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RICE–FISH CULTURE *in* CHINA

EDITED BY
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INTERNATIONAL DEVELOPMENT RESEARCH CENTRE

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Rice-Fish Culture in China: The Past, Present, and Future[1]

Cai Renkui,[2] Ni Dashu,[3] and Wang Jianguo[3]

The combination of rice and fish has a long history in China. The practice of rice-fish farming may have evolved from pond culture. The canon for fish culture written by Fan Li about 400 BC states:

> *... dig six mu of land into a pond ... put 2 000 fry into the pond ... sell the rest in the market.*

In a good year with ample rainfall and moderate weather, 2 000 carp fry could produce numerous eggs. Some wise farmers may have placed excess fry in their ricefields. The fish in the ricefields may have grown better than those in the ponds, and the practice of raising fish in ricefields was born. There are no records of when the practice started, but this seems to be a logical explanation of how rice-fish farming began in China.

The archeological and written records do suggests the rice-fish culture is almost 2000 years old. In 1964-1965, tombs of the mid-Eastern Han Dynasty (25-220 AD) were excavated in the suburbs of Hanzhong County, Shanxi Province. Two clay models were unearthed: a model of a pond and a model of a ricefield. The pond model contained 15 miniature pieces (6 common carp, 1 soft-shell turtle, 3 frogs, and 5 water chestnuts). In 1977, a stone carving of a pond and ricefield model was discovered in the brick tomb of the Eastern Han Dynasty in Emei County, Sichuan Province. Half the stone was carved into a pond with frogs, fish, and ducks. The other half was carved into a ricefield with an inlet and outlet, two farmers toiling on one side, and two heaps of manure on the other. In 1978, four mid-Han Dynasty tombs with 200 relics were excavated in Mian County, Shanxi Province. One of the intact relics was a ricefield model containing 18 pottery miniatures of aquatic plants and animals. In it were sculptured frogs, eels, spiral shells, crucian carp, grass carp, common carp, and turtles. Another of a winter ricefield showed farmland with a reservoir that also contained these fish.

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[1] This paper is a combination of two papers: The History of Rice-Fish Culture in China by Cai Renkui and The Past, Present, and Future of Rice-Fish Farming in China by Ni Dashu and Wang Jianguo.

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These relics suggest that at least 1 700 years ago, rice-fish culture was practiced in the vicinity of Hanzhong and Mian Counties in Shanxi Province, and in Emei County in Sichuan Province. The fish species stocked in the ricefields were common carp (*Cyprinus carpio)*, crucian carp (*Carassius auratus*), grass carp (*Ctenopharyngodon idellus*), and silver carp (*Hypophthalmichthys molitrix*). The bamboo fish trap and sluice gate that were installed at the inlet and outlet indicate that a primitive model of rice-fish culture existed at that time.

The earliest written record of rice-fish culture is from *Recipes for Four Seasons*, which was written in the Wei Dynasty (220-265 AD):

> *A small fish with yellow scales and a red tail, grown in the ricefields of Pi County northeast of Chendu, Sichuan Province can be used for making sauce.*

The small fish with yellow scales and a red tail could be common carp. This indicates that common carp may have been grown in ricefields in Pi County. This record coincides with excavated relics. An alternate view[4] is that the fish referred to is a type of small carp that "came from rice paddies" but was not necessarily raised in the ricefields. It is possible that, instead of being raised by rice growers, the fish was washed into ricefields during the rainy season through flooded waterways.

