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# Community based fish culture in seasonally flooded rice fields in Bangladesh and Vietnam

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**Abstract**

During the rainy season in extensive river floodplains and deltaic lowlands, floods lasting several months render the land unavailable for crop production. 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 stocked fish 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 WorldFish Center and its national partners recently tested (1) concurrent rice-fish culture in the shallower flooded areas and (2) alternating rice and fish culture in the deep-flooded areas of Bangladesh and Vietnam through a community-based management system. The results indicate that community-based fish culture in rice fields is technically feasible, economically profitable, environmentally non-destructive, and socially acceptable. It can increase fish production by about 600 kg/ha/year in shallow flooded areas and up to 1.5 t/ha/year in deep-flooded areas, without reduction in rice yield and wild fish catch. For the overall system, an additional income ranging from US$ 135 per hectare in southern Vietnam to US$ 437 per hectare in Bangladesh was achieved, which is an increase of 20 to 85 percent over the previous profitability. The communities neighboring the trial sites have been adopting the technology widely. The potential application areas for this approach in floodplains and irrigation systems of Asia and Africa are considerable.

**Media summary**

Community-based fish culture in seasonally flooded rice fields is technically feasible, economically viable, socially acceptable and environmentally non-destructive. It has high potential for adoption in Asia and Africa for income and employment generation for the poor.

**Key Words**

Community-based management, rice-fish culture, floodplain agriculture.

# Introduction

During the last few decades, the flood-prone ecosystems in Asia have undergone dramatic changes. Traditionally, farmers grew deepwater rice and captured fish during the rainy/flood season and subsequently cultivated a wide range of crops such as pulses, oil seeds, and vegetables during the post-flood dry season. Today, a range of practices during the flood phase exist, depending on local conditions, from growing deepwater rice or tall-growing rice varieties to complete fallow. The flood-prone areas are seasonally flooded during the monsoon and remain submerged from 4 to 6 months. Opportunities for further increased production in the flood-prone ecosystem is the concurrent integration of fish culture with rice farming, or the culture of fish in these seasonal waters, without concurrent rice.

In these flood-prone areas, land ownership is fixed according to tenure arrangements during the dry season. However, during wet season floods, individual land holdings are not visible and waters are a community property granting all members access to fish in all areas of the community. Therefore, it is essential that the rice-fish culture activity in the flood-prone ecosystem is undertaken by the rural community under a group approach. The group should include the landless who have traditionally accessed the flooded areas for fishing, but would lose this key resource if they were denied access because the areas are stocked with fish.

Generally, three types of rice-fish culture systems can be established in flood-prone areas: (i) concurrent culture of deepwater rice (with submergence tolerance) with stocked fish during the flood season followed by dry season rice in shallow flooded areas; (ii) concurrent culture of deepwater rice (with elongation ability) with stocked fish during the flood season, followed by dry season non-rice

crops; and (iii) alternating culture of dry season rice followed by stocked fish only during the flood season (that is, without rice) in the enclosed area (for example, as in a fish pen).

The WorldFish Center and its national partners tested the concurrent rice-fish culture (option i above; two pictures on the left hand side of Figure 1) in the shallower flooded areas and the alternating rice and fish culture (option iii above; two pictures on the right hand side of Figure 1) in the deep-flooded areas of Bangladesh and Vietnam through a community-based management system over a three-year period (1998-2000). Under this approach, fish is cultured communally during the flood season while the same land is cultivated with rice during the dry season by individual farmers in their separately owned plots. This contribution presents the key results of this work, which are further detailed in Dey and Prein (2003, 2004, 2005) and Prein and Dey (2001).

# Methods

The project was implemented over three years (1998 to 2000) in four areas of Bangladesh representing the floodplain ecosystems of the Ganges, Brahmaputra and Meghna rivers, and in two areas of Vietnam representing the Red River and Mekong River floodplains. These can be categorized as shallow and medium flooded (with 50 to 150 cm flooding depth) and deep-flooded (150 to 250 cm flooding depth). The flooding is generally uncontrolled in Bangladesh and in the Mekong River floodplains delta of southern Vietnam, but it is controlled in the shallow/medium flooded Red River delta in northern Vietnam.

