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ECONOMIC AND TECHNICAL ASSESSMENT OF ORGANIC VEGETABLE FARMING IN COMPARISON WITH OTHER PRODUCTION SYSTEMS IN CHIANG MAI, THAILAND

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ABSTRACT

The government of Thailand is promoting alternative vegetable production such as organic, chemical pesticide free, and safe use production systems. Most vegetable producers do not have confidence in transforming from their conventional system to organic farming, presumably due to technical difficulties and low production efficiency. Based on a questionnaire survey of 142 farmers under different production systems in Chiang Mai Province in 2008, this paper aims to clarify the common vegetable practices, cost and returns of major crops, profitability of organic farming in comparison with other production systems.

Over 15 kinds of vegetable were grown under different farming systems in Mae Rim District, Chiang Mai Province. Kinds of vegetable grown depended on market demand and growing time. In this district alone, vegetable production accounted for 0.57 million USD in 2007, of which 0.08 million USD was from organic vegetables. There were no differences in types of input used for major organic crops such as kale, pak choy, and yard long bean. Economic analysis revealed characteristics of four types of farming system: organic, chemical pesticide free, safe use, and conventional farming systems. The organic farming system was economically the most feasible due to high prices of produce; however, it would need further improvement in order to increase yields and production efficiency. Both safe use and pesticide free farming systems were also economically feasible. The conventional farming system faced the highest risk because of increased prices of synthetic chemical inputs, even though it was economically feasible. Under the Royal project foundation, most farmers sold their products at the project site, and price was determined by the project office. Organic vegetables reached consumers in Chiang Mai through supermarkets (63.3%), while other production systems had to sell their products through middlemen or local markets (over 80%). In this study, three kinds of analysis were done, namely cost and benefit analysis, production function analysis and marginal productivity analysis to compare four types of farming system. The benefit-cost ratio (B/C ratio) of organic farming system was greater than one, especially the B/C ratio of organic yard long bean was the highest. In organic kale, labor and seed were the most important factors in improvement of organic kale production, while the highest efficiency of resource use was seen for labor, indicating that the increased use of labor would lead to higher income for organic farms.

Key words: Royal project, input use, yield, profitability, marketing, alternative farming

INTRODUCTION

While rice has been the traditional food crop in Thailand, the government started promoting commercial vegetable farming about two decades ago. Some parts of rice land were rapidly converted to vegetable production, which seemed to be preferred by farmers for faster cash flow, as well as the fact that the paddy price stagnated and fluctuated (Matsuda and Fujimoto, 1998). Since the emergence of commercial vegetable farming, several vegetable production systems have been developed. According to the Provincial Government (Chiang Mai Department of Agriculture, 2007), there were a number of vegetable production systems in Chiang Mai: conventional farming, safe use

farming, natural farming, chemical pesticide free farming and organic farming. The conventional system depended heavily on synthetic chemical inputs such as pesticide, fertilizer and hormones. Seeds produced with the use of chemical inputs were used for the cultivation of conventional vegetables.

Both safe use and pesticide free systems referred to attempts to reduce dependency on synthetic chemical inputs. The safe use system has limited use of chemical fertilizer and pesticide, which was similar to what the government recommended as Good Agricultural Practice (GAP). The chemical pesticide free system excluded the use of synthetic chemical pesticide but still used chemical fertilizer. Only the organic system referred to true organic vegetable cultivation, in which no synthetic chemical inputs were applied and seeds were produced without the use of chemical inputs. Most organic vegetable growers, in the villages studied, utilized all of their land resources under the Royal Project Foundation or NGOs, and the whole organic farming area was certified in 1995 by the Department of Agriculture (DOA). Although most commercial vegetable farms are managed by companies, there are also small-scale vegetable farmers, most of whom are found in Chiang Mai Province (Kawasaki and Fujimoto, 2008). Total planted area of vegetables in Chiang Mai was approximately 37,997 ha or nearly 14% of total planted area in 2007; there were about 330 ha and 222 farmers practicing organic farming in 2005, with an average of 1.5 ha per household (Chiang Mai Department of Agriculture, 2008).

Organic Agriculture is not necessarily a new concept for Thai farmers because it resembles their traditional farming system. They rarely had high technologies, and always managed their farms well with simple skills in line with natural resources and environment. In fact, the area planted to organic vegetables in Thailand has greatly expanded since the 1980s. Many of the past studies on organic farming in Thailand focused on organic standard (Department of Agriculture, 2000; Saetang et al., 2003) and technical issues (Ruenglertpanyakul, 2004). Demand studies for organic vegetables showed clearly an increasing trend domestically and internationally, due to the increased awareness of the danger of chemical inputs. The average price of organic vegetables appeared to be higher than conventional vegetables by 15% (Jongworakitwattana, 2002), while the total number of retail stores dealing with organic vegetables was estimated to be 340 stores, of which 64% were in Bangkok (Vanit-Anunchai, 2006). However, some farm-level studies revealed that small organic farmers had inadequate capital, knowledge and labor for efficient management of their farms (Reunglertpanyakul, 2002). It is thus necessary to clarify the technical and economic performance of small organic vegetable farmers. 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 which 32, 32, 38 and 40 farmers were organic, chemical pesticide free, safe use, and conventional vegetable farmers, respectively. There are two specific objectives in this paper: (1) to identify and analyze production issues of the major vegetables under different farming systems by examining input use and yield, and (2) to determine the profitability of organic vegetable farming in comparison with other production systems and to suggest possible ways for improvement.

CHARACTERISTICS OF THE AREA AND FARMERS STUDIED

This study was conducted in four subdistricts (Tambon) of Mae Rim District, Chiang Mai, namely; Mae Raem, Huai Sai, Pong Yaeng, and Sa Luang (**Fig. 1**). Mae Rim District is located in the central part of Chiang Mai Province and consists of 11 Tambons. It has a total area of 443.6 square kilometers with approximately 82,943 inhabitants, 35%of whom are engaged in farming. Temperature ranged from 20 to 32 °C, with the average annual rainfall being about 1,098 mm with 116 rainy days (Chiang Mai Meteorological Station, 2007). There are several tributaries and irrigation canals (such as Muang or Faay) from Mae Ping River (Wiroonsri, 1988). The typical soil type is clay loam with medium fertility. It seems that Mae Rim is a well established temperate vegetable area in Chiang Mai.

