Community Based Fish Culture in Irrigation Systems and Seasonal Floodplains

A project proposal submitted to

CGIAR Challenge Program on Water and Food

CPWF PN35

14 February 2005

Project title

Community Based Fish Culture in Irrigation Systems and Seasonal Floodplains

Brief title

Community Based Fish Culture

Executive summary

This is a proposal for a five-year interdisciplinary action research project with the overall aim of enhancing the productivity of seasonally occurring floodwaters for the improved and sustained benefit of the livelihoods of the poor. The main activities of the project are to be conducted in seasonal floodplain and irrigation areas of two benchmark river basins (Indus-Ganges and Mekong) and one non-benchmark basin (Niger), with the option to expand the activities into the Senegal basin in the later part of the project. The underlying assumption of the approach is that seasonal waterbodies (over flooded crop fields, or in ponds and reservoirs in irrigation schemes), can be communally managed by all stakeholders under equitable and sustainable sharing arrangements. Recent on-farm demonstrations using such a community-based approach in Vietnam and Bangladesh have confirmed the feasibility of this approach.

During the rainy season in extensive river floodplains and deltaic lowlands, floods lasting several months render the land unavailable for crop production for several months each year. These waters are considerably underutilized in terms of managed aquatic productivity. This raises the opportunity to enclose parts of these floodwater areas to produce a crop of specifically stocked aquatic organisms aside from the naturally occurring 'wild' species that are traditionally fished and are not affected by the culture activity, overall resulting in more high-quality, nutrient-dense food production and enhanced farm income for all stakeholders, notably the poor.

The outputs of the project will provide:

- User-verified technical options for integrating fish and other living aquatic resources into irrigation systems and seasonal floodplains.
- Demonstrated and locally rooted institutional options for sharing benefits of integrating fish and other living aquatic resources into irrigation systems and seasonal floodplains.
- A validated participatory diagnostic and stakeholder-involving diffusion approach for community based fish cultured in shared water bodies.
- Improved capacity of NARES for supporting community based fish culture in shared water bodies.

The approach would help mitigate the trend of declining inland capture fisheries production, with increasing prices of fish, rendering these less affordable to the poor. For example, in Bangladesh alone, there are 3 million hectares of medium and deep flooded areas, out of which about 1.5 million hectares are estimated to be suitable for community-based fish culture. If this approach is adopted in only 50% of these areas, annual fish production will increase by 450,000 t (additionally to presently produced 60,000 t of wild fish caught) at an approximate value of 340 million US$ and will be of benefit to an estimated 6.7 million people (2.7 million of which are landless and functionally landless). Similar opportunities are seen for floodplain and deltaic systems in other countries in Asia and Africa.

Institutions participating

Name	Postal address	Email	Type of institution
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IFPRI	2033 K Street, N.W., Washington, D.C. 20006, USA	ifpri@cgiar.org	CGIAR
WARDA – The African Rice Center	c/o ICRISAT, BP 320, Bamako, Mali	warda@cgiar.org	CGIAR
Central Inland Fisheries Research Institute (CIFRI), Indian Council for Agricultural Research (ICAR)	Barrackpore, Kolkata, West Bengal 700120, India	pkatiha@yahoo.com, pkatiha@rediffmail.com	NARES
Central Institute of Freshwater Aquaculture (CIFA), Indian Council for Agricultural Research (ICAR)	Kausalyaganga, Bhubaneswar - 751002, Orissa, India	jkjena2@rediffmail.com	NARES
Bangladesh Agricultural Research Council (BARC)	New Airport Road, Farmgate, Dhaka 1215, Bangladesh	barc@bdmail.net	NARES
Department of Fisheries, Cambodia	Department of Fisheries, 186 Norodom Boulevard, P.O.Box 582, Phnom Penh, Cambodia	catfish@camnet.com.kh	NARES
Research Institute of Aquaculture No. 2	Research Institute for Aquaculture No. 2 (RIA-2), Ministry of Fisheries, 116 Nguyen Dinh Chieu St., District 1, Ho-Chi-Minh City, Vietnam	ria2@netnam2.org.vn	NARES
Inland Valley Consortium-Mali Unit	C/O Dr Paul Kiepe, IVC Scientific Coordinator, WARDA- The Africa Rice Center, c/o ICRISAT, BP 320, Bamako, Mali	p.kiepe@cgiar.org	NARES

Project leader (PL)

Name: Mark Prein
Discipline: Integrated Agriculture-Aquaculture Systems
Institution: WorldFish Center (formerly known as ICLARM)
Title: Senior Scientist and Leader, Freshwater Resources Research Program

Principal investigators - (PIs)

