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Conditions for collective action: understanding factors supporting and constraining community-based fish culture in Bangladesh, Cambodia and Vietnam

Conditions for collective action: understanding factors supporting and constraining community-based fish culture in Bangladesh, Cambodia and Vietnam

Olivier Joffre and Natasja Sheriff

The WorldFish Center is an international, nonprofit research organization dedicated to reducing poverty and hunger by improving fisheries and aquaculture. WorldFish is one of 15 members of the Consortium of International Agricultural Research Centers supported by the Consultative Group on International Agricultural Research (CGIAR). The CGIAR is a global partnership that unites organizations engaged in research for sustainable development with the funders of this work. The funders include developing and industrialized country governments, foundations, and international and regional organizations.

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Authors
Olivier Joffre and Natasja Sheriff

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ABBREVIATIONS

CBFC	–	community-based fish culture
CBFM	–	community-based fishery management
DoF	–	Department of Fisheries (Bangladesh)
FiA	–	Fishery Administration (Cambodia)
FMC	–	floodplain management committee
PIC	–	project implementation committee

NOTE

In this report, "$" refers to United States dollars.

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FOREWORD

In 2005, the WorldFish Center embarked on a project to pilot test approaches to community-based fish culture (CBFC) in five countries. A previous study conducted between 1997-2000 demonstrated the potential of the approach in Bangladesh and Vietnam, although a greater understanding was needed regarding the social and instutional factors that would permit the development of CBFC in larger waterbodies to reach a greater number of beneficiaries. The five countries selected for dissemination of CBFC included Cambodia, Vietnam, China, Bangladesh and Mali, each very different in terms of history, politics, social-cultural context, aquaculture experience and development status. They appeared to share environmental characteristics, all having seasonally flooding areas and experience of rice-fish culture.

A program of community organizing, fish stocking and harvesting was developed at selected locations in each country, where flood duration and amplitude was sufficient to support fish culture, and communities were willing to participate in the trials. The model developed in Bangladesh was to be introduced at each location, with the expectation that adaptations would be made to suit local conditions, based on the preferences of participating communites. Responsibility was given to national teams to develop many of the processes and procedures, with some aspects centralized to ensure a degree of internal consistency. As a result, the project capitalized on their knowledge and experience, ensuring that the fish culture model suited local preferences and met national priorities. The benefits of this approach are clear, including local ownership and capacity building, although it did necessarily give rise to dissimilarities in procedures and research outputs. In terms of innovation and learning, the advantages outweighed the disadvantages, as new models emerged, particularly in China and Mali, with significant potential for out-scaling.

In the second year of implementation, uptake of the CBFC model was lower than anticipated, with communities in Vietnam and Bangladesh choosing to discontinue fish culture activities. Participants in Cambodia discontinued a year later. Alternative sites were selected in Vietnam and Bangladesh, with greater levels of success in the latter. In both Vietnam and Cambodia, the model did not become established. In China, the model was adapted to a locally preferred management model. In Mali, where aquaculture is rarely practiced, time was needed to work with participating communities leading ultimately to the completion of one fish culture cycle in the final year of the project, which yielded surprising results. In Cambodia, research efforts were diverted to exploring options for community-based fish refuges, to support national priorities and preferences.

It was clear that local conditions were having a significant impact on uptake of the model in a way that had not been anticipated, and a new component was introduced to the project in the third year designed to understand the factors that were supporting or constraining community-based fish culture in each of the countries. This report presents the findings of this study, based on a detailed evaluation undertaken in 2008-2009 in Cambodia, Vietnam and Bangladesh. Mali and China were not included in the study, both for reasons of time and cost, and due to the different path that project development had taken in each country. Details of project activities and outcomes in each country can be found in Russell et al. (2010) for Mali and Hong (2010) for China, and in Sheriff et al. (2010).

Although the research was conducted as consistently as possible across the three countries, using the same methodology in each location, the results are nonetheless also indicative of the differences encountered at each location. The diversity of reasons why CBFC worked and didn't work led to difficulties in drawing conclusions across countries, or in quantifying results, with the exception of Vietnam where the number of communities involved in the study made quantification possible. The findings of the study are therefore primarily qualitative in

nature, with figures provided relating to number of responses where available. The issues raised by respondents participating in the study are grouped according to environmental conditions, socio-cultural conditions, livelihood context, institutional context, markets and economic viability, technical issues and implementation and incentives and disincentives for uptake and continuance. The report concludes with a summary of lessons learned.

The purpose of the study, and this report, is to enrich our understanding of the conditions supporting or constraining an activity such as fish culture, carried out on a collective basis in a floodplain environment.

EXECUTIVE SUMMARY

During the rainy season in extensive river floodplains, floods render the land unavailable for crop production for several months. Traditionally these areas are common pool resources for fishing. One option to increase water productivity in these flood prone areas is to integrate aquaculture in the production cycle, with concurrent or alternate rice-fish culture. Enclosed areas can be utilized for fish production to produce a crop of stocked fish alongside naturally occurring self-recruited species using a community-based management system.

Enhanced water productivity is the basis for the community-based fish culture concept, which has been tested by the WorldFish Center and national research partners in five countries (Vietnam, Cambodia, Bangladesh, China and Mali) between 2005 and 2010. The objective of the project was to develop locally appropriate models for fish culture in seasonal water bodies where the costs of individual aquaculture systems are prohibitive for poor people. Thus Community Based Fish Culture (CBFC) introduced local institutions for collective management of fish culture although the technical implementation of fish culture does not differ from individual production systems.

The outcomes of the Community Based Fish Culture trials vary between and within countries, with successful trials but also some sites where fish culture activities were discontinued. The causes of discontinuance, and conversely, the factors supporting success, showed both similarities across countries, as well as context specificity. The WorldFish Center undertook a series of surveys in Bangladesh, Cambodia and Vietnam sites to understand the reasons underlying the adoption or the discontinuance of community based fish culture.

A systematic approach was applied to understand the interactions and the role of different factors in adoption or discontinuance. The factors include the following themes: environmental conditions, socio-cultural conditions, livelihood context, institutional context, markets and economic viability, technical issues, implementation process and the incentives and disincentives for uptake and continuance. The survey included semi-structured interviews, focus group discussions and a topic checklist for open-ended questioning and was conducted between October 2008 and March 2009 in Vietnam, December 2008 and January 2009 in Cambodia, and June and July 2009 in Bangladesh. The survey sample included project beneficiaries, non-beneficiaries and local authorities.

Information about the historical, political and social context, as well as current policy environment and the status of fisheries and aquaculture at the national level were gathered from secondary sources, and supplemented with data from the field survey. Data were analysed by using a framework to stratify enabling and constraining factors at different levels: national, local, community, household and individual. For each level of analysis, information was classified for each factor, such as political and historical context, governance, social and economic factors, and environmental and technical factors.

Research findings shows that the past experiences for collective action in Vietnam (failure of agricultural cooperatives) and Cambodia (Khmer Rouge regime and collectivisation) have a negative impact on the development of CBFC. Lack of social cohesion was reflected in some cases in communication problems and issues of trust, and in others in the desire to work individually. This aspect was particularly constraining in Vietnam and Cambodia. In Bangladesh, several successful past experiences of collective action for management of common pool resources, including fisheries, facilitated the introduction of community based fish culture.

Changes in access rights and exclusion from common pool fisheries resources created tension between group members and with previous users of the area, especially in Vietnam and Cambodia. In

Bangladesh, previous users continued to have access the sites for fishing, thus limiting conflicts. In addition, benefits for the entire community, with access to cheap fish during the harvest period, facilitated the acceptance of the project by community members.

Specific agro-ecological conditions at each site reflect different farming systems and water-management systems, which influence the technical implementation of projects and incentives for beneficiaries to develop CBFC. In Bangladesh, the flooding period was longer compared to Vietnam and Cambodia, with deeper water levels allowing better conditions for fish growth. In Cambodia the absence of dikes required the creation of small fenced enclosures for fish culture. In those sites, the livelihood of villagers is also based on seasonal migration for off farm employment, which limited the participation of farmers in fish culture. In Bangladesh, groups included landless and fishers of local communities, creating large fish culture groups (more than 100 households) able to operate fish culture over large areas.

In Vietnam, other livelihood options or land use in the flooded area limited the participation of farmers. Benefits from fish culture were compared to other land use options and income generation activities. Villagers and specifically poor farmers preferred not to be bound to a project with daily or weekly duties, but rather be available for off-farm activities that can provide daily income. In Vietnam, where farmers do not have access to other land or agro-ecological system (unlike in Cambodia or Bangladesh), fish culture duration is limited between two rice crops, necessitating a previous agreement with rice farmers to decide the calendar for fish culture and rice culture.

The support of local authorities was found to be a critical factor in the successful development of community-based fish culture. Local authorities were instrumental in preventing illegal fishing and poaching, supporting the installation of water management infrastructure, encouraging participation in co-management, and promoting transparent management practices, Beneficiaries in Bangladesh cited the development of transparency as one of the most important factors enabling community based fish culture. A 'floodplain management committee', comprising local authorities, beneficiaries and local partners, closely monitored the fish culture group. In other countries such an institutional framework was not developed and lack of trust amongst participants was clearly stated as a constraint and reason for discontinuance in several cases.

Site size and distance between the culture site and the village were important contributing factors for successful fish culture together with appropriate size of fingerlings and robust structures to delimit the fish culture area.

Economic returns and individual benefits were an important factor in Vietnam and Bangladesh but of a lower importance in Cambodia where food security was the main incentive driving participation in community-based fish culture. Comparative analysis between Vietnam and Bangladesh shows that the lower economic records found in Vietnam can mainly be attributed to marketing and local fish market characteristics, with a fish harvest concomitant with the bulk of wild fish harvest inducing a drop in fish price.

At the national and regional level, the development of the aquaculture sector played an important role for access to knowledge and inputs. In Cambodia the sector is not as well developed as it is in Vietnam and Bangladesh. This translated into differences in the availability of inputs, links to markets, capacity of government agencies to provide technical support, and infrastructure development.

Lessons learned and recommendations to develop community based fish culture can be categorised into several domains such as governance, economic, social or technical. Recommendations relate to site selection characteristics (environmental and socio-economic context) and governance mechanisms to create an institutional setting that promotes trust and transparency. Choice of fish species, size of fingerlings, culture area and water

management structure are also important technical factors to take into account.

To succeed, CBFC has to integrate good governance and technical suitability with favorable socioeconomic and agro-ecological conditions. CBFC is not approprate for all floodplains. Results from Cambodia and Vietnam confirm that a major focus in implementing CBFC is governance, while technical issues are also crucial. Difficult and complex as CBFC is, experience in Bangladesh shows that, where suitable, it can provide substantial benefits.

1 INTRODUCTION

Flood-prone ecosystems in South and Southeast Asia are traditionally farmed with deepwater rice followed by post-flood rice culture during the dry season. During the flood season, the same land is inundated, creating an open-access water body subject to multiple uses by multiple users. Fish production in these areas is based on the capture of wild fish. In these seasonal flood plains, fish are trapped in rice fields, reproduce and are harvested by farmer-fishers or full-time fishers. These flooded areas cover about 4.5 million hectares in Bangladesh, and 1.2-1.4 million hectares (Catling 1992) is deeply flooded in the Mekong Delta of Vietnam and Cambodia for 4 to 6 months each year.

One option to improve access to protein and diversified income for local users and to improve water-use efficiency is to integrate fish culture into this system. A number of studies conducted in the 1980s tested the technical feasibility of culturing fish in seasonally flooded rice fields (Roy et al. 1990, Mukhopadhyay et al. 1992, Rothuis et al. 1998a, Rothuis et al. 1998b, Ali et al. 1998). These studies showed that fish production could be increased by more than 1 ton per hectare per year (t/ha/yr) by stocking fish in flooded rice fields in individual plots.

Based on these findings, the WorldFish Center implemented between 1997 and 2000 on-farm experimental trials of community-based fish culture (CBFC) on the Ganges and Meghna floodplains of Bangladesh and the Red River and Mekong deltas in Vietnam (WorldFish 2002). Farms are cultivated individually during the dry season, but during the flood season individual landholding boundaries disappear under the water, and water bodies and flooded rice field resources become common property. The project was based on the premise that production from these water bodies could be enhanced by stocking locally important fish species, providing communities with an additional source of income and an increased supply of affordable fish for sale or consumption (e.g., Dey and Prein 2003, IIRR 2000, Sinhababu et al. 1984). The results showed that fish production can be increased, with an average of 226 kilograms (kg)/ha in Vietnam and 863 kg/ha in Bangladesh, with a significant improvement of the household income (Dey et al. 2005). CBFC was found technically and economically sound and socially acceptable. However, the project concluded that further research was needed to understand how the institutional mechanisms needed to support fish culture differ in a range of different contexts.

From 2005 to 2010, the Challenge Program on Water and Food project Community-based Fish Culture in Seasonal Floodplains developed a series of trials to test this technology under different environmental and socioeconomic conditions. The objective of the project was to test the feasibility of this approach to improve water-use efficiency and provide benefits to the various users of seasonally flooded rice fields. Technical and economic aspects were monitored, and locally appropriate group arrangements for fish culture management, benefit sharing and resource access were tested.

Although the technical and environmental aspects of culture-based fisheries in various countries are well documented (De Silva 2003, Nguyen et al. 2001, De Silva et al. 2006), CBFC in seasonal floodplains is a relatively new concept, and the suitability of this approach in different contexts remains under question. The project aimed to address this issue by developing on-farm trials in seasonally flooding areas with otherwise contrasting socioeconomic and natural environments.

In this report, we focus on a study designed to understand the factors and conditons that support or constrain the feasibility and uptake of community-based fish culture in seasonal floodplains. The aim of the study is to contribute to knowledge on institutions for collective action, and the feasibility of community-based approaches to resource management, based on lessons learned in this 5-year project. The study also offers useful lessons for project implementation in the field of research-for-development.

The report begins with an introduction to the Community-based Fish Culture project and a description of the technical intervention. The second part of the report introduces the study to investigate the conditions for collective action in community-based fish culture, beginning with a presentation of the research approach and methodology. The third section presents the findings of the study. Finally, we present a synthesis of the factors supporing and constraining community-based fish culture, key lessons learned and recommendations.

2 COMMUNITY-BASED FISH CULTURE IN SEASONAL FLOODPLAINS

The Community-Based Fish Culture in Seasonal Floodplains Project was implemented in collaboration with the Fishery Administration (FiA) in Cambodia, Research Institute of Aquaculture No. 2 (RIA2) in Vietnam, Department of Fisheries (DoF) in Bangladesh, and commune and district agencies in all 3 countries. As the WorldFish Center maintains regional offices in both Bangladesh and Cambodia, project sites in these countries enjoyed more frequent visits and better follow up than did sites in Vietnam. In Bangladesh, the presence of two PhD students further increased the project presence at sites, as well as the presence of enumerators for data collection, which facilitated information transfer.

2.1 SITE SELECTION AND STAKEHOLDERS

Local partners and WorldFish selected sites together according to information collected from local authorities and extension services. Selection criteria included

the presence of community-based floodplain aquaculture or community willingness to develop it,

- the absence of conflict over the use of the water body,
- good water-management infrastructure in Vietnam and Bangladesh, and
- sufficient flood depth and flood period to support fish culture.

Secondary source information was reviewed and field visits were done in 2006, and one site was selected in Bangladesh and one Vietnam. In 2007, two more sites were selected in Bangladesh, as were three more sites in Vietnam, and project activity started in four villages in Cambodia. To compensate for discontinuance at three sites in Vietnam, local partners selected one more site in 2008. One site that discontinued in 2007 restarted in 2009 in a different setting. Table 1 shows the agro-ecological context of project sites.

The project was implemented in different ways in each country, using small enclosures in Cambodia and large water bodies in Vietnam and Bangladesh (Tables 1 and 2). Enclosures for fish culture in Cambodia are small for lack of embankments or natural delimitation as exists in Bangladesh and Vietnam. As enclosures depend on fencing, they cannot be large, which limits the number of beneficiaries.

In Bangladesh, individual project sites include more than one village and more than 100 beneficiaries, in contrast with those in Vietnam or Cambodia. This difference arises as several villages located around the water body house traditional users of the project area and those owning rice land within it. These two criteria were used to select the project beneficiaries. Bangladeshi beneficiaries are classified in three main groups — landowners, fishers and the landless — which determines their share of benefits and duties under the project (Tables 2, 3 and 4).

No such distinctions are made in Cambodia or Vietnam. In Cambodia, landowners and other villagers are included in the project, and there is no specific restriction on joining. Where the project site is located on public land, any villager is invited to join. At three sites in Vietnam, only those who own land within the project area can join. At two other sites, those without land could join, but their numbers were not significant (three households in Truong Xuan hamlet and six in Hung Binh hamlet at the beginning of the project, but none after 1 month of fish culture).

Only at Beel Mail in Bangladesh was access to the site already restricted before the project began. In this case, only members of the local fishers' society were able to fish in the beel. In Cambodia, part of the site at Chroy Poan was a private pond used for watering livestock and irrigating rice. Other sites in Vietnam, Cambodia and Bangladesh were in open access before the project.

