Rice–Fish Culture in China

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Development of Rice–Fish Farming in Guizhou Province

Shi Songfa

Rice–fish farming has been practiced for over 1000 years in Guizhou. It is most popular in eastern Guizhou (bordering the provinces of Hunan and Guangxi) in areas where communities of national minorities live. The most commonly cultivated species are "Gaopo" common carp and "river" common carp. Farmers gather fish eggs from ponds, ricefields, and rivers and hatch them to get fry. Because of climatic conditions, most areas have only two crops a year with a single crop of rice. Fish are cultivated at the same time as rice. Flat fields and extensive cultivation are the norm. Normally, fields are not drained and the farmers in southeast Guizhou even cultivate fish in the winter water fields.

In 1984, the Departments of Aquatic Products, Soil and Fertilizer, and Agricultural Extension were organized to promote high-yielding techniques for rice–fish farming. A number of technical guidelines, such as the Technical Rules for Rice–Fish Farming and Technical Standards for Cultivating Fish in Ridge Box-Ditch Ricefields were published. Many demonstration plots were developed.

By 1987, there were over 3000 ha of high-yield demonstration plots (a 13-fold increase from 1984). The average yield was almost 400 kg/ha (40% more than in 1984). With these encouraging results, rice–fish farming developed rapidly. In 1980, 42 700 ha of ricefields yielded 3348 tonnes of fish, by 1983, this had increased to 60 000 ha and 4 611 tonnes of fish. In 1987, there was a 75% increase in area and a 210% increase in yield (74 700 ha and 10 400 tonnes of fish). This amounted to 57% of the total fish production of Guizhou in 1987. The unit yield also increased 78% from 1980 to 1987 and reached 139 kg/ha.

Development Trends

With popularization and technical extension, rice–fish farming has improved the ecological environment of the ricefield and is making better use of the carrying capacity of the field and achieving additional benefits from low-level inputs.

13 Aquatic Products Division, Guizhou Aquaculture Bureau, Guiyang, Guizhou Province.

14 Winter water fields are ricefields that are left fallow and collect water during the winter. Rice is transplanted to these fields in the spring. This practice is prevalent in the cooler, mountainous areas of western China, particularly in the provinces of Sichuan and Guizhou.
New Rice-Fish Farming Techniques

Flat-field techniques of rice-fish farming have been replaced by ridge-ditch ricefields (in which the fish are grown in the ditches and the rice is grown on the ridges), box-ditch fish raising, and manure-pit fish raising in flat fields. Instead of farming fish only with rice, farmers now also grow wild rice or lotus.

Fish farming in the ridge-ditch fields does not require inundated irrigation, therefore, the conditions of water, fertilizer, oxygenation, and heat are improved in the soil. This has considerable impact on the rice. It stimulates the early growth of seedlings and early emergence of tillers. The grains of rice increase in number and size, which produces higher yields. This practice also increases field-water storage, improves drought-resistance capability, and provides sufficient deep water for fish. These factors all improve fish growth and lead to higher yields.

The Scientific Association of Southeast Guizhou Prefecture, the Information Institute of Scientific Committee, and the Prefecture Agricultural Institute conducted experiments in 1986 to observe the differences between ridge-field rice and flat-field rice. They found that there were considerable changes to the soil environment that affected the growth of the rice plants. Soil temperature in ridge fields was normally 0.2–0.4°C higher than in the flat fields. Results were particularly obvious in cold, muddy fields that had low soil temperatures. Growth was faster in ridge-rice cultivation. Seedlings recovered quickly after transplanting and tillers emerged 9 days earlier than in flat fields. The activity of soil microorganisms was also enhanced, which improves the breakdown of soil nutrients and helps provide adequate nutrition for root growth. With improved vitality, rice roots grew deep into the soil and the roots were stronger. During the tillering period, rice roots in the ridge fields were 8 cm longer than that in flat fields, and on average there were 20 more roots. During the full-ear period, the roots of plants on the ridges were 13 cm longer and there were 199 more roots. Ridge-rice cultivation can also enhance the resistance of the rice plant to drought and lodging.

