11. Prospects and Program for the Future

11.1 Prospects

It is now an opportune time to promote rice-fish farming. Integrated rice-fish farming has been practiced for some time but has failed to become so common as to become second nature to rice farmers. Interest in rice-fish farming over the years has waxed and waned among policy-makers, scientists, extension workers and farmers in different countries. This is understandable given the circumstances during particular periods. Now is a good time to rekindle the interest among all sectors since policy-makers, researchers, extension workers and farmers might be more receptive due to the convergence of four factors.

First, capture fisheries has in many areas reached its limit. Increasing aquaculture production is one obvious solution to meet growing demands, and the world's rice fields represent millions of hectares of fish growing areas. The 1996 World Food Summit agreed "to promote the development of environmentally sound and sustainable aquaculture well integrated into rural, agricultural and coastal development."

Second, there is a growing recognition of the need to "work with" rather than "against" nature. Integrated pest management (IPM) is being promoted in the place of extensive use of pesticides, and fish have been found to be an effective pest control agent. Chemical pesticides are a double-edged sword that can be as injurious to human health and the environment as to its targeted pests.

Third, fresh water is a limited resource and the integration of fish with rice is one way of using water more efficiently by producing both aquatic animals and rice. In addition, new land suitable for aquaculture is limited and the culture of fish together with rice is an effective way of utilizing scarce land resources.

Fourth, rice is not a purely economic commodity; in many countries it is a political commodity as well. The farm gate price of rice is not always based on providing a just economic return to the farmers, but often has political implications such as national food security and export potential. The market, however, usually determines the price of fish. While growing fish in a rice field entails minimal incremental costs, it is one way of augmenting the farmers' income.

These developments serve as an impetus for promoting rice-fish farming. Together, these trends cover various concerns of all sectors involved in rice farming.

11.2 Major Issues and Constraints

Several concerns over rice-fish culture have been identified (in a working paper prepared for the 16th Session of the International Rice Commission, 1985).

- <u>The greater water depth required in rice-fish farming than in traditional rice cultivation may be a limiting factor if the water supply is inadequate.</u> As discussed earlier, increased leaks, seepage and percolation due to maintaining deeper standing water in rice-fish culture can increase water needs significantly.
- <u>Fish cause damage to rice plants which they uproot and eat them</u>. Destructiveness of fish on the rice crop has been observed, particularly when bottom-dwelling *C. carpio* are stocked too early after crop establishment and the transplanted rice seedlings have not developed a good root system, or when herbivorous fish such as *C. idellus* are stocked at larger sizes capable of consuming whole plants. These problems can easily be avoided by good management practices including species selection, stocking size and timing of stocking.
- <u>More fertilizers are needed to increase the primary productivity of the water and feed the fish.</u> Increased fertilization is assumed since both the rice and the phytoplankton require nutrients. The increased fertilization was first estimated by Chen (1954) to range from 50 to 100%. However, experience has shown that in most cases the fertilizer requirement decreased with the introduction of fish (Gupta et al. 1998; Israel et al. 1994; Yunus et al. 1992). Cagauan (1995) found that a rice field with fish has a higher capacity to produce and capture nitrogen (N) than one without fish.
- <u>A small percentage of the cultivable area is lost through the construction of drains and shelter holes resulting in reduction of the paddy yield</u>. Again, experience has shown that the

rice yield often increases in rice-fish culture and thus the excavation of a small part of the rice field (normally no more than 10%) often results in no net loss but rather a net gain in rice production.

