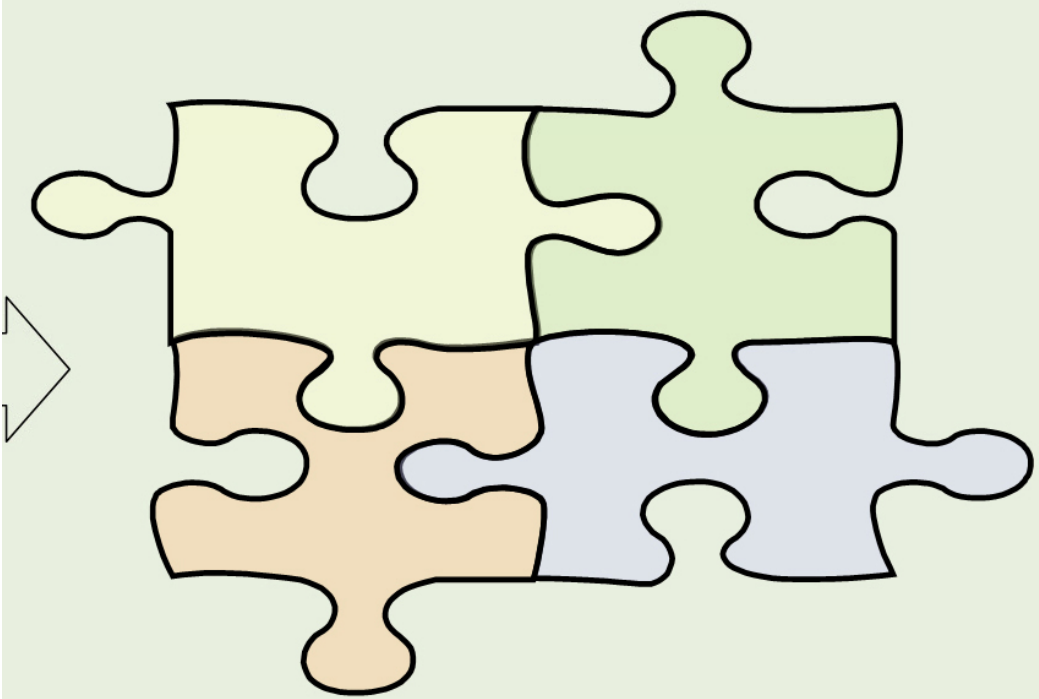
Sustainability of Small and Medium-sized Agro-Industries in Northern Thailand



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Preface

It has been almost twenty years since I studied at the undergraduate level and heard the word 'environment' and 'conservation'. These words have become more meaningful when I had to teach the environmental conservation courses in Chiang Mai University. My role as a lecturer has made me realize that to conserve the environment is extremely important, not only at the local level, but also at the regional and global levels. Through lecturing and doing research, I became more and more interested in this topic. This only increased when I became involved in the "Cleaner Agro-industries: Agro-Industrial Transformations towards Sustainability-Southeast and East Asia in Global Perspective (AGITS)" Project, a cooperation between Chiang Mai University, Chulalongkorn University, the University of Malaya, the University Malaysia Sarawak and Wageningen University, The Netherlands. In the framework of this project, generously funded by the INREF funds of Wageningen University, my Ph.D. research project started in 2001. Through this research my interest in the agro-industries has grown, especially in the Thais small and medium-sized agro-food enterprises (SMEs) and their relation to environmental deterioration and conservation.

This research would not be possible without the encouragement, support and suggestions in concepts, analysis and academic writing from my promoter, Professor Dr. Arthur P. J. Mol, Chair of the Environmental Policy Group, Department of Social Sciences, Wageningen University, and from my Thai supervisor, Dr. Songsak Sriboonchitta, Dean of Economics Faculty, Chiang Mai University. All their time and support throughout this project has made the research possible. I would like to make a special thank to both of them.

I also would like to thank many people who made it possible to finish this research, without problems. My special thanks to Dr. Peter Oosterveer, the Project Manager of AGITS who is a colleague as well as a teacher in sociological concepts, and also for his help in translating the summary to Dutch language. Many thanks to Professor Dr. Gert Spaargaren for his suggestions on research concepts, and how to ride bicycle in the Netherlands. My sincere thank to Ms. Corry Rothuizen who is a friend and also a sister, and who helped me with every aspect in dealing with institution within a Dutch university. Without her, I don't think I would have been able to get through all that. Also, thanks to my Thai Ph.D. colleagues in the same AGITS project, which have been sharing so many things together, especially when things didn't work out the way they had to work out: Thanes Sriwichailamphan, Chiang Mai University and Dr. Orathai Chavalparit, Chulalongkorn University. There are also colleagues from the Environmental Policy department at Wageningen University who I want to thank for their kind support, encouragement and academic sharing: Professor Dr. Kris van

Koppen; Dr. Tran Thi My Dieu; Dr. Zhang Lei; Dr. Phung Thuy Phuong; Dr. Bas van Vliet; Walit Jawjit; Er Ah Choy; Abas Bin Said; and Dr. Yi Liu. Thanks to Mr. Willy Baak for helping me with the computer hardware during my time in Wageningen. Thanks to Mrs. Loes Maas and her family for their hospitality during my time in Holland, especially on my first day of arrival. Thank to Dr. Montri Kunphoommarl, the CMU Project Manager of AGITS, who brought this project to our faculty at CMU and special thanks to Professor Dr. Manat Suwan, CMU for his academic support.

Without doubt, most of my time doing this research was in Thailand. Therefore, without the support of my home institution and my colleagues, I would not have been able to finish this research. I would like to acknowledge the research suggestions from Dr. David Sonnenfeld (Washington State University) and Dr. Aree Wiboonpongse. Special thanks to my colleague, Dr. Liwa Pardthaisong-Chaipnich, Geography Department, Chiang Mai University, for her support and to Dr. Pantip Jongkloy, Geography Department, Kasetsart University for her support and inspiration to do a Ph.D. Thank to my sampling enterprises and staffs from the related organizations for their cooperation in the interviews. Without them, I would not have the opportunity to learn new knowledge and experience that was very useful for my study.

Finally, I want to apologize and thank my dearest husband, Mr. Prakan Wattanapinyo, who has devoted himself for our family as well as given his kind support and encouragement when I was down. Thank to my late father for teaching me on the importance of education which has led me to this day. Thank to all of my elder sisters and brothers, especially Assistant Professor Wattana Poonyarit for taking responsibility in looking after our mother for me. Last but not least, thank to Mr. Kees and Mrs. Budsaba Schotten for their warmth hospitality as if they were my second home in the Netherlands which made me felt at home while I was actually being away from home.

Chiang Mai, August, 2006.

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ABBREVIATIONS

AIT	Asian Institute of Technology
APEC	Asia Pacific Economic Cooperation
BAAC	Bank for Agriculture and Agricultural Cooperatives
BBL	Bangkok Bank Public Company Limited
BIOTEC	National Center for Genetic Engineering and Biotechnology
BOD	Biochemical/Biological Oxygen Demand
BOI	Board of Investment
CAC	Command-and-Control
CEC	Commission of the European Communities
CFC	Chlorofluorocarbon
CMU	Chiang Mai University
COD	Chemical Oxygen Demand
CO_2	Carbon Dioxide
CP	Cleaner Production
CU	Chulalongkorn University
CUD	Custom Department
DEQP	Department of Environmental Quality Promotion
DEP	Department of Export Promotion
DGR	Department of Artesian Wells
DIP	Department of Industrial Promotion
DIW	Department of Industrial Work
DLD	Department of Livestock Development
DMS	Department of Medical Sciences
DSD	Department of Skill Development
EGAT	Electricity Generating Authority of Thailand
EIA	Environmental Impact Assessment
EMS	Environmental Management System
EMT	Ecological Modernization Theory
EoP	End-of-Pipe
EXD	Excise Department
EXIM	Export-Import Bank of Thailand
FAO	Food and Agriculture Organization of the United Nations
FDA	Food and Drug Administration
FCIB	Faculty Control and Inspection Bureau
FETB	Faculty Environmental Technology Bureau
FTI	Federation of Thai Industries
FTPI	Thailand Productivity Institute
GAP	Good Agricultural Practice
GDP	Gross Domestic Product
GMO	Genetically Modified Organism

GMP	Good Manufacturing Practice
GO	Governmental Organization
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
HACCP	Hazard Analysis Critical Control Point
HSCB	Hazardous Substances Control Bureau
HSRI	Health Systems Research Institute
ICFT	Industrial Finance Cooperation of Thailand
IEAT	Industrial Estate Authority of Thailand
IFRPD	Institute of Food Research and Product Development
IIE	Institute of Industrial Energy
ISMED	Institute for Small and Medium Enterprises Development
ISO	International Standards Organization
IWTI	Industrial Water Technology Institute
KU	Kasetsart University
MASCI	Management System Certification Institute (Thailand)
MJU	Mae Jo University
MNRE	Ministry of Natural Resources and Environment
MOAC	Ministry of Agriculture and Cooperatives
MOC	Ministry of Commerce
MOL	Ministry of Labor
MOST	Ministry of Science and Technology
MOSTE	Ministry of Science, Technology and Environment
MOI	Ministry of Interior
MOInd	Ministry of Industry
MOF	Ministry of Finance
MOPH	Ministry of Public Health
MRC	Meat Research Corporation
NEI	National Environmental Institution
NEQA	Enhancement and Conservation of National Environmental Quality Act
NESDP	National Economic and Social Development Plan
NFI	National Food Institute
NGO	Non-Government Organization
NO_2	Nitrogen Dioxide
NRIE	Northern Region Industrial Estate
NSO	National Statistical Office
NSTDA	National Science and Technology Development Agency
OAEP	Office of the Atomic Energy for Peace
OEPP	Office of Environmental Policy and Planning
OECD	Organization of Economic Cooperation and Development
OPNE	Office of Provincial Natural Resources and Environment
OSMEP	Office of Small and Medium Enterprises Promotion
OTOP	One-Tambon One-Product

PCD	Pollution Control Department
PEO	Provincial Natural Resources and Environment Office
PPHA	Provincial Public Health Office
PPP	Pollution-Pay-Principle
REO	Regional Environmental Office
SFAC	SMEs and Financial Advisory Center
SICGC	Small Industry Credit Guarantee Corporation
SIFC	Small Industry Finance Corporation
SIFO	Small Industrial Finance Office
SME	Small and Medium-sized Enterprise
STC	Safety Technology Center
TAO	Tambon Administration Organization
TBCDS	Thailand Business Council for Sustainable Development
TEI	Thailand Environment Institute
TIC	The Thai Irradiation Centre
TISI	Thai Industrial Standards Institute
TISTR	Thailand Institute of Scientific and Technological Research
TPI	Technology Promotion Institute
TRF	Thailand Research Fund
UNEP	United Nations Environmental Program
UNIDO	United Nations Industrial Development Organization
US(A)	United States (of America)
VAT	Value Added Tax
WRRC	Waste Reduction Resource Center
WWTS	Wastewater Treatment System

Chapter 1

Industrial Development and the Environment in Thailand

1.1 Introduction

For the past 40 years, Thailand has gone through several stages of economic and social change. During this time, the emphasis of the various National Socio-Economic Development Plans (NSEDPs) has been on economic growth. From an early stage the agricultural sector, which employs the largest proportion of the country's workforce, started to employ irrigation and more intensive agricultural production processes. At that time, economic growth through industrial development was the main objective of national development. The government allocated most of its resources to industrialization and the urban economy. This contributed to the nation's export-based economic success. As a result, the industrial and service sectors, particularly the seafood, textile, electronics and tourism industries, have accounted for 70 percent of the economic growth since the 4th National Socio-Economic Development Plan (1972-1976). Thailand achieved a remarkable economic growth during the late 1980s (Warr and Nidhiprabha, 1996) and was cited internationally as an example of a successful developmental model from 1990 onwards. However, a high growth rate does not guarantee a high quality of life. The nature and environment in Thailand have been under pressure due to this industrialization. In other words, these rapid economic changes have contributed to environmental degradation in Thailand, as well as causing various social conflicts (NSEDB, 2002). Business and industry are seen as the cause of, as well as being an important solution to, environmental problems, much in line with the ideas of the World Commission on Environment and Development (WECD, 1987). Since the Earth Summit held in Rio de Janeiro in 1992, the role of business and industry in achieving sustainable development has increasingly become the focus of attention of policy-makers throughout the world. Agenda 21, the action plan produced as a result of the Earth Summit, emphasizes the importance of involving business and industry, as well as workers and trade unions in sustainable development. Therefore, the 8th National Socio-Economic Development Plan (1997-2001) implied a shift of focus from economic growth to sustainable development, which requires public participation in planning and implementing environmentally friendly solutions. The agricultural sector, once the backbone of the Thai economy, has been given an important role in strengthening the economy with respect to the environment.

1.2 Economic Development of Thailand's Industrial Sector and the Environment

Thailand's development strategy during the last four decades has been to become one of the newly industrializing countries (NICs) in Asia. In achieving this main objective of the National Socio-Economic Development Plans since 1961, the Thai governments have supported industrial development[1] and facilitated the infrastructure needed to serve industrial investment from abroad. As a result, in the years 1985 to1995 Thailand was the world's fastest-growing economy. According to the World Bank, real average annual growth of GDP was 8.4 percent, while China's was 8.3 percent, Korea's 7.7 percent, and Singapore's was 6.2 percent (Phongpaichit and Baker, 1999). The Golden Era of Thailand was between 1987 and 1997, when the economic growth rate soared at 9 percent, climbing up to 10 percent from 1988 to 1991 (Kaosa-ard and Wijukprasert, 2001). In 1995, *The Economist* predicted that Thailand would be the world's eighth largest economy by the year 2020. The Thai economy rapidly changed from one based on agriculture to one based on industry, as a result of government policy.

