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SUSTAINABILITY ASSESSMENT OF ORGANIC VEGETABLE CULTIVATION IN CHIANG MAI, THAILAND

Jintana Kawasaki and Akimi Fujimoto

Tokyo University of Agriculture

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ABSTRACT

Thai farmers are interested in alternative vegetable farming such as safe use farming, natural farming, chemical pesticide free farming and organic farming. They strongly believe that alternative farming can provide economic feasibility due to the high prices of their products, while reducing the burden on the environment. Based on a questionnaire survey of 142 vegetable growers under different production systems in Chiang Mai Province in 2008, this paper aims to clarify whether or not organic farming is a feasible form of sustainable agriculture under small farm size conditions. Sustainability of organic farming is analyzed in terms of farm income, and environmental and social impact in comparison with other production systems.

There was diversified farming of rice, vegetables, fruits and livestock in Mae Rim District, Chiang Mai Province. In the villages studied, average overall cost of environmental and social impacts of kale production was estimated to be 350 USD per year (one rai is equivalent to 0.16 ha; one USD is equal to 34.35 Baht at the time of study in 2008). The environmental and social impacts were the most important factor in improvement of production efficiency among four vegetable farming systems. The conventional kale production appeared to have the highest negative environmental and social impact, while the lowest was attained by organic farming. Only in the case of organic production, the average cost decreased due to the reduced negative impact, and organic growers could raise farm income per ha per year to 7,150 USD. This situation demonstrates that organic farming had the sustainable manner due to the highest profit with higher prices contributing to the highest income, and the lowest negative impacts for environmental and social sectors in comparison with other production system in Chiang Mai.

Key words: environmental and social benefit, environmental impact, farm income, regression analysis.

INTRODUCTION

Total planted area of vegetables in Chiang Mai was approximately 37,997 ha or nearly 14% of total planted area in 2007 (Chiang Mai Department of Agriculture, 2008). There are various vegetable production systems in Chiang Mai, including conventional, safe use, chemical pesticide free, and organic production systems.

This paper attempts to clarify the sustainability of these systems from the environmental impact viewpoint, while an earlier paper analyzed the economics of the production systems (Kawasaki and Fujimoto, 2009). The conventional system heavily depends on the use of synthetic chemical materials, while organic farming uses only organic inputs. Both safe use and chemical pesticide free systems refer to the attempts to reduce the dependency on the use of synthetic chemical inputs. The safe use system refers to the limited use of chemical fertilizer and pesticide, while the chemical pesticide free system does not use any synthetic chemical pesticide, although chemical fertilizer is applied. The farming systems in Thailand concerned with health and environmental quality are popularly called alternative farming systems (Department of Agricultural Extension, 2002). The alternative farming systems discussed in this study are organic, chemical pesticide free, and safe use farming systems.

From the 1980s there emerged a new type of farming system in Chiang Mai, as many of the small farmers transformed their conventional farms to organic farms (Reunglertpanyakul, 2002). Organic vegetables seemed to have a good chance of marketing due to the increased demand, both domestically and internationally (Jongworakitwattana, 2002). Organic farming would reduce the environmental and social impacts, and enable the development of the agricultural sector in a sustainable manner (Jitsanguan, 2000). However, it is not easy to convince farmers that they have been using too much synthetic chemical inputs (Syaukat, 2003).

Some studies on environmental and social impacts of organic farmers in Thailand clarified the better livelihood and higher welfare from their better health condition, leisure time, farm environment and greater biodiversity of the farms (Jitsanguan, 2008). Organic farmers participating in the Royal Project had achieved an average annual income of 100,064 Baht per household which was substantially higher than the national average of 39,193 Baht (Jayamangkala, 2008). However, the literature on comparative impacts of organic vegetable farming with other farming systems in Thailand remains quite limited.

Specific objectives of this paper are: (1) to clarify the sustainability of organic farming in comparison with other production systems through an examination of household income, and environmental and social benefits, and (2) to identify the level of environmental and social impacts under different farming systems by socio-environmental index and total product.

