

Integrated Fish Farming in China

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Aquaculture in China, initially a common-carp monoculture, is at least 3,000 years old; as early as 473 BC, Fanli wrote the first monograph on the subject. However, in the Tang Dynasty (618-906 A.D.) people were forbidden to catch, sell, or eat common carp because the Chinese for this fish, "li," was the same as the emperor's surname. This was a great turning point in the history of fish culture since it led to the development of the famous polyculture of carps, the basis of modern Chinese integrated fish farming. By the time of the Ming Dynasty (1368-1644), detailed accounts of the technology had already been written.

Soybean (*left*) and cabbage (*right*) cultivated on narrow pond dike as pond inputs. Fishery Team No. 1, Holei People's Commune, Wuxi Outer District, Jiangsu Province.



Cabbage cultivated on wide pond dike and climbing plant on frame overhanging fish pond (*foreground*) for fish feed, and sugar cane on dike (*background*). Binbu Production Brigade, Shajiao People's Commune, Shunde County, Guangdong Province.

The development of integrated farming in China was no doubt also influenced by a large population living off a small amount of cultivated land. The country is vast but only about 10% is arable; with a population of 1,000 million, there is only 0.10 ha of arable land per person. So the Chinese learned centuries ago to fully utilize space, labor, and to recycle wastes, the basic tenets of integrated farming. They were also aided by the zoogeographic advantage of an outstanding diversity of carps feeding in various niches: grass carp and wuchang fish on macrophytes, mud carp on detritus, silver carp on phytoplankton, bighead carp on zooplankton, black carp on snails and common carp on benthic invertebrates.

Interactions

The three major interactions in Chinese integrated aquaculture are: (a) crops on pond dikes as green fodder for fish; (b) livestock manure as pond fertilizer; and (c) pond mud as crop fertilizer. The most impressive aspect of space utilization is the cultivation on dikes of crops: rye, sudan and elephant grass, and various kinds of cabbage. Soybeans are grown, ground and fed as soybean milk to fry. On some farms much of the dike is

devoted to fruit trees, sugar cane or mulberry. Crops are fertilized with pond mud usually removed from the ponds on draining. Nightsoil and chemical fertilizers are sometimes used.

Aquatic macrophytes are commonly cultivated, usually for livestock feed, but are also added to ponds: water lettuce, alligator weed and water hyacinth.

Pigs most commonly followed by ducks, geese, chickens, cows, sheep, and more recently rabbits, are integrated. Livestock manure is a major pond fertilizer, particularly in the Yangtze River basin.

Silk production is a traditional industry. Many farms raise mulberry bushes on the pond dikes. Silk work faeces and pupae wastewater, obtained when silk fibers are separated from the pupae at the processing factory, are used as pond fertilizer. The pupae, a traditional high-protein fish feed, today more likely will go into the production of medicine to lower blood pressure than be fed to fish.

A wide variety of agricultural by-products and grains is used in fish culture, particularly towards the end of the growing season when green fodder is insufficient.



1. Collecting pond mud by boat during fish growth to fertilize mulberry cultivated on pond dike. Xinfu Production Brigade, Le Liu People's Commune, Shunde, Guangdong. 2. Pigsty on top and cabbage on side of pond dike. Fishery Team No. 1, Holei People's Commune, Wuxi, Jiangsu. 3. Manual distribution of pig manure to fishponds. Large containers in foreground to temporarily store agricultural by-products and grain. Aerator on pond and vegetable covered dike in background. Fishery Team No. 1, Holei People's Commune, Wuxi, Jiangsu. 4. Communal pigsties and biogas digesters. Gas runs a diesel engine and electricity generating unit. Xinfu Production Brigade, Le Liu People's Commune, Shunde, Guangdong.

Major Regions and Pond Yields

The major aquacultural region in China is the Yangtze River basin, accounting for more than 60% of the country's freshwater fishery production. Mean net yields for farms are as high as 9,000 to 13,000 kg/ha/yr. These high yields are partly due to large quantities of aquatic macrophytes, snails and livestock integrated with production; aerators are also commonly used.

The second important region, the Pearl River basin, with about 30% of total yield, has lower mean net yields of 2,000 to 4,000 kg/ha/yr. The reason is that the farms here have fewer inputs from the farm; but, thus, they are more fully integrated.

Pond Management

Ponds have an initial high stocking rate and fish may be seined with intermediate harvesting and restocking several times a year. Maintenance of high densities

of protein-rich plankton by judicious fertilization is particularly impressive; water quality is judged, through experience, by the color and transparency of the water and behavior of fish in the early morning hours when dissolved oxygen levels are at their lowest.

Integrated Biogas Technology

China is justifiably world-renown for having over 7 million biogas digesters; small, family-size units provide gas for cooking and lighting; larger communal units run diesel engines for electricity generation. In Le Lin People's Commune, Shunde County, Guangdong Province, there is an integrated biogas technology involving aquaculture where a slurry is recycled into fishponds. Grass, sugar cane leaves and banana leaves are used in addition to pig manure and nightsoil.

Conclusion

The annual production of freshwater fish through aquaculture in China, most of it from integrated farming, is about 0.5 million tonnes, almost 50% of the country's total annual freshwater fish yield. This is the largest production by a single country and represents about 10% of the world's aquaculture total. With such an impressive record, it is not surprising that the rest of the world is clamoring for an insight into Chinese integrated fish farming technology, and indeed would benefit considerably from the adoption of their low-energy aquacultural practices. The Chinese, too, can learn from themselves: for instance, the collection of aquatic macrophytes is a valuable practice in the Yangtze but not yet in the Pearl River basin. And indeed the Chinese consider that still greater efforts are needed: mean fish production is just over 1 kg per capita, considerably less than the world average.