2.4 Ricefield fisheries and rice-based aquaculture – underestimated and undervalued resources

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Photo 6: Rice-based ecosystems often represent a dynamic and closely linked complex of rice fields, ponds, irrigation canals, and rivers (Viet Nam). (Photo: FAO/M. Halwart)

Introduction

The cultivation of most rice crops in irrigated, rainfed and deepwater systems offers a suitable environment for fish and other aquatic organisms. Over 90 percent of the world's rice, equivalent to approximately 134 million hectares, is grown under flooded conditions providing not only home to a wide range of aquatic organisms, but also offering opportunities for their enhancement and culture. Aquatic production, in addition to the rice crop itself, is a critically important resource for rural livelihoods in developing countries; its local consumption and marketing are particularly important for food security as it is the most readily available, most reliable and cheapest source of animal protein and fatty acids both for farming households as well as for the landless. The purpose of this paper is to synthesize recent information and highlight the important role that rice-based aquatic products play in rural livelihoods. This information is not commonly available but crucial for informed policy decisions. The time for emphasizing the importance of rice associated aquatic biodiversity is particularly relevant in view of the forthcoming UN International Year of Rice 2004[16].

[16] The United Nations General Assembly (UNGA) declared the year 2004 the International Year of Rice (IYR) and invited the Food and Agriculture Organization of the United Nations to act as the lead agency for the implementation of the IYR, in collaboration with partners from national, regional, and international agencies, non-governmental organizations, and the private sector. The FAO Fisheries Department with the assistance of Fisheries Officers from the Regional and Sub-Regional Offices contributes to the IYR through various awareness-raising activities related to the importance of aquatic biodiversity in rice-based ecosystems. Information will be available and regularly updated at http://www.rice2004.com.

The issue

Aquatic production other than rice obtained from rice-based ecosystems and its importance for rural livelihoods is generally underestimated and undervalued (FAO/MRC, 2003; Halwart, 2003) because the local consumption or marketing usually prevents this production from entering official national statistics. Additionally, the availability of this production is temporally and spatially variable, and the quantity of captured, collected, or farmed organisms is usually small. Rice is generally viewed as a monoculture and considered the key commodity for local and national food security. Thus, emphasis in national crop production strategies is usually placed on enhancing rice yields which in turn often leads to increased fertilizer and pesticide inputs.

Policy makers must base their decisions on sound information. Yet, the information they require in regard to ricefield fisheries and rice-based aquaculture is usually not available and, therefore, the contribution these resources make to rural livelihoods is not recognized. Development plans that only focus on increasing yields of rice may possibly give the people more rice to eat, but may at the same time take away much of the aquatic animals and plants also harvested from and around the rice fields. Without a sound understanding of the other components of the ricefield ecosystem and careful consideration of suitable extension there is a great risk that the aquatic animal and plant diversity can be severely affected. Importantly, it will be the poorer segments of rural society which will suffer most from the negative impacts of such development.

From fisheries to aquaculture – a continuum

Rice-fish systems can be separated into capture or culture systems depending on the origin of the fish stock. All these systems are referred to under the term “rice-based systems” or “rice-fish systems”, since the farm economy within which aquaculture takes place is usually dominated by rice cultivation. In the capture system wild fish enter the rice fields from adjacent water bodies and reproduce in the flooded fields. Rice fields may also be deliberately stocked with fish either simultaneously or alternately with the rice crop, this is also known as concurrent and rotational rice-fish farming (Photo 7). The rice fields may be used for the production of fingerlings or table fish depending on the size of fish seed available for stocking, the duration of the fish culture period, and the market needs for fingerlings or table fish (Halwart 1998, Demaine & Halwart 2001).

Rice field ecosystems have a rich aquatic biodiversity that is extensively used by the local people (Photo 8). The most important group, in terms of species diversity and importance for the local people, are the fishes. A total of 70 and 52 different fish species were found by Balzer, Balzer and Pon (2002) in Cambodia and by Luo (in press) in China (Table 1). In addition to fish, many species of crustaceans, molluscs, amphibians, insects, reptiles, and aquatic plants are listed totalling over 100 species with nutritional, medicinal, decorative and other uses (Balzer, Balzer and Pon, 2002) (Table 2).

