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RICE-FISH CULTURE *in* CHINA



EDITED BY
Kenneth T. MacKay

INTERNATIONAL DEVELOPMENT RESEARCH CENTRE

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Cultivating Different Breeds of Fish in Ricefields

Wang Banghuai³⁷ and Zhang Qianlong³⁸

Experiments were conducted in Shanggao, Shangyou, and Shuichuan Counties in 1985–1986 to study the adaptability of certain breeds of fish to ricefields. Experiments were carried out simultaneously in double-cropped ricefields in three separate villages. Soil fertility was poor in one village, average in one, and good in another. At each site, the experiment was replicated. The method of rice–fish culture with trenches and ponds was used at all three sites. The trenches and ponds took up 4–10% of the total area of the ricefield.

In 1985, each site had 30 ricefield plots and a total area of 1.3 ha. In 10 plots (0.05-ha each), the fish breeds were cultured separately (monoculture) and given no supplemental food. In 10 plots (0.003-ha each), the fish were cultured separately and given supplemental feed. In the final 10 plots (0.06-ha each), different polyculture mixtures of fish were given supplemental food (single replicate per trial).

The polyculture mixtures contained nile tilapia, (*Oreochromis niloticus*), grass carp (*Ctenopharyngodon idella*), silver crucian carp (*Carassius auratus*), local carp, and six other local breeds. In one trial, equal quantities of each breed was used (200 fish per breed). In the unequal mixed cultures, the main species (one of nile tilapia, grass carp, silver crucian carp, or local carp) made up 50% (1 000 fish) of the total number of fish raised. Chub and variegated carp made up 2.3% (45 fish) each, and the other seven fish species made up 6.5% (130 fish).

Culture of Different Fish Breeds

The breeds chosen for culture were fish that could grow to 3–4 cm in length in that year. Ten breeds of seven fishes were selected: nile tilapia, grass carp, silver crucian carp, local breeds of red carp (Xingguo red carp, pouch red carp, and glass red carp), shortnose catfish, chub carp, and variegated carp. The three red carps, the silver crucian carp, and the shortnose catfish were distributed by the local government; the other breeds were produced on-site. The fish were stocked before the end of May, except for nile tilapia, which were put into the ponds from late May to early June.

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Table 1. Results of monoculture of 10 fish breeds.

	Without Feeding		With Feeding		Average	
	Survival Rate (%)	Unit Yield (kg/ha)	Survival Rate (%)	Unit Yield (kg/ha)	Survival Rate (%)	Unit Yield (kg/ha)
Nile tilapia	14.3	247.5	51.6	364.5	33.0	306.0
Grass carp	29.3	193.5	41.9	412.5	35.6	303.0
Silver crucian carp	36.7	165.0	52.4	162.0	44.6	163.5
Local carp	37.8	223.5	50.7	310.5	44.3	267.0
Xingguo red carp	30.7	228.0	40.8	309.0	35.8	268.5
Pouch red carp	9.3	241.5	54.6	298.5	32.0	270.0
Glass red carp	25.2	159.0	49.7	415.5	37.5	288.0
Short-nose catfish	0	0	0	0	0	0
Variegated carp	7.1	69.0	8.6	150.0	7.9	109.5
Chub	20.1	120.0	50.6	342.0	35.4	231.0
Average	21.1	165.0	40.1	276.0	30.6	220.5

Lime was used to sterilize the ricefield before the fish were stocked. The main fish fed was natural food in the ricefield; however, concentrated feeds, such as fine chaff, wheat bran, and rapeseed cake, were added as needed.

The rice plants were grown and managed in the same way as rice in fields without fish. Although the area for growing rice was reduced because of the fish trenches and ponds, rice yields were not reduced because rice was planted along the edges of the trenches and ponds. When fertilizers or pesticides were applied or when the field was sun-dried, the fish were drawn into the trenches or ponds. The ricefields with fish did not need weeding.

All plots were inspected during the last 2 weeks of October. Each fish species was counted, weighed, and measured, and field management notes were examined (Tables 1-3).