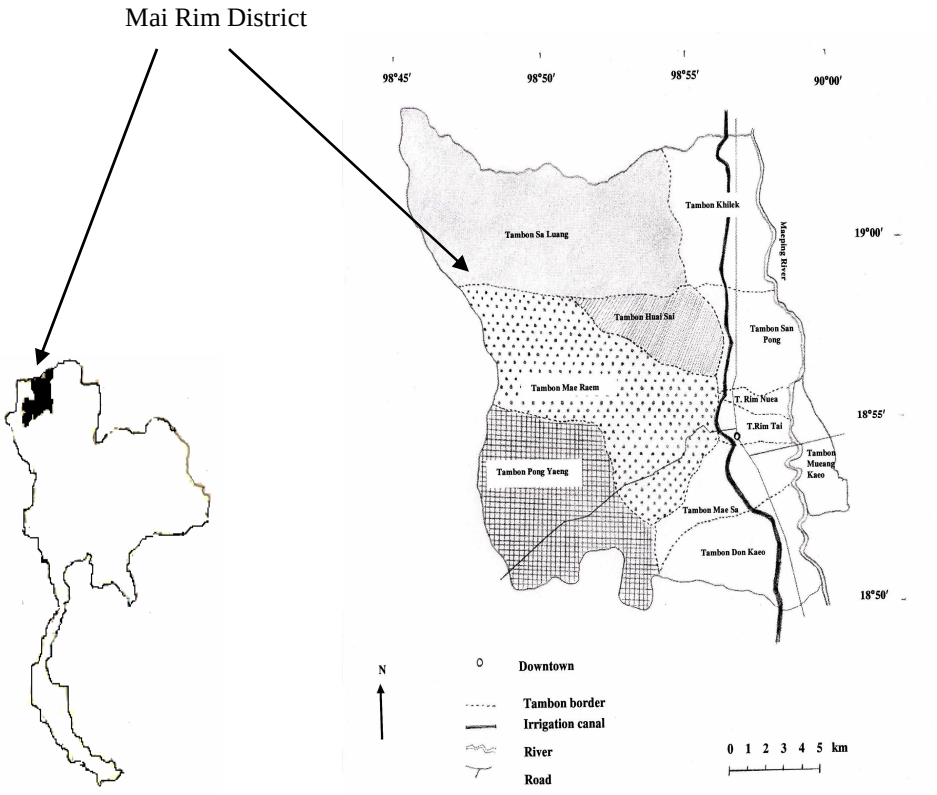


Fig. 1. Map of Mae Rim District, Chiang Mai Province

During the past 15 years, the total area planted in Mae Rim District increased by 132%. While the number of farms growing rice declined by 20% because of the decrease in price and yield of rice, fruit and vegetable growers increased by 331% (**Table 1**). Over 60% of the cultivated land area in Tambon Pong Yaeng, and Tambon Sa Luang was utilized in diversified commercial farming of fruits and vegetables, while rice was grown almost exclusively for home consumption (**Table 2**).

Table 1. Land resources in Mae Rim District, Chiang Mai Province.

Year	Rice		Field crop		Fruit and vegetables		Total	
	Area cultivated (rai)	No. of farms	Area cultivated (rai)	No. of farms	Area cultivated (rai)	No. of farms	Area cultivated (rai)	No. of farms
1992	17,887	2,960	334	105	4,917	777	23,138	3,842
2007	25,487	2,375	13,538	250	14,762	3,348	53,787	5,973
Growth ratio (%)	42	-20	3,953	138	200	331	132	55

Source: Chiang Mai Provincial Statistical Office, 2008
Note: One rai is equal to 0.16 ha.

Table 2. Land use in study area of Chiang Mai Province, 2007

Sub-District	Type of crops			Total
	Rice	Field crop	Fruit and vegetables	
Tambon Mae Raem	2,697	1,735	1,150	5,582
Tambon Huai Sai	1,731	527	1,026	3,284
Tambon Pong Yeang	42	2,426	5,252	7,720
Tambon Sa Luang	1,356	320	2,560	4,236

Source: Chiang Mai Provincial Statistical Office, 2008

Note: One rai is equal to 0.16 ha.

Land resources among the households studied under different production systems are presented in Table 3. The average area operated per household 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. Only a small proportion of organic farmers cultivated tenanted 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.

Table 4 shows profiles of farm household heads studied. The average age of the heads in alternative farming was older than those in conventional farming. Generally, the average farm experience was more than 30 years, while the alternative farming experience ranged from 3 to 5 years. The majority of farmers graduated only from primary school, which was the basic formal education. There were some farmers of alternative farming system who graduated from university, indicating that alternative farmers had higher education backgrounds.

Table 3. Frequency distribution of farmers by tenurial status in the studied area, 2007.

Production systems	Owner farmers	Tenant farmers	Average farm size (rai)	SD
Organic	24	8	3.4	4.6
Chemical pesticide free	23	9	3.9	3.1
Safe use	20	18	4.9	4.3
Conventional	24	16	5.3	4.1
Overall	91	51	4.4	4.1

Source: Survey January-March, 2008

Note: One rai is equal to 0.16 ha

Table 4. Profile of farmers interviewed in Mae Rim District of Chiang Mai Province, 2007

Items	Organic	Chemical pesticide free	Safe use	Conventional
No. of farmers (HH)	32	32	38	40
Average age of household heads (years)	55	56	54	48
Formal education of HH (years)	4	4	4	4
Farming experience of HH (years)	44	39	40	30
Alternative farming experience of HH (years)	3	3	5	none
Distribution of the HH by occupation				
Farming	30	30	35	40
Non-farm labor	2	2	2	none

Source: Survey January-March, 2008

MAJOR VEGETABLES GROWN AND CULTIVATION PRACTICE

Major Vegetables

Kinds of vegetable grown depended on market demand and growing time. In the studied area alone, vegetable production was valued at about 19.6 million Baht in 2007, of which organic vegetables constituted 2.6 million Baht (one USD was equivalent to 34.35 Baht in 2007). Table 5-6 shows the distribution of planted area for a total of 9 major vegetables under different farming systems, including kale, pak choy, yard long bean, green eggplant, chili, spinach, baby carrot, cabbage, and green bean.

In relation to planting season, proportion of planted area was varied by different farm management capability. Most vegetable farms planted various kinds of vegetables from December to February in the winter season because of fewer insects and pests, while vegetable plots were used for cultivation for the whole year under crop rotation. In the middle of the dry season, planted area to vegetable was reduced because of the shortage of water. The majority of vegetables were harvested within 2-3 months.

Cropping intensity of vegetables was calculated by total planted area over the total physical area operated by four types of farming system. Total planted area under organic, chemical pesticide free, safe use, and conventional farming systems in 2007 were 155.9, 123.6, 247.0, and 416.8 rai, respectively, while the total physical area was 48.3, 55.9, 10.1 and 111.3 rai, respectively. The highest value of cropping intensity was 374.5% in conventional farming system, followed by 322.5%, 274.1%, and 221.1% under organic, safe use, and chemical pesticide free farming systems. It shows that frequency of vegetable planting was 3.7, 3.2, 2.7 and 2.2 times on one and the same plot in a year under the respective systems.

Vegetable Cultivation Practice

Based on information obtained from interviews with the farmers, technical issues in organic vegetable cultivation are summarized in comparison with other production system, in this section. First, organic vegetable cultivation was carried out by various organic inputs, including seeds, manure, compost, Effective Microorganisms (EM), bio-pesticide, and labor. The seeds used should not be contaminated by chemical residue. All organic farmers under the NGOs and government bought organic seeds from nearby offices. Some seeds were produced domestically, but mostly imported from Japan, and EU at an expensive price. In individual organic farms, farmers grew local vegetables

and herbs mainly for household consumption by using seeds and seedlings from the previous crop, which were mostly resistant to pests and disease. The volume of organic vegetable seeds produced domestically was not adequate for the high demand and only a small proportion of domestically produced seeds could meet the International Federation of Organic Agriculture Movements (IFOAM) standard. Consequently, the improvement in quality and quantity of organic seeds is a very important factor for development of organic vegetable production in Thailand. Most seeds of other production systems were produced with the use of chemical inputs by domestic producers, and the quantity seemed adequate. In the case of chemical pesticide free and safe use farming systems, farmers purchased seeds from their farmer groups, while conventional farmers purchased their seeds from local shops.