Table 1: Agro-ecological conditions project sites

Country	Site Name	Flood Period	Land Tenure	Agro-system at site	Agro-system outside*	Previous use of the area	Flood management
Bangladesh	Beel Mail	Jul-Dec	Public land	Dry season rice	Rainy season rice + vegetable	Fishery (restricted access)	Sluice gates
	Angrar Beel	Jul-Dec	Private land	Dry season rice + fish trap pond	Rainy season rice + vegetable	Fishery	-
	Kalmina Beel	Jul-Dec	Private land	Dry season rice + fish trap pond	Rainy season rice + vegetable	Fishery	Culvert
Cambodia	Chroy Poan	Aug – Nov	Private land	Rainy season rice	Dry season rice	Irrigation, livestock	-
	Pom Eith	Aug – Nov	Private land	Rainy season rice	Dry season rice	Fishery	Sluice gates
	Thnal Kaeng	Aug – Jan	Public land	-	Rainy season rice	Fishery, livestock, irrigation	Sluice gates
	Potamon	Aug – Jan	Public land	-	Rainy season rice	Fishery, livestock	-
Vietnam	D1	Aug – Nov	Private land	Double rice crop	-	Duck raising, fishery	Early Flood protection (embankment)
	C2	Aug – Nov	Private land	Double rice crop	-	Duck raising, fishery	Early Flood protection (embankment)
	Trung Phu B	Sept – Nov	Private land	Triple rice crop	-	Duck raising, fishery, fish culture	Early Flood protection (embankment)
	Hung Binh	Sept – Nov	Private land	Triple rice crop	Orchard, sweet potato	Duck raising, fishery	Early Flood protection (embankment)
	Truong Xuan	Aug – Nov	Private land	Double rice crop	Planted forest	fishery, lotus culture	Early Flood protection (embankment)

*: represent the main agro-systems in a different land type (usually of higher elevation) used by villagers in the project sites

Table 2: Project stakeholders and institutional setting

Country	Site Name	Area (ha)[a]	Beneficiary Households[a]	Status of Beneficiaries	Villages	Previous Access Rights	Supporting Local Agencies[c]	Institution Created
Bangladesh	Beel Mail	40	124	Landowners, fishers, & landless	5	Restricted	DoF + WorldFish + upazilla	PIC + FMC[d]
	Angrar Beel	31	171		5	Open	DoF + WorldFish + upazilla	PIC + FMC
	Kalmina Beel	33	195 → 214		1	Open	DoF + WorldFish + upazilla	PIC + FMC
Cambodia	Chroy Poan	1.0	16 → 7	Landowners & villagers[b]	1	Restricted/ open	FiA + WorldFish	Committee
	Pom Eith	2.5	21		1	Open	FiA + WorldFish	Committee
	Thnal Kaeng	0.6	5	Villagers	1	Open	FiA + WorldFish	Committee
	Potamon					Open		
Vietnam	D1	65-19	34 to 30 and 11	Landowners	1	Open	RIA2 + commune + district	Committee
	C2	48	28	Landowners	1	Open	RIA2 + commune + district	Committee
	Trung Phu B	39	28	Landowners	1	Open	RIA2 + commune + district	Committee
	Hung Binh	26	17 →5 (2007)	Landowners & villagers	1	Open	RIA2 + commune + district	Committee
	Truong Xuan	90-120	13 and 7 (2009)	Landowners & villagers	1	Open	RIA2 + commune + district	Committee

[a] Showing change from beginning of the project in 2006 to the end of the project in 2009.
[b] Villagers are households belonging to the village but owning land outside of the project area.
[c] DoF = Department of Fishery of Bangladesh, upazilla = subdistrict, FiA = Fishery Administration of Cambodia), RIA2 = Research Institute of Aquaculture No. 2 of Vietnam.
[d] PIC = project implementation committee, FMC = floodplain management committee.

In Bangladesh, WorldFish and the district and subdistrict (*upazilla*) DoF were the main stakeholders for project technical support and monitoring production. Their role included creating at each site a floodplain management committee (FMC) composed of project beneficiaries and responsible for project management. The FMC was supervised by a project implementation committee (PIC) that included representatives of local authorities, WorldFish Center representatives and local partners in the form of the district DoF. FMC members are selected by beneficiaries. They operate under written regulations and are funded through a joint bank account managed by the president of the FMC and upazilla DoF officer.

In Cambodia and Vietnam, there were no PICs, only committees with a structure similar to that of an FMC, including an elected president, vice-president, secretary and accountant. At four project sites in Vietnam, regulations are written and accessible to all beneficiaries, but this is not the case in Cambodia. In each country, the technical setting and organization of the collective group was decided together with beneficiaries and local partners.

In Vietnam, local authorities supported the improvement of embankments if necessary. The commune and district DoF monitored the project together with local partners RIA2. DoF and RIA2 provide technical and management support. In Cambodia, monitoring and technical support was provided by the local and central FiA.

2.2 ORGANIZATION OF ACTIVITIES AND CONTRIBUTIONS

Groups are organized in many different ways according to their arrangement and activities. For example, in Cambodia all management and maintenance activities are carried out by all members, from fencing to harvest, without any payment. In addition, the technical setting includes fish feeding with locally collected food (duckweed of the *Lemnoidae* family, snails, insects, rice bran, etc.), and beneficiaries contribute to the project by providing bamboo for the enclosure or a financial contribution of $2.50-5.00 per member (Table 3).

In Vietnam, fish feeding was tried only once, using manufactured pellets during the nursing stage. Beneficiaries contribute labor for fencing and repairing dikes. At some sites, guarding and harvesting was a paid activity, while in others it was the duty of participants. Payment for guards and harvesters was necessitated by the lack of manpower or incentives for these activities. At D1 hamlet, this regulation changed in 2009, when the group became smaller, with only 11 members instead of 30. In 2009, guarding and harvesting were member duties. Contributions included a share of the lease money received from duck farmers.[1]

In Bangladesh activities were delegated to stakeholder groups, with fishers and the landless in charge of guarding and fencing. Fishers were also involved in harvesting, while landowners and moneylenders provided some monetary contribution to pay for labor and to lease public land. For a large group of beneficiaries, FMCs were subdivided into smaller groups with specific tasks such as stocking fingerlings and fencing, etc.

2.3 BENEFIT-SHARING ARRANGEMENTS

Arrangements for sharing benefits vary from site to site. In Bangladesh, benefit shares were negotiated according to the type of beneficiary (Table 4). In contrast, benefits are shared equally among members in Cambodia and the Vietnamese hamlets of Truong Xuan, D1 (in 2009) and Hung Binh, or by owned area at other sites in Vietnam (Table 5). This last arrangement is possible only at sites where all project participants are landowners. Only at D1 hamlet in Vietnam (and only in 2006 and 2007) was a fixed amount of the benefit paid to the management committee to cover management costs. At all sites but Truong Xuan hamlet, self-recruited species were included in the total harvest.

[1] Farmers rent their land to duck farmers for a month after the rice harvest.

Table 3: Duties, activities and contributions of project beneficiaries

Country	Name Site	Year	Duties, Activities and Contribution				
			Feeding	Guarding	Fencing-Earthwork	Harvest	Other
Bangladesh[a]	Beel Mail	2006-09		Fisher + Landless (salary)	Fisher + Landless (salary)	Fishers (share)	Lease amount
	Angrar Beel	2007		Landowners + Landless	Outsiders (salary)	Landowners and landless	Salary for guards
		2009		Fisher + Landless (salary)	Fisher + Landless (salary)	Fishers (share)	
	Kalmina Beel	2007 to 2009		Fisher + Landless (salary)	Fisher + Landless (salary)	Fishers (share)	Salary for guards
Cambodia	Chroy Poan	2007 to 2008	All, in small groups	All, in small groups	Collecting bamboo+ fencing	All	Contribution :5 USD/member
	Pom Eith	2007	All, in small groups)	All, in small groups	Collecting bamboo+ fencing	All	Contribution :2.5 USD/member
	Thnal Kaeng	2007	All, in small groups)	All, in small groups	Collecting bamboo+ fencing	All	Contribution : 3 USD/member
	Potamon	2007	-		Collecting bamboo+ fencing		
Vietnam	D1	2006	Fish feed pellets for nursing	Security Team (salary)	Contribution: nursery fencing,	Beneficiaries (salary)	Nursing (guard and nursery) + dike rehabilitation by commune
		2007		Security Team (salary)		Beneficiaries (salary)	
		2009	-	All, small groups	Fencing, pole	All	Modification of duties due to group size evolution
	C2	2007		Security Team (salary)	Fencing, pole and dike reparation	Beneficiary + outsiders	Duck raising income invested in the fish culture Dike rehabilitation by commune
	Trung Phu B	2007		All, small groups	Fencing, pole and dike reparation	All, according to owned area	10% of duck raising income invested in fish
	Hung Binh	2007		All, individually		All + outsiders	Nursing done by private entrepreneur
	Truong Xuan	2008-09		All, small group	Fencing, pole and dike reparation	All	Harvest equipment provided by the group

a) in Bangladesh beneficiaries are classified according to their livelihood type: landowner, fishers and landless

Table 4: Diversity and evolution of benefit sharing arrangements in the different sites in Bangladesh.

	Bangladesh			
	Beel Mail 2006	**Beel Mail 2009**	**Angrar Beel 2007**	**Kalmina Beel 2007-2008**
Share of the Benefit for landowners	Area	Area	Area	Area
Landowners	-	-	20%	50%
Landowners - moneylenders	54%	38%	-	-
Ditch Owners	-	-	25%	15% of Culture Fish + 50% of Wild Fish
Fishers	42%	12%	10%	5%
Fisher - Money lenders	-	50%	-	-
Landless	0%	0%	5%	5%
Revolving Funds (%)	Already included		25%	25%
Management cost (%)	-	-	15%	5%
Donation to community (%)	4%	-	-	10%
Harvest cost (%)				
Culture Fish	20%	20%	10-20%	10-15%
Self Recruiting Species (SRS)	50%	50%	50%	20-40%
Access to fishing ground	Landless + fishers + landowners			

a) In Beel Mail the revolving fund necessary for the next season is already subtracted from the profit and kept in the bank account before the benefit sharing

Table 5: Diversity and evolution of benefit sharing arrangements in the different sites in Vietnam and Cambodia. (In Thnal Kaeng and Potamon site the benefit sharing arrangement were not defined.)

	Cambodia		Vietnam					
	Chroy Poan	**Pom Eith**	**D1 2006-07**	**D1 2009**	**C2**	**Trung Phu B**	**Hung Binh**	**Truong Xuan**
Share of the Benefit	Membership	Membership	Area	Membership	Area	Area	Membership	Membership
Landowners or beneficiaries	60%	55%	100% - revolving fund		100% - revolving fund	100% - revolving fund	100% - revolving fund	100%- revolving fund
Harvest Cost	Duty	Duty	Salary	Duty	Salary	Duty	Duty	Duty
Revolving fund	15%	30%	Reimbursement		Reimbursement	Reimbursement	Reimbursement	Reimbursement
Donation	10%	15%	-	-	-			
Management Cost	15%	-	28 USD/ mb of the committee	-	-	-	-	-
Self Recruiting Species (SRS)	Included in total harvest	Included	Included	Included	Included	Included	Included	High water level : shared between landowners and beneficiaries; Low water level: wild fish belongs to landowners

In Cambodia, the sharing arrangement agreed at the start of the project included revolving funds, management costs (only in Chroy Poan village) and donations to the village.

In Bangladesh, benefit-sharing arrangements varied between sites according to the land tenure of the water body. At Beel Mail, where public land is leased by the fishers' society, fishers received a larger share of the net benefit than is the case at project sites that are entirely privately owned (Kalmina and Angrar beels). The benefit share was also proportional to the investment made in the lease. The fishers' share at Beel Mail increased during the course of the project, with fishers investing in the lease amount. At all sites, the share includes revolving funds that has created financial autonomy for the fishers group since 2007 (the project site was able to reinvest in fingerlings and fencing after 1 year of fish culture). At Kalmina and Angrar beel, financial autonomy was not reached, and the benefit-sharing arrangement continued to include revolving funds. At two sites, management costs were included in the bebefit sharing arragment, and at one site it further included a donation to religious authorities to renovate the mosque. One interesting point is that harvesting payment for fishers corresponds to a share of the harvested fish value, including both self-recruited and cultured fish.

At Kalmina and Angrar beels the share for owners of ditches or trap ponds varied. At Kalmina Beel, owners received only the harvest cost, while at Angrar Beel ditch owners received the largest share of the total benefit (25%). At these two sites, fishers received 10% or 5% of the benefit and were paid for harvesting, while landless participants received 5% of the total benefit. At Beel Mail, landless participants did not receive any share of the benefit but were allowed to catch self-recruited species, as at other project sites.

Benefit-sharing arrangements seem more complex in Bangladesh because of the diversity of stakeholders and the presence of trap ponds. However, revolving funds established to sustain fish culture at the end of the project reflect the sharing agreement only at Beel Mail, while at other sites savings from fish culture were insufficient to sustain fish culture activity into the next year.

2.4 TECHNICAL SETTINGS AND RESULTS

The model is based on extensive fish polyculture (mainly carp, sometimes associated with silver barb, tilapia or snakehead) stocked in low densities at a maximum of 0.25 individuals per square meter in Bangladesh and Vietnam. In Cambodia, stocking densities were higher, at 1-2 individuals per square meter, because of the smaller cultured area.

Production and economic results were extremely variable at different sites (Table 6). Operational costs included capital costs (fingerlings, fencing and harvesting gear), labor (harvesting and security teams at D1 and C2 hamlets), land rent (at C2 hamlet and the government lease at Beel Mail), and management and nursing (at D1 and Hung Binh hamlets). Fence depreciation was not calculated as it only lasted for 1 year. Dike maintenance, paid for by local authorities in Vietnam, was also not included. In Bangladesh, operational costs did not include the share of the harvesting cost. All costs and benefits are converted in US dollars using the prevailing exchange rate. Net returns are calculated as gross return from cultured and wild fish, less operational costs.

Variable costs in Vietnam depended on the involvement of beneficiaries in the different activities, with lower costs recorded at sites where harvesting and guarding is a beneficiary duty. In addition, the first year of production in D1 hamlet registered higher costs because of the use of manufactured pellets for nursing snakehead fingerlings. In Cambodia, the fingerling cost is extremely high because of high fingerling prices. Comparatively, costs are generally higher in Bangladesh than in Vietnam because of the land lease in the case of public land and investment in fencing and labor.

Productivity in Vietnam and Cambodia is low, at less than 300 kg/ha including self-recruited species, while productivity at one site in Bangladesh has exceeded

600 kg/ha. Sites in Bangladesh use large fingerlings, longer growth periods and selective harvesting to enable fish to be sold at the market size of 700 grams to 1 kg per fish. In Vietnam, fish did not reach market size. Lower productivity at Kalmina and Angrar beels in 2007 was due to a short growth period at the first site and poaching at the second. The productivity differences in Vietnam and Cambodia reflect several constraints, including high waters exceeding the height of dikes or fences, poaching, presence of predatory fish, stocking of small fingerlings and short growout periods. Low productivity and high costs depressed economic net returns in Cambodia and Vietnam, yielding low or even negative economic results.

Economic results at Beel Mail and Kalmina Beel in Bangladesh in 2008 show that the model can be profitable. However, the results at Angrar Beel and project sites in Vietnam and Cambodia highlight the difficulties and uncertainties of CBFC in seasonal floodplains. Several sites discontinued or never even started, such as Potamon village in Cambodia, where the lack of incentives put a stop to project activities. Projects discontinued at two other sites in Cambodia, three sites in Vietnam and one site in Bangladesh. At Angrar Beel in Bangladesh, Chroy Poan village in Cambodia, and Truong Xuan and D1 hamlets in Vietnam, fish culture was discontinued and later started again after the intervention of local authorities and modification of aspects of fish culture management and group size.

The following analysis of the sites aims to show the reasons for success and discontinuance and explore the diversity of challenges faced by this community-based approach.

Table 6: Productivity and economic results (1USD = 17,429 Vietnamese Dong or 4,074 Cambodian Riels or 68 Bangladeshi Taka)

Country	Site Name	Year	Enclosure Type	Stocking Density (ind/m^2)	Productivity kg/ha	Cost USD/ha	Net Return USD/ha
Bangladesh	Beel Mail	2006	Dike – rice fields	0.16	636	325	119
		2007		0.10	625	238	197
		2008		0.12	691	262	244
	Angrar Beel	2007	Dike – rice fields	0.11	215	152	28
	Kalmina Beel	2007	Dike – rice fields	0.07	196	95	100
		2008		0.11	382	130	185
Cambodia	Chroy Poan	2007	Dike + fence - Rice fields and small reservoir	2	55	878	-790
	Chroy Poan	2008		1	20	935	-935
	Pom Eith	2007	Fence Rice fields	1.4	20-30	515	-515
	Thnal Kaeng	2007	Fence Large reservoir	2	0	1,116	-1,116
Vietnam	D1	2006	Dike – Rice Fields	0.25	173[a]	74	-4
		2007		0.16	162	39	41
		2009	Dike – Rice Fields (fence)	0.2	180	90	-27
	C2	2007	Dike – Rice Fields (fence)	0.20	124	65	13
	Trung Phu B	2007	Dike – Rice Fields	0.12	136	21	16
	Hung Binh	2007	Dike – Rice Fields (fence)	0.15	92	50	-23
	Truong Xuan	2008	Dike – Rice Fields (fence)	0.21	104[b]	31	-6
		2009	Dike – Rice Fields (fence)	0.2	112[c]	32	-8

a) wild fish productivity not recorded
b) including 6.3 kg/ha Wild Fish harvested by the group and 31.2kg/ha Wild Fish estimated harvest by landowners when the water level was lower than rice field's dike
c) including 9.1 kg/ha of wild fish harvested by the group and 12.5 kg/ha estimated harvest by the landowners

3 CONDITIONS FOR COLLECTIVE ACTION – THE CBFC CASE STUDY

3.1 METHODOLOGY

RESEARCH APPROACH

Studies to understand community-based project efficiencies and constraints in floodplains and water bodies use a wide range of approaches. Culture-based fisheries in water bodies in Asia are well documented (De Silva 2003, Nguyen et al. 2001, De Silva et al. 2006). These studies analyzed the effectiveness of this approach in terms of economic and technical factors. Saphakdy et al. (2009) document the diversity of community structure and benefit-sharing arrangements in culture-based fisheries in Laos. In this last study, the diversity of rules of access to common resources and benefit sharing is explained by the socioeconomic context and household economy. Other studies integrate governance and socioeconomic factors, such as Lorenzen et al. (1998), which analyzes the effect on productivity of different access rules in culture-based fisheries in Laos.

