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Research Report No 02/2002
June 2002

Farm and Horticultural Management Group
Lincoln University

ISSN 1174-8796

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ORGANIC FARMING IN THAILAND: CASE STUDIES ON FRUIT AND FLOWER PRODUCTION IN CHIANGMAI, THAILAND

Thawatchai Dechachete and Peter Nuthall

Abstract

The purpose of this study was to examine organic horticultural production in Chiangmai, Thailand, through discovering the farmers' objectives, economic performance, as well as elucidating other impacts including social and environmental effects. Interviews and available data were used to gather information from the people in three villages which were selected as case studies. Forty-five farmers from three categories, chemical-free vegetable farming (CFA), mixed agriculture (MA) and conventional agriculture (CA), were interviewed. The 'chemical-free' farming (CFA) was not strictly totally chemical-free, but the intention is to minimise artificial chemical use.

The study found that profit maximisation was the first priority in all production categories. Lower CFA production costs were also a reason for farmers to move away from CA. Few farmers seriously realised the social and environmental impacts caused by conventional farming. However, CFA farmers tended to be more concerned about their health and environment than CA farmers.

The economic comparisons indicated that the running costs of CFA farming were less than the running costs of CA farming. The economic and the social cost comparison results varied among the research sites. It could not be concluded that the economic and the social costs of CFA farming were less than for CA farming.

Nor could it be concluded that CFA farming gains a higher net farm income than CA farming. However, the study suggested that the net farm income of the CFA farms was greater when the CFA farmers could sell their produce at a reasonable price. In one research site, the negative social net farm income finding indicated that the government CFA promotion project had failed.

Social comparisons between CFA and CA methods showed CFA results in education and health benefits in comparison to conventional agriculture. Finally, the environmental comparisons found that CFA had beneficial impacts on the farm environment. The farmers realised that the use of artificial agricultural chemicals resulted in decreases in local wildlife quantity and variety, and they actually noted that CFA seemed to have positive effects on these variables.

Keywords: Organic farming; sustainable agriculture; economic costs; social costs; farmer's net farm income; economic net farm income; social net farm income.

Abbreviations

CA	=	Conventional agriculture
CFA	=	"Chemical-free" production
FEDRA	=	The Foundation for the Development of Rural Education
GDP	=	Gross Domestic Product
GPP	=	Gross Provincial Product
IFOAM	=	The International Federation of Organic Agriculture Movements
IPM	=	Integrated Pest Management
MA	=	Mixed Agriculture
NGO	=	Non Governmental Organisation
USDA	=	The United States Department of Agriculture

Introduction

1.1 General Introduction

Thailand occupies an area of close to 514,000 square kilometres and has a population of 60.8 million and is a country currently undergoing rapid change. It is a primarily agricultural nation and, before the national economic crisis in 1997, was intending to be propelled into the ranks of the newly industrialised countries (NICs) with an annual economic growth rate of around 7.7 percent (8.8 per cent in 1994, 8.7 percent in 1995, and 6.9 percent in 1996) (Viravaidya and Sacks, 1997). Thai economic progress has undoubtedly been accompanied by social costs. For instance, an increasing gap between rich and poor has placed considerable pressure on the livelihoods of the 74 percent of people who occupy rural areas, leading to an increase in rural-urban migration. Approximately 40 million of the total 60 million people are still earning their livelihood from agriculture and agriculture-related industries (Centre of Agricultural Information, 1999). Over 10 million of these are regarded as living in poverty (Farrington and Lewis, 1993). The average per capita income in the capital, Bangkok, is US$1,000 per annum, while in the rural Northeastern part of the country, where most of population are farmers living at a subsistence level, the average is US$235 per annum.

1.2 Research Issues

The Green Revolution in agricultural production has brought high levels of productivity to farmers (Oelhaf, 1978). It is clear that agriculture has dramatically changed its character due to this development of new knowledge, varieties, machinery and chemicals. However, besides boosting food production dramatically, the developments have also caused many negative side effects. The International Federation of Organic Agriculture Movements (IFOAM, 1997) states the following major criticisms of current agricultural practice:

1) damage to soil structure,

2) damage to the natural environment,

3) creation of potential health hazards in food, bringing about a global decline in food quality,

4) an energy-consuming system,

5) destruction of traditional social structures and the changing of agriculture to an industrial process.

These changes arise as conventional agriculture is not forced to take account of its effect on the environment and social structures, nor of the hidden dimensions of food quality, nor of the distribution of resources between present and future generations. Thus, issues of sustainable agriculture have to be raised if the increasing the world population is to have its requirements for food and a safe environment met in the new millennium.

In the case of Thailand, agricultural productivity has increased remarkably, as it has in many parts of the world, with the application of modern technologies and the public and research policies support of the Green Revolution (Angkasith, 1994). Thai agriculture pursued monoculture in its traditional agriculture systems as it could be supported by rainfall, soil, seed, and so on. As the development of agriculture worldwide involved more advanced technologies, Thailand incorporated these advanced inputs to keep pace. Thai extension services promoted inorganic fertiliser, insecticide use and mechanised farm operations. Due to competition in the agricultural export market this campaign for high technology agriculture provided Thai farmers with a high return.

However, pesticide problems have become very serious and difficult to manage. Thai farmers are now more dependent on pesticides, and the importation of pesticides in Thailand has increased annually. The value of pesticides used is more than US$81.4 million per year (Centre of Agricultural Information, 1999). The basic problem is the lack of information and awareness about appropriate pesticide application levels. This has resulted in adverse effects on living organisms and the environment, and produced a hazard to human health. Farmers are especially at risk because they are constantly exposed to pesticides, and crops tainted with pesticide residues are not suitable for export. Pesticide residues in soil, water and air affect environmental safety, sociological balance and wildlife. The beneficial insects, predators and parasites are often destroyed while the targeted pests themselves survive by developing better resistance against the pesticides used (Tayaputch, 1991).

The Thai agricultural sector has become concerned about how to manage a "sustainable agriculture". The Eighth National Economic and Social Development Plan (1997-2001) states that it is desirable to change the system from conventional agriculture to "sustainable agriculture" in at least 20 percent of the total national agricultural area by the end of the plan period. Sustainable agriculture includes natural agriculture, organic farming, agro-forestry and aggregate agriculture. Chemical-free vegetable production is one of the organic farming systems promoted by national policies. However, as chemical-free farming was adopted in Thailand less than 15 years ago, only a few studies on this form of organic farming have been carried out.

1.3 Research Objectives

The general aim of this study is to examine the outcomes of chemical-free vegetable production in Chiangmai, one of the most important agricultural areas in Thailand, with an emphasis on the farmers' objectives, economic performance, and other effects including social and environmental effects.

Thus three questions were asked:

1. *What are the objectives or goals of the organic farmers in Thailand with respect to non- chemical vegetable production in Chiangmai?*

Some farmers may change because of the higher price of organic produce. Other reasons for shifting may be soil protection and the risk to human and animal health from the potential hazards of pesticides. The desire for lower production inputs and a general concern for the environment may also be relevant.

To understand the chemical-free vegetable farmers' attitudes, it is necessary to see if it supports and enhances the farmers' goals. Furthermore, it is also useful for policy makers who are concerned about sustainable agriculture policies to understand farmers' views and wishes.

2. *Does the chemical-free vegetable production in Chiangmai support the farmer's objectives or goals in terms of economic performance?*

The first question is whether the profit from chemical-free vegetable farming is greater than from conventional farming. The second question is that if the profit from chemical-free vegetable production is less, how do the farmers solve this problem and what support might they need from government or NGOs? The final question is whether the organic farming approach, especially chemical-free vegetable production, is suited to Thailand in terms of "sustainable agriculture".

3. *Does chemical-free vegetable production affect the farmers' quality of life and their environment?*

Previous studies indicate that organic farming is improving farmer and consumer health (Wernick and Lockeretz, 1977) as well as improving the environment (Oelhaf, 1978). Therefore, it is important to include issues of health and the environment of Thai people.

2. Literature Review

2.1 Organic Farming

One widely accepted definition of organic farming is that adopted by the United States Department of Agriculture (USDA, 1980):

"Organic farming is a production system which avoids or largely excludes the use of synthetically compounded fertilisers, pesticides, growth regulators, and livestock feed additives. To the maximum extent feasible, organic farming systems rely on crop rotations, crop residues, animal manure, legumes, green manure, off-farm organic wastes, mechanical cultivation, mineral-bearing rocks, and aspects of biological pest control to maintain soil productivity, to supply plant nutrients and to control insects, weeds and other pests."