Experiments carried out in 1986 by the Aquatic Products Station of Chishui County revealed that ridge-rice cultivation could improve rice tillering and increase average grain weight. In these experiments, the average number of grains per ear in the ridge fields was 140–155 compared with only 105–110 in flat fields. The average weight of 1000 grains in the ridge fields was 27.5–28.4 g, compared with 26.5–27.0 g for flat fields. The empty grain rate was 26.5–28% in the ridge fields and 39–41% in the flat fields.

Additional evidence of the benefits come from farmer experiments. A farmer, Jiang Chengxu in Suiyang County, conducted a comparison trial in an area of 0.05 ha (0.025 ha for each of the two methods). In each area, he stocked 200 7-cm fingerlings. The flat field yielded 170 kg rice and 12.6 kg fish. The ridge field
yielded 200 kg rice and 34 kg fish, or an increase of 18% for rice and 172% for fish. In the Southeast Guizhou Prefecture, ridge-field cultivation required 6-8 more farmer-days of labour, but the value of production increased by 50%.

Raising of fish in box ditches and manure pits in flat fields can also create a good ecological environment for fish because pesticides are not applied and exposure to sun and drought is reduced. This system increases the potential of the ricefield and produces higher fish and rice yields. Manure pits normally only occupy 10% (or less) of the ricefield and poses no threat to rice production. Chishui and Songtao Counties have carried out rice-wild rice-fish and rice-lotus-fish experiments. Production values were CNY3 809/ha in Chishui and CNY4 170/ha in Songtao.15

**New Species**

Instead of raising only common carp, farmers now raise several fish species. The temperature of shallow water in ricefields changes with air temperature and is unstable. However, during the warm season, leaves of the rice plants shade the water surface and stabilize the water temperature. This creates a suitable environment for growing grass carp, common carp, silver carp, variegated carp, tilapia, and crucian carp.

The ricefield is an artificial ecosystem that abounds with various grasses, weeds, plankton, and other organisms. If only common carp are grown, these resources are not fully utilized and yields are not very high. In recent years, several species have been raised together and the results have been encouraging. This demonstrates that the ricefield ecosystem is suited for polyculture of fish. Normally, common carp are raised with grass carp or silver carp, grass carp with tilapia, or common carp with crucian carp and catfish. Either fry or adult grass carp can be raised.

With the appropriate number of fish, rice seedlings are not eaten by the grass carp. The fish consume grass and weeds to the benefit of rice growth. For example, 2,250–3,000 grass carp and common carp (in the ratio of 4:6 of 10-cm fish) can be raised in 1 ha without damage to seedlings. When the fish have grown to 17 cm in length and are able to eat seedlings, the rice plants are tall enough to avoid damage. If the grass carp are over 20 cm in length, 450–750 fingerlings can be put into a 1-ha ricefield. In this case, additional feed (grass) must be provided during the early stage to keep the grass carp from eating the rice seedlings. If silver carp and variegated carp are raised, their number should be limited to 5–10% of the total number of fish raised.

In Huangping County, farmer Yang Zaigui raised fish in a 0.08-ha ricefield. On 12 June 1988, he stocked 49 grass carp fingerlings (8.9 kg), 372 common carp fingerlings (18.4 kg), and two silver carp fingerlings (0.6 kg). After 105 days, he harvested 34 grass carp (31.15 kg), 356 common carp (66.9 kg), and two silver carp.15

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15 In October 1988, USD1 = CNY3.7221 and CAD1 = CNY3.1889.
carp (1.81 kg). Total net production was 73.05 kg. Yield per hectare was 906.8 kg fish and 7875 kg rice.

Species Improvement

Local common carp have been replaced with hybrid common carp. The trend is toward improved species. Local Gaopo carp has long been raised in Southeast Guizhou. It is docile, quiet, and usually does not jump. During floods, it does not panic and swim away. It hides in muddy rice water when disturbed. However, its quality is deteriorating because of poor selection of brood stock. Parent fish are so small that their offspring do not develop properly.