ANALYTICAL FRAMEWORK

We conducted a farm management questionnaire survey in Mae Rim District, Chiang Mai Province from January to March 2008. A total of 142 farmers were interviewed, of whom 32, 32, 38 and 40 farmers were organic, chemical pesticide free, safe use, and conventional vegetable farmers, respectively. The survey data were evaluated by statistical analysis, in order to clarify the sustainability under different farming systems.

The conversion to organic farming from conventional farming may create production inefficiency during the transition period. The production efficiency of organic vegetable cultivation in Chiang Mai is analyzed by examining yield, level of material input use (area, labor, seed, fertilizers, and pesticides), and socioeconomic factors (education, credit, environmental and social benefits). It is expected that a good farming system would increase yields and provide positive environmental and social impacts.

The level of environmental and social impacts depended on the type of farming system. It is assumed that organic farming has the lowest negative impact on farm environment and rural communities, while other farming systems have higher negative impact because of the application of synthetic chemical materials and poor management.

The environmental and social impacts can be considered to be the result of environmental and social factors, presented in Table 1. The environmental factors were composed of three dimensional factors: the reduction of the quantity of pollutants in the environment, the increase in aesthetic quality of environmental and scenic values of farms, and the provision of ecological linkages and biodiversity of farms. The social factors relate to increasing habitat conservation, reduction in health cost by farming system, and creating and strengthening communities through participation in the farmers' groups.

Table 1. Scale of socio-environmental impacts of kale production in Mae Rim District, Chiang Mai Province

Items	Scale
Environmental Aspect (Ei):	
1. Reduction of the quantity of pollutants in the environment	
1.1 **E1**: Cost of waste water treatment in farming: 1/	1-5
1.2 **E2**: Nitrogen residue:2/	1-5
1.3 **E3**: Nonburning weeds after harvesting: (Yes=1 and No=5)	1-5
2. Bringing about aesthetic quality of environmental and scenic values of farms	
2.1 **E4**: Per capita health cost of neighbors breathing toxic fumes used in farming: 4/	1-5
2.2 **E5**: Knowledge of natural resource management: (Have=1 and None=5)	1-5
3. Provision of ecological linkages and biodiversity of farms	
3.1 **E6**: Providing habitat for small animals and local plants as natural foods: (Have=1 and None=5)	1-5
3.2 **E7**: Use of simple skill for reduced production cost in farming: (Have=1 and None=5)	1-5
3.3 **E8**: Controlling insects and pests by crop rotation: (Have=1 and None=5)	1-5
Social Aspect (Si):	
4. Increasing habitat conservation	
4.1 **S1**: Per capita food expenditure of households:3/	1-5
5. Reduction in health cost by farming system	
5.1 **S2**: Per capita health cost of farmers:4/	1-5
6. Creating and strengthening communities by participation in the farmers` groups	
6.1 **S3**: Frequency of gambling in leisure:5/	1-5
6.2 **S4**: Total debts:3/	1-5
6.3 **S5**: Shares technical knowhow with other farmers:(Have=1 and None=5)	1-5
6.4 **S6**: Shares family labor with other farms:(Have=1 and None=5)	1-5
6.5 **S7**: Participation in the farmers' groups: (Have=1 and None=5)	1-5
Minimum-Maximum Score	15-75

Source: Survey January-March, 2008
Note: One rai is equal to 0.16 ha.
One USD is equal to 34.35 Baht.

1/ Scale:
1 = Less than 5 Baht per rai year
2 = 5-10 Baht per rai
3 = 11 - 15 Baht per rai
4 = 16 - 20 Baht per rai year
5 = More than 20 Baht per rai year

2/ Scale:
1 = Less than 20 grams per rai
2 = 20-29 grams per rai
3 = 30-39 grams per rai
4 = 40-50 grams per rai
5 = More than 50 grams per rai

3/ Scale:
1 = Less than 15,000 Baht per capita per
2 = 15,000-20,000 Baht per capita per year
3 = 20,001-25,000 Baht per capita per year
4 = 25,001-30,000 Baht per capita per
5 = More than 30,000 Baht per capita per

4/ Scale:
1 = Less than 500 Baht per capita per year
2 = 500-1,000 Baht per capita per year
3 = 1,001-1,500 Baht per capita per year
4 = 1,501-2,000 Baht per capita per year
5 = More than 2,000 Baht per capita per year