Another universally accepted definition is "Organic agriculture includes all agricultural systems that promote the environmentally, socially and economically sound production of food and fibres. These systems take local soil fertility as a key to successful production. By respecting the natural capacity of plants, animals and the landscape, it aims to optimise quality in all aspects of agriculture and the environment. Organic agriculture dramatically reduces external inputs by refraining from the use of chemo-synthetic fertilizers, pesticides and pharmaceuticals. Instead it allows the powerful forces of nature to increase both agricultural yields and disease resistance. (IFOAM)"

In the 1970s, one of the main reasons for the adoption of organic farming was made on the basis of financial advantage. The surge in demand for organic food brought higher prices and new entrants based on the profitability motive. With higher chemical fertiliser prices, and

with increasing restrictions of some of the cheaper pesticides, farmers were more receptive to organic farming.

One of the other main reasons for changing was a desire to improve family health (Wernick and Lockeretz, 1977). These farmers believe that organic food is the best way that they can feed their families. Equally as important, there are some organic farmers who are deeply concerned about pollution and consumer well-being and may be willing to sacrifice some other goals to satisfy their desire to do good to their neighbours (Oelhaf, 1978).

2.2 Previous Studies Related to Organic Farming Systems

Most of the previous studies on organic farming focus purely on the financial performance of the systems, leaving out the wider economic benefits for the environment and society. Comparing organic farming against existing conventional systems is the one most frequently adopted approaches used by researchers and institutions new to the organic farming concept.

Many studies (MAFF, 1991; Murphy, 1992; Padel and Zerger, 1994; Dubgaard, 1994: Mühleback and Mühleback, 1994; Henning, 1994; Anderson, 1994; Wynen, 1994) have used survey methods to collect data in order to compare organic farming against conventional systems in terms of financial performance of organic farms in many developed countries including Britain, Europe, North America and Australia. They studied physical productivity, enterprise financial performance and whole-farm financial performance. The studies are summarised below.

2.2.1 Physical Performance

Crop yields

Absolute yield levels under organic management are increasing over time, but at a slower rate than for comparable conventional systems, especially in Germany (Padel and Zerger, 1994) and Switzerland (Mühlebach and Mühlebach, 1994). Absolute yields are, however, subject to considerable variability. This is due to a number of factors, including variety selection and plant breeding (Lampkin, 1994), soil type, rotation design and manuring (Padel and Zerger, 1994), length of time under organic management, as well as management ability and the development of scientific knowledge and technology (Padel and Lampkin, 1994).

Second, yields relative to comparable conventional systems are directly related to the intensity of the prevailing conventional system. This is the case not only for comparisons between regions, but also between crops within a region, and for individual crops over time. In most of the studies reported, crop yields under organic management are lower than for comparable conventional systems. However, the studies from Canada (Henning, 1994), the United States (Anderson, 1994), and Australia (Wynen, 1994) report yield reductions of 10-20 percent in some cases, and similar or higher yields in others, while reductions of up to 40 percent are reported in Britain (Lampkin, 1994), Germany (Dubgaard, 1994), and Denmark (Henning, 1994). The relative yield differences are greatest for crops such as wheat where it is produced intensively, as in Europe, and least for crops such as oats and field beans, or in America and Australia where conventional production systems are less intensive.

Table 1: Example of comparative yields for organic and conventional wheat.

Country	Organic (t/ha)	Conventional (t/ha)	Relative (conv=100)
Britain	3.73	6.16	61
Germany	3.80	6.20	61
Denmark	3.4	6.8	51
Canada	3.3	2.9	114
USA	1.7	2.2	82
Australia	2.4	2.5	96

Source: Adapted from Murphy (1992); Padel and Zerger (1994 Dubgaard (1994); Henning (1994): Anderson (1994) and Wynen (1994).

2.2.2 Enterprise Financial Performance

1) Prices

Premium prices for organic crops are widely available in northern European countries, but the size of the premium varies from crop to crop and country to country. For example, premiums for milling wheat range from up to 300 percent in Germany (Padel and Zerger, 1994), over 100 percent in Britain (Lampkin, 1994), to 80 percent in the United States (Anderson, 1994), to 40 percent in Switzerland (Mühlebach and Mühlebach, 1994) reflecting both the level of demand of organic food in each country and the level at which conventional prices are supported by agricultural policy measures (the conventional price for wheat in Switzerland is more than three times as high as in the European Union). The situation is different in Canada and Australia, where premiums for non-horticultural organic crops are less available and many farmers consider that their organic systems should be able to function profitably without premium prices (Henning, 1994; Wynen, 1994).

Although premium prices are available, their level and availability are closely related to the choice of market outlets, and the commitment of time and resources to market development and added-value activities such as on-farm processing (Padel and Lampkin, 1994). In the absence of higher prices to compensate for reduced yields, good financial performance of the organic system depends on maintaining output and cost reductions.

Table 2: Examples of price difference between organic and conventional products.

Country	Unit	Organic	Conventional	Relative (conv=100)
Germany (wheat)	DM/t	990	380	260
Britain (wheat)	£/t	230	113	204
Switzerland (wheat)	SF/t	1410	1010	140
Canada (wheat)	C$/t	202	160	126
USA (rice)	US$/t	360	190	189
Australia(wheat)	N.A.	N.A.	N.A.	106

(Note: Using 1989 wheat prices, the USA case uses the 1989 rice price)

Source: Adapted from Padel and Zerger (1994); Murphy (1992) Mühlebach and Mühlebach (1994; Henning (1994); Anderson (1994) and Wynen (1994).

2) Demand for organic food

In the late 1980s and early 1900s, various market research reports pointed to strong and rapid growth in consumer demand for organic produce, both in North America and in Europe (Table 3). The increase in consumer demand was attributed to two factors: the food scares, particularly in the UK (salmonella, listeria and BSE) and in the US (alar); and the growth of the environmental movement and 'green' consumerism (Mintel, 1989).

However, a number of factors have combined to slow down growth in the middle of the 1990s. Reasons for this include the recession in Europe, which has had a general impact on demand for green products, and the small supply base for organic produce, with the associated difficulties and costs of marketing small amounts of produce (Tate, 1994).

Table 3: Market demand and supply growth projections for the organic sector, 1990-2000

Report	Region	Parameter	Unit	1989/90	1995	2000
Henley Centre (1989)	UK	Retail sales:				
		Vegetables	Percent	1.56	5	n/a
		Other	Percent	0.2-0.6	0.8-2.0	n/a
Ross (1991)	UK	Retail sales:				
		Vegetables	Percent	2.5	5.0	10.0
		Other	Percent	0.3	2.0	5.0
Mintel (1991)	UK	Retail sales	£ million	89	673	n/a
			Percent			5-10
Landell-Mills (1992)	EC	Land area	1000 ha	198	n/a	n/a
Tate (1991)	Europe	Retail sales:	£ million	900	2700	8200
		Land area	1000 ha	255	776	2362
Marketdata Enterprises (1990)	USA	Retail sales	$ million	1250	3960	n/a
Lampkin (1994)	Worldwide	Retail sales	£ million	2000	7000	20000

Source: Lampkin (1994), based on references cited.

3) Variable input costs

The replacement of external inputs by farm-derived resources normally leads to reduced variable input costs under organic management. For example, total variable costs are typically 50-60 percent lower for organic cereal and grain legumes, and 10-20 percent lower for potatoes and horticultural crops than in conventional systems. Expenditure on fertilisers and sprays is substantially lower in almost all cases (MAFF, 1991; Murphy, 1992; Padel and Zerger, 1994; Dubgaard, 1994; Mühlebach and Mühlebach, 1994; Henning, 1994; Anderson, 1994, Wynen, 1994). In a few cases, higher input costs may result from the use of organically raised transplants and casual labour for hand weeding and harvesting, or the use of special equipment such as flame weeders (Padel and Lampkin, 1994). However, few of the studies examine crops in detail.

4) Enterprise gross margins

Most of studies from Europe and Canada (Lampkin, 1994, Padel and Zerger, 1994; Mühlebach and Mühlebach, 1994; Henning, 1994), show variations in organic gross margins between regions (Table 4). These examples illustrate that, in addition to lower costs, higher prices are also required in order to compensate for reduced yields. The achievement of similar gross margins simply on the basis of lower costs would require a percentage reduction in costs much greater than the percentage reduction in yield (Padel and Lampkin, 1994).

Table 4: Examples of the margins of wheat production in different countries (1989)

Country	Unit	Organic	Conventional	Relative (conv=100)
Britain	£/ha	525	588	89
Germany	DM/ha	2815	1548	182
Switzerland	SF/ha	6505	5292	123
Canada	C$/HA	453	175	259

Source: Adapted from Lampkin (1994); Padel and Zerger (1994); Mühlebach and Mühlebach (1994) and Henning (1994).

