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# RICE-FISH CULTURE *in* CHINA



EDITED BY  
Kenneth T. MacKay

INTERNATIONAL DEVELOPMENT RESEARCH CENTRE

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# Rice-Fish Culture in China: Present and Future

*Chen Defu and Shui Maoxing<sup>8</sup>*

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In China, fish are raised in ricefields in the southeast and southwest mountainous areas where there are few bodies of water for growing fish and fishing regions and towns are far away. Rice-fish culture is a traditional and popular way for the people to grow their own supply of fresh fish in the mountainous areas of: Qingtian and Yongjia in Zhejiang Province; Jiening, Taining, Saxian, and Yongan Shaowu in Fujian Province; Yulin, Guilin, and Jinzhou in Guangxi Province; the southern part of Guizhou Province; and Pingxian, Jian, and Yichun in Jiangxi Province.

In these areas, the farmers practice rice-fish culture to raise fish for their own consumption, although it requires extensive management and fish harvests are poor. Before 1949, there was no organized extension of the technology; therefore, rice-fish culture did not improve.

## Present Situation

### Extension of Rice-Fish Culture

Since the founding of the People's Republic of China in 1949, the government has paid more attention to rice-fish culture. In 1954, the First National Conference on Aquatic Products formally called for the promotion of rice-fish culture. The area devoted to rice-fish culture increased rapidly and reached over 670 000 ha by the end of the 1950s. During the mid1950s to the early 1960s, rice-fish culture developed rapidly in the mountainous areas of south and north Zhejiang and in the plains and hilly areas of Shaoxin, Jin Hua, and Hangzhou. However, this development suffered a major setback during the 1960s to the mid1970s when planting systems were reformed and highly toxic pesticides were used. The area devoted to rice-fish culture decreased drastically, but began to increase slowly by the end of the 1970s as improved breeds of rice and less toxic, but effective, pesticides were introduced. In the 1980s, more farmers became interested in rice-fish culture as the government encouraged its adoption and introduced a family contract system in rural areas.

In 1983, the office of the Central Committee of Patriotic Hygiene in Xinxiang City, Henan Province, held a meeting about controlling mosquitoes in ricefields. They decided to promote and disseminate information about rice-fish culture and to advance its development.

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<sup>8</sup> Soil and Fertilizer Institute, Zhejiang Academy of Agricultural Sciences, Hangzhou, Zhejiang Province.

The first national meeting on rice-fish culture was held by the Ministry of Agriculture, Husbandry and Fishery in Wenjiang County, Sichuan Province, in August 1983. Similar meetings followed in provinces, cities, and autonomous regions. Rice-fish culture in China began a new period of rapid development. The total area of rice-fish culture increased 65% between 1983 and 1984. In Zhejiang Province, the total area<sup>9</sup> was 18 127 ha in 1984, a 36% increase from the 12 353 ha in 1983.

In 1984, the Bureau of Aquatic Products of the Ministry of Agriculture, Husbandry and Fishery organized and launched a project "Extending the Techniques for Fish-Raising in Ricefields" in 17 provinces, cities, and autonomous regions. The total area for rice-fish culture in the country increased to 846 700 ha in 1985 and to 985 300 ha in 1986 and had a positive effects on the economy, society, and ecology. The project received the first grade award for advanced scientific technology from the Ministry of Agriculture, Husbandry and Fishery in 1986.

Rice-fish culture has now developed and been adopted in the southeast and southwest mountainous areas and the plains, and the northeast and northwest regions. It is practiced in the ricefields of Sichuan, Hunan, Guizhou, Chongqing, Guangxi, Jiangxi, Anhui, Fujian, Zhejiang, Jiangsu, Yunnan, Guangdong, Henan, Shaanxi, Hebei, Xingjiang, Liaoning, Helongjiang, Beijing, and Shanghai.

### Research on Rice-Fish Culture

Since 1949, the main research areas in rice-fish culture have been:

- The relationship between rice and fish and ways to increase rice production using rice-fish culture;
- The different forms of the ricefield that can be used for rice-fish culture (plain, ditches, pits, wide ditches, and ridges);
- Suitable breeds of fish (i.e., grass carp, common carp, crucian carp, murrel, and mud loach). A few silver carp and bighead carp can be raised together with these fishes in ricefields with wide ditches. The raising of grass carp is the most effective way to clear up weeds and pests. Adult grass carp grow quickly in ricefields; therefore, fish yields and economic returns are increased. Techniques to prevent grass carps from injuring the rice plants must be used;
- Comprehensive techniques to improve harvests from rice-azolla-fish systems;
- Economic evaluations;

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<sup>9</sup> In some cases the areas differ from the summaries presented in Tables 1 and 2 of the previous paper by Cai et al. The editors have retained the figures presented by the individual authors.



