Research article

Comparative Study on 3 Rice Farming Systems: Conventional, Partially Organic, and Organic Farming, Case Study in Prey Kabbas District, Takeo, Cambodia

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Abstract Sustainable agriculture is an integrated farming system of plant and animal production practices with site-specific applications that can maintain over the long term. It is both environmentally sustainable and also can generate several impacts on rural society. Unfortunately, the development of sustainable farming in Cambodia is still limited, and in its early stages. Despite sustainably farming has the potential for targeting niche markets and ensure higher incomes, it is reported that the number of farmers choose to do or revert to produce conventional rice farming instead. The application of chemicals in conventional agriculture can generate high productivity; however, the intensive use of the chemical has led to the destruction of soil and water resources. By observing these matters, this study aims to examine the differences in characteristics and profitability between 3 farming systems: conventional, partially organic, and organic rice farming, and to identify impacts from sustainable farming to rice farmers. The present study is based on the survey conducted in Prey Kabbas District, Takeo province, in 2018. In this study, a random sampling method was applied, and 75 rice farmers were interviewed. Among the samples, 30 farmers practiced conventional rice farming, and others 45 farmers practiced sustainable rice farming (25 adopted partially organic, and 20 farmers adopted organic rice farming). The findings showed that despite the production costs of organic rice farming is higher, organic farmers still ensure higher yield and generate better profit. Both of sustainable rice farming systems also found to benefit farmers with both social and human impacts. Nevertheless, there are some constraints inhered these rice farming in this study area, such as labor shortage, lack of organic materials, and market instability. There are needs for farmers, supported institutes, consumers to work together to promote organic rice farming in the study area.

Keywords conventional rice, organic rice, partially organic rice, profitability, Cambodia

INTRODUCTION

Food is crucial to human life. The rapid growth of populations, which in turn entails increased demand for food, has led to changes in agricultural systems. With respect to Cambodian agriculture, more Cambodian farmers are in the midst of transition from traditional subsistent to modern commercial ones (Slayton et al., 2015). Modern agriculture systems have been practiced in many countries, including Cambodia, with the aim of poverty alleviation, food security, and increasing competitiveness. Although conventional agriculture has many large-scale positive effects, such as high yields in crops and increases food supply through the adoption of new technologies. The intensive use of chemical and mechanization has led to the destruction of the soil and water resources. It has damaged the critical supporting ecosystems (OECD, 2001).

Cambodia is one of the countries in Southeast Asia that is profoundly affected by the impacts of climate change, from the enormous floods in 2011 to the prolonged droughts in 2016. Cambodian farmers have been increasingly exposed to the adverse effects of climate-related risks, both in terms of crop growth and pest and disease outbreak. It is recommended by Slayton et al. (2015) to strengthen sustainable agriculture for future agriculture growth in Cambodia. However, there is still much work that needs to be done in promoting sustainable agricultural practices to Cambodian farmers. Improper and excessive use of fertilizer is still one of the major agricultural issues in the country. Farmers apply pesticides that are often not safe or counterfeit. Aside from being an unnecessary expense, this also results in an opposite outcome, which is the reinforcement of pest outbreaks by increasing pest resistance.

OBJECTIVES

The objective of this study is to grasp the differences in characteristics and economic performances of 3 farming systems in the study area: conventional, partially organic, and organic farming, and to identify the impacts of sustainable agriculture toward farmers in Prey Kabbas District, Takeo, Cambodia.

METHODOLOGY

The study was conducted in Prey Kabbas District, Takeo province. This province classified as one of the most significant rice-producing areas in Cambodia. Eighty-three percent of the population is engaged in this sector. However, this research site is regarded as low diversification in farming systems, and it is easy to prone to a natural disaster such as drought and flood every year. With such a poor farming condition, farmers in the research site have gradually shifted toward sustainable farming with the help from the government and Non-Profit Organization (Prey Kabbas district report, 2014).

This study is based mostly on primary data collected through direct interviewing with rice farmers in the district. Interviewed farmers were selected by random sampling method. The survey was conducted from August to September 2018 (20 days). Totally 75 rice farmers were interviewed and categorized into three groups: group A (conventional farmers- 30 respondents) and a group of farmers who practiced sustainably adopted rice farming: group B (partially organic farmers- 25 respondents) and group C (organic farmers- 20 respondents). The partially organic farmers refer to a group of farmers who used at least 50 percent of organic material in rice farming, and organic farmers refer to a group of farmers who applied only organic material in rice farming.

