



Rice-Fish Culture: Enhancing Rice Quality and Economic Benefits

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Abstract

Rice-fish culture is a composite agricultural technique that integrates rice cultivation with fish farming, effectively promoting ecological and economic benefits in agriculture. This model enhances rice quality and yield, reduces the use of chemical fertilizers and pesticides, and increases biodiversity in farmlands. It also improves soil structure and fertility. Additionally, by introducing fish species that adapt to the paddy field environment, it not only increases the direct income from agricultural production but also reduces environmental pollution through decreased chemical use. Rice-fish culture further contributes to agricultural climate regulation by improving water quality and recycling resources, enhancing the carbon sequestration capacity of farmlands. To optimize and promote this model, technical training for farmers, along with policy support and marketing assistance, is essential to ensure its sustainable implementation and evaluation.

Keywords

Rice-fish culture; Rice quality; Economic benefits; Sustainable agriculture

In the process of modern agricultural development, innovative planting and breeding models have become one of the key means to improve agricultural ecological and economic benefits. As an ancient and efficient agricultural model, the rice-fish farming model has shown new vitality in the current sustainable agricultural development strategy. Through compound planting, this model not only significantly improves the quality and yield of rice, but also increases the economic benefits of agricultural production, reduces the use of chemical fertilizers and pesticides, and effectively promotes the health of the agricultural ecosystem and the biodiversity of farmland. Enhance.

In addition, the rice-fish farming model also has a significant effect on improving soil structure, enhancing soil fertility and water quality, providing a feasible path for the transformation of agricultural production methods.

1. Development background and theoretical basis of rice-fish farming model

1.1 The need for change in agricultural ecosystems

In the context of sustainable development of global agriculture, the traditional monoculture model has gradually shown its limitations, especially in terms of ecological environment protection and economic benefit improvement. As an ancient agricultural practice, the rice field fish farming model has been re-recognized and promoted in modern agriculture.

This model effectively integrates rice cultivation and fish farming, which not only improves the comprehensive utilization rate of land, but also enhances the stability of the agricultural ecosystem. For example, through rice-fish farming, the use of fertilizers and pesticides is reduced, thereby reducing the burden of agricultural production on the environment.

1.2 Theoretical support and technological progress

The implementation of the rice-fish farming model has benefited from the continuous progress of ecological principles and agricultural engineering technology. Ecological principles show that the rice field environment, due to its semi-aquatic characteristics, is very suitable for the growth of certain fish, such as the Hefang Crucian Carp No. 2 used in an agricultural cooperative in Hunan. The growth of this fish species in rice fields not only accelerates the circulation of soil nutrients, but also effectively controls pests and weeds and reduces the use of chemicals. In addition, technological advances, especially the application of water quality monitoring systems and the use of biotechnology in fish disease prevention, have greatly enhanced the sustainability and efficiency of the rice-fish farming model. For example, by installing intelligent water quality monitoring equipment, water quality changes can be tracked in real time, and management measures can be adjusted in a timely manner to ensure optimal conditions for fish health and rice growth. These technological innovations have supported the widespread promotion and successful implementation of the rice-fish farming model [1].

1.3 Model innovation and practical application

The successful implementation of the rice-fish farming model also depends on the innovation of agricultural production models. For example, in the Hunan Yuze Agricultural Cooperative, by introducing high-quality fish species and improving the water conservancy facilities of rice fields, the rice fields have been effectively transformed into an ecosystem suitable for the symbiosis of rice and fish. In addition, the cooperative has also adopted the model of ecological circular agriculture, converting organic waste from rice fields into fish feed, further reducing production costs and increasing the closedness of the agricultural ecological cycle. The promotion of this model has not only improved the yield and quality of rice and fish, but also promoted the transformation and upgrading of regional agricultural production methods.

2. Positive effects of rice-fish farming on rice quality

2.1 Improving the nutritional value of rice

The rice-fish farming model can improve the nutritional content of rice by increasing the complexity of the farmland ecosystem. Studies have shown that the protein content and concentration of other important nutrients in rice under this model are generally higher than those in traditional planting models. Specifically, through the rice-fish farming model, the nitrogen utilization efficiency of rice is improved because fish excrement provides a natural and easily absorbed nitrogen source for rice, thereby indirectly increasing the nitrogen content in grains, which is directly related to protein synthesis.

2.2 Improving the taste and appearance of rice

The rice-fish farming model not only improves the nutritional value of rice, but also significantly improves its taste and appearance. Fish activities in rice fields can help loosen the soil and increase soil permeability, making the rice root system healthier and absorbing more nutrients. This healthy growing environment results in better swelling and less impurities in the rice. In addition, fish in rice fields reduce the number of pests and mitigate the occurrence of diseases through their daily activities, further ensuring the overall quality and safety of rice [2].

