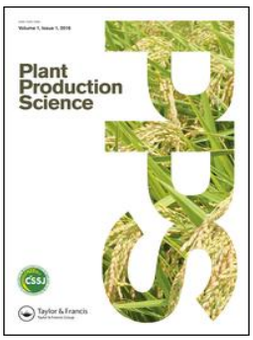

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Increased Income from Seasonally Flooded Rice Fields through Community Based Fish Culture in Bangladesh and Vietnam

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Abstract : In extensive river floodplains and deltaic lowlands, floods lasting several months render the land unavailable for crop (often rice) production during the rainy season. Aside from crop production during the flood-free dry season, the land area can be utilized for fish production during the flood season. This can be done by enclosing parts of these floodwater areas to produce a crop of stocked fish aside from the naturally occurring 'wild' species. 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. This paper presents the key results of this work, focusing on the economics of existing land use patters and the impact of community based fish culture on rice yields and income. Rice production was maintained, or even enhanced. Fish production was increased beyond the wild catch 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 wild fish catch. For the overall system on an annual basis, 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 profitability of the previous systems involving cropping and fish capture. The results indicate that community-based fish culture in rice fields is technically feasible, economically profitable, environmentally non-destructive, and socially acceptable.

Key words : Community-based management, Floodplain agriculture, Rice-fish culture.

In recent decades, agricultural land use patterns in the flood-prone ecosystems in Asia have considerably changed (Catling 1992). The flood-prone areas are seasonally flooded during the monsoon and remain submerged from four to six months. Traditionally, farmers grew deepwater rice and captured fish during the 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. Opportunities for further increased agricultural 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.

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 community property granting all members access to fish in all areas of the community. Consequently, 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.

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 in deep flooded areas; 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, in a fish pen) in deep flooded areas.

The WorldFish Center and its national partners tested the concurrent rice-fish culture in the shallower flooded areas and the alternating rice and fish culture in the deep flooded areas of Bangladesh and Vietnam through a community based management system over three years (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, focusing on the economics of existing land use patters and the impact of community based fish culture on rice yields and income. Further details of the project results are available in Dey and Prein (2003, 2004), Dey et al. (2005), and Prein and Dey (2001).

Materials and Methods

The action research activities were implemented over

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Table 1. Economics of existing land use patters in flood prone areas of Bangladesh and Vietnam, 1998 to 2000[a].

	Bangladesh								Vietnam	
	Shallow and medium flooded areas				Deep flooded areas				Red River Delta	Mekong Delta
	Kuripara	Sadhukhali	Maizpara	Average	Konapara	Uzanishar	Urshiura	Average		
Land use patterns	MV Rice - TDW Rice	MV Rice - TDW Rice	MV Rice - TDW Rice		MV Rice - Fallow	MV Rice - Fallow	MV Rice - Fallow		MV Rice-L/MV Rice	MV Rice-MV Rice
Gross Return (US$/ha/yr)	892	949	846	896	874	1021	1078	991	1386	1107
Total Cost (US$/ha/yr)	385	325	299	336	407	604	663	558	498	459
Net Return (US$/ha/yr)	508	624	547	560	467	417	415	433	888	648

MV= modern variety; L= Local Variety, TDW= Transplanted deepwater; [a] 2000 for Bangladesh, 1998-2000 for red river delta (Vietnam) and 1999 for Mekong delta (Vietnam)

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 delta of southern Vietnam, but it is controlled in the shallow/medium flooded Red river delta in northern Vietnam.

The activities followed in the project were: a) comparative analysis of existing land use patters, b) participatory design and testing of various technical options for improvements in productivity of the seasonally flooded rice fields, and c) designing and testing of viable institutional arrangements for introducing community managed enhanced fisheries into flood prone rice areas.

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, nonparticipating 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.

For each project site, a control site with similar agroecological environment was selected. A range of variables including biophysical (water quality, soil quality), agricultural (input use, crop yield, fish yield) and socioeconomic (input and output prices, fish consumption) were monitored in both the control and project sites.

In the concurrent rice-fish system in shallow-flooded rice fields, fish 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, fish 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.

Results

Existing land use patterns in seasonally flooded areas in Bangladesh and Vietnam and their economics

The dominant farming system in the shallow and medium flooded areas in Bangladesh (e.g., in Kuripara, Sadhukhali and Maizpara areas) is HYV (high yielding variety) winter rice (known as Boro rice) during the dry season (January to June) grown under irrigation, followed by transplanted deepwater Aman (TDW) rice during the rainy season (June/July to November/Dec). In the deep-flooded project areas in Bangladesh (e.g. in Konapara, Uzanisher and Urshiura areas), farmers usually grow single-crop irrigated HYV Boro during the dry season (January to June) and keep the land fallow during the rest of the year. In these areas, late harvest of Boro does not allow the establishment of a deepwater rice crop before the arrival of the flood (in May/June). In the shallow flooded project areas in the Red river delta (northern Vietnam), where flooding is relatively controlled, farmers generally grow high yielding irrigated rice during the dry season, and

Table 2. Rice* yields (t/ha/yr) obtained in field trials by the project and control farmers, Bangladesh and Vietnam, 1998 to 2000**.