RESULTS AND DISCUSSION

Socio-Economic Characteristics of Studied Farmers

Table 1 Socio-economic characteristics of sustainable and conventional rice farmers

	Conventional (a)	Sustainable farming		T-test (t stat)		
		Partially Organic (b)	Organic (c)	(a) & (b)	(a) & (c)	(b) & (c)
Number of household (HH)	30	25	20			
Average of male head of HH	25(81.48%)	24 (96%)	20 (100%)			
Average family size (person)	4	4	4	-0.8	-1.4	-0.73
Average age (years old)	53.93	46.20	49.50	1.99*	1.07	-0.89
Year of education (years)	6.33	7.32	8.17	-1.08	-1.73	-0.85
Average owned land per HH (ha)	0.80	0.38	0.64	-1.46	-1.14	0.24
Average planted area per HH (ha)	1.02	0.87	0.64	0.37	1.03	1.10

Source: Field survey in 2018
**Indicates statistical significance at 0.05 level*

The basic features of interviewed farmers are presented in Table 1. Table 1 showed that farmers of groups B and C had more extended education compare to farmers in group A, although it is not significantly different. This indicated that education encourages farmers to adopt a new farming system while considering the environment and agricultural production in the long term. However, concerning family size and owned and planted areas, there was no significant difference among these 3 group farmers.

Total Production Cost of Rice Farming

Table 2 Total production cost of three farming systems

Item	Conventional (a)	Sustainable farming		T-test (t stat)		
		Partially organic (b)	Organic (c)	(a) and (b)	(a) and (c)	(b) and (c)
Number of HH (HH)	***30***	***25***	***20***			
Paid purchased seed	8.88	13.35	3.25	-0.65	1.16	1.57
Imputed cost of keeping seed	79.66	60.61	14.35	1.61	6.15 *	5.55 *
Chemical fertilizer	66.63	42.97	0.00	3.66 *	15.17 *	9.06 *
Paid organic fertilizer	0.00	3.72	119.99	-2.14 *	-6.68 *	-6.42 *
Imputed cost of organic fertilizer	0.00	20.20	23.89	-6.98 *	-3.65 *	-0.52
Insecticide	15.62	22.22	0.00	-1.08	4.92 *	4.32 *
Herbicide	20.78	22.42	0.00	-0.46	9.49 *	7.99 *
Fuel	13.71	20.17	30.72	-1.39	-3.97 *	-1.94 *
Water charge	3.13	5.00	0.00	-0.45	1.36	1.44
Material cost	***208.41***	***210.66***	***192.30***	***-0.17***	***0.89***	***0.99***
Paid land preparation service	65.19	47.30	30.40	2.58 *	3.64 *	1.74
Imputed cost of land preparation	28.70	32.00	18.06	-0.67	1.74	2.25 *
Paid harvesting service	***107.41***	93.00	40.97	2.36 *	5.68 *	4.23 *
Imputed cost of harvesting	0.00	0.00	0.00	-	-	-
Total service cost	***201.30***	***172.30***	***89.43***	***2.63*** *	***5.90*** *	***-4.08*** *
Hired labor	*23.85*	32.35	117.72	-1.43	-5.48 *	-4.90 *
Family labor	106.43	96.50	276.79	1.05	-6.45 *	-7.10 *
Total labor cost	***130.28***	***128.85***	***394.51***	***0.12***	***-8.37*** *	***-8.55*** *
Rented land	2.67	5.80	0.00	-0.65	1.00	1.44
Total variable cost	**325.20**	**302.50**	**343.05**	**1.30**	**-0.65**	**-1.37**
Total cost	***542.66***	**517.61**	***676.14***	**1.33**	**-3.92** *	**-4.56** *

Source: Field survey in 2018 *Unit: USD/ha*
**Indicates statistical significance at 0.05 level*

It found that in the study areas, there were three different types of rice farming existed and that the systems differed much in the input use among them. Thus, in the analysis of costs and returns of rice farming, diversified aspects among three farming systems should be full took into account.

Concerning the cost analysis, this study followed the method of Slayton et al. (2015). The study calculated the cost not only of cash payment, but also imputed costs such as cost of organic fertilizer, family labor costs, cost of owned land, and depreciation of farm assets. To check the significance of differences in cost items between farming systems, T-test with two-sampled assuming unequaled variances is applied in this study as well.

As shown in Table 2, the total production cost of organic farming per ha was higher than conventional and partially organic farming in the study area. Cost comprised both cash and non-cash costs, based on the result of the survey; cash costs were the ones that directly affected the farmers' financial conditions. High cash costs could disrupt farm production activities and put farmers in debt. Although the overall total costs of organic rice were higher, it is also clearly shown that organic rice farming initially entailed similar cash costs to the conventional and partially organic rice farming in the study area.

