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Rice-Fish Culture

Introduction

Cultivating rice and fish together has been a 2,000-year-old tradition in some parts of southeast Asia. However, this beneficial cultivation system was gradually abandoned due to population pressures, decreasing stocks of wild fish and the "Green Revolution" which emphasized high-input monoculture using high-yield rice varieties, pesticides, and herbicides (which are toxic to fish).

During the 1980s and early 1990s, rice-fish culture as managed cultivation systems experienced a revival, as concerns over the widespread use of pesticides emerged. In several southeast Asian countries, rice fields as natural fisheries are more important than as places where cultured fish are raised. Native fish species are favoured over species which are generally cultured like the common carp, Nile tilapia and silver barb.

Rice-fish culture can actually increase rice yields (up to 10% in some cases) while providing farmers with an important source of protein and extra income. Implementation is relatively inexpensive and low-risk.
To incorporate fish in a rice paddy, farmers generally follow this procedure:

* They begin by digging a small pond or trench 0.5 to 1 metre deep in a low-lying area of the rice field. This trench becomes a refuge for the fish during planting and harvesting, or when there is little or no water. This also allows the farmer to keep the fish alive well after the growing season;

* The excavated soil is used to raise banks around the field for better water control. These banks provide some land above water level, which can be used to grow other crops such as vegetables or fruit trees;
* After flooding, the rice is planted; fingerlings of carp, tilapia, catfish, or other species are introduced into the trenches. In some parts of the Philippines, freshwater shrimps, snails, clams, and a loach species are stocked;
* After three weeks, once the rice is well established, the fish are let into the rice fields;
* Supplemental feeding varies from none at all to frequent feedings, depending on the farmer and local conditions;
* At harvest, or if chemicals are used, the water is drained and the fish are collected from the trenches.

Benefits of rice-fish culture include:

* The recycling of nutrients by the fish through feeding and depositing feces in the soil. This increases the uptake of nutrients such as phosphorus and nitrogen by the rice;
* An increase in rice yields;
* An increase in income from the production of both rice and fish;
* A reliable source of protein for farmers and their families, countering the decrease in available wild fish in many countries;
* A reduction in insect pests (such as leaf-hoppers, stem-borers and aphids) and weeds, which the fish eat.
* A reduction in using fertilizers.

Constraints to rice-fish culture include:

* Requires a significant amount of labour (especially for poorer families for whom time spent may be a substitute for cash inputs);
* Can be risky (e.g. flooding, drought, poaching, poisoning, etc.) compared to rice monoculture;
* Low fish prices;
* Other sources of animal protein (e.g. poultry, beef, and pork) are often preferred to fish;
* Commonly cultured species (e.g. tilapia and carp) are not highly valued by people who have access to marine species, milkfish, and wild species;
* Often only an option for subsistence fish production given particular circumstances (e.g. reliable water supply and source of fingerlings, fields located close to the family house, and no danger of pesticide poisoning);
* Farmers unconcerned with the long-term environmental benefits (many tend to focus on the short-term because they are tenants and not landowners);
* Landless families are often the poorest people in countries like the Philippines. Traditionally, these people would catch whatever aquatic organisms they could find in rice fields. Since rice-fish culture farmers will protect their investment against intrusion so that cultured fish can be sold, this free source of protein is no longer available;

* Difficulty in properly stocking fingerlings, which are often not available at the right time, in the right number or the correct size
* Lack of consideration for women, who are decision-makers regarding changes to rice fields and household consumption, when promoting rice-fish culture.
* Very low-lying paddies, which are susceptible to floods;
* Poor soil conditions (e.g. sandy soil);
* The uncertainty of rainfall and limited irrigation water;
* The possibility of water contamination by pesticides, herbicides, and chemical fertilizers, which are toxic to the fish and the organisms on which they feed;
* Fish predators such as snakes, which can lower the fish yield.

There are many different methods of rice-fish culture, which vary in types of trenches used, stocking rates, fish species used, and supplemental feeding. It is important to base rice-fish culture on local farmers' current cultivation methods.