Adult Fish Culture in Ricefields

In 1986, eight breeds were cultivated in the three sites (silver chub and shortnose catfish were not used). The number of plots was decreased from 30 to 24, and the area was decreased from 1.3 ha to 1 ha. Eight plots were used for monoculture

Table 2. Results of equal-quantity mixed culture (with feeding) for 10 fish breeds.

	Survival Rate (%)	Unit Yield (kg/ha)
Nile tilapia	23.8	39.0
Grass carp	35.7	124.5
Silver crucian	53.0	24.0
Local carp	53.6	117.0
Xingguo red carp	27.1	31.5
Pouch red carp	15.7	7.5
Glass red carp	21.4	61.5
Short-nose catfish	0.5	4.5
Variegated carp	57.5	27.0
Chub	70.8	82.5
Average	35.9	
Total		519.0

with and without feeding (without replicate experimental plots). The area of each plot was the same as in 1985. Two plots were used for equal-quantity mixed culture with feeding; the rest were used for 3-breed mixed culture with feeding (the three breeds were Nile tilapia, grass carp, and local carp). Each breed was cultivated separately as the main breed in two plots using the same techniques used in 1985. For each breed, 4 500 fish/ha were stocked in the ricefield. In equal-quantity mixed culture, 562 fish of each breed were stocked per hectare (each breed made up 12.5%). In unequal-quantity mixed culture, 2 250 fish were stocked per hectare: 50% of the main breed plus 7% chub, 3% variegated carp, and 20% each of two other breeds. Breeds cultivated the previous year were harvested at a length of 10 cm, and stocking was completed by early May. Results are presented in Tables 4–6.

Results

Growth of Different Breeds (1985)

Nile tilapia. Even without feeding, high unit yields were obtained when Nile tilapia was monocultivated or used to supplement mixed cultures. Survival rates, however, were not high because the fingerlings were small when stocked.

Grass carp. Survival rates were average; however, when grass carp were used to supplement mixed cultures, survival was high. Unit yield was low in monoculture without feeding. With feeding in both monoculture and mixed cultures, yields were higher than for other breeds.

Table 3. Results of unequal-quantity mixed culture (with feeding) for 10 fish breeds (SR survival rate; UY unit yield).

	Nile Tilapia as Main Fish		Grass Carp as Main Fish		Silver Crucian Carp as Main Fish		Local Carp as Main Fish		Average Proportion of Fish Breeds	
	SR (%)	UY (kg/ha)	SR (%)	UY (kg/ha)	SR (%)	UY (kg/ha)	SR (%)	UY (kg/ha)	SR (%)	UY (kg/ha)
Nile tilapia	18.6	241.5	60.3	94.5	29.8	45.0	34.2	51.0	41.4	63.0
Grass carp	33.9	45.0	23.9	111.0	43.2	147.0	59.0	96.0	45.4	96.0
Silver crucian	66.5	19.5	39.8	15.0	53.3	99.0	55.7	48.0	54.0	27.0
Local carp	38.8	52.5	39.6	48.0	48.9	25.5	45.2	129.0	42.5	42.0
Xingguo red carp	30.2	21.0	24.2	25.5	43.8	9.0	22.3	18.0	30.1	18.0
Pouch red carp	24.0	6.0	13.0	7.5	35.0	13.5	25.9	6.0	24.5	9.0
Glass red carp	16.0	48.0	19.7	36.0	20.5	51.0	29.5	58.5	21.4	48.0
Short-nose catfish	1.0	4.5	0	0	0	0	0	0	0.3	1.5
Variegated carp	43.2	12.0	56.5	15.0	55.0	21.0	52.8	24.0	51.9	21.0
Chub	45.9	13.5	73.2	27.0	88.9	31.5	77.5	39.0	71.4	28.5
Average	31.8		35.0		41.8		40.2		38.3	
Total		313.5		25.3		442.5		469.5		354.0
Average survival rate = 37.2%										
Average unit yield = 402.0 kg/ha										

Silver crucian carp. Survival rates were usually higher than for other breeds, but because the fish took longer to grow and body size was small, unit yields were low.

