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Effects of implementing organic rice-duck integrated farming on reducing agricultural diffuse pollution around Dianshan Lake in the western suburbs of Shanghai

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Located in the western suburbs of Shanghai, Dianshan Lake is a major source of Huangpu River, a mother river flowing through the metropolitan area. To protect the drinking water source areas, the development of any industries and livestock breeding is forbidden around the lake since the early time. However, the lake is still under a eutrophic state throughout the year. In 2013, for example, total N and total P in the lake water were 2.98 mg L^{-1} and 0.17 mg L^{-1} on average, respectively. It is believed that 72.2% of N and 73.1% of P in the lake come from agricultural diffuse pollution. The areas surrounding the lake include six towns and are all low-lying in landform. There are 5975 ha paddy fields at the six towns, making up 33.1% of total farming land in the areas. According to our questionnaires to local farmers at Jinze Town, one of the six towns, for the consecutive five years, the amounts of N and P_2O_5 applied within the rice growing season under the conventional rice farming are 336.6 kg ha^{-1} and 76.9 kg ha^{-1} on average, respectively, and those lost through leaching and runoff are 15.42 kg ha^{-1} and 3.55 kg ha^{-1} on average, respectively. Further study estimated that the total amounts of N and P_2O_5 applied around the lake within the rice growing season are 2.01×10^6 kg $year^{-1}$ and 4.59×10^5 kg $year^{-1}$, respectively; those lost through leaching and runoff are 0.99×10^5 kg $year^{-1}$ and 0.23×10^5 kg $year^{-1}$, respectively; those discharged from the fields into the lake are 0.99×10^4 kg $year^{-1}$ and 0.23×10^4 kg $year^{-1}$, respectively. Our study also indicated that the amount of pesticides and herbicides discharged from the paddy fields at the six towns into the lake is approximately 1.67×10^4 kg $year^{-1}$. Appreciately, the agricultural diffuse pollution from the paddy fields surrounding the lake have posed severe threat to the lake. The field experiments indicated that raising ducks in the paddy fields within the rice growing season can not only highly reduce weed hazards and incidence of rice pests and diseases, but also significantly improve soil fertility. The rice plants co-cultured with ducks grow healthily, if not applying any herbicides and pesticides, which is conducive to establish organic rice farming. It is estimated that the total amounts of N and P_2O_5 discharged from the paddy fields into the lake would reduce by 75.8% and 95.2%, respectively, and the potential pollution from pesticides and herbicides can be totally prevented, if implementing the organic rice-duck integrated system at the six towns surrounding Dianshan Lake. This will contribute greatly to improve the water quality of the lake. Moreover, the organic rice produced by the rice-duck integrated system is five times higher in prize than the conventional rice, and the ducks ecologically growing in the fields are four times higher in prize than the intensively cultivated ones. This will also be beneficial to increase farmers' incomes.