Access rules change with enclosure of water bodies under CBFC and can exclude previous users, causing conflicts, as described by Tubtim and Hirsch (2005) in Laos. In this study, a qualitative approach is used to describe the process and legitimization of property rights changes and their social consequences. The authors place the whole process in the national institutional and legal context. In addition to technical and economic aspects, the exclusion of previous resource users, access rules and institutional aspects need to be assessed. The policy and socioeconomic contexts can play important roles in the success or discontinuance of community-based action.

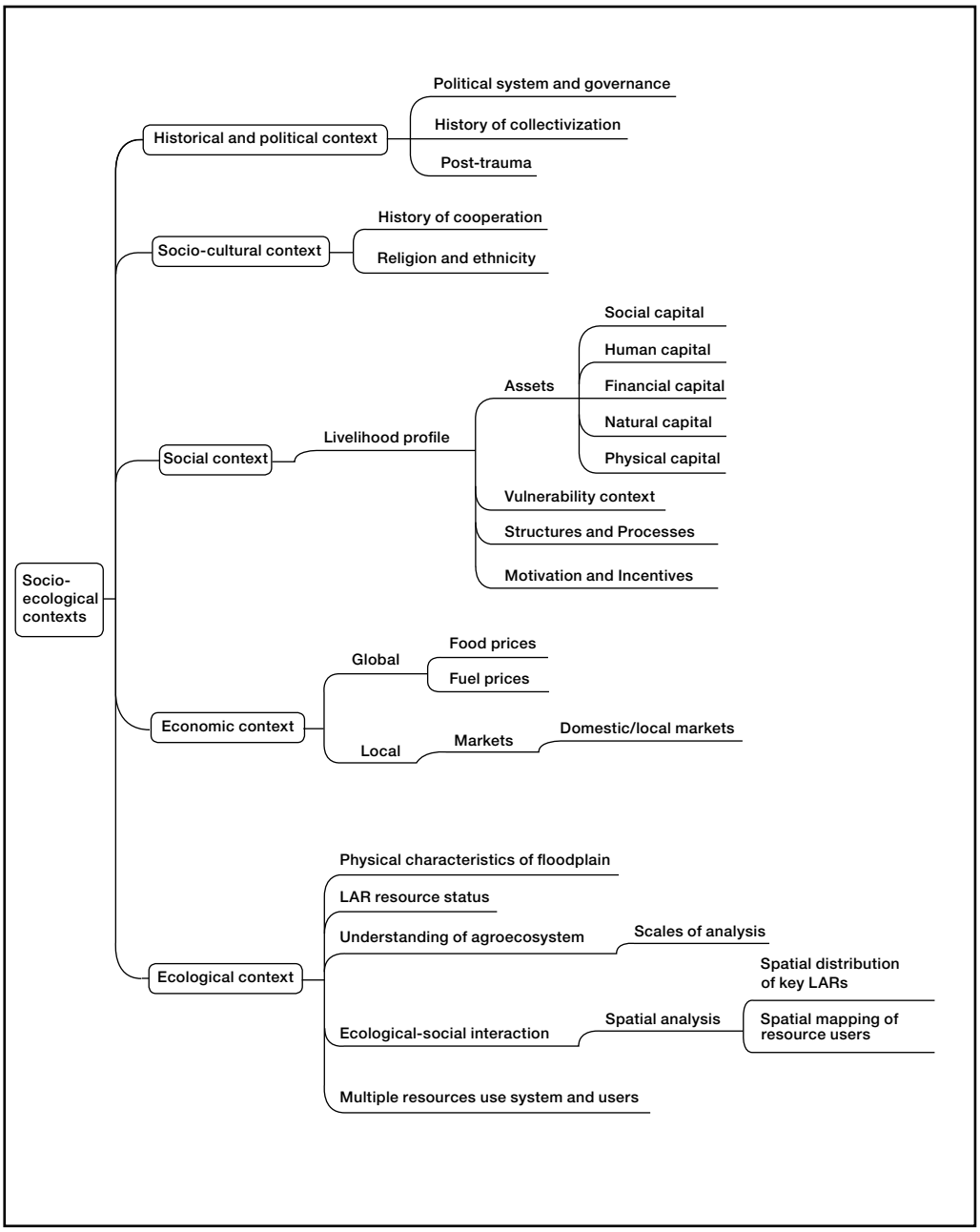
The challenges in introducingcommunity-based fishery management (CBFM) in the floodplains of Bangladesh are well described and analyzed by Thompson et al. (2003). The authors use data collected during the course of a long-term investigation into community-based fisheries managament at several sites in Bangladesh to understand the conditions of acceptance of such community-based approaches. The approach includes an institutional analysis framework (ICLARM and IFM 1998) to examine local co-management and institutional arrangements together with close monitoring of the fish catch, and household interviews. The authors take into account institutional factors, including implementation processes, and technical factors to draw lessons from the community-based approach.

Less well documented in the literature is the role of socio-historical context in understanding the factors that may motivate or constrain individuals or communities to adopt a new technology, particularly when adoption involves collective action and the pooling of common resources. Cambodia, Vietnam and China have, in their recent history, experienced events that have caused massive social, political and economic upheaval with important implications for the way in which people interact with one another, and for governance systems. Understanding the way in which these events have influenced the success or failure of community-approaches to fish culture has made a critical contribution to the analysis, and has led to important lessons learned for R4D.

Compared with fisheries or even culture-based fisheries, CBFC interacts strongly with agriculture. Flooded rice fields are used to culture fish. Interactions between aquaculture and agriculture can strongly influence acceptance or discontinuance of fish culture, as the same individuals pursue both activities on the same land at different times of the year. Considering how intimately aquaculture and agriculture interact, farming systems and agricultural policy need to be integrated into the CBFC approach.

In order to develop a full appreciation of the factors that may have led to the outcomes generated by the project, a research framework was developed to capture the many facets of influence affecting community-based action for fish culture (Figure 1). The framework guided the research to explore the role of the socio-ecological context, including historical background, livelihood profiles, policies, infrastructure, ecological aspects, in the development of CBFC; the factors governing incentives and motivation for participation, and the the role of the implementation process in the development of CBFC. These factors guide the presentation of the analysis, which is classified according to the following themes: environmental conditions, socio-cultural conditions, livelihood context, institutional context, markets and economic viability, technical issues and implementation and incentives and disincentives for uptake and continuance.

Figure 1: Research framework for analysis of the socio-ecological context



SITE SELECTION AND SAMPLE SIZE

The study covers 12 sites in Vietnam[2], Cambodia[3] and Bangladesh (Figures 2 and 3). National partners at the Research Institute for Aquaculture No. 2 selected the sites.

In Vietnam and Cambodia, more than half of the beneficiaries were interviewed at each site, as were at least 10 other households living nearby.[4] Respondents included association leaders, secretaries and representatives, as well as long-term, recent and discontinued beneficiaries. Non-beneficiaries included landowners living adjacent to the fish culture area and those farming within the fish culture area but not involved in the project. Landless farmers living in the project area were also included.

As Bangladesh had larger sites, some including five villages and beneficiary groups of more than 100 households, a different approach used key informant interviews and focus group discussions with distinct stakeholder groups at each survey site: landowners, fishers and the landless, as well as the management group. Non-beneficiaries were not interviewed in Bangladesh because the high population density around the project sites would have required too large a sample of non-beneficiaries to ensure that it was representative.

DATA COLLECTION

Data collection comprised both desk-based analysis and the collection of primary data. Information about the historical, political and social context, as well as current policy environment and the status of fisheries and aquaculture at the national level were gathered from secondary sources, and supplemented with data from the field survey.

The survey comprised semi-structured interviews and a topic checklist for open-ended questioning and was conducted in October 2008 and March 2009 in Vietnam, December 2008 and January 2009 in Cambodia, and June and July 2009 in Bangladesh.

Semi-structured household interviews in Vietnam and Cambodia, and focus group discussions in Bangladesh with beneficiaries and other community members (Table 7), investigated the following topics

- the beneficiaries' incentives to join the project and their expectations;
- constraints to community-based aquaculture and enabling factors;
- the governance and institutional setting of the community and its evolution since the beginning of the project;
- the roles of local partners and government agencies; and
- the main impacts, both positive and negative, of the project.

Open-ended questions were addressed to project participants[5] and other community members.[6] More structured questions were asked at the individual household level to understand the economic opportunities at project sites and estimate operational costs, yields, gross returns and net returns of different land uses, including rice cropping and individual fish culture. The role of fisheries in livelihoods was also investigated to allow estimates of the importance of fisheries in term of income, catch and fishing ground locations. The economic importance of households' off-farm activities was also estimated.

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2 In Vietnam, two projects sites in An Giang and Dong Thap provinces that were implemented in 2006 but discontinued in 2007 were not visited.

3 At Potamon in Cambodia the project was never implemented beyond preliminary meetings, so the number of beneficiaries is null.

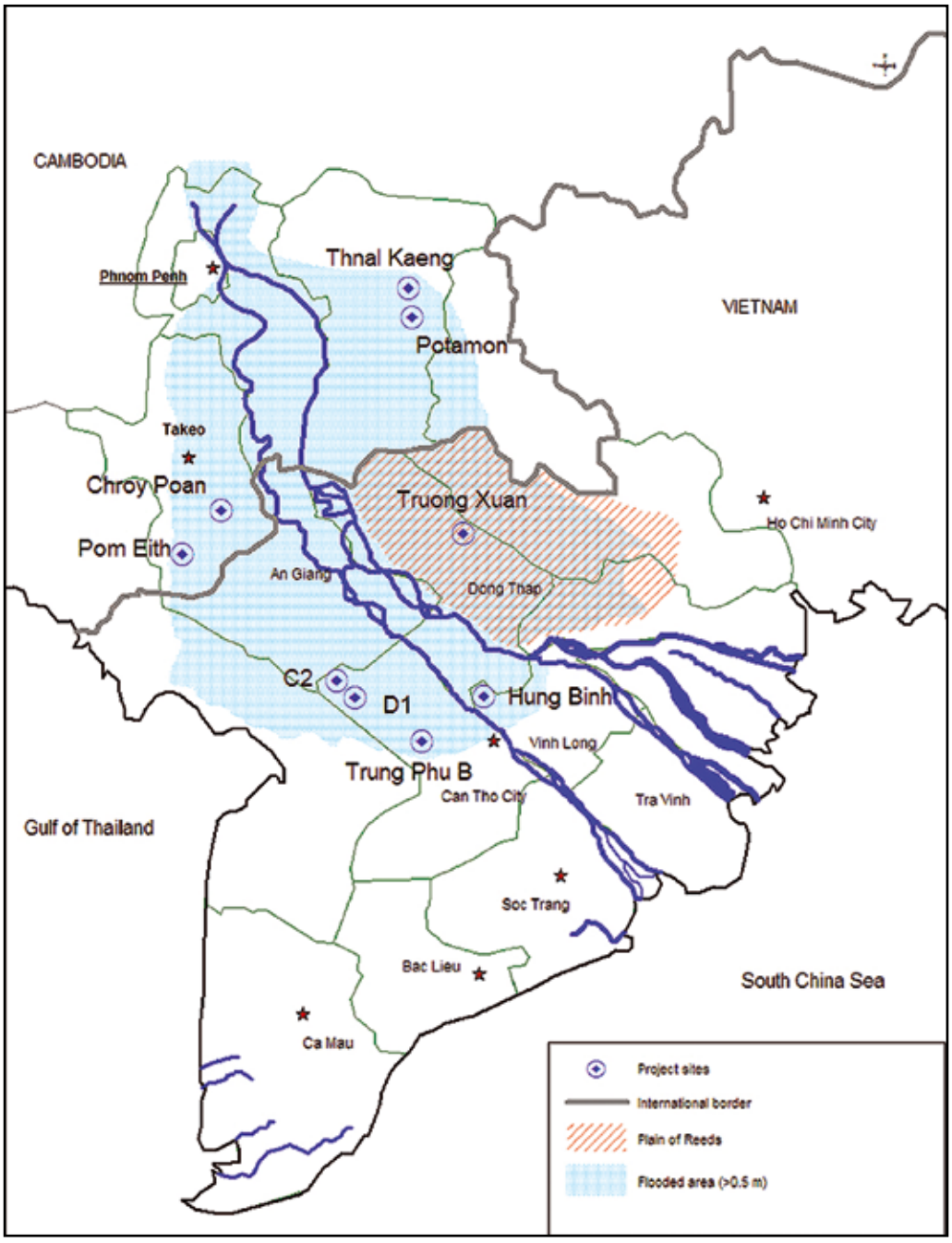
4 At Truong Xuan hamlet in Vietnam, only five non-beneficiary households were available for interviews.

5 For example: Why did you join the project? What are the challenges of developing CBFC? How is the group organized and what are its regulations? What is your opinion of group management and collective activities? What are the impacts of the project? What are the benefits of the project? Did the project cause any problems? What would you have liked to do differently?

6 For example: How did you learn about the project and what were you told about it? Why didn't you join the project? How did you use your land during the project? Where did you fish during the project?

7 Sample questions: What were the criteria for site selection? Can you explain your role in the project? What are the challenges to developing CBFC?

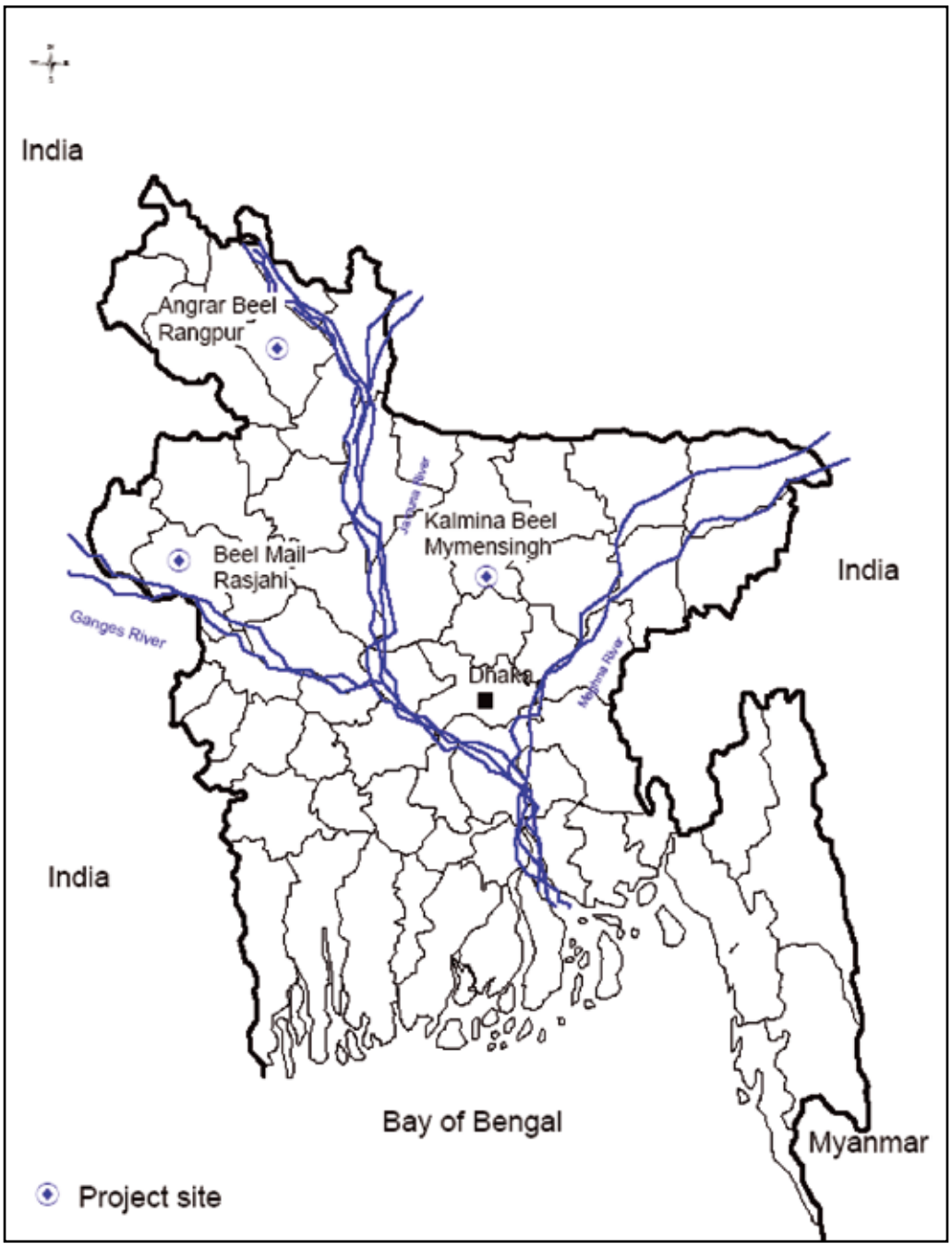
Figure 2: Study sits in Bangladesh (Gangetic Delta)



The roles of local authorities and partners were investigated using semi-structured interviews to collect qualitative data.[7] Information on the agro-ecological context were collected from local institutions for better understanding of the context. The following data was collected:

- criteria for site selection used by local partners and authorities, as well as local authorities' background and plans.
- role of local authorities and partners in project implementation and how they introduced the project to beneficiaries.
- policy context for local and national agriculture and aquaculture development, with a special emphasis on policy for collective action; and
- hydrological data on flooding and water levels, land-use, flood-control infrastructure, and fish market price.

Figure 3: Study sites in Bangladesh (Gangetic Delta)



DATA PROCESSING AND ANALYSIS

Household interviews provided qualitative information on incentives and enabling or constraining factors for CBFC development. Responses were grouped according to topic and survey site to show the relative importance of factors affecting CBFC adoption or discontinuance at each site.