5/ Scale:
1 = Never
2 = Very seldom
3 = Seldom
4 = Often
5 = Very often

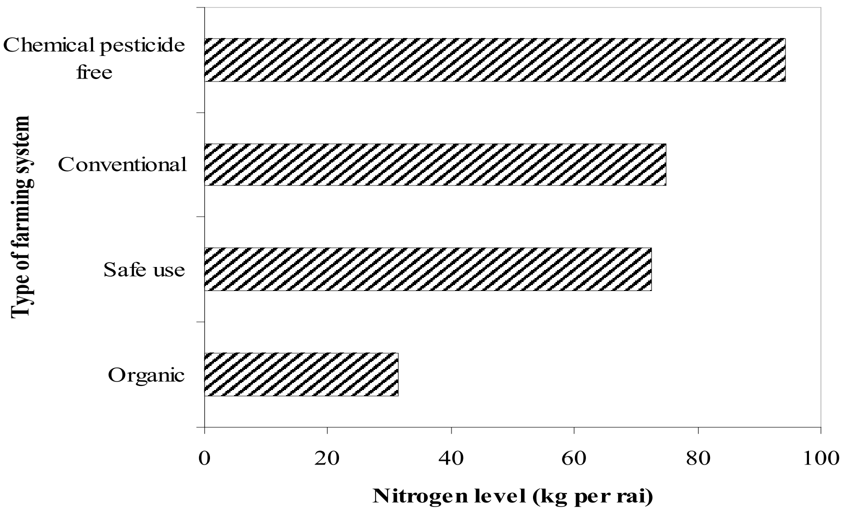
As the environmental factor, the following eight variables were used: cost of waste water treatment in farming (E1), nitrogen residue in farming (E2), nonburning of weeds after harvesting (E3), health cost of neighbors breathing toxic fumes used in farming (E4), knowledge of natural resource management (E5), providing habitat for small animals and local plants (E6), use of simple skill for reduced production cost in farming (E7), and controlling insects and pests by crop rotation (E8). The social factor was comprised of seven variables: decrease in food expenditure (S1), decrease in health cost of farmers (S2), decrease in frequency of gambling in leisure (S3), decrease in total debts (S4), sharing technical knowhow with other farmers (S5), sharing family labor with other farmers (S6), and participation in the farmers' groups (S7).

An estimation of environmental and social impacts was carried out using the market and non-market evaluation approaches. Since the environmental and social impacts are not traded in the markets, their non-market values were defined based on interviews with local farmers and available information, as follows. First, concerning the environmental impact, a large quantity of chemical fertilizer and pesticide flowed into rivers and community reservoirs from vegetable fields (Chiang Mai Department of Environmental Station, 2007). The cost of intake wastewater treatment per liter was nearly 49.50 Baht for planting of vegetables (Kaewlon, 1994). Second, the increase in dust and smoke came from the burning of weeds and the use of chemical synthetic materials, which caused 15% of respiratory patients in Chiang Mai (Chiang Mai Provincial Public Heath Office, 2007). This also caused an increase in medical expenses among neighbors of vegetable growers as a negative impact on public health. Therefore, the public health expense of neighborhoods could be taken as an environmental impact caused by vegetable cultivation. Third, organic farming seemed to provide more habitat conservation, leading to the increase in biodiversity of farms. Thus the increase in habitats could be taken as a positive impact on environment.

Fourth, the amount of nitrogen input is one of the important factors in the assessment of the environmental impact. The difference in total input of nitrogen and the amount absorbed by vegetables was calculated for the four farming systems. The nitrogen of organic inputs was estimated from the use of compost and animal manure. The amount of nitrogen in organic inputs was estimated to be 38, 28, and 6 grams for a kilogram of chicken manure, pig manure, and rice straw compost respectively (Mihara and Fujimoto, 2007). Generally, the Effective Microorganisms (EM) were produced from available ingredients of fields and widely used in alternative farming. There were 7 grams of nitrogen per liter of the EM consisting of ingredients of golden apple snails (*Pomacea canaliculata*) and vegetable, while the corresponding figure was 9 grams for EM of only vegetable ingredients (Department of Agricultural Extension, 2002). Excess nitrogen from chemical fertilizer became the cause of pollution in river and soil and so damaged biodiversity.

