Advance Journal of Food Science and Technology 5(4): 404-407, 2013
DOI:10.19026/ajfst.5.3279
ISSN: 2042-4868; e-ISSN: 2042-4876
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Submitted: October 31, 2012 Accepted: January 03, 2013 Published: April 15, 2013

Research Article

Technological and Theoretic Analysis Regarding Rice Planted on Ridge and Fish Reared in Ditch

[1]Ming-wei Li, [2]Fei-yue Huang, [2]Yong-sheng Xiang, [1]Yan-xia Zhang,
[1]Peng-fei Li, [1]Zhi-hua Yuan, [1]Wen-jing He and [1]Dan-ying Xing
[1]College of Agronomy, Yangtze University, Jingzhou, Hubei 434025, China
[2]Soil and Fertilizer Sector of Enshi Enshi, Hubei Province 445000, China

Abstract: To study the technological theory and economic benefit of which rice planted on ridge and fish reared in ditch, we conducted the experiment. The results showed that: a) the technology can optimize the ecological environment of paddy; increase soil water storage and decrease weed harm. b) It can improve economic benefit. The margin of the model was 22.85% compared to 16.22% for traditional rice and advanced seven points. c) It can bring good social effect, such as increasing total fish protein in society, promoting labor transformation and improving labor value. d) It have good ecological benefit, such as coordinating ecological niche of different species and ridge planting can provide good environment for rice. The model can create a best ecological environment for rice and fish, so as to achieve the rice and fish double harvest.

Keywords: Ditch fish, paddy, ridge rice

INTRODUCTION

With 1700 years of history, rice-fish is a traditional eco-agriculture model in China (Pan and Zhuang, 1999). Since the 1980s, the theory research and practice of eco-agriculture has been started in China (Gao, 1998; Duan *et al*., 1997). Rice-fish is an important technical measure of raising rice production and eco-economic benefit (Ni and Wang, 1998), it has become large-scale, standardize, base and Industrialization gradually (Cao *et al*., 2001). Rice-fish mode has improved from flat field type to various forms such as Long-dao-gou-yu (Yang and Yang, 2002). It is a progressive planting breeding models in the rice field, which can rational use the water, fertilizer, gas, heat and light resources of paddy, thus, promote rice and fish double harvest.

Enshi mountainous area is located in the southwest of Hubei, with an average altitude of 1000 m, where the rainfall is abundant, the vegetation coverage rate is high and the ecological environment is good. Rice field is mainly distributed in valley basin and mountains terrace. The water of paddy is abundant at the flatland of the low hill, so farmers have tradition of raising fish in paddy field. Long-dao-gou-yu was that rice planted on the ridge and fish reared in the little ditch, with rice-fish intergrowth. Since the 1980s, on the basis of Se-mi-arid cultivation, the agricultural technology department of Enshi makes practice of Long-dao-gou-yu, for hill farmers probing out a set of suitable ecological planting mode. Practices show that the model can bring good economic benefit, social effect and ecological benefit. We research the model in Enshi to provide reference for further popularizing and applying.

MATERIALS AND METHODS

Ditching and ridging: We leveled off land, drained away the water of paddy, 7 days before rice transplanting. We excavated surrounding ditch with the width and depth of ridges or ditches of 50 cm, then ditched and ridged. The ridges fall into two types, narrow ridge planted two rows of rice, which total width is about 65-72 cm, ridges width 24 cm, ditch width 41-48 cm and depth about 30 cm and wide ridge planted four rows of rice which total width is 100 cm, ridges width 60 cm, ditch width 40 cm and depth 60 cm.

Rice ridge-cultivation: In order to ensure the rice yield, we transplant 120000-130000 seedlings per 667 m^2. When planting, the ditch filled with water, when seedling greening, water over the ridge, when tillering, water flush with ridge, when active tillering stage, water filled half ditch, when seedlings adequate, ridge dried in the san 5-7 days, in the heading flowering period, water over the ridge, after flowering period, ridges above water. The field management measures are the same as the traditional rice. We select pesticides

Corresponding Author: Dan-ying Xing, College of Agronomy, Yangtze University, Jingzhou, Hubei 434025, China, Tel.: +86-136-0721-3390; Fax: 0716-8066314
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Table 1: Average economic benefit analysis per hm^2 (changeless in 2003)

Items	Per unit yield (Yuan/hm^2)	Unit price (Yuan/hm^2)	Total income (Yuan/hm^2)	Input (Yuan/hm^2) Fertilizer (fish food)	Pesticide (fish medicine)	Seed rice (seedling)	Labor	Total input	Net profit (Yuan/hm^2)
Rice	8250	1.00	8250	750	225	240	4500	5715	885
Fish	1575	8.00	12600	1500	300	1200	4350	7350	2100
Total			20850				8850	13065	2985
Traditional rice	9000	1.00	9000	8700	525	300	4500	6195	1005
Difference			+11850					+6870	+1980

The reaction was conducted in anoxic conditions; b this is the format for table footnotes

with high-effect and low-toxicity as well as harmless to fish (Xu *et al*., 2006).