The collected data were analyzed using a framework to stratify enabling and constraining factors at different levels: national, local, community, household and individual. For each level of analysis, information was classified for each factor, such as political and historical context, governance, social and economic factors, and environmental and technical factors. Constraining and enabling factors were then ordered by relative importance in each

Table 7: Community-Based Fish Culture Project survey sites and household samples[a]

	District/Province	Beneficiaries (household)	Beneficiaries Who Quit (household)	Non- Beneficiaries (household)	Local Authorities
Bangladesh					
Beel Mail	Rajshahi	Landowners/ fishers/landless + key informants			District and subdistrict DoF
Angrar Beel	Rangpur				
Kalmina Beel	Mymensingh				
Cambodia					
Chroy Poan	Takeo	5	5	10	Provincial FiA, commune council
Pom Eith	Takeo	9		11	
Potamon	Prey Veng	0	13	6	
Thnal Kaeng	Prey Veng	4		14	
Vietnam					
D1 hamlet	Can Tho City	15	4	15	District DoF and commune officials
C2 hamlet	Can Tho City	15		11	
Trung Phu B	Can Tho City	16		16	
Hung Binh	Vinh Long	5	3	16	
Truong Xuan	Dong Thap	9		5[b]	Provincial & district DoF and commune officials

DoF = Department of Fisheries, FiA = Fishery Administration.
[a] Site names in italics are those where activity discontinue or stopped for 1 year.
[b] The number of households was fewer than 10 due to members' unavailability during the survey.

category and each level of analysis. Another layer of analysis is added by developing a synthesis focusing on interaction between enabling and constraining factors at different scales. This approach allows us to propose models for developing CBFC by synthesizing the factors highlighted in this study.

4 RESEARCH FINDINGS

4.1 HISTORICAL AND POLITICAL CONTEXT

INFLUENCE OF RECENT HISTORICAL EVENTS ON COLLECTIVE ACTION

Examining recent historical events at a potential site for community-based fish culture can provide insights into the likelihood of uptake by a community of fish culture on a collective basis. Understanding the historical context is of particular importance in countries such as Cambodia and Vietnam, where recent history indicates that the introduction of collective action may be problematic. Bangladesh, Cambodia and Vietnam each have a different background concerning collective action, as the collectivization of the land and production under socialist regimes in Vietnam and Cambodia never occurred in Bangladesh.

In post-independence Vietnam in the 1950's, Communist ideology favoured land collectivization. Although relatively successful in the North, farmers in the South resisted collectivization and continued to farm individually. Agricultural collectivization in the Mekong Delta between 1975 and 1981 was undermined by low adhesion to collectivist ideals by local farmers, who had only recently obtained rights to their land after decades of conflict with large landowners (Le Coq et al. 2004).

In Cambodia, agrarian reform implemented by the Khmer Rouge (1975-1979) transformed the landscape. Agrarian reform, land collectivization and drastic changes in rice cultivation techniques caused production to fall by 60% from 1970 to 1978 (Pillot 2007). After Vietnam deposed the Khmer Rouge regime, reconstruction attempted under the Vietnamese-supported administration was partly collective for rice culture through cooperatives and mutual help groups, but without much success due to intramural conflicts. Collectivization was rapidly abandoned in 1985 and land redistributed to households (Pillot 2007).

More recently, other collective approaches to fisheries were developed in Bangladesh and Cambodia. In Bangladesh, 19 rivers and other water bodies came under community-based fishery management (CBFM) from 1996 to 2000, with 116 water bodies added later. CBFM included the development of local fishery management bodies, secure access rights for fishers, and training. Since 1990, during the third and fourth fishery projects, 250 community organizations have been developed for managing wetland fisheries in Bangladesh, involving both nongovernmental organizations and the DoF.

CBFM is also promoted in Cambodia, notably by a royal decree of 29 May 2005 and a sub-decree promulgated on 10 June 2005, to empower communities and enhance the management and sustainability of fishery resources. In 2006, 440 community-managed fisheries were in place. Since the late 1990s, more than 100 community fish refuges have been developed through several projects with varying success. A recent statement from the prime minister requires each commune to develop a community fish refuge to enhance rice field fisheries.

In Vietnam, community fish management and refuges are not developed, as most collective action is directed toward rice cooperatives, irrigation, drainage and pest management. Only a few sporadic collective aquaculture trials in floodplains have been implemented locally through provincial or district initiative. However, the technology was disseminated from experimental CBFC in 1999 and 2000 in Dong Thap and Tien Giang provinces to Can Tho and Vinh Long provinces. In Vinh Thanh District, aquaculture conducted by individuals or small groups of two or three households has been developed in 200-300 ha of inundated rice fields since 2004 with relative success. However, extensionists for CBFC have never, when interviewed, cited these past experiences as advantageous.

Given the sensitivity of the issue, it is not, therefore, surprising, that the introduction of a community-based approach to fish culture, dependent on the collective use of land and water resources, should fail in Cambodia and southern Vietnam, although past experience of collective action at individual sites was not explicitly stated by respondents as a constraint to collective action.

Recent historical events, such as enforced collective action under the Khmer Rouge in Cambodia, or the failure of collectivized agriculture in the Mekong Delta suggest that the introduction of fish culture on a collective basis may be sensitive and likely to see little or no uptake and adoption, or that there is a preference for individual culture systems. Under these conditions, there should be evidence of other strong incentives, such as limited alternative livelihood options (see 4.5), before community-based fish culture is introduced.

At the local level, communities have experienced different patterns of settlement and development with the potential to influence agricultural preferences, attitudes to land ownership and access, and social interactions within and outside the community. Both D1 and C2 hamlets in Vietnam were established in 1954, following the displacement of the Catholic minority from the north of Vietnam, who later settled in this area. Prior to settlement, the area was a wetland, not cultivated and affected by deep flooding during three to four months of the year. The Ngo Dinh Diem Government allocated 3 hectares of land to each household and developed canals and dikes to allow rice farming. Rice culture then expanded to other hamlets using deep water rice with a growth period of 180 days. At the same time the neighboring hamlet in Than An Commune was populated by local people (from the South of Vietnam), but the area was owned by large absentee owners, a remnant of the colonial era under French and later the Diem administration (Concession) and after 1975 the area was divided and allocated to the different households working in the Concession.

At the same time, farmers in the area had access to High-yielding Variety (HYV) rice and started to cultivate 2 rice crops per years, but with variable success, due to high dependence on weather conditions and flood level. In the late ninety's (1998-2001), an early flood protection was build by the government to improve water management. Together with this improvement, the value of the land increased and people from the North who were buying land from the Southern Vietnamese since the early nineties began to be considered as rich landowners by the Southerners.

4.2 POLICY AND INSTITUTIONAL CONTEXTS

NATIONAL DEVELOPMENT POLICIES

In each country, aquaculture plays an important role in regional and national economic development. Vietnam and Bangladesh have well-developed aquaculture sectors. Cambodia's development plan now names aquaculture as a government priority.

Rice culture and aquaculture intensification in Vietnam. Rice culture and aquaculture are the main drivers of the economy of the Mekong Delta. These primary sectors are moving toward more industrial scale, market orientation and specialization, and away from extensive production (Dong Thap, DoF director, personal communication.).

In Vietnam, the reorientation of national policies on agriculture in the late 1980s and early 1990s brought dramatic change to agriculture and aquaculture. The *Doi Moi* policy encouraged farmers to intensify agriculture and aquaculture with the development of market economy. Regionally, the implementation of this policy can be seen with the intensification of rice production from single to double or triple cropping, denser drainage and irrigation systems, and flood protection infrastructure. For example, in Trung Phu B hamlet, triple-cropped rice ballooned from 5,600 ha in 2000 to 23, 878 ha in 2005. Embankments that limit the onset and duration of flooding in rice fields also

limit the growth period for cultured fish. As high-input aquaculture is market oriented, it became a major sector of the regional economy.

AGRICULTURE AND AQUACULTURE DEVELOPMENT IN THE MEKONG DELTA OF VIETNAM

Following decades of Marxist collectivization in Vietnam, the liberalization of economic policy under *Doi Moi* recognized the roles of free markets and smallholder family farms, thereby creating a new environment for developing Vietnamese agriculture and aquaculture. Change was allowed by a reorientation of agricultural policy and improved access to production inputs and equipment and postharvest facilities (Le Coq et al. 2004). Between 1990 and 2000, the Vietnamese government planned and constructed new dikes and embankments in the upper Mekong Delta to control flooding and increase rice productivity with two or three crops per year. In previously deeply flooded areas in An Giang Province, the area of floating rice decreased by 80% between 1975 and 1994 and the area of irrigated rice increased from 35,000 ha to 175,000 ha. According to the provincial master plan, 40% of the land planted to rice would be triple cropped by 2010 (Kakonen 2008).

Another dynamic of rural development in the Mekong Delta was the expansion of aquaculture. In the past 2 decades, aquaculture development in freshwater areas of the Mekong Delta has been driven by international market demand of catfish (*Pangasisus hypophthalmus* and *P. bocourti*). Catfish production in 2004 was 315,000 tons (mainly in An Giang, Can Tho and Dong Thap provinces), or 3.6 times that of 1999 and accounting for 56% of total freshwater aquaculture production in the Mekong Delta. The Ministry of Fisheries (MOFI 2005) estimated that catfish production would reach 1 million tons in the Mekong Delta by 2010. The development of aquaculture was made possible by the expanded private sector, with 500 freshwater fish hatcheries producing 15 billion fish fry in 2004. The production of catfish fry leads, at 3 billion annually. The production of freshwater prawn and tilapia fry is also increasing, with 35 million monosex tilapia fry produced in 2002 and 180 million fingerlings in 2004. Carp and tilapia production is mainly for the domestic market. On the domestic market, aquaculture products generally fetch lower prices than wild catch.

Aquaculture plays an important role in Vietnam's economic development. New regulations, policies and programs have created a favorable environment for expanding aquaculture in terms of seed production,[8] access to credit[9] and development programs.[10] Governmental policies are complemented by provincial and local policies to encourage the development of aquaculture, which has created employment for more than 2 million people in the Mekong Delta of Vietnam and generated exports valued at more than $1.6 billion annually (MOFI 2006). Catfish farming contributes significantly to export revenues, generating $320 million in 2005 (MOFI 2005). The Vietnamese government's target for aquaculture exports was $2.5 billion annually by 2010. Increased foreign exchange earnings from the sector are expected to be a major driver defining the development strategy.

Vietnam has seven public organizations and departments involved in aquaculture development. Provincial and district DoF offices are responsible for extension services. The lowest administrative level with professional staff responsible for aquaculture is the district, as the DoF is not formally represented in communes, though policies are implemented through village extension agents. Growing demand for aquaculture inputs and services has encouraged the development of the private sector inputs in the Mekong Delta,

8 Decision 103/2000/QD-TTg dated 25 August 2000 and Decision 112/2004/QD/TTg.
9 Decision 03/2000/NQ-CP dated 2 February 2000.
10 Decision 224/199/QD-TTg.

including the more than 42 fish feed formulas available on the Vietnamese market. Knowledge is easily accessed in Vietnam through extension services, the private sector and broadcast media.

AGRICULTURE AND AQUACULTURE DEVELOPMENT IN CAMBODIA

Compared with Vietnam, aquaculture in Cambodia is far less developed. Freshwater aquaculture supplied just 8.3% of Cambodian inland fishery production in 2004, 72% of that amount from cage culture and 28% from pond culture (So et al. 2005). Pond culture is not traditional in Cambodia and, even if introduced to farmers through the FiA or nongovernmental organization projects, would be constrained by poor seed supply (So et al. 2000). Cambodian hatcheries supply only 18% of fish seed supplies, with wild capture supplying 26% and imports 56% (So and Haing 2007). Government-owned hatcheries supply 61% of the fingerlings produced in the country, as small private hatcheries are not well developed and face technical and marketing constraints. An estimated 20 million wild-caught fingerlings supplied cage culture in 2004, while imports from Vietnam, including illegal imports, were estimated at 60 million fingerlings for both cage and pond culture.

Farmers' lack of investment in homestead pond construction, which costs $100-500 per pond, and poor access to knowledge are two other main constraints on smallholder aquaculture development in Cambodia. Accessing technical knowledge and support is more difficult for Cambodian farmers than for their counterparts in Vietnam or Bangladesh, as less broadcast media reach remote areas to spread market information or share technical knowledge. The FiA cites the lack of human and financial resources in provincial FiA offices as constraining the development of aquaculture in Cambodia. In floodplain villages, extensive fish aquaculture uses mainly wild-caught seed, and production is mainly for home consumption.

A statement of the government of Cambodia on national fishery sector policy (2005) stipulates that aquaculture at different scales has to be encouraged by implementing regional codes of conduct. The government wants to encourage the private sector in aquaculture to meet demand for fish. One of the six priorities of the Fisheries Development Action Plan, 2005-2008 is to improve the livelihoods of poor rural people by increasing community and household production through aquaculture development.

As in Vietnam, agriculture (specifically rice culture) shows the results of intensification, as the double-cropping of rice has become widespread with the development of irrigation systems.

AGRICULTURE AND AQUACULTURE DEVELOPMENT IN BANGLADESH

In Bangladesh, inland aquaculture showed spectacular growth at 10.5% per annum between 1986 and 2006. Freshwater pond aquaculture is the dominant fishery subsector in Bangladesh, contributing 33% of total fish production and 85% of total aquaculture production in 2006. The government of Bangladesh has declared fisheries and aquaculture to be thrust sectors of the economy. Such national plans as Three-Year Rolling-Investment Program, 2003-2006 have promoted both capture fisheries and aquaculture, including rice-fish farming systems in floodplains. They have also addressed conservation and management issues and institutional and manpower training. The private sector is rapidly expanding in Bangladesh, with 764 private freshwater fish and/or shrimp hatcheries producing more than 98% of the seed used in the country (DoF 2007). According to a study by the Asian Development Bank (2005), fish markets are competitive, and farmers have a wide choice of seed suppliers. Dey et al. (2008) found fish feed markets to be competitive, with a good network of fish feed traders linking hatcheries and nurseries to fish farmers. Fourteen public organizations and departments are involved in managing and developing aquaculture in Bangladesh. The DoF is the main agency responsible for fishery extension services, with offices in districts and upazillas.

4.3 ENVIRONMENTAL CONTEXT AND LANDSCAPE LEVEL FACTORS

AGRO-ECOLOGICAL CONDITIONS: VARIABILITY OF FLOODPLAINS

Table 1 presents the agro-ecologic conditions of project sites in each country. Sites in Bangladesh offer longer flood periods than do sites in Vietnam and Cambodia. A seasonally flooded depression, or *beel*, is used for fishing in the flood season and for a single crop of rice in the dry. In Bangladesh and Cambodia, agricultural land is locally classified in upland, medium upland and lowland according to flooding duration, which determines land use, with rainfed rice or vegetables on more elevated land and dry season rice on lowland. Villagers have access to other agricultural land during the rainy season to grow rainfed rice or vegetables. In Vietnam, by contrast, farmers growing double- or triple-cropped rice in most of the Mekong Delta have access only to inundated rice fields in the rainy season. A few orchards, tree plantations and sweet potato fields exist, but these crops cover very little area compared with rice. In the Plain of Reeds of the Mekong Delta, acid sulfate soils have been reclaimed for agriculture by leaching, but with the effect of acidifying the water of canals and rivers in May and June. The Plain of Reeds covers 10.6% of the Mekong Delta and is now used for double- and triple-cropped rice, but strong acidity persists at the beginning of the rainy season. The intensification of rice culture in Vietnam was made possible by government investment in flood-protection infrastructure in the upper Mekong Delta since the late 1980s. The embankment system can delay the flood to protect the second rice crop in June and July.

In Bangladesh, flood control infrastructure is less developed than in Vietnam, but water levels in depressions are managed using embankments and sluice gates. Embankments here do not shape the landscape as they do in the Mekong Delta; rather, natural land elevation protects crops from flooding. Cambodia's floodplain is mainly an open system with no infrastructure to manage water. Some reservoirs allow water management with sluice gates to irrigate lowland rice in the dry season. Where it exists, reservoir management in Cambodia occurs on a larger scale than rice field water management in Vietnam, with several villages involved.

DURATION AND AMPLITUDE OF FLOODING

The length of the flood in Vietnam and at some sites in Cambodia is shorter than it is in Bangladesh. In Vietnam, early flood protection to protect the mature second rice crop and the draining of rice fields in December limits the period of fish culture to August-December and, in triple-cropped rice areas, September-December. As in Cambodia, inter-annual variation of the flood renders the start and amplitude of the flood unpredictable.[11] At two sites in 2008, the flood was delayed until after August, and fingerling stocking was cancelled. A shortened flood period necessitates the use of larger fingerlings to reach market size and reduces the potential of advantageous sequential harvest as practiced in Bangladesh.

Delayed flooding and low amplitude impeded fish stocking at Thnal Kaeng and Pom Eith in Cambodia in 2008, as the flood was delayed until September and the water was too low to allow fish culture. In 2007, Bangladesh experienced abnormal flooding. At Beel Mail, a flood height of 5 meters was recorded in 2007 and 3.5 meters in 2008. At Angrar and Kalmina beels, the lack of flood control was highlighted as a main technical constraint on fish culture.

At Trung Phu B hamlet in Vietnam, 24% of beneficiaries considered the flood too low in 2007 for fish culture, as the maximum water depth of 60 centimeters in September meant high water temperatures and a lack of nutrients for fish culture. In the same month, the depth was 106 centimeters at C2 hamlet and 102 centimeters at D1. In

[11] In his study, Pillot (2007) shows that the Mekong flow is within ±10% its 40-year average in only 3 years out of 5. The maximum height of the river can vary by 2 meters, which greatly affects the extent of flooding.

2009, late and low flooding at D1 slowed fish growth. With rice culture intensification and a shortened flood period, stocking is 1-2 months later in Vietnam than in Bangladesh and the harvest is earlier, finishing in early December, as compared with January in Bangladesh. These differences in the growth period can partly explain differences in productivity.

PRESENCE OF FLOOD-MANAGEMENT INFRASTRUCTURE

The presence of flood management infrastructure may be essential to control unpredictable flooding events and the associated damage to the fish culture system. Flood management infrastructure and fencing are strongly linked technical requirements. In Vietnam, the regional early flood-protection system provides a favorable environment for fish culture, with large areas delimited by embankments. Sites were selected in Vietnam on the basis of the presence of dikes to protect against flooding. Community development of an irrigation scheme provides tools with which to manage water for flood protection and drainage, facilitating the harvest. However, some losses were incurred in C2 and Hung Binh hamlets as the dike was too low, and fish escaped after a heavy rain. Flashflooding was the main technical constraint on CBFC cited by 53% of respondents at C2 and all respondents at Hung Binh.