Nitrogen absorption by vegetables was estimated to be 30, 29, 23 and 13 grams out of each kilogram applied for chili, pak choy, kale and yard long bean respectively (Department of Agricultural Extension, 2002; Nikornpun, 2000). Among the major vegetables in the villages studied, kale appeared to be most wide spread, therefore, we selected kale for further examination. As shown in Figure 1, chemical pesticide free farming used the largest amount of nitrogen per rai, and the input of nitrogen was lowest in organic farming.

Lastly, other indicators of environmental impacts in the estimation were qualitative. They included nonburning of weeds after harvesting, controlling insects and pests by crop rotation, use of simple skills for reduced production cost, and knowledge of natural resource management.



Source: Survey January-March, 2008
Note: One rai is equal to 0.16 ha

Fig . 1. Estimated nitrogen input per rai for kale production in Chiang Mai Province

Regarding the social impact, farm biodiversity could provide natural foods to farm households, reducing food expense of the household. This saving of food expense was assumed to be a value of social impact. Second, alternative farmers believed their health became better than when they were engaged in conventional vegetable farming, which heavily used synthetic chemical materials. This led to a decrease in medical fees among alternative farmers. Third, organic farming seemed to require more intensive use of family labor, causing their attention to be directed to their farm activities. This could reduce their interest in gambling, leading to the decrease in gambling cost and debts. Lastly, most alternative farmers shared their family labor and technical know how with other farmers in their farmers groups, leading to strengthening of the communities (Tong-ngam and Chaosilp, 1999; Kramol, et al., 2006).

GENERAL INFORMATION OF STUDIED FARMERS

As mentioned in detail in our earlier paper (Kawasaki and Fujimoto, 2009), the average age of the alternative farmers was older than those in conventional farming, and they were mostly Buddhists. Generally, the average farm experience was more than 30 years, while alternative farming experience ranged from 3 to 5 years. While the majority of farmers graduated only from primary school, there were some farmers of alternative farming system who graduated from university, indicating that alternative farmers had higher education backgrounds. Some farmers were Hmong hill tribe people, and both Thai and Hmong farmers in the villages studied were bound together by kinship, and respected their elders. The support of government reached rural farmers through the heads of villages as the elders.

However, the development of the Hmong community was limited by low education. Many Hmong farmers were found to have inadequate knowledge for the efficient management of their farms and for marketing. About two decades ago, they became strongly interested in the planting of opium, a time when many of them were sick due to the use of agrochemicals in the planting of vegetables. His Majesty the King launched the projects of organic vegetable farming to encourage Hmong farmers to convert their opium area to organic vegetables, and to reduce the use of chemical inputs in the Hmong community (Wiboonpongse, et al., 1989). Hmong people still believed in gods and ghosts of forest and river, and then there was good management of forest and river in their community. However, Thai vegetable growers, except for organic farmers, used all kinds of chemical inputs, and there were chemical residues in river and soil (Wiroonsri, 1988).

Average operated land of the households was 3.4, 3.9, 4.9 and 5.3 rai (one rai is equivalent to 0.16 ha) for organic, chemical pesticide free, safe use and conventional farming, respectively. The majority of organic farmers were owner farmers. A small proportion of organic farmers cultivated rented land, because conversion to organic farming system would require a minimum of 3 years, while there was the risk of sudden termination of tenancy contract due to the current rapid tourism sector expansion.

There were six types of enterprise combinations in the villages studied, including only vegetables, rice-vegetables, vegetables-livestock, vegetables-fruits, rice-vegetables-livestock and rice-vegetables-fruits under different farming systems. The most common cropping pattern was the planting of only vegetables by 27 farmers for organic farming, while 19, 14 and 13 farmers under conventional, safe use and chemical pesticide free farming respectively grew rice in combination with vegetables during the rainy season. Most of the household income came from farm activities, and all family members were still living together in their villages. In fact, most organic vegetable growers in the villages studied utilized all of their land resources to produce vegetables, and the kinds of vegetables planted depended on the Royal Project Foundation. The entire organic farming area under the project was certified by the Department of Agriculture (DOA), while the Good Agricultural Practice (GAP) was used for production of chemical pesticide free and safe use farming systems.