2.3 Promote the improvement of rice safety

In the rice field fish farming model, the use of chemical fertilizers and pesticides is significantly reduced through natural ecological cycles, thus directly affecting the safety of rice. In actual cases, for example, after an agricultural cooperative in Hunan implemented this model, the use of pesticides and fertilizers was reduced by more than 30%. This reduction not only reduces the chemical burden on soil and water bodies, but also significantly reduces potential heavy metal and pesticide residues in rice. Therefore, the food safety of rice has been greatly improved, and consumers' trust and satisfaction with agricultural products have also been enhanced.

2.4 Enhance rice market competitiveness

Rice grown through the rice-fish farming model has high market acceptance due to its excellent quality and improved safety, and can meet the growing demand for healthy consumption. Rice produced under this model usually achieves

higher market prices and better consumer reviews. Consumers' preference for green and healthy food has made rice grown in this ecological way more popular, thereby increasing farmers' income and the market competitiveness of rice. While the economic benefits are significant, it also promotes the sustainable transformation of agricultural production methods.

3. Economic benefit analysis: income-increasing potential of rice-fish farming model

3.1 Direct income increase

The rice-fish farming model directly brings farmers an additional source of income by increasing the development of aquatic resources. In traditional rice cultivation, farmers' income comes only from the sale of rice. In the rice-fish farming model, not only can rice be sold, but also profits can be obtained from the output of fish. For example, by raising fish in one hectare of rice fields, an additional 50 to 100 kilograms of aquatic products can be added. According to market prices, each kilogram of aquatic products (such as crucian carp, grass carp, etc.) can be sold for an average of RMB 15, which can increase the income by RMB 750 to 1,500 on the basis of the original rice income.

3.2 Cost savings and efficiency improvement

The rice field fish farming model reduces the use of chemical fertilizers and pesticides through a natural ecological cycle, thereby reducing the cost of agricultural production. The activities of fish in paddy fields help control weeds and pests, reducing the need for chemical drugs, which not only saves costs but also avoids environmental pollution caused by excessive use of chemicals. In addition, fish excrement provides rich organic fertilizer for rice fields, improving fertilizer utilization and further reducing fertilizer input costs [3].

3.3 Enhanced market competitiveness

Agricultural products using the rice-field fish farming model are increasingly favored by consumers due to their green and healthy quality characteristics. Rice and fish products produced under this model usually achieve higher market recognition and sales prices. Consumers are highly concerned about eco-friendliness and food safety, giving these products a better competitive advantage in the market. In addition, government support and subsidies for ecological agriculture also provide additional economic incentives for farmers, further increasing the attractiveness of engaging in this model of agricultural activities. Table 1 below shows the analysis of the potential economic benefits of one hectare of rice field under the rice-fish farming model.

Table 1 shows that under the rice field fish farming model, not only the direct income has been significantly increased, but the cost reduction has also brought higher economic benefits to farmers. Through the implementation of this model, farmers' total income increased by 105.56% compared with the traditional rice field model, effectively improving the economic benefits of agricultural production.

Table 1. Comparative analysis of economic benefits between rice field fish farming model and traditional rice fields

Project	Traditional rice fields (yuan/hectare)	Rice-fish farming model (yuan/hectare)	Increased income (yuan/hectare)
Rice sales revenue	12,000	13,000	1,000
Fish sales revenue	0	7,500	7,500
Fertilizer and pesticide costs	3,000	2,000	-1,000
Total income	9,000	18,500	9,500
Economic benefit improvement ratio	-	-	105.56%

4. Environmental and ecological benefits: sustainable agricultural practices

4.1 Enhanced biodiversity in farmland

The rice-fish farming model integrates aquaculture into the traditional rice-field planting system, forming a more complex farmland ecosystem. In this system, the introduction of fish not only increases biodiversity, but also

improves the water environment through its natural activities. For example, fish reduce diseases and weeds in farmland by eating pests and weed seeds, thereby reducing dependence on chemical pesticides. At the same time, fish excrement is rich in nutrients such as nitrogen and phosphorus, which can be used as natural fertilizers to promote the growth of rice, further enhancing the self-sustaining ability of the farmland ecosystem.

4.2 Water quality improvement and resource recycling

In the rice-fish farming model, the symbiotic relationship between rice and fish effectively promotes the recycling of farmland water and the natural purification of water quality. The breathing and excretion processes of fish increase the oxygen content in the water, which helps to reduce the concentration of harmful substances in the field water. In addition, the activities of fish in the paddy field help to evenly distribute nutrients in the water, avoiding the local accumulation of fertilizers in the field. In this way, the rice-fish farming model effectively improves water quality and reduces water pollution caused by agricultural activities [4].