Fish ditch-breeding: We generally select omnivorous or predatory fish and a small amount filter feeder. Main breeding objects have carp, tilapia, grass carp, etc. After transplanting, the fish can be stocked.

Fingerling stocking size is 4~5 cm long. Stocking volume is 400 to 500 per 667 m^2. The management measures of fish reared in ditch is the same as the one reared in ponds (Wen, 2001).

The measure which rice planted on the ridge and fish reared in the ditch can expand the temperature between day and night. We can culture edible fungi on the ridge and plant zizania latifolia in the ditch, which can further reflect three-dimensional agriculture strengths.

RESULTS AND DISCUSSION

Optimizing the ecological environment of paddy: Rigde planting can deepen arable layer and be beneficial to the growth and development of the plant roots; ventilation condition was improved and crops utiwsation light and heat energy was increased. Because ridge above the top of the water, sun light can raise the temperature of mud, which is good for transforming nutrient and coordinating the relationship of water, fertilizers, gas and heat. So that we can solve seedlings' contradiction of "prophase delayed, interim root decline, later over-green".

Increasing soil water storage: Ridge planting can deepen paddy water-holding depth, so make oxygen dissolution enough and food rich which was beneficial to polyculture fish and raise survival rate.

Decreasing weed harm: The measure which rice planted on the ridge and fish reared in the ditch can reduce weed of rice fields and lower the index of diseases and pest. Ultimately, make a food chain which is fish eat weed, fish rich rice and rice protect fish and this could create a virtuous cycle.

CONCLUSION

Economic benefit: The results of experiment and demonstration statistics showed that the model of rice planting on the ridge and fish rearing in the ditch showed good economic benefits in Xuan'en, Laifeng and Lichuan (Table 1). Gross income per hectare of rice and fish was 20850 Yuan compared to 9000 Yuan for traditional rice, the difference was 11850 Yuan. Total input per hectare of rice and fish was 13065 Yuan compared to 6195 Yuan for traditional rice, the difference of input was 6870 Yuan. Total net profit per hectare of rice and fish was 2985 Yuan compared to 1005 Yuan for traditional rice, the difference of input was 1980 Yuan. Just by comparison, the net profit of rice and fish was 1980 Yuan more than traditional rice. To sum up, rice planting on the ridge and fish rearing in the ditch is a model of "three-high", which was "High cost, high output, high profit". Through the comparison and analysis, we can find that:

- The profit margins of the model were 22.85% compared to 16.22% for traditional rice and advanced seven points.
- Compared with traditional rice per hectare, input increased by 110.9%, labor costs increased by 96.7%, physical inputs increased by148.7% and intensivism degree is almost double traditional rice.
- We costed nearly double in labor, traditional rice was 4500 Yuan and the model was 8850 Yuan, Labor value increased by 4350 Yuan (Huang *et al*., 2003).

Social benefits:

Increasing total fish protein in society: Farming area occupied 40% per ha. There was most fertile land-maybe 5.33×104 ha-to reform the model of rice planting on the ridge and fish rearing in the ditch in Enshi. Farming area can increase by 2.13×104 ha. With producing fish 720 kg/ha, the society can receive an additional 1.5336×10^7 kg.

Promoting labor transformation and improve labor value*:* Labor time per hectare of the model was more 150 days than traditional rice, so 2.13×10^4 ha can increased by 3.20×10^6 days. If we treated 300 days as a job opportunity, create jobs for nearly ten thousand people.

Ecological benefits:

Coordinating ecological niche of different species: The model of rice planted on the ridge and fish reared in the ditch can solve contradictions of ecological

Table 2: Contrast water temperature of ditch with fishponds (°C)

Items	May	June	July	August	September
Air temperature	18.2	23.4	25.8	23.6	20.1
Temperature of 10 cm under water in ditch	17.5	22.9	24.1	23.1	19.7
Temperature of 10 cm under water in fishpond	16.8	22.5	24.6	22.6	19.3
Difference	0.7	0.4	-0.5	0.5	0.4

condition between rice and fish, which existed traditional rice-fish culture, for instance, the depth of water. It also developed a favorable and mutualistic symbiosis relationship between rice and fish. Such as rice provided more oxygen, food and adjust temperature for fish; fish can decrease weed and pest harm and provided fertilizer for rice. Further study indicates that the model has the following advantages: It requires little or no herbicides and pesticides in plant growth process, so rice and fish with pesticide residues were very low. The pesticide inputs of fish and rice were 225 Yuan/ha, compared to 525 Yuan for traditional rice. By comparison, we reduced the used were low-residue, low-toxicity, so the rice and fish can better satisfy the quality and safety test of agricultural products.