Although gross margins are useful for comparative purposes, whether between enterprises of the same type on organic and conventional holdings, between different organic holdings, or between different enterprises on the same farm, there are some important limitations of their use, First, high individual enterprise gross margins for cash crops do not reflect the potentially very different enterprise mix on the organic farm and the need for fertility building crops in the rotation. Taken out of the whole-farm context, they can therefore be misleading. Second, gross margins represent the difference between enterprise output and variable costs, with the exclusion of fixed costs. Gross margin comparisons between enterprises with different fixed cost structures can be misleading, particularly where conventional variable costs, such as fertiliser and crop protection inputs, have been substituted by fixed costs (machinery and labour) in the organic context (Padel and Lampkin, 1994).

2.2.3 Environmental and social Effects Associated with Conventional Farming

Most of the financial assessments above are based only on direct crop returns. They do not include the indirect environment and economic costs associated with the pesticide use of conventional farming. Pimentel et al (1994) estimates the environmental and economic costs associated with pesticides in the USA. Their results show there to be about US$8 billion compared with US $16 billion direct benefit from pesticide use (Pimentel et al, 1994). The environmental and social costs include the following:

Public health effects

The World Health Organisation and United Nations Environmental Programme report (WHO/UNEP, 1989, cited in Pimentel et al, 1994) estimated there are one million humans poisoned by pesticides each year in the world, with about 20,000 deaths. A higher proportion of pesticide poisoning and deaths occur in developing countries, where there are inadequate occupational and other safety standards, insufficient enforcement, poor labelling of pesticides, illiteracy, inadequate protective clothing and washing facilities, and users' lack of knowledge of pesticide hazards (Bull, 1982, cited in Pimentel et al, 1994 page 48.

Based on available data, Pimentel et al (1994) estimated the human health effects from pesticide use in the USA by including costs of hospitalised poisoning victims, outpatient costs, lost work due to poisonings, pesticide cancers and costs of facilities.

Animal poisoning and contaminated products

In addition to pesticide problems that affect humans, many animals are poisoned by pesticides each year. Colvin (1987, cited in Pimentel, 1994) reported that 0.5% of animal illnesses and 0.04% of all animal deaths reported to the US veterinary diagnostic laboratory were due to pesticide toxicosis. Furthermore, economic losses occur when meat, milk, and eggs are contaminated with pesticides.

Destruction of beneficial natural predators and parasites

Like pest populations, beneficial natural enemies are adversely affected by pesticides used by conventional farming. In both natural and agroecosystems, many species, especially predators and parasites, control herbivorous populations. Indeed, these natural beneficial species make it possible for ecosystems to remain "green" (Pimentel, 1994). Losses of these species are social costs of the conventional agricultural system.

Pesticide resistance in pests

In additional to destroying natural predator populations, the extensive use of pesticides have often resulted in the development of pesticide resistance in insect pests, plant pathogens, and weeds. In a report by the United Nations Environment Programme, pesticide resistance was ranked as one of the top four environment problems in the world (UNEP, 1979, cited in Pimentel et al., 1994).

Increased pesticide resistance in pest populations frequently results in the need for several additional applications of the commonly used pesticides to maintain crop yield. Thus, the impact of pesticide resistance is felt in the economics of conventional agricultural production.

Honeybee and wild bee poisoning and reduced pollination

Wild honeybees are vital for pollination of fruits, vegetables, and other crops. Because most insecticides used in conventional agriculture are toxic to bees, pesticides have a major impact on both the honeybee and wild bee population. In addition to direct losses caused by the damage to bees and honey production, many crops are lost because of the lack of pollination (Edwards, 1994).

Effect on wildlife

One of the most effected form of wildlife has been birds, especially endangered birds such as eagles, hawks, and owls. It is extremely difficult to protect birds when highly poisonous pesticides are used. It is also difficult to put a commercial value on rare birds, but clearly they are very important to many people. The second most significant impact on wildlife has occurred on fish and marine crustaceans, which are killed by contamination of aquatic systems with pesticides.

Effects on soil and water

While serious and obvious direct effects of agricultural chemical use on soil structure and fertility are probably uncommon, there are also indirect effects of pesticides which are also

difficult to assess. Such effects are likely to be significant but they are not usually long term. However, the indirect effects of pesticides in accelerating soil erosion have been much more obvious and adverse to the environment (Edwards, 1994).

3. The Background to Sustainable Agricultural Production and Policies in Thailand

3.1 Problems Associated with Previous Agricultural Development

Most previous agricultural policies focused on the monoculture-based system of cash crop production. However, this system raised economic, social and environmental problems, which are described as follows:

1) Expanding Income Gap between Agricultural and Non-agricultural Sectors

The difference in income between the agricultural and non-agricultural sectors has been widening. Table 5 shows the comparison between the GDP per capita in the agricultural sector and the GDP per capita in the non-agricultural sector. It is clear that the difference in GDP per capita of the two groups has been increasing through time. In the third plan (1973-1976), the GDP per capita of the non-agricultural sector is 7.82 times greater that the GDP per capita of the agricultural sector, a figure that increased to 13.30 at the time of the seventh plan.

Table 5: GDP per capita of the agricultural and non-agriculture sectors
(US$/head/year)

National Plan (year)	**3rd Plan (1973-76)**	**4th Plan (1977-82)**	**5th Plan (1983-86)**	**6th Plan (1987-92)**	**7th Plan (1993-96)**
National GDP per capita	359	456	532	804	1,154
- Agricultural Sector	118	136	152	181	204
- Non-Agricultural Sector	902	1,078	1,215	1,870	2,718
Ratio Agricultural: Non-agricultural	**1:7.82**	**1:7.91**	**1:7.98**	**1:10.30**	**1:13.30**

Source: Office of Agricultural Economics, 1998

2) *Increasing Farmer Debt*

Table 6 shows the comparison of the farmers' debt between 1991 and 1995. In 1991, 34 percent of farmer's families (1.73 million families from 5.11 million families) had an average debt of 12,775 baht (US$511). Four years later, in 1995, this had increased to 64 percent of farmer's families (3.27 million families from 5.13 million families) who had an average debt of 24,036 baht (US$964). In short, within five years, there was approximately a two-fold increase of debt in the agricultural sector in terms of both number of families and value.

Table 6: Comparison of farmers' debt

Year	No. Agricultural Families (Million)	No. Agri Families in Debt (Million)	Amount of Debt (US$/family)
1991	5.11	1.73	297
1996	5.13	3.27	559

Source: Office of Agricultural Economics, 1998

Conventional agricultural demands inputs from an outside firm, such as artificial fertilisers and pesticides. This leads to increased costs of production, causing increased debt. Moreover, most of these chemicals are imported from overseas, which also affects the national balance of payments. Tables 7 and 8 show the increase of chemical use in the agricultural sector.

Table 7: Imported pesticide use in Thailand
(Unit: Tonne)

	Crops				
Year	Rice	Field Crops	Fruit and Trees	Vegetables and Flowers	Total Quantity
1992	988,000	610,290	769,810	438,684	2,806,784
1993	1,271,250	588,470	924,140	411,280	3,195,576
1994	1,231,250	659,630	1,035,900	461,020	3,387,800
1995	1,369,000	708,540	1,112,500	495,220	3,685,260
1996	1,400,100	795,970	1,249,760	556,3220	4,002,150

Source: Office of Agricultural Economics, 1998

Table 8: Imported pesticide use in Thailand

Year	Number of products	Quantity (kg)	CIF Value (US$)
1994	223	32,274,652	83.56 million
1996	222	45,701,227	114.48 million

Source: Office of Agricultural Economics, 1998

3) Reduction of Forest Resources

Acceleration of the conventional agricultural production led to continuous expansion of agricultural areas from forest. In the period 1971-1991, approximately 56.5 million rai (9.06 million hectare) of forest area was destroyed. This amounted to 24 percent of the total forest area in Thailand, 60 percent of this destroyed area was used in agriculture. This led to extensive bio-diversity losses and flooding problems (Rattanavaraha,1999).

4) Degradation of Soil

Previous agricultural development, which went ahead without ecological concern, had serious effects on soil quality. The area affected by soil erosion increased from 107,7 million rai (17.3 million hectare) in 1981 to 134.5 million rai (21.5 million hectare) in 1991, a 24.9 percent increase (Rattanavaraha, 1999). Soil degradation has a direct negative effect on agricultural production efficiency. This is one reason why farmers have felt an increasing need to use fertilisers (see Table 3.2.3).