Small and medium-sized enterprises in Thailand's economic development

In Thailand, there are four sub-sections in the industrial sector: manufacturing, retail, wholesale and service. The manufacturing sector can be classified into 23 manufacturing industrial categories arranged by their economic activities. In 1998, over 95 percent of enterprises were either small or medium-sized (DIW, 2001), contributing to more than 61 percent of the total workforce in the industrial sector (BBL, 2001)[2]. Nevertheless, the data on small and medium-sized enterprises[3] supplied by the National Statistical Office of Thailand (NSO) are quite different from former data, due to differences in how SMEs are defined[4]. According to NSO data, in the year 2002, there were 1,645,530 enterprises in Thailand. Amongst these, the number of SMEs was 1,639,427 or 99.63 percent of the total number of enterprises. This number has grown by 840,394 from 1997, when there were only 799,033[5] (Figure1.1). In 2002, the number of SMEs in each business sector was as follows: the

[1] See more details of government policy on industrial development in the latest NSEDP in Chapter 4.

[2] It should be noted that the numbers of SMEs in Thailand vary, as they are based on data sets from various agencies. The Department of Industrial Works (DIW) data report statistics of establishments which register with the Ministry of Industry as required by law. Some micro or cottage industries are exempt from registration. Thus, the DIW data could well be underestimating the number of establishments and level of employment in these industries.

[3] See Chapter 3 for a detailed definition of SMEs.

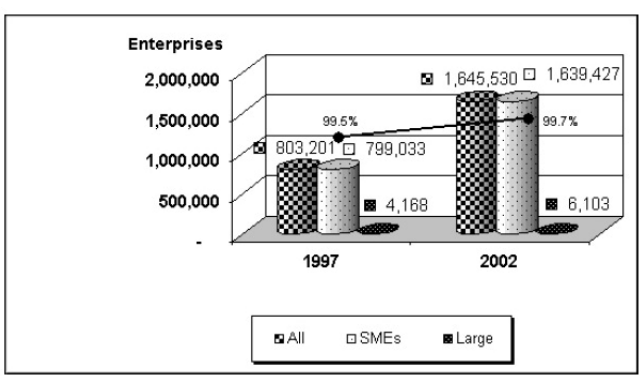
[4] The dataset derived from NSO includes micro-scale (household) industry in their data base, which makes the total number of SMEs much larger than the numbers from the Ministry of Industry.

[5] Due to the main policy of the government in supporting SMEs after the 1997 Economic crisis.

largest number was in the retail sector (44.69 percent of the total SMEs), next was the service sector (30.56 percent), and lastly were the manufacturing and wholesale sectors (21.76 percent and 2.99 percent respectively; Figure 1.2). In terms of regional distribution of the SMEs in the year 2002, the Northeastern region had the highest number of SMEs, i.e. 31.07 percent of the total SMEs. Next was the Bangkok Metropolitan area, (21.14 percent), North (16.9 percent), South (13.62 percent), Central (12.24 percent) and finally the Eastern region had 4.66 percent (Figure 1.3). The number of enterprises operating in the manufacturing sector was 359,552 in the year 2002, out of which 356,806 were SMEs and the remaining 2,746 were large enterprises. The importance of these SMEs was underscored by the following: they comprised 70 percent of all industrial employment, produced 50 percent of exports and accounted for 60 percent of value added to GDP (Paitoon, 2001). They have contributed significantly to the Thai economic growth rate since the financial crisis of 1997. In particular, the share of SMEs in the country's GDP had reached 38.91 percent and if farm income and agricultural processing are included, the GDP share of SMEs reached 50 percent (Table 1.1). At the same time, SMEs' share of exports of manufactured goods had reached 38.2 percent of the total value of exports (OSMEP, 2003). Moreover, SMEs employed about 69 percent of the nation's workers (APEC, 2003).

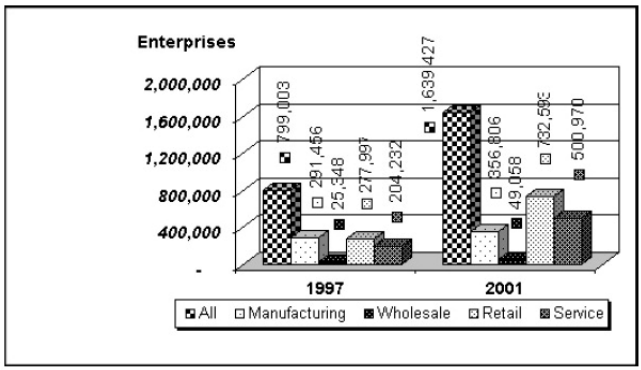
Traditional agricultural activities and formal sector employment in large-scale enterprises cannot provide sufficient employment opportunities for the large number of people entering the workforce in developing countries each year (Scott, 2000). SMEs are increasingly seen as an important means of addressing the problem of unemployment, especially when they are located in rural areas and related to agricultural activities.

Figure 1.1 The number and the proportion of SMEs in 1997 and 2002



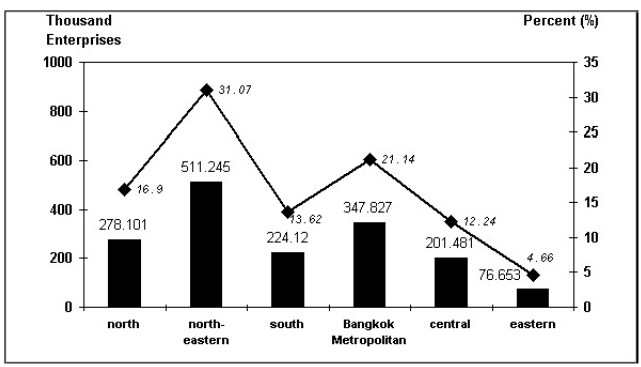
Source: Office of SMEs Promotion, 2003.

Figure 1.2 Number of SMEs classified by business sectors in 1997 and 2001



Source: Office of SMEs Promotion, 2003.

Figure 1.3 The number and the proportion of SMEs classified by region in 2002



Source: Office of SMEs Promotion, 2003.

In 2002, the food and beverage sub-sector had the largest number of enterprises that could be classified as manufacturing (Table 1.1). It consisted of 99,659 operations, of which 27.93 percent belonged to the SME manufacturing sector, which in turn employed 19.81 percent of the total workforce in this sector (OSMEP, 2003). Moreover, its contribution towards national GDP was as high as 28.3 percent, it had an average annual growth rate of 13 percent a year, and value added[6] in this industry

[6] Exchange rates were 1 Euro to 47 Thai Baht (2003) and 50 Thai Baht (2004).

made up 19 percent of the total amount of value added in the industrial sector (NFI, 2003). In the manufacturing or production sector, food processing plays a significant role in the Thai economy.

Table 1.1 Thailand's gross domestic product (GDP) from 1998 to 2002

Gross Domestic Product (%)	1998	1999	2000	2001	2002
GDP for agricultural sector	12.17	10.84	10.39	10.39	10.03
GDP for SMEs	37.73	39.37	39.80	39.36	38.91
- Mining	0.91	0.96	1.16	1.23	1.23
- Manufacturing	8.38	8.94	9.52	9.64	9.89
- Construction	2.82	2.64	2.25	2.18	2.18
-Wholesale and Retail	13.15	13.33	13.35	12.88	12.25
- Services	12.48	13.51	13.52	13.44	13.35
GDP for large enterprises and others	50.09	49.79	49.81	50.25	51.06
Total GDP	100.00	100.00	100.00	100.00	100.00

Source: Office of SMEs Promotion, 2003.

Table 1.2 The number and proportion of SMEs classified by economic activities (2002)

Industries	Number of enterprises			Percentage of SMEs	
	Total	Large	SMEs	Industrial sector	Manufacturing sector
1. Food and Beverages	100,130	471	99,659	99.53	27.93
2. Tobacco	549	5	544	99.09	0.15
3. Weaving	58,676	291	58,385	99.5	16.36
4. Garments	70,515	254	70,261	99.64	19.69
5. Leather products: shoes and bags	4,363	117	4,246	97.32	1.19
6. Wood and wooden products*	44,822	58	44,764	99.87	12.55
7. Paper and paper products.	1,599	59	1,540	96.31	0.43
8. Printing and advertising.	4,813	32	4,781	99.34	1.34
9. Petroleum, Coal and Fuel.	90	12	78	86.67	0.02
10. Chemicals	2,263	124	2,139	94.52	0.6
11. Rubber and plastics	3,870	225	3,645	94.19	1.02
12. Mineral products	9,676	115	9,561	98.81	2.68
13. Raw steel	1,773	58	1,715	96.73	0.48
14. Refined steel	25,518	102	25,416	99.6	7.12
15. Machinery and spare parts	4,797	103	4,694	97.85	1.32
16. Office applications	51	16	35	68.63	0.01
17. Electronic appliances	1,089	90	999	91.74	0.28
18. Radio, TV & Communications devices	673	188	485	72.07	0.14
19. Medical equipment	347	33	314	90.49	0.09
20. Motor vehicles and parts	1,168	112	1,056	90.41	0.3
21. Other transportation equipment	701	21	680	97	0.19
22. Furniture	21,943	260	21,683	98.82	6.08
23. Raw materials from recycling	126	-	126	100	0.04
Total	**359,552**	**2,746**	**356,806**	**99.24**	**100**

*Note: Excluding furniture

Source: Office of SMEs Promotions, 2003.

The food processing industry and economic development

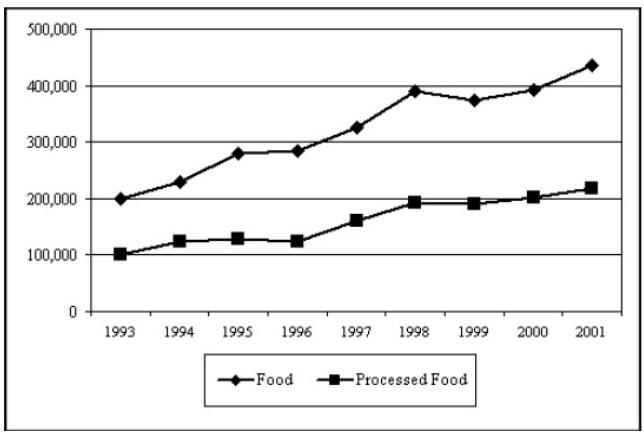
The food processing industry has contributed a substantial value added to the domestic raw material sector, which it relies on for 80-90 percent of all raw materials. In other words, more than 80 percent of the raw materials used in the food industry come from the domestic agricultural sector, which adds more value to the products for rural people (Table 1.3). Agro-industry is an industry that takes raw materials from the agricultural sector and transforms them into goods that are ready and easy for consumption, or into materials for other production processes. The agro-industry also prolongs the life of products by using technology to preserve product quality. Thailand is famous for the high quality of its food products in the world market (BOI, 2001). The products in the food processing industry in Thailand are produced via various production and conservation methods. A broad range of products is produced: frozen and dried fruits, high quality preserved fruit jams, canned vegetables for the domestic market, pre-cooked meats in roll, block or sliced cold cut meats, ready-to-eat and ready-to-prepare meats and whole meals, etc. Over the past decade, Thailand has become one of the Southeast Asia's largest producers and exporters of processed food products. Projected growth in the industry is estimated at around 13 percent over the next several years (NFI, 2003). The sector has a large domestic market with over 60 million people and it competes with other countries in the world market (NESDB, 2001). The market share of its food products that are exported is still increasing, although an economic recession has occurred around the world, which hit Asia especially hard in 1997. Figure 1.4 shows how much food exports in Thailand have risen. The agro-industry has become one of the key sectors in the recovery of the Thai economy since the 1997 economic crisis. It is expected that manufacturing capacity and exports will rise, increasing the value added and helping Thailand compete with neighboring countries.

Table 1.3 Value-added of Thai food industry in 1995 and 1996

Type of Industries	1995		1996	
	Value-Added	Proportion	Value-Added	Proportion
Processed and canned seafood	19,557.9	11.0	20,356.9	10.0
Processed and canned fruit and vegetables	5,267.4	2.9	9,000.5	4.4
Processed animal products	7,093.8	4.0	7,018.4	3.4
Seeds and Tuber	21,578.2	12.2	27,493.8	13.3
Sugar	20,626.1	11.6	25,441.6	12.3
Livestock feed	7,019.3	9.0	9,716.9	4.7
Beverages	80,471.7	45.3	88,213.7	42.8
Others	15,922.4	4.0	28,929.2	9.2
Total	**177,536.8**	**100.0**	**206,171.0**	**100.0**
Proportion in the Industrial Sector	**13.8**		**14.9**	

Source: Compiled by the author based on 2003 data provided by the Ministry of Commerce.

Figure 1.4 Food exports and processed food exports



Note: in Million Baht

Source: Compiled by the author based on 2003 data provided by the Office of Agricultural Economics.

