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RESEARCH ARTICLE

Linking Farmers and Businesses in Integrated Organic Rice and Shrimp Farming – The Best Way for Enhancing Farmer's Income and Sustainable Agriculture Development

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ABSTRACT

Introduction: The model of shrimp-rice rotation in coastal provinces in Mekong Delta (MD), Vietnam, is a special farming system and has become the cultivation practices for decades. **Material and Method:** This paper taking integrated organic rice and shrimp farming and value change linkage between farmers and companies into consideration for research and development and suggesting suitable solutions in organic agriculture (OA) development. **Result:** Organic rice production increased profit from 6 to 10 million VND per ha compared to conventional inorganic rice production. Organic products will maintain stable market credibility in the country as well as export, creating mutual benefit for both farmers and business in the value chain linkage. **Conclusion:** OA is also contributed to protecting the public health and preserving the environment in a clean and sustainable way.

Key words: Organic rice, shrimp-rice system, value chain linkage, Mekong delta

INTRODUCTION

The model of shrimp-rice rotation in coastal provinces in Mekong Delta (MD), Vietnam, is a special farming system and has become the cultivation practices for decades. At present, seven provinces in the MD are applied shrimp-rice farming systems; those are Soc Trang, Tra Vinh, Bac Lieu, Ca Mau, Ben Tre, Kien Giang, and Long An. In it, there are some provinces not only produce shrimp but also other aquatic species such as white leg shrimp, green crayfish, crab, fish of all kinds. in general, the rice-shrimp system with a total area of about 140,000 ha, which is the largest area with 60,000 ha in Kien Giang and lowest area is 500 ha in Long An provinces.[1] According to Thanh *et al.,*[2] they have reported in the proceedings of the IAS in 2016 that shrimp-rice farming systems in the MD, in general, and, in particular, in Tra Vinh are a model of environmentally sustainable farming, in line with climate change and high economic efficiency. With the recommendation that the system should maintain rotational cultivation of rice-shrimp/aquaculture, rice monoculture is not suitable and cannot give up the rice-shrimp system to chase for mono shrimp cultivation (due to the high profits of shrimp, but the monoculture shrimp cultivation, income of farmers is not secure and more than 80% are failed).

The rice-shrimp system has the characteristics of mutual benefits as follows:

- Taking advantage of residual organic matter after the shrimp cultivation to supplement nutrition for the rice crops,
- Shrimp/aquaculture raising after rice was used artificial and natural feeds from plankton in the wetland environment and developed well due to the decomposition of roots,
- A rice-shrimp farming creates ecological balance and environmental safety condition for crops and livestock (aquaculture),
- Limiting pests for both rice and livestock thank to the rotation to cut the pest's source,

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- Increase resolution and leaching toxic elements by rotating modes of ecosystems (saltwater, freshwater exchange, and rice root activity and the movement of livestock in the field),
- Reduce production costs by limiting the use of fertilizers due to persistent organic material residues in the soil,
- Limit or no use of pesticides by cutting off sources of pests by rotation, no tillage, no weeding or do very little because no weeds in the flooded fields before planting rice, thus reducing environmental pollution,
- As a basis condition for the creation of delicious, organic cleaning products to serve for human health, creating important commodities for export, and increasing income for farmers and businesses participating in the linkage from production to consumption.[3]

This paper presents the research and successful development of the rice-shrimp model in the direction of organic linkage from production to consumption of certified organic rice products. Throughout the model, farmers have improved their incomes and profits. Companies have built stable, high-quality organic rice material zones for export, serving people in the domestic markets and step by step expanding the model to ensure effective agricultural development, sustainability, environmental protection, and public health.

METHODOLOGY OF RESEARCH PAPER

This paper taking integrated organic rice and shrimp farming and value change linkage between farmers and companies into consideration for research and development and suggesting suitable solutions in organic agriculture (OA) development. The authors have implemented many scientific researches for organic rice production such as: Baseline survey on agricultural production status, and strengths, weaknesses, opportunities, and threats (SWOT) analysis in the project area. Many experiments were designed with suitable methodology such as research on sowing methods and sowing density suitable for rice-shrimp cultivation system. The two types of sowing (row seeding and scatter seeding) are arranged in the main plot and the main factors are the sowing density (60, 80, and 100 kg of rice seed per ha for main factor) located in subplots.