Impact

* Rice-fish culture emerging as an incentive to implement IPM (integrated pest management) - According to Gesa Horstkotte-Wesseler, a Ph.D student from Germany's Goettingen University, " ... the real potential of rice-fish culture (is to) create a favourable environment in which wild fish can thrive." Incorporating rice-fish culture in IPM programs and " ... creating a favourable environment for aquatic organisms in rice fields ... seem to be far more promising than any further refinement of fish culture techniques." Ms. Horstkotte spent three years studying the issues of small-farmer household economies vis-à-vis IPM in rice-fish culture in the Philippines. Many farmers reported that once they stopped spraying with pesticides, fish returned to their rice fields, reducing the need to stock fingerlings. Since IPM programs often cover entire villages, the danger of fish poisoning from adjacent fields is minimized. IPM training should include rice-fish culture techniques (e.g. field modifications and fish feeding) and information on the pest control characteristics of fish.

* Non-commercial approach - As a bonus, wild fish, which live within the irrigation system, are available for the nutritional benefit of landless people. This non-commercial approach can provide a considerable amount of protein to a community at minimal cost.

* Expanding traditional systems - Recently traditional systems for managing and capturing wild swamp fish, which are tolerant of the marginal agricultural environment of a rain-fed rice field, have been expanded.

* Successful research results in Bangladesh - A recently completed International Center for Living Aquatic Resources Management (ICLARM) study of 256 farms integrating aquaculture with agriculture reports increased rice yields and decreased infestations of both pests and weeds. Given Bangladesh's growing population of 116 million, population density of 783 people per km∑, staple food sources of rice and fish, and growing concern for the environmental impact of pesticide use in intensive agriculture, rice-fish development can play a crucial role. According to the study's

authors (Gupta, M.V. et al.), " ... the present study has conclusively shown that integration of aquaculture with agriculture can increase rice yields, besides being a viable, low-cost, low-risk, sustainable economic activity, with multiple benefits: production of diversified products, rice and fish from the same land area; increased incomes and nutrition to farm households; reduced labor costs in rice cultivation; lesser use of pesticides and spread of risks due to diversity of produce. Thus integration is economically and ecologically beneficial and is a way for food security for small farmers. In spite of the small size of fish at harvest due to the short rearing period, farmers are continuing integrated farming indicating the sustainability of the system. ... Overuse and misuse of pesticides are quite high in developing countries. Integrated aquaculture-agriculture could be an entry point for IPM. A 'do not spray' strategy could be changed to the more attractive ‘integrate fish' strategy."

* Further research - ICLARM continues its research efforts on rice-fish culture, focusing on two aspects:

* impact evaluation of a previous rice-fish culture extension project in Bangladesh, examining production, economics, and social and gender issues;
* a new three-year project on deep water rice-fish culture, located in Bangladesh, and North and South Vietnam; concentrating on socioeconomic and community-based management issues.

In addition, CARE Bangladesh is developing an indigenous freshwater prawn-rice-fish or 'gher' system, designed to earn foreign exchange by exporting prawn.

* Asian Fisheries Social Science Research Network (AFSSRN), Phase IV - This network has been supported by IDRC since 1983 with the goal of developing multidisciplinary social science research capacity in southeast Asia, and undertaking applied research on fisheries and aquaculture. Phase IV is concerned with policy and the influence of programs for sustainable management of coastal resources and agriculture-aquaculture systems. Four research themes are being pursued: common property and community-based management; methods for analyzing capture fisheries management, integrated coastal resources management, and aquaculture systems; integrated agriculture-aquaculture systems; and policy analysis. In addition to Indonesia, Malaysia, Philippines, and Thailand, countries to be added to the Network include Viet Nam, China, and Bangladesh. South-to-South collaborative research and training is encouraged. Partners include the Danish International Development Agency (DANIDA) and the Ministry of Development Cooperation of the Netherlands.

Prerequisites

Availability of good quality water (uncontaminated by pesticides and chemicals). Availability of fish fingerlings of the right size and at the right time, because the timing for introducing the fish is critical to the success of the system. This means that rice-fish culture will be more successful in areas where there are local fish hatcheries. However, some farmers allow nature to stock their fields with wild fish, or use various types of traps. If supplemental feeding is necessary, it usually consists of locally available rice bran, termites, vegetables, leaves, etc.

Potential users

Rice-fish farming can be a low-cost, low-risk option for poor rice farmers in rice-farming countries, including Malawi, Bangladesh, China, India, Indonesia, Korea, Laos, Madagascar, Malaysia, the Philippines, Thailand, Cambodia, and Vietnam.