Rice-fish culture probably continued to develop. The next written record is found during the latter part of the Tang Dynasty. Liu Xun (about 889-904 AD), wrote in *Wonders in Southern China*:

> *In Xin, Long, and other prefectures, land on the hillside is wasted but the flat areas near the houses are hoed into fields. When spring rains come, water collects in the fields around the houses. Grass carp fingerlings are then released into the flooded fields. One or two years later, when the fish are grown, the grass roots in the plots are all eaten. This method not only fertilizes the fields, but produces fish as well. Then, rice can be planted without weeds. This is the best way to farm.*

The districts of Xin and Long are now in the vicinity of Xinxing and Luoding Counties in Guangdong Province. This means that rotational rice-fish farming was practiced there over 1 000 years ago. The chronicle of Shunde County, Guangdong, from the Ming Dynasty (about 1573) states that:

> *The periphery of a land was trenched as a plot, called the field base.... In the plot, a pond was dug to rear fish. During the dry season, rice seedlings were transplanted to the plot. The area might be several hectares.*

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[4] The first view was expressed in the paper by Cai Renkui; whereas, the alternate view was expressed by in the paper by Ni Dashu and Wang Jianguo.

According to this chronicle, the area for rice-fish culture was expanded in Guangdong 400 years ago.

Formal research appears to have started in the 20th century. In 1935, a rice-fish culture experiment was conducted in Songjian, Jiangsu Province. The species stocked were black carp (*Mylopharyngodon piceus)*, grass carp, silver carp, bighead carp (*Aristichthys nobilis*), and common carp. During the rice-growing period, the weight of the silver carp increased 50-fold and the weight of common carp increased 20-fold. After 2 years, 20 000 fry hatched and were distributed to farmers for culture in rice paddies. Scientists provided technical assistance.

After the founding of the People's Republic of China in 1949, rice-fish culture developed quickly. In 1954, the fourth National Aquaculture Meeting proposed the development of rice-fish culture across the country. By 1959, the area of rice-fish culture had been expanded to 666 000 ha.

From early 1960s to the mid1970s, several factors, including the intensification of rice production and the large-scale application of chemical insecticides, impeded the development of rice-fish culture.[5] For example, in Guangdong Province the area of rice-fish culture dropped from 33 333 ha in the early 1950s to 320 ha in the mid1970s, and in Hunan Province the area dropped from 232 000 ha in 1958 to 5 333 ha in 1978.

Rice-Fish Farming in China Today

During the late 1970s, there were changes in rice production. Improved modern varieties of rice and less toxic chemicals were used and there were changes in the units of production. The production-contract system was implemented in rural areas starting in 1978 and this allowed individual families to become the main units of production. In addition, there was a rapid development of aquaculture, which required the production of a large amount of fry and fingerlings. This demand was partly met by fingerling production in ricefields. Research and supporting policy and development activities have also encouraged the expansion of rice-fish production.

The research established an optimum ecological system to increase rice production, economize labour, and maximize economic returns. This lead to the evolution of a theory of rice-fish mutualism that has provided the theoretical basis for rice-fish culture. The practice has now spread to all rice-growing areas in China through the adaptation of rice-fish techniques that are suitable to local agroecological conditions.

[5] The years 1965–1975 also coincided with the cultural revolution. During this period, the raising of fish was considered a bourgeois way of making money and was officially discouraged. In addition, there were severe dislocations of research and extension during this period.

A number of regional and national meetings focused attention on rice-fish culture and advanced its development. In 1983, a workshop on Fish Farming for Eradicating Mosquitoes was held in Xinxiang, Henan Province, to exchange information on eradicating mosquitoes by rearing fish in ricefields. The First National Ricefield Fish Culture Seminar was held on 11-15 August 1983 at Wenjian County, Sichuan Province, under the auspices of the Ministry of Agriculture, Animal Husbandry and Fisheries (now the Ministry of Agriculture). The seminar established a large coordination group for Eastern China to popularize rice-fish farming techniques.

The potential and actual production in Eastern China is summarized in Table 1. There are 9 million ha of ricefields in Eastern China. This accounts for one-third of the country's total rice area, and 45% of it is suitable for raising fish. Before 1982, rice-fish farming was concentrated in the mountainous areas of Jiangxi, Fujian, and Anhui and covered only 26 000 ha. The area was expanded to include the plains and, by 1986, 138 000 ha were in production and yielded an average of 183 kg of fish per hectare.