Many fish species can be harvested from rice fields but in the culture system only few are commercially important – among the most common and widespread are common carp and Nile tilapia. They feed low in the food chain and are therefore preferred species in the culture systems (Photo 9). Other popular species are *Puntius gonionotus* and *Trichogaster* spp. Many air-breathing species such as the snakehead *Channa striata* or catfishes *Clarias* spp. are well adapted to the swamp-like conditions of rice fields. They are highly appreciated wild fish in the capture system as they fetch good market prices, but less appreciated in the culture systems as they can decimate the stocked fish significantly[17].

[17] A clear distinction between the capture and culture systems is not always possible. For example, an intermediate system exists in Thailand where the management system relies on stocked fish as prey to the wild species. These losses are accepted due to the high market value of the wild fish at local markets (Setboonsarng, 1994).

Traditionally a good deal of the fish for household consumption was caught from the paddy fields. With increased fishing pressure, the conversion of many wetlands into agricultural land, and the intensification of rice production, the ricefield fishery has declined in many areas and farmers have often turned to aquaculture as an alternative source of animal protein.

Photo 7: Both concurrent and rotational rice-fish farming are practiced in southwest China. In some rice fields, the stubbles remain in the field after the rice harvest. The ratooning plants are regularly cut and fed to grass carp (Photo: FAO/M. Halwart)

Table 1: Aquatic species (number) collected from rice-based ecosystems and used by rural households

	Cambodia	China
Fish	70	52
Crustaceans	6	2
Molluscs	1	4
Amphibians	2	4
Insects	2	3
Reptiles	8	–
Aquatic Plants	13	19

Source: Balzer, Balzer, Pon, 2002; Luo, in press.
Note: Specimens were identified to species level, as possible.

Table 2: Indicative list of uses of various aquatic organisms from rice fields

Taxon	Scientific Name	Uses	
Fish	*Cyclocheilichthys* sp.	Fresh; fermented fish paste; fermented fish pieces; dried salted fish; fish sauce	
Reptile	*Erpeton tentaculatum*	Medicinal use	
Amphibian	*Bufo melanostictus*	Fresh; medicinal use (anthelmintic)	
Crustacean	*Somanniathelphusa* sp.	Fresh; feed; bait	
Mollusc	*Pila* sp.	Fresh; feed; bait; sale	
Plant	*Nelumbo nucifera*	Flowers, leaves, seeds, rhizome for consumption, sale, decoration and wrapper	
Insect	*Lethocerus* sp.	Fresh; medicinal use	

Photo 8: Rice-based ecosystems are often modified to enhance the production from a rich and diverse biodiversity (Viet Nam). (Photo FAO/M. Halwart)

Ecological functions

Many of the aquatic organisms found in rice ecosystems play an important role as biological control agents of vectors and pests of medical and agricultural importance and are an important element of Integrated Pest Management (IPM). Fish that are specialized to feed on mosquito larvae or on particular snail species may control vectors of malaria and schistosomiasis. Some fish species contribute to the biological control of rice pests such as apple snails, stemborers, or caseworms (Halwart, 1994; 2001). Fish also feed on weeds and other insects thereby reducing potential pest problems and maintaining the ecosystem balance. In fact, biological control has been proven to be more profitable than prophylactic or threshold-based pesticide treatments (Rola & Pingali, 1993). Moreover, farmers have experienced that the concurrent culture of fish with rice often increases rice yields, particularly on poorer soils and in unfertilized crops, probably because under these conditions the fertilization effect of fish is greatest. With savings on pesticides and earnings from fish sales, increases in net income on rice-fish farms are reportedly 7 to 65 percent higher than on rice monoculture farms (Halwart, 1999).

Photo 9: A refuge for the fish is usually provided in rice fields (Sri Lanka). (Photo: FAO/M. Halwart).

Rice fields may also harbour species which are under threat of extinction. The deepwater rice ecosystem and the adjacent flooded grass and shrub lands near the Tonle Sap, Cambodia, are habitat for many birds, among them the bengal florican, an endangered species of which only two populations remain world-wide (Smith, 2001). The use of some endangered species, as is the case for *Ichthyophys bannanicus* (Photo 10) which has medicinal value, in the long term is probably a blessing, since it is the economic value which may lead to its cultivation thus ultimately ensuring the survival of the species.