The author also implemented experiment to evaluate rice varieties suitable for rice-shrimp cultuvation areas. The experiment was arranged in randomized complete block design, one factor with three replications in farmers' fields representing the production area.

Building organic rice production model in large scale

Building organic rice production model is based on principles for organic production. According to the International Federation of Organic Agriculture Movement (IFOAM), there are four principles of OA, approved by IFOAM from September 25, 2005[4]: Principles of health: OA maintains and increases the health of soil, plants, and animals and people as a whole and cannot be separated; ecological principle: OA based on living ecological systems and cycles, the impact on them, simulate and support them; principle of fairness: OA builds on relationships that ensure fairness concerning common environment and life opportunities for all people, creatures, and plants; and principle of preserving the environment: OA needs to manage in a prudent and responsible to protect the health and welfare of the current generation, and environmental future.

Standards of organic farming: According to the USDA,[5] OA produces products using the methods of conservation of the environment and avoids the use of synthetic inputs such as chemical fertilizer and pesticides and antibiotic. The USDA organic standards will specify the inputs used for crop and OA for pets. USDA defined organic standards in particular. These standards include products from farm to eating table and even the quality of soil, water, pest management, agricultural practices, animal husbandry, and processing.

RESULTS AND DISCUSSION

Why produce organic? Author Nguyen Cong Thanh has summarized the following reasons for organic production[6]:

- Avoid poisonous chemicals from fertilizers and pesticides
- Mitigate the impact of climate change
- Protect the environment and the planet for the present and the future
- Organic products accumulate nutrients better for health

- Stay away from harmful ecological and health effects from genetically modified foods
- Taste of organic food is tasty, natural, and better
- Direct support for cultivators
- Preserve biodiversity, agriculture
- Prevent antibiotics, growth drugs, hormones in animal products
- Ensuring the true value of organic products "less is more" > no hidden costs
- Guaranteed reliability with high standards (international)
- Better animal care and good for wildlife
- Ensure honesty in production, business, moral values, humanity, and justice for all living things.

Summary of some research results on organic production

SWOT analysis of the status on organic production

SWOT analysis of the status on organic production has shown in the Table 1. Organic rice still faces many difficulties and challenges. However, the strengths and opportunities are very important for the expansion of production and the development of organic agricultural markets. As for strengths: The potential of land and labor are available. For opportunities are growing demand of organic food in the country and internationally. So the demand for organic rice for export is very high, this is the new opportunities for businesses to enter into organic agriculture.

Sowing research

The results showed that two types of sowing such as scattered sowing and sowing in rows with seed density of 60 kg, 80 kg, and 100 kg per ha in organic rice-shrimp model showed that the highest productivity got at density of 80 kg/ha; rowing seeding or sowing in rows pattern tends to produce higher yields than scattered sowing.[5]

Rice variety testing

The study on some suitable rice varieties in the rice organic shrimp model showed that the yield of rice variety namely VTN 19 (imported rice) was highest (47.17 quintals per hectare), next by the control variety ST 5 (45.20 quintals/ha) followed by OM 4900 (43.71 quintals/ha), OM 6162 (41.90 quintals/ha), and OM 5451 (40.92 quintals/ha).

The level of infection of some major pests and diseases in varietal experiment did not affect the growth and productivity of the testing varieties.

Kind of organic fertilizer testing

The study on some current organic fertilizers and compared to inorganic fertilizers showed that experimental fertilizer treatments have affected lightly on growth parameters of rice, but most of them were not statistically significant.