Name	Professional Discipline	Institution	Title
Madan Dey	Agricultural and Resource Economics	WorldFish Center	Senior Scientist
Ruth Meinzen-Dick	Development Sociology	IFPRI	Senior Research Fellow
Paul Kiepe	Land and Water Management	WARDA	Natural Resource Management Scientist, IVC Coordinator
Utpal Bhaumik	Inland Fisheries	CIFRI	Senior Scientist
Khabir Ahmed	Fisheries and Aquaculture	BARC	Chief Scientific Officer and Head, Fisheries Division
Nao Thuoc	Inland Fisheries	Department of Fisheries, Cambodia	Director
Nguyen Van Hao	Aquaculture	Research Institute for Aquaculture No. 2	Director

Note: In India, Dr. S. Ayyappan, Deputy Director General Fishery of ICAR, is signatory of the Consent Letter covering both CIFRI and CIFA, as ICAR is the apex agriculture research body in India. In Bangladesh, BARC is the apex agricultural research body that will implement the project with partnership of relevant NARES institutions. In Mali, the project activities will be implemented by the 'Inland Valley Consortium-Mali unit under the coordination of WARDA. WARDA being the host and coordinator of IVC is signatory of the consent letter on behalf of the IVC-Mali unit.

Budget requested from CP (in US$)

1,697,910

Budget offered as matching funds (in US$)

295,000

Total budget (in US$)

1,992,910

Duration of project

5 years

Coverage of basins

Mekong, Indus-Ganges and Niger river basins

Coverage of themes

Crop Water Productivity Improvement (Theme 1)	10%
Multiple Use of Upper Catchments (Theme 2)	0%
Aquatic Ecosystems and Fisheries (Theme 3)	90%
Integrated Basin Water Management Systems (Theme 4)	20%
Global and National Food and Water System (Theme 5)	10%

Background and justification

The past decade has seen growing recognition of the crisis facing the world's water resources and the need for concerted action to use these more efficiently. The efficiency of water use (or water productivity) can be increased by producing more output per unit of water used or by reducing water losses, or by a combination of both. So far, strategies for increasing output have been limited to crop cultivation only. Water productivity at several organizational levels can be increased further by integrating fish and other living aquatic resources into the existing water use systems. Such opportunities of integration include community based fish culture in irrigation schemes and seasonal floodplains.

At present, no comprehensive assessment of the value of fisheries in irrigation systems exists. Fish have been harvested in the reservoirs and canals of irrigation systems for at least two millennia and a variety of studies show that these continue to yield substantial fish harvests, which are important sources of protein and livelihoods for the poor and landless households. Yet the current use of irrigation systems and floodplains for fish production falls far short of potential. In seasonal floodplains, fish production essentially emanates from capture activities by seasonal or part-time fisher-farmers where wild fish enter, reproduce and are harvested from the flooded fields. In Cambodian floodplains, the value of fish caught through trap ponds within rice fields reaches 37-42% of that of rice production.

A number of studies have been conducted in the 1980s to test the technical feasibility of culturing fish in seasonally flooded rice fields (B Roy et al. 1990, Das et al. 1990, Mukhopadhyay et al. 1991, Ali et al. 1993, Rothuis et al. 1998a, Rothuis et al. 1998b, and Ali et al. 1998). These studies show that fish production can be increased by more than 1 mt/ha/year by stocking flooded ricefields with fish (i.e., individual farmers fencing their plots and stocking fish during the flood season). In addition, the culture of fish within ricefields can increase rice yields, especially on poorer soils and in unfertilized crops where the fertilizing effect of fish is greatest. Savings of pesticides and earnings from fish sales lead to increased yields and result in net incomes that are 7-65% higher than for rice monoculture. But the adoption of this technology by farmers has been very low due to the high cost of fencing individual plots.

Recently the WorldFish Center established a new approach in Bangladesh and Vietnam, where fish is cultured communally during the flood season and the same land is cultivated with rice during the dry season individually. The results of initial trails show an additional 10% lower cost of rice production and a net return from fish production of 400 US$/ha in the Ganges and Meghna floodplains (Bangladesh), 340 US$/ha in the Red river delta (Vietnam), and 220 US$/ha in the Mekong delta (Vietnam). Significantly, these benefits were obtained with no reduction in the wild fish catch, composed mainly of small indigenous species (SIS). The returns from the sale of the produced fish were distributed among the group members according to a sharing arrangement that was pre-negotiated among group members at the beginning of the season. Gains to the landless were in form of cash income, which was significant as they did not have any alternative income generating opportunities.

