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RICE–FISH CULTURE *in* CHINA

EDITED BY
Kenneth T. MacKay

INTERNATIONAL DEVELOPMENT RESEARCH CENTRE

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Different Methods of Rice-Fish Farming

Nie Dashu and Wang Jianguo[22]

Many methods of rice-fish farming have been developed in China. Although they involve various production systems, these different methods are inseparable and interlinked. The common aim is to boost rice production by eliminating weeds and pests. Many different types of rotation are practiced.

Rice-Fish Mutualism

Early, middle, and late rice are planted continuously without interruption. Two kinds of fry (fingerlings and summer fry) are released directly into the flooded ricefields. Specific practices include raising fingerlings in flooded ricefields, raising fish in ricefields and in nearby ponds, planting rice on the ridges while raising fish in the furrows, and raising fish in ricefields in which channels have been dug.

Breeding Fry in Ricefields

To reduce the cost of summer fry, a model has been devised that involves releasing fry directly into early flooded ricefields. Grass carp (*Ctenopharyngodon idella*) fry are generally used, and because feed is not needed, the method is economical.

After middle rice is planted, 1 000 fry, 3.3-5 cm in length, can be harvested from the early ricefields. Because costs are kept to a minimum, it is easy to popularize the method in areas with large expanses of water. The early rice planting season (late April) in Hunan, Jiangxi, Anhui, Jiangsu, and Zhejiang coincides with the production of common carp (*Cyprinus carpio*) fry. Therefore, after the rice seedlings have been transplanted, the ditches dug, and the screens installed, *C. carpio* fry can be released into the ricefield. The fry are too small to uproot the seedlings and because this is the peak period for plankton, fry growth is enhanced. It is best to release the fry as early as possible to take full advantage of this peak in plankton growth. If the artificial hatching of fry is delayed, the application of base manure and the transplanting of early rice should also be delayed to maximize the mutual benefits that can be achieved.

At present, large fish-fry breeding farms have advanced the season of fry hatching to late April and the rice growers on these farms delay the transplanting of rice seedlings. But the practice has not gained much popularity. Additional effort is needed to disseminate the idea and launch demonstration projects. For every

[22] Institute of Hydrobiology, Academia Sinica, Wuhan, Hubei Province.

hectare of ricefield, 45 000 artificially hatched fry are needed. Along the Yangtze and Zhujiang Rivers, where people catch river fry, it is better to put these fry into early ricefields because it makes it easier to regenerate fish of the same family. Stocking fry, which have just begun to eat, into early ricefields 3–4 days after the rice is transplanted offers many advantages. It eliminates the need to buy summer fry, means that ponds are not needed for summer fry, and maximizes the mutual benefits of growing rice and fish together. It is an economical, practical method that yields better and faster results.

Ctenopharyngodon idella, with its ability to eliminate weeds and worms, can help increase rice output and reduce the need for labour. However, in areas with few ponds or banks, other fish species *(e.g., C. carpio*, crucian carp, and tilapia) can be raised. Even in ricefields overgrown with weeds, it is feasible to grow *C. idella* along with some *C. carpio* and *C. auratus*.

When this method is adopted, the banks of the fields must be raised 50–70 cm and strengthened before the fry are released into the field. Lime is applied (375–750 kg/ha) to kill leeches, eels, and other natural enemies of the fish. Six to eight days later, water is channelled into the field and base manure is applied. The field is raked level, and the rice seedlings are transplanted. Fish canals and ditches (30 cm wide and 30 cm deep). Where the canals cross, a fish ditch 100 cm long, 70 cm wide, and 80–100 cm deep is dug. Rice seedlings in the canals should be transplanted to the edges of the field to from a fence. Screens, each 100 cm wide and 80–90 cm tall, should be installed in the water inlet and outlet. Each screen should be arch-shaped with thin bamboo strips placed 0.2 cm apart. Fry may then be released into the field. Field management should be strengthened. Before the rice ripens and all the weeds are eaten by the fish, the canals and ditches are opened and the water is drained slowly to force the fish to gather in the canals. The fish are then driven into the ditch where they are netted.