ENVIRONMENTAL AND SOCIAL IMPACTS

Based on these assumptions, the evaluation of environmental and social impacts was carried out by the following scoring method. The indicators carried scores ranging from one to five, while total scores ranged from 15 to 75. The lower the score, the larger were the environmental and social benefits: if the score is close to 75, the larger the negative impact. The magnitude of socio-environmental index (SEI) shows that the average total score of the organic farming system was only 27, while that of the conventional system was 68, implying that organic kale production had a much lower negative impact in comparison with other farming systems (Table 2).

These variables of the socio-environmental factor were regressed on total kale production for four different farming systems in order to clarify the nature of their impact. The results are shown in Table 3. The four variables including E1, E2, E4 and S2 indicated a negative impact on kale production under the four farming systems, while other variables showed different impacts, depending on different farming systems. It is considered that although many of the fifteen variables did not significantly affect kale production independently, this does not necessarily mean that the socio-environmental factor as a whole was not a significant determinant of vegetable production. We will explore further the impact of the socio-environmental factor in a later section.

There were three types of cost in kale production, including production cost, environmental cost, and social cost. Production cost was measured by variable costs such as labor, seeds, fertilizers, and pest control cost, and fixed cost such as depreciation, interest on capital and payment of land rent. Environmental cost was obtained by the value of environmental impact, while social cost refers to the value of social impact. Total cost (TC) in this study is an aggregation of production cost, environmental cost and social cost, and it is assumed that the lower the TC, the more sustainable the farming. Economic values of environmental cost and social cost in this section were estimated by all indicators of environmental and social impacts, presented in Table 2.

Table 2. Average degrees of socio-environmental impact under different farming systems in Mae Rim District, Chiang Mai Province.

Characteristic Quality	Type of farming system								Overall	SD
	Organic	SD	Chemical pesticide free	SD	Safe use	SD	Conven tional	SD		
Environmental issues:										
E1: Cost of waste water treatment in farming	1.0	0.4	2.9	2.1	3.1	3.9	4.4	4.2	2.9	1.8
E2: Nitrogen residue	2.5	2.7	3.7	3.9	4.3	3.8	4.4	4.1	3.7	2.4
E3: Nonburning weeds after harvesting	2.0	1.3	2.7	2.9	3.1	3.3	4.7	4.4	3.1	0.9
E4: Per capita health cost of neighbors breathing toxic fumes used in farming	1.8	1.2	2.8	2.4	3.1	3.6	4.9	4.3	3.2	1.7
E5: Knowledge of natural resource management	1.1	1.3	2.2	1.4	2.3	2.5	3.9	3.7	2.4	1.5
E6: Providing habitat for small animals and local plants as natural foods	1.0	1.4	3.4	3.4	3.8	3.4	4.7	4.9	3.2	1.5
E7: Use of simple skill for reduced production cost in farming	1.3	1.7	2.3	2.5	2.7	2.5	4.9	3.7	2.8	1.4
E8: Controlling insects and pests by crop rotation	1.0	0.4	2.2	2.1	2.4	2.7	3.8	3.7	2.4	1.1
Social issues:										
S1: Per capita food expenditure of households	3.1	3.5	3.7	3.2	4.5	3.7	4.8	4.9	4.0	3.6
S2: Per capita health cost of farmers	3.7	3.6	4.8	4.2	4.6	3.9	5.0	4.6	4.5	4.0
Creating and strengthening of community:										
S3: Frequency of gambling in leisure	1.1	1.4	1.2	1.3	3.8	3.7	4.9	4.4	2.7	2.8
S4: Total debts	2.1	2.2	4.8	4.4	5.0	4.8	5.0	4.6	4.2	3.8
S5: Shares technical knowhow with other farmers	1.9	1.3	1.5	1.8	1.8	1.1	3.9	3.5	2.3	1.2
S6: Shares family labor with other farms	2.2	2.8	2.8	2.4	3.7	3.9	5.0	4.6	3.4	1.5
S7: Participation in the farmers' groups	1.1	1.3	1.2	1.4	2.4	2.5	3.8	3.6	2.1	1.3
Total Score	27.0	21.4	42.4	30.4	50.5	35.3	68.1	38.2	47.0	30.4

Source: Survey January-March, 2008

Note: Standard deviation (SD) is a measure of the variability of a data.