In 1983, a key research project on the economics of aquatic resources in China included a subproject on economic problems related to rice-fish culture. The scientists, who thoroughly studied the economic benefits of rice-fish culture, received the Second Science and Technology Progress Award from the Agriculture Ministry in 1988.

In 1984, the Ministry of Agriculture, Animal Husbandry and Fisheries (MAAHF), organized a project to popularize the technique of raising fish in ricefields in Sichuan, Beijing, Hebei, Shanghai, Jiangsu, Anhui, Zhejiang, Jiangxi, Fujian, Henan, Hubei, Hunan, Guangdong, Guangxi, Shaanxi, Guizhou, and Yunnan. To promote the project, a technical group of six researchers was formed to provide guidance.[6] The members of the group were: Jiang Cimao of the Aquatic Products Bureau of Sichuan Province, Ni Dashu of the Institute of Hydrobiology of the China Academy of Sciences, Yin Pizhen of the Aquatic Products Institute of Jiangxi Province, Yang Yongshuan of the Aquatic Products Bureau of Hubei Province, Yang Jintong of the Aquatic Products Bureau of Hunan Province and Xu Xushi of the Bureau of Agriculture, Animal Husbandry and Fisheries of Zhongging City. The project sought to popularize the practice on a large scale. Initial achievements won the project a first-class award for technological progress from the MAAHF in 1986.

In 1985, 17 institutes were involved in another key research project called, "Ricefields as Fish Nurseries and Fish Grow-out Systems." This project, under the auspices of the National Aquatic Products Bureau, aimed to rear hybrids of common carp, tilapia, and crucian carp *(Carassius carassius)* in ricefields and to nurture grass carp fingerlings in ricefields. Each province was requested to extend rice-fish culture in a 200 ha demonstration area. The target yield was 225-625 kg

[6] A number of the researchers in this group were present at this workshop.

Table 1. Rice-fish culture in Eastern China in 1985 and 1986.

Province or Municipality	Area of Ricefields (10^3 ha)	Suitable for Rice-Fish (10^3 ha)	Area Used for Rice-Fish (10^3 ha)		Fish Production (tonnes)		Production (kg/ha)	
			1985	1986	1985	1986	1985	1986
Jiangxi	2 067	1 400	52	47	9 360	8 815	180	188
Fujian	1 040	400	22	28	2 915	4 265	131	150
Anhui	1 667	667	23	34	6 500	6 630	285	195
Zhejiang	1 333	667	21	19	3 050	2 810	149	150
Jiangsu	2 400	667	11	10	2 585	2 760	237	267
Shanghai	200	200	0.8	0.2	1	11	150	450
Shandong	66	13	0.7	0.4	3	0.5	153	—
Total/ Average	8 773	4 014	131	138	24 414	25 292	183.6	183

of fish per hectare. The total demonstration area of rice-fish culture in the eight provinces south of the Yangtze River was 1 600 ha. The project sought to promote the extension of rice-fish culture in the country to cover a total area of 800 000 ha.

There was also an increase in rice-fish culture in Northern China. In 1985, the Aquatic Products Section of the Water Resources Committee of the city of Urumqi in the Xinjiang Uygur Autonomous region in Northwest China, carried out an experiment on rearing fish varieties in ricefields in the northern suburbs of Urumqi. They put 1 977 fingerlings in two batches (10 and 2-3 cm in length) into a 0.4-ha experimental field. After 68 and 87 days, they harvested 174 kg of fish per hectare. The largest fish weighed 0.25 kg and the average weight was 0.11 kg. Rice output was 9 292.5 kg/ha, 18% more than in 1983. Net profit was CNY1916/ha.