- Rice yield per hectare was highest in the inorganic fertilizer treatment (5128.33 kg/ha) and significantly different from the organic fertilizer treatments.
- Rice yield/ha among the organic fertilizer treatments such as Nhat Nong (4637.33 kg/ha), Komix (4608.67 kg/ha), and Ecotiger (4646.67 kg/ha) was equivalent and not statistically significant, but these treatments have higher yields than treatments of ADC organic fertilizer (4439.00 kg/ha) and Que Lam (4391.67 kg/ha) and statistically significant. The two treatments of ADC and Que Lam were similar yields.

Study on the dosages of organic fertilizers

- Study on the dosages of imported organic fertilizer (Ecotiger) and domestic organic

Table 1: SWOT analysis of the current status on organic production

Strength	Weakness
Potential land, labor	The market is not strong
Production experience	Low income of most people
Source of organic fertilizer available in nature and production	High organic input prices
Biotechnology	Lack of certification bodies and high cost of certification
	Production is not concentrated
	Production is small and backward
	Lack of trust
Opportunity	**Challenge**
Big demand, increasingly	Weather climate change
Social fit, trend of the times	Many competitors
New attractive business	Serious lack of certified organic fertilizers
Interest/support policy	Serious lack of certified organic plant protection products
	Serious lack of nitrogen (N) and potassium (K) organic fertilizers
	There is no guarantee of productivity in intensive farming when moving to organic cultivation

SWOT: Strengths, weaknesses, opportunities, and threats

fertilizer (Nhat ong): Increasing organic fertilizer Ecotiger dose tends to increase the yield of ST 5 rice. However, if the increase is over 300 kg/ha, the yield tends to decrease and economic efficiency is low due to increased cost (the price per kg is very high). Hence, in the rice-shrimp areas, land is available with many nutrients, the suitable dosage of organic Ecotiger fertilizer can be applied <300 kg/ha.
- For Nhat Nong organic fertilizer (low price fertilizer), with dosage of about 1000 kg/ha for the highest yield. Fertilization with more than this dosage, the yield increased but not significant.

Study on the organic rice plant protection

The study on the occurrence of pests in organic rice and apply biopreparations to prevent them led to the observation that during the experiments, the occurrence of pests and diseases in rice field on organic production was not considerably. Therefore, the effect of biopreparations is not clear. This result in line with Litterick *et al* statement. They stated that pests are generally not a significant problem in organic systems since healthy plants living in good soil with balanced nutrition are better able to resist pest attack.[7]

Results of the organic rice model in 3 years (2015–2017) **[Table 2]**

- Average yield of organic rice model in 2015 was 4.29 tons/ha, in 2016 was 4.50 tons/ha, and 2017 was 4.70 tons/ha.
- Organic rice price was 8700 Viet Nam Dong (VND), 9280 VND, and 10,440 VND per kg for the year 2015, 2016, and 2017, respectively.
- Total income per ha for organic rice model, respectively, for 2015, 2016, and 2017 was 37,323,000 VND, 49,782,000 VND, and 51,183,000 VND.
- The profit per ha of organic rice for 2015, 2016, and 2017 is 24,023,000 VND, 36,482,000 VND, and 37,883,000 VND.
- On an average per ha of 3 years developed organic rice model, the total cost was 13,300,000 VND; the productivity was 4.5 tons/ha; average selling price was 9473 VND/kg; total income was 46,097,000 VND and profit was 32,797,000 VND. While the average of inorganic rice over 3 years mentioned above has a total cost of 14,400,000 VND/ha; average yield was 5.40 tons/ha; average price of rice was 6400 VND/kg; total income 34,992,000 VND; profit was only 20,592,000 VND.
- Total cost of organic rice production was 1,100,000 VND/ha lower than inorganic rice; yield decreased compared to inorganic 0.9 tons/ha. However, the price of organic rice was higher than that of 2993 VND/kg; the higher inorganic income was 11,105,000 VND/ha, resulting in a higher profit of 12,205,000 VND/ha (1 USD = 22,745 VND, exchanged rate in 2017)
- Efficiency of one capital (or marginal benefit-cost ratio [MBCR]) to produce organic rice was increasingly following production years 2015, 2016, and 2017 with 1.81, 2.74, and 2.85, respectively. In average was 2.47. While in inorganic rice only 1.43, the difference was 1.04.
- Effectiveness of fisheries: Rice-shrimp/crab farming rotations: Given income of about 70 million VND/ha, excluding cost, the benefit was about 40 million VND. In case of aquatic farming intercropped with rice, farmers can increase revenue from 15 to