5) Impacts on the quality of life

Outcomes of chemical use in agriculture include negative effects to both farmer and consumer health. Farmers suffer from headaches, vomiting, itches, dizziness and allergic reaction as a result of using artificial agricultural chemicals (Renner, 1998). It has also been asserted that chemical residues in agricultural products led to abortions and cancer in consumers. However, there is still no data to support this in Thailand.

Past agricultural policies aimed at accelerating economic growth without considering the negative impacts on society and the environment have generated the types of problems described. In the Eighth National Economic and Social Development Plan (1997-2001), the Thai government has changed the direction of agricultural development from emphasising the economic growth rate to emphasising sustainability. This new direction has been called "sustainable agriculture".

3.2 The Study Area

As one of the largest vegetable production areas in Thailand, Chiangmai province in the northern part of the country was chosen as the study area.

The province of Chiangmai is situated between north latitude 17.21 and east longitude 98.99 in the upper area of Thailand's northern region. The distance from Chiangmai to Bangkok, the capital city, is 750 kilometres. Geographically, Chiangmai resembles a large valley that is 310 metres above sea level, with an area of 20,107 square kilometres. Chiangmai province is the second largest in the country in terms of land area, 82.7 percent of the land area is covered by mountains and forests, 12.8 percent is cultivated area, and about 4.5 percent is used for residential and other purposes, (Chiangmai Province Office, 1999).

With a population of 1.5 million in 1998, Chiangmai is one of Thailand's largest provinces. Of this, the total labour force (13 years of age and over, and actively seeking jobs) stood at 1.2 million, with the same proportions of males and females. Currently living in Chiangmai's central city area are 170,000 people, with the rest distributed throughout Chiangmai's 21 districts (Chiangmai Province Office, 1999).

In 1996, the Chiangmai Gross Provincial Product (GPP) (at market prices) was B 78,379.6 million (US$3,093.1 million). Chiangmai's GPP accounted for about 20 percent of the northern Gross Domestic Product (GDP) and about 9.2 percent of the National Gross Domestic Product (NGDP). The main production sectors of Chiangmai comprise services, manufacturing, agricultural, wholesale and retail trade sectors, each with a share of 22.3, 16.3, 13.8, and 11.3 percent in total production, respectively. Per capita income of Chiangmai in 1996 was estimated at US$2,173 per annum, which is the second highest in the north and the twenty-fourth highest in the country. This is, however, lower than the average Thai per capita income of US$3,065 (Chiangmai Province Office, 1999).

3.3 Agriculture Sector Background

Just over half (52 percent) of Chiangmai's population are classified as being in the agricultural sector. This includes 202,248 farmers' families with average earnings of US$1,840 per family per annum, or US$460 per head per annum. The average cultivated area is 1.04 hectares (ha) per family. Table 9 gives a breakdown of the use of cultivated areas in Chiangmai province.

The main economic crops of Chiangmai are rice, longan, garlic, soy bean, potato, onion, lychee, cutting flowers and red onion.

Table 9: Cultivated areas in Chiangmai (1997)

Cultivated land	Area (ha)
1. Paddy land	93,967
2. Under field crops	31,510
3. Under fruit trees	50,587
4. Under vegetables	44,658
5. Under flowers	251
6. Other agricultural land	36,833
Total agricultural land	257,806

Source: Chiangmai Province Office, 1999

3.4 Projects Involved with Chemical-free Production in Chiangmai

There are two projects in Chiangmai of particular interest: the government's chemical-free vegetable extension project and the Northnet Foundation's project for development of an alternative agriculture producers' and consumers' network in upper northern Thailand. The projects are summarised as follows:

1) Chemical-free Vegetable Extension Project

This project is under the responsibility of the Chiangmai Agricultural Office. The district agricultural offices throughout the province act as implementation units. The project started in 1988, aiming to i) decrease the amount of agricultural chemical used by farmers; ii) increase the supply of chemical-free vegetables to consumers; iii) increase farmer's income through lower production costs; iv) gain higher prices for better quality produce; and v) conserve natural resources. The project provides nylon netting and some alternatives to agricultural chemicals, as well as giving marketing and extension advice to the farmers (Chiangmai Office of Agriculture, 1988).

2) Project for Development of an Alternative Agricultural Producers' and Consumers' Network in Upper Northern Thailand

This project is under the responsibility of the Northnet Foundation, which is a collection of NGOs. The Foundation for the Development of Rural Education (FEDRA) and Imboon, (both part of the Northnet Foundation) are the implementations units, which aim to work collaboratively with producers and consumers through marketing and policy initiatives (Panyakul, 1995). FEDRA aims to promote self-help, and to leave farmer groups when they become self-reliant, although no group of farmers has yet achieved self-reliance (Prompunya, 2000). Tangtrongbenjasil and Tanakilkosert (1992) explain that some of the villagers, through their experience with government projects, expect to be given funding for these projects, and that they do not always follow these projects through. This causes a financial dependence on FEDRA, which is unlikely to lead to any self-reliance.

FEDRA promotes home consumption first. The small level of excess production is mainly sold locally to reduce the transport costs and the problems involved with perishable produce (Prompunya, 2000). For example, Wat Pa-Darapirom provides a stall for the farmers to sell their excess chemical-free products, where the chemical-free farmers set their own price. However, the local prices are lower than the prices in the city. The Imboon NGO contributes to the marketing aspects of production. The Imboon Centre (in the city) also sells labelled chemical-free vegetables at prices usually set above their conventional equivalents. Unfortunately, the Imboon Centre has been running at a loss, particularly in the vegetable and fruit sector (Bontuyan, et al., 1996).

3.5 Background to the Research Sites

This study selected three sites: Santonkwoa, Pong-yang and Sanpaying, based on their different location, and different organisations promoting the chemical-free vegetable production. Santonkwoa was selected since it is close to the main chemical-free vegetable market, Chiangmai city (10 kilometre) and developed villages. Pong-yang and Sanpayang were selected as they are agricultural villages run by different organisations. Chemical-free vegetable farming in Pong-yang is promoted by the government District Agricultural Extension Office, whereas in the Sanpayang area extension occurs through NGOs.

The focus of the chemical-free project in Santonkwon involves vegetable production, with provision of nylon netting and some alternatives to agricultural chemicals, as well as marketing and extension advice. These non-chemical produced/grown vegetables are sold using a 'chemical-safe' label. The farmers sell their products to the supermarkets in the city at a higher price than conventional produce. Recently, the products have been sold to a Japanese company which is a Bangkok market distributor. The conventional agricultural

commodity in this village is longan – a fruit, which is one of the major agricultural commodities in Chiangmai.

Pong-yang, located in Mae Rim district around 50 kilometres from the centre of Chiangmai, is a model village for government agricultural extension work, under the government-funded Mea Rim Agricultural Extension Office.

The focus involves vegetable production, with provision of nylon netting, some alternatives to agricultural chemicals, as well as marketing and extension advice. The method used in this village is Integrated Pest Management (IPM) under net. These non-chemical produced vegetables are sold using a 'chemical safe' label.

The government has also advised farmers to switch from the more traditional farming of rice and soybean to more intensive and supposedly higher income cash crops of IPM flower production. Although IPM is supposed to minimise agricultural chemical use, flower production for conventional markets requires that the products be free from insect damage and disease. For this to be achieved, high levels of artificial agricultural chemicals are applied. For this reason, it was decided to classify IPM flower production as a type of conventional agriculture.

In Sanpayang the chemical-free and mixed agriculture farmers have been provided with extension advice, resources and market outlets from Thai NGOs, including the Foundation of the Development of Rural Education (FEDRA). Imboon (another NGO) also provides advice and market opportunities. The NGOs promote integrated farming, chemical-free vegetable production and agroforestry using outside funding from Thai and international donations. FEDRA also promotes the Integrated Pest Management (IPM) method *but without using netting* to farmers. The reason that FEDRA does not promote the "under net" method is due to its high cost. Government involvement in the area has been minimal.

Sanpayang does not have the same land shortages as Pong-yang, so agricultural methods are usually less intensive, and the conventional farmers are more traditional than Pong-yang farmers. Most of the conventional farmers produce maize.