From 1984 to 1985, the Rice Institute of the Agricultural Reclamation Academy in Heilongjiang Province, Northeast China, conducted experiments on rice-fish farming in high, cold areas. Rice yields increased by 7.2-12.1%, and the survival rate of fingerlings to harvest was 71.3-88.9%. The net value of the output increased by CNY656-950/ha. Grass carp averaged 0.2 kg in weight; common carp averaged 0.15 kg. Meanwhile, in Huanren County, Liaoning Province, another rice-fish culture experiment stocked grass carp and common carp as major species and tilapia as minor species in a 0.1-ha ricefield. They harvested 85.8 kg of fish and rice yields increased by 7.3-8.4%.

In 1985, Changchun City in Northeast China's Jilin Province raised common carp fry during the summer in 4.3 ha of ricefields. They harvested 35 000 fingerlings that measured 10–15 cm in length and weighed a total of 875.5 kg. The ricefields yielded 279 kg of fish per hectare. The current situation (1986) of rice-fish production in China is summarized in Table 2. There are almost 1 million ha of rice-fish culture in China in 15 provinces and three municipalities (Beijing, Shanghai, and Zhongging). In addition, experimental culture is being carried out in the northern provinces of Jilin, Liaoning, and Heilongjiang and in the Xinjiang Uygur Autonomous Region. Rice-fish culture is now practiced from southern Guangdong and Guangxi at 22°N to Beijing at 40°N, and experimental activities as far north as Heilongjiang Province (45°N).

The Development of Rice-Fish Culture Techniques

Concept and Significance of Rice-Fish Farming

The new concept of "mutualism" in raising fish in ricefields is entirely different from the traditional purpose and nature of rice-fish culture. The mutualism concept is to improve rice production by letting herbivorous fish eliminate weeds that compete with rice plants for sunshine, fertilizer, and space. At the same time, fish in ricefields feed on weeds, plankton, and benthos, and form an optimum ecological system that benefits both the fish and the rice. Traditionally, the idea was simply to raise fish with rice as an additional source of food. Now the concept includes the mutualism of both crops and has indeed become an effective way to boost rice yields. There are two basic forms of rice-fish farming: (1) rotating rice and fish, and (2) growing fish and rice together. Rice-fish rotation involves growing rice one season and raising fish the next. This method has been extensively adopted in winter ricefields, in fields that need to conserve water, and in low-lying areas in Sichuan Province. The fish raised in these fields are mainly adult or large fish.

The new concept of rice-fish farming combines the otherwise contradictory principles of growing rice and farming fish. By making full use of the mutual benefits of both rice and fish, the new concept provides a modern biological technique to invigorate agriculture in China. The emphasis is on growing rice and the role of the fish is to enhance the growth of the rice plants. But, the ultimate goal is to increase the production of both rice and fish in rice-growing areas. There are many advantages of growing fish with rice:

- The fish increase rice yields by more than 10%;
- A 0.07-ha ricefield can yield 300 fingerlings each measuring 10–16.5 cm. When table fish are reared, 150–450 kg/ha can be harvested. In rice-fish rotation, more than 50 kg of fish can be caught from 0.07 ha of surface water;
- The fish feed on weeds and worms, and loosening up the soil. This helps reduce labour requirements and is one of the outstanding benefits of raising fish in ricefields;

Table 2. The area (ha) of rice-fish culture in China (1981-1986).