Second, soil fertility on organic farms was maintained by crop combination and organic inputs, including manure, compost, and EM. There were six types of enterprise combination 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 for organic farming, while the majority of farmers under conventional, safe use and chemical pesticide free farming grew rice in combination with vegetables only during the rainy season. The organic farms applied only organic fertilizer by raising animals themselves such as cows and chickens. EM was produced by available ingredients in the fields but farmers did not clearly know effectiveness of EM. If soil was low in fertility, the farmers usually applied organic compost. Normally in organic farming, the manure and compost were applied during land preparation, while EM was applied twice: 2 weeks after transplanting and 2 weeks before harvesting. The proportion of fertilizer inputs was varied by physical properties of the soil. The three production systems, chemical pesticide free, safe use and conventional farming depended on synthetic chemical fertilizer. In particular, the conventional system heavily depended on external inputs such as synthetic chemical fertilizer and pesticides (Saengyot et al., 2005). Synthetic chemical fertilizers such as urea were readily available in local shops, while organic fertilizer was available only at the project office. However, the farmers faced high prices for chemical fertilizer.

Third, pest and disease control was often carried out by mechanical method and use of bio-pesticides in organic farms. The methods to control pests and diseases were as follows: physical method, use of bio-control agents such as natural enemies or pathogens including bacterial antagonists, micro parasites, parasitoids, and predator (Sudana et al., 2003). In the studied area, while small organic farmers used the mechanical methods including glue tray, light trap, and nets, the use of microbes and botanical pesticide was the most popular method (Table 7). There were more than 20 homemade botanical pesticide formulas in the study site, which were produced by available ingredients of the fields. Farmers in the studied area and other villages learned how to process botanical pesticide formulas from local NGOs and the learning center, which belonged to the government project. It seemed that farmer network was also expanded by using this learning center. Main herbs of homemade botanical pesticide included lemon grass (*Cymbopogon citrates*), tobacco (*Nicotiana tabacum*), and seed of neem tree (*Azadirachta indica*). For example, a typical bio-pesticide formula consisted of one kilogram of neem seeds, chili (*Capsicum spp.*), lemon grass, bo-ra-phet (*Tinospora crispa*) and galinga tuber (*Alpinia galanga*) chopped and finely pounded, mixed with 20 liters of water and left to ferment for 1-2 days. This bio-pesticide was applied once a week. However, these bio-pesticides were not so clearly effective for pest control. In addition to the use of bio-pesticide, microbial pesticides were also applied.

Table 5. Production of the 10 major vegetables under different farming systems by farmers studied in Chiang Mai Province, 2007.

	Types of farming system									
	Organic		**Chemical pesticide free**		**Safe use**		**Conventional**		**Overall**	
	Total area planted (rai)	Total production (tons)	Total area planted (rai)	Total production (tons)	Total area planted (rai)	Total production (tons)	Total area planted (rai)	Total production (tons)	Total area planted (rai)	Total production (tons)
Kale	33.3	27.2	29.1	37.7	57.5	58.1	85.6	108.2	205.4	231.1
Pak choy	22.5	19.0	25.3	38.9	49.6	60.6	136.8	177.6	234.1	299.8
Yard long bean	16.6	23.0	20.0	64.2	42.6	90.9	76.6	108.2	155.8	286.4
Chili	12.5	15.4	17.4	25.0	41.1	62.6	51.4	69.6	124.7	172.5
Green eggplant	13.9	23.2	17.8	32.7	35.9	82.2	45.8	100.6	113.2	238.7
Spinach	22.8	10.1	-	-	5.5	10.2	-	-	28.3	20.3
Baby carrot	22.5	15.5	-	-	-	-	2.0	6.3	24.5	21.8
Cabbage	6.3	9.8	-	-	8.0	0.4	1.0	3.4	15.3	13.6
Greenbean	-	-	14.0	7.0	-	-	-	-	14.0	7.0
Others	2.6	3.1	-	-	-	-	15.0	626.0	17.6	44.1
Total	155.9	146.6	123.6	205.4	247.0	388.7	416.8	632.3	943.3	1,374.5

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

Table 6. Sale of the 10 major vegetables under different farming systems. by farmers studied in Chiang Mai Province, 2007 **Unit: million Baht**

	Types of farming systems				
	Organic	**Chemical pesticide free**	**Safe use**	**Conventional**	**Overall**
Kale	0.5	0.7	0.9	2.4	4.5
Pak choy	0.3	0.6	0.7	1.6	3.2
Yard long bean	0.3	1.0	1.1	1.3	3.6
Chili	0.4	0.5	1.0	1.2	3.1
Green eggplant	0.2	0.4	0.9	1.1	2.6
Spinach	0.3	-	0.2	-	0.5
Baby carrot	0.5	-	-	1.0	0.6
Cabbage	0.1	-	0.01	0.2	0.2
Greenbean	-	0.1	-	-	0.1
Others	0.0	-	4.8	8.7	0.9
Total	2.6	3.3	5.0	8.7	19.6

Source: Survey January-March, 2008

Note: One USD is equal to 34.35 Baht

Table 7. Methods for controlling pests and diseases in Chiang Mai Province, 2007.

Methods	Processing	Target pest/insect	Application method
1. Physical methods			
1.1 Nets		insects, worm	
1.2 Light trap	This trap is about 1.5 meters above the ground, and 0.3 meters from the light	insects	2 sets per rai
1.3 Glue tray	Mix 600 cc of castor oil, 390 grams of rubber and 10 grams of carnuaba wax. Simmer for 45 minutes. After 1 hour, pour the cold glue in a tray.	insects	20 -60 sets per rai
2.Biological methods			
2.1 Botanical Insectcides:			
2.1.1 Spray Mix : main herbs used :			
Neem (*Azadirachta indica*)	Chop all the materials into finely pounded mass.	Insects (Adults and larvae)	Spray once a week
Chili (*Capsicum* spp.)	Mix all materials in 20 liters of water and		
Lemon grass (*Cymbopogon citrates*)	leave to ferment for 1-2 days		
Bo-ra-phet (*Tinospora crispa*)			
Galanga tuber (*Alpinia galanga*)			
2.1.2 Fungicide : main herbs used:			
Lemon grass (*Cymbopogon citrates*)	Chop all the materials into finely pounded mass.	*Colletotrichum*	Spray once a week
Siam weed (*Eupotorium odortum* L.)	Mix all the materials with molasses in 20 liters	*gloeosporioides* fungi	
Galanga tuber (*Alpinia galanga*)	of water and leave to ferment for 3 days		
2.2 Microbial pesticideds			
2.2.1 *Bacillus thuringiensis* (BT)	Mix 40-60 grams of BT per 20 liters of water	Insects (Adults and larvae)	Spray once a week
2.2.2 Nuclear Polyhedrosis Virus (NPV)	Mix 1 milligrams of NPV per 20 liters of water	Insects (Adults and larvae)	Spray once a week
2.2.3 *Trichoderma harzianum*	Mix 250 grams of *Trichoderma harzianum* (fungal biopesticide) per 20 liters of water	Fungal diseases	Spray once a week

Source: Survey January-March, 2008

The main components of microbial pesticide were bacterium, fungus, and virus (Banpot, 2007), that particularly used to control common fungal diseases such as *Phytophthora inferstans* in the rainy season and *Peronospora parasitica* during the growing time of young kale. For controlling these fungal diseases, farmers sprayed about 250 grams of *Trichoderma harzianum* (fungal biopesticide) per 20 liters of water (Office of the Permanent Secretary for Agricultural and Cooperatives, 2005). In fact, organic farmers bought the microbial pesticides at high price but they did not know the effectiveness of the microbial pesticides, which were not registered in the Ministry of Agriculture and Cooperatives. Recently the cost of production of the conventional farming system increased rapidly due to the increased price of synthetic chemical pesticides, resulting in the increase of the use of bio-pesticide in conventional farms.