Environmental impact from developing sectors

Rapid industrial development has taken its toll on Thailand's environment. Air and water pollution and rising amounts of solid waste have had dramatic negative effects on the environment. Water pollution has become a particularly pressing issue. According to certain estimates, as much as one third of Thailand's water and coastal resources are of poor quality. Industrial water pollution is caused by the discharge of organic substances, hazardous chemicals including heavy metals and non-biodegradable material. Discharge of untreated wastewater containing organic materials reduces the dissolved oxygen level in rivers and diminishes aqua-animal populations. High concentrations of hazardous bacteria are discharged along with organic material. Domestic and agricultural wastewaters are the main source of organic pollution. Yet, particular sectors of industry such as sugar, tapioca starch, rubber, palm oil, paper production etc. contribute significantly (up to 25 percent) to the organic pollution load of rivers and coastal areas (OEPP, 2000). Industrial manufacturing in Thailand also increasingly produces high amounts of toxic waste that contain complex chemicals and heavy metals. These pose a serious threat to public health not only because their contents are potentially dangerous, but also because the harmful effects of these substances could last a long time.

This is not fundamentally different for SMEs. Next to their economic contribution, they also contribute substantially to environmental degradation, especially to increases in water and air pollution. Several reasons have been given as to why SMEs cause so many environmental problems (Hillary, 2000). A low level of energy efficiency and high level of pollution result from using old and inefficient technologies with poor waste disposal and treatment systems (Visvanathan and Kumar, 1998). In this way, their production activities are thought to be major sources of environmental pollution (PCD, 1997). Generally, national economic statistics on SMEs do not tally with data collected on emissions and waste generation from firms, so it is doubtful whether smaller firms' contribution to pollution can be calculated at all (Hillary, 2000). Although precise data are scarce, there is general agreement within relevant literatures (Visvanathan and Kumar, 1998 and Hillary, 2000) that SMEs put considerable pressure on the environment. This is not necessarily because individual SMEs are big polluters (although some of them may have a significant impact on their local environment), but rather because of the environmental effects they have collectively. The vast number of small firms means that cumulatively they undoubtedly have a significant impact on ecological systems. A frequently quoted estimate is that SMEs could be responsible for up to 70 percent of all industrial pollution in general (Hillary, 2000). The Marshall Report (1998), which originally endorsed proposals for a climate change levy, estimated that as much as 60 percent of carbon dioxide emissions from businesses result from the activities of SMEs. Unfortunately, there is little hard data to determine the sector's contribution to pollution load, although the increasing number of small firms suggests that their total environmental impact is quite substantial. While the combined impact of pollution from SMEs is not known at a national level, the significance of this pollution at a local level cannot be underestimated.

While agro-industries are considered beneficial to the Thai economy, it is broadly known that their production processes generate a lot of waste, especially in terms of wastewater and organic waste. Although the pollution they generate is not as poisonous as that from heavy industry, the spreading around the country of household industries with little control is bound to have a negative impact on the environment. There are some indications of SMEs agro-industries' impact on water quality. According to a study of Thailand's environmental situation, the water quality of the main rivers is above standard (PCD, 2001) and management of waste is a serious problem in every city in Thailand (Hazardous Substances and Waste Management Division, 2001). This implies that agro SMEs play a crucial role both in economic development and in causing environmental pollution. The Government's support of SME activities to increase economic growth should be balanced with effective environmental management policies.

National industrial environmental management

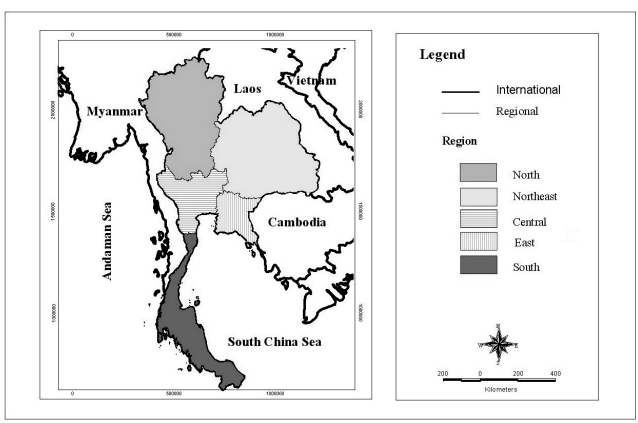
As early as 1981 the government introduced effluent standards for controlling effluents discharged from factories. This has been formalised more comprehensively by the National Environment Quality Enhancement and Protection Act (NEQA), which was drawn up in 1992 and has been enforced since then by the Thai Government. The NEQA sets the pollution emission standards from point sources with respect to wastewater discharge, air pollutant emissions, and the discharge of other pollutants into the environment within, among others, the industrial sector. The issuance of operating permits to factories is linked to their compliance with effluent standards. Actual control and enforcement of the prescribed effluent standards, however, is weak. Industrial pollution problems continue to exist, especially from small and medium-sized industries, where environmental awareness, appropriate management and government enforcement are lacking. There are many reasons for this latter deficiency. One of them is that personnel and budget resources needed for factory monitoring are not sufficient. In spite of these difficulties, today most large-scale factories operate well-designed wastewater treatment plants and measure effluent quality, so that it lies within the prescribed standards. But many small and medium-scale factories discharge their wastewater untreated. The Department of Industrial Works (DIW) is the department within the Ministry of Industry that is responsible for industrial factories. In order to prevent further environmental degradation that may become a bottleneck for economic and social development, DIW has cooperated with foreign organizations, such as GTZ[7], to promote alternative sustainable technologies for industrial production.

At present, industrial environmental management policy concentrates on the following two approaches: i) Social-economic instruments: Polluter-Pays-Principle and Pollution-Prevention-Pays-Principle and ii) Environmentally Sound Technology and Clean Technology (DIW, 2002). Following these approaches, the government has adopted a policy of environmentally sustainable industrial development. First, it controls environmental performance of factories through a compliance system based on environmental laws, regulations and effluent standards. Second, as a new approach, DIW is in the process of introducing economic instruments. The Asian Crisis forced many entrepreneurs to downsize operations and cut down on environmental investments. Therefore, it has become a vital element of pollution

[7] The Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) is an international cooperation enterprise for sustainable development with worldwide operations. It provides viable, forward-looking solutions for political, economic, ecological and social development in a globalized world. Its corporate objective is to improve people's living conditions on a sustainable basis. In Thailand it has cooperated with DIW since 1987 with the main policy focusing on sustainable environmental development of Thailand's industry. For details, see http://www.gtz.de/en/.

prevention and reduction to develop economic incentives to encourage the companies to lower their pollution load. DIW has developed 'Technical Guidelines' for the introduction of environmental management in nine of the most polluting industrial sectors in Thailand[8]. The application of an Environmental Management System (EMS) in a factory improves production process efficiency and productivity, and results in a significant reduction of overall costs. It also creates new opportunities for recycling and reusing by-products. Pilot activities have been successfully completed in several industrial sectors (DIW, 2002). The results of these demonstration projects have been incorporated in the guidelines[9] that describe the most suitable measures for Good Housekeeping, Cleaner Production and the treatment and disposal of wastewater and waste. The conventional EMS has been further adapted to the needs and conditions of SMEs, which have little capital, knowledge or organized structure, but have large potential for improvement. However, more effort and knowledge is needed to help SMEs improve their environmental management (DIW, 2003).

Map 1 Map of Thailand



Source Geo-informatics and Space Technology Center (Northern Region), Thailand.

[8] These were the steel processing industry, non-ferrous metal smelting, the textile dying and finishing industry, leather tanning and finishing, pulp and paper production, and several agro-industries.

[9] Guidelines have been completed and disseminated for the steel processing industry, non-ferrous metal smelting, the textile dying and finishing industry, leather tanning and finishing, pulp and paper production, and several agro-industries such as the milk and pineapple cannery industries.

1.3 Research Objectives

With this we approach the core objectives of this research. The overall objective of this research is to analyze how small and medium-sized agro (food) processing industries in Northern Thailand, which are causing serious environmental problems, can improve their environmental performance and contribute to environmental sustainability. So as to achieve this, the following two research objectives were formulated.

- To understand how various actors, institutions and social structures influence the environmental performance of the agro (food) processing industry in the North of Thailand.

- To use this understanding to develop strategies to improve the environmental performance of the small and medium sized agro (food) processing industry in Northern Thailand.

To realize these objectives, this study has tried to answer the following questions:

- Which actors, institutions and social structures are involved in the agro-food processing industrial networks?

- How and to what extent do these actors, institutions and social structures influence the environmental performance of the SMEs agro-food processing industry?

- What are the appropriate strategies for waste prevention and management, and what kind of technology can make SMEs agro-food processing in northern Thailand more environmentally friendly?

1.4 Structure of the Dissertation

This dissertation is organized in eight chapters. Chapter two reviews and analyzes theories and approaches to construct a conceptual framework suited to improving the environmental management of the agro-processing sector in Thailand. The research methodology and the selection of case studies (sub-sectors and industries) are outlined in this chapter. Chapter 3 analyzes the present situation of the SMEs agro-food processing industry, its impact on the environment as well as current environmental management practices. Chapter 4 provides a brief overview of state institutions and policies with respect to industry and the environment. Environmental

institutions, legislation, policies and instruments, and the role of governmental actors related to improvements in the environmental management of the agro-food processing industry are analyzed.

After these chapters, which provide general background information, the second part of the thesis consists of empirical chapters. Chapter 5, 6 and 7 consist of case studies of different food-processing sectors: fruit and vegetables products (Chapter 5), meat products (Chapter 6), and beverages (fruit and herb wine) (Chapter 7). Each of these chapters has a similar structure and starts with a general introduction to the geographic and economic profiles of the case studies, followed by an environmental profile of their production processes. Subsequently, a model of waste minimizing of each product category is developed. The main part of each chapter consists of an analysis and investigation of the actors and institutions involved in the current environmental performance of that particular sector.

The final chapter is devoted to a comparison of the three case studies and an integration of the conclusions of each of the three cases. The comparison and integration of the results are the basis for drawing conclusions on the current situation and future potential for improving the environmental management of the (SMEs) food processing industry in Thailand. Finally, the application of the Ecological Modernization Approach in Thailand's industrial sectors is analyzed.

Chapter 2

Agro-industrial Transformation in Thailand: Theory and Approach

This chapter aims to develop a theoretical and conceptual framework with which to analyze environmental transitions of and reform in small and medium-sized industries. In order to do so, the chapter starts by defining the characteristics of small and medium-sized companies. Subsequently, the theory of ecological modernization is introduced as an overall theoretical perspective, useful for understanding socio-environmental change in industrial systems. In the third section, this general theory is further operationalised to facilitate empirical research via the development of the so-called quartet-network model. Finally, the last section provides an overview of research methodology and case study selection.

2.1 Small and Medium-sized Enterprises in Transformation

2.1.1 SMEs: characterization and development

There are many studies on small and medium-sized enterprises (SMEs)[1] which consider SMEs as important for economic development in both developed and developing countries. SMEs have been recognized as a major source of employment and income in many countries, especially in the Third World. In Africa and Asia, the majority of the population lives in rural areas where small-scale enterprises provide 20-45 percent of full-time employment and 30-50 percent of rural household income. Latin America, which is more urbanized, has an estimated 50 million micro and small-scale enterprises, employing 120 million people (Scott, 2000). Micro and small-scale enterprises are characterized by low returns on investments and generally use simple, low-cost technologies. They serve local, low-income markets, and jobs are often part-time or seasonal. Many of them are in the informal sector, which means that their operations are not properly regulated. In developing countries, small-scale enterprises tend to be concentrated in a small number of industrial sectors, but they, along with medium-scale enterprises, account for a large proportion of those employed in the entire manufacturing sector.

[1] In general, 'micro' is used to refer to firms that employ one to nine workers, 'small-sized' is the label used for firms with 10-49 employees, and 'medium-sized' is used for firms with 50-249 employees. See Chapter 3 for a detailed discussion on the definitions of SMEs, especially in Thailand.

In the aftermath of the 1997 economic crisis, the awareness of the role of SMEs as one of the 'backbones' of the economies of East and Southeast Asian countries has increased. In general, SMEs are believed to have six characteristics: i) minute in size, ii) transitionary life cycle, iii) widespread presence, iv) diverse nature, v) importance both in their own right and also to the economic system as a whole, and vi) close relationship with larger producers, either by metamorphosis, or through direct and indirect interactions (Wan, 2002). Other characteristics that have been pointed out are that they are often owned, managed and run by family members, and have a less complex production process due to a lack of resources and/or skilled manpower. They often have a simple management and administrative organization, do not undertake high-risk jobs, and are usually involved in the subcontracting market (Hillary, 2000; Scott, 2000). These characteristics are similar to those of this kind of industry in Africa and the Caribbean, which has been summarized by Mead and Liedholm (1998) under seven main headings: i) size of labor force: the real number of employees is estimated to be more than the registered number, which is reported in most official statistics; ii) size distribution: SMEs can be any size from one person working alone to a company with 50 employees; iii) labor force characteristics: the labor force consists of family members, hired workers, trainees and apprentices that vary according to the size of the firm; iv) location: the majority of SMEs operate in rural areas or in the suburbs or peri-urban areas of the city; v) composition of activities: most SMEs are primary vendors and small traders and manufacturers, of which the most important sectors are textiles and apparel, food and beverages, and wood and forest products; vi) gender: the majority of the SMEs are owned and operated by women as home-based enterprises; and vii) efficiency: resource, labor and capital efficiencies vary according to company size: surveys show that the enterprises with 2-5 workers have a larger return per working hour than others.