- The use of short-stemmed, high yielding rice varieties is limited by the deeper standing water required for rice-fish farming. Even IR36, which has a tiller height of 85 cm, has been successfully used for rice-fish farming. Costa-Pierce and De la Cruz (1992) found that widespread use of HYV was not considered a major constraint in rice-fish culture in most countries,[21] neither was pesticide usage. In fact, as was pointed out at the 19th Session of the International Rice Commission, the case of the P.R. China with 1.2 million ha under rice-fish farming in a rice area almost exclusively planted with modern varieties shows that the use of these varieties does not appear to be a constraint for rice-fish farming (Halwart 1999, Table 17).
- The use of pesticides will be limited. It is argued here that reduced use of pesticides is an advantage to farmers, the communities and the environment in general. Studies undertaken in Bangladesh have revealed that rice-fish farmers use less than 50% pesticides than that used by rice-only farmers (Gupta et al. 1998). Saturno (1994) observed that farmers are less likely to use pesticides when fish are stocked in their rice fields and still enjoyed high yields. Kenmore and Halwart (1998) have pointed out that elimination of nearly all pesticides in rice fields of farmers who have undergone IPM training results in a higher biodiversity of frogs, snails, aquatic insects and others which frequently is used by farmers in a sustainable manner.
- The farmer has to make a greater initial investment for installations in the rice field (higher bunds, drains, shelter holes). The initial investment is a factor that retards a widespread adoption of rice-fish culture. It is a disadvantage in increasing a farmer's financial exposure, but the potential returns can be very rewarding and the risks are often low.
- The practice of multiple cropping (several annual rotations) will be limited because the fields are flooded for a shorter period - four months compared with six to eight months, in the case of the annual crop. On the contrary, continuous flooding from six to eight months is advantageous to rice-fish farming since it makes it possible to grow the fish to larger size.

Many constraints that are not inherent to rice-fish farming, but apply to aquaculture and agriculture in general, such as lack of seeds and credit facilities, have been identified (Costa-Pierce and De la Cruz 1992). Some are site-specific, for example the natural flooding cycle (Bangladesh, Cambodia and Vietnam) and poor soils (Indonesia and Thailand). However, it is argued that the major constraint to adoption by more farmers is the fact that rice-fish farming is not part of the mainstream agronomic practice.

11.3 Research and Development Needs

There is a need to refine rice-fish farming, where the thrust is on improving fish production without affecting rice production. De la Cruz et al. (1992) identified possible areas and topics for research for various countries. Topics common to several countries where rice-fish farming is practiced or has high potential are:

- Ecological studies specifically on food webs and nutrient cycle in a rice field ecosystem;
- Determination of the carrying capacity and optimum stocking densities;
- Development of rice field hatchery and/or nursery system;
- Development of rice-fish farming models specific to different agroclimatic zones;
- Optimum fertilization rates and fertilization methods;
- Evaluation of new fish species for rice field culture;
- Evaluation of different fish species in the control of rice pests and diseases;
- Development of fish aggregating and fish harvesting techniques for rice fields; and
- Optimal rice planting patterns for rice-fish farming.

Other topics identified are not necessarily specific to rice-fish farming and may be covered by regular aquaculture research, such as fish nutrition and feed development, or in agronomy, for example weed ecology and management. Long-term, "wish list" research includes the development of new rice varieties for different rice-fish systems.

[21] With the exception of the Philippines.

Fernando and Halwart (2000) argue that a systematic approach to fish farming development is needed at irrigation system level which will alleviate most of the constraints that are met when trying to promote fish farming in rice fields only. One important task is to classify rice-producing areas for their suitability for rice-fish farming, considering the capacity of the irrigation infrastructure, general soil characteristics, physical requirements as well as the socio-economic situation. The result could serve as a guide as to where to concentrate greater effort in promoting rice-fish culture. The availability of materials from China may be useful to field-test some systems for possible adoption in other countries.

It will be useful if socioeconomic studies are conducted before and after the introduction/ promotion of rice-fish culture. Baseline data on income status and diet will be important in assessing the full impact of rice-fish technology. Deepwater rice systems warrant more studies as such areas could be natural places for fish culture. Low yields of such systems could potentially be compensated by fish yields as Dehadrai (1992) reported yields of 1 100 $kg \cdot ha^{-1} \cdot crop^{-1}$ in India and 650 $kg \cdot ha^{-1}$ in four months in Bangladesh (Ali et al. 1993), although the system was not found financially viable due to the cost of the 4 m high net enclosure.