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The aspirations for aquaculture development for the period 2001-2020

In the next 20 years, the emphasis of fisheries and aquaculture development in China will be to:

* meet the needs of social and economic development;
* increase the efficiency of fisheries production;
* develop and promote aquaculture, agriculture and the rural economy;
* expand and diversify production so as to meet the demand for fish and fishery products; and
* make the best use of market potential.

To realise these goals, the state will primarily support the development of six core systems and six areas of concern. The systems to be developed are:

* original and fine species diversification system;
* fishery scientific and standardization system;
* fishery technology extension system;
* disease control system;
* fishery marketing system; and
* fishery management and environmental protection system.

The six fields to be developed are the:

* vertical integration of aquaculture production in the fish culture bases;
* development of offshore and distant water fishing;
* processing of fish products and comprehensive utilization of materials;
* building of fish ports;
* building of fishing vessels and
* manufacture of fishery machinery and new technical exploitation.

The implementation of the “TWO SIXES” systems will play an important role in strengthening Chinese fisheries and aquaculture, realising sustainable and healthy development, as well as speeding up the modernization process.

The distribution of fishery resources

It is unlikely that there will be any significant increase in pond areas in view of the limited suitable land available in China.

Consequently, the emphasis is on the upgrading of pond conditions, as well as the readjustment of culture techniques and the structure of the species cultivated. The enhancement and protection of the natural resources has to be encouraged, applying cage and pen culture in other water bodies, where appropriate. The development of polyculture alongside the capacity for multispecies applications will provide opportunities for diversification and the production of high-quality species and products.
Meeting market demand through recognized consumption patterns and economic realities would also encourage diversification. The assurance of stability within the aquaculture

sector will support efforts towards the production of higher value species, providing greater economic benefit and a wider market potential.

The administration of fish farming

A number of requirements has been identified to allow the efficient administration of fish farming in China, including:

* establishing, as soon as possible, a specific legal system for fish farming to guarantee the realisation of sustainable aquaculture development;
* implementing a sector support system for fish breeding, fry supply and disease control;
* optimizing the industrial structure to reconfigure production and have a rational distribution of the activity; and
* modernizing fish farming.

The plan for upgrading the national technological base

The fishery technical development trends to be seen in China in the next century have been identified as the following:

* research on bioengineering technology with emphasis on the improvement of new culture species or strains;
* research on the sustainable development of fishery enhancement and aquaculture in order to assure positive and rational development;
* research on disease control and production technology for aquaculture, with particular reference to molecular biology tools;

* research and development to transform traditional aquaculture systems, develop new culture technology systems (e.g. raceways), eliminate self-pollution and improve management systems; and research to develop applicable technologies for the culture of marine species and to guarantee the supply of high-quality aquatic products.

Strengthening technical services

In order to bring fishery technical extension into full play, it is necessary to develop different types of services for the benefit of the production sector. These include technical associations, mutual insurance aid and other nongovernmental service organizations that can serve the fisheries and aquaculture sectors. It is also necessary to improve the abilities for self-protection and self-development of the labor force under the conditions of a market economy.

Strengthening legal and institutional capacities

Firstly, current legislation and regulations require full implementation, where the following issues require completion or establishment:

* standards for aquaculture production;
* the code for aquaculture operations;
* quality standards for fish products;
* environmental standards for fisheries, including water quality standards; and
* standards for rearing techniques.

Secondly, aquaculture systems and technologies should be developed in accordance with accepted ecological standards. Measures to promote the application of ecological standards and "green" products that have been reared in such systems should be the subjects of research and extension, giving focus on the supply of healthy, nutritious food. These are instruments that will assist the policies adopted for readjusting the market. Thirdly, a licensing system for the discharge of sewage drain waters into fishery environments should be implemented where sewage could only be released after approval by the fishery environment monitoring department, which would be required to demonstrate discharge standards. Financial charges would be collected from those discharging sewage, the money to be used as a management fee to assist in:

* production management,
* technical renovation,
* treatment of wastes and drainage waters, and
* cleaning of pollution to protect or recover fishery environments.

Planning to transform Chinese aquaculture into a professional industry

Aquaculture has become an industry, and it is necessary to organize farmers' associations, such as the National Collaboration Network for Eel, the Scientific Aquaculture Association, and others, in order for these to help in the management of the aquaculture sector and to coordinate the development plans for the industry. Detailed actions would include:

* collection and dissemination of updated information;
* exchange and dissemination of experiences (e.g. production techniques, marketing etc.); and
* guarantee the support and benefits of the industry.