4. Research Design and Methods

4.1 General Approach

Sustainability of chemical-free vegetable production depends on the economic performance of these crops, typically indicated by the net farm income. This must be compared with conventional agriculture in the same area. Furthermore, sustainable chemical-free vegetable production depends on the "real" costs of production. These "real" costs include the farmers" labour costs, any opportunity costs, as well as subsidies. According to the farmers, removing the subsidies (especially nylon net subsidies) may affect the decision of farmers on whether to continue producing chemical-free vegetables. Finally, in addition to economic goals, sustainable organic farming (which in this study means chemical-free vegetable farming) should also be based on its philosophical issues. These include environmental quality (such as soil quality) and quality of life concerns (such as the health of both producers and consumers).

With these tenets of sustainable, chemical-free vegetable production in mind, this research investigated the goals and motivations of chemical-free vegetable farmers, as well as their economic performance and compared these with conventional farmers.

To meet these research objectives both *qualitative and quantitative information* was required from both chemical-free vegetable and conventional farmers. Since the chemical-free vegetable production in Thailand has been promoted for less than 12 years, the number of chemical-free vegetable farmers are few and concentrated in particular areas. Furthermore, few Thai farmers keep production records.

A large farm survey was initially considered appropriate for the research objectives, since it includes the collection of facts, figures and opinions from various farmers and farms (Nuthall, 1974). However, because the population of farmers practising chemical-free vegetable production is small and confined to a particular area, a random sampling method was not suitable.

Consequently, a case study approach was used. A case study is "an empirical inquiry that investigates a contemporary phenomenon within its real-life context: when the boundaries between phenomenon and context are not clearly evident and in which multiple sources of evidence are used" (Yin, 1984). The advantage of the case study is that it suits "how" or "why" questions being asked of a contemporary set of events over which the investigator has little or no control (Yin, 1984).

Farmers in each village were categorised into three categories: chemical-free vegetable agriculture (CFA), mixed agriculture (MA) and conventional agriculture (CA). Chemical-free vegetable (CFA) farmers are farmers who are producing chemical-free vegetables only, whereas mixed agriculture (MA) farmers are those who use both chemical-free production methods and 'chemical-use' conventional agriculture. As there are only a few CFA farmers in each selected village, five farmers from each category and from each village were selected for individual interview.

Table 10: The general background of the three research sites

	Santonkwoa	**Pong-yang**	**Sanpayang**
1. Distance from Chiangmai (km)	10	50	60
2. Type of conventional agriculture	Longan Orchard	Cut flowers	Maize
3. The supporting organisation	Government	Government	NGOs
4. Input subsidies	Yes	Yes	No
5. Average farm area (ha's/family)	0.75	0.67	1.58

Personal interviews were used for all three categories of production in each village, as well as informal interviews with government policy makers, government extension officers, and NGO officers involved with the chemical-free vegetable production projects.

4.2 Farmers' Goals and Movitation

The farmers were asked to rank in order their top five reasons for choosing their farming method. It was then possible to interpret the results in terms of scoring. The most important reason to choose the farming method is assigned a score of 5. Scores of 4,3,2, and 1 are assigned to the second, third, forth and fifth reasons, respectively. Zero means that it was considered not to be a reason to choose the farming method.

4.3 Economic Performance

1) Cost of Production

This study analyses costs of production in three ways: running costs, economic costs, and social costs.

Firstly, running costs include all costs of input used for agricultural production paid for by the farmers, such as soil preparation, fertiliser, and pesticides. However, in this study, it excludes the input cost which is subsidised by the government, such as nylon net for the CFA farm.

Secondly, the economic cost includes the input costs, the farmers' own labour costs, and the opportunity costs of both land and capital. In general, farmers seldom consider all costs involved with their production, which often leads to misunderstandings about their production performances.

In this study, the farmer's labour cost is estimated by multiplying the number of days the farmers spent on the agricultural activities by the local labour hire rate per day (100 baht - around US$2.70 per day).

Land at Pong-yang and Sanpayang is provided by the government to poor or minority groups for agricultural purposes only. The farmers there have no right to sell or to rent the land so it was assumed that the opportunity cost was zero. In the Santonkwoa village the opportunity cost of capital was calculated as five percent of the running costs (estimated from current deposit interest rates at the local bank).

Finally, the social cost was defined as the economic cost plus the costs subsidised by the government. In the government chemical-free vegetable production extension projects, nylon netting is provided for the CFA farmers. The Sarapee District Agricultural Extension Office (1991) estimates the cost of nylon netting is US$1,434 per hectare per year.

2) Net Farm Income

Net farm income is the total farm income minus the total costs. The net farm income in this study is also examined in three ways according to the three types of production cost mentioned above: farmer net farm income, economic net farm income, and social net farm income.

The means of the three costs of production and three net farm incomes of each category was calculated as well as the standard deviations (SD). T-tests were used to test the difference between each set of means.

The farmers were asked to give their opinions about the social effects, environmental effects and problems associated with CFA farming. These results are categorised and similar answers are grouped together.

5. Results and Discussions

5.1 Goals and Objectives

Table 11 shows that the most important reasons why CFA and MA farmers choose CFA farming are economic concerns. These include the profit motivation with an emphasis on cost minimisation and income performance factors. The second factor was advice from an outsider – both government and NGOs. Finally, a few CFA and MA farmers indicated that their family's health and environmental issues were significant considerations in choosing to practise CFA.

Similarly, from Table 12 it can be seen that the main reason why CA and MA farmers were using CA is profit maximisation. The second factor is the dislike of working harder, followed by the influence of their neighbours. None of the CA farmers are concerned about their health and the environment.

Table 11: Scores on the reasons why CFA and MA farmers choose to practise CFA – Mean Scores (Standard deviations given in brackets)

	CFA Farmers				MA Farmers			
Research Site / Reason	Santonkwoa	Pongyang	Sanpayang	**Average**	Santonkwoa	Pongyang	Sanpayang	**Average**
1. Profit motivation	4.6	2.0	4.8	3.8	4.6	1.8	4.2	3.53
	(0.55)	(0.45)	(0.44)	(1.61)	(0.55)	(1.30)	(1.30)	(1.64)
2. High cost due to CA	0	5	2.2	2.4	0	3.6	2.4	2.0
	(0)	(0)	(1.64)	(2.29)	(0)	(1.95)	(1.95)	(2.20)
3. Earning cash every day	2.4	2.0	0.8	1.52	2.4	3.0	0.6	2.0
	(1.52)	(1.87)	(1.30)	(1.62)	(1.52)	(1.87)	(1.34)	(1.81)
4. Government advice	2.2	2.4	0	1.30	2.2	3.0	0	1.73
	(1.30)	(1.82)	(0)	(1.64)	(1.30)	(1.41)	(0)	(1.67)
5. Income stability	3.2	1.2	0	1.47	3.2	1.0	0	1.1
	(2.17)	(1.30)	(0)	(1.92)	(2.17)	(2.24)	(0)	(2.16)
6. NGO advice	0	0	4	1.33	0	0	4.0	1.33
	(0)	(0)	(0.71)	(1.64)	(0)	(0)	(0.71)	(1.99)
7. Family's health	0.6	1.6	1.2	1.13	0.6	1.0	1.4	1.0
	(0.55)	(0.55)	(0.83)	(1.13)	(0.55)	(1.00)	(1.67)	(1.13)
8. Food for family	0.4	0.6	1.6	0.87	0.4	1.0	1.25	0.86
	(0.89)	(0.89)	(1.14)	(1.06)	(0.89)	(1.73)	(0.50)	(1.17)
9. Soil degradation due to CA	1.2	0.2	0	0.47	1.2	0.4	0	0.53
	(1.79)	(0.45)	(0)	(1.13)	(1.79)	(0.89)	(0)	(1.19)
10.Environmental issues	0	0	0.4	0.13	0	0.2	1.4	0.53
	(0)	(0)	(0.51)	(0.51)	(0)	(1.34)	(1.34)	(0.99)

Note : A score of 5 means it is the most important reason to choose the farming method. 4,3,2,1 are the second, the third, the fourth and the fifth reasons, respectively. Zero means that it is not a factor affecting choice of the farming method.