Finally, most products under organic, chemical pesticide free, and safe use farming were sold directly to their farmer groups. For example, organic farmers harvested products by themselves, and the commodities were sorted and graded according to the quality standards as specified in the agreement. Price was determined by buyer as the standard price. It is also noted that organic produce was significantly more expensive than conventional produce. In the case of conventional production, farmers sold their produce to wholesalers or a local cooperative without sorting, grading and packaging. The price depended on the quality of the produce. In the case of both chemical pesticide free and safe use farmers, the products were sorted and graded, although no packaging was involved. Prices were determined by buyer and markets because there were no specific markets for chemical pesticide free and safe use vegetables.

Input Use and Yield

Most organic vegetable growers studied produced their products under the Royal Project Foundation, and only 7 growers practiced organic system outside the organization, as individual farms. It seems that there were no differences in types of inputs used for major organic crops such as kale, pak choy, and yard long bean. **Table 8** shows input values and yield by different vegetable farming systems. Average yield levels of organic vegetables were slightly lower than other production systems. Organic farmers seemed to lack efficiency in management of their farms, while conventional farmers had more than 30 years of farming experience (**Table 4**). In chemical pesticide free farms, farmers got knowledge and technical support from the provincial government.

The average amount of seeds used seemed to make no difference. Manure and/or compost and bio- pesticide were the major inputs for organic and chemical pesticide free farming systems, while safe use and conventional farms heavily depended on synthetic chemical inputs such as chemical fertilizer and chemical pesticide. The amount of bio-pesticide for organic farm was 8-10 bottles per rai for major organic crops. According to the government's promotion of production of safe food, the conventional farmers were also advised to apply some amount of bio-pesticide for pak choy and yard long bean.

Vegetable cultivation in Chiang Mai heavily depended on family labor, and no hired labor was used in organic farming. It seemed that family labor worked intensively in their organic farms, resulting in the family labor input of 93 mandays per rai in pak choy. Other farming systems were dependent on both family labor and hired labor, and it is seen that conventional farming had the highest level of hired labor among all farming systems, accounting for 40% of total labor inputs. The conventional farmers usually employed landless villagers for land preparation, water management, and pest control.

Table 8. Estimated yield and inputs per rai of major vegetables by different farming systems in Chiang Mai Province, 2007

Types of farming system and Major vegetables	Seed (kg)		Manure and/or Compost (kg)		Chemical fertilizer (kg)		Chemical pesticide (bottle)1/		Bio-pesticide (bottle)1/		Labor Family (man-days)		Labor Hired (man-days)		Yield (kg)	
Kale																
Organic	0.3	a	112	a	-		-	-	9	a	88	a	-	-	1,180	a
Chemical pesticide free	0.4	b	122	a	119	a	-	-	5	b	48	b	20	a	1,297	b
Safe use	0.3	b	49	b	157	b	1	a	1	c	33	c	23	a	1,103	a
Conventional	0.2	c	18	b	147	b	2	b	-	-	26	c	17	b	1,474	c
Pak choy																
Organic	0.3	a	195	a	-	-	-	-	10	a	93	a	-	-	1,559	a
Chemical pesticide free	0.4	b	153	a	77	a	-	-	6	b	60	b	23	a	1,609	b
Safe use	0.3	a	34	b	99	a	2	a	3	c	34	c	11	b	1,511	a
Conventional	0.3	a	13	b	128	b	2	a	1	d	29	d	19	c	1,781	c
Yard long bean																
Organic	0.3	a	213	a	-	-	-	-	8	a	90	a	-	-	2,167	a
Chemical pesticide free	0.4	b	169	a	107	a	-	-	6	b	67	a	20	a	2,536	b
Safe use	0.3	a	67	b	135	b	3	a	3	c	40	b	34	b	2,280	a
Conventional	0.4	b	31	b	195	b	4	b	5	d	43	c	26	c	2,706	b

Source: Survey January-March, 2008

Note: Values in each column followed by the same letters indicate insignificant differences at P<0.05.

1/ One bottle contained 500 cc.

One rai is equal to 0.16 ha

Problems of Vegetable Cultivation

According to the farmers interviewed, there were no differences in kinds and extent of management problems among four vegetable farming systems, the common problems being inadequate water supply in the dry season, inadequate labor during harvesting and transplanting, high pest and disease occurrence, low soil fertility, high chemical residues, inadequacy of farm equipments, inadequate product supply for market demand, and increasing investment cost. The most important problems in organic farming were inadequate seeds, and labor. Most seeds were usually imported from foreign countries at high price. Under organic farming, the farmers grew vegetables in an open system without a net. The pest and diseases frequently found were leaf worm and damping-off of seedlings. The techniques used for pests and diseases management were crop rotation and mechanical control by manually picking pests. Therefore, organic farming was more labor-intensive, and the farmers need to pay more attention to disease and pest control and soil improvement. During harvesting period, the farmers followed the harvest guidelines under organic standard. There were four main types of accreditation institutions in Chiang Mai, providing organic certification services: Organic Agricultural Certification Thailand (ACT), Organic Crops Institute of the DOA, foreign companies, and Northern NGOs (Ellis et al., 2006). Organic vegetables in villages studied area were certified for quality level by organic standard of the DOA, while the good agricultural practice (GAP) was used for production of pesticide free and safe use vegetables.

The DOA encouraged farmers with respect to acquiring knowledge, farmland inspection, and the standard method for efficient management of alternative farming such as organic, chemical pesticide free and safe use production systems. The Department of Agricultural Extension established learning centers in villages to promote production of alternative farming. Recently, the conventional farmers encountered serious economic problem in producing vegetables, due to the increased prices of synthetic chemical pesticides and fertilizers. They also started using manure and compost to reduce chemical fertilizer cost, but still depended heavily on chemical pesticides.

ECONOMIC ANALYSIS

Costs and Returns

The data collected from the questionnaire survey were used to estimate costs and returns per rai for major vegetable crops under four types of farming system. Costs have been classified into variable costs such as seeds, fertilizers, and labor, and fixed costs such as depreciation, interest on capital and rental payment of land. Total cost was divided into cash cost and non cash cost. Total revenue was measured by price and yield for each crop. Net profit was obtained by deducting total cost from total revenue, while profit above cash cost was calculated by deducting only cash cost from total revenue.

Average costs per rai for three major vegetables, kale, pak choy and yard long bean are presented in **Table 9.** In organic farming, yard long bean had the highest total production cost of 24,016 Baht (nearly 699 USD), followed by pak choy (23,524 Baht) and kale (21,625 Baht). It should be noted that production cost of yard long bean included the extra costs of beanpole. Among input costs, labor constituted the largest expense, amounting to 14,004, 14,847, and 14,326 Baht in kale, pak choy and yard long bean respectively for organic farming. Labor and seed costs for organic farming were the highest among all farming systems. However, the use of synthetic material inputs such as pesticide and fertilizer were greatly higher than other material costs in conventional farms. Results show that pesticide cost was the highest in kale (2,229 Baht) and yard long bean (4,952 Baht) for conventional farming, and pak choy (2,391 Baht) for safe use system. Most operated lands of conventional farms were located close to main roads and irrigation canals, and land value was therefore high, leading the average rental to 1,296, 1,246, and 1,274 Baht in kale, pak choy and yard long bean respectively for conventional farms.

