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Review of rice–fish-farming systems in China — One of the Globally Important Ingenious Agricultural Heritage Systems (GIAHS)

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Abstract

Rice–fish-farming systems constitute a unique agro-landscape across the world, especially in tropical and sub-tropical Asia. Rice is a globally important staple food crop, with a wide distribution and constituting diversified varieties. The introduction of fish rearing to rice farming creates an integrated agro-ecological system. China boasts a history of 1700 years in rice–fish-farming practice. It is no longer a sole agro-production practice, but an agro-cultural pattern. Therefore, it has been listed by the Food and Agriculture Organization of the United Nations (FAO) and the United Nations Educational, Scientific and Cultural Organization (UNESCO) as one of the Globally Important Ingenious Agricultural Heritage Systems (GIAHS). Qingtian County of the Zhejiang province has been selected as a pilot conservation site. The rice–fish-farming systems in China diversify China's agro-landscape and favor the conservation of species variety of both rice and fish. The survival of deep-water rice, an indigenous rice variety, and Oujiang red carp, an indigenous fish variety, are cases in point. Being low external input systems, the rice–fish-farming systems necessitate only small amounts of pesticide and fertilizer. The application of pesticides can be lowered to 50% of that of modern, high-input rice production; sometimes, no pesticide application is required. The natural enemies of rice pests show a prominent rise, making the bio-control of rice diseases and pests highly feasible. The rice–fish-farming system is also of great significance in global food security and global change. It provides food and animal protein for subsistence farmers living in ecologically-fragile mountainous regions. It also reduces economic risks that these farmers potentially face. The nitrogen-fixation role of the system increased the content of organic matter, total nitrogen and total phosphorus in the soil by 15.6–38.5%. It also reduces the emission of CH_4 by nearly 30% compared with traditional rice farming. However, the economical development and industrialization in China pose a threat to rice–fish farming and, consequently, the numbers of farmers involved in rice–fish farming are decreasing. This calls for the Chinese government to engage itself in the conservation and development of this system and to innovate the existing technologies. It would also be useful, in the meantime, to exploit and conserve rice–fish farming as eco-tourism resources, so that the income of the mountainous farmers can be increased and this important, indigenous agro-culture be conserved and developed.

Keywords: Agro-landscape; Agro-biological diversity; Low external input; Integrated eco-system; Global change; Protective strategies

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1. Introduction

Rice–fish farming has been practiced in China for more than 1700 years (Mackay, 1995), which has enabled China to accumulate a rich experience in rice–fish culture, both scientifically and technically. It has become an important agro-cultural activity (Ni and Wang, 1990; Chinese Academy of Agricultural Sciences, Chinese Academy of Fishery Sciences, 1990). The integration of fish into rice farming provides invaluable protein, especially for subsistence farmers who manage rain-fed agricultural systems. Rice fields provide shade and organic matter for fish, which in turn oxygenate soil and water, eat rice pests and favor nutrient recycling. According to the statistics issued by the Ministry of Agriculture of China, the total area of rice–fish farms in China is 1.5 million hectares, which is distributed mainly in the mountainous areas in southeast and southwest China — for example, Qingtian County, Yongjia County in Zhejiang province, Jianning County, Taining County, Sha County, Yong'an County, Shaowu County in Fujian province, Yunling County, Guiling County, Quanzhou County in Guangxi Autonomous Region, the southern part of Guizhou province and Pingxiang County, Ji'an County and Yichun County in Jiangxi province. Rice–fish farming in China, owing to its long history, diversified patterns and mature techniques, was listed by the Food and Agriculture Organization of the United Nations (FAO) as one of the Globally Important Ingenious Agricultural Heritage Systems (GIAHS) early in 2005. Qingtian County in Zhejiang province, a place that is renowned for rice–fish culture, was listed as a conservation site (FAO, 2002, 2003; Boerma, 2005).

Rice–fish systems have constituted a unique agro-landscape in not only China, but also in many other countries across the world — particularly in countries in Asia, such as Thailand, the Philippines, India, Bangladesh and Indonesia (David et al., 1996; Haroon and Pittman, 1997; Mackay, 1995). These farming systems, as part of an integrated ecosystem in line with the local cultural, environmental and economic conditions, are composed of complementary sub-agricultural ecosystems and play important ecological service roles, such as bio-control, nitrogen fixation and landscape combination. The traditional low input rice–fish farming systems have a significant function in protecting the global environment and maintaining its bio-diversity. Therefore, a review and analysis of China's rice–fish-farming systems has vital, theoretical significance in the conservation of these systems as one of the GIAHS.

Rice–fish-farming systems in China have many difõferences to other countries all over the world. First, rice–fish-farming systems have a long history in China (Little et al., 1996). In Japan, the practice began only in the last century and, in Java, in the mid-nineteenth century. Rice–fish farming has followed a chequered pattern in Thailand since its introduction by the Department of Fisheries (DOF) in central and eastern Thailand in the 1950s (Little et al., 1996). In Africa, the introduction of an Asian-based Sawah farming system through an eco-technology approach has opened a new frontier for diversification of the rice-based cropping system, and on-farm rice–fish-culture experiments have been reported in recent years (Ofori et al., 2005). Second, fish yields are highest in China, fish yields could be increased by up to 2.5 t/ha in China, 2.0 t/ha in India, 805.0 kg/ha in Indonesia, 980.0 kg/ha in Bangladesh, 2.2 t/ha in Vietnam and 900.0 kg/ha in Thailand (Haroon and Pittman, 1997). Third, the total area of rice–fish-farming systems in China is also the highest in the world, having reached about 1.5 million ha. In India, about 20 million ha of rice fields is suitable for the adoption of a rain-fed rice–fish integration system; however, only 0.23 million ha is under rice–fish culture at present (Mohanty et al., 2004). Forth, in general, the main species that are stocked in rice fields in China and other countries are *Cyprinus carpio* and *Oreochromis niloticus*. However, *Barbodes gonionotus* (Bleeker) is often stocked in polyculture in rice fields in south (Bangladesh and India) and southeast (Indonesia, Malaysia, Thailand and Vietnam) Asia (Vormant et al., 2002; Little et al., 1996; Mohanty et al., 2004; Ofori et al., 2005). Fifth, increasingly, fish is viewed as a tool within an integrated pest management (IPM) system to make rice production more sustainable and environmentally friendly, as well as having direct monetary benefits and/or nutritional value, such as in Thailand, Vietnam and Bangladesh (Berg, 2001; Haroon and Pittman, 1997; Little et al., 1996). According to Berg's (2001) report, during the 3 years of IPM in Vietnam, farmers on rice–fish farms estimated that they had decreased the amount of pesticides used by approximately 65%, whereas non-IPM farms said that they had increased the amount of pesticide used by 40%.

2. Globally Important Ingenious Agricultural Heritage Systems (GIAHS)

The GIAHS have been created by FAO in partnership with the Global Environment Fund (GEF), the United Nations University's People Land Management and Environment Change (PLEC) Project, and UNESCO's Man and the Biosphere (MAB) and World Heritage Programmes. The so-called GIAHS are "developed over millennia, they [GIAHS] represent a wealth of accumulated knowledge and biodiversity that needs to be preserved —