In this study, we will assess the various characteristics of SMEs given in the literatures mentioned above, and apply them to the specific local conditions of Thailand. The Thai SMEs in this study have the following characteristics: i) size of labor force: SMEs range from 1-200 workers, ii) gender: most workers in SMEs are women due to lower wages, while men are found when hard, physical work is required; iii) labor force characteristics: most SMEs are owned and managed by family members, with additional workers hired when needed; iv) industrial sector: SMEs can be found in the manufacturing, service and trade sectors; v) location: most Thai SMEs are to be found in rural areas or suburban districts; vi) structure of SMEs: most use simple technology, simple management and organizational schemes and low levels of administration; and vii) market: most SMEs produce for the local and domestic market, and also often do subcontracting work.

In Southeast Asia there is evidence of a recent increase in the number of micro enterprises due to the loss of better-paid jobs in other sectors of the economy. This

means that micro enterprises and SMEs play a role in economic development that is different from large-scale firms (Sandee, 2002). Anderson (1982) distinguishes three distinct historical phases regarding the relative importance of micro enterprises and SMEs as a country develops, and especially as it industrializes. Phase I is the early stage of industrial development, when cottage and household industries are predominant in terms of their contribution to both the labor force and production. Phase II is characterized by increased urbanization and expanding cash markets that give rise to a shift from traditional household activities to growing specialization in small-scale production with more use of hired labor and apprentices, in addition to family workers. Micro enterprises are increasingly replaced by SMEs in a growing number of manufacturing sub-sectors. And in phase III, the dominance of large-scale firms becomes the engine of growth in the manufacturing sector. SMEs continue to play a vital role in the development of the manufacturing sector through growing involvement in subcontracting. While this three phase model can be criticized for resembling too much a simple modernization theory of evolutionary development, it is interesting to note that SMEs are perceived to create employment – and thus economic growth – both in the early phases of industrialization and towards its maturation.

East Asia experienced rapid economic growth, both before and after the 1997 economic crisis. Wan (2002) studied SMEs in the rapidly growing developing economies in some Asia-Pacific countries (Korea, Taiwan, Hong Kong, Singapore and Malaysia) in order to examine the way in which they developed, their contribution to overall economic growth and the factors that are essential for SME product and technology innovation. He found two different groups of SMEs, in terms of their role in the economy and their operations. Both the more advanced highly technological and the more traditional subsistence SMEs make major contributions to the economic development process, albeit in different ways, with varying amounts of capital, different attitudes to information use and inter-firm linkages, and in different markets.

2.1.2 SMEs transformation and the environment

Although, most literature on SMEs emphasizes issues of economic efficiency and employment and ignores environmental concerns, the importance of SMEs to both the economy and the environment is now generally accepted. From various studies (e.g. Groundwork, 1998; Friedman and Miles, 2002; and UNEP, 2003), the sheer number of SMEs, together with their rapid growth, has had a substantial impact on the environment in developing countries, specifically with respect to air, soil, surface water and groundwater pollution. Although the size of their combined impact has not been calculated, it is clear that their production processes have had significant effects on human health and the quality of life. It has been noted that SMEs contribute to

environmental problems by using natural resources, such as water, firewood and other energy sources, inefficiently. The large number of SMEs in the manufacturing sector also contributes significantly to environmental degradation through the amount of pollutants they release into the environment. Although the pollution load from individual units might be low, the pollution per unit of output has been proved to be normally higher than that of large-scale companies. This is largely due to the following facts: i) they tend to use outdated technology which is inefficient; ii) they use raw materials and energy less efficiently due to limited skill and knowledge; iii) they tend to refrain from any kind of effluent or waste treatment; and iv) a large number of them manage to avoid inspection and enforcement of regulations by authorities (Scott, 2000). SMEs in certain sub-sectors are generally recognised as having a larger impact on the environment than others, because of the nature of their processing or because of their total contribution to production in their sub-sectors or location. These heavy polluting sub-sectors are, among others, tanneries, foundries, and the textiles, brick-making, metal-working, electroplating, food processing, mining, and paint producing industries (Scott, 2000).

Most environmental studies try to investigate how to support SMEs to overcome their attitudinal, organizational, technical, economical, and resource constraints. Many of the studies on SMEs and the environment have up to now focused on analyzing the obstacles these firms face in adopting environmental best practices. For example, some of the literature has focused on the pollution and waste generated by SMEs, and issues commonly highlighted include waste reduction and regulation. These studies show that small companies have an advantage over large organizations when adapting to environmental challenges, for example in the flexibility and speed with which they can develop products or technologies that meet both business and environmental goals (Meredith, 2000). Frijns, Kirai, Malombe, and van Vliet (1997) carried out research on small-scale metal industries in Nairobi, with the focus on supporting small-scale industries in improving their environmental performance without jeopardising their importance as a source of employment. They found several opportunities for small-scale industry in Kenya to use cleaner production measures to reduce pollution levels at low cost. Implementation of such measures required technical and financial support from political organizations and NGOs, as well as better coordination between firms. Similarly, Bhalla (1992) concluded from a study on innovations by small producers in developing countries that small firms need support from relevant organizations, such as formal and informal R&D institutions and large-scale enterprises abroad, to reduce the cost of production and raise the quality of their products through technological innovations, in order to make their businesses more environmentally friendly. Palmer (2000) studied programs that assist SMEs to improve their environmental management in the United Kingdom. He found that, in general, firms improved their environmental management for commercial incentive, but in his study it showed that their decisions were also greatly influenced

by a personal commitment to the principles of sustainable development. This shows that, although the main barrier to improving environmental management is due to a lack of money and/or time, personal motivation is also a crucial factor when supporting environmental management of SMEs.

In Asian developing countries, research on SMEs and environmental pollution problems has previously been done to prove that there is an opportunity for SMEs to improve their performance and thus limit the impact they have on the environment. So as to develop a conceptual framework for such analyses and investigations, I will review the work done on the tradition of Ecological Modernization Theory. While this theory has been developed specifically with developed European countries in mind, it is one of the few theoretical frameworks that conceptualize processes of environmental improvement and reform related to industrial production. Moreover, there has recently been a number of studies that have sought to apply ecological modernization ideas to Asian context (e.g. Sonnenfeld, 2000; Phuong, 2002; Dieu, 2003; Barret, 2006), discussing the adequacy of an initially European idea to the Asian region.

2.2 The Ecological Modernization Theory

The Ecological Modernization Theory is a rather recent sprout of theorizing with the environmental political and social sciences. It focuses on understanding and explaining how environmental improvement and reforms emerge, and how technological innovations, economic actors and market dynamics, political institutions and arrangements, and civil actors and cultural institutions (can) play a crucial role to turn the industrial system into sustainability directions.

2.2.1 Development of the Ecological Modernization Theory

Historically, environmental sociologists and political scientists have especially focused on the social dynamics behind and social impacts of environmental problems. The Ecological Modernization Theory is a relatively recent theory in the environmental social sciences, emerging in the 1980s in Western European countries, against the backdrop of failing state environmental policies and an environmental movement seemingly intent on de-modernization or de-industrialization perspective. Ecological modernization tried to conceptualize an alternative agenda of environmental improvement and reform, incorporating a major shift in the dominant and unsuccessful environmental policies while at the same time reflecting on a reoriented belief system of the environmental movement (Mol, 1999). In elaborating on these changes in policies and discourses Huber (1985), Spaargaren and Mol (1991), Weale (1992), and Hajer (1996) suggested that economic and environmental goals are increasingly perceived as being no longer in principle contradictory or

antagonistic within a framework of industrialized modernity. The zero-sum game perception of environment versus economic growth was replaced by a perspective of the possible harmonization of industry with ecology (Andersen and Massa, 2000). Hence a modernization along ecological lines became possible: ecological modernization. Initially, this notion became especially popular and was developed in a limited number of Northwestern European countries, especially Germany, the Netherlands and the United Kingdom. The socio-political, economic and cultural conditions in this geographical area played an important role as the empirical foundation on which this theory has been developed (Mol, 1995).

Parallel to the development of this theory, ecological modernization was also put into practice. As Jänicke (1988) stated, the strategy of ecological modernization aims for the improvement of both ecological and economic efficiency. The policy concept of ecological modernization was developed during the 'optimistic' period of environmental policy-making in the 1980s, in response to the failures of the old pollution control policies of the 1960s and 1970s. It was recognized as a promising policy alternative, and with the global endorsement of the Brundland report 'Our Common Future' and the general acceptance of Agenda 21 at the United Nations Conference on Environmental and Development held at Rio de Janeiro in June 1992, it can now be said to be the dominant approach in political and policy debates and practices on ecological affairs in at least the developed countries.

The Ecological Modernization Theory was first developed through the work of the German social scientists Joseph Huber (1985) and Martin Jänicke (1984, 1988), who used it to refer to a more foresighted and preventive type of environmental policy and reform. Subsequently, many scientists contributed to the further development and maturation of the Ecological Modernization Theory. These include Udo Simonis (1989) from Germany; Arthur Mol (1995), Maarten Hajer (1995), and Gert Spaargaren (1997) from the Netherlands; Albert Weale (1992), and Joseph Murphy and Andy Gouldson (1995) from UK, followed by various scholars from Scandinavian and North American countries (see the various overviews of Ecological Modernization: Mol and Spaargaren, 2000; Sonnenfeld and Mol, 2002). Joseph Huber (1982, 1984, 1985, 1991) began to promote the idea that environmental problems could be addressed through super-industrialization, which involved addressing environmental problems primarily through the transformation of production via the development and application of more sophisticated technologies and the use of the market. In summarizing the development of Ecological Modernization ideas, Sonnenfeld and Mol (2002) distinguished three stages or periods in the maturation of ecological modernization theory. In the first period, Ecological Modernization contributions emphasized on the role of technological innovations, the contribution of market actors and market dynamics in environmental reforms, while there was a relatively under-developed notion of human agency.

During the second period, from the late 1980s onwards, Ecological Modernization Theory turned its attention more to the institutional and cultural dynamics of environmental reforms with a less prominent role for technological innovation as the central motor and axis around which ecology inspired transformations emerged (Spaargaren and Mol, 1992; Hajer, 1995; Cohen, 1997). At the same time a more balanced view of the role of state and market dynamics in ecological transformation processes was emphasized (Weale, 1992; Jänicke, 1991). In this second period, Ecological Modernization scholars also started to pay more attention to consumption processes, next to the emphasis on (industrial) production (Spaargaren, 1997; Mol, 2000). The emphasis on national and comparative studies of industrial production in the Organization for Economic Cooperation and Development (OECD) countries remained during this second period. The third period of ecological modernization studies, from mid 1990s onwards, focused more on global processes of environmental reform and expanded studies in non-European countries, such as Kenya (Frijns et al., 1997), Asian industrializing economies (Sonnenfeld, 2000; Frijns et al., 2000; Phuong, 2002; Dieu, 2003; Zhang, 2002; and Liu, 2005). The present study is very much in line with these latter studies, and is thus a typical product of this third generation of ecological modernization studies.

2.2.2 Core features

Thus, Ecological Modernization Theory started with an emphasis on technology and a criticism of conventional models of regulation, and argued for a stronger involvement of economic actors and institutions, as well as public participation in solving environmental problems. The concept of ecological modernization implies that it is possible, through the development and implementation of new and integrated technologies, to reduce the consumption of raw materials, as well as the emissions of various pollutants, while at the same time creating innovative and competitive products. But such a development takes place through a specific institutional setting where various actors are involved. The core of Ecological Modernization Theory is especially focused on understanding these specific institutional settings and actor constellations that assist in the transformation of production and consumption processes. As such Ecological Modernization Theory focuses on the role of the nation-state and other political actors and arrangements, economic agents and market mechanism, and social actors and institutions in ecological reforms. To be more precise, Mol and colleagues have classified the socio-ecological transformations that fall under the banner of ecological modernization into five clusters (Mol, 1995; Mol and Sonnenfeld, 2000; Mol, 2001).

1. *The changing role of science and technology in environmental deterioration and reform*: science and technology are not only causes of environmental problems as was the central idea in the 1970s, but also valuable and potential sources of solutions, despite an apparent growing uncertainty of expert knowledge.
2. *The increasing importance of economic and market dynamics and economic agents:* economic agents, such as producers, customers, consumers, credit institutions, insurance companies, etc., are not just the disruptive forces that bring about ecological degradation, as has been so strongly emphasized in neo-Marxist contributions to environmental sociology. They are also increasingly turning into social carriers of environmental reform, depending on the specific setting and context. These results in changing state-market relations in ecological restructuring and reform, disrupting the simple dichotomy of the state taking care of public goods, while the economic and market actors and arrangements are the principle causal factors of environmental degradation.
3. *The changing role of the state in environmental reform:* The conventional model of a dirigistic nation-state as a monopoly making and implementing environmental policy in a top-down fashion is no longer applicable. First, a shift has taken place from top-down and centralized policy-making toward more decentralized, flexible and consensual styles of governance. Second, the conventional monopoly position of the nation-state in environmental policy and politics is submerged by an increasing involvement of non-state actors in environmental governance and the emergence of sub-political arrangements. Third, supra-national institutions, regimes and arrangements, also beyond the political arena, increasingly condition, frame and limit the role of nation-states in environmental reform.
4. *Modifications in the position, role and ideology of social movements, most notably the environmental movement, in the process of ecological transformation:* The environmental movement is no longer located only at the periphery or outside environmental decision-making centers and institutions, as was the prevailing in the 1970s and 1980s in OECD countries. Instead, social movements are increasingly becoming directly involved in decision-making processes within the state and, to a lesser extent, the market, using their strategic resources, among which legitimacy, political consumerism, information advantages and reputational capital. This goes together with internal debates with environmental – and other – non-governmental organizations and movements and with dualistic strategies of cooperation and conflict.
5. *Changing discursive practices and the emergence of new ideologies in political and societal arenas:* The conventional notion of limits to growth

and antagonistic positions of economy and ecology have been replaced by the concept of sustainable development as the common and widely accepted denominator in environmental discourses. Neither complete neglect of the environment, nor the fundamental counter-positioning of economic and environmental interests are accepted as legitimate positions.