The water bodies into which fish culture was introduced in Bangladesh are local depressions surrounded by rice fields, with dikes that allow some water management, facilitated by sluice gates at Beel Mail and Angrar Beel. However, at Kalmina Beel, some improvement in water management was necessary to lengthen the fish culture period. The local population welcomed the construction of a sluice gate because it benefits not only fish culture but also rice cultivation by protecting against flashfloods and allowing irrigation during droughts.

In Cambodia, which lacks a flood control system, and there are no mechanisms for local management of broad flood conditions, fish culture groups suffered losses of stocked fish as a result of high and unpredictable flooding events. In Pom Eith village, the enclosure fence failed to hold fish after heavy rain caused a sudden rise in the water level at Pom Eith village. The effects of downstream infrastructure can exacerbate flood problems in Cambodia. In Takeo Province in southern Cambodia, the sluice gates at the Cambodian-Vietnamese border built to protect Vietnamese rice cause higher flooding in the upstream part of the floodplain and constrain fish culture during this period, according to villagers, necessitating a higher dike or fencing to protect the cultured area.

WATER CHEMISTRY

Water acidity in the Plain of Reeds of Vietnam limits fish culture to the flood period. The local DoF officer in Thap Moi District characterizes Truong Xuan hamlet as having only limited potential for year-round aquaculture, as half of it is severely affected by acidity, thus limiting fish culture to the flood season. This may favour community-based fish culture, as acidity could preclude the development of commercial, year-round pond aquaculture.

4.4 SOCIO-CULTURAL CONTEXT

PREVIOUS EXPERIENCE OF COLLECTIVE ACTION AND COMMUNITY-BASED MANAGEMENT

The presence of existing community-based institutions and evidence of collective action has been put forward as a pre-condition for successful collective action. Site selection in Vietnam was partly based on the willingness of farmers to join the group and on the presence of an existing collective for rice farming or fish culture. In C2 and Trung Phu B hamlets, farmers were grouped by irrigation unit to share drainage and irrigation costs. Collective fish culture had been successfully developed in 2005 in D1 hamlet and in 2006 in Trung Phu B with the support of provincial and district authorities. In Trung Phu B, a rice cooperative was established from 1978 to 1988. After the Doi Moi reform, the cooperative disappeared and only in 2004, with the ASPS project a new form of collective action was developed, with the creation of a “Rice Group”. This group

was formed to coordinate the activity of rice culture (mainly for Integrated Pest Management) and to develop also collective aquaculture. This project was implemented by the Department of Agriculture and Rural Development (DARD) of Can Tho city and the main activities were to provide technical support and training. This group was the basis for the development of fish culture in 2005. However, this "Rice Group" is not recognized as a formal group by many farmers, and most of them do not know the project ASPS. For them the group is not formal and consists of meetings for rice culture coordination and for water and pest management.

In Vietnam, a number of official groups exist in every commune, with branches at the hamlet level level, including a Farmer Organisation, Womens Organisation, Youth and Veteran Unions and a Health Care Organisation (Werthmann and Mai Thi Truc 2008). Even if CBFC was not successful, project implementation was facilitated by the presence of these groups, as in Kalmina Beel in Bangladesh, with collective action for school construction or rotational microcredit and integrated rice pest management in Pom Eith village in Cambodia. In Cambodia, a Khmer NGO Chamroe Chiet Khmer Organisation (CCK) supported the formation of three self-help groups in Pom Eith village, including a group to prevent the outbreak of brown plant hopper, a savings group and a bicycle group. In Thnal Kaeng, the international NGO CARE has encouraged community activities in the village, including the establishment of rice and credit banks, as well as the Farmer Water User Group (FWUG) (Werthmann and Mai Thi Truc 2008).

However, the extent to which the presence of these organizations influenced the outcome of community-based fish culture activities is unclear. The nature of the interaction amongst members of the fish culture group differs considerably from the requirements of participation in the official groups in Vietnam, or the NGO created groups in Cambodia. The benefits from collective action in the institutions described are qualitatively different from the potential benefits from fish culture, and also do not carry a financial risk if the activity fails. As Gillinson (2004) reports, solidarity benefits and social gratification are important incentives for collective action, as studies by Schlozman (1995) and Walker and King (1992) have showed, albeit in the United States. In the case of pest management, and the control of the brown hopper, cooperation is essential for effective control against outbreaks. As a contributing factor in the continuance of community-based fish culture, the primary advantage that can be gained from community participation in existing organizations, is the creation of greater social cohesion, mutual understanding and trust amongst members.

SOCIAL COHESION AND COOPERATION BETWEEN DIFFERENT STAKEHOLDERS

Cooperation and social cohesion is a necessary community attribute if CBFC is to succeed. Lack of social cohesion was apparent in some cases as communication problems and in others to the desire to work individually.

In Bangladesh, developing the project with an established local institution such as the fishers' society at Beel Mail or with the involvement of religious authorities as at Kalmina Beel helped to build cohesive community action. Moreover, cooperation between fishers and landowners in Beel Mail was facilitated by cooperation previously exercised during 7 years of holding the lease on the water body. In Vietnam, the process was constrained by weak social structures such as the hamlet farmers' association, which was considered weak at Trung Phu B, or the rice group at C2 hamlet, which most farmers did not recognize. At D1 hamlet the group had only 11 households in 2009, 9 of which were closely related. According to the members of this small group, "they will know how to keep their money" and in 2007 it was public fish and in 2009 it is their "own fish." In 2009, the project site enjoyed efficient guarding and technical implementation, with no poaching. In addition, members did not receive any payment for guarding and harvesting tasks, as in previous years.

Group size was often cited as a challenge to effective group management. In Vietnam, 16% of respondents at D1 hamlet and 20% at C2 found it difficult to manage a group of farmers, expressed as "too many people, too many ideas." At Trung Phu B hamlet, 18% of respondents thought that collective action was possible only for rice culture because rice belongs to individuals at harvest time, unlike production from CBFC. At this hamlet, more than 50% of respondents voiced their concern about managing a large group, as at D1 and C2 hamlets. In addition, the community neighboring D1 hamlet, which was considered poorer because of its high percentage of landless households, complained about the lack of access to their usual fishing grounds. Tensions between the two communities were reported during project implementation. In 2009, landowners near the poorer community declined to join because of reports of poaching by villagers in the neighbouring hamlet.

In Cambodia, sharing information, specifically during the project startup, was a constraint at Pom Eith, where 30% of respondents indicated poor communication from the village leader, and at Potamon, where 10% voiced that complaint. At this last village, 52% of respondents highlighted the lack of cooperation among villagers, which was often linked to frequent and unpredictable migration to Phnom Penh for wage labor, creating an unfavorable environment for collective action.

Often, working together on a collective basis caused stress and conflict within the participating communities, as reported at 3 sites in Vietnam and 1 site in Cambodia. At D1 hamlet in Vietnam, three beneficiaries explained that fish culture caused more stress than any other livelihood activity, with night watch, fear of poaching and suspicion among neighbors. These beneficiaries explained that they preferred not to report poaching by other project participants to maintain good relations with their neighbors. The project is a source of tension among beneficiaries, according to 5% of respondents at D1, 12% at Trung Phu B and 15% at Hung Binh. Similar effects on relations were found at Potamon village in Cambodia, according to one villager there.

Excluding resource users from a common resource inevitably leads to some tension, as was found in Vietnam and Cambodia. However, mechanisms can be put in place to reduce the impact on non-beneficiaries, and to increase their acceptance of the fish culture intervention. The acceptance of the project by non-beneficiaries depends on the benefits they receive. At the successful sites of Kalmina Beel and Beel Mail in Bangladesh, non-beneficiaries could buy fish more cheaply than at the local market. At Kalmina Beel, the price of silver carp dropped from $1.02-1.17/kg at the local market to $0.51-0.58/kg in the village. A similar impact was described at D1, C2 and Trung Phu B hamlets in Vietnam but to a lesser extent, as the benefit of lower fish prices was reported for only a short period of 15-20 days during the fish harvest and applied only to neighboring households, not to the entire village, as in Bangladesh.

In Vietnam, greater cooperation with other users of the area such as fishers would reduce the likelihood of conflict between resource users. At Hung Binh and Truong Xuan hamlets, cooperation with fishers was enabled by access to other fishing grounds and information sharing with the support of local authorities.

Integration with other land uses in Vietnam requires coordination with the rice cropping calendar, as rice culture is the farmers' priority. In some cases, when the irrigation scheme is collective, coordinating the rice cropping calendar is necessary on a scale larger than that of the fish culture site, as at Hung Binh and Truong Xuan hamlets. Coordinating the drainage and irrigation calendar of the area therefore requires the cooperation of a larger group and, in the case of Truong Xuan hamlet, the cooperation of commune and district authorities. Integration with rice culture can require technical adjustments such as using pesticides for rice that will not harm fish. Shortening the fish grow-out period to accommodate a third rice crop may require buying or nursing larger fingerlings so that fish reach marketable size.

4.5 LIVELIHOOD CONTEXT

FLOODING, FARMING SYSTEMS AND HOUSEHOLDS ACTIVITIES

Specific agro-ecological conditions at each site reflect different farming systems, access rights or water-management systems, which influence the technical implementation of projects and incentives for beneficiaries to develop CBFC. Farming systems are closely linked to flood period and water management systems.

Bangladesh. In Bangladesh, the flood period is long, stretching from July to December, with highest water at between 3 and 5 meters deep in the beel, while higher land, either less inundated or not at all, supports rainy season rice (Figure 4). The main rice crop is grown in the beel during the dry season, while the rice crop grown on elevated land during the rainy season is economically less important (Table 8). Landowners usually have access to another agro-ecosystem, enabling different kinds of production during the year. Vegetable

Figure 4: Seasonal calendar in project sites in Cambodia, Vietnam and Banlgadesh

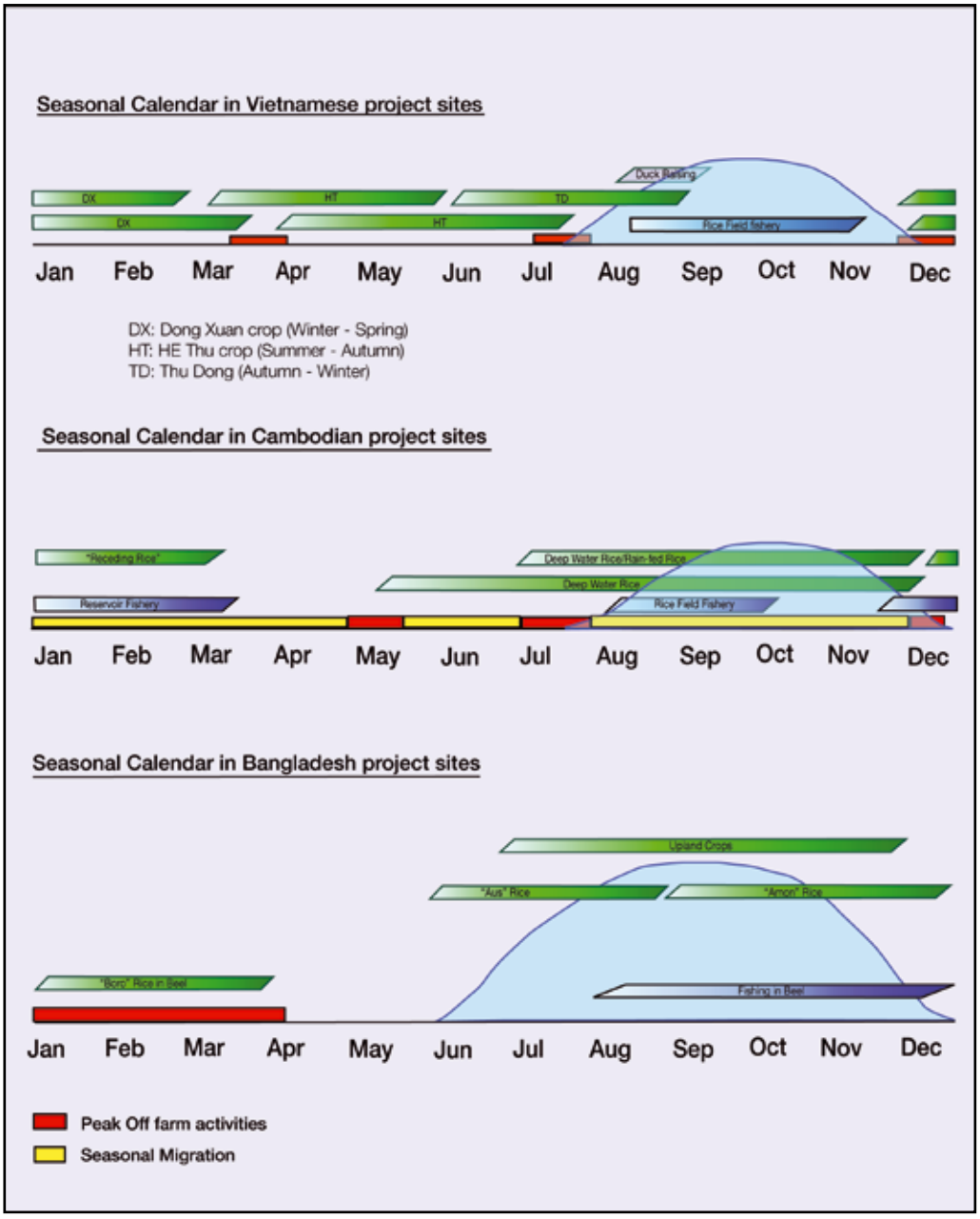


Table 8: Agricultural production cost and return at project sites

	Yield	Variable Cost ($/ha)	Net Return ($/ha)
Dry season rice			
Vietnam (n = 28)	6.6-7.9	487-748	860-1612
Bangladesh (n = 3)[a]	3.0-3.6	726-772	331-363
Cambodia (n = 9)	> 3	nd	nd
Rainy season/2nd rice crop			
Vietnam (n = 29)	3.0-5.1	516-757	(44[b]) 391-612
Bangladesh (n = 3)[a]	2.0-2.5	363-445	70-152
Cambodia (n = 36)	0.5-2.325	150-302	75-525[c]
3rd rice crop			
Vietnam (n = 9)	4.0-4.1	677-694	172-292
Upland crop (Bangladesh)			
Fish culture (n = 86[e])	nd	nd	1,845/HH
Potato (n = 2)	nd	1,000-1,300	1,625-4,537[d]

ha = hectare, HH = household, n = number, nd = no data available.
[a] Data collected during group discussion.
[b] Result in Plains of Reeds, which is low because of low yield and low rice price in 2008.
[c] In Cambodia most of the rice production is for home consumption.
[d] Selling price of potato varies by 100% during the year.
[e] Results from a baseline survey of 86 households at Kalmina Beel.

and potato cultivated on areas not affected by the flood are economically important for landowners, as is fish culture. In some beels, landowners own and operate small trap ponds at the end of the flood season, subsequently using the water for irrigation. The main fishing season is during the flood, from September to December. At this time, fishers are fully employed, unlike during the dry season, when fishing is less important and fishers and landless farmers work as paid laborers in others' rice fields. The landless are employed as agricultural labor or involved in fishing or other off-farm activity during the flood season. For both fishers and the landless, the most food insecure period is the end of the dry season and beginning of the flood season, when employment is scarce and fish availability is low.

Combodia. Flooding can start earlier in Cambodia than in Vietnam, as the latter has infrastructure for early flood protection. Downstream water management infrastructure in Vietnam affects Cambodian provinces such as Takeo (Kakonen 2008). Sluice gates at the Cambodian-Vietnamese border are operated to protect rice fields in An Giang and Ken Giang provinces from flooding, which is delayed until September in Ken Giang. This causes higher flood damage in the floodplain in Cambodia (Hoa et al. 2007). Open rice fields can be flooded from early June or July until January in the lowest areas. However, at project sites the duration of flooding was shorter in two cases, from August to November or December, with fish culture in rice fields during the flood and until January in reservoirs.

Rice culture is less intense in Cambodia than in Vietnam or Bangladesh. Farmers harvest only one crop of deepwater rice and rarely a second rice crop for lack of irrigation. As few farmers can cultivate rice in the dry season, opportunities for hired rice labor are limited. Young family members and some household heads migrate to cities, other provinces or even to Thailand to work as wage labor in factories, agriculture or construction. Low rice yields and the absence of off-farm activities strongly limit livelihood strategies, with farmers depending on rice field fisheries and seasonal migration to meet households needs.

Vietnam. The flood period in Vietnam is short compared with that of Bangladesh. Rice fields are intensively used, with well-develop irrigation and flood-protection systems allowing two or three rice crops per year. Vietnamese farmers in the Mekong Delta typically have access to only one type of agro-ecological area. Off-farm activities are important for smallholder farmers, but there is little migration like that observed in Cambodia. During the short flood season, rice fields are used mainly as open-access fishing grounds or to rear ducks. A few are

used for lotus culture. In late November or early December, rice fields are drained to start rice culture, thus limiting the duration of the flood. The flood season is considered the least-active season, as farmers fish for their own consumption. Usually farmers and the landless also pursue such off-farm activities as construction but may migrate to work as hired labor in rice fields in other provinces of the delta.

AVAILABILITY OF ALTERNATIVE LIVELIHOOD OPTIONS

The employment opportunities provided by fish culture may provide a strong incentive for participation and cooperation, particularly where alternative occupations are limited or absent. Employment as guards or workers building the bamboo fence is an incentive for poor fishers and the landless to participate. At Beel Mail, the monthly salary for a guard is $29.40 /month and for fencing labor $2.20/day, which is the daily rate for labor in the region. At Kalmina Beel, the landless hired to work in rice fields benefit from higher rice yields, which creates more jobs. At D1 hamlet, employment as a guard or harvester was a clear incentive, paying $1.17/night in 2007 and similar rate for harvesting. Beneficiaries working as both night guards and harvesters could earn more than $117 during the fish culture period. Competition for work as night guard and harvester later created conflict in the group.