Economic Returns of Rice Farming

Regarding economic returns, several indicators, such as gross margin, total cash income, and net profit of each rice farming type, are examined in this study. Gross margin obtained by deducting gross revenue, intermediate inputs, and hired labor. Total cash income calculated by subtracting total cash expenses from gross revenue. Finally, net profit calculated by deducting costs of family

labor, costs of owned land, and depreciation cost from gross margin. In addition, T-test analysis with two-sampled assuming unequal variances was applied in this study as well.

Table 3 showed the comparison of cost and returns per hectare among conventional and sustainable rice farming in the study area. The production of organic rice was significantly more profitable than conventional rice farming in terms of gross margin and total cash income. However, when total net profit was analyzed, the result showed conventional, partially organic, and organic rice farming was not significantly different. This indicated that whatever model used that excluded non-cash cost, organic farming in the study area was the most profitable. It is understandable since organic farming in the study area obtained higher yield and premium price compare to conventional and partially organic rice. Although partially organic rice practiced in consideration of environment and health purposes, however, the average price of partially organic rice was not significantly different from conventional rice, which resulted in less profitable than organic rice farming.

As mentioned earlier, whenever non-cash expense considered in this study, organic rice was not significantly the most profitable one among groups. In general, most organic rice farmers used their on-farm resources to do organic farming; however, in this specific study area, farmers tended to purchase lots of animal manure from farmers from other villages. Higher organic fertilizer and family labor costs resulted in less total net profit in comparison to conventional and partially organic farming. This result also realized the reason behind the concerns of farmers to continue producing the organic products in the study area.

Table 3 Net profit of three farming systems

Item	Conventional (a)	Sustainable farming		T-test (t stat)		
		Partially organic (b)	Organic (c)	(a) and (b)	(a) and (c)	(b) and (c)
Number of HH (HH)	***30***	***25***	***20***			
Paddy yield (ton/ha)	3.27	3.37	3.57	-0.57	-1.26	-0.79
Paddy price per ton (USD)	287.96	289.50	329.17	-0.65	-3.20 *	-3.11 *
Paid Material Cost	128.75	129.85	153.96	-0.07	-1.40 *	-1.15
Total Material Cost	208.41	210.66	192.20	-0.17	0.89	0.99
Hired labor cost	23.85	32.35	117.72	-1.43	-5.48 *	-4.90 *
Family labor cost	106.43	96.50	276.79	1.05	-6.45 *	-7.10 *
Total labor cost	130.28	128.85	394.51	0.12	-8.37 *	-8.55 *
Total job commission	172.60	140.30	71.37	3.33 *	6.51 *	4.34 *
Cash land rent	2.67	5.79	0.00	-0.65	1.00	1.45
Owned land Rent	71.99	72.38	75.00	-	-	-
Depreciation	33.05	57.32	105.68	-1.06	-1.80	-1.10
Total cash expense	327.87	308.29	343.05	1.11	-0.56	-1.16
Total expenses	616.33	609.51	838.76	0.23	-3.91 *	-3.88 *
Gross revenue	**941.63**	**975.62**	**1175.14**	**-0.63**	**-3.02 ***	**-2.60 ***
Gross margin	**616.43**	**673.12**	**832.09**	**-0.95**	**-2.51 ***	**-1.81**
Total cash income	**613.76**	**667.33**	**832.09**	**-0.89**	**-2.54 ***	**-1.87**
Net profit	**402.29**	**441.13**	**374.62**	**-0.61**	**0.30**	**0.68**

Source: Field survey in 2018 *Unit: USD/ha*
**Indicates statistical significance at 0.05 level*

Impacts and Constraints of Sustainable Rice Farming

Understanding the considerable differences in costs and returns between conventional and sustainable rice farming in the study area, it is also necessary to examine the impacts and constraints from adopting these farming systems to farmers. The distribution of respondents' opinions and benefits they received is explained mainly in the descriptive analysis.

Social Impact

Farmer group participation: Based on the survey, it was seen that only 30 percent of conventional farmers were able to participate in farmer groups since most of them were seen to engage in some other off-farm works heavily. On the other hand, organic and partially organic farmers were instead more focus on on-farm work. They found to have some additional spare time to join and participate more enthusiastically in farmer group activities. Some of their hard works

were already recognized and able to generate profit, such as selling their own made livestock feeds, organic rice wine, seeds, and fertilizers to both inside and outside the village. Participation in farmer group activities is not only providing them financial benefits to farmers, but things such as labor sharing, farming information, idea sharing, updating marketing news, and possible sources of funds are provided while joining the group as well.