Recent activities

The high availability of wild fish usually favoured the development of the capture system in the rice fields associated with flood plains of large river systems. This system has been studied recently with regard to the living aquatic resources availability and use pattern of rice farmers in the Upper and Lower Mekong River flood plains in Xishuangbanna, Yunnan Province, China (Luo, in press) and in Kampong Thom Province, Cambodia (Balzer, Balzer, Pon, 2002). A relatively lower availability of wild fish in remote mountainous areas resulted in the emergence and evolution of the culture rice-fish system. Indigenous rice-fish systems using locally adapted strains of fish species are found in the uplands of northern Viet Nam and the Lao People's Democratic Republic. The traditional knowledge in these rice-fish societies has been the particular focus of recent work in the Vietnamese Provinces of Hoa Binh, Son

Photo 10: Ichthyophys bannanicus, an endangered amphibian with medicinal value endemic to Southwest China, is found in irrigated rice systems in Xishuangbanna, China. (Photo: FAO/A. Luo)

La and Lai Chau (Meusch, in prep.), and the Laotian Provinces Xieng Khouang and Houa Phanh (Choulamany, in prep.).

Productive ecosystem under threat

The availability of aquatic resources in rice fields is declining. While the amount of aquatic organisms consumed has remained constant, a decade ago rice-based capture supplied half of this consumption, nowadays only one-fifth to one-third is derived from capture in rice-based farming and the remainder has to be bought or farmed (Luo, in press; Photo 11). Farmers in Xishuangbanna claimed that fish are becoming less and less abundant, and that the amount of aquatic organisms collected in one day nowadays is equivalent to what was collected a decade ago in one hour. Similarly, the Cambodian study points out that fish catches have greatly reduced over the past two decades. The villagers estimate that in three to five years there will not be enough fish to make a living. Human population increase and the consequent increased fishing pressure on aquatic resources is an important factor in the decline of living aquatic resources, and a number of related activities are also responsible: pesticide use, destruction of fish breeding grounds, and illegal fishing tools such as electro-fishing or chemical poisoning do not allow fish populations to maintain themselves. Development efforts urgently need to address these threats.

It is particularly the rural poor who are often highly dependent on the aquatic biodiversity in rice fields. They may not have access to money but in many areas they still have access to the biodiversity that supports them. Particular threats to them are the destruction of the fishery resources through overexploitation by industrial capture fishery and the restriction of access to the fishery resources, for example when fishing grounds are leased to commercial fishery companies as fishing lots. These poor people will be hit hardest since they have no land to cultivate and completely depend on the capture of wild resources.

Looking forward

The findings of these recent studies allow an increased understanding and appreciation for the rich diversity and value of aquatic resources, the local practices related to their capture and culture, and the

Photo 11: Aquatic organisms caught and cultured in rice-based farming systems are part of the daily meal; the surplus is conserved or sold at the local market (China). (Photo: FAO/A. Luo)

need to work closely with farmers to develop appropriate interventions for aquaculture production. Making this rice-based aquatic biodiversity visible has had first policy implications at international level (see Box next page).

However, more efforts particularly at country level are needed. Activities planned by local institutions in Cambodia, China, the Lao People's Democratic Republic and Viet Nam include national and regional workshops during which information on the collection and use of aquatic organisms and their importance for rural livelihoods will be presented to policy makers and extension staff. Developing communication and extension materials will be discussed and prioritized together with defining institutional arrangements for their implementation (FAO/NACA, 2003).

The diversity of aquatic species and their importance for rural livelihoods in rice has relevance for irrigated, rainfed and deepwater rice ecosystems covering about 134 million hectares world-wide (Map 9). Specific studies are needed to investigate the nutritional contribution of aquatic biodiversity for rice farming households (FAO/NACA, 2003), and preliminary investigations have taken place in Attapeu, the Lao People's Democratic Republic (Meusch, in prep.). Similar activities are planned in other regions, particularly in West Africa and Latin America (Photos 12 and 13).