There are many options for enhancing food production from fish in managed aquatic systems. The most appropriate technology will vary from country to country and site to site. Additionally, the social and economic conditions under which these technologies can be implemented need to be understood. Although our recent studies in Vietnam and Bangladesh demonstrated the feasibility of the community-based fish culture systems, much more work is needed to understand the social and economic viability of these approaches under different socio-cultural and institutional environments, and to design appropriate institutional arrangements for different social settings. Similarly, the governance arrangements for fish

culture in irrigation systems (canals, fields, reservoirs) also require detailed analyses if the full social value of these resources is to be harnessed.

At the ecosystem or basin level, water provides a wide range of goods and services, all of which need to be considered in broader analyses of the value obtained from water. Most of the previous studies of water productivity have concentrated on measuring the value of crop production only and excluded the existing and potential contributions by living aquatic resources. There is therefore a need not only to increase water productivity, but also to improve the methodologies for measuring water productivity.

Goal

The purpose of the project is to increase water productivity, to reduce poverty, generate employment and increase income of all classes of rural society in floodplain and irrigation areas (including disadvantaged groups such as women and landless).

The project will contribute to achieving the following Outputs of Themes and Benchmark Basins:

Theme 1:	Outputs 3 and 5
Theme 3:	Outputs 10, 11 and 12
Theme 4:	Outputs 10, 11 and 12
Theme 5:	Output 1
Mekong Basin:	Outputs 1.1, 1.2, 3.3, and 4.1
Indus-Ganges:	Outputs 1.2, 1.4, 3.1, 3.2, 3.3and 4.3

Specific objectives

The project has four specific objectives, each benefits one or more target groups:

1. To develop a methodology for measuring water productivity at the landscape level and to assess the contribution of aquatic resources to water productivity in irrigation systems and floodplains.
2. To develop appropriate technical and institutional options for increasing water productivity at basin level through integration of community based fish production into existing floodplain and irrigation systems.
3. To develop a participatory diagnostic and stakeholder-involving diffusion approach for community based fish cultured in shared water bodies.
4. To enhance human resource capacity of NARES for supporting community based fish culture in shared water bodies

Activities and methodology

The project proposes to achieve the objectives through the corresponding activities and methodologies described below. It will be implemented in two countries (Bangladesh and India) in the Indus-Ganges basin, two countries (Cambodia and Vietnam) in the Mekong basin, and one country (Mali) in the inner delta of the Niger basin. After successful initiation of the project activities in Mali, the project will explore the possibility of initiating activities in the irrigation system of the Senegal basin.

Activity 1: Development of methodology for measuring water productivity at the landscape level.

At the landscape level (such as in floodplains and irrigation systems) water provides a wide range of goods and services, all of which need to be considered in broader analyses of the value obtained from water. However, most of the previous studies of water productivity have concentrated on measuring the value of crop production only and excluded the existing and potential contributions by living aquatic resources. Building upon the approaches of Bakker et al. (1999) and Meinzen-Dick (2001), this study will develop a holistic methodology to measure the overall water productivity at the landscape level that includes aquatic resources. This activity will include i) review of the literature on measurement of water productivity during the first nine months of the project and ii) development of the methodology for measuring water productivity by the end of the 18th month of the project. A workshop will be organized during the 1st year of the project to finalize the methodology. At least one PhD student from participating countries enrolled to a reputed university will work with the relevant WorldFish staff (Dr. Madan Dey) to implement this activity.

Activity 2: Assessment of the current and potential contribution of aquatic resources.

Using the methodology to be developed under this project (activity 1), the contribution of aquatic resources to water productivity in irrigation systems and floodplains under different land and water use patters will be assessed. To help achieve this, the project will conduct a series of comparative case studies in different ecosystems and localities varying in characteristics such as methods of water usage (regulated versus non-regulated) and means of exploitation of aquatic production (e.g. irrigated rice fields, irrigation canals, etc. compared to "non-cultured" and flood systems). A series of case studies and appraisals will also be conducted to document the contribution of aquatic ecosystems to the livelihood and food security of poor households. These activities will be conducted during the first two years of the project in all the basins under study (Mekong, Ganges and Niger), the output of which will help in designing appropriate technical and institutional options for integrating the culture of fish and other aquatic resources into existing farming systems. This and the subsequent activities will be implemented in 9 areas of the Indo-Gangetic floodplain (covering the Teesta Mahananda, Gangetic, Damodar-Kangshabati, and coastal floodplains of West Bengal state of India, the Brahmaputra floodplain of Assam state of India, and the Ganges-Padma, Jamuna-Brahmaputa, Meghna, and coastal floodplain of Bangladesh), 5 areas of the Mekong delta (3 areas of southern Vietnam and 2 areas of Cambodia) and 2 areas of inner the Niger delta in Mali. Study areas will be identified based on i) review of information from secondary sources and ii) reconnaissance field visits by multidisciplinary teams.