Province or Municipality	1981	1982	1983	1984	1985	1986
Beijing	—	—	1	21	7	7
Hebei	—	—	—	15	15	100
Shanghai	—	—	1	23	83	23
Jiangsu	—	—	26	3 133	10 886	14 000
Anhui	—	—	2 666	10 000	22 666	34 000
Zhejiang	—	—	13 353	17 733	26 486	18 733
Jiangxi	3 333	16 666	18 666	37 800	52 000	47 000
Fujian	—	—	14 666	19 113	22 353	28 433
Henan	—	—	—	20	8 766	6 666
Hubei	1 000	2 333	3 333	13 333	28 133	21 653
Hunan	—	79 666	112 613	167 100	188 746	227 000
Guangdong	—	4 333	4 000	5 300	8 120	13 333
Guangxi	20 000	35 333	31 853	34 546	45 520	54 200
Shanxi	—	—	140	727	1 506	5 700
Sichuan	—	156 666	192 473	241 393	282 186	333 333
Zhongging	—	—	54 000	68 666	78 000	80 000
Guizhou	94 666	100 666	106 666	100 000	66 920	87 333
Yunnan	—	—	8 540	11 560	10 580	14 000
Total	120 980	397 645	564 980	732 467	854 958	987 500

- The fish (especially grass carp) conserve and enrich the fertility of the water and soil and therefore stimulate the growth of rice plants and increase grain yields;
- The fish eliminate some insect and disease pests of rice, and in addition eat mosquito larvae, which are pests to both animals and people, and thus help to reduce the incidence of meningitis, malaria, and filariasis.

Rice-fish farming is closely integrated with freshwater fish farming in China, especially in ponds, reservoirs, lakes, and family ponds. Freshwater aquaculture requires increased quantities of fry. The demand for fry cannot be met by relying on stock fish farms or by expanding stock fishponds.

The use of ricefields to grow fingerlings has allowed the demand to be met. If the area for rice-fish farming in China was expanded by 6.7 million ha, rice production would increase by more than 2 million tonnes and 30-50 billion fingerlings would be produced. This would also help increase the annual harvest of freshwater fish.

Fish Species Stocked in Ricefields

In ancient times, the fish species stocked in ricefields were: common carp, crucian carp, grass carp, silver carp and bighead carp. In the 1950s, the species used were: black carp (*Mylopharyngodon piceus*), Chinese bream (*Megalobrama amblycephala*), tilapia (*Oreochromis mossambicus* and *O. niloticus)*, mud carp (*Cirrhina molitorella)* in the south, loach (*Misgurnus anguillicaudatus* and *Xenocypris argentea)* in Guangxi and Hunan, and snakehead *(Ophiocephalus argus)* in Guangdong.

In the 1960s and 1970s, rainbow trout (*Salmo gairdneri)* were introduced in the north, and catfish *(Clarius leather)* in the south. In the 1980s, the new species used were: carp (*Carassius auratus)*, aquatic crab (*Eriocheir sinensis)*; shrimp (*Macrobrachium nipponensis),* American snail, pearly clam, and field snail.

Increased Rice Yields After Fish Culture

There is considerable evidence that fish increase the yield of rice. Table 3 summarizes the information from a number of experiments throughout China. All experiments show an increase in rice yield of 2-34% (average of 11.8%).

Chemical Insecticides Applied to Ricefields

There are over 50 pests and 10 diseases that attack rice. The major pests are: yellow stemborer (*Tryporyza incertulas* and *Chilo simplex*), green rice leafhopper (*Nephatettix apicalis)*, rice plant skipper (*Parana guttatus)*, and rice blast (*Piricularia oryzae)*, which is the most serious disease. Secondary pests and diseases are: snout beetle (*Echinocnemus squameus*), rice leafroller (*Cnapholocrosis medinalis*), yellow-legged lema (*Lama flavipes*), locust (*Oxya chinensis*), and brown spot (*Cochliobolus miyabeanus).*

In the early 1970s, chemical insecticides toxic to fish gained widespread use. Some of these were 666, DDT, and limestone powder. Later, less toxic chemicals (Roxin, Dipterex, Kitazine, and Fenitrothion) were produced. Methods of application were improved to minimize damage to fish and to achieve the maximum effect of the chemicals. For example, the water level in the ricefields was increased before the chemicals were applied. Powdered chemicals were applied

Table 3. Increase in rice production in rice-fish culture.