- Suitable pesticides, their safe dosage, and methods of use, and the residual effects of methamidophos, carbofuran, and insect-paste in the rice-azolla-fish system;
- The control of mosquitoes in ricefields using fish-raising, and the development of the rural economy;
- Comprehensive techniques to efficiently manage agriculture, animal husbandry, and fisheries;
- The rates of absorption, transfer, and application of N and P, and the use of azolla by fish; and
- Feasibility studies.

### **Types of Rice-Fish Culture**

There are two ways to combine rice and fish:

- Rice and fish together. Planting rice while raising fish is the main method used. The method makes full use of time, space, energy, and resources of the ricefield and provides economic benefits. Its shortcoming is the rather high requirement for labour and management.
- Rice and fish in rotation. Planting rice and raising fish are carried on alternately; therefore, the contradictions between growing rice and raising fish are avoided. After the rice is harvested, fish are raised in deepwater fields, which can improve fish yields. The disadvantages are that the growing period for the fish is shortened, and that the mutually beneficial and efficient relationship of rice-fish culture is lost. In regions with two rice harvests, the rotation of rice and fish will reduce rice yields.

The main methods of the rice and fish rotation are:

- early rice - late fish;
- early fish - late rice;
- after the harvest of one rice crop, fish are raised in deep water;
- fish are raised in clean summer fields for 1.5-2 months after the harvest of early rice and before the late rice is transplanted;
- fish are raised for 120-130 days in clean winter deepwater fields after the annual harvest of late rice (the fish are caught the following year before the early rice is transplanted); and
- in the same ricefield, two harvests of fish are raised and two crops of rice are planted during the same year (i.e., early rice - raising fish in summer, and late rice - raising fish in winter). In Guangdong Province, summer fish are raised for 40-50 days, winter fish for 80-100 days.

### **Yields and Techniques**

Fish yields in ricefields have been low. The average yield of fish per hectare from 1982 to 1987 was 70.5, 82.5, 100.5, 126, 141, and 133.5 kg, respectively. New techniques and high-yield demonstration plots all over the country have led to increased fish yields. However, average yields in large areas of the country are still low. Traditional techniques of rice-fish culture are still used in most parts of China.

The reasons for low yields of fish from ricefields are:

- Low water volume and little shelter. Traditionally, ricefields used to raise fish do not have ditches or pits. The low volume of water in these ricefields results in insufficient dissolved oxygen and few plankton, high water temperature in summer, and few places for the fish to hide from predators. The density of the fish, the rate of catching, and yields are limited.
- Inbreeding of fish and genetic degeneration. Carp are raised in most ricefields in China. For example, Tian carp are popular in south Zhejiang, West Hunan, and Sichuan, Gao Bei carp and Jin carp are popular in the mountainous area of Guizhou, "Hehua" carp are popular in northern Guangxi. These breeds of carp have mild characteristics and do not jump well; therefore, they cannot escape easily. They are suitable for raising in ricefields. However, because of prolonged inbreeding, the breed characters have degenerated and the fish grow slowly.
- Small fish breeds. The old regions of rice-fish culture use the traditional method in which small fish are raised and, in some regions, fingerlings are stocked directly into the field. This has led to slow growth of fish and low survival rates.
- Insufficient feed. Artificial feed is not used in the traditional method. However, there is insufficient natural feed in ricefields, especially in mountainous areas. The weeds decrease as the fish grow; therefore, the fish do not get a sufficient supply of weeds during the middle and late growing stages of the rice.
- Low density of fish. For breeding, 10 500–22 500 summer fingerlings are raised per hectare. For food, 1 500–7 500 summer fingerlings and 750–1 200 spring fingerlings are raised per hectare.
- Late stocking, early harvest, and short growing periods. Fingerlings are usually stocked a week after the rice seedlings are transplanted and the fish are caught during the rice harvest. The period for the rice and fish to grow together is short — about 90 days in regions with one rice crop and 160–180 days in regions with two rice crops. In southern China, 240 days (Jiangsu) and 330 days (Guadong) are considered suitable.
- Once raising and once catching. The fish carrying capacity in ricefields changes during the growing period. Early in the season, the field has many weeds and the fish are small; therefore, the

natural feed is sufficient. Later, when the fish are larger, there are fewer weeds. The resources in the field no longer match the density of the fish.

- Small-scale production. The farmers consider the fish a by-product; therefore, the area used to raise fish in ricefields is small and scattered.