Economic and social expectations of aquaculture

Aquaculture can effectively promote economic development and societal progress. Firstly, the basic expectation for aquaculture should be that it should be an activity to guarantee the supply of fish products and, hence, food security, thus contributing to social stability and development.

Secondly, aquaculture can create significant employment opportunities, absorb and utilize surplus rural labour, encourage women and young people to be engaged in production activities, increase farmers' income and assist in poverty alleviation. Aquaculture development can also provide opportunities for leisure and recreation through sports fishing and tourism.

Thirdly, the awareness of the needs for environmental protection and social responsibility should be heightened when developing aquaculture. It is the duty of the sector to control pollution and resource degradation and to meet the needs of current social and economic development, achieving these aims without threatening the viability of the resource for the next generation.

Fourthly, aquaculture should be developed as an economic activity that can provide significant export earnings. As the world economy becomes more and more unified, it is necessary to take advantage of resources and technology to advance the economy and improve the stability of society.

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1 People' s Republic of China.

2 The original Chinese manuscript was translated by Mr Zhou Xiaowei, Programme and Training Specialist at the Network of Aquaculture Centres in Asia-Pacific (NACA) Secretariat. Additional inputs were taken from the review of Chinese aquaculture and development plans presented by Mr Miao Weimin, Deputy Director of the Chinese Freshwater Fisheries Research Centre in Wuxi, at the Asian Regional Aquaculture Development Planning Workshop in Kanchanaburi, Thailand, September 1999.

3 This refers to a national campaign in China in the late 1980s and early 1990s to convert low-lying and saline-alkaline or waterlogged lands that are not suitable for crop production into fish ponds for large commercial-scale freshwater fish (in some cases also for shrimp and brackishwater species) production. With the expansion of pond area to approximately 500 000 ha, a significant increase in fish production was achieved.

4 FAO statistical data show 27 million mt because FAO counts shelled weight for molluscs and live weight for seaweed, while Chinese figures are in meat and dry weight, respectively.

5 1 US$ = 8.27 Chinese Yuan (exchange rate for 2000).

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3. Rural Aquaculture Systems

3.1 Freshwater Production Systems

3.1.1 Pond fish culture

Rural freshwater fish culture in China mainly refers to pond fish culture. In 1997, pond fish culture area reached 2 million ha (not including paddy field culture area), with an output of 8.9 million mt, accounting for 72.1% of the total freshwater aquaculture production. Technological system for pond fish culture is basically the ancestors' traditional Chinese fish farming technology refined and improved through knowledge and experience gained from research and development efforts of last five decades. The system has the following outstanding features:

i) Rearing short food-chain fish: Fish reared in China is largely herbivorous or omnivorous. Their food chain is very short. Fertilizer, grass, wastes from farm products processing industry can be used as fish feed. So their feed sources are abundant and wide, and culture cost is low and resulting in good economic benefits.
ii) Self-sufficiency in seed production: Now over 20 species are being artificially bred. Hatchery produced seed of all the major culturable species are available in almost all rural areas where aquaculture is an important activity. Culture activities therefore can be done in a planned way and in accordance with demands.
iii) Mixed and polyculture with high density: Several species are cultured in the same pond. This experience was explored and accumulated by the Chinese fishfarmers in a long period of practical production activities. Different species of fishes are cultured in the same pond according to their biological characteristics, food and feeding habits, and the water column inhabited by different species, so as to fully utilize the water space and the available natural feed to maximize production per unit area.

iv) Integrated culture: Pond fish culture is carried out by integrating it with other farming activities such as livestock rearing (chicken/duck/pig/cattle etc.) and/or crop cultivation/horticulture (vegetables, mulberry, fruits etc.). It is a comprehensive and integrated method of production with fish culture as the main activity and growing different kinds of crops, cash crops, grass as feed, and raising livestock and poultry on and around the pond banks. Fermented waste of farmed animals can be used as fertilizer or as fish feeds, the sludge from the pond bottom can be used as quality fertilizer for crops on land, and crops and grass can be used as feed for farmed animals and fish. Such integration allows best uses of all available resources and results in higher household income for the farmer.
v) Water quality management: For healthy growth of fish, the pond water quality is maintained at the optimum level by balancing the pond ecosystem. This is done through carefully managed feeding regime, water inflow and outflow, and aeration.