Experimental Unit	Increase (%)	Year
Guiping, Guangxi	3.6–11	1957
Gaoxi, Lingling, Hunan Institute of Hydrobiology	4.8–13.4	1958
Hubei Agriculture Research Institute and Wuhan Fisheries Research Institute	9315	9051
Guangxi Aquatic Products Experimental Station	8614.5	8697
Fujian Fisheries Research Institute Freshwater Branch	4.6	1965
Southwestern Normal College and Qingshen Hydroelectric Bureau, Sichuan Province	13.6	1976
Zhulou, Yuanyang Counties, Hunan	15	1976
Wenjia, Chendu, Sichuan	4.1–8	1976–1977
Shatou, Fanyu Counties, Guangdong	6–8	1978
Institute of Hydrobiology and Changsha Agriculture Modernization Research Institute, Academia Sinica	19.7	1979
Heyan, Taoyuan, Hunan	34	1981
Qing-guda Lake, Urumqi, Xinjiang	18	1984
Huanren County Broodstock Fish Farm, Liaoning	7.3–8.4	1984
Heilongjiang Academy of Agriculture Reclamation Science, Heilongjiang	7.2–12.1	1984–1985

when the plants were covered in dew, and spray chemicals were applied when there was no dew. In some areas, fish were driven to trenches or sumps before the chemicals were applied. Insecticides were also applied in instalments or in patches. Table 4 shows the current dosages of chemicals that are used.

Development of Rice-Fish Culture

Ricefields can be used as fish nurseries or to produce fish for food. In fingerling production, either 450 000–600 000 eggs/ha or 300 000 fry/ha of common carp are stocked early in the season. By the summer, the fingerlings are ready for harvest. To nurture large-sized fingerlings, the stocking density should be 15 000–22 500/ha. If grass carp is the dominant species, 12 000–15 000 grass carp should be stocked per hectare with 3 000–4 500 silver carp and bighead carp and 4 500–6 000 common carp and bream.

Table 4. Dosages of chemicals applied in ricefields.

Chemicals	Common (g/ha)	Maximum (g/ha)
Dipterex	1 500	2 250
DDV	750	1 500
Fenitrothion	1 125	1 500
Calcium methyl arsenate	3 000	3 750
Kitazine	1 500	2 250
Methamidophos	750	1 500
Roxion	50	100
Chlordimeform	3 000	3 750
Jiangangmycin	2 250	—
Farmon condex	15 000	18 750

In Shanxi Province, rainbow trout was cultured in winter fallows by using slightly running waters. Fish production was very high (30 t/ha). Rice-fish culture has been practiced, not only in shallow-water ricefields, but also in deepwater rice fields and in fields of wild rice (*Zizania* spp). In brackishwater along coastal reclamation areas, a rotational system is used. One crop of rice is grown one year, mullet *(Mugil so-iuy)* is cultured the next.

During the 1980s, several new developments occurred:

- Ridge rice planting - ditch fish farming system. This system is suitable for water-logged ricefields. The system involves a series of ridges and ditch in the ricefield. The rice is grown on top of the ridges and the fish in the ditch. The width of the ridge and the ditch is 40 cm, the height of the ridge is 80 cm, and water depth is 50 cm.[7]
- Rice-azolla-fish system. Rice is planted in the fields, azolla is cultured on the surface of the water, fish are cultured in the water, and squash or legumes are planted on the bunds. This is a multilevel comprehensive system of resource use.
- Running water system of trench fish farming. One or two broad trenches (1-1.5 m in width and 60-90 cm in depth) are dug in a ricefield. The trenches account for about 6% of the total area of the ricefield, and fish are cultured in the water running through the trenches.

[7] The dimensions of the ridge-ditch system appear to vary considerably. The ridge is often only 25 cm wide and 30 cm in height.