Table 9 also shows the average revenue and profit for major vegetables per rai and per kg. Although organic farming had higher cost because of labor, they had the highest revenue of all farming systems, with higher prices contributing to its higher profits. Normally, vegetable prices depended on the demand and growing time, but organic vegetable prices were fixed for the whole year because there were specific markets such as supermarkets. Average price per kg of three organic vegetables were 21, 18, and 21 Baht for kale, pak choy, and yard long bean respectively. Average revenue per rai of yard long bean was the highest at 45,210 Baht, followed by pak choy (28,075 Baht) and kale (25,328 Baht) for organic farming. Concerning other production systems, chemical pesticide free farms also received a high revenue, the average total revenue being 22,960 Baht for kale, 22,894 Baht for pak choy, and 38,713 Baht for yard long bean.

Regarding the average total cost per kg under different farming systems, organic farms had the highest cost, while average cash costs per kg were the lowest for pak choy (3.7 Baht) and yard long bean (2.9 Baht). It is clear that the organic farms had the higher non cash cost than other production systems because of family labor costs, while there were higher hired labor costs to be accounted in cash cost for safe use and conventional farms. Consequently, the highest profits over cash cost per kg were 13.0 Baht for kale, 14.3 Baht for pak choy, and 18.0 Baht for yard long bean for organic farms. The profitability of all farming systems was also evaluated by the ratio of benefit to cost of farm. If the ratio is greater than unity, it indicates that the return was larger than the cost. If the ratio is less than unity, the cost was higher than the return. The benefit-cost ratio (B/C ratio) of all farming system was greater than one, especially the highest B/C ratio of organic yard long bean was 1.9.

Production Function Analysis

In order to examine mechanism of vegetable production in Chiang Mai, the production function of the Cobb-Douglas type was estimated for the farmers studied. Because kale appeared to be a dominant crop and data were available for 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 five independent variables were used: X_1 refers to kale's planted area (rai), X_2 is total labor inputs of family labor and hired labor (man-days), X_3 refers to total amount of seed used (Baht), X_4 is amount of Nitrogen element in fertilizer (kg), and X_5 refers to cost of pest control (Baht).

Table 10 presents the results of the estimation of production function for different farming systems in Chiang Mai. In organic kale production, there were three significant regression coefficients: labor and seed at the 1% level and pest control cost at the 5% level. The coefficient of determination (R^2) was 51%, indicating a reasonable explanatory power of the variables included in the estimation. The results imply that family labor and quality of seed were the most important factors in improvement of organic kale production. If the number of labor and seed increased by 10%, organic kale production would increase by 2.97% and 2.69%, respectively. Our study revealed that the planted area was not a significant contributor to the determination of organic kale production, presumably because the expected influence of planted area was somehow affected by land fertility management during the transition period from conventional to organic production.

In the case of chemical pesticide free farming, the regression coefficients for labor and pest control cost were significant at the 1% level. It implied that a 10% increased in labor and pest control cost would increase the production of chemical pesticide free kale by 2.42% and 2.28%, receptively. However, the seed variable was not significant in chemical pesticide free farming, implying that kale seeds produced locally with the use of chemical inputs were probably of low standard. The coefficient of determination (R^2) was 62.3%.

The regression coefficient for farm size was significant at the 1% level for safe use and conventional farming system, indicating that a 10% increased in farm size would increase kale production by1.76% and 2.86% for safe use and conventional farms, respectively. Farmers often used the mechanical methods including glue tray and light trap, which reduced the production cost, and then the pest control cost was not significant for safe use farming. Conventional farmers heavily depended on chemical fertilizer and pesticide to increase their productivity, and its regression coefficient was significant at the 5% of level. Labor was not significant for conventional farming because the farmers widely adopted in the labor-saving technology such as tractor, truck, sprayer, and pump. The coefficients of determination were 58% and 56% for safe use farming and conventional farming.

Marginal Productivity Analysis

Based on the production function estimates (**Table 10**), the marginal products of inputs can be estimated in order to evaluate the efficiency of input use. First, the marginal physical products of labor, seed, fertilizer and pest control under organic farming were 15.41 kg/man-day, 0.10 kg/can, 103 kg/kg of fertilizer and 0.19 kg/bottle, respectively. Since the average price of organic kale was 21 Baht/kg, marginal value products would become 330.81 Baht/man-day, 2.09 Baht/can, 2,210.85 Baht/kg and 4.06 Baht/bottle, respectively (**Table 11**). Second, the marginal physical products of land, labor, fertilizer and pest control under chemical pesticide free farming were 370.76 kg/rai, 10.02 kg/man-day, 46.13 kg/kg of fertilizer and 0.21 kg/bottle respectively, and the marginal value products became 6,563.59 Baht/rai, 177.41 Baht/man-day, 816.73 Baht/kg and 3.67 Baht/bottle respectively at an average price of chemical pesticide free kale of 18 Baht/kg. Third, the marginal physical products of land, labor, seed and fertilizer under safe use farming systems were 291.17 kg/rai, 3.33 kg/man-day, 0.09 kg/pack and 137.99 kg/kg of fertilizer, respectively, while the marginal value products were 4,527.50 Baht/rai, 51.81 Baht/man-day, 1.47 Baht/pack and 2,145.62 Baht/kg at an average price of safe use kale of 16 Baht/kg. Lastly, the marginal physical products of land, seed, fertilizer and pest control under conventional farming were 484.97 kg/rai, 0.10 kg/pack, 22.88 kg/kg of fertilizer and 0.09 kg/bottle, respectively, and the marginal value products would become 6,571.41 Baht/rai, 1.41 Baht/pack, 310.01 Baht/kg and 1.17 Baht/bottle at an average price of conventional kale of 14 Baht/kg.

The opportunity cost of land was the fixed rent in the village studied. The tenant farmers paid approximately 2,000 Baht/rai/year by cash, so that an opportunity cost of land for kale production was estimated to be 667 Baht for the period of four months. The opportunity cost of labor was assumed to be the on-going wage rate; 150-155 Baht per day. The opportunity cost of organic seeds was the highest among all farming systems at 1,000 Baht per can, while the opportunity cost of organic manure was at 8 Baht/kg. The efficiency of resource use was evaluated by the ratio of marginal value product to opportunity cost of the input. As shown in **Table 11**, the ratio of land and fertilizer were higher than unity for all vegetable farming systems in Chiang Mai, indicating that the increased use of land and fertilizer would lead to higher income. On the other hand, the ratio of seed and pest control was lower than unity, indicating the use of seed and pest control was beyond the optimum level. Under organic farming, the ratio of seed and pest control was also lower than unity, implying the use of organic seed and pest control methods were still inefficient.

Table 9. Costs and returns per rai of major vegetables in Chiang Mai Province, 2007.