2.2.3. Variations of ecological modernization

The above transformations are seen as the central dynamics to understand the emerging contemporary processes of environmental reform. Some scholars see or use them also as guidelines for designing the best and most effective environmental reform models for the future, and thus have a more normative conceptualization of ecological modernization. Consequently, ecological modernization is used i) as a theoretical concept to analyze and understand the changes in the central institutions in modern society that are taking place in modern society's effort to solve the ecological crisis, and ii) to describe and develop a more pragmatic political program to redirect environmental governance in order to make it fit for contemporary environmental challenges (Gibbs, 2000).

In debating the main value of ecological modernization, Hajer (1995) distinguished a reflexive and a technocratic ecological modernization. The strong point of ecological modernization is to be found in reflexive variants, where political and economic developments are redirected along ecological lines on the basis of critical self-awareness involving public scrutiny and democratic control. The weak, technocratic versions of ecological modernization involve the support and incorporation of capitalist economics which constantly threaten the ecological sustenance base. Such naïve optimist versions of ecological modernization emphasize science and technology to solve environmental problems, without profound consideration of the role of civil society, citizen consumers and participative political institutions, according to Hajer. More or less along similar lines, Chrisoff (1996) has distinguished a weak and strong version of EMT, as summarized in Table 2.1.

Table 2.1 Characteristics of weak and strong versions of Ecological Modernization Theory

Weak	Strong
Technological solutions to environmental problems	Broad changes to the institutional and economic structure of society, incorporating ecological concerns
Technocratic/corporatist styles of policy making by scientific, economic and political elite	Made in an open and democratic way with participation and involvement
Restricted to developed nations who use EMT to consolidate their global economic advantages	Concerned with the international dimension of the environment and development
Imposes a single, closed-ended framework on political and economic development	A more open-ended approach with no single view, but multiple possibilities with ecological modernization providing orientation

Source: Gibbs, 2000. (cf. Christoff, 1996.)

These debates on the meaning and value of ecological modernization have resulted in variations of ecological modernization, but all these variations still have the core features as introduced above. Different scholars emphasize different features, give slightly different interpretations or undertheorize some of the five core features, leading to the variations and debates. But all these interpretations still fall under one banner, are clearly distinct from post-modern, neo-Marxist, demodernization or social-constructivist theories and as such can indeed still be labeled one school of thought.

Various empirical studies in the ecological modernization tradition have shown that Ecological Modernization Theory is a theory on a too aggregated level to directly operationalize for empirical investigations. Most of these empirical studies (e.g. Dieu, 2003; Zhang, 2002, Hotta, 2004) have developed an intermediate theory or conceptual model to operationalize the general ideas of ecological modernization into an applicable conceptual model that directly guides empirical research. In the next section, I will develop such an intermediate theory or model, labeled quartet-network model, in order to investigate how SMEs in the agro-industrial sector of Northern Thailand are becoming more environmentally friendly.

2.3 Network Analyses: Towards a 'Quartet-network' Model

The sustainability of small and medium-sized companies in the food processing industry depends on many interrelated economic, political and social institutions and actors. The role of these institutions and actors, including their structural

embeddedness, need to be examined to understand how actors, institutions and structures limit, condition and enable the greening of firms. To systematically analyze this complex relationship between SMEs and their social environment, we need an analytical tool to guide, frame and focus on existing interactions and relations between actors within and outside the industrial system, as well as the institutions that govern and structure these relations and interactions. For studying the complex interference of various actors have on the environmental performance of SMEs, network analysis seems to be an appropriate approach and tool. As Van Koppen and Mol (2002) stated, network models have the advantage of combining both the structural properties of institutions and the interactions between actors constructing a network. Networks can be characterized as social systems in which actors engage in more or less permanent, institutionalized interactions. With respect to the characteristics of network approaches, it is useful to apply a network perspective in this study on the sustainability of the food processing industry, as it involves complex relationships and interactions among institutions and actors.

A network is a set of actors connected by a set of ties. The actors can be persons, groups, organizations, etc. Ties connect pairs of actors and can be directed (i.e., potentially one-directional) or undirected (as in being physically proximate) and can be dichotomous (present or absent) or valued (measured on a scale). A set of ties of a given type constitutes a specific social relation, and thus defines a different network (e.g. the friendship network is distinct from the advice network), although empirically they might be correlated (Borgatti and Foster, 2003). Network analysis is the study of social relations among a set of actors to search how the social structure of relationships around a person, group, or organization affects beliefs or behaviors (Roger, 1986). Network analysis is a method of collecting and analyzing data from multiple individuals or organizations that may interact with one another and it allows for the examination and comparison of relationships between two organizations, among clusters or cliques of organizations, and among all organizations within the network (Provan et al, 2005). Network researchers have developed a set of distinctive theoretical perspectives that help to understand these relations (Borgatti, 2000). Actors and their actions are viewed as interdependent, and relational ties (linkages) between actors are channels for the transfer of resources (either material or non-material) between actors. Network models view the network structural environment as providing opportunities for or placing constraints on individual actions. Network models conceptualize structures (social, economic, political, and so forth) as lasting patterns of relations among actors. The unit of analysis in network analysis is not the individual, but an entity consisting of a collection of individuals and the linkages among them. Network methods, which focus on dyads (two actors and their ties), triads (three actors and their ties), larger systems (subgroups of actors), or entire networks (Wasserman and Faust, 1994), are applied to analyze and explain all relationships in the model. Network studies analyze the ordered arrangements of

relations that are contingent upon exchange among members of social systems. They map these structures, describe their patterns and seek to uncover the effects of these patterns on the behavior of the individual members of these structures – whether individuals, groups, or organizations – by examining relations between social actors (Wellman and Berkowitz, 1988).

There are many studies and a wide literature on network analysis, to which various disciplines have contributed, such as social psychology, anthropology, economics, sociology, business administration and management, and political and policy sciences (Howell, 1988; Wellman, Carrington, and Hall, 1988; White, 1988; Owen, 1995; Bryson and Daniels, 1998; Jost and Jacob, 2004; Kiong and Kee, 2005; Provan et al, 2005; Warner and Pratt, 2005). In some respects, network analysis is a fundamental intellectual tool for the study of social structures, which can be represented as sets of social system members (nodes) and sets of ties depicting their interconnections (Wellman and Berkowitz, 1988). For example, Cooke and Morgan (1993) use a network paradigm to analyze the nature and extent of networking activity within and between firms, and pay attention to network relations between firms and the public or quasi-public intermediary agencies, with a special focus on small and medium-sized firms. Network approaches also play a prominent role in policy management studies around the world. For example, Warner and Pratt (2005) used a neural-network approach to examine the role of state policy on local revenue generation under decentralization tendencies in the Mid Atlantic and East North Central region of the United States in the late 1980s. Network models, within the political and policy sciences, have emerged strongly in academics since the late 1980s and have more recently become popular for analyzing globalization processes through transnational networks (e.g. Bulkeley et al., 2003). Eichstädt et al. (1999) used policy network analysis to examine what factors influence the modern environmental governance, in addition to the environmental and economic efficiency, of the German packaging policy. Network analysis is also used to identify the ways in which weak and strong ties either enable or constrain opportunities for SMEs to access the knowledge and expertise available both from private sector business-service companies and from state agencies (Bryson and Daniels, 1998).

Among the studies making use of network models, there are a number that can be placed in the ecological modernization tradition. Several studies on socio-environmental changes in industrial systems have been applying network models to analyze, understand and interpret the environment-informed social and institutional changes of industrial systems. The classical study has been that of Mol (1995), in which he operationalizes ecological modernization theory via network models for the study of environment-induced transformations in the European Chemical industry. More recently, similar studies have been carried out in less developed and developing countries (cf. Vliet and Frijns, 1995; Frijns et al., 1998; Phuong, 2002; Zhang, 2002;

Dieu, 2003; and Chavalparit, 2006). The triad-network analysis that is applied in most of these studies is a more theory-based conceptualization for analyzing the interactions between industrial systems and their institutional environment. This triad-network model consists of a policy network, an industrial network, and a societal network, which are practically closely interacting and interrelated, but can be conceptually distinguished. In building our network model I will strongly rely on the triad network model, but add to it for the specific purpose of this study. I will start by elaborating on the concepts of economic, policy and societal networks.

2.3.1 Economic network

The concept of economic networks, or so-called industrial networks, was primarily developed from marketing, industrial policy and business strategy studies and turned to more sociological analyses of industrial networks later on. In recent studies, economic network studies have focused on stability and the transformation of such networks when confronted with the ecological crisis. It is especially here that relation with ecological modernization theory become prevalent. Mol (1995) identified the 'economization of ecology' as central to ecological modernization theory, pointing to the introduction of economic concepts, actors, institutions, mechanisms, and principles in environmental reform processes. The main emphasis with ecological modernization was the placing of an economic value on nature and encouraging economic actors to take the environment into consideration. To identify and analyze these new economic dynamics in environmental reforms, economic network studies were given a central place in Mol's study on 'The Refinement of Production: Ecological Modernization Theory and the Chemical Industry' (Mol, 1995).

Economic networks consist of interacting economic organizations, which have economic goals as their principal motive for interactions and which are structured via predominantly economic and market rules and resources. Thus, such economic network analyses focus on the economic interactions via economic rules and resources between economic agents in and around industrial parks, industrial chains, industrial sectors or industrial systems. The formal and informal economic rules (those of the market, of ownership, of patents, of liability, of trust, of negotiations, and of cooperation) and the economic resources (raw materials, scientific and technical knowledge, financial means, power, information, access to networks or relationships) are investigated and interpreted to analyze and understand the functioning of economic networks in relation to environmental challenges and reforms.

Economic or industrial networks consist of three types of relations: vertical, horizontal, and neither vertical nor horizontal (Mol, 1995). So economic network studies analyze; i) the relationships between firms in a product chain by looking at

the vertical interactions from input suppliers to producers and final consumers; ii) the relationships between competing firms in the same sector and interaction among others via branch organizations; iii) the interactions between firms and other economic agents (i.e. banks, insurance companies, and infrastructure companies) and research institutes and; iv) regional relations and interactions in restricted geographical areas (Dieu, 2003).

The small and medium-scale companies in the food processing industry, which are the central focus of study in the economic network analyses of this research (see Chapter 5, 6 and 7), are also – to a greater or lesser extent - engaged in these types of relations. Hence we will use such an operationalization of economic networks to analyze how and to what extent economic actors, institutions and interactions enable, encourage, restrain or structure environmental reforms in small and medium-sized companies in the food industry in Northern Thailand.

2.3.2 Policy network

The policy network concept is used for describing and analyzing the relations between public and other public actors, or between public and private actors, in specific policy areas. The classical study on policy networks is that of Rhodes (1986). Following Rhodes, numerous scholars have applied and further developed the idea and framework of policy network studies. Policy network is an outcome of close cohesive relationships between a small number of actors (Owen, 1995). Policy networks are generally seen as a cluster of public and private actors connected to each other through dependency on certain resources, such as information, expertise, money and legitimacy. Within the context of industrial transformations made in response to environmental concerns, such policy network studies focus on government-industry relations from a political-administrative point of view, where policy incentives and arrangements support and/or regulate industrial sectors (Mol, 1995). They examine, amongst other things, the main policy processes and dynamics, the institutionalized interaction patterns and power relations, the division of task labor among government agencies, the role of intermediary organizations, and the emergence and functioning of innovative private-public partnership constructions.

The relations between industrial companies and local and central environmental management agencies and authorities in policy networks are analyzed to understand the functioning (dynamic) of the network in environmental transformation processes. Usually, such analyses follow four dimensions:

i) The rules of the game: A distinction is usually made between formal or legal rules on the one hand, and informal, unofficial rules of the game on the other. Together these rules make up the unwritten constitution that guides the behavior of the actors

and influences the strategic deployment of their resources. Sometimes 5 rules are identified in contemporary industrial policy networks (Wilks and Wright, 1987b): i) mutuality (acceptance and expectation of mutual advantages and benefits from participation in networks), ii) expectation of consultation and respect of confidence, iii) emphasis on informality, iv) articulation of policy issues in an acceptable mode and language, and v) the use of legal remedy and the legitimization of state action.

ii) The resources used: The analysis of resources used by different actors within the network focuses attention on the distribution and use of legal resources (authority), economic and financial resources and information resources, such as information on investment plans, technical information, knowledge of production processes, information on emissions and resource use, etc. Legislation related to the environment includes relevant laws, regulations, circulars, decrees, guidelines, standards, etc. which can should and sometimes have influence environmental innovation in firms and industrial systems.

iii) The strategies: Generally, four general strategies are distinguished in policy network studies (cf. Grant et al., 1988): i) insulation (keeping government out of its affairs or minimizing governmental intervention), ii) penetration (using government consciously and successfully to protect company interests; or otherwise, the penetration of the government into industrial businesses), iii) mutual adaptation (cooperation between the government and industry), and iv) interorganizational concertation (cooperation between different organizations based on a mutual understanding of each other's interests).

iv) The appreciative systems: This dimension concerns the worldview that is dominant among the actors in the policy network. The dominant worldview limits the legitimate solutions by identifying some of the proposed solutions as too extreme or demonstrating a lack of knowledge. The appreciative system can consist of elements such as: the science-based nature of the sector (technological, production oriented skills, as opposed to marketing skill), ii) an outlook shaped by expansion or consolidation, iii) a more domestic or a more international orientation and perspective. Such appreciative systems structure the kind of environmental reform potentials that are discussed and put forward in the policy network.