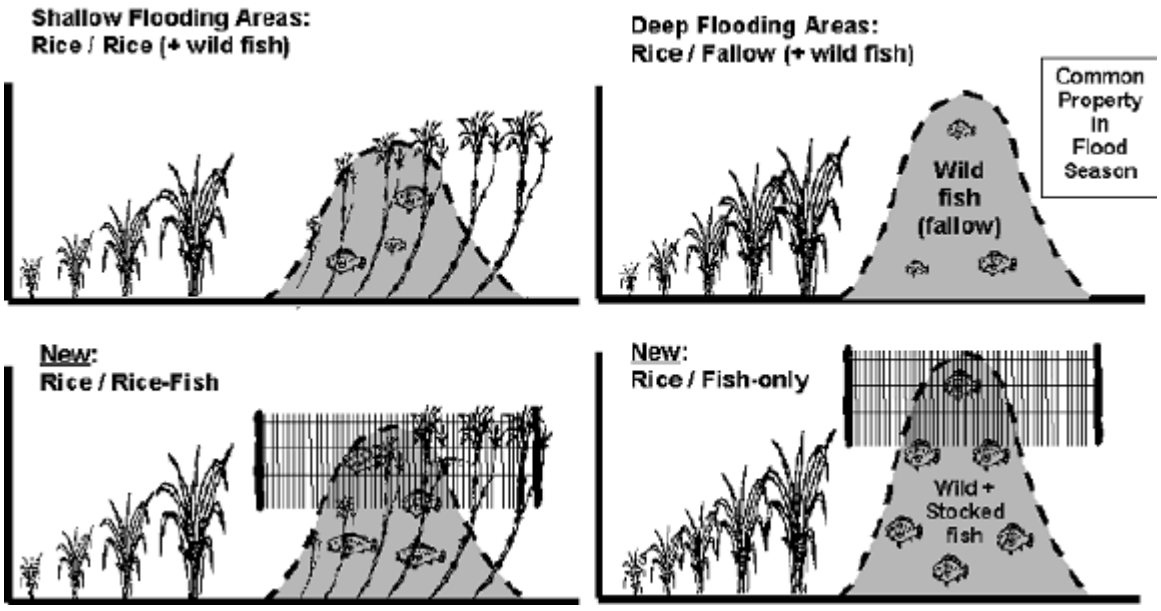

**Figure 1. Seasonal floodplains: two options for improvement of productivity of farming systems through community-based fish culture.**

# Identification of Stakeholders and Assessment of Their Needs

The users/stakeholders included landowners as well as other people of the community who rely on the landscape for fishing during the rainy season. In identifying users, discussions were held with representatives from various classes of the society, namely poor farmers, rich farmers, landless laborers of the nearby communities, and members of local organizations.

The steps followed in assessing the users' needs were: (i) diagnostic survey conducted by scientists and representatives from local level organizations (that is, NGOs in Bangladesh; local agriculture extension offices in Vietnam); (ii) baseline surveys of socioeconomic, institutional, and biophysical conditions; and (iii) group discussions with users.

# Participatory Design and Testing of Technical Options

Site-specific technical options were tested by users, with minimum support from researchers. Users provided labor in managing experiments and collecting simple experimental data (for example, input use level). Researchers basically acted as resource persons.

Users designed institutional options (such as group formation, sharing arrangement) for testing technical options; researchers and NGO workers acted as facilitators. Users included participating farmers, non-participating farmers, and practicing non-farmers (termed 'landless') who used to rely on the landscape for fishing. In the first year the communities received financial support for the initial investment in fences. In subsequent years, communities re-invested a portion of their proceeds from the previous year's fish sales into the subsequent year's fish culture operation, e.g. for the purchase of fish fingerlings and the maintenance of the fence.