	Kale				Pak choy				Yard long bean			
	Organic	**Chem. pesticide free**	**Safe use**	**Conven-tional**	**Organic**	**Chem. pesticide free**	**Safe use**	**Conven-tional**	**Organic**	**Chem pesticide free**	**Safe use**	**Conven-tional**
Costs												
Variable Costs (Baht):	20,973	17,907	15,386	14,192	22,940	19,393	14,347	13,891	23,121	24,440	21,072	21,357
Seed	690	547	392	210	635	564	426	195	873	588	493	578
Fertilizer (Manure,Compost, EM)	3,326	2,896	2,124	1,012	4,926	2,109	2,025	1,178	4,891	5,954	2,827	924
Chemical fertilizer	-	1,610	2,122	1,991	-	1,045	1,334	1,731	-	1,438	1,824	2,633
Pesticide	-	-	1,297	2,229	-	-	2,391	2,256	-	-	2,815	4,952
Bio pesticide	1,788	969	249	-	1,950	1,290	562	259	1,517	1,236	573	958
Labor	14,004	10,841	8,915	6,876	14,847	13,390	7,202	7,556	14,326	13,863	11,801	10,977
Opportunity cost of investment (1.7% per year)	76	109	117	91	74	116	117	90	80	124	158	94
Others	1,090	936	170	1,784	508	880	291	626	1,434	1,237	580	240
Fixed Costs (Baht):	652	351	284	1,311	583	706	200	1,255	895	867	545	1,288
Land tax and land rent	640	337	271	1,296	574	695	191	1,246	882	850	532	1,274
Depreciation of farm machinery	12	14	14	14	10	11	9	10	13.2	17.0	13.1	14.6
Total cost per rai	21,625	18,258	15,670	15,503	23,524	20,099	14,548	15,147	24,016	25,307	21,617	22,646

Table 9. Costs and returns per rai of major vegetables in Chiang Mai Province, 2007.

	Kale				Pak choy				Yard long bean			
	Organic	**Chem. pesticide free**	**Safe use**	**Conven-tional**	**Organic**	**Chem. pesticide free**	**Safe use**	**Conven-tional**	**Organic**	**Chem pesticide free**	**Safe use**	**Conven-tional**
Returns												
Baht per rai												
(1) Total revenue	25,328	22,960	17,157	19,969	28,074	22,894	17,785	16,336	45,210	38,713	26,377	33,265
(2) Total costs	21,625	18,258	15,670	15,503	23,524	20,099	14,548	15,147	24,016	25,307	21,617	22,646
Benefit-cost ratio (1)/(2)	1.2	1.3	1.1	1.3	1.2	1.1	1.2	1.1	1.9	1.5	1.2	1.5
Baht per kg												
(3) Selling price	21	18	16	14	18	14	12	9	21	15	12	12
(4) Total costs	18.3	14.1	14.2	10.5	15.1	12.5	9.6	8.5	11.1	10.0	9.5	8.4
(5) Total variable cost	17.8	13.8	13.9	10.4	14.7	12.1	9.5	7.8	10.7	9.6	9.2	7.9
(6) Total fixed cost	0.6	0.3	0.3	0.1	0.4	0.4	0.1	0.7	0.4	0.3	0.2	0.5
(7) Total cash cost	8.5	7.6	9.2	7.6	3.7	6.1	5.9	5.9	2.9	5.5	6.5	5.8
(8) Total non-cash cost	9.9	6.4	5.0	2.9	11.4	6.4	3.7	2.6	8.2	4.5	2.9	2.6
Net profit (3) - (4)	3.1	3.6	1.3	3.0	2.9	1.7	2.1	0.7	9.8	5.3	2.1	3.9
Profit over cash cost (3) -(7)	13.0	10.1	6.3	5.9	14.3	8.2	5.9	3.3	18.0	9.8	5.0	6.5

Source: Survey January-March, 2008

Note: One rai is equal to 0.16 ha

One USD is equal to 34.35 Baht

Table 10. Estimate of kale production function under different farming systems in Chiang Mai Province, 2007.

	Type of vegetable farming											
	Organic			Chemical pesticide free			Safe use			Conventional		
	Reg coeff.		t value	Reg coeff.		t value	Reg coeff.		t value	Reg coeff.		t value
Constant	1.637	*	1.761	2.404	***	4.411	3.161	***	7.78	2.871	***	5.564
Area (rai)	0.114	ns	1.386	0.167	**	2.632	0.176	***	2.38	0.286	***	3.745
Labor (man-day)	0.297	***	2.703	0.242	***	2.905	0.122	*	1.66	0.035	ns	0.540
Seed (Baht)	0.269	***	3.521	0.058	ns	1.181	0.097	**	2.29	0.106	*	1.759
Nitrogen element in fertilizer (kg)	0.118	*	1.922	0.096	**	2.532	0.141	*	1.67	0.073	**	2.135
Pest control cost (Baht)	0.177	**	2.557	0.228	***	2.134	0.075	ns	1.27	0.089	**	2.025
R square	0.512			0.623			0.580			0.564		
F value	11.324			16.170			18.220			20.958		
Durbin-watson value	1.992			1.773			2.138			2.411		
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 signigicance at 10% level

Table 11. Marginal products and opportunity costs of selected variables under different farming system in Chiang Mai Province, 2007.

	Type of farming system											
	Organic			**Chemical pesticide free**			**Safe use**			**Conventional**		
	Marginal value products (MVP)	Oppor-tunity costs (OC)	MVP/ OC ratio	Marginal value products (MVP)	Oppor-tunity costs (OC)	MVP/ OC ratio	Marginal value products (MVP)	Oppor-tunity costs (OC)	MVP/ OC ratio	Marginal value products (MVP)	Oppor-tunity costs (OC)	MVP/ OC ratio
Area (Baht/rai)				6,563.6	667	9.8	4,527.5	667	6.8	6,571.4	667	9.8
Labor (Baht/man-day)	330.81	150	2.21	177.4	155	1.1	51.8	155	0.3			
Seed (Baht/can or pack)	2.09	1,000	0.002				1.5	15	0.1	1.4	15	0.09
Fertilizer (Baht/kg)	2,210.8	8	276.4	816.7	14	58.3	2,145.6	14	153.3	310.0	14	22.1
Pest control (Bath/bottle)	4.06	20	0.20	3.7	15	0.2				1.2	15	0.08

Source: Survey January-March, 2008

Note: A fixed rate of rental land was 2,000 Baht/year, while kale was planted 3 crops per year.