Policy networks are thus means of categorising the relationships that exist between interest groups and the government. It is also an approach to analyse policy incentives and arrangements in supporting or regulating industrial SMEs deal with environmental challenges. With policy networks analysis, the following three questions need to be asked: What is the nature of this relationship between government and industry? What kind of resources are used by which actors in furthering environmental or economic interests? Which rules structure the interaction

patterns between the actors in these networks? In analyzing the policy networks these SMEs in the food industry are engaged in, we identify the relevant actors and institutions, including their positions, strategies, resources and interactions, which co-determine environmental performance and outcomes.

2.3.3 Societal network

Within the context of environmental pollution and reform, societal networks analysis examines interactions between industry and civil society that are related to different external effects of the various production processes and products. Civil society consists of local communities, local and national social organizations, and the various institutions that govern and express interests and concerns of civil society (such as the media). Both direct relations between industrial systems and civil society, and indirect, or state-mediated relations are examined and identified.

Social network studies try to analyze the nature of these relationships, for example, the interdependencies between the actors, the resources being used in interaction patterns and the mechanisms at work (Dieu, 2003). Resources that are used in the networks relate to scientific information on the ecological consequences of industrial production processes and products, the dissemination of ideas and interests via the media to generate support among the general public, and the mobilization of state intervention. Environmental NGOs and interest groups are usually seen as the key civil society actors in societal networks of western industrialized societies and a rich literature on new social movements has developed from the 1970s onwards. Interaction patterns between these environmental NGOs and industries can be categorized in the following way:

- Direct interactions, such as (ir)regular communications, negotiations, product campaigns, protests at company headquarters.
- Indirect interaction via state agencies, such as involvement in the formation and implementation of environmental policies towards industries; independent monitoring and control activities to support the enforcement of regulations; demands, requirements and pressure from environmental organizations for state action.
- Interactions aimed at the construction of general public awareness about the industry's environmental performance.

While in the US, Europe and other industrialized countries, societal network studies often focus on environmental NGOs as key actors in social network analyses, this is not always useful in developing and industrializing societies. In countries such as Thailand, no strong environmental NGOs exist, and societal network studies have a different orientation and emphasize different key actors in civil society. Phuong

(2002) and Dieu (2003) are interesting examples of how societal network analyses are used when studying industrial transformations made in response to environmental concerns in Vietnam. Both studies focus not so much on environmental NGOs but rather on local communities, mass media, women's associations, and the youth union.

2.3.4 Family/Informal network

The triad-network model has proven its usefulness for understanding the interactions and institutions involved in industrial transformations, especially with respect to environmental challenges. However, the environmental performance of SMEs in Thailand cannot be fully understood by focusing only on the more formal economic, policy and societal networks. The informal relations and family connections are also crucial to the understanding of how the external social environment influences decision-making within small companies. Fulop and Richards (2003) have argued that cultural differences between nations may have a significant influence on how SME operations are structured. In Western countries, business networks, including SMEs, have been mainly formed through interventions of third parties, such as industrial associations, industry development boards or governments, or through a combination of these agents. By contrast, in most East and Southeast Asian countries, business networks have developed more organically and have not been formed so strongly by deliberate involvement from outside agencies. This is even more valid for SMEs in these countries. Compared to Western countries, SME networks in Asia are constructed more through personal relations than formal contracts: 'the relationship comes before the contract' (Hampden-Turner and Trompenaars, 1997). Various studies of overseas Chinese firms indicated the strong role and importance of family businesses, linked into '*informal networks'* that are not so much influenced and structured by governments or formal economic institutions, but rather by a complex system of kinship and extended family ties. Therefore, for studying SMEs in developing Asian economies I have introduced the '*family/informal network'* to complement the triad network model, in order to enrich our conceptual framework and our understanding of how the social environment structures the development of the food processing industry.

The concept of family/informal network originated from the concept of *guanxi*[2]. The notion of *guanxi* increased in the aftermath of the Cultural Revolution in China.

[2] Guanxi, by its definition, is a kind of personal possession: an asset owned by an individual and working only at personal level. In the process of personal interactions, one individual asks for a favor from another individual and they are engaged in the personal exchange and bond by mutual obligations (Fan, 2002). It could refer to one of three things: i) the existence of a relationship between people who share a group status or who are related to a common person, ii) actual connections with and frequent contact between people, and iii) a contact person with little direct interaction (Bian, 1994).

Guanxi is a Chinese term referring to interpersonal connections and cultural factors which structure and affect important parts of social life in China, including business. It is believed that *guanxi* formed – and still forms – a vital factor in business operations in China, and could bring a wide range of benefits: securing rare resources, bypassing or short-cutting the bureaucratic maze, obtaining information or privileges, selling otherwise unsaleable goods, providing insurance, and giving assistance when any problems arise (Fan, 2002). Most authors accept the idea that *guanxi* is a kind of *special relationship*. There is an area of guanxixue's association in public discourse, referring to the gray area between proper and improper behavior, and to getting around rules and regulations. It is then easily conflated with corruption and bribery, whose instances have increased in the reform period. Some sociologists suggest that *guanxi* practices may decline in some social domains now that China is modernizing, but find new areas to flourish, such as in business transactions, and display new social forms and expressions. It is then not only used in the form of personal relationships, but it can be used to refer to connections, exchanges, and resources to acquire an end product (Fan, 2002). Since the bulk of China's industrial-commercial order is made up of SMEs positioned at lower administrative levels in cities or in the dynamic small towns and rural localities, *guanxi* can be a useful tool when dealing with legal issues (monitoring regulations, for example). Similarly, Ledenova (1998), a Russian sociologist based in London, has given a most descriptive analysis of how *blat*, or the Russian economy of favors, personal networks and reciprocity, operated in both the Soviet and post-Soviet periods. She found that while *blat* was no longer used to obtain commodities for personal consumption, its sphere of influence and operation had moved to businesses. Here blat, which could be described as being similar to corruption, refers to how businesses deal with authorities in charge of taxes, customs, banking and regional administrations.

The term 'Family networks', sometimes also referred to as 'informal networks' or 'organic networks', refers to a set of informal ties among a group of actors. The notion has been developed based on the collectivist culture of the overseas Chinese in Southeast Asia that run their family businesses with typical characteristics: long-lived relationships, collectivist loyalty and effective communications between family members, loyalty and cohesion of inside family members, and the family and patronage loyalties determine family relationships (Mead and Liedholm, 1998). In these networks, relational personalism, interpersonal relationships or informal relationships with 'insiders' are utilized to develop business (Fulop and Richards, 2003), often complementing other networks. In that sense, Chinese capitalism is qualitatively different from Western capitalism; it emerges from a Chinese cultural tradition of small family firms based on paternal authority and personal trust rather than a legal system, and interpersonal and kinship relations are of greater importance than individual rights. As Tong (2005) argues, the unique characteristics of Chinese

family firms[3] are the centrality of decision-making (within the leadership of the family), personalism and paternalism[4], and the emphasis on *guanxi* relations. All of these characteristics value the informal over the formal. Tsang (1998) classifies a *guanxi*-based relationship as one that has one or more of the following three characteristics; i) relationship by birth or blood: family, kinships, and in-laws; ii) relationship by nature: locality (from the same town or province), classmate or alumni, teacher-student, co-worker (colleague, superior or subordinate), neighbor, in the same profession; and iii) relationship acquired: acquaintance, knowing the same person (intermediary), friend, and sworn brotherhood. The first group of *blood based ties* is largely predetermined. The second and third categories are *socially based.* Positions of trust within the firm and its network are given to close relatives, and jobs that require the handling of money are assigned to those closes in kinship. Ownership of the business is effectively passed on to family members, thus restricting the entry of outsiders into the inner circle. The interpersonal trustworthiness is of the utmost importance, and they prefer to deal with those whom they are familiar with (Tong, 2005).

The typical overseas Chinese small family firm has a simple structure and an ephemeral nature, whereas the personal networks between firms and their suppliers and buyers often outlast the existence of individual firms as firms open and close, merge or change their operations, with the help of a stable enduring network (Hamilton, 1990; Redding, 1993). This form of Chinese *guanxi* capitalism, with small flexible firms based on personal networks that provide access to new markets and supplies, share several characteristics with rural businesses in Thailand. These kinds of informal relationships are found in Thai society, partly because the overseas Chinese have co-determined and co-structured the Thai economy for more than four decades. One of the major benefits that guanxi is believed to offer is that through it companies can obtain better and quicker information on government policies, market trends and business opportunities. Another benefit widely cited is that the *guanxi* networks improve economic efficiency for small firms by reducing transaction costs (Davies et al., 1995). These benefits are obtained via personal relationships between two parties, business person to business person (B2B) or business person to government official (B2G), in which exchanges sometimes take place as informal, complicated, multiple processes involving more than two parties. The interesting point related to this study is that informal B2G relationships represent a way to bypass laws and regulations through personal connections with government officials, to obtain special treatment or scarce resources from the government, or to put moral

[3] Chinese family firms are generally characterized by three features: personalism, paternalism and centralized authority structures, and business relationships tend to be highly personalized, built on personal trust, and with personal control of the enterprise (Tong, 2005).

[4] Paternalism means that decision-making is thus highly centralized with a minimum degree of delegation of authority and responsibility (Ibid: 48).

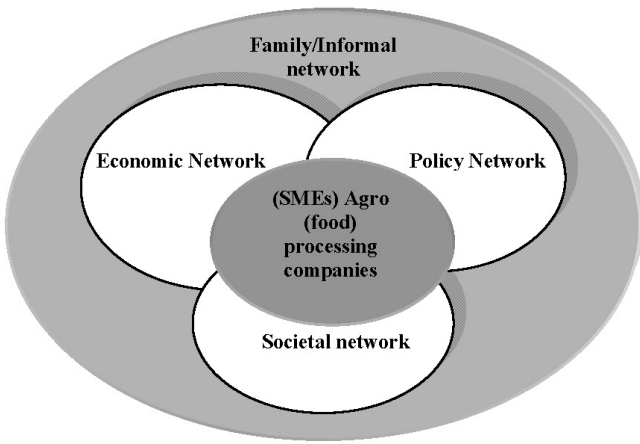
pressure on small enterprises from closely connected government officials, all potentially affecting environmental performance. Informal B2B relations may facilitate off-site recycling, help implement product requirements and standards in business to business exchanges, facilitate information exchange in economic chains on environmental issues, or create solidarity and thus facilitate joint and common solutions to environmental problems.

Guanxi principles and informal/family networks can thus result in or contribute to corruption and other negative consequences, but may also have a positive impact on civil society and further the implementation of environmental policies and better cooperation between firms on environmental issues. Informal/family networks thus need our attention as a potential factor when dealing with environmental protection, especially when small and medium-sized companies linked to rural production are considered. Consequently, from this point of view the triad-network model will be complemented with an informal or family network, to be turned into a *'quartet-network'*.

2.3.5 Analytical framework: a quartet-network model

The quartet-network model, as presented in Figure 2.1, is a conceptual model for analyzing the extent to which the ecological perspectives and interests penetrate and transform the social practices in small and medium-sized firms. With three of the four interdependent networks, constitute a combination of a specific analytical perspective in distinction of institutional arrangements and a restricted number of interacting actors, which are considered to be most important regarding that perspective. Within the 'economic network', economic interactions related to economic rules and resources between economic agents in and around the agro-food SME sector are emphasized. The 'policy network' focuses on interactions between and institutions involving state organizations and industry, where specific policy and political rules and resources are exchanged. The 'societal network' emphasizes on identifying relations between the economic sector and civil society organizations, both directly and indirectly via state agencies or authorities. The 'family/informal network' takes a specific position in this quartet-network model in that it is not characterized by a specific group of actors or analytical perspective, but rather aims at identifying the 'hidden' informal relations within the industrial sector with actors from the other networks. The quartet-network model is applied in the analyses of case studies in the food processing industry to understand how interactions and institutions outside these SMEs encourage or hinder environmental reforms of this sector.

Figure 2.1 An analytical model of the 'Quartet-Network'



2.4 Research Methodology and Methods

2.4.1 Research methodology

As stated earlier, small and medium-sized companies contribute to the current environmental problems Thailand faces. If we are to understand which actors, institutions, and social structures govern the function and development of SMEs in the food industry, how they do that, and how and why these actors and institutions influence the environmental performance of these firms, we need a qualitative research design. Qualitative case study research is used as the most appropriate strategy in this investigation, as it forms an empirical methodology to investigate events with unclear boundaries between the event and the context, for which several information sources are used (Yin, 1984). Case study research is done via a detailed and in-depth investigation of a small number of food processing enterprises, to understand how the social environment of these SMEs structure and 'determine' the (non)activities and strategies of these firms on waste prevention and management, environmental technology investment, and on-site and off-site recycling. Thus, we are less interested in how often SMEs are involved in environmentally friendly production activities (which would rather involve a quantitative survey among a large

groups of SMEs in the food industry), but rather in questions of how and why they are – or are not – involved in these environmental practices.