# Results

# *Technical Feasibility*

The trials at the sites in Bangladesh and Vietnam lead to the conclusion that the community-based approach is technically feasible, confirming earlier experiments and trials on the basis of individually-managed fenced-in plots (Ali et al. 1993, 1998, Das et al. 1990, Rothuis et al. 1998a, 1998b, Roy et al. 1990). However the level of success depended on the local agro-ecological situation and the prevailing socio-cultural conditions. It was generally concluded that wild fish biodiversity and abundance was not affected by the culture operation.

In the concurrent rice-fish system in shallow-flooded rice fields, culture periods ranging from 150 to 210 days were observed in Bangladesh, while 210 days were the norm in northern Vietnam, coinciding with the duration of rice cultivation.

In the alternating system in deep-flooded rice fields without rice cultivation during the floods, cultivation periods averaged 169 days in Bangladesh, and were similar in duration in the last two trial years in the sites in the Mekong Delta of southern Vietnam, averaging approximately 155 days. This system is essentially similar to large shallow fish ponds with extensive management, i.e. no fertilization, and minimal or moderate supplementary feeding towards the end of the culture period, albeit that these systems have open water exchange to the floodplains through the fences.

# *Economic Viability*

Criteria used to assess economic viability of community based fish culture in flooded rice fields are 1) net return from fish culture (i.e., enterprise profitability) and 2) additional annual net return per hectare from fish and rice (i.e., system profitability). All the costs involved in growing rice as well as fish and returns from rice and fish were recorded through periodic monitoring and converted to US Dollars using the prevailing exchange rate. Net returns were calculated as gross returns (from fish culture for enterprise profitability and from both rice and fish for system profitability) less total cost (both variable and fixed costs). The fixed costs included in the analysis are depreciation of the fence (mostly in Bangladesh and southern Vietnam) and depreciation of the construction costs of the trench and dike (mostly for concurrent system in northern Vietnam). Both family and hired labor used for crop husbandry, guarding, harvesting and post harvesting operations were included as variable costs. Therefore, net returns reported in this study represent returns to land and management, i.e. net returns were allocated

between landowners (both participating and non-participating) and poor fishers/landless poor depending on the contribution of their land and management/operational responsibilities.

## *Net return from fish culture*

The results show that community based fish culture in flooded rice fields was very profitable at most sites in Bangladesh and at all sites in Vietnam. At a few sites in Bangladesh farmers incurred net losses due to natural calamities (floods and storms) and poor water quality. Overall, the profitability of the community-based fish culture approach was higher for the alternate rice-fish system practiced in deeper flooded areas of Bangladesh and for the concurrent system practiced in relatively flood controlled areas of the Red River delta. The result of the experiments in 1998 at Hien Khanh and Tan Khanh sites immediately encouraged farmers in neighboring communes of Vu Ban district to adopt the technology. From the results of the three-year experiment on community-based fish culture in seasonally flooded rice ecosystems in three different environmental situations, it can be concluded that fish culture along with rice (concurrent rice-fish culture) or during the fallow period (alternate rice-fish culture) is profitable. The main problem is to save the stocked fish during abnormally high floods.

## *Cost of community based fish culture*

The per-hectare cost of community based fish culture in flooded rice fields varies from US$168 to US$811. Cost varies from site to site due to the variation in area of site, management options followed and the type of enclosure required. Three categories can be distinguished at the Bangladesh trial sites: (1) small area (<5 ha) with 30 to 60 % perimeter fence required and minimal feeding; (2) small area (<5 ha) with less than 30 % perimeter fence required and minimal feeding; and (3) large area (10-20 ha) with less than 30 % perimeter fence required and moderate feeding. The main operational cost was for fingerlings which representing 49% to 75% of the total cost. Fence cost is minimal (about 4 to 33% of the total cost) if less than 30% of the perimeter requires fencing..

## *Impact on Net Farm Income*

The impact of community based fish culture in seasonally flooded rice ecosystems on farm income was estimated by comparing the total farm system income (that is, total net return from rice and fish production) in project sites (with fish culture)

to that in control sites (without fish culture). The total farm system income in the project sites comprises net returns obtained from rice production, cultured fish production and wild fish catch, while that in control sites comprises net returns obtained from rice production and wild fish catch only (Table 1).