The opportunity cost of land was estimated to be 667 Baht per crop

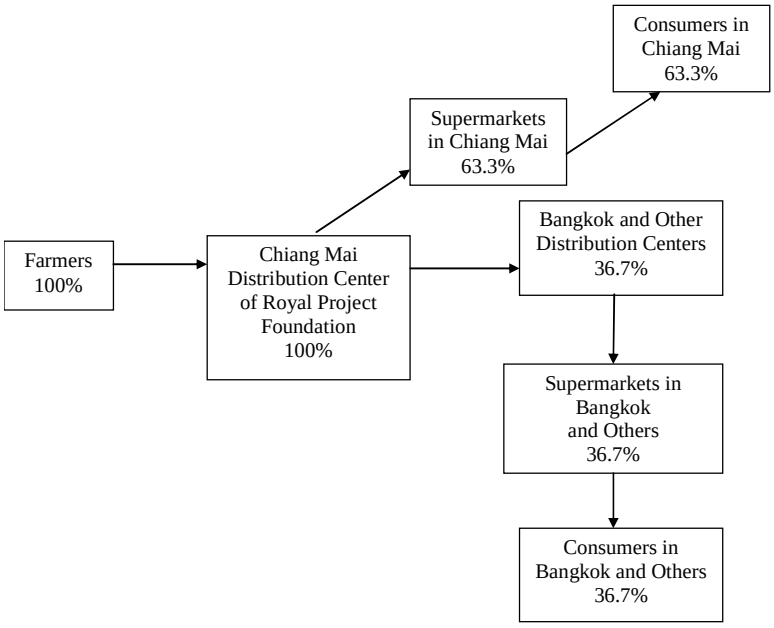
One rai is equal to 0.16 ha

One USD is equal to 34.35 Baht

VEGETABLE MARKETING PRACTICES

Economic efficiency of organic farming appeared to depend on the level of vegetable price under the unique marketing system. The prices of major vegetables under different farming systems, are shown in Table 12. The selling prices of vegetable under different farming systems differed significantly, and organic vegetables were sold at the highest prices both at the farm and market levels. The price difference from farm to hypermarket of organic vegetables was 257% for yard long bean and 495% for kale, while the conventional vegetable prices seemed to be the lowest. It indicates that organic vegetables prices were mostly higher than conventional vegetables prices by 25% for water spinach and 471% for Chinese parsley and tomato. The price difference between farm price and supermarket price was also high, ranging from 100% for Chinese parsley and okra to 367% for yard long bean and winged bean under chemical pesticide free farming, and 226% for okra and lettuce to 500% for pak choy in safe use farming.

Organic farmers of the Royal Project Foundation were all encouraged to use organic inputs due to high prices of organic vegetables under the contract marketing system of the Royal Project. The prices of organic vegetables were estimated by the marketing cost and vegetable prices of other farming system, while vegetable prices of other farming systems still depended on market demand. His Majesty the King had supported expenditure of the project for the organic vegetable production and marketing activities. The marketing channels of vegetables produced by different farming systems in Chiang Mai are shown in Figures 2 to 5. In organic marketing, farmers sold all of their vegetables to the Royal Project Foundation's sites, located nearby their farms. The organic vegetables of the Royal project were distributed domestically under the brand name "Doi Kham". In terms of quantity, 63% of the Royal project's organic vegetables were bought by consumers in Chiang Mai, and 37% shipped to supermarkets and retail shops of the Royal Project Foundation in Bangkok and other large provinces such as Hat Yai, Phitsanuloke, and Khon Kaen (Fig.2).



Source: Survey January-March, 2008

Fig. 2. Marketing channels of organic vegetables under the Royal Project Foundation in Chiang Mai Province

Table12. Farm and market prices of major vegetables under different farming systems in Chiang Mai Province, July-August 2007

Unit: Baht per kg

Kinds of vegetable	Type of farming system													Farm price differences (Organic-Conventional)	
	Organic			Chemical pesticide free				Safe use			Conventional				
	Farm (1)	1/ Hyper market	% Price difference	Farm	2/ Safe food market in weekend	3/ Super market	% Price difference	Farm	3/ Super market	% Price difference	Farm (2)	4/ Local market	% Price difference	Baht / kg (1)-(2)	Percent
Kale	21	125	495	15-20	20-25	40	122	15-23	75	369	7-15	14-23	64	6	40
Pak choy	20	95	375	10	17	25	150	10-15	90	500	7-9	11-13	44	11	122
Yard long bean	35	125	257	15	20-25	65-70	367	11-16	65	306	10-14	21-26	86	21	150
Green egg plant	20	100	400	10	15	33	230	11-15	75	400	5-7	13	86	13	186
Chinese parsley	40	150	275	15-20	25-40	40	100	-	-	-	5-7	12	71	33	471
Tomato	40	150	275	8	15	25	213	-	-	-	5-7	13	86	33	471
Winged bean	-	-	-	15	40	70	367	-	-	-	-	-	-	-	-
Water spinach	15	75	400	10	17	25	150	7-10	40	300	6-12	12-16	33	3	25
Okra	20	100	400	10	40	20	100	15-23	75	226	-	-	-	-	-
Lettuce	40	150	275	15-20	25-30	50	150	15-23	75	226	-	-	-	-	-

Source: Survey January-March, 2008

1/Office of Marketing, The Royal Project Foundation, 2008

2/MCC, Chiang Mai University, 2008

3/Rim Ping Supermarket, 2008

4/ Chiang Mai Agriculture office, 2008

Note: One USD is equal to 34.35 Baht

Both safe use and chemical pesticide free vegetables have a similar system of marketing, because they were produced by Good Agricultural Practice (GAP) through grouping of farms which were also involved in joint marketing. As much as 94% of the chemical pesticide free vegetables were bought by local collectors and/or their farmer groups, of which 52% were sold at their Saturday market (**Fig. 3**). The Saturday market was established by a network of chemical pesticide free vegetable growers, and only farmer members were allowed to trade in this market. In other words, the local collectors and/or their farmer groups sold 55% of safe use vegetables to the local retailers, and 18% sold at the local open markets by farmers (**Fig. 4**). In fact, there was no formal marketing arrangement for both safe use and chemical pesticide free vegetables. Therefore, some farmers had no trading post, and they sold their vegetables within village and local open markets.

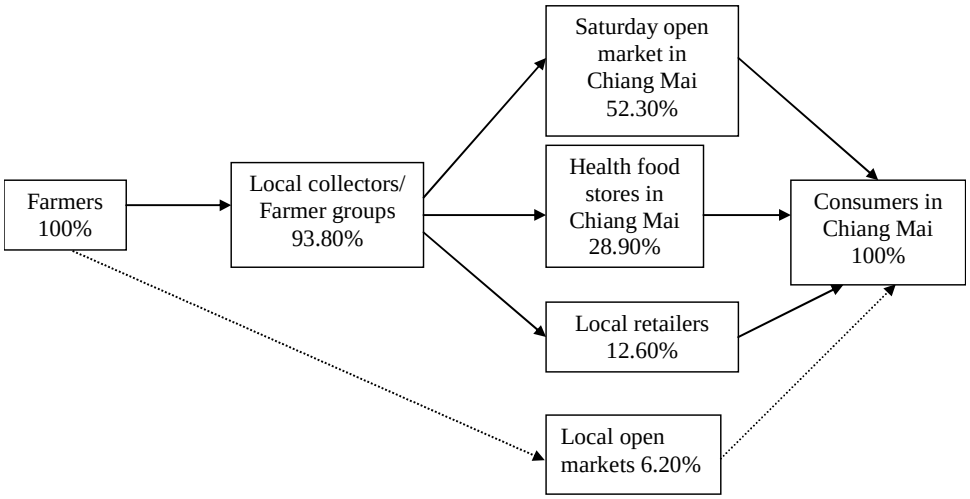


Fig. 3. Marketing channels of chemical pesticide free vegetables in Chiang Mai Province