4.3 Agricultural climate regulation and carbon capture

The rice-fish farming model also helps increase the carbon fixation capacity of farmland and combat greenhouse gas emissions from agricultural production. As a semi-aquatic environment, paddy fields generally have higher carbon fixation efficiency than dry land. The activities of fish help improve soil structure and increase the soil's ability to fix organic carbon. In addition, the water layer in the rice field can reduce soil respiration, thereby reducing the release of CO₂. In this way, the rice-fish farming model not only optimizes the microclimate of the farmland, but also helps reduce the negative impact of agricultural activities on global climate change.

4.4 An agricultural cooperative in Hunan

After implementing the rice field and fish farming model, an agricultural cooperative in Hunan successfully combined agricultural production with ecological environmental protection and created a sustainable agricultural production model. By introducing high-quality fish species into 1,000 acres of rice fields, the cooperative not only increased the overall output and quality of agricultural products, but also significantly improved the local ecological environment. Specifically, the cooperative has successfully reduced chemical inputs in agricultural production and reduced agricultural non-point source pollution by reducing the use of chemical fertilizers and pesticides by more than 30%. At the same time, by improving water quality and increasing biodiversity, rice production has increased by 5-10% per mu, while additional fish production has brought economic benefits of approximately 500-600 yuan per mu.

5. Optimization and implementation strategies of rice field fish farming model

5.1 Choose suitable fish species

The successful implementation of the rice-fish farming model first relies on the correct selection of fish species. Fish species need to adapt to the ecological environment of rice fields, be able to grow well in semi-aquatic conditions, and have a positive impact on the ecological balance of farmland. It is recommended to select fish species that are tolerant to low oxygen environments, have short growth cycles, and have high market demand. For example, grass carp, crucian carp, and bighead carp, etc. These fish species can not only effectively control weeds and pests in paddy fields, but also provide natural fertilizers for rice through their excrement. In addition, the types of fish species and the stocking density should be adjusted according to the specific environment and market demand of the region to achieve the best economic and ecological benefits.

5.2 Improving paddy field design and management

To ensure the efficient operation of the rice-fish farming model, the design and management of paddy fields should be optimized. Paddy fields should have a good water management system to ensure that there is enough water and suitable water quality to sustain the survival of fish. Improve the drainage system of the fields to ensure that excess water can be quickly drained during rainy seasons and disasters to prevent paddy fields from being flooded, which affects the growth of rice and fish. Reasonable design of fish ditches and fish ponds within the fields should help fish hide and reproduce, and facilitate harvesting. For example, the fields can be designed with a slight slope to allow water to circulate naturally, and special fish collection areas can be set up to facilitate fishing.

5.3 Promote agricultural technology extension and training

The implementation of the rice-fish farming model requires farmers to have certain technical knowledge and management capabilities [5]. Therefore, the government and relevant agencies should strengthen technical training and support for farmers. Through organizing seminars, workshops and on-site teaching, farmers can be taught key technologies such as how to choose fish species, how to manage water quality, and how to coordinate the schedule of rice cultivation and fish farming. In addition, the promotion of modern agricultural technologies, such as intelligent water quality monitoring systems and automated feed delivery equipment, can further improve the efficiency and benefits of the rice-fish farming model.

5.4 Policy support and marketing

The government plays a key role in promoting the rice-fish farming model. Support policies should be formulated to provide financial subsidies, tax exemptions and technical support to farmers who implement rice-fish farming. In addition, relevant market systems should be established and improved to help farmers explore markets and improve sales channels for agricultural products. For example, the government can assist in establishing brands for rice-fish products, conduct market promotion, establish online and offline sales platforms, and increase consumers' awareness and acceptance of ecological farming products.

5.5 Continuous monitoring and evaluation

In order to ensure the sustainable benefits of the rice-fish farming model, its implementation effect must be continuously monitored and evaluated. This includes monitoring water quality changes, ecological impacts, economic benefits, and social impacts. By collecting relevant data and feedback, management measures can be adjusted in a timely manner and the model can be continuously optimized. At the same time, through case studies and long-term follow-up studies, experience can be summarized, best practices can be refined, and a model that can be used as a reference for other regions.

6. Conclusion

As an ancient and modern agricultural practice, the rice-fish farming model has shown significant advantages in improving agricultural production efficiency, increasing biodiversity, and promoting environmental sustainability. By integrating aquaculture into rice field cultivation, it not only significantly increases economic returns, but also improves the agricultural ecological environment, reduces dependence on chemical fertilizers and pesticides, and enhances the market competitiveness of agricultural products. In the future, the key to continuing to optimize this model lies in selecting appropriate fish species, improving farmland design, strengthening technology promotion and policy support, and ensuring the effective implementation of the model through continuous monitoring and evaluation. With the advancement of technology and the increase in consumer demand for healthy and ecological products, the rice-fish farming model is expected to be more widely used and promoted globally, providing strong support for achieving a win-win situation between agricultural production and ecological protection.

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