Relationship establishment: Two kinds of relationships were found: (i) direct relationship and (ii) indirect relationship. With respect to the direct relationship, the connection within the farmers' families is observed. From the survey, within conventional farmers, men mainly took care of most of all the farming work, while women took care of small activities such as seeding, weeding, and post-harvest tasks. Most children and women found to engage more in off-farm jobs. For farmers who practiced sustainable farming, on the other hand, spouses found to work mainly on farmland, and due to the additional labor required, children and wives also took a big part in farming activities as well. This suggesting that a closer family relationship of organic farmers is observed during their work, which also instills agricultural loyalty in the children.

The Indirect relationship between farmers who practice sustainable farming and consumer also existed. Farmers gather together once a month and share their monthly results, update marketing news from dealers, and sharing new sustainable farming knowledge and information. This type of relationship plays a crucial role in strengthening the promotion of organic agriculture in the study area, considering external factors, such as consumer demand, influence the development of agricultural systems.

Human Impact

Knowledge development on sustainable farming: Based on the survey, organic farmers obtained their knowledge of sustainable farming techniques and skills through joining agricultural cooperatives. Certain developments, however, have been adopted by organic farmers through a process of combing local culture and recent findings, to respond to the requirements of agricultural production and environmental conditions. Tables 4 and 5 showed the result estimation of multiple comparison tests between conventional and partially organic farmers regarding their awareness of sustainable farming knowledge. The result implied that partially organic farmers are significantly aware of organic farming and some local knowledge related to a safe way to use agrochemical products.

Table 4 Level of awareness of organic farming technique

Count of respondents			
	Conventional	Partially organic	Total
Aware	9	19	28
Unaware	21	6	27
Total	30	25	55
Chi square value		9.78*	

Source: Field survey, 2018 **Indicates statistical significance at 0.05 level*

Table 5 Level of awareness of safety use of agrochemical

Count of respondents			
	Conventional	Partially organic	Total
Aware	10	20	30
Unaware	20	5	25
Total	30	25	55
Chi square value		10.17*	

Source: Field survey, 2018 **Indicates statistical significance at 0.05 level*

Constraints on Organic Rice Farming

The constraints of organic farming in the study can classify into five categories: (i) lack of organic material, (ii) labor shortage, (iii) long growing period, (iv) low yield, and (v) market instability. As illustrated in Fig. 1, farmers believed that the labor shortage was the main reason that hinders them from adopting organic farming. This is understandable since organic farming spent more time on transplanting and weed management activity, which resulted in higher numbers of labors. In addition, due to off-farm work availability in the study area. This implied that the labor shortage

has already existed in the study area. Lack of organic material was also mentioned as the constraints since most of the farmers in the study are aging, and they found it hard to find or collect the organic materials around their village. As mentioned, farmers tended to purchase lots of animal manure from other farmers even though the price of the animal manure was much higher compared to the inorganic fertilizer.

The long growing period and market instability were concerned by studied farmers as well. They noted that organic farming had a more prolonged production stage, which hindered them from producing rice more than once in a year. Furthermore, most conventional farmers were not members of any organic farmer group, so it was hard for them to find a market for organic products with the premium price.

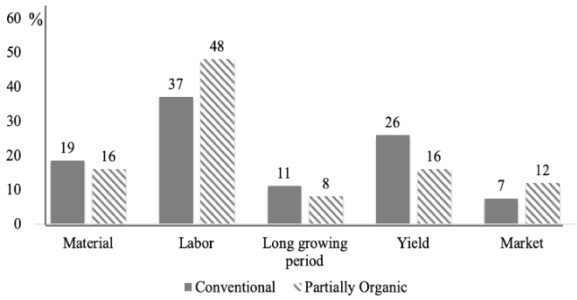

Fig. 1 Farmers' perception of constraints toward organic rice farming

Source: Field survey in 2018

CONCLUSION

The result of the analysis of production costs and returns revealed that cost indicators, such as gross margin and total cash income, reported that organic farming received higher income and more profitable from the economic viewpoint in comparison to conventional and partially organic farming. Moreover, sustainable farming systems such as partially organic and organic also benefited farmers in the study area to establish relationships within their family, among farmers and consumers, aware of the endangerment of agrochemical products to society and environment, and provide the opportunity to share and discuss knowledge and information. Unfortunately, constraints such as labor shortage and lack of organic material had hinder farmers from adopting sustainable farming in the study area. To respond to these matters, two significant issues are needed to address in order to improve the organic farming in the study area: (i) providing detailed training programs more widely especially to young farmers, and (ii) introducing farmers to the integrated farming system to help them minimize production cost, improve quality and quantity of soil and food produced, and increase cash income.

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