Activity 3: Development of participatory diagnostic and stakeholder-involving diffusion approach for community based fish culture in shared water bodies.

The project will develop participatory diagnostic methods and stakeholder-involving diffusion approaches that will help designing and testing of community based fish culture in irrigation systems and seasonal floodplains. These will be prepared by drawing together the experiences from various case studies on community based natural resources management and by convening workshops to review these and extract lessons that can be applied for community based fish culture in irrigation systems and seasonal floodplains.

Activity 4: Design of technical options for integrating living aquatic resources in irrigation systems and seasonal floodplains.

The following sub-activities will be implemented during the first two years of the project to identify location specific technical options:

Activity 4.1. Identification of landscapes and stakeholders

For each study area, one or more project sites will be selected depending on the socio-economic and agro-ecological diversity within the area (more study sites will be selected for more diversified areas). In selecting project sites, both the agroecological condition of the landscape and the socioeconomic and institutional aspects of the users of the landscape will be considered. For each project site, a control site with similar agroecological environment will be selected. After collecting relevant information on potential sites, several rounds of group discussions will be undertaken with the users in each site.

In identifying different stakeholders/users, the project will conduct group discussions and participatory rural appraisals (PRA) and will involve representatives from different classes of the society (i.e., poor farmers, rich farmers, landless of the nearby communities, women's groups, and members of local organizations). The stakeholders will include land owners as well as other people of the community who rely on irrigation canals/floodplains in the selected sites for their livelihoods

Activity 4.2 Assessment of users' needs

The steps to be followed in assessing users' needs are: (i) conduct of diagnostic survey and participatory rapid appraisal, (ii) baseline surveys of socioeconomic, institutional, and biophysical conditions; and (iii) group discussions with users. Preliminary results of appraisal and surveys will be presented and discussed during the group meetings. One main objective of the baseline survey is to generate baseline information on various socioeconomic aspects of the farmers so that the same parameters can be compared as part of the impact assessment of the project (activity 6.2).

Activity 4.3 Designing location specific technical options

Location specific technical options will be identified jointly by researchers and users based on (i) the assessment of users' needs, (ii) assessment of current and potential contributions of irrigation systems (e.g. fields, reservoirs, canals) and floodplains to the livelihood of poor households, (iii) available research results on these topics (secondary data) and (iv) indigenous knowledge of the local communities. Group discussions will be organized to finalize various potential technical options.

The technical options will include fish technologies (i.e., choice of species, stocking density, sizes at stocking and species combination, management practices, etc.) as well as other agricultural technologies to be practiced as concurrent (i.e., with fish) and/or alternate (before or after fish) enterprises in the same land.

Activity 5: Design of institutional options for integrating living aquatic resources in irrigation systems and seasonal floodplains.

This Project will devise institutional approaches for the introduction of scientific fish culture into the moderate to deeply flooding ecosystem and irrigation systems that recognize the often overlapping common and private property regimes governing relevant land and water resources as well as the nature of other relevant local institutions. The project will identify community-based mechanisms for the supply of fingerlings, access to land and water, tenure security of farmers and fishers, decision-making involving multiple-ownership, and post-harvest processing and marketing. This will include attention to negotiation processes over rights to land and water resources and inclusion of women and landless households in

decision-making, production, and control of output, building on the methods described by Sultana and Thompson (2002). As in the case of identification of technical options (activity 4), the area/site-specific institutional options will be identified during the first two years of the project.

Activity 6: Implementation of identified technical and institutional options in selected sites.

Identified technical and institutional options will be tested, monitored and evaluated, and disseminated in stages.

Activity 6.1. Testing of identified technical and institutional options:

Site specific technical and institutional options will be tested by stakeholders with minimum support from researchers. Stakeholders will provide labor, manage experiments and collect simple experimental data (e.g. input use levels). Researchers will be basically acting as resource persons. The project will provide initial financing support, as seed money, during the first two years to cover material costs. Stakeholders/users will deposit a certain portion of the proceeds from the experiments (i.e. fish sale) to cover the future project expenditures in subsequent years.

Groups will be formed with more or less homogenous users. A Project Implementation Committee (PIC) will be formed in each site with representatives from different categories of users, local organizations and the research team. The functions of the PIC will be: (i) preparation of a budget; (ii) finalization of the sharing agreement; (iii) overseeing the implementation of the project; (iv) settlement of disputes; (v) supervision of fish sales; (vi) distribution of proceeds from experiments according to terms earlier negotiated by the group; and (vii) management of the project account.