The average overall cost of environmental and social impacts of kale production in Chiang Mai Province in 2008 was 12,050 Baht per year for a total planted area of 205 rai. Table 4 shows the average value per rai of environmental and social impacts. The lowest environmental and social impacts were attained by organic farming, while the cost of 98, 49 and 29 Baht for conventional, safe use and chemical pesticide free farming, respectively, were estimated as negative impacts. Average cost of organic kale production decreased from 18.33 Baht to 18.32 Baht per kg due to the reduced negative impact, while the average cost of conventional, safe use and chemical pesticide free farming increased to 10.58, 14.25, and 14.10 Baht per kg respectively due to the large negative impact.

The average income of the households studied was 218,198 Baht per year, comprising 162,899 Baht farm income and 55,299 Baht off farm income in 2008. Average incomes per rai for three major enterprise combinations in the villages studied, including only vegetables, rice-vegetables, vegetables-livestock under different farming systems, are presented in Table 5.

Net farm income per rai was highest (39,289 Baht) for planting of only vegetables under organic farming, followed by conventional farming (32,261 Baht). Under chemical pesticide free farming, planting of vegetables plus livestock was highest (20,374 Baht). For planting of rice-vegetables, it was highest (22,340 Baht) under organic farming, followed by safe use farming (17,099 Baht). Because planting of only vegetables appeared to be a dominant enterprise combination for all four production systems, we estimated the value of farm income by adding the socio-environmental cost. Assuming no differences in levels of environmental and social impacts for all vegetables, reduction in total cost due to the reduced negative impact could raise farm income per rai per year to 39,295 Baht for organic planting growers, while the increased total cost would lower the farm income of chemical pesticide free (15,549 Baht), safe use (16,685 Baht), and conventional farming systems (32,163 Baht), respectively (Table 6).

According to the Provincial Government (Chiang Mai Department of Environmental Station, 2007), the Government was operating a pollution control policy for the industrial sector, while this was not so clear for the agricultural sector because of limited information. Therefore, the total cost of the negative impact management may be subsidized by Government through taxes and/or price increases. If the government uses a price increase policy, the price of conventional vegetables may be increased to reach the same price as alternative vegetables. Therefore, the number of consumers for the alternative vegetables will increase, and more conventional farmers may convert to alternative farming.

Overall, there were differences in the levels of environmental and social impacts among the four vegetable farming systems in Chiang Mai, which could affect total product, income and community of small farmers. The relationship between crop total product and the environmental and social impacts is discussed in the next section.

Table 3. Regression analysis of environmental and social factors in kale production.