In Bangladesh, detailed monitoring of control and project sites was undertaken in 2000. Results show that, on average, concurrent and alternate systems of community-based fish culture in seasonally flooded rice ecosystem generated an additional annual income of US$169/ha/year and US$506/ha/year, respectively. The increase in total net return was higher in areas where the alternate system is applied. Alternating fish and dry season rice farming is usually implemented in deep-flooded areas, which are more conducive for fish culture and give higher fish yield. In Vietnam, fish culture in seasonally flooded rice fields generated an additional annual farm income of US$346/ha in the Red river delta, and US$211/ha in the Mekong river delta.

**Table 1: Total net benefit (US$/ha/yr) obtained in field trials by the project and control farmers, Bangladesh and Vietnam, 1998 to 2000**

| System | Site | Year | Trials | | | | Control | | | Total increase in income |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Rice* | Cultured fish | Wild fish | Total | Rice* | Wild fish | Total | (US$/ha) |
| ***Bangladesh*** | | | | | | | | | | |
| Concurrent | Kuripara | 2000 | 510 | 112 | 26 | 648 | 508 | 22 | 530 | 118 |
| | Sadhukhali | 2000 | 632 | 191 | 29 | 852 | 624 | 37 | 661 | 191 |
| | Maizpara | 2000 | 544 | 132 | 37 | 713 | 547 | 62 | 609 | 104 |
| | **Average** | | **562** | **145** | **31** | **738** | **690** | **40** | **600** | **138** |
| Alternating | Konapara | 2000 | 397 | 322 | 49 | 768 | 467 | 50 | 517 | 251 |
| | Uzanisher | 2000 | 544 | 446 | 153 | 1143 | 417 | 12 | 429 | 714 |
| | Urshiura | 2000 | 379 | 435 | 146 | 960 | 415 | 198 | 613 | 347 |
| | **Average** | | **440** | **401** | **116** | **957** | **433** | **87** | **520** | **437** |

***Vietnam***

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Concurrent | Red River Delta | 1998-2000 | **1001** | **223** | **25** | **1249** | **888** | **14** | **902** | **346** |
| Alternating | Mekong River Delta | 1999 | **670** | **116** | **84** | **870** | **648** | **87** | **735** | **135** |

Notes: *In Bangladesh: two rice crops (rice in dry season and rice and fish in wet season) in concurrent system and one rice crop (in dry season) in alternating system; in Vietnam: two rice crops per year.

## *Social Acceptability*

A group approach was used with landowners, fishers of the community and landless laborers (with customary access rights for fishing in the flood season) who were encouraged to determine for themselves the management criteria and institutional arrangements which they considered suitable to their local conditions and social context. In Bangladesh, average group size was 38, comprising 15 participating landowners, 8 non-participating landowners and 15 landless laborers.

Net returns were distributed between landowners and landless laborers/poor fishers depending on their contribution. Landless laborers received a share of net returns for their role in managing the operations (as group members). Non–participating landowners received a share depending on their land. Landowners participating actively in the group activities received an additional share of benefits for their role as group members (on top of the share they already received through mere provision of their land). The general sharing agreement of net returns in Bangladesh was as follows: landowners 40-30%, labor group members 40-55%, and savings/ institution building 0-10%.

Overall, the results show that the community-based fish culture approach in seasonally flooded rice ecosystems as described in this paper has benefited both landowners as well as landless participants and is socially acceptable. It was found that existing social harmony among the groups before the introduction of the community-based fish culture approach was a requirement for its successful implementation.

# Conclusion

Results of the trials conducted over a three-year period (1998-2000) in Bangladesh and Vietnam indicate that the community-based fish culture in flooded rice fields is technically feasible, economically viable and socially acceptable. The local population in Bangladesh and Vietnam are convinced of the benefit of this technology. Numerous communities neighboring the trial and demonstration sites have already copied the technology for their situation. Their established group arrangements seem more harmonious and longer lasting than those orchestrated by external organizations under the project. Overall, farmers obtained additional income from fish culture without reduction in income from rice cultivation (Lightfoot et al. 1992) and wild fish catch.

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