The National Project Team (with representatives from research institutes, extension agencies, NGOs, financial institutes such as rural/agricultural banks) will repeatedly visit the sites to ensure smooth interactions among the group members and to facilitate the implementation of the action research activities. The project will also facilitate interaction between group members and local service institutions such as banks.

Actual testing of technical and institutional options will be carried out in selected sites in the Mekong and lower Gangetic flood plain in Asia and in the inner Niger delta of Mali in western Africa during the 2nd, 3rd and 4th year of the project.

Activity 6.2. Monitoring and evaluation

A range of variables including biophysical (for example, water quality, soil quality, water depth), agricultural (for example, input use, crop yield, fish culture, fish catch) and socioeconomic (input and output price, profitability, fish consumption) variables will be monitored in both the control and project sites. In addition, group performance will also be monitored in the project sites. This information will be used in assessing the impact of the community-based fish culture in flooded rice fields and irrigation systems. This activity will be conducted concurrently with activity 6.1 during the 2nd, 3rd, and 4th year of the project.

Activity 6.3. Dissemination of validated technical and institutional options

After testing and evaluation (activities 6.1 and 6.2), the project will initiate dissemination of validated technical and institutional options to farmers through relevant extension agencies

(government, non-governmental). This activity will begin from the fourth year of the project. Adoption surveys will be conducted to monitor the adaptation and adoption of the options by different types of farmers. As community based fish culture is a very new concept in western Africa, this activity will be implemented only in Asian sites.

In Bangladesh, two relevant government extension agencies (Department of Agriculture Extension, and Department of Fisheries) and a number of non-governmental organizations (e.g. Proshika Manobik Unnayan Kendra, BRAC, etc) and the Technology Transfer Monitoring Unit (TTMU) of the Bangladesh Agriculture Research Council (BARC) will be involved in disseminating the technology (i.e., technical and institutional options) to farmers. The TTMU of BARC (the lead participating institute in Bangladesh) will coordinate the dissemination activities of all the agencies involved.

In India, the Directorate of Fisheries and Directorate of Agriculture of West Bengal and Assam states, Central Inland Fisheries Research Institute (CIFRI), Central Institute of Freshwater Aquaculture (CIFA) and a number of NGOs (e.g. Ramakrishna Mission) operating in West Bengal and Assam will disseminate the technology, and CIFRI will coordinate these extension activities. In Cambodia and Vietnam, the relevant government agencies (i.e., Department of Fisheries in Cambodia and Research Institute of Aquaculture no. 2 in Vietnam) will be responsible for disseminating the technology with the help of local government units.

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Activity 7: Capacity building of NARES for supporting community based fish culture in shared water bodies.

The project will be structured so as to provide substantial capacity building opportunities. This will be achieved by joint planning and implementation of the detailed work of the project by IARCs and NARES. In addition, specific PhD and Masters projects will be identified, funded and pursued. These will generally be conducted through collaborative arrangements linking national universities within the Benchmark Basins with ARIs and IARCs (WorldFish, IFPRI and WARDA).

Roles of project researchers and institutions

A multidisciplinary team of researchers from international and national institutions will implement this interdisciplinary action research project.

WorldFish Center staff will help develop methods for measuring water productivity and assess the contribution of aquatic resources, provide guidance in designing and testing technical and institutional options for integrating fish culture in floodplains and irrigation systems, supervise Ph D students from participating NARES, and provide overall coordination and management of the project and ensure implementation and outcomes in all sixteen sites. In the past, the national institutions in Bangladesh, Cambodia and Vietnam and CG centers like IRRI and IFPRI collaborated fruitfully with WorldFish Center on similar projects. Close and frequent interaction with all partners aside from regular site visits will contribute to the synchronous achievement of milestones towards planned outputs.

IFRPI staff will help develop methods for evaluating multiple uses of water systems, coordinate the studies of community action, group formation and operation with the involvement of all stakeholders, sharing arrangements for the explicit inclusion of the poor and landless, related gender issues in the group operation and access to resources and benefits.

WARDA staff will facilitate the establishment of the first nucleus site for the community based fish culture approach in Africa and assist in the selection of appropriate sites in the inner Niger delta in Mali. After successful establishment of the project in Mali, WARDA-IVC in collaboration with the WorldFish Center will attempt to initiate community-based fish farming in the irrigation system of the Senegal basin.

CIFRI staff will coordinate with staff of the Department of Agriculture of the State of West Bengal and the State of Assam for the establishment of sites, community organization and institutional arrangements and liaise closely with CIFA partners. CIFA staff will provide appropriate technology advice at these sites, facilitate supply of juvenile fish and assist in monitoring the production ecology in the fenced-in floodplain areas. Previous trials have shown that wild fish production in the fenced areas is not reduced, rather in most cases increased.