	Type of vegetable farming											
	Organic			**Pesticide free chemical**			**Safe use**			**Conventional**		
	Reg coff.		**t value**	**Reg coff.**		**t value**	**Reg coff.**		**t value**	**Reg coff.**		**t value**
Constant	-0.220		-1.518	-0.365	***	-3.524	0.127		1.121	-0.590	***	-5.660
E1: Cost of waste water treatment in farming	-0.024	*	-1.817	-0.026	**	-2.534	-0.106	***	-2.538	-0.066	**	-2.302
E2: Nitrogen residue	-0.044	***	-2.840	-0.001		-0.170	-0.060	**	-1.902	-0.018		-1.506
E3: Nonburning weeds after harvesting	0.008		0.715	0.022	**	2.106	0.011		0.993	0.022	**	2.401
E4: Per capita health cost of neighbors breathing toxic fumes used in farming	-0.015	**	-2.194	-0.002		-0.510	-0.006		-0.259	-0.039	**	-2.253
E5: Knowledge of natural resource management	0.008		0.414	0.055	***	4.325	0.016		0.813	0.011	*	1.493
E6: Providing habitat for small animals and local plants as natural foods	0.027	*	1.582	0.002		0.074	0.003		0.341	0.021		0.932
E7: Use of simple skill for reduced production cost in farming	0.002		0.115	0.049	***	2.890	0.010		0.425	0.005		0.214
E8: Controlling insects and pests by crop rotation	0.009		0.374	0.021	**	2.071	0.006		0.513	0.029	*	1.726
S1: Per capita food expenditure of households	0.073	***	4.309	0.004		1.119	0.002		0.401	0.019		0.508
S2: Per capita health cost of farmers	-0.011		-0.608	-0.005		-0.614	-0.082	**	-2.368	-0.008		-0.947
S3: Frequency of gambling in leisure	0.018	*	1.489	0.013	*	1.949	0.013	*	1.850	0.025		0.795
S4: Total debts	0.0001		0.008	-0.009		-0.740	0.011		1.056	0.000		0.021
S5: Shares technical knowhow with other farmers	0.013		1.279	0.000		0.019	0.008	**	2.181	0.001		0.093
S6: Shares family labor with other farms	0.001		0.086	0.003		0.601	0.003		0.631	-0.034	*	-1.851
S7: Participation in the farmers' groups	-0.141	***	-5.076	0.048	***	5.040	0.015	**	2.067	0.004		0.232
R square	0.866			0.965			0.600			0.531		
F value	18.974			72.312			55.893			21.639		
Durbin-watson value	2.411			2.125			1.831			2.345		
N	60			55			72			87		

Source: Survey January-March, 2008

To the expected production of each farm.

***Denotes significance at 1% level

** Denotes significance at 5% level

* Denotes significance at 10% level

Table 4. Economic value of socio-environmental cost in kale farming of Mae Rim District, Chiang Mai Province.

	Type of farming system			
	Organic	**Chemical pesticide free**	**Safe use**	**Conventional**
Baht per rai:				
(1) Production cost	21,625	18,258	15,670	15,503
(2) Socio-environmental cost	-6	29	49	98
(3) Total cost (1)+(2)	21,619	18,287	15,719	15,601
(4) Yield (kg)	1,180	1,297	1,103	1,474
Baht per kg:				
(5) Production cost (1)/(4)	18.33	14.08	14.20	10.52
(6) Total cost (3)/(4)	18.32	14.10	14.25	10.58
(7) Difference between (6) and (5)	-0.004	0.02	0.05	0.06
Price levels:				
Farm gate price	21	18	16	14
Market price	125	40	75	14-23

Source: Survey January-March, 2008

Note: One rai is equal to 0.16 ha.

One USD is equal to 34.35 Baht.

Table 5. Farm income per rai under different farming systems in Mea Rim District, Chiang Mai Province 2007.

Type of farming system	**Types of enterprise combinations (Baht per year)**		
	Only vegetables	**Rice + vegetables**	**Vegetables + livestock**
Organic	39,289	22,340	9,324
Chemical pesticide free	15,578	10,228	20,374
Safe use	16,734	17,099	16,786
Conventional	32,261	13,245	22,056

Source: Survey January-March, 2008

Note: One rai is equal to 0.16 ha.

One USD is equal to 34.35 Baht.

Table 6. Farm income in the planting of only vegetable in Mae Rim District, Chiang Mai Province.

Type of farming system	Gross Income (Baht/ rai) (1)	Expenditure (Baht/ rai) (2)	Socio-environmental Cost (Baht/rai) (3)	Net farm income (Baht/rai)	
				Without Environmental and Social cost (1)-(2)	With Environmental and Social cost (1)-(2)-(3)
Organic	58,570	19,281	-6	39,289	39,295
Chemical pesticide free	23,723	8,144	29	15,578	15,549
Safe use	28,752	12,018	49	16,734	16,685
Conventional	53,525	21,264	98	32,261	32,163

Source: Survey January-March, 2008
Note: One rai is equal to 0.16 ha.
One USD is equal to 34.35 Baht.
Socio-environmental costs of other vegetables are assumed to be the same as that of kale.