In Bangladesh, harvesting, night watch and other duties are undertaken by the landless and fishers, not by landowners as in Vietnam. The daily rate in Bangladesh for harvesting is $5.88/day, which is more than 2.5 times the labor rate in agriculture of $1.70-2.20/day. In Vietnam, daily rates in agriculture or construction are $2.00-4.60, which is more attractive than harvesting fish for about $1.10/day. At several sites in Vietnam, harvesting by members of the fish culture group was mandatory and unpaid.

However, in locations where alternative occupations exist, and generate greater or more stable benefits than fish culture, community-based fish culture is less likely to be adopted due to the high costs of cooperation and demand for labour for guarding and harvesting the fish stock.

Economic benefit is key to individual decisions to continue CBFC. In Cambodia and Vietnam, the economic results were negative (Table 6), prompting 68% of beneficiaries at D1 hamlet, 78% at C2, 76% at Trung Phu B and 44% at Truong Xuan to quit the project. At Choy Proan village in Cambodia, 40% of participants stopped CBFC due to lack of income.

Even if seasonal migration in Cambodia or other employment during the entire flood period did not occur, villagers and specifically poor farmers preferred not to be bound to a project with daily or weekly duties, but rather be available for off-farm activities that can provide daily income. For example, four participants at Truong Xuan hamlet left the project for off-farm employment. Another declined to join in favor of being hired by a forest enterprise with a daily wage. In addition, the project was perceived as a new technique with no guarantee of benefits at the end of the flood season, and thus not really appealing to villagers. Off-farm activities and fishing are subsistence activities during the flood season, while income from fish culture is earned only after fish harvest in December or January, if at all. During a meeting of the fish culture group at Truong Xuan hamlet, the wives of some small landowner participants interrupted the meeting to complain about the lack of income due to their husbands' involvement in the project instead of fishing or being hired as wage labor.

In Bangladesh, involvement in other activities affected only the attendance of landowners at meetings at Angrar Beel. Participation in the project did not interfere with other activities, perhaps thanks to the involvement of professional fishers during the harvest and the employment of the landless for the night watch. Various stakeholders pointed out that other wage labor is not regularly available at this time of year.

Land use, cropping and livelihood activities vary slightly between sites in the Mekong Delta. In D1, C2 and Truong Xuan the main land use is two rice crops per year with a Dong Xuan crop (end of November/ December to February/March) followed by He Tu crop (end of March to June). In Trung

Phu B and Hung Bin farmers follow a triple rice crop calendar, with the third crop from June to the end of August/September. In the latter site, other crops such as sweet potato and watermelon are also popular and are important source of income.

The livelihood activities are related to two mains seasons: dry and flood season. During the flood season (from July/August up to November) in D1, the main activities are fishing for home consumption and off-farm activities. Between the rice harvest and the beginning of the flood, rice plots are rented out for duck rearing, which is an important source of income with a renting fee of 0.5 Mvnd/ha for one month in 2008. Similar activities are found in C2. Within the group participating in fish culture, which represented 77% of the community, 36% of the households have an off-farm activity during the flood season (construction building, digging land or carrying rice) and 21% of the households receive remittances from their relatives (son or daughter) who migrated to cities (Ho Chi Minh City or Can Tho). Forty percent of the respondents are fishing during the flood season for home consumption and 13% more intensively (trap net and longer gill net) for additional income.

In Trung Phu B, fishing activity and hired labor are the main activity of the households, even if hired labor opportunities are limited in this commune. Digging land or land transportation does not provide enough employment in the hamlet, most households rely on their own labor force. Rice carrying is the main hired labor activity in the area, but only a few farmers are involved. For most households and specifically the landless, poor and even medium income households, the main income comes from fishing activity and collecting snails (300 vnd/kg). Rat, frog and snake hunting also provide additional income for poor households.

In this hamlet, a distinction can be made between poor and medium households, with a difference in fishing equipment. Poor households usually fish in rice fields because they cannot afford to buy a river gill net (170,000 vnd/net) and they do not own a boat, whereas fishing in rice field requires a smaller minimum investment (50,000 vnd/net). The daily income varies between 30,000 to 40,000 vnd on average.

The flood season is the most difficult period at all sites, with fewer wage labour opportunities available. The season between rice crops during the dry season is also a difficult time.

In C2 hamlet, the end of the flood season (October) and January /February is considered the most difficult period for poor households with are fewer opportunities to work, no income and school fees to pay (1 Mvnd for 10 years old pupil). Households have to borrow money or buy goods on credit. In this period, fishing is important to provide daily food for many poor households.

In Trung Phu B , the most difficult periods for most poor households are in the flood season, and between the two rice harvests (2 months) when there is little work available. Frequently, they borrow money to buy the family needs during this period or to finance their rice crop from the farmers who usually hire them, with a monthly interest rate of 10 to 20%.

In Hung Binh hamlet, hired labor in the dry season is an important source of income for poor and medium households. The peak activity period is during February and March during DX harvest and HT land preparation and later between June and July for the second peak period for wage labor. The main activities are harvesting rice (40 to 80,000 vnd/day) and carrying rice (40 - 50,000 vnd/day). During these periods a person can be hired 15 to 20 days in a month. Sweet potato also requires hired labor during harvest, but to a lesser extend than rice culture.

AVAILABILITY OF LABOUR

Labour is important to the success of fish culture, as protecting and harvesting the fish stock is labour intensive. Lack of labour for fish culture due to seasonal out-migration was reported as an issue at 4 of the 12 sites included in the study. In Cambodia

more than in Vietnam, participation in the project was limited by seasonal migration. Men and, to a lesser extent, women migrate to Phnom Penh or Thailand to work in construction, in factories or on large farms when there are no rice-farming activities in the village (Figure 4). The percentage of households with at least one member, usually the head of household, migrating during the flood was 77% in Thnal Kaeng (n = 18), 76% in Pom Eith (20), 70% in Potamon (19) and 20% in Chroy Poan (20). Villagers preferred to migrate even briefly to ensure a monthly income for the household instead of joining a group for fish culture, thus limiting the number of participants in the project. Seasonal migrations are less pronounced in Vietnam, with only 10% of interviewed households in D1 hamlet, 11% in C2 and 26% in Trung Phu B with a member, usually a young member, migrating for economic reasons. This phenomenon was not observed in Bangladesh, as farmers were occupied in rice fields that were not inundated during the rainy season.

In Vietnam, as in Cambodia, the availability of labor for guarding cultured fish was a constraint at sites where sharing this responsibility was mandatory. Some fish culture groups chose to pay hired labour to guard the fish, increasing the cost of fish production. At Hung Binh hamlet, where only five households participated in fish culture, labour shortage was a problem. At Truong Xuan hamlet, 33% of the respondents found the work too onerous, as 90 ha was managed by only 13 participants. The following year, 2009, saw seven participants managing 120 ha and hiring workers during the harvest. Among non-beneficiaries interviewed at Pom Eith in Cambodia, 45% said they preferred not to join the project because of the heavy duties involved in the night watch and food collection.

Labour problems were compounded by the constraints on some members of the group to participate in the night watch and harvesting activities, from which women and older participants were excluded. At Thnal Kaeng in Cambodia, four interviewed women explained that they did not participate because they could not fulfill night watch duties. In Truong Xuan and Hung Binh, two farmers decided to quit the group because they were too old for project activities.

LAND AVAILABILITY AND DEPENDENCE ON FISHING AND FISH CULTURE

In Bangladesh, farmers have access to land at different elevations, allowing them to cultivate rice during the rainy season. In the Mekong Delta in Vietnam, by contrast, farmers do not have access to lands unaffected by floods and cannot cultivate during this period. This allows farmers to dedicate some of their time to monitoring fish culture, having secured a part of their income from rice, upland crops like vegetables and potatoes, or individual fish culture. In Vietnam, fish culture is the only activity on farmers' land during the flood, so Vietnamese farmers are involved in more CBFC activities such as guarding and harvesting than are landowners in Bangladesh. This is why the risk for Vietnamese farmers is higher.

4.6 INSTITUTIONAL CONTEXT

SUPPORTIVE LOCAL AUTHORITIES

The support of local authorities was found to be a critical factor in the successful development of community-based fish culture. Local authorities were instrumental in preventing illegal fishing and poaching, supporting the maintenance of critical infrastructure, including water management infrastructure and promoting transparent management mechanisms in a co-management arrangement.

Local authorities play an important role in preventing illegal fishing and poaching at project sites. At two sites in Vietnam where poaching was high, D1 and C2 hamlets, as well as at Thnal Kaeng village in Cambodia where the project faces vandalism problems, beneficiaries saw lack of support from local authorities as a constraint; 5% of respondents in D1 and 13% of respondents in C2 cited this lack of support, as did four project participants, or 80% of the beneficiaries, in Thnal Kaeng village. At Kalmina Beel in Bangladesh, local authorities' support in preventing vandalism of the fence was an important

factor contributing to success, according to project beneficiaries.

In Cambodia, access to knowledge and support from extension services or the private sector is limited. In Chroy Poan village, for example, uptake and adoption of aquaculture on an individual basis spread only after frequent visits of FiA staff during the project.

In Bangladesh, district and upazilla officers were involved directly in the project, making several visits to the site and participating in the PIC. In addition, FMC meetings were held in the presence of the senior upazilla DoF officer. Upazilla and district officers received some payment from the project for their involvement. In the case of public land, support from the administration is needed to acquire the lease, and on private land the support of local authorities is needed as a guarantee against vandalism and poaching. The DoF also supports CBFC through fingerling release programs. Project beneficiaries report that technical, economic and management supervision by an external advisor such the DoF or WorldFish is needed. In Beel Mail, members of the FMC acknowledge as an enabling factor the proper planning of tasks done in collaboration with project partners. Project beneficiaries contrast this approach with their less-successful first attempt at CBFC in 2005, when there was no scheduled planning or monitoring of activities.

In Truong Xuan hamlet in Vietnam and Chroy Poan village in Cambodia, project implementation prompted more frequent visits from local authorities and technicians in the DoF and FiA to these remote areas, bringing new access to knowledge and inputs and creating a favorable environment for aquaculture development.

However, land tenure is a sensitive issue and source of conflict in Bangladesh. The involvement of government agencies in a privately owned area can create suspicion among landlords of land tenure change. This suspicion limits the participation of landowners in the project, as happened in Kalmina Beel during the early stages of the project.

The influence of DoF officers and local authorities in project management is a greater constraint in the case of private land, as at Kalmina and Angrar beels, than of public land such as Beel Mail, where the the DoF has the legal authority to manage resources. Beneficiaries' perception of DoF staff was also important. At Kalmina Beel, corruption amongst government officials was feared and transparent roles and behavior were required to gain beneficiaries' trust.

Technical support from WorldFish and/or local project partners was highlighted as important at the three sites in Bangladesh and at the villages of Chroy Poan and Pom Eith in Cambodia. For 30% of the beneficiaries at Pom Eith and 40% at Chroy Poan, the incentive to join the project was to gain access to aquaculture knowledge.

GOVERNANCE MECHANISMS FOR COMMUNITY-BASED MANAGEMENT

Beneficiaries in Bangladesh cited the development of transparency in accounting as the most important factor enabling CBFC, along with project support. PICs closely monitored FMCs, specifically regarding budget issues. Joint bank accounts and the presence of stakeholder groups' representatives during monetary transactions built trust among stakeholders.

Change in FMC organization at Angrar Beel in 2009 after the failure of the project the previous year is symptomatic of the importance of FMC organization. In 2009, the FMC was reformed with new members to prevent power lying with one individual, the group leader, subcommittees were created for such tasks as harvesting, marketing, fencing and guarding. Accounts were made more transparent to regain the trust and confidence of members. More active members were selected to join the FMC to prevent a small group of individuals monopolizing decision-making and to promote more democratic processes.

At Beel Mail and Kalmina Beel, the FMC is composed of trusted and respected people representing each stakeholder group, which has facilitated cooperation among

landowners, fishers and the landless. At these sites, transparent accountancy, joint bank accounts together with the DoF officer, and the presence of WorldFish staff during fingerling stocking improved mutual trust among beneficiaries. At Kalmina beel, local religious authorities are present during FMC meetings and create an environment of trust.

The experience of successful sites in Bangladesh suggests that management committees need to be composed of proactive representatives of stakeholder groups such as landowners, fishers and the landless, as well as previous resources users. For a large group, the committee is divided into subcommittees that are allocated specific tasks. Each subcommittee is similarly representative of stakeholder groups to promote transparency. The effective sharing of information is another key to developing community-based action at sites with multiple communities. At Angrar Beel, which has five villages involved in the project, beneficiaries highlighted the importance of conducting meetings to share information and ensuring that different beneficiary groups are informed of the meetings.

LAND OWNERSHIP

The average cultivated area at project sites belonging to individual households in Vietnam varies from 1.1 ha to 2.8 ha (n = 100) and, in Cambodia, from 1.2 to 2.0 in Cambodia (n = 61). In Bangladesh, land tenure was difficult to estimate, but landholding varies from 0.1 ha to more than 5 ha in the different sites, with medium-scale and large landowners having access to land in different agro-ecological zones. Unlike at Vietnamese or even Cambodian project sites, large landowners in Bangladesh represent 14-29% of households cultivating more than 0.4 ha, while poor households who are either landless or cultivate less than 0.2 ha represent 34-49% of households.[12]

The size of individual land holdings within the fish culture area had implications for benefit sharing, which occasionally led to disagreements amongst participants. In D1 hamlet in 2006 and 2007, as well as in C2 and Trung Phu B hamlets, benefits were shared according to landholding, as in Bangladesh. However, two landowners with less than 1 ha in C2 hamlet preferred not to participate in the project because their potential benefit was too small, considering the time investment. In Bangladesh, small landowners joined the project, perhaps because of the absence of any constraining duties such as the night watch or harvesting.

4.7 THE FLOODPLAIN AS A MULTIPLE USE SYSTEM

COMPETITION FOR SPACE

At the household and individual level, flooded rice fields in Vietnam are fishing grounds and areas suitable for duck farming. Renting out rice fields early in the flood season for duck rearing is a common source of income for rice farmers in the Mekong Delta. In D1, C2 and Trung Phu B hamlets, income from land renting varies by year from $5.80-28.00 per month per hectare. As fish culture and duck rearing are not compatible, farmers have to decide between renting land out for duck rearing or stocking fish, usually basing their decision on the comparative potential for profit.

At D1 hamlet, 46% of respondents stated that the lack of access to fishing grounds greatly affected them, as 77% of the households in the area used to fish during the flood season. At Trung Phu B, 30% of the respondents were affected by the change in access rights. However, at Trung Phu B, access restriction did not lead to frequent poaching, as at D1.

In Cambodia, competition for resources was found in two places, regarding access for fishing and watering cattle at Thnal Kaeng village and regarding duck farming and rice irrigation at Chroy Poan. In both sites, no agreement was found, and competition for resources ended in poaching and vandalism.

In Vietnam, fish culture takes place in the only agro-ecosystem of an area, in which farmers cultivate two or three rice crops,

[12] Results based on participatory rapid appraisals of villages at project sites at an early stage of the project.

rear ducks early in flood season, and fish (Figure 4). This succession of activities in the same land area requires timing adjustments, and the addition of fish culture may create conflict with other users. Some examples found at Vietnamese project sites are described below:

- In Trung Phu B and Hung Binh hamlets, farmers planted three rice crops per year, which delayed fish stocking and necessitated early drainage of water, limiting the fish grow-out period.
- Even in areas with only two rice crops, such as D1, C2 and Truong Xuan hamlets, fish culture was affected by early land preparation at the end of fish culture. Plowing increased water turbidity to the detriment of the environment for fish, and farmers' allocation of time to rice culture created a labor shortage during fish harvesting at C2. Farmers at these project sites — even those involved in fish culture — prioritize securing their rice crop with early land preparation and sowing. Similar constraints affected areas with three rice crops, such as Trung Phu B.
- In Truong Xuan hamlet, the project site is part of a larger water management or hydraulic unit, with a pumping station draining the water to irrigate a few hundred hectares of rice fields. Fish culture in rice fields has to follow the water management calendar decided by district and commune authorities. In 2008, early drainage shortened the fish grow-out period and forced farmers to harvest fish prematurely.
- Pesticide residues from rice culture may affect fish growth, according to RIA2 staff, specifically in triple-cropped areas of Trung Phu B and Hung Binh.

Other land use in the same area can affect fish culture. At Truong Xuan hamlet, the cultivation of lotuses for roots and seeds constrained the harvest by limiting the efficiency of harvesting methods in 2008 and 2009.

Before the project, fishing in inundated rice fields was common for home consumption or to provide daily income. Fishing restrictions following project implementation were not well accepted by beneficiaries in D1 and Trung Phu B hamlets or by outsiders in D1 and C2 hamlets in Vietnam and Thnal Kaeng village in Cambodia, who lost previous access rights, although alternative fishing grounds were available nearby. In D1, 15% of survey respondents, including project participants, cited the lack of access to fishing grounds as a harmful impact of the CBFC project, as did 18% of respondents in Trung Phu B. This was mainly a concern for households who usually fished for home consumption behind their houses. In Truong Xuan in 2009, the fish harvest triggered social conflict. Some landowners not involved in fish culture did not allow project participants to enter their land during the harvest, even where previous agreement existed. Landowners benefit from fish culture by harvesting both wild and cultured fish.

C2 and D1 hamlets in Vietnam were affected by poaching, according to interviewed project participants, 58% of whom at D1 and 27% of whom at C2 ranked poaching as one of the main constraints. High rates of poaching by beneficiaries and others alike were explained by the difficulty of policing large areas measuring 48 ha and 65 ha at night, compounded by their previously open access nature. At other sites in Vietnam, poaching was not highlighted as a constraint. Rivers provided alternative fishing grounds at Trung Phu B and Hung Binh hamlets, and the site at Truong Xuan hamlet was, according to farmers, not productive or heavily fished before the project.