Prospects for Rice-Fish Farming in China

China has 25 million ha of ricefields, and over 90% of this area is south of the Huai He River Basin. Although the practice has achieved excellent results in terms of scale and economic return, its potential to meet the needs of modern development remains untapped. If 10% of the ricefields south of the Huai He River were used (half for commercial fish and half for stocking fish), the commercial fish yields could be 346 000 tonnes (assuming 300 kg/ha) and the number of full-size fingerlings would be 5 billion (assuming 4 500/ha). The area north of the Huai He River is not as suitable for rice-fish culture, but if 5% of the rice fields become rice-fish systems, they would produce 8 000 tonnes of commercial fish and 243 million fingerlings. The total increase in rice output would be one million tonnes annually on the basis of the 1981 output (if annual increase is calculated at 10%) and commercial fish yields would reach 354 000 tonnes and 5.7 billion fingerlings. The number of fingerlings raised in ricefields would be sufficient to stock 0.75 million ha of water (e.g., ponds and reservoirs). The achievement of these goals would have very large ecological and economic benefits.

If fish farms were used to raise fry, ricefields were to be used to raise full-sized species, and ponds, reservoirs, and lakes were used to raise adult fish, fish farming would undergo considerable change. Fujian Province reported that, if ricefields are used to rear fingerlings, 200 ha of stock fishponds would be freed for intensive farming of commercial fish, and labour and feed, which would otherwise be used for breeding fingerlings, could be used for commercial fish farming. Jiangsu Province reported that, in 1986, Jianhu County used 4 700 ha of ricefields to raise fish. Three major stock fish farms supplied enough fry to meet the need for big-sized stock fish for 2 000 ha of intensive fish farming in the county. This indicates that the output of freshwater fish could be increased considerably.

Rice-fish farming has the potential to fully maximize the use of ricefields. Present trends for popularizing the practice are encouraging, and the area used to grow rice with fish is increasing yearly. In the past, the development of China's aquatic products has been slow, quality has been poor, and supply was often short. There have also been policy problems that remain unsolved. As the internal structures of agriculture are adjusted, various localities are becoming aware that rice-fish farming is an effective way to increase rice production and improve economic, social, and ecological conditions.

Since the national conference on rice-fish farming in 1983, various provinces, autonomous regions, and municipalities have undertaken measures to popularize the practice in line with local conditions. The Science Commission and Aquatic Products Department of Fujian Province organized several research projects. They achieved success by strengthening their leadership and by coordinating technical forces. East China's coordinating group met once a year to summarize work experiences and coordinate actions. Representatives from various provinces visited advanced units to draw on their experiences and to increase the awareness of leaders from different areas about the significance of rice-fish farming. They held

meetings to discuss the practice and conducted training courses to expand the area of ricefields for fish farming.

Rice-fish farming should be combined with intensive fish farming in ponds, reservoirs, lakes, and cages to ensure that more fingerlings can be raised in ricefields. Recently, a national symposium called for the rapid development of ecological agriculture to improve productivity. Ecological agriculture has received increased attention in recent years, and the structure for agricultural production has been improved significantly. Undue emphasis used to be placed on plant culture; however, attention has now shifted to the comprehensive development of farming, forestry, animal husbandry, and fisheries. Instead of focusing only on economic results, both economic and ecological benefits are now considered. In the past, single items of technology were emphasized. Today, due attention is given to the comprehensive application of technical packages.

Rice-fish mutualism offers a model of ecological agriculture. However, fish farming has not yet been closely integrated with crop cultivation and the division of labour has not been clear; therefore, development and popularization have been slow. The production of both rice and fish can be maximized if agricultural researchers pay more attention to rice-fish farming and help hasten its development. It is imperative to integrate fish farming with crop cultivation. If the area for rice-fish farming was increased to 6.7 million ha as the area devoted to rice is increased, the supply of freshwater fish could be quadrupled.

Rice-fish farming can play an increasingly important role in freshwater fish farming if the nation's leaders give it due attention, if the technology is sound, and if the practice is carefully adapted to local conditions.