Table 2: Economic efficiency of organic rice production model in Chau Thanh, Tra Vinh

Model	Year	Total cost (million VND/ha)	Rice yield (tons/ha)	Rice price (VND/kg)	Total income (million VND/ha)	Profit (million VND/ha)	MBCR
Organic rice	2015	13.3	4.29	8700	37.323	24.023	1.81
	2016	13.3	4.50	9280	49.782	36.482	2.74
	2017	13.3	4.70	10.440	51.183	37.883	2.85
	Average	13.3	4.50	9473	46.097	32.797	2.47
Inorganic rice	Average (2015-17)	14.4	5.40	6480	34.992	20.592	1.43
Difference		−1.1	−0.9	2993	11.105	12.205	1.04

1 USD=22.745 VND, exchanged rate in 2017. VND: Viet nam dong, MBCR: Marginal benefit-cost ratio

20 million/season/ha [Figure 1]. There is also effective in environmental safety, and human and animals health.

Shrimp, crab, and fishes rotational farming and intercropping in organic rice fields, farmers strictly follow the process of organic production, absolutely do not use chemical products to meet the standards of organic rice. It is important condition for shrimp, crabs, and fishes cultivation to earn more income while inorganic rice fields cannot be developed due to toxic pollution.

Rice products from the research project have achieved organic certificates from international

Figure 1: Thanks to organic rice production, farmers can collect more aquatic resources from intercropping and rotating shrimp and fish in the field (picture by Nguyen Cong Thanh)

Table 3: Evaluation on economic efficiency of organic rice model in An Minh district, 2017

No.	Items	Total cost per ha (mil. VND) ST 24 OMMBĐ IM		Difference (OM/IM; %)
I	Total cost (mil. VND/ha)	12.150	13.850	−14
1	Fertilizers	3.500	3.850	−10
2	Plant protection products	0.300	1.150	−283.3
3	Rice varieties	1.500	2.000	−25
4	Labor cost	6.850	6.850	0
II	Average yield (Tons/ha)	4.20	4.90	−17
III	Total income (mil. VND/ha)	25.648	25.480	0.6
IV	Profit/ha			
	At market prices	13.498	11.630	14 (1.868)
	Plus 500 VND/kg	15.599	11.630	25 (3.969)
	20% bonus on organic certification	19.009	11.630	39 (7.397)

ST 24 OM: Soc Trang 24 rice variety in organic model; MBĐ IM: Mot Bui Đo rice variety in inorganic model, VND: Viet Nam Dong

Table 4: Evaluation on economic efficiency of organic rice model in Long Son village Cau Ngang district, Tra Vinh Province, 2017

Average yield of organic rice model compared to mass production in Autumn-Winter 2017				
Model	**Area (ha)**	**Average yield (tons/ha)**	**Highest yield (tons/ha)**	**Lowest yield (tons/ha)**
Organic rice	14.9	5.0	5.9	4.1
Mass production	1200	5.6	6.0	4.0

Cost of organic rice production compared to mass production in Autumn-Winter 2017					
Model	**Rice varieties (mil. VND/ha)**	**Fertilizers (mil. VND/ha)**	**Plant protection products (mil. VND/ha)**	**Labor cost (mil. VND/ha)**	**Total cost (mil. VND/ha)**
Organic rice	1.550	5.175	0.680	11.400	18.805
Mass production	1.500	3.000	1.100	9.500	15.100

Efficiency of organic rice model compared to mass production in Autumn-Winter 2017					
Model	**Yield (tons/ha)**	**Rice price (VND/kg)**	**Total income (mil. VND/ha)**	**Profit (mil. VND/ha)**	**MBCR**
Organic rice	5.3	7000	37,100	18,295	1.0
Mass production	5.0	5600	28,000	12,900	0.8
Difference	0.3	1400	9100	5395	0.2

organizations such as EU (Europe), USDA (United States), and JAS (Japan). Organic rice product was exported to Europe or other countries at relatively high prices compared to normal inorganic rice, which helps increase income for farmers and businesses.