Poaching happened at only one site in Bangladesh, Angrar Beel, where the accused were participants involved in guarding the site and related to the president of the FMC.

In Cambodia, beneficiaries at Thnal Kaeng village reported poaching and vandalism, as the project site was in a public reservoir previously open to fishers. All beneficiaries and 30% of other respondents claim that fishers deliberately damaged the fence to allow fish to escape.

At Chroy Paon village, where the project site included a private rice field and a pond with multiple owners, 60% of beneficiaries cited vandalism as the main constraint on CBFC. The conflict originated in the multiple use and users of the pond. The pond included in the project was previously used by one of the owners for rice irrigation, watering livestock and rearing ducks, which created conflict after the first year of fish culture. In the second year of the project, the pond was divided into two parts, one for fish culture and the other for private use. The pond owner and project beneficiaries could not agree on water and pond usage, and the resulting conflict saw the fence vandalized, allowing fish to escape and suppressing fish production.

In all project countries, governance mechanisms showed their limited ability to control poaching and other misbehavior. It is important to balance power in the beneficiary group and, where there are multiple resource users, agree on land and water use.

4.8 MARKETS AND ECONOMIC VIABILITY

INFLUENCE OF INTERNATIONAL MARKETS AND THE IMPORTANCE OF RICE

With the liberalization of the economy and the intensification of rice culture, Vietnam became the world's second-largest rice exporter in the early 1990s. The national market is therefore influenced by fluctuation of international rice prices. In April 2008, for example, domestic rice prices rose 10% within a week to record a 45% gain over the January 2008 price (TopNews.in 2008). The price of rice affects the relative profitability of aquaculture. Higher rice prices induced individual farmers to intensify their rice culture, as was noted in Hung Binh hamlet, where most of the farmers decided to shift from two rice crops per year to three when the price for paddy increased from 4,000 VND/kg to 6,000 VND/kg.

In Bangladesh, lower rice prices in 2009 in the midst of the global food crisis influenced farmer strategies and land-use choices, inducing farmers to shift to aquaculture in areas where seed, knowledge and other inputs were available, as observed at Kalmina Beel.

ACCESS TO MARKETS

The presence of a market for distribution of culture products is crucial to the success of any fish culture enterprise. However, it was found that market factors were an important constraint in the development of viable, profitable, fish culture.

In Cambodia, smaller size fish were marketed in villages for a retail price of $1.50-2.00/kg, which was higher than wholesale price, according to beneficiaries. Marketing was an important constraint in Vietnamese project sites, with low market prices for cultured fish during the fish harvest period and trading of a large quantity of fish, with big head carp sold at $0.22/kg, silver carp at $0.34/kg and common carp sold at $0.20-0.40/kg. In Bangladesh, where the size of the fish trade is similar to that of Vietnam at more than 20 million tons, marketing was not found to be problematic. The involvement of professional fishers in the group ensured good techniques in harvesting and processing fish for the wholesale market. Beneficiaries reported average selling prices of $1.04/kg for common carp, $0.69/kg for big head carp and $0.63/kg for silver carp between 2006 and 2008 and benefiting from a more competitive market than in Vietnam, where marketing is done by contract with a few fish traders during a short period when fish prices are at their lowest.

MARKET PRICES THAT PROVIDE A RETURN ON INVESTMENT

Alternative marketing with early sequential harvest using long fence trap nets before the bulk of harvest did not provide significant results, accounting for only 6% of the gross return at Truong Xuan hamlet. At all sites in Vietnam, economic results were limited by marketing constraints and fish market price fluctuation. Marketing was ranked as a main constraint by 26% of respondents at D1 hamlet, 33% at C2, 18% at Trung Phu B and 33% at Truong Xuan. Low market price and the marketing of large amounts of fish through traders in a short period lowered

the selling price. Alternative marketing with early sequential harvest using long fence trap nets before the bulk of harvest did not provide significant results, accounting for only 6% of the gross return at Truong Xuan hamlet.

AVAILABILITY OF COST EFFECTIVE, HIGH QUALITY INPUTS

In both Vietnam and Bangladesh, information, fingerlings and other inputs are easily available. In both countries, aquaculture development is supported by a growing market, extension services and a dynamic private sector. In Bangladesh, the DoF is the main public agency in charge of aquaculture development, together with 13 other agencies. Seven public organizations support aquaculture at different administrative levels in Vietnam. Private sector development and market integration have been key factors in successful aquaculture development in both Bangladesh and Vietnam. In Bangladesh, more than 98% of fish seed is produced by the private sector (DoF 2007). In Vietnam the development of catfish production was made possible by the production of 15 billion fish fry by 500 private fish hatcheries. In both countries, the integration of the value chain has made national and international markets accessible to local producers.

However, in Cambodia, the cost and availability of inputs for fish culture, particularly fingerlings, was also a limiting factor. During project implementation in Cambodia, access to high-quality seed was difficult and even delayed stocking. In Prey Veng and Takeo provinces, only one public hatchery and eight private or farmer-run hatcheries function in each province, producing 2.4 million fingerlings in Prey Veng in 2004 and 3.1 million in Takeo. The average price of fingerlings stocked during the project is higher in Cambodia, at $3.55-4.71/kg, than in Vietnam, at $2.01-2.88/kg. The lowest average fingerling price was found in Bangladesh, at $1.14-1.41/kg. Thus, fingerlings cost three times more in Cambodia than in Bangladesh, and the average fingerling size smaller, at 11 grams each compared with more than 30 grams in Bangladesh. This reflects a considerable difference in fingerling market development between the two countries.

4.9 TECHNICAL ISSUES AND IMPLEMENTATION

SITE SIZE AND LOCATION

Beneficiaries identified site size and location as important factors contributing to fish culture success. In Vietnam, sites in rice fields are usually adjacent to homesteads, facilitating fish-culture activities. Only at Hung Binh hamlet were homesteads far from project site, which was considered a constraint as close proximity to the culture site makes guarding more practical. At Pom Eith village in Cambodia, the site in 2007 was found to be too far from the village, at 1.5 kilometers, and was relocated closer to the village in 2008 to facilitate the night watch. Similarly at Thnal Kaeng, a project site was selected close to beneficiaries' houses.

The size of the enclosure was found to be problematic at several places in Vietnam. In Truong Xuan, 33% of respondents found 90 ha too large for 13 participants to harvest. In 2009, the area was enlarged to 120 ha with only 7 participants, requiring the group to hire labor for the harvest. At C2 hamlet, 22% of respondents considered 48 ha too large for 28 beneficiaries. At D1 hamlet, 40% of respondents stated that an area smaller than the existing 65 ha would be easier to protect from poaching.

SIZE OF STOCKED FINGERLINGS

In selecting the most appropriate size of fish for stocking in flooded areas, farmers had to make important trade-offs between the cost of investing in larger fingerlings, which are less vulnerable to predation and mortality, and increasing the financial returns by selecting smaller size fingerlings. Farmers were also constrained by the availability of fingerlings at the time of stocking. However, as a result of stocking smaller size fingerlings, the presence of predatory fish in the enclosure after fingerling stocking became a significant

technical constraint for all respondents at Thnal Kaeng and Chroy Proan villages in Cambodia. At Truong Xuan hamlet in Vietnam, the stocked common carp fingerlings were small at 1.54 grams each, and only 6.6% survived predation by self-recruited species. The fingerling survival rate in Vietnam in 2007 and 2008 averaged 13-33% at various sites, with fingerlings weighing 2.97-8.31 grams. In Bangladesh, the survival rate was better at 35-51% using fingerlings weighing 36.4-49.0 grams.

Beneficiaries at Beel Mail in Bangladesh compared their first experience of CBFC without technical support in 2005 with the present situation. The difference in survival rate and production between 2005 and later years was explained by better selection of fingerling size, selective harvesting and bamboo fencing at water inlets and outlets. Fingerlings larger than 30 grams brought better results than the smaller fingerlings used in 2005. At other sites in Bangladesh, technical support improved the model with better fish species selection at Angrar Beel and longer grow-out periods at Kalmina Beel.

APPROPRIATE FENCING AND ENCLOSURE TECHNOLOGY

Fencing and other protection of the culture site from vandalism and sudden flooding was a main technical constraint. Net fencing was a costly $1,147 at Truong Xuan hamlet and $105-189 at Cambodian project sites, and it is more easily damaged and difficult to maintain than dikes like those found at Pom Eith, Chroy Poan and Thnal Kaeng in Cambodia and Truong Xuan hamlet in Vietnam. At Pom Eith, beneficiaries decided to change the location of the enclosure, preferring to use an area with a higher dike to reduce the need for fragile net fencing.

In Bangladesh, the use of bamboo fencing instead of net requires more work but offers the advantage of allowing naturally occurring fry to migrate into the site while blocking the entry of large predatory fish. Bamboo also allows better water exchange with the floodplain and, according to rice farmers, does not modify the deposit of alluvium in rice fields, unlike in Vietnam, where systems of dikes and culverts seem to limit sediment deposit and the natural renewal of fertility in rice fields over the years.

TECHNICAL EXPERIENCE OF FISHERS

As noted above, the lack of labor in Vietnam made harvesting problematic. In Bangladesh, by contrast, the involvement of professional fishers, who keep 50% of the self-recruited catch and 15-20% of the cultured catch, allows an efficient fish harvest. Moreover, in Vietnam, the absence of professional fishers with their own harvesting gear and the consequent need to rent gear for $114 at Trung Xuan and $430 at C2 was found to be expensive. Professional fishers also bring skills that other beneficiaries lack. Some beneficiaries in Vietnam preferred to allocate their time to preparing rice fields instead of participating in the fish harvest.

4.10 INCENTIVES FOR UPTAKE AND ADOPTION

The economic viability of fish culture is the strongest incentive to pursue community-based fish culture. In Vietnam, the incentive to join the project was mainly economic, as 95% of respondents at D1 hamlet and 73% at C2 joined the project to increase their income during the flood season, expecting income of up to $117/household, or more than the value of fishing for home consumption or renting land out for duck rearing. At other sites, the expectation of increased income was less important (52% of respondents at Trung Phu B and 38% at Hung Binh). However, economic benefits from fish culture have not matched expectations or been able to compete with other income-generating activities. This outcome is primarily a result of the low market value of fish at the time of ha rvest in Vietnam, which is dictated by the start of the next rice cultivation period. Lower than expected financial benefits prompted 68% of beneficiaries at D1 hamlet, 78% at C2, 76% at Trung Phu B and 44% at Truong Xuan to quit the project. At Choy Proan village in Cambodia, 40% of participants to chose discontinue fish culture.

In the Mekong Delta, November and early December see the volume of capture

fishery trade rise to an average of 1,040 kg/day in the market at Muong Luon in Dong Thap Province, sharply up from 601 kg/day in the dry season (Vu et al. 2007). In five markets in the Mekong Delta, from 56% to 92% of traded fish comes from capture fisheries at this season, with only 32% to 59% coming from capture fisheries in the dry season. The abundance of fish at this time of year forces down fish market prices to $0.34/kg for common carp (*Cyprinus carpio)* from $1.14/kg in the dry season, and less than $0.28/kg for big head carp *(Hypophthalmichthys nobilis).*

In contrast, at Kalmina Beel and Beel Mail in Bangladesh the economic results for individuals improved with the project. In Bangladesh, it was important that landowners could also benefit from fish culture, as flooded rice fields provided no benefits before the project. At Kalmina Beel, landowners were able to gain $72.60/ha in 2008, and moneylending landowners at Beel Mail increased their income by 25%. The landless reaped a net benefit of $2.20/participant from the improved fish catch with restricted access for previous users. At Beel Mail, the landless can catch 250-2,000 grams of fish per day, many times the 50 grams/day caught before the project.

Fishers are the main beneficiaries at Beel Mail, increasing their income with their share of the net benefit and of the harvest. On average, fishers claim to earn $103-294 each, compared with $14-73 previously. Similarly at Kalmina Beel, fisher's income rose from $29-36/household/year to $59-73/person/year. At Beel Mail and Kalmina Beel, participants cited increased income for all beneficiaries as the main impact. Compared with other opportunities like off-farm labor, earning $2.20/day, CBFC is more lucrative. Moreover, the successful result at Beel Mail and Kalmina Beel created opportunities for beneficiaries to diversify their incomes. At Beel Mail, more than 20 households are now involved in potato or fingerling trading. At Kalimina Beel, 10-12 households started fingerling nurseries. Economic incentives are important for the continuance of collective action in Bangladesh, with all stakeholders benefiting from the project.

FOOD SECURITY INCENTIVES

In Cambodia, cultured fish are harvested in the dry season, after the peak of wild fish harvest, to secure higher prices averaging $1.50-2.00/kg or even higher. However, ncreased fish production and access to cheaper fish during off-peak harvest season was an important incentive in Cambodia, as 80% of respondents at Chroy Poan village and 20% at Pom Eith expecting to increase their fish consumption. In Bangladesh, improved fish stocks and communities' access to cheaper fish were important incentives. Fishing was not totally restricted in Bangladesh, but this regulatory difference reflected local fishing practice. The Bangladeshi use of extensive fishing gear like push nets or trap nets to catch only self-recruited species is uncommon in Vietnam, where most use long fence trap nets or gill nets, which do not restrict the catch to self-recruited species.

IMPROVEMENT OF RICE YIELD AND WATER MANAGEMENT

Farmers noticed several positive impacts in Bangladesh and Vietnam, where fish culture takes place in large rice fields. At both Angrar Beel and Beel Mail, landowners have found fish culture to improve rice yield by 10-20%. However, these results are unverified farmers' claims and follow only few years of fish culture, affecting two rice crops at Beel Mail and one at Angrar Beel.

At Kalmina Beel, the impact on rice farming is a main factor that attracts farmers to CBFC. The dry season rice crop and, to a lesser extent, the rainy season rice crop benefited from the improved water management necessary for fish culture. Early in the dry season, longer water storage allows irrigation during the first step of rice culture in January. Before the improvement of the water management infrastructure, the flood plain was drained earlier in the season and affected by flash floods in April, damaging the rice crop at the flowering or maturing stage. During the rainy season, rice culture on areas not inundated can benefit from irrigation at the critical flowering stage when there is a drought.

Rice culture benefited from the project at two sites in Vietnam, C2 and D1 hamlets, with improved dike systems. A better dike system in Vietnam allows earlier drainage and an early winter rice crop, which fetches a higher selling price. In addition, farmers in these hamlets expected to cultivate a third rice crop with a better flood-protection system.

CHANGE IN SOIL STRUCTURE, FERTILITY, PEST AND WEED DENSITY, AND THE RICE CROPPING CALENDAR

Fish culture is thought to improve the fertility of rice fields while suppressing weeds and pests. However, Vietnamese participants found it to reduce rice yield as it encouraged golden apple snail, a rice pest, by preventing their collection by villagers and fishermen, according to 38% of respondents at Hung Binh hamlet, 26% at C2, 25% at D1 and 12% at Trung Phu B. Fish culture interfered with rice field leveling, according to 7% of respondents at C2 hamlet and 35% at Trung Phu B. Lower alluvium deposit because of reduced water exchange was cited by 15% of respondents at D1 hamlet and 6% at Trung Phu B hamlets. Delay in rice seeding was a complaint of 10% of respondents at D1 and 18% at Trung Phu B. At C2, 33% of respondents stated that fish culture harmed rice yield. However, as there was no control site outside the area, a relationship between fish culture and rice field could not be confirmed. It is also possible the lower yield could reflect interannual variation arising from other causes such as weather. 26% of respondents at C2 hamlet and 36% at D1 reported that fish culture suppressed rice field weeds. A similar effect was described at Truong Xuan.

TECHNICAL SUPPORT

Technical support from WorldFish and/or local project partners was highlighted as important incentive at the three sites in Bangladesh and at the villages of Chroy Poan and Pom Eith in Cambodia. For 30% of the beneficiaries at Pom Eith and 40% at Chroy Poan, the incentive to join the project was to gain access to aquaculture knowledge, and links to government and development agencies. Chroy Poan has seen the establishment of five new privately owned ponds using improved extensive culture systems since the beginning of the project in 2008. Villagers also benefited from the presence of development agencies. The development of individual aquaculture is the main impact of the project for 90% of the project beneficiaries and 71% of others interviewed. One hypothesis is that the presence of the project and its technicians, and the resulting access to knowledge and inputs, reduced the risk local farmers faced in changing their production systems. At Truong Xuan hamlet in Vietnam and at Kalmina Beel in Bangladesh, gaining access to local administrators and politicians for purposes other than for fish culture, such as requesting road improvements, provided an incentive to participate in the fish culture project.

4.11 DISINCENTIVES

CHALLENGES OF COLLECTIVE ACTION

In Cambodia and Vietnam there was a clear lack of incentives to attract individuals to collective action. At C2 and Hung Binh hamlets, all respondents highlighted the difficulty of implementing collective action. At Trung Phu B hamlet, 53% of the respondents found no advantage to working collectively.

In Cambodia, most participants in implementation meetings at Thnal Kaeng clearly expressed their desire to start individual aquaculture, as they were not interested in collective action. At Chroy Poan, 30% of group participants and all others interviewed did not see any advantage of working together. At Thnael Kaeng, farmers clearly explained that the main consideration when starting an activity is independence from their neighbors and other farmers, and ownership of production. At this last village, resistance to collective action was explained by the lack of trust among members regarding work duties, poaching and inequity in benefit sharing. Further production arising from collective action did not belong to individuals but to the group, which was a familiar Vietnamese approach of collective action. This individualistic behavior clearly

brought little social cohesion and limited the implementation of collective or community action.

CONTRIBUTION OF TIME OR MONEY TO PARTICIPATE

In order to create a sense of ownership, and to encourage sustainability beyond the project lifetime, beneficiaries were required to make a contribution either in the form of their own time and labour for dike maintenance, providing poles or bamboo for fencing, or a monetary contribution. At Chroy Poan village in Cambodia, villagers paid $5 each to join the group, and 20% of the nonparticipants interviewed in this village explained that this monetary contribution was beyond their means. In Potamon, Thnal Kaeng and Pom Eith villages, the contribution of $2.50-3.00 worth of bamboo per participant and labor to create the fence was also considered too high for villagers, who preferred to use their time for more lucrative activities.