BARC staff will act as main implementer and coordinator for other institutions such as Bangladesh Fisheries Research Institute (BFRI), Department of Agricultural Extension (DAE), the Department of Fisheries (DoF), NGOs, and the Bangladesh Krishi Bank. Both institutional arrangements and technology support will be provided to locally formed groups.

The Cambodian Department of Fisheries staff will implement both institutional arrangements and technology transfer, and conduct monitoring activities. Linkages with and local implementation by NGOs and CBOs will be sought where possible and of utility.

Staff of Vietnam's Research Institute for Aquaculture No. 2 will coordinate and implement the activities of group formation, technology advice and monitoring in the Mekong delta through its dissemination branch and technology development branch.

The Inland Valley Consortium (IVC) Mali unit will implement the project activities in Mali in cooperation with the Institut des Economies Rurale (IER) under the coordination of WARDA.

Outputs

Seasonal multi-month floodwaters are mostly unutilized for agricultural production, with the exception of deepwater rice culture, which is diminishing in attractiveness to farmers due to comparatively low productivity and returns. During this time, the area becomes an open access resource, from which the landless derive essential benefits. This project will implement and test on a wider scale community based arrangements for the equitable, profitable and sustainable management of low-technology aquaculture operations involving all relevant stakeholders, i.e. landowners, landless and traditional seasonal fishers.

The project will have 3 principal outputs, corresponding to the 4 objectives and 7 activities:

1. Methodology for measuring water productivity at the landscape level, and knowledge on the values of the contribution of aquatic resources to water productivity in irrigation systems and seasonal floodplains.
2. Technical and institutional options for integrating fish and other living aquatic resources into irrigation systems and seasonal floodplains.
3. Improved capacity of NARES for supporting community based fish culture in shared water bodies.

The project will sponsor 5 PhDs students recruited from involved NARES partners and precipitate several associated MSc studies. Based on existing information, brochures will be

produced in local languages for decision makers of local and community based organizations to obtain basic information required to successfully establish and operate fish culture groups, together with necessary guidelines on technical and institutional aspects of implementation. From previous experience, a spread-over effect based on spontaneous local adoption is anticipated. This process will be monitored and analyzed in order to understand the specific criteria of the technology's attractiveness to floodplain inhabitants and the characteristics of the negotiated group arrangements.

Beneficiaries and impact

Direct beneficiaries and short-term impacts: Inland capture fisheries are the most threatened globally, with a constant negative trend. These fish are of highest importance for the rural poor for income, nutrition and food security, but the demand is increasing which is reflected in constant price increases. Fish also have a high value for nutrition of the poor due to their nutrient density and quality (protein, oils, micronutrients) that is in highly bio-available form in most small fish species.

Fish production from the fenced floodplain areas will be increased at least two to 10 fold over the natural catch through culture the activities, as shown from our previous work in Bangladesh and Vietnam. Harvests are in bulk and therefore are sold on the market producing cash returns that are shared among group members, including the landless. Capture of non-stocked, small indigenous species by landless with traditional fishing methods within the culture areas during the culture period is specifically permitted by the groups, and thereby ensure their continued supply of protein and income over the culture season from the fenced areas. Cash income will increase for all involved, notably for the landless relative to their base income. We expect similar levels of benefits from group based fish culture approaches in irrigation systems.

In the longer term, the project aims at providing the populations of rural in the floodplain areas and irrigation systems of the targeted basins with an equitable source of additional income and supply of fish, both from natural fish production, as well as from stocked culture species. This will directly benefit the members of the communities involved, but also fish consumers outside the culture areas due to increased supply on the markets, thereby countering the negative trend of inland fisheries production. Revenues from fish production can also be used to improve the maintenance and hence the sustainability of irrigation systems.

Beneficiaries

Several groups will directly benefit from the outputs of the project:

- Farmers and fishers at the study sites in India, Bangladesh, Cambodia, Vietnam and Mali: Increased income from share of revenue from cultured fish at bulk harvest following contribution of labor and (for landowners) of land; ensured access to flooded area for fishing on wild species for food and income during the culture period; higher fish consumption; enhanced social capital through harmonious group operations; enhanced human capital through training.
- District and provincial resource management and extension personnel: added portfolio of technical options and proven cases to support the approach and assist in implementation; data on relative benefit vs. other technical options.
- Policymakers at regional/national levels: awareness of value of floodplains for livelihoods and institutional and technical options to increase the income from these areas.