3.1.2 Culture-based fisheries

Fish culture in large water body, such as lake fish culture, began in the Western Han Dynasty in China (206 B.C.-A.D. 24), but the Dongqianhu Reservoir built in 744 is the earliest record of reservoir for fish farming. However, community fish culture in large water bodies began in the 1950s. At the beginning, it adopted stocking and extensive culture method, which resulted in enhancement of natural resources and improved the productivity of water bodies. Fish species and number for stocking are determined according to size and type of water body. For example, the ratio of fingerling stocking in fertile lakes is generally silver carp and big-head carp 80%, grass carp and black carp 5%-10%, common carp, crucian carp and bream 10%-15%, etc. At the same time, 0.5 kg crab seed and 0.5 kg eel fry can be stocked per 20 ha water area. Fish screen facilities and daily management must be stressed in such water area. Owing to the fact that large-sized fingerling is required for stocking in large water body, this gives an impetus to rearing of fingerlings in surrounding areas and has encouraged the development of a complete and separate production system. For the purpose of tapping the potentials of lake and reservoir fish culture, net enclosure and net cage cultures are gradually developing in large water bodies depending on their suitability.

3.1.3 Cage culture

The Chinese modern net cage culture started in the early days of 1970s and major efforts were devoted to developing and extending the method in 1980s. Net cage culture is now being used in lakes, reservoirs, rivers, ditches and shallow sea water and can be largely divided into 4 types: (1) to use natural feed (planktons) to culture large-sized silver carp and big-head carp fingerlings for stocking large water bodies; (2) to use natural feed (planktons) to culture table fish; (3) to use artificial feed to culture table fish; and (4) to culture high value species such as eel, mandarin fish, sea bream, etc. through high density intensive feeding system. Net cage culture in developed countries is usually an intensive culture system, but the culture system in China is either traditional or semi-intensive.

3.1.4 Paddy-fish culture

Paddy-field fish culture in China has a history for more than 2 000 years. In the early days of 1970s, China carried out extensive research on ecology and biology of culturing

fish in rice-fields. This led to the development of various methods of rice-fish culture, based on a symbiotic relationship between fish and rice cultivation, leading to increased economic benefits to the farmer. The major types of rice-fish culture are as follows:

(1) Raise fingerlings in paddy fields in the plains: The fry are directly reared in early rice fields and after they have grown to 4-5 cm they can be transferred to the semi-late rice fields to grow them to market size by the time the rice is harvested. This is the easiest and most effective way which brings the maximum benefits to fishermen.
(2) Planting rice on a ridge and rearing fish in a ditch: The best specifications are a ridge - containing two rows of rice seedlings and a ditch of one meter in width and one meter in depth. Some farmers even plant melons and soy-beans on banks and rear duckweeds in water. And thus a kind of multi-layer planting and culture mode is established.
(3) Rearing fish in a wide ditch: Wider ditches of varying sizes are prepared in the rice-field and are connected with the water inlet for fish culture. The total area for fish culture may vary from 5-10% of the rice-field.
(4) Culturing fish in an adjacent pond which is connected with the rice-field. The fish pond serves as a water reservoir for the rice-field.
(5) Another way of rice-fish culture is to cultivate rice and fish in rotation in the same field.
The above-mentioned culture methods are extensive, though in some cases supplemented feed are given to the fish.

http://www.new-agri.co.uk/98-5/focuson/focuson1.html

Rice-fish culture: supporting the rural poor

The aquatic phase of rice production creates a highly productive biological system that generates and sustains a wide range of plants and animals. And, to many rice farming communities in Asia, wild fish and other aquatic resources, such as crabs and frogs, are important sources of food. Fish species, such as carps, tilapias and catfish, can also be cultured (commonly yielding 50-300 kg/ha/yr) and their introduction to rice fields may effectively increase rice production by as much as 15%. This increase may be due to a number of possible causes: farmers often invest more effort in water management, spend longer with their paddies and may introduce fertiliser and/or potential fish feed stuffs. And, it is also because fish excreta increases soil fertility and the fish also contribute to the control of weeds and insect pests.