Table 12: Scores on the reasons why CA and MA farmers choose to practise CA – Mean Scores (Standard deviations given in brackets)

	CA Farmers				MA Farmers			
Research Site / Reason	Santonkwoa	Pongyang	Sanpayang	**Average**	Santonkwoa	Pongyang	Sanpayang	**Average**
1. Profit motivation	4.8	4.6	4.6	4.67	4.6	4.2	4.2	4.33
	(0.45)	(0.55)	(0.55)	(0.49)	(0.55)	(1.3)	(1.3)	(1.05)
2. Convenience not hard work	4.0	0	3.6	2.53	3.0	0	3.4	2.13
	(0.71)	(0)	(1.14)	(2.00)	(1.87)	(0)	(1.52)	(2.03)
3. Following neighbours	1.4	2.6	2.4	2.13	2.8	1.2	2.8	2.27
	(1.51)	(1.82)	(0.89)	(1.46)	(1.64)	(2.17)	(1.64)	(1.87)
4. Lack of labour	2.4	0.8	1.4	1.53	2.0	2.0	2.2	2.07
	(1.52)	(1.79)	(0.55)	(1.46)	(1.00)	(1.22)	(1.3)	(1.1)
5. Government advise	1.8	3.4	0	1.73	2.2	2.4	0	1.53
	(0.45)	(0.89)	(0)	(1.53)	(1.30)	(1.14)	(0)	(1.46)
6. Earning cash every day	0	1.8	0	0.6	0	3.2	0	1.07
	(0)	(0.45)	(0)	(0.91)	(0)	(1.48)	(0)	(1.75)
7. No choice	0	0	3	1.0	0	0	0.6	0.2
	(0)	(0)	(1.58)	(1.69)	(0)	(0)	(1.34)	(0.78)
8. Income stability	0.2	1.8	0	0.67	0.4	0.8	0	0.4
	(0.45)	(1.64)	(0)	(1.23)	(0.89)	(1.79)	(0)	(1.12)
9. High costs of CF farming	0	0	0	0	0	1.2	1.8	1.0
	(0)	(0)	(0)	(0)	(0)	(1.64)	(1.30)	(1.75)

Note: A score of 5 means it is the most important reason to choose the farming method. 4,3,2,1 are the second, the third, the fourth and the fifth reasons, respectively. Zero means that it is not a factor affecting choice of the farming method.

Discussion

The high scores on the economic concern indicates that the farmers lack information and/or knowledge associated with CA health and environmental problems. Although CA is known by the farmers to impact on their health and environment, these are not major issues compared with the economic problems from the farmers' point of view.

It is apparent that CFA and MA farmers practising CFA are more concerned about health and environment issues than the CA farmers, although it is not their first priority.

5.2 Costs of Production

The first economic hypothesis is concerned with whether the costs of production were lower for CFA than MA and CA. The costs of production can be examined in three ways: running costs, economic costs, and social costs.

1) Running Costs

Table 13 shows the comparisons of the production running costs on an area basis. In Table 14, t-statistic values to assess the significance of the mean differences are presented. The performance means of CFA farming are significantly different from MA and CA at the one percent level. However, the means of the running costs between MA and CA are not significantly different.

Table 13: Comparisons of mean running costs
(US$/ha/year) (Standard deviations given in brackets)

Research site	CFA	MA	CA
Santonkwoa	24.1 (1.7)	33.7 (1.6)	32.7 (1.2)
Pong-yang	15.2 (.8)	43.7 (3.5)	55.9 (4.7)
Sanpayang	1.3 (.5)	6.6 (2.1)	7.2 (1.1)

Table 14: t-statistic testing of mean running costs (p-value)

Research site	Santankwoa	Pong-yang	Sanpayang
On an area basis			
CFA = MA	0.0000	0.0000	0.0040
CFA = CA	0.0000	0.0000	0.0000
MA = CA	0.3179	0.0022	0.6140

Thus, the results confirm the first economic hypothesis that CFA running costs are the lowest compared with the CA activities of longan, cut flowers, and maize production. The reason for the lack of difference between MA and CA running costs may be that most of the land used by MA farmers is still used for conventional agricultural production.

2) Economic Costs

Table 15 shows comparisons of the production economic costs. t-statistic values of the comparison of the means are presented in table 16 and show that at all three research sites the performance means of CFA farming are significantly different from MA and CA at the one percent level, except in Sanpayang.

Table 15: Comparisons of mean economic costs (US$/ha/year)
(Standard deviations given in brackets)

Research site	CFA	MA	CA
Santonkwoa	108.9 (3.8)	84.3 (1.8)	91.7 (3.1)
Pong-yang	34.9 (1.4)	101.6 (8.3)	139.1 (8.8)
Sanpayang	4.6 (1.5)	21.3 (2.5)	20.8 (1.1)

Table 16: t-statistic testing of mean economic costs (p-value)

Research site	Santonkwoa	Pong-yang	Sanpayang
On an area basis			
CFA = MA	0.0000	0.0000	0.0000
CFA = CA	0.0000	0.0000	0.0000
MA = CA	0.0028	0.0001	0.7140

Again, no difference in the economic costs between MA and CA could be discerned. The reason for this may be the same as in the running cost analysis mentioned above.

Interestingly, the economic costs of CFA are greater than the MA and CA in Santonkwoa village. This is because the CA longan orchard in Santonkwoa uses less labour than CFA. Hence, the estimated labour costs of CA are significantly less than the CFA, which would have, in turn, a higher economic cost.

Since chemical-free vegetable production demands intensive labour use, the economic costs of CFA are greater than the costs of CA in a low-labour activity such as a longan orchard. However, when CFA is compared to CA activities using similar labour hours for production (such as cutting flowers and maize production in Pong-yang and Sanpayang), the results confirm the hypothesis.

3) Social Costs

Table 17 show the comparisons of the production social costs. Table 18 gives the t-statistic values which show that at the three research sites similar results exist to the running costs and economic costs data. The means of CFA are significantly different from MA and CA at the one percent level, while the means of the social costs of MA and CA are not significantly different.

Table 17: Comparisons of mean social costs (US$/ha/year)

Research site	CFA	MA	CA
Santonkwoa	145.7	89.0	91.7
	(3.8)	(1.0)	(3.1)
Pong-yang	71.6	111.4	139.1
	(1.4)	(9.2)	(8.8)
Sanpayang	4.6	21.2	20.8
	(1.5)	(2.5)	(1.1)

Table 18: t-statistic testing of mean social costs (p-value)

Research site	Santonkwoa	Pong-yang	Sanpayang
On an area basis			
CFA = MA	0.0000	0.0005	0.0000
CFA = CA	0.0000	0.0000	0.0000
MA = CA	0.1164	0.0012	0.7140

Adding the government subsidies to give the social costs produces similar results to the economic cost comparisons. In Pong-yang and Sanpayang, the CFA social costs are less than the MA and the CA. Again, there is no significant difference between the social costs of MA and CA. The social costs of CFA are also greater than the MA and CA in Santonkwoa due to higher labour requirements compared with CA in this area.

Discussion

Due to high CA production costs, chemical-free vegetable production can be an alternative for farmers who want to move away from conventional agriculture. This comparison clearly shows that the running costs of CFA are less than MA and CA in all three research sites due to the lower input use associated with CFA.

However, it cannot be concluded that the costs of production of CFA are less than the costs of MA and CA with respect to the economic costs. Since the CFA is labour-intensive production, the labour costs of CFA are a high proportion of the economic costs (around 35 percent in Santonkwoa and more than 50 percent in Pong-yang and Sanpayang). The CFA's higher economic costs of production compared with MA and CA in Santonkwoa shows that CFA cannot be an alternative when it is compared with the less labour-intensive CA such as in a longan orchard. Labour costs amount to only 15 percent of the economic costs of CA (longan orchard) in Santonkwoa.

The analysis of social costs does not give useful data when only considering the costs of production. However, it will be useful in the following section when net farm income is discussed.

5.3 Net Farm Income

The second economic hypothesis examines whether CFA leads to a higher net farm income than MA and CA. The net farm income in this study is examined in three ways: farmers' net farm income, economic net farm income, and social net farm income.

1) Farmers' Net Farm Income

Table 19 gives the net farm income figures, and Table 20 the t tests.
On an area basis, the t-statistics of the means at the one percent level are significantly different for most comparisons, except between CFA and MA (15.7 percent) and between CFA and CA (6.8 percent) at the Sanpayang research site.

Table 19: Comparisons of mean farmer's net farm income
(US$/ha/year) (Standard deviations given in brackets)

Research site	CFA	MA	CA
Santonkwoa	222.2	85.5	66.2
	(25.1)	(7.0)	(6.9)
Pong-yang	52.6	92.7	167.3
	(1.6)	(15.0)	(16.5)
Sanpayang	12.1	14.0	9.0
	(2.1)	(1.7)	(2.4)

Table 20: t-statistics testing of mean farmer's net farm income (p-value)

Research site	Santonkwoa	Pong-yang	Sanpayang
On an area basis			
CFA = MA	0.0001	0.0038	0.1572
CFA = CA	0.0000	0.0000	0.0679
MA = CA	0.0023	0.0000	0.0071

Only in Santonkwoa is the CFA farmer's net income the highest compared with the MA and the CA. In Pong-yang, the income of CFA is the least, followed by MA and CA, respectively. Whereas, in Sanpayang, the MA is the highest, followed by CFA and CA, however these values are not statistically significant. Therefore, the second economic hypothesis cannot be supported across all sites.