This is the best method for raising fingerlings. In Sanming City, Fujian Province, the area of ricefields for raising fingerlings increased in 1982–1984, from 270 ha to more than 670 ha, and the number of fingerlings raised increased from 2 to 8 million (62% of the fingerlings raised in the entire city). In addition, rice output increased by 6–17 %.

The catch of adult *C. idella* from fishponds has remained low. Because they are unable to adapt to the environment in fishponds, the fish easily become ill. Usually only 20–30% survive. In ricefields, on the other hand, the ecological environment is suitable for *C. idella*, and few, if any, become ill. This is why the output of freshwater fish can be doubled.

Rice, Fish, and Azolla

In this method, the raising *of C. idella* or tilapia in ricefields is organically combined with the growing of azolla. Rice is grown in the field, azolla on the surface of the water, and fish in the water. Fish feed on the azolla, and the field is fertilized by fish excrement. Melons and beans can also be planted on the banks

of the field to form a vertical cultivation system. Instead of the conventional equal-distance planting method, rice growers use wide and narrow rows. They raise azolla and fish in the wide rows and plant rice in the narrow rows. This keeps the field well ventilated and maximizes the use of sunshine and the effects of edge rows. As a result, it ensures stable and high yields of rice and fish, good economic returns, social benefits, and ecological efficiency.

This research was sponsored in recent years by Liu Zhongzhu, President of the Fujian Academy of Agricultural Sciences. After 3 years of experimentation, the method is now widely applied in Jianning County, Fujian Province. In 1986, the county devoted 6 670 ha or 46% of its ricefields to this method of farming. The method generates additional income of CNY2 250–2 700/ha of rice planted, and rice output can be increased by about 7%. Because there are fewer weeds and pests in the fields, there is less need to apply chemical fertilizers and pesticides, which helps reduce costs by about CNY150/ha. The county reported a total fish catch of 1.15 million kg from ricefields in 1985 and 1.5 million kg in 1986. Most of the fish were sold in the market, which added, on average, CNY20 of income per household.

Raising Fish in Ricefields with Wide Ditches

This method is used to raise winter fingerlings. Ditches, about 1-m wide and 1-m deep, are dug on the water inlet side and inside of the field bank. The total area of the ditches is about 5–10% of the area of the ricefield. The ditch ridge is raised 25 cm above field level. A 24-cm opening every 3–5 m links the ditches with the field and allows the fish to move freely from the ditches to the field. Long before the rice-transplanting season, winter fingerlings are put in the ditches so that they can enter the ricefield for food as soon as the early rice seedlings turn green. Jiangxi Province devoted 6 670–9 330 ha of ricefields to this method in 1985–1986 and reported a 20–50% increase in rice output.

Ricefield Plus Fish Farming in a Pond

In rice–fish farming, there is a time difference of about 1 month between the early rice and the hatching of summer fingerlings. The rice plants need sunlight, fertilizer, and pesticides. These conditions are not favourable for fish farming. In areas where a double rice crop is planted, the fingerlings and early rice must be harvested between the two rice crops, the field must be worked, and the late rice must be transplanted. At the same time, the ditches must be redug and fry released. Therefore, there is a need for more labour than is available. If rice–fish culture is combined with pond culture these contradictions can be eased. The method is easy to popularize.

One basic condition is that there be ditches or ponds around the ricefield. The pond should be 10–30 m^2 and about 1.5 m deep. The pond can be dug in advance and should be linked by a bank to the ricefield. It can also be used to hatch the fry. After the early rice is transplanted and the fish canal dug, the pond and ricefield are linked to let the fish in the pond swim across into the ricefield. Just before the

early rice is harvested, the fish are driven back into the pond. After the field is reworked, the second rice crop is transplanted, a ditch is dug, and the fish in the pond are allowed back into the ricefield.