The rising sea level may necessitate research into brackishwater rice-fish farming. Penaeid shrimps grown concurrently with rice in brackish water as demonstrated in Vietnam (Mai et al. 1992), and in India, the *pokhali* and *Khazan* systems,with salt-resistant rice are reported to produce 885-2 135 $kg \cdot ha^{-1} \cdot crop^{-1}$ of giant tiger shrimps and mullets and 500-2 000 $kg \cdot ha^{-1} \cdot crop^{-1}$ of shrimps and perches, respectively. The *sawah-tambak* (Indonesia) may be appropriate for low-lying coastal areas suffering from saltwater intrusion as it produces 2 000-3 500 $kg \cdot ha^{-1} \cdot year^{-1}$ of brackishwater species (such as penaeid shrimps, milkfish and seabass). It may also be possible to use abandoned shrimp farms for rice-shrimp farming, as many such farms were originally rice fields.

11.4 Institutional Policy and Support Services

11.4.1 Mainstreaming rice-fish farming

People involved in rice production often regard rice-fish farming as a novelty, and standard literature on plant protection in rice production (e.g. Heinrichs 1994; Reissig et al. 1986) does not mention fish as a possible bio-control agent or rice-fish culture. To address this, rice-fish farming should be made part of the agriculture curriculum in universities and colleges, and recognized as a viable farming system.

If possible the agriculture ministry, or its equivalent, in rice producing countries should make integrated rice-fish farming part of the standard agronomic practice so it becomes a logical and viable option for farmers.

Since IPM is now an accepted approach to pest control this is a logical entry point for raising fish in rice fields. However, suitable curricula for the Farmer Field Schools still need to be developed.

11.4.2 Popularization of the concept

Many farmers are aware that fish can be cultured with rice, but few realize the advantages. A major concern is likely to be how to deal with insect infestations when growing fish in the fields. Since governments are often promoting IPM for rice cultivation, the culture of fish should be considered as part of IPM methods as fish cultivation can be effective in strengthening other non-chemical IPM strategies (Kamp and Gregory 1994) and better utilization of resources. Increased income and a healthy crop of rice reinforce farmers' acceptance of non-chemical IPM and rejection of pesticides (Kenmore and Halwart 1998).

Rice-fish farming should become part of public awareness so the culture of fish in rice fields becomes as integral to rice growing as fertilizer application. In fact not too long ago, before the promotion of chemical pesticides, fish and other aquatic organisms were the most natural thing to have in the flood water of rice fields. This continues to be the case for example in parts of Cambodia, the Lao PDR and other parts of Southeast Asia where pesticide use is negligible.

11.4.3 Training and education

Generating public awareness alone is not sufficient however. It may lead to frustration if suitable technologies cannot be delivered. Farmers should know where to turn for assistance. To do this it is necessary to train and re-orient agricultural extension officers. Agriculturists rather than fisheries officers should be targeted for such training since they are the persons who are most often in contact with the rice farmers.

Beyond short-term training for agricultural extension officers, agricultural school curricula should include rice-fish culture as a viable farming system, and the role of fish in pest management should also be taught. Textbooks on rice farming should include sections on rice-fish farming. All those involved in rice production should be made aware that the advantages of rice-fish farming go beyond the production of fish.

11.4.4 Fingerling supply

A vital input in rice-fish farming is fish seed for stocking. In countries where aquaculture is not an important industry, fingerlings are scarce and expensive. There are many issues pertaining to how to successfully promote fingerling production, but this is common for all aquaculture and not specific to rice-fish culture. Any effort to promote a wider adoption of rice-fish farming needs to be accompanied by developing local capability in fingerling production. This could be done through the rice farmers themselves as has been successfully done in Madagascar where a network of private fingerling producers was set up gradually. As a private producer became operational, fingerling distribution by the government in that area was discontinued. In the next step, extension services for rice-fish farmers in the area were included in the marketing strategy for fish seed producers, ranging from demonstrating their own rice-fish operations to organizing meetings. To achieve this, fingerling producers were trained in marketing methods, teaching skills, and extension methods. Activities were supported by a small but highly qualified group of government extension agents (Van den Berg 1996).

11.4.5 Financing

Financing may be required since the raising of dikes and excavation of ponds or trench refuges may incur extra expenses beyond what is normally required for rice farming. Often the amounts involved (US$ 500 or less) are small enough to fall within the scope of micro-credit. Even if hundreds of farmers are to be financed in each locality the total amount involved will certainly be within the capability of rural banking facilities to service. The more critical issue is often to get the financing body to accept this farming practice as a viable venture, as aquaculture has had difficulties in being seen as a low risk farming option.