### **The Rise of Modern Rice-Fish Culture**

Traditional rice-fish culture is no longer suited to the country's social development, and it hampers the extension of modern methods of rice-fish culture. In the 1980s, several reforms were made:

- The layout of the ricefields used to raise fish was improved. The traditional plan was changed to include ditches, wide ditches, pits, and ridges. The volume of water was increased to improve the environment for the fish.
- Several breeds of fish are now used instead of a single breed. Fish (e.g., grass carp, common carp, Nile tilapia, silver carp, variegated carp, and crucian carp) were selected to suit local conditions.
- Fish size was increased. Fingerlings 10-cm or larger are now used instead of fingerlings 6-8 cm in length.
- Stocking density of the fish was increased. Depending on the fertility of the soil and feed supply, 4 500-6 000 adult fish from the previous year and 3 000-4 000 summer fingerlings are raised per hectare. The numbers can be increased if conditions are improved.
- Shifting from late stocking - early harvest to early stocking - late harvest. Because the ditch, pit (pool), and ridge systems have permanent fish pits, fish-raising can begin in the winter. Fish are now raised continuously after the harvest of late rice in deep-water ricefields. If crops are planted in winter for spring harvest, fish are caught 2 weeks before wheat or rapeseed are planted.
- Feed or the rice-azolla-fish method are used instead of not feeding the fish.
- One-time raising and one-time catching were changed to alternative catching and raising.

The new techniques have improved average yields to 750-3 000 kg of fish per hectare while increasing rice production. The highest fish yield reached 5 500 kg/ha in two-crop ricefields in Zhejiang. These new approaches have helped to modernize the traditional methods of rice-fish culture in China.

### **Prospects for Rice-Fish Culture**

#### **Potential**

Because of the country's large population and limited agricultural land, agriculture in China is moving toward intensification. Rice-fish culture is part of this

intensification. It is an effective way to increase the productivity of ricefields by harvesting both rice and fish. It is the quickest method to increase the economic efficiency of the ricefield and to help farmers increase their income.

There are about 25 million ha of ricefields in China. If 30%<sup>10</sup> were to be used to raise fish, about 7.5 million ha would be available for rice-fish culture. If 600 kg of rice and 375 kg of fish were harvested per hectare, this would increase the country's production to 45 billion kg of rice and 28 billion kg of fish. Less than 1 million ha of land, or 3.9% of the total area of ricefields, are now devoted to rice-fish culture. Therefore, there is great potential to develop rice-fish culture.

The rapid development of township industries has improved the skills of farmers. The development of family farms has prepared favourable conditions for the large-scale management of rice-fish culture using advanced scientific techniques. A modern and effective rice-fish industry will alter traditional concepts about rice-fish culture and encourage more farmers to raise rice and fish together.

### **Factors Limiting Development**

- Fish can only be raised in ricefields with sufficient water resources and good irrigation and drainage. Poor water resources, drought, serious leakage, and poor water-holding capacity of the soil make rice-fish culture difficult in north China; whereas, south China is rainy and flood-prone.
- Higher economic efficiency can be achieved in township industries and trade businesses than in areas that practice traditional methods of rice-fish culture.
- The family-contracted fields are scattered and on a small-scale. Advanced and scientific methods of rice-fish culture are difficult for farmers to adopt without further land consolidation.
- Support systems for rice-fish culture are inadequate. It is very difficult for farmers to obtain loans, new and improved fish breeds, feed, fertilizer, and pesticides. There are also few technicians available to instruct farmers. Therefore, the breed characters of some carps that are popular with farmers degenerate and as a result the fish grow slowly.
- For a long time, traditional techniques have hindered the development of rice-fish culture because they prevent farmers from accepting and grasping modern techniques. Farmers worry that fish pits and ditches will affect grain yield. These ideas hamper the extension of rice-fish culture.

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<sup>10</sup> Different authors suggest various levels for potential expansion of rice-fish culture in China. The estimates in this paper are probably overly optimistic because only about 25% of the rice area is suitable for rice-fish culture.

### **Strategies for the Development of Rice-Fish Culture**

Rice-fish culture must be given as much attention as the production of food grains, and should be seen as a way to develop grain production and to improve the economic conditions of farmers. Several tactics can be used to improve rice-fish culture:

- The efficiency of rice-fish culture, and the area devoted to rice-fish culture in traditional regions, should be increased through technical training and increased funding.
- Testing sites should be established in plain areas and modern techniques should be extended to farmers to increase yields of rice and fish, and to spark interest in rice-fish culture in these high-production rice areas.
- Rice-fish culture should be extended to large farm families who mainly grow rice. The technology could help improve their livelihood and become pioneers in the large-scale development and efficient management of rice-fish culture in the country.
- Agricultural and aquatic products units should be merged to coordinate research and improve extension of practical techniques for rice-fish culture. The basic theories of rice-fish culture and techniques for good harvests of both rice and fish must be studied.