In 1983 at Lingshan Village in Meichuan District, Guangji County, Hubei Province, a rice farmer named Hu Maoyu used this method on a 0.17-ha ricefield linked to a 0.02-ha natural pond. He raised fish in the ricefield for 348 days, including 117 days when rice and fish lived together (61 days for early rice and 56 days for late rice). He put in 2 143 fry and netted 1 770 fish that had a net weight increase of 216.2 kg and a harvest rate of 82.6% (Table 1). The output was 5 431 kg/ha for early rice and 4073 kg/ha for late rice, or 5.81% more than the output from fields in which fish were not raised. Average net income was CNY2 156/ha. This method is gradually gaining popularity.

Rice-on-Ridges and Fish-in-Furrows

Ridges are built in the ricefield for the rice and fish are raised in the furrows. This method was developed on the basis of a semidry cultivation method advocated by Hou Guangjun. This method improves low-yielding ricefields because it makes multiple uses of available resources. It helps increase the contact of soil and air; balances water, air, and heat to raise soil temperature; and reduces the formation of toxic matter. Soil, water, microclimate, and heat are therefore stabilized at an appropriate level. This stimulates rice to grow roots, which absorb water and nutrients and changes gravitational water in the ricefield into lateral water that rises through capillaries to moisten the rice roots. Movement of fish in the furrows moves the water in the lower strata, stimulates the solution of nutrients, and increases soil fertility. The deep furrows increase the volume of water stored in the ricefield and create more room for fish activity. Fertilizers applied in the furrows make the water fertile and increase natural feed for fish.

In 1986, 16 counties of the Southeast Miao and Tong Autonomous Prefecture of Guizhou Province popularized this farming method over 688 ha. To ensure its success, the prefecture and the country earmarked CNY100 000 for the project. Thirty six persons went on a study tour to Sichuan Province and 83 persons from the Departments of Aquatic Products and of Soil and Agricultural Technique Popularization were sent to the fields. Various districts, townships, and villages ran 21 training courses for 1 000 people. In 1985, a 4.5-ha experiment area yielded more than 10 350 kg/ha of rice and 472 kg/ha of fish.

Specifically, the method involves digging a ditch, 50-cm wide and 67-cm deep, and building ridges 70-cm wide (enough to plant 4–6 rows of rice). Mud from the ditch is spread onto the ridge and rice is transplanted without working the soil. In a 0.07-ha field, 300 5-cm fingerlings [100 *C. idella*, 75 silver carp *(Hypophthalmichthys molitirix)*, 50 bighead carp *(Aristichthys nobilis)*, and 75 *C. carpio* and *C. auratus*] are released. During the growing season, green grass is put into the ditch to feed the *C. idella*, but no other feed is provided for the other species.

Table 1. Results of rice-fish farming in ricefields and adjacent ponds in Lingshan Village, Guangji County, Hubei Province (1983).

	Number of Fish	Size (g)	Weight (kg)	Average Weight (kg)	Recovery Rate (%)
Fry released 10 January					
Ctenopharyngodon idella	161	50–150	11	—	—
Cyprinus carpio	300	50–150	32.5	—	—
Hypophthalmichthys molitrix	369	20–50	6.5	—	—
Aristichthys nobilis	13	100–350	3	—	—
Fry released 16 January					
Ctenopharyngodon idella	1 300	5.0–6.7 cm	4.8	—	—
Total	2 143		57.8		
Fish harvested 23 December					
Cyprinus carpio	271	200–500	70.5	260	90
Hypophthalmichthys molitrix	357	100–400	82.8	235	97
Aristichthys nobilis	13	300–900	7.8	600	100
Ctenopharyngodon idella	1 129	20–650	112.9	—	77
Total	1 770	—	274	—	83

Research using this high-yielding, high-efficiency semidry cultivation method in Chongqing City showed that yields of 6 750–7 450 kg/ha of rice and 705–765 kg/ha of fish could be achieved. This method has been popularized in the Mianyang and Huangbo Counties of Hubei Province, and in Hunan and Jiangxi Provinces where conditions are suitable. Good economic returns have been reported.

Rotating Rice and Fish

In this method, rice and fish are alternatively raised in one ricefield. In 1 year, only one rice crop is planted, the rest of the time is devoted to fish farming. First, rice and fish are farmed in one field. When the rice is ripe, the rice and fish are harvested and the straw is left in the field to rot. Adult fish are then released into the harvested ricefield. The method can also be applied in double-cropping areas, but the fish are only raised in winter.