	Bangladesh								Vietnam	
	Concurrent				Alternating				Concurrent	Alternating
	Kuripara	Sadhukhali	Maizpara	Average	Konapara	Uzanishar	Urshiura	Average	Red River Delta	Mekong Delta
Project	5.67	4.35	8.87	6.30	6.81	7.79	7.53	7.38	9.90	10.12
Control	6.63	7.62	6.79	7.01	6.90	6.94	7.79	7.21	9.70	9.95

*) 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.
**) 2000 for Bangladesh, 1998-2000 for red river delta (Vietnam) and 1999 for Mekong delta (Vietnam)

Table 3. Total net benefit (US$/ha/yr) obtained in field trials by the project and control farmers, Bangladesh and Vietnam, 1998 to 2000*.

System	Site	Trials				Control			Total
		Rice**	Cultured fish	Wild fish	Total	Rice**	Wild fish	Total (US$/ha)	increase in income
Bangladesh Concurrent	Kuripara	510	112	26	648	508	22	530	118
	Sadhukhali	632	191	29	852	624	37	661	191
	Maizpara	544	132	37	713	547	62	609	104
	Average	562	145	31	738	560	40	600	138
Alternating	Konapara	397	322	49	768	467	50	517	251
	Uzanisher	544	446	153	1143	417	12	429	714
	Urshiura	379	435	146	960	415	198	613	347
	Average	440	401	116	957	433	87	520	437
Vietnam									
Concurrent	Red river delta	1001	223	25	1249	888	14	902	346
Alternating	Mekong river delta	670	116	84	870	648	87	735	135

*) 2000 for Bangladesh, 1998-2000 for red river delta (Vietnam) and 1999 for Mekong delta (Vietnam).
**) 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.

a tall-growing local or higher yielding variety during the rainy season. In the project areas located within the Mekong delta (southern Vietnam), where rice fields are also deeply flooded in the rainy season and flooding is uncontrolled, farmers grow two irrigated crops of high-yielding rice varieties with a flood fallow period in between (August to November) (Table 1). During the baseline survey, data on input use, price of input, yield and price of output were collected on the above rice cropping seasons. Data was analyzed on the basis of individual crops grown within the period of one year and finally two crops were combined together to obtain the yearly return from rice production where two crops are grown.

The results from the survey show that net returns from rice cultivation per unit area per year are not substantially different between singled cropped and double cropped areas in Bangladesh (Table 1). The yield and profitability of the TDW Aman crop is not very high. However, farmers in some areas are still interested to grow TDW Aman as a subsistence crop and for maximum utilization of their own resources. Though the gross return and yield are higher in single cropped areas, which is due to the higher yield of longer duration Boro rice cultivated in these areas, the cost of cultivation is also higher for this system as it requires more fertilizer, pesticides and irrigation water. In Vietnam, on average, farmers in the Mekong delta are obtaining less profit from rice cultivation than farmers in the Red river delta. However, since they are cultivating a relatively larger farm area, they are obtaining higher incomes from this activity.

Benefits of community based fish culture in seasonally flooded rice fields:

Rice and fish yield

The average rice yield is about 7 t/ha/year, inoth single and double cropped systems in Bangladesh and about 10 t/ha/year for two corps in Vietnam. Except in the case of concurrent rice fish culture in shallow and medium flooded rice fields in Bangladesh, the

rice yield did not decrease with the introduction of community based fish culture. In fact, rice production was even enhanced in most cases (Table 2). Community based fish culture can increase fish production to about 600kg/ha/year in shallow flooded areas and up to 1.5 t/ha/year in deep flooded areas, without reduction in wild fish catch (Dey et al. 2005). The trials at the sites in Bangladesh and Vietnam led 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 (Das et al., 1990; Roy et al., 1990; Ali et al., 1993, 1998; Rothuis et al., 1998a, 1998b; Sen et al. 2003; Singh et al. 2003). 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.

Impact on farm income

Criteria used to assess the impact of community based fish culture in flooded rice fields on farm income 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) subtracting the 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.

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 (see Dey et al. 2005 for details). At a few sites in Bangladesh farmers incurred net losses due to natural calamities (storms and exceptionally high floods) 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.

The impact of community based fish culture in seasonally flooded rice ecosystems on annual net return was estimated by comparing the total farm system income (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.

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 produce 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 3).

Benefit to poor households

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 persons, comprising 15 participating landowners, 8 nonparticipating 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). Nonparticipating 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.

Conclusions

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. Various groups among the local population in Bangladesh and Vietnam who have adopted the technology are convinced of its benefits. 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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