In order to gather data related to the objectives and research questions, this research has been carried out in a systematic way: First, an extensive review of the literature on the food processing industry was collected, and then supplemented by interviews with experts in the relevant research and governmental institutes. This allowed us to identify the most important environmental problems related to the production practices of food processing industrial firms. The second step consisted in collecting data from the case study enterprises by investigating the following items related to environmental problems and performance: production processes; relations and interactions of the case study companies with external actors and stakeholders; identification and investigation of the institutions and structures that made up the industrial network, the policy network and the societal network.

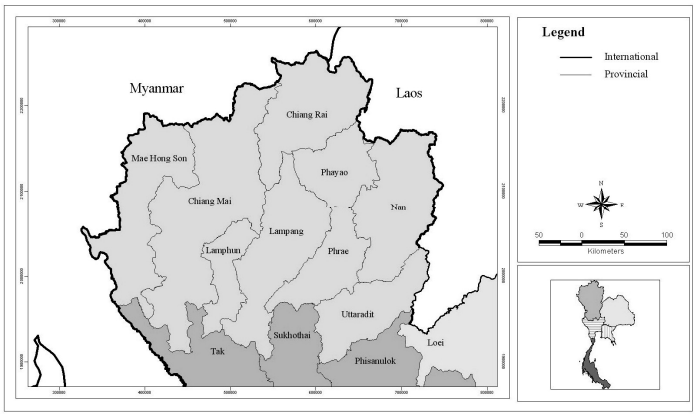
Third, after all the data had been collected I analyzed the data. The companies in the case study were analyzed using the 'quartet-network' model. This helped generate ideas for designing new environmental management, policy and reform options. Moreover, through a comparative analysis the various case studies are compared, both within and across sub-sectors of the food industry.

2.4.2 Case study selection and data collection

Small-sized enterprises in Thailand are – following the international standard – defined as small enterprises that employ less than 50 employees, use simple manufacturing methods and investment less than 10 million Bahts[5]. Medium-sized industries employ 51-100 employees and have between 10 and 100 million Bahts invested in them. Among these enterprises, this research focused on agro-food manufacturing enterprises that employ less than 100 employees, have impacts on the environment, especially pollution of air and water and production of (in)organic waste, and which use up natural resources.

[5] The exchange rate in 2003 was 47 Thai Baht to the Euro. This value is used for all the calculations in this chapter.

Map 2 The upper north of Thailand



Source Geo-informatics and Space Technology Center (Northern Region), Thailand.

As mentioned earlier, the manufacturing sector has contributed significantly to the growth of Thailand's industrial sector as well as making up a large share of the country's GDP. In the manufacturing sector, the agro-industrial sub-sector produces a high value added (Table 1.2 and 1.3). Moreover, out of the total number of SMEs in Thailand (Figure 1.3) upper Northern Thailand has a significant number of food processing factories. SMEs in the food industry from Northern Thailand contribute significantly to both economic development and impacts on the environment. Therefore, for this case study, a limited number of companies were selected from the SMEs in the food processing industry from Northern Thailand. The companies had to satisfy the following criteria:

- The companies should be situated in upper northern Thailand;
- They are representative of small or medium-sized companies in the food processing industry;
- Their production processes should potentially cause environmental problems;
- They have a potential to contribute to economic growth, among which exporting;
- There should be some difference between the case studies to make comparison possible, such as differences in product, manufacturing processes, location etc.;
- Willingness of the companies to share their experiences.

According to official statistics, Upper Northern Thailand has a total of 323 small and medium-sized companies in the agro-food processing industry. There are different kinds of sub-sectors within the agro-food industry, producing fruit-based products, vegetable-based products, and animal products. However, within the criteria mentioned above, the three sub-sectors of the agro-food industry, namely the fruit and vegetable, meat, and beverage producers are representative of the agro-food sector. From these three groups, between three and five enterprises per group were selected from total number of them to be case studies.

Primary data collection: In order to collect data, I conducted in-depth interviews with individuals and representatives of relevant organizations. Questionnaires were developed using the analytical model introduced above. Field observations, site visits at industries, participatory observations in policy-making and implementation practices, and gray literature complemented the data from the interviews. In this research, the primary data were collected from the case studies. These consist of two groups of data: i) socio-economic, geographical and environmental data to understand the economic structure and nature of the firms and to identify the impacts they have on the environment, and ii) data with respect to actors and institutional frameworks involved in food processing. To gather all the data, direct interviews and questionnaires were conducted, and these were supplemented by information on the companies' production processes. The in-depth interviews with respect to the role and practices of current actors participating in the four networks were collected by semi-structured and open-ended interviews with selected key individuals[6]: company owners, enterprise managers and employees, government officials, representatives of local communities, representatives of industrial organizations, etc. A detailed list of interviewees is included as appendix 1.

Secondary data collection: All secondary data, such as annual environmental booklets and reports, scientific reports on relevant issues, and environmental programs related to food processing, were collected from relevant governmental and private agencies. These data provided insight into the socio-economical, political, environmental, and technological profiles of the sites studied.

[6] The real names of the selected enterprises and of the interviewees have been kept confidential.

Chapter 3

Small and Medium-sized Agro-industry and Environment

The growing awareness of environmental deterioration has led to calls, both national and international, for businesses to take up the 'green challenge'. So how should we best promote environmental awareness and environmentally sound actions to businesses? This chapter tries to find a solution, by analyzing environmental policies and waste management approaches, to see which approach is best suited to making SMEs in the agro-industry in Thailand more environmentally friendly. This chapter starts with a definition of SMEs so that we have a clear understanding of their characteristics. Section 3.2 presents the development and current situation of SMEs in the food industry in Thailand. In section 3.3 the environmental impacts of these SMEs' production methods are presented. Section 3.4 looks at environmental and waste management approaches in SMEs in the agro-industry. Then in section 3.5, the future environmental direction of SMEs in the agro-industry in Thailand is assessed.

3.1 Definition of SMEs

In the context of international studies, the term 'SME' refers to private enterprises (both in the manufacturing industry and the service and trade sectors) with fewer than 250 employees. SMEs are generally subdivided into three categories: micro (0-9 employees), small (10-49 employees) and medium-sized (50-249 employees) enterprises. Large enterprises are defined as enterprises that have more than 249 employees. The European Commission (CEC, 1996) defines SMEs as enterprises which i) have fewer than 250 employees, ii) have either: a) an annual turnover not exceeding Euro 40 million, or b) an annual balance-sheet in total not exceeding Euro 27 million, and iii) are independent, i.e. 25 percent or more of the capital or the voting rights is not owned by one other enterprise, or jointly by several enterprises. Micro and small enterprises are those that i) have fewer than 50 employees, ii) have either: a) an annual turnover not exceeding Euro 7 million, or b) an annual balance-sheet in total not exceeding Euro 5 million, and iii) are independent.

In Thailand, different agencies define SMEs in different ways. For example, the Ministry of Labor (MOL) classifies firms into four groups: 1–9, 10–49, 50–299, and more than 300 workers and defines them as micro, small, medium, and large firms, respectively. The National Statistical Office (NSO) classifies the firms into three groups: 10–49, 50–199, and more than 200 workers. The Department of Industry Promotion (DIP) defines medium enterprises as having between 50 and 200 employees and invested capital of between 10 and 100 million bath, and small

enterprises as having no more than 50 workers and having invested capital (equity) not exceeding 10 million bath. The Ministry of Industry (MOInd) classifies the firms into three groups: 1–49, 50–199, and more than 200 workers. The differentiation of these classifications leads to a certain amount of confusion regarding the amount of SMEs in Thailand, and also the number of employees in different categories of SMEs. This study uses data based on MOInd's classification. The description of SMEs according to the regulations of the MOInd issued on September 11, 2002 categorizes SMEs using the number of employees or the value of the total fixed assets (not including land), whichever is the lowest. Business activities can be classified into 4 categories, which are shown in Table 3.1.

Table 3.1 Criteria for the classification of SMEs in Thailand

Industrial Sector	Number of Employees (person)		Fixed assets* (million bath[1])	
	Small-sized	Medium-sized	Small-sized	Medium-sized
Manufacturing	≤ 50	51-200	≤ 50	51-200
Wholesale	≤ 25	26-50	≤ 50	51-100
Retail	≤ 15	16-30	≤ 30	31-60
Service	≤ 50	51-200	≤50	51-200

*Excluding land

Source: Ministry of Industry, 2002.

It is important to bear in mind that SMEs form a very heterogeneous group and that large differences exist among individual companies. Obviously, public policies (e.g. in relation to the environment) directed at SMEs should take this heterogeneity into account. The SME sector is vast. In the whole country, 99.5 percent of the more than 2 million private enterprises are SMEs (OSMEP, 2004). The percentages are similar in countries all over the world and their numbers are set to increase. Most of the cases in this study are classified into groups 1 and 2. Factories in group 1, which are micro-scale firms, do not need to register with MOInd, and so the MOInd does not inspect them regularly. However, if the factories are accused of any wrongdoing, the factories have to prove that they are not the cause of that environmental problem. This implies that in practice they have to comply with environmental regulations. Group 2, the small-sized enterprises, are regularly inspected by MOInd.

[1] The exchange rate in 2005 was approximately 50 Thai Bahts to the Euro. This value is used for all calculations in this chapter.

3.2 SMEs Agro-industry Development in Thailand

Following the 1997 economic crisis, SMEs have been thought of as being central to the development of the Thai economy and society. Although little information is known about their likely contribution to growth potential, the government and the related agencies have referred to SMEs as vital for the country's further economic development. Although SMEs have been considered to be fundamental to industrial development and have been addressed within the strategic development policy since 1977, they didn't receive specific attention until after 1997. The businesses that received particular attention were SMEs in the agro-industry, which remained relatively healthy during and after the economic crisis, when compared to other manufacturing industries. The latter faced stagnant export markets. In 2003, the agro-industry contributed 14.12 percent to the country's total export value, accounted for 13.16 percent of GDP, while relying on domestic resources for 80 percent of all raw material inputs (NFI, 2004). This is why SMEs in the agro-industry have been regarded as being key to dealing with economic crises, and have been promoted in the plans and policies of various government agencies, including the Ministry of Industry (MOInd), the Ministry of Finance (MOF), the Ministry of Commerce (MOC), the Ministry of Agriculture and Cooperatives (MOAC), the Ministry of the Interior (MOI), the Ministry of Science, Technology and the Environment (MOSTE) and the Ministry of Public Health (MOPH). The ultimate goal of these agencies is not just economic, but also to develop a comprehensive environmental policy for sustainable development as mentioned in the National Economic and Social Development Plans (e.g. NESDB, 2004).

3.2.1 Development of SMEs agro-industry

Many studies have demonstrated that the food industry is still an essential part of the Thai economy. Its contribution towards the gross domestic product is as high as 28.3 percent. It has an average annual growth rate of 10.5 percent a year, and value added in this industry makes up 19 percent of the total amount of value added in the industrial sector (NFI, 2004). More than 80 percent of the raw materials used in the food industry are supplied by the domestic market at low prices. This gives the industry a high level of competitiveness. Moreover, the food industry provides a market for domestic agricultural products as well as employment for over 10 million people (MOInd, 2004). Furthermore, the industry has the potential of gaining a large portion of the world market share.

The agro-industrial sector in Thailand has been analyzed and classified by many agencies, such as the Board of Investment (BOI), the Ministry of Labor and Social Welfare (MOL), and the Ministry of Industry (MOInd). These classifications provide data regarding the numbers of factories and employees as well as the amounts

invested. This study uses data based on MOInd's sources, according to which the agro-industry supplies the following products: processed agricultural products, processed animal products (excluding fishery products), milk and dairy products, processed fishery products, vegetable oil and animal fat, various milled crops, processed flour products, sugar and confectionery, tea, coffee, chocolate, candy and ice cream, seasoning and sauces, ice, alcoholic beverages, non-alcoholic beverages and drinking water, and processed fruits and vegetables (MOInd, 2004).

The development of the agro-industry started with the main objective of increasing production for domestic consumption and reducing food imports. The first period began in 1960, with exporting surplus agricultural products, of which 70 percent were foods or preserving technologies like drying, pickling and sugar glazing. Between 1960 and 1970 technologies that had been used in Japan and Taiwan were introduced, and the agro-industry started to process sweetened condensed milk, canned fruits and vegetables, and vegetable oil. This led to an increase in exports of the processed products to the detriment of local consumption in 1970-80, although experience was lacking in the areas of marketing and mass production. During this period, the technologies used in food production were improved to increase product quality so as to satisfy the requirements of international standards and markets. The following decade, 1980-90, was characterized by a rapid growth with the help of technologies brought in from US and Europe. In addition to using advanced production methods, Thailand benefited from having a low-cost labor force, and this opened up new international markets contributing to a growth in the agro-industry. From 1990 onwards, the food industry has been confronted with severe competition in the world market, especially with regard to hygiene, food safety, wholesomeness, production costs, value added, international standards[2], effects on the environment and other regulations. The agro-industrial sector in Thailand therefore has to develop and improve its manufacturing processes so as to meet these challenges and remain competitive in the world market.