2) Economic Net Farm Income

Table 21 gives the economic net farm income, and Table 22 the t-statistics.

The t-statistics of the means at the one percent level are significantly different for most comparisons, except between CFA and MA in Pong-yang (84.3 percent) and between MA and CA (2.9 percent) in the Sanpayang research site.

Table 21: Comparisons of mean economic net farm income
(US$/ha/year) (Standard deviations given in brackets)

Research site	CFA	MA	CA
Santonkwoa	137.4	34.9	7.1
	(24.4)	(7.3)	(6.0)
Pong-yang	32.9	34.8	84.1
	(1.9)	(20.0)	(17.5)
Sanpayang	8.8	- 0.6	- 4.6
	(1.3)	(1.1)	(2.8)

Table 22 T-statistics of mean farmer's net farm income (p-value)

Research site	Santonkwoa	Pong-yang	Sanpayang
On an area basis			
CFA = MA	0.0004	0.8434	0.0000
CFA = CA	0.0001	0.0027	0.0000
MA = CA	0.0002	0.0034	0.0290

The results confirm the second economic hypothesis in two of the research sites: Santonkwoa and Sanpayang. In both these villages, the CFA economic net farm incomes are the highest, followed by the MA and CA, respectively. Surprisingly, the economic net farm income of MA and CA in Sanpayang are negative. Conventional production of maize in this site is not appropriate for farmers. However, in Pong-yang, the CFA economic net farm income is the least when compared with the MA and CA. Overall then, the second economic hypothesis cannot be totally supported.

3) Social Net Farm Income

Table 23 gives the social net farm income and Table 24 presents the t-statistics.

The t-statistics of the means at the one percent level are significantly different for most comparisons between CFA and MA in Pong-yang (2.4 percent) and between MA and CA (2.9 percent) at the Sanpayang research site.

Table 23: Comparisons of mean social net farm income
(US$/ha/year) (Standard deviations given in brackets)

Research site	CFA	MA	CA
Santonkwoa	100.7	30.2	7.1
	(24.4)	(7.1)	(6.0)
Pong-yang	- 3.8	25.0	84.1
	(1.9)	(18.3)	(17.5)
Sanpayang	8.8	- 0.6	- 4.6
	(1.3)	(1.1)	(2.7)

Table 24: t-statistic testing of mean farmer's net farm income (p-value)

Research site	Santonkwoa	Pong-yang	Sanpayang
On an area basis			
CFA = MA	0.0020	0.0.238	0.0000
CFA = CA	0.0007	0.0003	0.0000
MA = CA	0.0006	0.0008	0.0290

The social net farm income comparisons are similar to the economic net farm income results. Nevertheless, it is interesting to note that the social net farm income of CFA in Pong-yang is negative indicating that the chemical-free vegetable farmers cannot continue without support from the government. It could also be suggested that the government chemical-free promotion programme is a non-sustainable programme in this instance.

Discussion

In general, the analysis indicates that CFA provides higher net farm income than conventional agriculture.

The chemical-free vegetable production programme seems to be successful if the products sell at a reasonable price. In the case of Santonkwoa, 10 kilometres from Chiangmai, the farmers can sell their products directly to the market with higher prices than the other sites. The analysis of net farm incomes in Santonkwoa shows that the CFA net farm incomes are greater than for MA and CA in all the net farm income definitions. Although the CFA farmers require more labour than the CA farmers, this is compensated by the greater income per land unit so that net farm income is high enough for them to continue their production without subsidies from the government.

In contrast, the CF farmers in Pong-yang, who also are supported by the government, gain less net farm income than the MA and CA net farm income definitions. Furthermore, the CFA farmers in Pong-yang have a negative social net farm income indicating that CFA farming cannot substitute for CA farming in economic performance terms.

The main difference between the two villages is in the price of their produce. The greater distance from the city to Pong-yang means the net product price is greater for the Santonkwoa farmers.

In the case of Sanpayang, it is not clear whether the CFA farmers gain more net farm income compared with the MA and CA. The greater economic and social net farm incomes indicate that CFA farming performs better than MA or CA in the economic sense. Since the farm gate price in this area is still significantly low when it is compared with the price of chemical-free vegetables in the city, marketing support should be an obvious target for further extension.

5.3 Social Comparisons

There are a number of *a priori* beliefs that are related to the social effects of CFA. This section examines two such beliefs by looking specifically at farmer education and working conditions. These two aspects are often priorities for improvement within sustainable agriculture projects.

1) Extension Information and New Skills

The first *a priori* belief is that CFA farming requires new extension information and skills. All of the CFA and MA farmers responded that this was indeed the case and Table 25 gives the specific new skills and knowledge that the CFA and MA farmers learnt. The most prevalent were quality control skills, marketing, management, and networking.

Table 25: New CFA skills learnt by CFA and MA farmers
(percentage of farmers reporting that they have learnt the following new skills and knowledge by being involved with CFA).

Research site	Santonkwoa	Pong-yang	Sanpayang	Average
Farming	73.68	50	80	67.89
Quality Control	42.10	75	70	62.37
Marketing	36.84	50	30	38.95
Management	26.32	50	20	32.11
Networking	5.26	50	0	18.42

Table 26 shows the sources of extension information and skills training for CFA and MA farmers. In Santonkwoa and Pong-yang, the government is seen to be the main source, followed by 'self-teaching', other farmers and other sources. In Sanpayang, NGOs were the main source, followed by self-teaching, the government, other farmers and other sources.

Table 26: Sources of extension information and skills training
(percentage of farmers reporting that they learnt their CFA techniques from the following sources)

Research site	Santonkwoa		Pong-yang		Sanpayang	
	CFA	MA & CA	CFA	MA & CA	CFA	MA & CA
Self-taught	36.8	73.71	36.0	80.0	50.0	91.7
Government	63.2	21.1	72.3	20.0	26.9	26.27
NGOs	0	0	0	0	83.3	0
Other farmers	26.3	15.8	15.3	30.0	15.4	29.5
Other	15.8	21.1	5.7	15.0	7.7	18.0

Table 26 also shows the sources of CA extension information and new skills for MA and CA farmers. The figures show that self-teaching is the main source, followed by other farmers, the government and other sources.

The difference between CA and CFA is apparent, with greater levels of support from organisations involved in CFA farming compared to CA farming. This result was expected due to the emphasis placed on CFA extension at the research sites.

2) Health, Safety and Working conditions

The second social *a priori* belief associated with the effects of CFA is that the health, safety, and working conditions of CFA farmers are better than those of their CA counterparts. The majority of MA and CFA farmers (90 percent) felt that their health and safety were better because they were practising CFA. Greater than 90 percent of MA farmers, and all CFA farmers, said that they had changed to CFA for health reasons although it was not the first reason. The majority of the CFA and MA farmers (87 percent) also felt that working conditions were better since they had become involved with CFA, 7 percent thought they had remained the same, 3 percent did not know, and another 3 percent thought they had worsened.

Nearly 75 percent of the MA farmers and 60 percent of the CFA farmers stated that CFA farming had improved their lives and health, the lives and health of their families and/or the lives and health of villagers. Some stated that their health was better, not only in physical terms, but also mentally, with less quarrelling and tension, more freedom and better moods. Some also mentioned the health benefits associated with eating CFA vegetables that they had produced, as well as those benefits being passed on to other consumers.

In contrast, 80 percent of the MA farmers and 87 percent of the CA farmers stated that CA farming had led to a worsening in their lives and health, the lives and health of their families and/or the lives and health of the villagers. Some of the CA farmers mentioned that they felt weak and suffered from headaches, vomiting, itches, dizziness and allergic reactions as a result of using artificial agricultural chemicals. Mental health problems were also stated. These included anger, bad moods, worry and a feeling of dissatisfaction.

5.5 Environmental Comparisons

Two environmental *a priori* beliefs, relating to the use of chemicals and local wildlife diversity, were used to examine whether CFA had improved the environment. As with the social *a priori* beliefs investigated in the previous section, these environmental issues play an important role in achieving "sustainable agriculture".

1) Use of Artificial Agricultural Inputs

The first environmental *a priori* belief is that the use of artificial agricultural chemicals and artificial fertilisers in CFA is lower than in MA and CA. It is assumed that the application of most artificial chemicals causes negative environmental impacts (Chantalakhana, 1995) and that the larger the number of different artificial products applied, the greater the associated environmental and health risks.