- NARES scientists and extension service staff: increased knowledge of feasible systems and identified opportunities for further research towards understanding, adaptation, sustainability and improvement under local conditions; options for utilization of other local fish species with market demand and the timely availability of fingerlings in adequate amounts, sizes and quality.
- NGOs: confidence from experiences in facilitating institutional arrangements and disseminating community based technologies.
- People living outside of the study area: increased supply of fresh fish in local markets, thereby reducing the price; higher consumption.
- International researchers and members of the development community: understanding of viable and sustainable institutional arrangements; knowledge on comparative performance, suitability and adaptability of the approach to local situations; opportunities for further improvement of production.

Pathway to impact

This project will operate on scales 1 (activities 4 and 5) and 2 (activities 6.1 and 6.2), with some degree on scale 3 (activity 6.3) of the 'pathway to impact' process reported in the CPWF guidelines. The project will begin with conceptualization and prioritization of alternative options (activities 4 and 5), evaluate the options by stakeholders at key sites (activities 6.1 and 6.2) and then disseminate the validated options in project areas through local extension systems (activity 6.3). The project will also assess the impact of the recommended options based on the data collected through monitoring and evaluation of trials (activity 6.2) and adoption surveys (activity 6.3). The impact will be assessed at evaluation stage (i.e., during the testing of options at farm level) and final adoption stage, and this will be done both at household and community/landscape level.

The impact indicators to be used at household level will include: increase in fish production (kg/ha, wild and cultured fish), increase in total farm productivity, increase in total farm income (USD per ha per year), increase in fish consumption (kg/capita/year), increase in food consumption (Kcal/capita/year) and increase in employment (person days per ha by gender). At community /landscape level, the impact indicators to be used will include: increases in overall productivity and revenue from irrigation systems, reduction in number of people below poverty line, sustainability of farmers'/fishers' groups, level of conflicts among group members, increase in the availability of fish in local markets (by season), and status of biodiversity. The list of impact indicators will be finalized during the inception phase of the project (during the first six months of the project) in consultation with various stakeholders.

Extrapolation Domains

The potential application areas for the community-based fish culture approach in floodplains and irrigation systems are considerable. These areas are usually densely populated, however the seasonal floodwaters are underutilized.

In the Mekong river basin, 0.8 million hectares of medium and deep-flooded areas exist which could be utilized by the communities living in them for joint fish culture activities during the flood season, which is otherwise a fallow season with very low economic and agricultural activity. Of 5.2 million hectares of medium and deep flooded areas the Indo-Gangetic basin, 3 million hectares are in Bangladesh, wherein an estimated 27 million potential direct beneficiaries live. If only 25% of these adopt the approach, 6.7 million would benefit, of which 2.7 million persons are landless. Other seasonally flooding areas suitable for the approach in other basins in Asia are Myanmar (1.2 million ha), Thailand (0.7 million ha), and the Red river delta in Vietnam (0.1 million ha).

In Africa, the potential is greatest in presently used deepwater rice areas in Nigeria (726,000 ha), Guinea (240,000 ha), Sierra Leone (68,000 ha) and Cote d'Ivoire (42,000 ha).

Assumptions and risks

With the official commitment of all the participating institutes (Annex 6: support letters) and with funding support from CPWF, we assume that the project will have adequate resources (financial, human and facilities) to successfully implement the project activities on time. Building on the earlier success of similar activities in some areas of Bangladesh and Vietnam and on wide-scale consultations with partners, we believe that the prospects for success of this demand driven project are very high. We have minimized the risk of experiment failure by having multiple project sites in each of the project areas (16 areas covering 5 countries). We are also using a highly participatory strategy in implementing this project, which will ensure full participation and cooperation of all the parties concerned (e.g. farmers, extensionists, researchers, policy makers, etc).

Monitoring and evaluation plan

The Gantt chart (annex 3) will enable self-monitoring. In order to ensure synchronized performance across sites and partners, software tools for the management of virtual teams will be utilized. The WorldFish Center has strict project management guidelines, as part of which monitoring of expenses according to budgets and reporting to donors is conducted by staff in close interaction with the Center's Financial Management Unit, the Planning and Budgeting Unit, and the Project Development Coordination Unit.

A Project Implementation Committee (PIC) will be established at each site in each country whose task will be to monitor activities within the country and will meet at least three times annually. A National Project Steering Committee within each country, made up of senior representatives from the participating institutions, will meet annually to review project progress. Further, internal project review meetings will be held at regular intervals.
It is planned to conduct two external evaluations: one during the second year and one during the fourth year. The evaluator team should consist of a community action specialist, a resource economist and floodplain ecologist/rural aquaculturist.