In 1985, the Aquatic Products Bureau of Leishan County sampled 50 Gaopo carp. The heaviest one was 350 g and the smallest 25 g. Five of the fish that weighed 25–95 g were mature. Work by the Aquatic Products Bureau of Luping County revealed that this fish is sexually mature at approximately 100 g. Results from the Aquatic Products Bureau of Guiyang City showed that 35% of the fish with an average weight of 185 g were sexually mature. This suggests that Gaopo carp have seriously deteriorated and are maturing at a small size. Since 1980, many localities like Zunyi, Chishui, Wuchuan, Zheng'an, Jinping, and Tianzhu have worked to improve carp varieties. While paying attention to the selection and improvement of local varieties, they have also introduced improved brood fish.

In 1983, the Aquatic Products Bureau of Zunyi Prefecture introduced parent fish of two common carp varieties, Yuanjiang carp and Wuyuanhese red carp. They achieved good results when they released the hybrid Heyuan carp from these two varieties. In 1988, the Aquatic Products Bureau of Luping County compared improved common carp and local common carp. Growth characteristics were evaluated by taking five samples at monthly intervals after release. Improved common carp gained 1.95 g more each day and relative growth was 1.5% higher. When the improved common carp weighed 520 g each, the local common carp weighed only 200 g (40% less).

In 1987, the entire province began the systematic improvement of common carp. In 44 variety improvement sites, 31.4 million fry and 9.8 million fingerlings of improved common carp were produced. A total of 967 ha of ricefields received this variety and results were good.

Intensive Cultivation

Intensive cultivation of fish is now replacing extensive cultivation. Extensive cultivation only uses natural feed; therefore, yields are low. In 1980, the provincial average yield of fish was 78.3 kg/ha. To achieve high yields, traditional culture systems must be replaced with intensive culture systems that make full use of the carrying capacity of the ricefield ecosystem. Farmer Lu Binlun in Danzai County conducted a comparison trial in 1985. Intensive culture yielded 1242 kg of fish per hectare or 4.6 times more than extensive cultivation (220.5 kg/ha). In 1983, farmer Liu Dingzhong of Longquan Township raised fish in a 0.32-ha ricefield using
earthworms and maggots as additional feed. He harvested 580 kg fish or 1812 kg/ha. In 1984, farmer Li Xingji in Suiyang County harvested 325.4 kg from a 0.21-ha field by using wastewater from factories.

Prospects

Guizhou Province is a subtropical area with a humid monsoon climate. It has low latitudes and high elevation. The temperature is relatively high in winter but low in summer. The yearly average temperature is between 14°C and 16°C in most areas. The temperature is above 10°C for 220–240 days a year, and 270 days are frost-free. Annually, there are about 180 rainy days, 1100 mm of rainfall, and 1200 hours of sunlight. There are many cloudy and rainy days and yearly changes in light, heat, and water are synchronized. All these conditions are conducive to growing rice and fish. The longer growth period for fish and the good overwintering conditions allow a sound farmland ecosystem can be established to increase the production of rice and fish.

Ricefields in the province cover a total area of 791,000 ha, over half (about 400,000 ha) of which are low-yielding fields. There are 122,000 ha of winter water fields. These areas are, to various degrees, poor, barren, highly acidic, sticky, sandy, muddy, and cool and therefore do not produce high yields of rice. Fish farming improves the soil and rationally uses the land to produce more rice. Fish farming is profitable and has the potential to improve the economic situation of farmers, particularly in mountainous areas.

In 1984, a survey was conducted of 20 farming households in Danzai County that covered about 1.32 ha of rice–fish farms. The output of fish and rice was valued at CNY4374/ha, 90% more than rice cultivation alone. Surveys in Danzai and other counties showed that rice–fish farming increased the output value of ricefields by CNY817.5/ha.

In the future, rice–fish farming will undoubtedly supply a large portion of the fisheries production in Guizhou, especially in mountainous areas where there are large ricefields but few ponds or reservoirs. It is important to develop rice–fish farming and to establish systems for technology extension and for the production and supply of improved varieties. Ridge-ditches, box-ditches, manure pits in flat fields, and other forms of rice–fish farming should be adopted to suit local conditions. Improvement of the common carp variety must continue. Mixed culture of species (mainly common carp and grass carp) should be practiced. Intensive cultivation should replace traditional extensive cultivation, which usually has low yields with low input. Improved fish-farming techniques should be adopted in a systematic way to make the best use of ricefield resources and to improve fish yields.