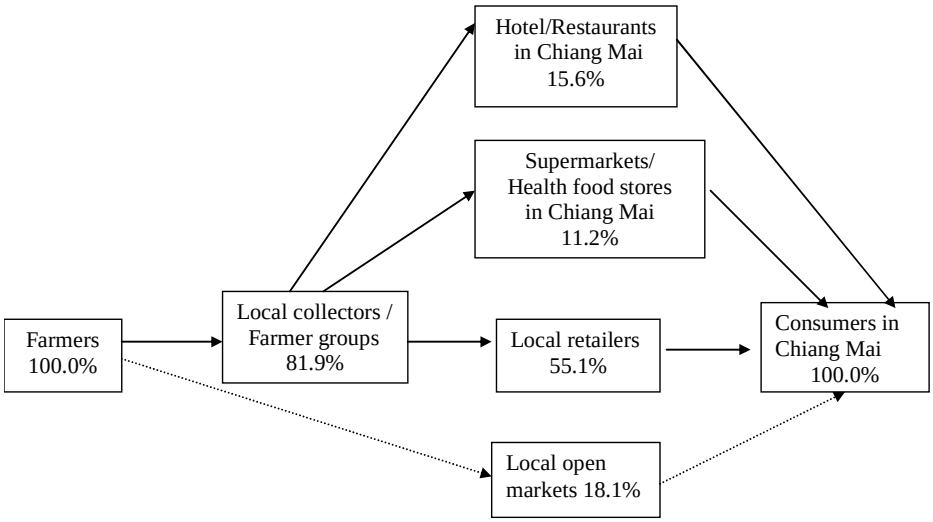


Fig. 4. Marketing channels of safe use vegetables in Chiang Mai Province

The shelf space for alternative vegetables in supermarkets in Chiang Mai such as Carrefour and Rim Ping supermarkets had increased rapidly during the past few years, but the number of varieties of alternative vegetables available did not increase (Kramol et al., 2006). Due to the lack of marketing information on quantities and prices, which usually fluctuated all the time, alternative vegetable growers needed time to learn and get experience, and to increase efficiency in their business. This may be one type of entry barrier for the alternative vegetable growers in the supermarket. However, there were some advantages of selling in the supermarkets, including the stable number of consumers, exact payment time, and preservation of the freshness of vegetables in air-conditioned rooms.

Most of conventional vegetables were distributed through various middlemen: 52% by local wholesalers, and 39% by local collectors (**Fig. 5)**. Prices were determined by demand and supply. In Muang Mai market of Chiang Mai, vegetable prices were determined by the negotiation between buyers and sellers, but level of prices depended on seasonality, quality of products and marketing costs. It became clear that nearly 46% of conventional vegetables were sold to wholesalers in Bangkok and other provinces by local wholesalers, while the remaining 54% were traded in Chiang Mai and the neighboring provinces.

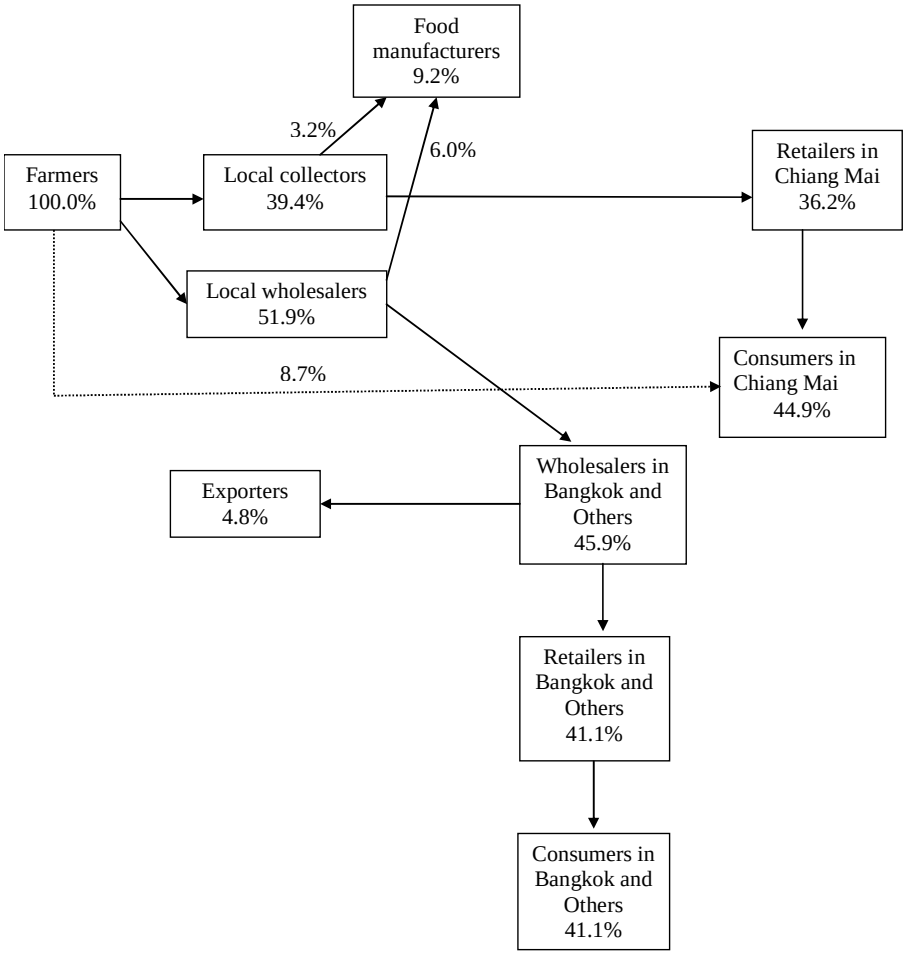


Fig. 5. Marketing channels of conventional vegetables in Chiang Mai Province.

Currently, marketing system for alternative vegetables in Chiang Mai was in the early stage of the development process. The number of consumers was still small, while most of the consumers were in Bangkok and other big cities. Consumers were often confused by different brands when buying alternative vegetables. However, alternative vegetables appeared to have a good chance of marketing due to an increasing demand from supermarkets. For instance, Carrefour supermarket launched a healthy vegetables project under the name "organic vegetables" from the alternative vegetables growers in Chiang Mai to export to Singapore (Wibbonpongse and Sriboonchitta, 2004). In villages studied, there was a small number of alternative vegetable growers whose quality of vegetables met the supermarket requirement, but most of them were still inadequate. Therefore, the government should help them with marketing management and promote alternative vegetables for local people.

CONCLUSION

Based on data obtained from the questionnaire survey of 142 farmers in Mae Rim District, Chiang Mai, this paper analyzed the major vegetables cultivated under different farming systems, and discussed production efficiency and profitability of organic farming in comparison with other production systems: chemical pesticide free, safe use and conventional farming systems. Kinds of vegetables grown depended on market demand and growing time. The common problems found in organic farming were inadequate seeds and labor, while conventional farmers faced the increased prices of synthetic chemical pesticides and fertilizers. The yield of organic vegetables was the lowest among all farming systems due to the lack of experience in organic vegetable production and inadequate knowledge of management, while the benefit-cost ratio of organic farms were greater than one, indicating that organic farming was also the profitable farming for small farmers.

Through the estimation of the production function of kale under different farming systems, this paper showed that labor was the most important factor for organic and chemical pesticide free farming systems, while production depended on farm size for safe use and conventional farming systems. These results raised important issues for the development of each vegetable farming system, as follows: 1) Improvement in the availability of high quality but reasonably priced seeds for organic farming; 2) Clear and easy demonstration of know-how and standard method for efficient management of the chemical pesticide free and safe use farming systems; and 3) the guaranteed farm gate price for conventional vegetables.

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