangements. There had been 9 fold (from BDT  $1176\pm 668$  to BDT  $10491\pm 5423$ ) net increase in the financial benefit derived from per hectare of seasonal floodplains after the

project intervention. The study indicated that the beneficiaries could be enormously benefited from fish culture activities in seasonal floodplains. A recent study showed significant increase of the household income for the subsequent higher income groups (BDT 50, 001-00,000 and >BDT 100,000) in case of three experimental seasonal floodplains in three river basin areas in Bangladesh (Fig. 2-4) (Rahman, 2010; Rahman *et al.*, 2011). The enhanced income of the respondents appeared to be derived from fish culture activities in the seasonal floodplain.

The study also reported that proportion of kutchha houses were reduced in all the seasonal floodplain beneficiaries in an average of 13%. Semi pucca houses were increased by 12% in those areas. About 3% increased in the pucca houses was noted in case of Beel Mail floodplain after the project intervention. Though the project was of short duration but it yielded positive outcome in the housing condition of the respondents. Significant positive changes ( $p<0.05$ ) took place in the sanitary conditions of the respondents in the selected floodplains. Very remarkable positive changes occurred in case of pucca toilets after the project intervention. Percentages increased in the pucca toilets were noted to be 14% in Beel Mail floodplain, 20% in Kalmina Beel floodplain and 13% in Angrar Beel floodplain. Rahman (2010) also concluded that the project intervention was successful in improving the overall status of sanitary condition of the respondents in all the selected seasonal floodplains.

There was a pronounced positive change in the involvement of increased number of fishermen in fish harvesting activities for a much longer period in all the floodplains owing to intervention. He also stated that there was significant increase in the rate of fish consumption among the respondents' family members directly involved with the selected floodplains during the period of intervention. It was demonstrated that project intervention had been successful in elevating the fish consumption rate of the beneficiaries of the concerned seasonal floodplains. This enhanced fish consumption

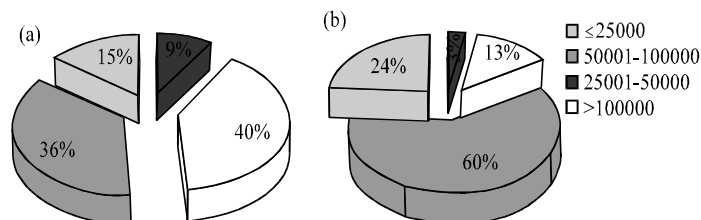


Fig. 2(a-b): Distribution of respondents in Beel Mail floodplain according to their level of income, (a) Before and (b) After intervention

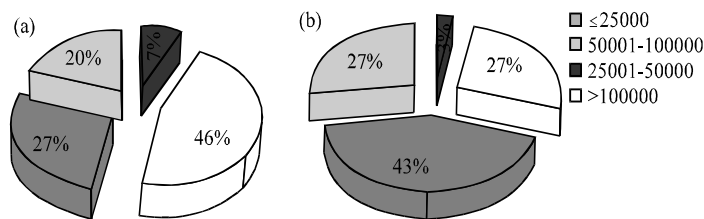


Fig. 3(a-b): Distribution of respondents in Kalmina Beel floodplain according to their level of income, (a) Before and (b) After intervention

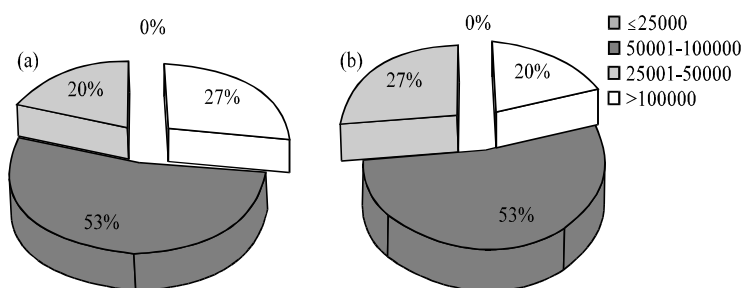


Fig. 4(a-b): Distribution of respondents in Angrar Beel floodplain according to their level of income (a) Before and (b) After intervention