Local carp. Survival rates were high. Unit yields were high in mixed cultures. When local carp were used as the main breed in mixed cultures, unit yield was higher than for any of the other nine breeds. In monoculture, yields were low.

Table 4. Results of monoculture experiment.

	Without Feeding		With Feeding		Average	
	Survival Rate (%)	Unit Yield (kg/ha)	Survival Rate (%)	Unit Yield (kg/ha)	Survival Rate (%)	Unit Yield (kg/ha)
Nile tilapia	53.5	265.5	98.1	393.0	75.8	330.0
Grass carp	49.0	348.0	69.4	639.0	59.2	493.5
Local carp	53.0	273.0	74.8	423.0	63.9	348.0
Xingguo red carp	64.2	208.5	79.8	339.0	72.0	274.5
Pouch red carp	34.1	330.0	42.6	240.0	38.4	285.0
Glass red carp	54.5	280.5	43.9	240.0	49.2	261.0
Variegated carp	72.9	153.0	64.9	231.0	68.9	192.0
Chub	67.5	133.5	62.4	199.5	65.0	166.5
Average	56.1	249.0	67.0	337.5	61.6	294.0

Table 5. Results of equal-quantity mixed culture with feeding.

	Survival Rate (%)	Unit Yield (kg/ha)
Nile tilapia	94.7	75.0
Grass carp	70.7	108.0
Local carp	52.9	63.0
Xingguo red carp	63.8	45.0
Pouch red carp	21.5	30.0
Glass red carp	40.9	43.5
Variegated carp	56.9	39.0
Chub	64.8	48.0
Average	58.3	
Total		451.5

Pouch red carp. In monoculture or mixed culture, survival rate and unit yield were low.

Xingguo red carp. In monoculture without feeding, both survival rate and yield were fairly high, but in mixed culture, both survival rate and unit yield were rather low.

Glass red carp. Survival rates and unit yields were high in monoculture. In mixed cultures, survival rates were low, but unit yields were high.

Shortnose catfish. Survival rates and unit yields were low because the fingerlings used were small. Outside the experimental sites, some farmers stocked larger fingerling and obtained good harvests.

Variegated carp. In monoculture, survival rates and unit yields were the lowest of any breed. In mixed cultures, unit yields were low, but survival rates were high.

Chub. In monoculture, survival rates and unit yields were low. In mixed cultures (in the proportion 2.5–6.5%), survival rates and unit yields were the highest among the 10 breeds. Chub also grow fast.

Stocking Methods

Survival rates were lower in monoculture (30.6%) than in mixed cultures (36.6%) and lower in monoculture without feeding than in monoculture with feeding. Survival rates in equal-quantity mixed cultures were slightly lower than in unequal-quantity mixed cultures. For example, when used as the main breeds in mixed cultures, survival rates were: silver crucian carp > local carp > grass carp > Nile tilapia. In mixed cultures, the survival rate of the main breed was usually lower than when that breed was used to supplement other breeds either in unequal-quantity mixed culture or in equal-quantity mixed culture.

Unit yields were lower in monoculture without feeding (16.5 kg) than in monoculture with feeding (276 kg); lower in monoculture with feed (276 kg) than in mixed cultures with feed (460.5 kg); and lower in unequal-quantity mixed cultures (354 kg) than in equal-quantity mixed cultures (519 kg). In unequal-quantity mixed culture, unit yields were: local carp > silver crucian carp > grass carp > Nile tilapia.

Growth of Different Breeds (1986)

Nile tilapia. Fingerlings can be bred in the ricefield. In monoculture without feeding, the survival rate was not high, but in the other culture methods, survival rates were higher than for other breeds. Unit yields, however, were lower those for grass carp and local carp.

Grass carp. Survival was low, especially when grass carp were cultivated as the main breed in mixed culture without feeding. Unit yields were highest with most culture methods.

Local carp. Survival rates were higher than grass carp in most cases, but were lower than grass carp in equal-quantity mixed cultures with feeding. Unit yields were lower than grass carp with most culture methods.