Rotating Rice and Fish in Low-Lying Land

In 1982, this method was adopted on 1.3 ha of low-lying land farmed by the Luopitang Production Brigade of the Huaqiao People's Commune in Guangji County, Hubei Province. This piece of low-lying land previously grew only one late rice crop a year and remained fallow for the rest of the year. On 2 July 1982, fish ditches (50 cm wide and 27 cm deep) were dug, and the next day, rice seedlings (Gu-154) were transplanted at a distance of 11.5 x 17 cm. The field was not weeded during the entire rice-growing season and no pesticides were applied. Only 300 kg of sodium bicarbonate (232.5 g/ha) and 140 kg of urea as a top dressing (109 kg/ha) were used. The rice output was 5 530 kg, 10% more than the expected 5 000 kg, with a per-unit output of 4 298 kg/ha. On 23 July, 19 690 fingerlings [84% *C. idella*, 5% black carp *(Mylopharyngodon piceus)*, 10% *H. molitirix*, and 1% *A. nobilis*] were introduced at a rate of 115 300/ha. The fish were grown for 64 days without feed and on 24–25 September, 10 094 fish, weighing a total of 229.5 kg (176.5 kg/ha) were collected. Ten percent of the fish were 10 cm in length, 70% were 10.1–20 cm, and 20% were over 20.1 cm.

During the second rotation season, 10 787 fingerlings (vaccinated for *C. idella* bleeding) were introduced (8 385/ha). The total weight was 279 kg and the average size of the fingerlings was 15.6 cm. A small amount of fertilizer was applied after January 1983 and the rate was increased after April. During the entire rotation season, 40 kg of urea, 1 450 kg of night soil, 600 kg of vegetable cake, 3 508 kg of azolla, and 1 830 kg of green grass were applied. Because 5 500 kg of rice straw were left in the field, the total amount of fertilizer and feed was 12 928 kg.

On 26–27 June 1983, 1 689 kg of fish (average 1 300 kg/ha) were harvested. Excluding the fingerlings, the net catch was 1 095 kg/ha. The net income from fish alone was CNY2 519, or an additional CNY1 957/ha.

Raising Fish in Winter Ricefields

This rotation method makes full use of the ricefields after the late rice harvest until the middle rice is planted the following summer or the next late rice crop is planted. In some areas, fingerlings are released right after late rice is transplanted, and the fish are harvested either before the spring festival in January or February or before the next early rice crop is transplanted. This method yields a high output of fish, mostly as food. During the winter season, most ricefields store water that is overgrown with plankton and bottom organisms, especially in East Sichuan Province. This water is very suitable for fish.

In the winter of 1983, Cheng Jinghong of the Freshwater Products Institute of Fujian Province reared fish in three pieces of land covering 0.25 ha at the Andou Fry Farm, Jinjiang County, Fujian Province. On 20 November 1983, he released 57.5 kg of fingerlings (*C. idella*, *C. carpio*, *H. molitrix*, and *A. nobilis)*. On 28 March 1984, 128 days later, he collected 85 kg of fish, a net increase of 27.5 kg. The weight of *C. carpio* increased 5–8 fold (average 0.2 g/day), and the

survival rate was 89.3%. After the costs for fingerlings and feed were deducted, the net profit was CNY92 (CNY5 520/ha).

Cheng Jinghong raised the field bank by 50 cm and packed it firm after harvesting the late rice. He dug a ditch 30-cm wide and 30-cm deep along the field banks (1 m from the banks) and dug two fish ditches or pits (each covering 1 $m^{2)}$ near the water inlet. He installed screens at the inlet and outlet of the field, stored water in the field, and released the fingerlings. Fish feed consisted of peanut cake, rice husk, wheat bran, and fish powder mixed in a ratio of 8:6:5:1 with water. The mixture was spread in the ditches or put on a food platform at 14:00–15:00 each day. The total amount of feed used was 2–3% of the total weight of the fingerlings, depending on the weather and how well the fish fed.