For 3 consecutive years (2015-2017), the project has coordinated with enterprises to organize the organic rice production model for farmers participating in the project. The organic rice product from the model got EU, USDA and JAS certified standards. Organic rice products in the model are exported to the EU markets bringing high profit to farmers and protect sustainable environment [Figure 2].

Figure 2: Organic rice products with EU, USDA, and JAS certification from 2015 to 2017

Figure 3: Organic rice model in Thanh An Cooperative, Dong Thanh Village, An Minh district, Kien Giang Province, 2017

Figure 4: Organic rice model in Long Son Village, Cau Ngang district, Tra Vinh Province, 2017

Figure 5: Organic rice model in My Xuyen district, Soc Trang Province, 2017

Figure 6: Organic rice model in Giang Thanh district, Kien Giang Province, 2018

Figure 7: Organic rice model in Tri Luc village, Thoi Binh district, Ca Mau Province, 2018

Table 5: Evaluation on economic efficiency of organic rice model in My Xuyen district, Soc Trang Province, 2017

No.	Items	Inorganic local rice variety	ST24 organic model	Difference (OM-IM)
I	Total cost (mil. VND/ha)	13.802	17.040	3.238
1	Rice varieties	0.600	1.200	0.600
2	Transplanting	4.855	4.000	−0.855
3	Fertilizers	3.747	5.240	1.473
4	Irrigation and plant protection	-	2.000	2.000
5	Harvesting	4.600	4.600	0
II	Rice yield (tons/ha)	4.74	4.50	−0.24
III	Total income (mil. VND/ha)	20.200	33.750	13.550
IV	Profit/ha	6.398	16.710	10.312

OM: Organic model; IM: Inorganic model, VND: Viet Nam Dong

Figure 8: Organic rice model in Tan Loc Bac village, Thoi Binh, Ca Mau Province, 2018

Figure 9: Some photos on the activities of the agricultural extension organizations in the organic rice models in the Mekong Delta

Organic rice model multiplication

Scaling up model of organic rice in Thanh An Cooperative, Dong Thanh Village, An Minh district, Kien Giang Province, 2017

Results of replication of organic rice model in Thanh An cooperative, An Minh district, Kien Giang province in 2017 were presented in Table 3 and Figure 3.

The Table 3 shown that, In the organic rice model using ST 24 rice variety compared to conventional production control using the Mot Bui do traditional variety. Paddy rice in the model of organic rice farmers in Thanh An cooperative is purchased by the company at a higher price than regular rice. So farmers have a profit of 19009000 VND/ha compared to inorganic rice only 11630000 VND per hectare, an increase of over 39%.

Scaling up model of organic rice in Long Son Village, Cau Ngang district, Tra Vinh Province, 2017

Results of replication of organic rice model in Long Son village, Cau Ngang district, Tra Vinh province in 2017 are presented in Table 4 and Figure 4.

In this model, organic rice yield is higher than inorganic (5.3 tons compared to 5.0 tons/ha). The price of organic rice was bought 7000 VND/kg compared to inorganic only 5600 VND/kg, from which the income/ha increased by 9100000 VND/ha, the profit increased by 5395000 VND/ha, the profit margin increased more than 0, 2 times as compared to conventional production.

Scaling up model of organic rice in My Xuyen district, Soc Trang Province, 2017

Results of replication of organic rice production model in My Xuyen district, Soc Trang province in 2017 are presented in Table 5 and Figure 5.