REGRESSION ANALYSIS OF ENVIRONMENTAL AND SOCIAL IMPACTS

The environmental and social impact of organic farming in comparison with other production systems in Chiang Mai can be measured through production function by adding the SEI. The production function of the Cobb-Douglas type was estimated for the farmers studied. Because kale appeared to be most wide spread and data were available for all four production systems, we estimated the production function of kale. The variables used are as follows. The dependent variable (Y) is production of kale per farm per crop (kg) in a whole year, and six independent variables were used: X_1 refers to kale's planted area (rai), X_2 is total labor inputs (man-days), X_3 refers to total amount of seed used (Baht), X_4 is amount of Nitrogen element in fertilizer (kg), X_5 refers to cost of pest control (Baht), and X_6 is socio-environmental index (SEI).

The production function without SEI was presented in our earlier paper (Kawasaki and Fujimoto, 2009), while the relation of the SEI and kale production among four farming systems is expected to be negative in that kale production will be reduced by an increase in negative environmental and social impact (Table 7).

Our study revealed that the environmental and social impacts were important factors in improvement of production efficiency among four vegetable farming systems. It is remarkable to note that the magnitude of the regression coefficient of SEI differed so clearly among the four farming systems: -1.014 for organic, -1.597 for chemical pesticide free, -1.818 for safe use, and -2.275 for conventional systems. The conventional kale production was most severely affected by the environmental and social impacts. Therefore, farmers may be able to increase their profitability and reduce the environmental and social impacts if they could improve their production efficiency by adopting an environmentally friendly farming system.

Table 7. Socio-environmental impacts of kale production function under different farming systems in Chiang Mai Province, 2007.

	Type of vegetable farming											
	Organic			**Pesticide free chemical**			**Safe use**			**Conventional**		
	Reg coeff.		**t value**	**Reg coeff.**		**t value**	**Reg coeff.**		**t value**	**Reg coeff.**		**t value**
Constant	5.417	**	2.512	7.796	***	6.324	3.609	***	4.596	3.814	***	8.067
Area (rai)	0.068	ns	0.829	0.142	***	3.032	0.212	**	2.238	0.125	**	1.998
Labor (man-day)	0.347	***	3.183	0.141	*	1.831	0.141	***	3.194	0.233	***	3.099
Seed (Baht)	0.253	***	3.401	0.023	ns	0.565	0.123	*	1.753	0.062	ns	0.975
Nitrogen element in fertilizer (kg)	0.101	*	1.674	0.056	*	1.809	0.166	**	2.182	0.056	*	1.885
Pest control cost(Baht)	0.165	**	2.413	0.157	*	1.863	0.161	***	3.429	0.165	***	3.106
Socio-environmental index (SEI)	-1.014	*	-1.872	-1.597	***	-4.621	-1.818	***	- 2.842	-2.275	***	-4.572
R square	0.546			0.740			0.836			0.737		
F value	10.604			22.776			55.107			37.321		
Durbin-Watson value	1.923			1.806			1.692			1.897		
N	60			55			72			87		

Source: Survey January-March, 2008

Note: ***Denotes significance at 1% level

** Denotes significance at 5% level

* Denotes significance at 10% level

ns Denotes non significance at 10% level

CONCLUSION

Based on data obtained from the questionnaire survey of 142 farmers in Mae Rim District, Chiang Mai Province, this paper clarified the sustainability of organic farming through an examination of household income, and environmental and social benefits in comparison with other production systems: chemical pesticide free, safe use and conventional farming systems. Organic farming had the most beneficial impacts for environmental and social sectors among various vegetable production systems in Chiang Mai. There was a lower level of the environmental and social impact for chemical pesticide free system in comparison with conventional and safe use systems. Although organic farming still had the negative impacts for environment and community, it provided the highest income per rai (39,295 Baht).

A 10% increase in socio-economic index under organic farming would still reduce kale production by 10.14%. Therefore, the negative impacts should be controlled, irrespective of farming system. If the Government is promoting organic agriculture as a way to develop the agricultural sector in a sustainable manner, it is thus necessary to look into the actual conditions faced by organic farmers, in relation to their cultivation technology, socio-environmental impact and marketing practices.

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