Ridge planting can provide good environment for rice:

- **Raise the temperature:** According to data from a long term fixed location observation, the temperature 5 cm underground of ridge planting raise 1°C compared to conventional tillage.
- **Well-ventilated:** The oxidation-reduction potentials 5 cm underground of ridge planting is higher 150 mV than conventional tillage.
- **Good transparency:** The available light per plant of ridge planting increased by 15% compared to conventional tillage, causing more intensive marginal effect.
- **Concentrate fertilizer:** Fertilizer of ridge planting relatively concentrated. The dispersion degree of fertilizer reduced to 36 from 100%, greatly improving the fertilizer efficiency.

The above improvements produced noticeable effects on rice:

- **Rice hills were larger:** The effective ear of ridge planting was 13 ears/hill compared to 11 ears/hill for traditional rice.
- **Rice spikeds were larger:** The number of grain per spike of ridge planting was 102, which was 24 grains more than traditional rice.
- **Grain weight was higher:** The thousand-grain weight of ridge planting was 27.5 g which was 0.3 g heavier than traditional rice.
- **Rice spike were growing coincide:** The uniformity of heading was 83.4%, which was 22.2 points higher than traditional rice.
- **The leaf of rice was greener:** At the dough stage, the flag leaf was greener than traditional rice and above 1 to 5 levels of leaf color.
- **The root of rice was whiter:** At mature period, the white root rate was 81.0%, which was 49 points higher than traditional rice (Xiang *et al*., 1988).

Ditch can provide good environment for fish:

Adjust the temperature: The water temperature of ditch was higher than fishponds at low temperature, whereas the ditch was lower than fishponds at high temperature. According to data from a long term fixed location observation after that resulted in Table 2. As the conductivity and absorption of mud were higher than water on temperature, mud absorbed heat from sunlight and transferred to the water. Even in the early spring, the water temperature of ditch was 0.5° above fishponds.

In the highest temperature of dog days, rice produced the shadowing effect after the closing of the crop and the strong sunlight was absorbed and reflected. That was the reason why the ditch temperature was lower than fishponds. So a temperature buffer system was created, which was more fit to fish growth.

Increase oxygen content: The rice consumed carbon dioxide and released oxygen, which gone into water and the oxygen would also give fish air to breathe. According to the measuring the oxidation-reduction potential of ditch was 200-500 mV higher than fishpond. Beyond that, there was no fish emerging the phenomenon “floating head”, on the demonstration area of 20 ha. Other ponds, by contrast, low dissolved oxygen in water, fish floating head phenomenon occur severely.

Provide more natural bait: There were abundant natural bait due to the reasons of fertilization, plants and high temperature, such as water animals and plants, weeds and pests. The volume of fish can reach up to 150 to 300 kg/ha without throwing bait according to data provided by our there testing grounds. According to the input-output ratio of fish, these fish can eat off 450 to 900 kg of water animals and plants, weeds and pests.

In conclusion, the model of rice planting on the ridge and fish rearing in the ditch was an agricultural ecological pattern with higher economical benefits, better ecological benefits and more social benefits. From 1988 to 2003, along with the spread of the

pattern, growing area increased from 1.33 to 5695.33 ha. Altogether we extended 7460.33 ha of the pattern, which increased about 14.77 million for farmer.

REFERENCES

Cao, Z., Z. Liang, Y. Zhao and Y. Dong, 2001. Symbiotic effect of cultivating fish in rice field in north China. Chinese J. Appl. Ecol., 12(3): 405-408 (In Chinese).

Duan, S.S., S.M. Luo and K.Z. Cai, 1997. Principles of ecosystem and sustainable agriculture. Chinese J. Appl. Ecol., 6: 663-668 (In Chinese).

Gao, S.B., 1998. Developing eac-agriculture for sustainable agriculture in China. Eco-Agric. Res., 2: 10-14 (In Chinese).

Huang, F.Y., M.W. Li, D.H. Yang *et al*., 2003. Analysis of comprehensive benefits of rice planted on the ridge and fish reared in the Ditch. Hubei Agric. Sci., 2: 26-27.

Ni, D.S. and J.G. Wang, 1998. Resent development of fish culture in the rice field in China. Acta Hydrobiologica Sinica, 12(1): 361-375 (In Chinese).

Pan, W.B. and D.P. Zhuang, 1999. The history of development and major models of rice-fish in China. J. Fujian Province Vocat. Coll., 6: 69-75 (In Chinese).

Wen, J.J., 2001. The reason of long-lasted high production and high efficiency of rice planted on the ridge and fish reared in the Ditch and matching techniques. Tillage Cultivation, 5: 17-18.

Xiang, X.J., F.Y. Huang, H.W. Zhang *et al*., 1988. Effect analysis of semi-arid cultivation of paddy on improving soil fertility and increasing crop yield. Soils Fertilizers, 1: 23-26.

Xu, S.H., R.P. Li, L. Ling *et al*., 2006. The techniques for raising fishin paddy fields of single cropping rice. Hybrid Rice, 21(2): 53-54.

Yang, Q.H. and Z.K. Yang, 2002. The model and technology of cultivating fish in rice field. Rural Anim. Prod. Technol., 10: 16 (In Chinese).