To date, most research into integrated rice fish farming has focused on areas of reliable rainfall or on irrigated systems, the so-called high potential areas. However, the Systems Group of the Institute of Aquaculture at the University of Stirling in Scotland is also turning its attention to more complex rain-fed areas where farmers must continually adapt their farming systems to respond to changing conditions. Where rainfall is unreliable, families often are poor and 'pre-packaged' technologies are usually inappropriate. An alternative approach is therefore needed if rice-fish culture is to be successful and sustainable.

The Systems Group at the Institute of Aquaculture is currently developing and using participatory research techniques for its development projects (funded by DFID) in several countries in Asia. In each of the projects, efforts are being made to build up a partnership between farmers and those involved in supporting their efforts (scientists, extension officers, NGOs, etc.). The development and management of such partnerships is new and complex: there are many problems that have to be overcome but the value of the approach lies in the potential benefits for those that are most in need of support in improving their livelihoods.

In Laos, where the Institute of Aquaculture has been working for two years, the vast majority of rice production (97%) is rain-fed. However, different regions are affected by varying periods of water availability. To investigate the different options available for fish production (through encouraging wild fish populations or by stocking and culturing fish), the project is addressing the technical, social and economic constraints to rice-fish culture in three Districts in the Savannakhet Province. Several organisations are collaborating in the work but a particularly crucial role has been played by the Lao Women's Union in order to understand and appreciate the role and view of women in aquaculture. Graham Haylor of the Institute of Aquaculture feels that this is very important and, as he says, “It is commonly considered that men are mainly involved with aquaculture so that, too often, the role of women has been neglected. But, in Laos, women are very much involved in the decision making for aquaculture so participatory monitoring and evaluation has been essential to access the difference in knowledge, experience and attitudes between men and women. As Graham Haylor also observes, “Farmers respond very well to sharing their experiences and government institutions are eager to promote that forum for the exchange of ideas and for them to then use and disseminate the information more widely for the benefit of others.”

Participatory methods are also being used in a new project in Eastern India. The project covers extremely poor rural areas in three states (Bihar, Orissa and West Bengal) where fish are highly valued but fish culture is currently not a common practice. The project is to improve the long-term livelihoods of poor farmers by encouraging and supporting the integration of aquaculture. Thirty-seven different trials are already planned with groups across West Bengal. The particular aspects of each trial has been determined by farmer groups and one of the main areas of interest has been to develop fish production even if water is only present for part of the year. Researchers are investigating carp and other indigenous fish species which can be spawned outside the rainy season. The idea is to produce fingerlings for stocking temporary ponds at the start of the rainy season which will grow fast enough for farmers to harvest a reasonable crop before the water dries up. In Bangladesh, INTERFISH, one of two aquaculture projects (managed by CARE Bangladesh and funded by DFID) operates farmer field schools for men and women in four districts with an aim to greatly increase the adoption of rice-fish integration in farming systems. By the year 2000, it is hoped that these projects will have promoted more socially and environmentally sustainable farming to more than 70,000 farmers throughout Bangladesh. Using a number of participatory learning methods (discussion and hands-on learning etc.), farmers are introduced to basic ecology, pest management and other issues relating to rice-fish culture. The INTERFISH approach and transfer of

knowledge to NGOs will ensure that the adoption of these field management approaches will benefit the farming community and improve the environment for all. As Muzaffar Ahmed of CARE says, “INTERFISH recognises that farmers are the experts and that they are the decision makers. If the farmers can also recognise the benefits that they have gained then their activities will continue long after the project has come to an end.”
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Integrating aquaculture - more to fish farming than fish

The greatest variety and development of agro-pisciculture farming systems are found in China but the integration of aquaculture with agriculture is common in different forms across the Asian continent. These small-scale traditional systems promote diversity and sustainability and there is enormous potential for the system to be adapted to other regions in Asia and Africa where there is a demand for fish products to be farmed on a small, but ecologically sound, scale.

Perhaps the best known system in China is the mulberry dike-fishpond system in which mulberry is raised on the pond dike and the leaves are fed to silkworms. Silkworm excreta and pupae are fishpond inputs and the enriched pond mud is then used to fertilize the mulberry. Rice-fish systems are also well known across Asia (see Rice-fish culture: supporting the rural poor).