Studies in this integrated area of rice farming and fisheries require cooperation and exchange between the different disciplines. Close collaboration within FAO is expected to continue in the future, particularly with the Agricultural Divisions dealing with plant production and protection and with land and water use as well as the Food and Nutrition Division of the Economic and Social Department. The International Year of Rice 2004 will certainly stimulate further thoughts and discussion.

Rice-based aquatic biodiversity highlighted at the 20th Session of the International Rice Commission, 23-26 July 2002

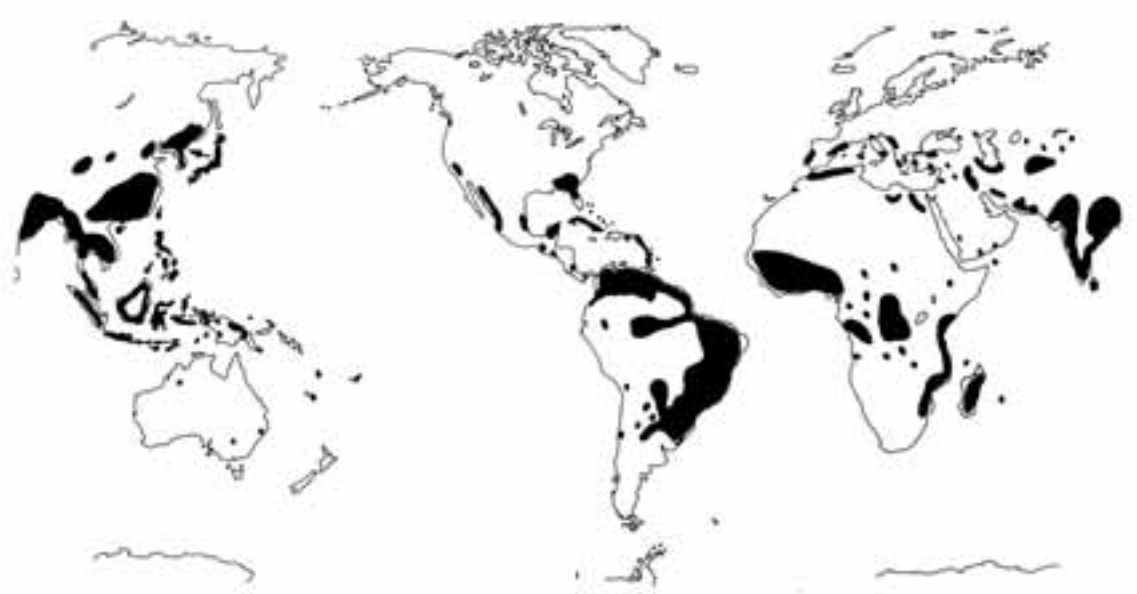
The FAO's International Rice Commission is a forum where senior policy-makers and rice specialists from rice producing countries review their national rice research and development programmes. Its objective is the promotion of national and international action in matters relating to the production, conservation, distribution and consumption of rice.

With regard to the presentation on "Recent initiatives on the availability and use of aquatic organisms in rice-based farming" the Commission made the following recommendations:

1. Member countries should promote the sustainable development of aquatic biodiversity in rice-based ecosystems, and policy decisions and management measures should enhance the living aquatic resource base. In areas where wild fish are depleted, rice-fish farming should be considered as a means of enhancing food security and securing sustainable rural development.

2. Attention should be given to the nutritional contribution of aquatic organisms in the diet of rural people who produce or depend on rice.

Source: FAO, 2002.



Map 9: Rice is cultivated in approximately 151 million hectares worldwide in irrigated (57 percent), rainfed lowland (31 percent), deepwater (4 percent) and upland (11 percent) environments (Fernando, 1993; Fernando & Halwart, 2001; data from IRRI World Rice Statistics and FAO database 2001 at http://www.irri.org/science/ricestat/index.asp)

Photo 12: Rice, fish and vegetable production are often associated in inland valleys in West Africa (Côte d'Ivoire). (Photo: FAO/G. Juanich)

Photo 13: Rice management, including establishment of the crop with pre-germinated rice seeds, is often being done from the plane in large-scale irrigation schemes in Latin America. Aquaculture has the potential to augment low incomes derived from rice, but requires an integrated approach to pest management (Suriname). (Photo: FAO/M. Halwart)

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