Dissemination strategy

This project places great emphasis on timely dissemination of project outputs (i.e. scientific information, research methods, technical and institutional options, dissemination strategy, etc) to relevant users (e.g. farmers, extensionists, researchers, policy makers, etc). The project will also develop participatory and stakeholder-involving diffusion approaches (activity 3). The multi-partner cooperation of this project with national research institutions, extension departments, financial institutions, universities and national and international NGOs will ensure wider familiarity and implementation experience with the approach. These institutions also have their own linkages and networks and subsequently implement and disseminate new technologies to farmers as part of their operations, as is presently the case following our recent work in Vietnam and Bangladesh. Field days will be conducted at the key project sites to inform farmers about the recommended technical and institutional options. Furthermore, publications will be prepared in descriptive and locally accessible language, to enable wider local dissemination.

For the designed approach which involves technical as well as social actions, full stakeholder engagement is necessary for success and this mode of operation will be demonstrated and implemented as a center piece of the project. Decision makers will be informed first-hand through their involvement in field visits to communities implementing the approach. Regional level workshops will be organized to share experiences among scientists,

extensionists and policy makers across countries. The project will also facilitate dissemination of scientific results among the scientific community through national and international publications.

The project will for the first time introduce the approach to Africa, albeit to floodplains and irrigation systems in non-benchmark basins, but which are regarded to have highest potential for adoption and most convincing demonstration effect. The project will first be implemented in Mali in the inner Niger delta. The Mali experiences will then be disseminated to other West African areas like the Senegal irrigation system.

Continuity Beyond Project Period

Towards the end of the project, a five-day international workshop will be held to review project achievements and to outline the strategy to ensure continuity of dissemination activities beyond the present project. The workshop will recommend sustainable approaches to ensure the continuity of the community-based fish production programs initiated in the context of the present project.

The participatory approach to be followed in this project is a positive factor for wider dissemination of project outputs beyond the project period. The involvement of policy-makers (at local, regional and district levels) in the project design and implementation will ensure their ownership of the concept of community based fish farming and will facilitate incorporation of the concept in relevant development plans. Participation of farmers in designing, testing and disseminating the community-based fish farming technique, will accelerate the dissemination of the technology through farmer-to-farmer extension.

Resources needed

The project will need 41 person months of international scientists covering disciplines of aquaculture and fisheries, agricultural and resources economics, development sociology, and natural resources management to execute the planned activities. We request CP support for 31 person-months of 4 international scientists (including PL and PIs). The other 10 person-months of international scientists will be provided in kind by the WorldFish Center. We also need CP support for 25 person-months of national PIs, 52 person months of PostDocs/ consultants to provide specialized scientific tasks (particularly on 'institutional arrangement') and six full time support staff (one in each of the participating countries to manage country operations and one at WorldFish Headquarters) to implement project activities on time. National partner institutes will provide another 20 person-months of national PIs time as matching funds.

On the average, there will be 4 visits per year in each country by the international staff and consultants to assist NARES staff in implementing the project activities. There will be three international workshops (one project inception workshop during the first year of the project, a mid-term review workshop during the 3rd year of the project and a final workshop during the 5th year of the project) to be attended by key national and international scientists from the participating institutes and resource persons from advanced institutes. The project will provide partial funding to 5 Ph.D. students from NARES to enhance human resources in the participating NARES countries.

About 43% of the CP funds are allocated for NARES. However, the actual expenditure on NARES partners will be much higher; it is highly likely that the PostDoc/consultants (their expenditures are shown under the CG centers) will come from NARES.

Overall, the WorldFish Center will provide USD 195,000 as matching funds; USD 135,000 as staff time spent on this CP project, USD 40,000 as office equipment, and USD 20,000 in form of communications and publications. Similarly, NARS partners are expected to provide in kind contribution of USD 60,000 as staff time and USD 40,000 as office and field equipment. The total matching fund (USD 295,000) is about 14% of the total project costs, although matching funds from CG Centers and partners from Bangladesh, Cambodia, India, Mali and Vietnam are not required.

To save resources, we will establish linkages with the following on-going WorldFish projects funded by other donors:

1. Community based fisheries management project in Bangladesh (funded by DFID, UK)
2. Community-based fisheries management program in south and southeast Asia (funded by IFAD)
3. Sustainable aquaculture development project in Bangladesh (funded by USAID)
4. Adaptive learning project in India (funded by DFID, UK).

Annexes
Annex 1: Abbreviated CVs
Annex 2: Potential environmental impact
Annex 3: Gantt chart
Annex 4: Bibliography
Annex 5: Budget details
Annex 6: Figures: "Floodplain farming system evolution with community based fish culture"
Annex 7: Formal letters of consent of participating institutions