Away from the paddy fields, livestock may be integrated with fish and crops where every constituent in the system helps to increase production and income. The water stored in farm ponds can be used to extend crop production into dry seasons, thereby increasing total production and attracting premium prices for out-of-season produce; increased production also provides by-products for feeding livestock (cattle, small ruminants, rabbits and poultry); livestock manures, household waste and cereal brans added to ponds feed aquatic plants and animals that in turn feed the fish; and finally, the mud that accumulates as sediment can be used to fertilize the land for fruit and vegetable crops. Just as the integration of trees into crop and livestock production on farms (agroforestry) has provided benefits that reflect a synergy between the various elements, similarly agro-pisciculture can be seen to offer farmers more than just fish as an extra farm crop. Overall, crop yields are increased, fish, fruit and vegetables enrich family diets, greater surpluses provide greater income and, finally, soils are not continuously degraded but made more fertile. It is also important to note that whilst waste is reduced and water quality is maintained, farmers are also more circumspect in their use of pesticides and other chemicals so that pollution is generally avoided.

This system that has worked so well for millennia could help to break the double downward spiral of falling food production and declining soil fertility which affects so many regions in Asia and Africa. Integrated aquaculture systems involve many variables and are therefore highly site-specific. However, providing that soils are water retentive,

this integrated system, which promotes species diversification and nutrient recycling, can make even the most marginal lands more productive. Fish is also a popular food but marine catches are falling and even where production from inland waters is available, demand often outstrips supply. Yields of farmed fish in integrated systems cannot be expected to make good the shortage but the additional benefits often exceed the simple value of the harvested fish.

The density of fish that can be maintained in a pond is largely related to the availability of food. As a result, integrated agriculture-aquaculture systems are very flexible and a wide range of the raw materials available can be used. A comparison of different levels of pond management shows that whereas unfertilized, poorly-managed ponds yield 50-200 kg/ha/yr, ponds which benefit from agricultural waste feeding and better stock management can increase yields to 5000-10,000 kg/ha/yr.

Actual yield depends also on the species of fish stocked, as different species feed on different organisms and plant matter. Fish in vegetation-fed systems include the Chinese grass carp (Ctenopharyngodon idella), giant gourami (Osphronemus goramy) and silver barb (Barbodes [=Puntius] gonionotus) which are common in traditional systems in south-east Asia. A wide range of Chinese and Indian carp and tilapia species are suited to manure-fed systems (e.g. Common carp, Cyprinus carpio and Nile tilapia, Oreochromis niloticus) whilst walking catfish (Clarias spp.) are more carnivorous. Yield can also be affected by availability of fry (young fish) or water, climate changes, and the need to drain and harvest ponds. 6000 kg/ha/yr would therefore be an excellent yield for most ponds.

Unrealistic expectations of fish yield has often contributed to the failure to establish fish culture in new regions. Many African countries were introduced to pond fish culture as early as the 1950s but many projects failed as the new system was promoted as a separate rather than an integrated farm enterprise and techniques were inadequately explained to farmers who were completely new to the concept. Many of them failed to grasp the importance of maintaining water quality and correct feeding, and very often there was no assured supply of fingerlings for re-stocking.

Much has been learnt from mistakes made in the past and several international organisations are actively promoting agro-pisciculture in Africa and Asia. FAO works in the SADC countries through the ALCOM development programme while CIRAD is active in much of francophone Africa and ICLARM in Ghana and Malawi. Many West African countries are also benefiting from the demonstration and teaching of integrated agro-pisciculture at the African NGO Songhai Centre in Porto Novo, Benin. In Asia, development and extension work is currently being carried out by CARE and DFID in Bangladesh, AIT in Laos, Cambodia and Thailand, ICLARM/IRRI in Bangladesh, Vietnam and the Philippines, and the SCALE and PADEK aquaculture projects in Cambodia, amongst many others.

Much has still to be learned about the factors that influence the success or failure of efforts to establish integrated agriculture-aquaculture systems. If agro-pisciculture is to be

successful, government assistance will be essential for training, initial supply of fingerlings and advice on management while farmers gain experience. Equally importantly, as Mark Prein, Program Leader for the Integrated Aquaculture-Agriculture Systems for ICLARM concludes, “Farmers have to recognise for themselves that there is need to improve their situation. If they are not able to observe the benefits, to understand how their farming system can be realistically enhanced and to participate in discussing how that process should happen, then the successful integration of aquaculture into existing agricultural systems, however beneficial, will not occur.”
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