Table 6. Results of unequal-quantity mixed culture with feeding.

	Nile Tilapia as Main Breed		Grass Carp As Main Breed		Local Carp As Main Breed		Average of Supplementary Breeds	
	Survival Rate (%)	Unit Yield (kg/ha)	Survival Rate (%)	Unit Yield (kg/ha)	Survival Rate (%)	Unit Yield (kg/ha)	Survival Rate (%)	Unit Yield (kg/ha)
Nile tilapia	59.5	174.0	67.6	57.0	89.1	127.5	78.4	91.5
Grass carp	29.5	105.0	36.1	291.0	41.0	106.5	35.3	106.5
Local carp	51.8	120.0	54.4	66.0	58.8	192.0	53.1	93.0
Variegated carp	65.0	37.5	67.6	40.5	48.0	27.0	60.2	34.5
Chub	62.0	60.0	80.5	61.5	85.1	78.0	75.9	66.0
Average	53.6		61.2		64.4		60.6	
Total		496.5		516.0		531.0		391.5
Average survival rate of all breeds 59.7%				Average unit yield 34.6%				
Average survival rate of main breeds 51.4%				Average unit yield of main breeds 14.6%				

Xingguo red carp. Survival rates were the highest of the four carp breeds, but unit yields were lower than local carp. In monoculture without feeding, unit yield was lower than pouch red carp and glass red carp.

Pouch red carp. Survival rates were the highest. Unit yields were low in mixed culture, but fairly high in monoculture, especially in monoculture without feeding.

Glass red carp. In monoculture without feeding, survival rates and unit yields were high. In monoculture with feeding as well as in mixed culture, survival rates and unit yields were low.

Variegated carp. Survival rates were fairly high, especially when cultivated without feeding. Unit yields, however, were low.

Chub. Survival rates were fairly high, but unit yields were low. In monoculture, survival rates and unit yields were lower than variegated carp. In equal-quantity mixed culture, both survival rate and unit yield were higher than variegated carp.

Stocking Methods

Survival rates in monoculture (61.6%) were slightly higher than in mixed cultures (59%) and lower in equal-quantity mixed cultures than in unequal-quantity mixed cultures. When cultivated as the main breeds in three kinds of unequal-quantity mixed culture, survival rates were Nile tilapia > local carp > grass carp.

Unit yields in monoculture (19.6 kg) were much lower than in mixed cultures (32.4 kg); lower in monoculture without feeding than in monoculture with feeding; and higher in unequal-quantity mixed culture than in equal-quantity mixed culture. The unit yields of the three breeds cultivated as the main breeds in unequal-quantity mixed culture were ranked from lowest to highest as follows: grass carp > local carp > Nile tilapia.

Discussion

The 2-year experiment on rice-fish culture was conducted under natural conditions (e.g., floods, droughts, and birds) and certain artificial factors (e.g., management level of staff, funds, the quality of fish breeds). It involved 50–60 farmers and was carried out in several sites in three counties, one in the South, one in the North, and another in the centre of Jiangxi Province. A lead group and a technical group were organized to undertake the experiment on the basis of unified leadership, unified planning, and unified standards. Limitations in the experimental methods included differences between sites in soil fertility, biological resources, water temperature, water quality, and water sources. There were also differences in rice-growing skills, management level, stocking, and time of harvest.

Conclusion

The fish breeds best suited to rice-fish culture are grass carp, common carp, and Nile tilapia. These breeds can be used as the main breeds for rice-fish culture. The breeds most suitable for use as supplementary breeds in rice-fish culture are crucian carp (mainly silver crucian carp), local red carps, chub, and variegated carp. Shortnose catfish can be used as a commodity fish under certain conditions.

In this method of rice-fish culture, trenches and ponds occupy 6–8% of the total area of each plot. The trenches should be 0.35-m deep and the pond 1-m deep. Rice-fish culture can be carried out while a stable increase in rice yield is maintained. Fish yields of 450–600 kg/ha of adult fish and 150–225 kg/ha of fry can be obtained.