Economic efficiency of replication model in My Xuyen district shows that Rice yield (tons/ha) of inorganic production is 4.74, compared to organic is 4.50, organic yield is lower than inorganic 0.24 tons/ha. Total income (mil. VND/ha) for inorganic is 20200000 VND/ha compared to organic is 33750000 VND/ha. The organic income is higher as compared to inorganic with 13550000 VND/ha. Profit/ha of inorganic rice production is 6398,000 VND/ha as compared to organic is 16710000 VND/ha. Then the profit of organic production higher than inorganic is 10312000 VND/ha.

Scaling up model of organic rice in Giang Thanh district, Kien Giang Province, 2018 **[Figure 6]**

Results of model replication in Giang Thanh and Tinh Kien districts in 2018 were also very exciting

when farmers achieved economic efficiency equivalent to organic rice production in An Minh district (Kien Giang) presented in Table 3.

Scaling up model of organic rice in Tri Luc village, Thoi Binh district, Ca Mau Province, 2018

Scaling up model of organic rice in Tri Luc (and Tan Loc Bac) Village, Thoi Binh district, Ca Mau Province, in 2018 was illustrated in Figures 7-9.

Due to the salinity conditions, the replication of rice-shrimp area in Thoi Binh district is not high in terms of economic efficiency, but the results show that it is very satisfactory in terms of productivity compared to inorganic production and farmers accept for multiplication in the next season with attention to sowing early time, saline management to limit damage.

Scaling up model of organic rice in Tan Loc Bac village, Thoi Binh district, Ca Mau Province, 2018

Companies and farmers win-win strategy

Smallholder farmers, small farming, and their development are important factors of sustainably developing agribusinesses. Businesses are increasingly looking to collaborating with farmers and integrating them into their business models to develop sustainable incomes for smallholders, companies with mutual benefit, and mutual responsibility to protect environment, provide assurance models, and guarantee supply security to achieve mutual win-win strategies.

Agriculture only develops sustainably and efficiently when farmers and businesses are linked together for the purpose of mutual benefits, sharing responsibilities, and interests in production and business and toward safety production, organic and environmental protection, and public health.

The participation role of extension organizations

The project has the active coordination and participation of local extension organizations in organizing the model with the following activities:

- As the core of organizing the link between entrepreneurs, farmers, local government organizations, and scientists from production to marketing.
- Organize farmers to negotiate with enterprises in developing contracts with preferential prices for farmers and support inputs for farmers in organic rice production.
- Organize technical training activities on organic rice production, set up a model to obtain international organic rice certification, model demonstration and organize study tours for farmers and students, etc.

CONCLUSION AND SUGGESTION

- Organic rice production model "linking 4 partners" starting from 2015 to 2017 has had good results.
- OA has many difficulties and challenges, but we can do it. The immediate area is in the rice-shrimp zones with the potential of hundreds of thousands hectares. After that, step by step expands the areas of intensive rice and other economically valuable crops.
- Organic rice production increased profit from 6 to 10 million VND/ha compared to conventional inorganic rice production.
- Organic products will maintain stable market credibility in the country as well as export, creating mutual benefit for both farmers and business in the value chain linkage.
- OA is also contributed to protecting the public health and preserving the environment in a clean and sustainable way.

Suggestion

- Early completion of OA policy and organic labeling related to international OA.
- Create good condition for private organizations participating in organic certification in accordance with national and international standards.
- Certification of organic inputs such as fertilizers, biopesticides in the country, and import.
- Planning organic production areas for rice and other high-value crops (pepper, cashew, cocoa, coffee, fruit, and vegetables).
- Develop organic markets in both domestic and international.
- Organizing research and training system-related OA.
- Promulgate policies to encourage businesses and individuals, farmers to invest in OA.

- The price subsidy policy for farmers, enterprises initially in terms of productivity can be reduced; cost in soil, water products analysis; training and certification costs.
- Support land use for OA in the planning area, long term.
- Support the propagation on organic products in all forms and all means of listening, viewing; introducing products, fairs, exhibitions, conferences in the country, and internationally.
- Reward: Research, technical transfer, and successfully build the OA models
- Develop OA in combination with maintains, develops, and preserves valuable native plant and livestock genetic resources.

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