5 LESSON LEARNED AND RECOMMENDATIONS FOR COLLECTIVE AQUACULTURE IN SEASONAL FLOODPLAINS

CBFC can provide animal protein and income diversification during the flood season and benefit various resource users. However, like other community-based activities, this model is fragile. Its success and sustainability depend on several interacting factors.

Technical, economic, social and governance aspects are important, but the method of implementation and the agro-ecological and socioeconomic context has to be taken in account. The following section synthesizes findings to identify the lessons learned in developing CBFC. Challenges and enabling factors and their interactions are presented in Figures 5 and 6.

5.1 GOVERNANCE, POLICY AND INSTITUTIONS

The following are the lessons learned regarding governance, policy and institutions:

CBFC can be more easily established where aquaculture is already developed.

- A strong national policy supporting aquaculture at the field level can ensure access to inputs such as fingerlings and knowledge at limited cost and without much constraint. Differences in aquaculture development in Bangladesh, Cambodia and Vietnam clearly show that CBFC is adapted to areas where aquaculture is well developed.
- A national policy for developing water-management systems can promote fish culture in large flooded areas, as in the Mekong Delta of Vietnam.
- Land use during the flood season depends on national and regional rice markets and national policy, as higher rice prices trigger a shift from two to three rice cropping per year, thus limiting the fish culture period. In Vietnam, the integration of fish culture on rice fields necessitates cooperation between fish and rice farmers regarding irrigation and drainage. Moreover, rice intensification can affect water quality regionally, as in the Plain of Reeds in Vietnam, where acidification early in the rainy season constrains aquaculture.
- The previous experience of beneficiaries, institutional stakeholders and development agencies in community or collective approaches to fishery management can be tapped to promote such systems. However, previous collective experiences in Vietnam and Cambodia that were unsuccessful have been seen to discourage farmers from joining new community-based initiatives.
- Strong governance within communities is important to create trust. In Vietnam and Bangladesh, mechanisms to promote transparency and control poaching were found to be necessary, as is trusted leadership. Here governance aspects link with social and economic aspects, as competition for the same space in Vietnam caused conflict with previous users of the area. Access can be restricted for previous users if other fishing grounds are readily available. Good governance also requires the effective communication of project goals and that regulations be disseminated to non-beneficiaries and previous users of the resource. Vietnamese experience shows that an effective system to control poaching is required, including law enforcement by local authorities. Otherwise, excluding previous users of the area usually generates conflict, which then demands revised regulations to allow limited use of the area. One way to avoid conflict with the landless and fisher previous users is to include them in the project, as was found in Bangladesh.
- Agreement and cooperation is needed with other land users in the fish culture area regarding the cropping calendar, access and other issues, especially where no other agricultural land is

available, as in Vietnam. Governance in Vietnam may also depend on social links in the community, as kinship can create sufficient trust among participants to allow good governance, transparency and effective mechanisms against poaching.

5.2 ECONOMY AND MARKETS

- For individuals, economic incentives are important. Beneficiaries need to compare the cost, return and risk of different agricultural options to assess the relative profitability of the model in the local context.
- Areas with low wage rates and few employment opportunities have greater potential for CBFC, as beneficiaries see higher economic incentives. However, the seasonal migration typical of such areas has to be taken into account, especially where the flood season is synonymous with local inactivity and therefore with out-migration.
- A national policy promoting aquaculture is important for market and economic viability. Even if the model uses extensive culture with few inputs, access to inexpensive fingerlings is important for system profitability, as is access to markets. Aquaculture is well developed in the Mekong Delta, with knowledge and inputs readily accessible, but marketing cultured fish at the same time as the peak of the wild fish harvest depresses prices and undercuts the economic returns of fish culture.
- Low economic results compared with other options or the previous use of the area discourages households and individuals from continuing fish culture. In Vietnam, economic returns from inundated rice fields is important for household incomes and food security. The area is used in different ways during the flood season, unlike in Bangladesh or Cambodia, where farmers have access to land that is not inundated. Economic profitability is key to the success and continuance of the model, which makes it dependant on the socioeconomic context. Some areas previously unsuitable because of the high cost of fingerlings or weak market linkage can become economically suitable in the future.

One lesson learned from experiments in Vietnam is the importance of rice culture compared with fish culture. Farmers consider fish culture complementary to rice culture, which is their main priority. In this case, incentives for farmers to implement and continue fish culture have to include improved rice field environment and water management with better flood-protection systems achieved through project implementation.

5.3 SOCIAL AND MOTIVATION ISSUES

Interest in the project and participants' involvement in community organization are important. In Cambodia and Vietnam, beneficiaries' lack of involvement in project activities reflects other employment and land-use opportunities, as well as participation being restricted to landowners. In Bangladesh, fishers and the landless are employed by the project and find attractive livelihood opportunities in CBFC. Inclusive beneficiary selection can avoid technical constraints and social conflict.

Conflicts with previous users and other land uses was problematic in Vietnam, with priority given to rice culture by farmers and national policy for rice intensification, and social and governance issues closely linked to the ago-ecological context.

The lack of social cohesion was highlighted as a major constraint at several sites, with conflict appearing during group management and collective decisions sometimes failing to find acceptance. In Vietnam, fewer conflicts and more effective management were found where strong social ties linked beneficiaries, with more than 80% of participants in the same clan.

5.4 ENVIRONMENTAL AND TECHNICAL ISSUES

Flood patterns, water management infrastructure and land use determine the duration of fish culture. These factors together with fingerlings size and the presence of predatory fish mainly

determine system productivity and the size of harvested fish. Marketing and the economic sustainability of the system demand that fish reach market size.

Lessons from Vietnamese and Cambodian sites show that, when the cropping calendar and flood duration restrict the growing period to 5 months, large fingerling and proper fingerling nursing are required. Flood length and its interannual variability are important. In Cambodia and Vietnam, the flood can be delayed and flood amplitude is difficult to predict, with some years being too low and others too high. The model therefore dependants on the natural environment, all the more so in Cambodia, where water-management infrastructure is poorly developed. Net fencing is not appropriate for an entire site; dikes and embankments are preferred to avoid flood damage, water run off and vandalism.

The production site has to be located near homesteads to facilitate management and security. Its size should accord with the number of beneficiaries, considering labor constraints, particularly at harvest time. Experience in Vietnam finds that no more than 2 hectares should be cultured per participant.

The impact of fish culture on rice culture must be considered. The project was too short to clearly indicate the ecological impact of fish culture on rice field fertility, pest management and yields. However, discussions with farmers in Bangladesh and Vietnam indicate that this effect is important. In Bangladesh, the improvement of water-management systems and the consequent benefits to the rice production of direct project beneficiaries and others brought better acceptance of CBFC by non-beneficiaries.

5.5 RECOMMENDATIONS FOR COLLECTIVE AQUACULTURE IN SEASONAL FLOODPLAINS

CBFC can be implemented in several ways and involve a variety of stakeholders. The model has to be adaptable to the agro-ecological and socioeconomic context. The following factors should be taken into account during site selection.

Regarding the agro-ecological context,

- the flood duration must be longer than 5 months,
- the agricultural calendar must not limit fish growth or the possibility of nursing fingerlings, and
- water-management infrastructure such as sluice gates and dikes are needed to control the water level and reduce the cost of net fencing.

Regarding the socioeconomic context,

- markets must be accessible and the harvest timed for acceptable prices for cultured fish,
- sufficient labor must be available during fish culture (at least one participant for each 2 ha of cultured area),
- the economic incentives of fish culture must compare favorably with other livelihood options, and
- previous successful collective action in the community indicates the necessary social cohesion.

Attention should be paid to the following points during project implementation.

Regarding beneficiary selection,

- previous users of the area should be included in the project to avoid conflict and poaching;
- where collective action is unpopular, as in Vietnam, the selection of beneficiaries may best be narrowed to kinship groups and relatives for higher social cohesion; and
- labor shortage can be avoided by integrating the landless and fisher previous users of the area.

Regarding governance and management,

- mechanisms for transparent management and poaching control must be developed in collaboration with project beneficiaries and

- developing regulations to improve transparency promotes social cohesion and participation.

Regarding economic aspects,

- marketing can be improved with selective multiple harvesting, which requires strong market linkage, and
- storing cultured fish in ponds or early harvesting may be options in the Mekong Delta to avoid having the harvest coincide with the peak harvest of wild-caught fish.

Regarding technical aspects,

- floodplains seem to be well suited for common carp and big head carp, but more valuable species may not be adapted to such extensive systems and can create incentives for poaching and
- large fingerlings are preferable, even at a significantly higher cost, to control predation and reach market size more quickly.

To succeed, CBFC has to integrate good governance and technical suitability in favorable socioeconomic and agro-ecological contexts. Not all floodplains are appropriate. Results from Cambodia and Vietnam confirm that a major focus in implementing CBFC is governance, while technical issues are also crucial. Difficult and complex as CBFC is, experience in Bangladesh shows that, where suitable, it can provide substantial benefits.

6. REFERENCES

Ali MH, Miah MNI, Elahi MN. 1998. Increasing farm income by incorporating fish culture in deepwater rice environment. *Bangladesh Journal of Fisheries Research* 2(2):183-188.

Asian Development Bank. 2005. An evaluation of small-scale freshwater rural aquaculture development for poverty reduction. Manila: Operations Evaluation Department, Asian Development Bank. ISBN 071-561-550-3. 164 p.

Catling D. 1992. Rice in deep water. Los Banos, Philippines: International Rice Research Institute. 542 p.

De Silva SS. 2003. Culture-based fisheries: An underutilized opportunity in aquaculture. *Aquaculture* 221:221-243.

De Silva SS, Amarasinghe US, Nguyen TTT (eds). 2006. Better practice approaches to culture-based fisheries development in Asia. ACIAR Monograph 120. Canberra: Australian Centre for International Agricultural Research. 96 pp.

Dey MM, Bose ML, Alam MF. 2008. Recommendation domains for pond aquaculture. Country case study: Development and status of freshwater aquaculture in Bangladesh. WorldFish Center studies and reviews no. 1872. Penang, Malaysia: The WorldFish Center. 73 p.

Dey MM, Prein M. 2003. Participatory research at landscape level: Flood-prone ecosystems in Bangladesh and Vietnam. In: Pound B, Snapp S, McDougall C, Braun A (eds). Managing natural resources for sustainable livelihoods: Uniting science and participation. London: Earthscan. 252 p.

Dey MM, Prein M, Mahfuzul Haque ABM, Sultana P, Dan NC, Hao NV. 2005. Economic feasibility of the community based fish culture in seasonally flooded rice fields in Bangladesh and Vietnam. *Aquaculture Economics & Management* 9:65-88.

DoF. 2007. Fishery statistical yearbook of Bangladesh. Dhaka: Department of Fisheries, Ministry of Fisheries and Livestock.

Gillinson, S., 2004. Why Cooperate? A Multi-Disciplinary Study of Collective Action. Working paper no. 234. Overseas Development Institute, London.

Hoa LVT, Nhan NH, Wolanski E, Cong TT, Shigeko H. 2007. The combined impact on the flooding in Vietnam's Mekong River delta of local man-made structures, sea level rise, and dams upstream in the river catchment. *Estuarine Coastal Shelf Science* 71:110-116.

Hong, M.C. 2010. China Country Report. WorldFish Center, Penang, Malaysia.

ICLARM and IFM. 1998. Analysis of co-management arrangements in fisheries and related coastal resources: A research framework. Manila: International Center for Living Aquatic Resources Management and Denmark: Institute for Fisheries Management, North Sea Center.

IIRR. 2000. Rice-fish culture in deepwater rice farming system. CITY: International Institute of Rural Reconstruction.

Kakonen M. 2008. Mekong Delta at the crossroads: More control or adaptation? *Ambio* 37(3):205-212.

Le Coq J-F, Trébuil G, Dufumier M. 2004. History of rice production in the Mekong Delta. In: Smallholders and stockbreeders: Histories of foodcrop and livestock farming in Southeast Asia. L. KITLV:163-185.

Lorenzen K, Garaway CJ, Chamsingh B, Warren TJ. 1998. Effects of access restrictions and stocking on small water body fisheries in Laos. J. Fish Biol. 53(Suppl. A):345–357.

Ministry of Fisheries. 2005. Progress report on aquaculture development in 2004 and solution for implementation of aquaculture development program in 2005. Hanoi: Ministry of Fisheries, Viet Nam. 15 p.

Ministry of Fisheries. 2006. Progress report on aquaculture development in 2005 and solution for implementation of aquaculture development program in 2006 of the North province. Hanoi: Ministry of Fisheries, Viet Nam. 15 p.

Mukhopadhyay PK, Das DN, Roy B. 1992. On-farm research in deepwater rice-fish culture in West Bengal, India. In: dela Cruz CR, Lightfoot C, Costa-Pierce BA, Carangal VR, Bimbao MP. Rice-fish research and development in Asia. pp 255–272. ICLARM Conference Proceedings 24. Manila: International Center for Living Aquatic Resources Management. 457 p.

Nguyen SH, Bui AT, Le LT, Nguyen TTT, De Silva SS. 2001. The culture-based fisheries in small, farmer-managed reservoirs in two provinces of northern Vietnam: An evaluation based on three production cycles. *Aquaculture Research* 32:975- 990.

Pillot D. 2007. Jardins et Rizieres du Cambodge. Paris: GRET-Karthala. 522 p.

Rothuis AJ, Nhan DK, Richter CJJ, Ollevier F. 1998a. Rice with fish culture in the semi-deep waters of the Mekong delta, Vietnam: A socioeconomic survey. *Aquaculture Research* 29:47-57.

Rothuis AJ, Nhan DK, Richter CJJ, Ollevier F. 1998b. Rice with fish culture in the semi-deep waters of the Mekong delta, Vietnam: Interaction of rice culture and fish husbandry management on fish production. *Aquaculture Research* 29:59-66.

Roy B, Das DN, Mukhopadhay PK. 1990. Rice-fish-vegetable integrated farming: Towards a sustainable ecosystem. Naga (International

Center for Living Aquatic Resources Management quarterly) 13(4):17-18.

Russell,A., Coulibaly, S., Sinaba, F., Kodio, A., Joffre, O., and N. Sheriff. 2010. Institutional histories, seasonal floodplains (mares), and livelihood impacts of fish stocking in the Inner Niger River Delta of Mali. The WorldFish Center CBFC Working Paper No. 5. The WorldFish Center, Penang, Malaysia.

Schlozman, K.L., Verba, S., and Brady, H.E.1995. 'Participation's not a Paradox: the View from American Activists', British Journal of Political Science 25:1

Sheriff, N., Joffre, O. Hong, M.C., Barman, B., Haque, A.B.M., Rahman, F., Zhu, J., Nguyen van H., Russell, A., van Brakel, M., Valmonte-Santos, R., Werthmann, C., and Kodio, A. 2010. Community-based Fish Culture in Seasonal Floodplains and Irrigation Systems. Final project report submitted to the Challenge Program on Water and Food. Available for download at http://www.waterandfood.org/page/Project-Reports

Saphakdy B, Phomsouvanh A, Davy B, Nguyen TTT, de Silva SS. 2009. Contrasting community management and revenue sharing practices of culture based fisheries in Lao PDR. *Aquaculture Asia Magazine* 14(3):3-6.

Sinhababu DP, Ghosh BC, Panda MM,. Reddy BB. 1984. Some preliminary observations on physico-chemical characteristics of soil and water under rice-cum-fish culture. *Journal of the Inland Fisheries Society of India* 16(1&2):58-61.

So N, Viseth H, Mov S, Navy H, Ka-Ming A. 2000. Overview of fish seed production in Cambodia. In: Proceedings of the national workshop on Cambodia's fish seed production: Current status and logical framework analysis. Phnom Penh: Department of Fisheries. 11 p.

So N, Tong E, Norng S, Hortle K. 2005. Use of freshwater low value fish for aquaculture development in the Cambodia's Mekong basin. Consultancy report for Mekong River Commission, Assessment of Mekong Capture Fisheries Project. Phnom Penh: Department of Fisheries. 34 p.

So, Haing L. 2007. An evaluation of freshwater fish seed resources in Cambodia, pp. 145-170. In: Bondad-Reantaso MG (ed). Assessment of freshwater fish seed resources for sustainable aquaculture. FAO fisheries technical paper no. 501. Rome: Food and Agriculture Organization. 628 p.

Thompson, P., Sultana, P. & Islam, N., 2003. Lessons from community based management of floodplain fisheries in Bangladesh. Journal of Environmental Management, 69(3), 307-321.

TopNews.in. 2008. www.topnews.in/paddy-rice-price-vietnam-rises-10-cent-week-237547.

Tubtim N, Hirsch P. 2005. Common property as enclosure: A case of a backswamp in southern Laos. *Society and Natural Resources* 18:41-60.

Vu VA, Tran KH, Phan TL. 2007. Monitoring sales of fish at retail markets in the Mekong delta. Fisheries ecology, valuation and mitigation component. Ho Chi Minh City: Mekong River Commission. 27 p.

Walker, Jack and King, David. 1992. 'The Provision of Benefits by Interest Groups in the United States', Journal of Politics, Volume 54.

Werthmann, C and Mai Thi Truc, Chi.2008. Community-Based Aquaculture for Poverty Reduction: Institutional and Technical Options for Sustainable Resource Use. Presented at IIFET 2008, Nha Trang, Vietnam

WorldFish. 2002. Increasing and sustaining the productivity of fish and rice in flood-prone ecosystems in South and Southeast Asia. Final Report to the International Fund for Agricultural Development. Penang, Malaysia: The WorldFish Center.

For further details contact:

The WorldFish Center
PO Box 500 GPO, 10670 Penang, Malaysia
email: worldfishcenter@cgiar.org

Authors:
Olivier Joffre and Natasja Sheriff

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