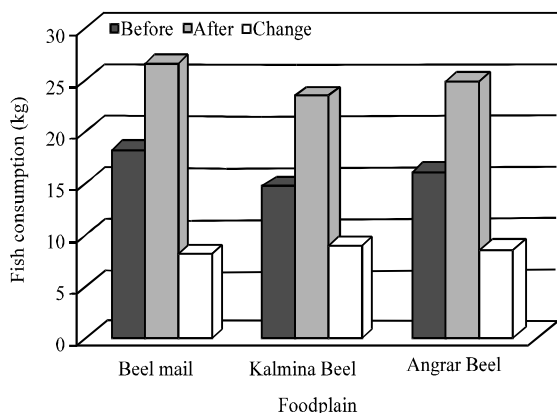


Fig. 5: Floodplain wise average changes in per capita fish consumption

rate was due to spectacular increase in fish production in the respective floodplains (Fig. 5). Furthermore, the fishes were easily available to the local communities as they were sold instantly at the landing sites at a much lower price as determined by the Floodplain Management Committee. The fishes were made available to the door-steps of the local people by the mobile fish traders at an affordable price.

### CONCLUSION

Form this study, the following conclusions can be drawn:

- A comprehensive resource survey should be conducted to assess the seasonal floodplain resources, the potentiality and risk factors in relation to environmental and climate change for future resource mapping
- The government should form a national policy to ensure the accessibility of the seasonal floodplain water bodies the community of real beneficiaries providing technical and management support under DoF/MoFL
- The government should undertake a special development project to bring all prospective seasonal floodplains (both public and private) under fish culture program through active supervision and guidance of DoF to enhance fish production and improve socioeconomic condition of the community people
- The competent authority should instruct the commercial bank and financial institution to open up new windows to provide financial support to the community people for fish culture in seasonal floodplains on soft terms and conditions
- The Department of Fisheries in collaboration with local government institutions should take pragmatic steps to create mass awareness regarding the usefulness, potentials and multi-dimensional benefit of seasonal floodplains in deriving livelihood support of the beneficiaries
- The DoF should provide training and motivational support to the local community people to culture fish in the seasonal floodplains

- The government should ensure the secure access to public water bodies for those CBOs that have a legal identity, community rules, compliance to rules, equitable access for poor stakeholders to decision making
- The government should develop a set of criteria and procedures for of the effectiveness of Community Based Organisations (CBOs) and their activities. Local government and the community should do these regular reviews jointly
- Government should end collecting revenue from the public water bodies where the local community will ensure conservation of wetland resources. A legal framework should be established for these kinds of sanctuaries and an agreement with local communities must be signed by the government
- Gradual harvesting of larger fishes for maximizing the total production
- Farm gate marketing will ensure the quality of fishes and also ensure the better prices
- Sharing arrangements among the stakeholders should be settled before stocking or at least before harvesting
- Awareness raising workshop and exchange visit for community based fish culture activities in seasonal floodplains
- Public water bodies need to extend the leasing period for long term sustainability

### RECOMMENDATION

To achieve the sustainable development of community based fish culture in seasonal floodplains the following issues need to be considered:

- Maximum fieldwork before final selection of the water body
  - Medium size of water bodies should be selected for proper management
  - During the selection time, illegally occupied public water bodies should be avoided
  - All the stakeholders of the surrounding areas of the floodplains should be included in the fish culture process
  - Poverty focus- poor people can get the benefit
  - Required minimum development cost of water bodies should be considered
  - Existing institutional arrangements and peoples willing to participate need to be considered
  - Longer inundation period and larger effective water area should need to be considered
  - Inlet-outlet system, physical accessibility, harvesting and marketing facilities also need to be considered before final selection of the water body
  - Selection of sincere, honest and devoted floodplain management committee president and members having previous experience and leadership quality is a vital requirement
  - Early stocking for maximizing the production period and ultimately very helpful for better production
  - Ensuring quality fingerlings for better production
  - Early preparation of flood control measures are also vital
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