Table 27 gives the differences in the costs of production associated with the chemical inputs used by farmers. The CFA farmers, of course, use no artificial pesticides or fertilisers. The MA farmers use only slightly less than the CA farmers as most MA land is largely farmed using CA methods.

Table 27: Comparisons of chemical costs (US$/ha/year)
(Standard deviations given in brackets)

Research site	Chemicals	CFA	MA	CA
Santonkwao	Fertiliser	0	16.6	16.4
			(1.3)	(1.2)
	Pesticide	0	12.8	8.6
			(0.7)	(0.7)
Pong-yang	Fertiliser	0	12.8	16.8
			(1.9)	(3.6)
	Pesticide	0	18.0	21.1
			(0.9)	(3.5)
Sanpayang	Fertiliser	0	1.6	2.1
			(0.4)	(0.2)
	Pesticide	0	1.9	2.6
			(1.0)	(0.3)

2) Wildlife Quantity and Variety

The second environmental *a priori* belief is that the wildlife quantity and variety increases with CF practices, and decreases with CA methods. When all the farmers were asked whether they had noticed any changes in the total amount of wildlife within their village boundary since the introduction of artificial agricultural chemicals, 67 percent of farmers said that the total had decreased, 18 percent said that the total amount had stayed the same, 5 percent said that the total amount had increased, 7 percent did not know, and, finally, 4 percent failed to answer this question. When asked if the variety of wildlife within the village boundary had changed, 20 percent felt it had remained the same, 4 percent said there had been an increase, 8.89 percent did not know, with 4 percent failing to answer the question.

Discussion

These wildlife variety and quantity results are as expected. The number of interviewees believing that CA farming negatively impacted on wildlife was greater than those believing that CFA had increased wildlife. This may be explained by the number of years that each farming method has been practised.

CA at Santonkwoa has been practised for an average of 15 years, at Pong-yang for an average of 11 years, and at Sanpayang for an average of 15 years, whereas CFA has been practised for an average of 2.4 years by MA farmers and for an average of 7.5 years by the CFA farmers at Pong-yang. At Sanpayang, the figures are 4 years and 6 years. In short, CA has generally operated for at least twice as long as CFA, hence the real effects of CFA farming on local wildlife may not have been fully observed.

5.6 Problems Associated with Chemical-free Vegetable Farming

Seventy eight percent believed that pests and diseases are major problems, and 50 percent of the farmers at Pong-yang stated that the produce prices were less than they expected in some seasons. In addition, 67 percent of the farmers at Sanpayang said that the price received was not different from the conventional produce (most of the Sanpayang produce was sold at local markets). Some of the farmers (33 percent) commented that the CFA market was too small. In some seasons, there was an over-supply of produce and farmers were forced to sell at the lower conventional produce prices.

In addition, farmers were asked about problems in changing their practises. In the case of the MA farmers, 80 percent of them stated that they had not converted their whole farm to CFA because the market was so dynamic and by growing both CFA and CA products risks could be reduced through diversification. In the case of CA farmers, 67 percent thought that the CFA markets, prices and incomes were uncertain and 60 percent believed CFA gained lower yields than the CA farming. Finally, 20 percent of the CA farmers said that the CFA produced lower quality produce than CA due to damage from insects and diseases.

The greater amount of time involved in practising CFA was also a main reason why CA farmers did not want to change to CFA with 67 percent of the CA farmers believing that they would have to work harder if they were to begin practising CFA. Finally, only a few of CA farmers (20 percent) answered that they did not have the skills or knowledge to practise CFA farming.

6. Conclusion and Recommendations

6.1 General

The Thai Government's strategy has accelerated economic growth, but it did not take into consideration the longer negative impacts. A multitude of problems have emerged and dominate further development of the agriculture sector. These problems include the exploitation and degradation of natural resources, environmental degradation affecting the quality of life, deforestation, rural poverty, and social imbalances resulting from the income gap.

Having more recently developed an awareness of these negative impacts, the Ministry of Agriculture and Co-operatives has changed the direction of agricultural development by emphasising sustainability and enhancing the development of the "farmer" and the "agricultural sector", conservation and protection of "natural resources and the environment".

The sustainable agricultural development strategy encompasses three key elements: i) restructuring agricultural production from conventional farming to "sustainable agricultural farming", ii) natural resource conservation and sustainable use of natural resources, and human resources and iii) development of agricultural institutions. This study investigated chemical-free vegetable production in Chiangmai, Thailand to help determine whether it is appropriate for adoption into "sustainable agriculture".

1) Farmers' Goals and Objectives

The main reasons for practising CFA farming are, in order of importance, profit motivation, lower cost of production compared with CA farming, improved cash flow, the extension officer's advice, and family health. Reasons for still practising CA focus mostly on the profit motivation, followed by convenience, the influence of neighbours, the lower labour required, and the government's advice.

Although not being a high priority, the CFA farmers are also concerned about their health and the environment, whereas the CA farmers are not concerned about these issues. Thus, the CFA farmers' goals are to achieve good economic performance at the same time as considering the social and environmental impacts.

2) Economic performances

Running costs of CFA farming are less than the running costs of CA farming, but given CFA farming (a labour intensive form of production) involves a range of crops, the economic and the social cost comparison results vary among the research sites. It could not be concluded that in general the economic and the social costs of CFA farming were less than for CA farming since one of the comparisons was made with a significantly less labour-intensive longan orchard at Santonkwoa.

In general, the study of net farm income provides a similar conclusion. However, net farm incomes of the CFA farms were greater when the CFA farmers could sell their produce at a reasonable price.

In the case of Pong-yang, the negative social net farm income indicates that the government CFA promotion project has failed. However, the lower price of the CFA produce in this village is the main factor for this. Thus, an improvement in the marketing of the CFA

products may create a positive social net farm income for CFA farming in this particular village.

3) Social and environmental impacts

The majority of respondents indicated that the extension information and new skills, training, health, safety and working conditions of CFA are better than those of CA. The farmers are also aware of the health risks from using the artificial agricultural chemicals associated with CA methods.

CFA was found to have beneficial impacts on the farm environment and required the use of fewer types of artificial agricultural inputs. The farmers realised that the use of artificial agricultural chemicals resulted in decreases in local wildlife quantity and variety in contrast to CFA having a positive effect on these variables.

Chemical-free vegetable production provides farmers with an opportunity to improve their economic, social and environmental situations. However, the number of farmers who practice CFA is small. This may be partly explained by the changes that modernisation is bringing to the research sites. As farmers are increasingly exposed to advertising for consumer products, their patterns of demand and consumption change. To be able to fulfil these changing wants and needs, farmers require increasing levels of cash income so the temptations, and often necessity, of high short-term earning from CA cash crops remain. Farmers often do not have accurate information concerning the potential profits and risks associated with different crops and agricultural methods and so they may be unable to make informed profit maximisation decisions.

The promotion by some NGOs for a move away from the market economy may prove to be unsuccessful if the farmers continue to increase their consumer demand, thereby requiring higher income levels. Modernisation is occurring rapidly in Thailand, and whether CFA will provide farmers with enough incentives and income remains to be seen. However, the effect of the continuing devaluation of the Thai baht will also affect the choices in that imported artificial agricultural chemicals may become too expensive for farmers, and their local CFA alternatives may become more appealing.

6.2 Recommendations

Raising farmers' realisation of the "real cost" of different methods of agricultural practise should be considered as the most important strategy for agricultural extension. For example, in most agricultural extension projects, farmers withdrew from the promoted practise once the subsidies were removed. The extension of organic farming in Thailand should be based on social costs.

Although there appears to be a lot of co-operation among the different NGOs involved with CFA in the north of Thailand, the co-operation between the NGOs and the government sector could be improved. Co-operation amongst different government departments could also be increased.

Improvement in marketing CFA products should also be considered. These include aiding contracts between farmers and distributors in the city, farm tours for consumers and providing market information for farmers.

The many different definitions of CFA farming and "chemical-safe" products in Thailand are likely to confuse many consumers. Therefore, clearer and more consistent definitions of CFA are likely to be advantageous to consumers, producers and traders. The government may need to address some of the uncertainty surrounding its choice of "chemical safe" production and labelling, and to clarify what "chemical safe" actually means. The NGO sector also needs a more unified and national approach to labelling and certification. Fair trade was found to be rarely mentioned on the labels of CFA products, and this could also be changed.

There is a need for a better understanding of how the users of chemicals can adequately protect themselves, their environment and the consumers of their products. Health and environmental problems could be addressed through education, the use of protective clothing, stricter artificial chemical labelling requirements, and improvements in artificial agricultural chemical application techniques.

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