The food processing industry, by utilizing farm products such as crops, livestock, or aqua-animals as raw materials, helps increase the economic value of agriculture, generate employment, earn national income, and increase export potential (MOInd, 2000). At present, the technologies used in food processing are: i) thermal processing such as sterilization, pasteurization and canning, ii) freezing, iii) dehydration, iv) fermentation, v) milling, and vi) microwave and irradiation. In sub-sectors that need higher technology, such as individual quick freezing, there is still a need to import the technology from abroad. The increase of SMEs in the agro-industry to more than 20,000 establishments, including rice mills (DIP, 2000), throughout the country

[2] Standard GMP, specific GMP, ISO 9000, ISO 14000, and HACCP are some of the standards that need to be met in the food industry.

provides medium-sized and large companies with primary production sources for further processing and refining. The expansion of SMEs in the agro-industry is the direct result of a policy aimed at solving economic problems at a grass-roots level and strengthening local communities' independence. The Thailand Office of the Board of Investment (BOI) reported that SMEs accounted for 87.99 percent of the national agro-industrial sector in 1997, whereas in 2001 the figure was 94.48 percent (MOInd, 2004). This is a clear indication of the increasing importance of SMEs in industry. As SMEs in the agro-industry rely on domestic resources for raw materials and enjoy continuing support from the government, this industry has growth potential, although this would be reliant on the availability of resources and future government policy.

3.2.2 Governmental policies toward SMEs agro-industrial sector

Due to the food industry's obvious importance, development within the food industry has remained a constant policy objective. The development of the food industry was raised in the 1st National Economic and Social Development Plan (NESDP) (1961-1966), and since then has been addressed in various national trade, financial, agricultural, industrial, health and environmental policies. A National Food Institute, which provides laboratory services, technological services (HACCP), information services and planning and research development, has also been set up. In addition, policies on food safety, science and technology, and SMEs have been introduced to strengthen the agro-industrial sector.

In previous NESDPs, although the agro-industry was mentioned, more emphasis was placed on the growth of other industrial sectors, especially the electronics and computer parts sector, as a result of a drive towards greater industrialization. However, more than 80 percent of the raw materials used in the electronics/computer industry have to be imported, and so the finished products have a very high import content. As a consequence, economic development has been unbalanced and unsustainable. Thus the 9th NESDP (2002-2006) has established a framework and guidelines for the development of the food industry to improve its competitiveness at the national level, at the enterprise level, and at the basic production unit level. Its objectives are to maintain food production levels in Thailand, increase market shares for agricultural products, and to make Thailand a primary location for high-quality processing of agricultural and food products (MOInd, 2004). It was after the 1997 economic crisis that the government focused on SMEs as a key component in the economy's recovery.

The policies of the Thai government for SME development are embodied and articulated in various forms. These include Acts of Parliament, National Economic and Social Development Plans, and Cabinet resolutions. These, in turn, are translated

into strategies and action plans by various ministries, mainly the Ministry of Industry and the Department of Industrial Promotion (DIP). The agro-industry has received significant support from both the public and private sectors. New policies are being formulated to further guide SMEs in the agro-industry. These policies will focus on: i) less government, ii) private sector empowerment, iii) laws and regulations, iv) standardization and simplification, v) massive use of information technology, vi) research and development, vii) environmental consciousness, and viii) internationalization of business facilities (DIP, 2002).

There has been much support, both in the public and private sectors, for the development of SMEs[3]. While the government launched the '*Small and Medium Enterprise Promotion Act 2000*', the Office of Small and Medium Enterprises Promotion (OSMEP) has formulated an action plan called 'Action Plan for the Promotion of Small and Medium Enterprises' to implement policies and plans which promote the further development of SMEs. In formulating the Plan, OSMEP cooperated with public related offices[4], government agencies, and state enterprises, taking into account the outcome of research and development as well as social and economic conditions and necessities. Related public offices, government agencies and state enterprises are responsible for formulating the Plan, which needs to be implemented on both a short term and intermediate to long term basis. Due care has to be taken that the development of SMEs satisfies financial, regulatory[5], marketing, human resource and technological criteria.

Policy support to SMEs focuses on three areas: i) helping promote exports, after upgrading standards to the appropriate levels, ii) assisting those SMEs that seem to have the potential to succeed in today's very competitive market place, and iii) encouraging the use of local resources and local know-how in an appropriate way so as to serve the needs of the market, while integrating SMEs into the local community.

[3] The following agencies support the development of SMEs: the Board of Investment (BOI), the Bank for Agriculture and Agricultural Cooperatives (BAAC), the Export-Import Bank of Thailand (EXIM), the Institute for Small and Medium Enterprises Development (ISMED), SFAC, the Industrial Finance Cooperation of Thailand (IFCT), and the Small Industries' Finance Office (SIFO).

[4] These are non-governmental agencies whose work overlaps with government agencies.

[5] The following authorities monitor SMEs from a regulatory perspective: the Department of Industrial Work (DIW), the Food and Drug Administration (FDA), the Industrial Estate Authority of Thailand (IEAT), and the Pollution Control Department (PCD). The following agencies monitor the human resource and technological side: the National Food Institute (NFI), the Department of Industrial Promotion (DIP), the Thai Industrial Standards Institute (TISI), the Thailand Institute of Scientific and Technological Research (TISTR), the Technology Promotion Institute (TPI), the Department of Skill Development (DSD), the Thailand Productivity Institute (FTPI), the National Center for Genetic Engineering and Biotechnology (BIOTEC), the National Science and Technology Development Agency (NSTDA), and the Department of medical sciences (DMS). For more details, see Chapter 4.

The BOI has designated the agricultural processing business[6] as one of the two business types[7] it will give investment support to (OSMEP, 2004). This support takes the form of exemption from import duties on machinery as well as personal income tax for 8 years. Furthermore, SMEs in the agro-industry can benefit from more general policy support such as the promotion of asset/property capitalization[8], the Financial Institution Development Plan[9], and the promotion of Intellectual Property using the patent system. Since 1999, SMEs' efficiency has been enhanced greatly by the adoption of the Competitiveness Enhancement Scheme - which includes the provision of a Consultancy Fund to arrange consultancy services - the Manufacturing Development of Industry Capacity Project (MDICP)[10], and the Invigorating Thai Business (ITB) project.

However, besides the fact that it has benefited from favorable government policies, the industry has also had to adapt itself in order to manage the changes imposed upon it by globalization, liberalization, and world trade rules and regulations. The major factors that directly influence the success of the food industry are raw materials, labor, capital, technology, and the management of the industry in the areas of capital, product quality and efficiency. Supporting factors include general management procedures, state control and assistance, and the basic infrastructure that is needed for the development of the food industry. External factors, such as rules and regulations, trade barriers, and competition, should be taken into account so that SMEs can grow in the current global climate and contribute to the further development of the Thai food industry.

3.3 Environmental Impacts of SMEs Agro-industrial Production

The industrial sector plays an important role in economic development generating substantial employment and producing consumer and investment goods. However, the obvious benefits of industrial development frequently result in damage to both the environment and human health. This sector contributes to environmental degradation from both input and output sides of its activities. Industrial production processes not only utilize water resources as an input which may cause the national resource stock to decrease, but also generate hazardous by-products such as wastewater, malodor,

[6] Food processing businesses are defined as businesses that produce or preserve food using modern technology in grading, sorting, packing and storing vegetables, fruits, flowers, and herbs.
[7] The second type applies to producers of creative or design products.
[8] This policy came into effect on January 1, 2005.
[9] This plan includes an intention to transform the Bank for Agricultural and Agricultural Cooperatives (BAAC) into a "Bank for Rural Development" to enable it to provide services to SMEs.
[10] MDICP project was joined by 110 food-processing firms out of the national total of 499 during 1999-2000, which was the 1st phase. The Project is presently in its 3rd phase.

air pollution, heat, smoke, and toxic waste. Moreover, the use of final products produced by industry for consumption and investment also creates a similar negative environmental impact on air, water and land. Since industries are usually clustered together near or in a community, these discharges have a negative impact on environmental quality and community health. In addition, the rapid growth in production and consumption also greatly increases the demand for natural resources, which in turn contributes to further environmental degradation. The following sections describe how the production processes of SMEs in the agro-industry affect the environment.

3.3.1 The depletion of natural resources

The food industry uses not only plants and animals as raw material inputs but also other natural resources like water and energy - in many forms - in the production process. In order to meet food safety standards, it has to utilize a substantial amount of clean water (from surface and underground sources) for raw material cleaning, as an ingredient, for cooling, and for the cleaning of both utensils and the factory. At present, there is no definite information available regarding the extent of water usage in the food industry in Thailand. However, various studies have found evidence of land subsiding, intrusion of salt water into groundwater strata and lowering groundwater levels in the central region of Thailand[11] due to the use of groundwater for manufacturing purposes. These have led to the implementation of various laws and regulations[12] prohibiting the pumping of groundwater by manufacturers in Bangkok and its periphery. Any permits previously granted to utilize groundwater became invalid after December 31, 2003. This experience shows that in absence of strict measures to control the use of water, this natural resource may eventually become depleted.

Energy is another resource that industry, especially SMEs, uses heavily. Energy is supplied to industry in many forms and varies according to the technology employed in that industry. Small and medium-sized industries, with low cost investment, start off by using firewood, charcoal, gas, bunker oil, and then go on to use electricity. These come from diverse sources: from national forest resources to imports from OPEC countries. The report from the Energy Authority of Thailand about energy consumption shows that industrial energy consumption is rising (Table 3.2). In addition, SMEs still manage energy use poorly, especially in the food processing sector (DIW and EGAT, 2002).

[11] The Greater Bangkok Metropolitan Area and the Provinces of Nonthaburi, Nakon Pathom, Patum Thani, Ayudhya, Samut Prakarn, and Samut Sakorn.
[12] Groundwater Act (3rd Amendment) B.E. 2546.

Table 3.2 Energy consumption per GDP in Thailand (1998-2001)

Energy Consumption				
Indicator	**1998**	**1999**	**2000**	**2001**
1. Final energy consumption per GDP at 1988 prices (Gram of oil equivalent per baht)	16.4	16.4	15.9	16.2
2. Percentage of modern energy per total energy	82.6	82.3	82.0	83.0
3. Percentage of renewable energy per total energy	17.4	17.7	18.0	17.0
4. Final energy consumption of economic sector per total energy				
- Manufacturing (%)	30.5	32.9	33.9	34.2
- Residential and commercial (%)	22.7	21.5	22.1	22.0
- Transportation (%)	40.1	38.8	37.7	37.6

Source: Department of Alternative Energy Development and Efficiency, Ministry of Energy, 2004.

3.3.2 Environmental quality/Pollution

In many mega cities, especially in developing countries, industry emits hundreds of gaseous, liquid, and solid pollutants, contributing to smog, accumulation of heavy metals, organic water pollution, hazardous solid waste, and many other sources of damage to communities and ecosystems. For example, at one extreme, China's State Environmental Protection Agency estimates that pollution from factories accounts for over 70 percent of total national pollution, including 70 percent of organic water pollution, 72 percent of sulfur dioxide emissions, and 75 percent of flue dust, a major component of suspended particulates (World Bank, 2002). In developing countries, SMEs typically dominate certain pollution-intensive economic sectors and are often leading contributors to environmental degradation, especially when they are grouped together. For instance in Ecuador, where 80 percent of the industrial labor force is employed in companies with ten or fewer workers, SMEs are responsible for over 90 percent of total water pollution associated with vehicle reparation and the manufacturing of furniture, iron goods, processed foods, pulp and paper, and textiles (Blackman and Kildegaard, 2003).

In Thailand, these negative impacts on the environment are why industrial activities have been prohibited in densely populated communities. Unfortunately, there exists no clear record as to how much Thai small-sized manufacturers have contributed to increasing waste and pollution. Nevertheless, many studies have shown that the food-processing industry, especially the meat and diary processing industry, produce highly contaminated wastewater (DIW, 2002). Laplante and Meisner (2001) pointed out that in all regions of Thailand, important producers of BOD are in the food

processing industry, such as dairy producers, sugar factories and refineries, and factories that distil spirits.

Therefore, the presence of many small industrial plants throughout the country has increased public concern about the environmental impacts of this sector. Waste from the food industry mainly consists of organic substances such as peels, flesh, bones, blood, etc. Inorganic solid waste, such as paper and tin scraps, or broken glass, tends not to be managed effectively, which again affects the environment. Wastewater, though, is the most worrying form of waste, both in terms of volume and concentration (Pranee, 1999), as shown in Table 3.3 below. For example, it is estimated that approximately 400,000 tons of waste, most of which is water-based waste, is generated annually from fish canning activities in Thailand (DIW and GTZ, 1997). This solid and liquid waste needs to be properly handled and disposed of so as not to contaminate the environment. Cooperation between the government's environmental protection agencies and the food processing industry is required to manage the environment effectively. In addition, proper planning[13] and selection of appropriate waste treatment approaches[14] can prevent and solve environmental problems which might otherwise become a nuisance to neighboring communities (MOInd, 2002). Given the constraints on conventional regulations (see Chapter 4), a promising strategy for controlling SME pollution is to promote the adoption of clean technologies that prevent pollution and either reduce production costs or do not raise them significantly. The hope is that firms will adopt clean technologies voluntarily or at least with minimal prodding. This approach has received considerable attention as a means of surmounting all kinds of barriers to conventional environmental regulation in developing countries (United Nations 2002; World Bank 1992 and 1998; World Commission on Environment and Development 1987).

Table 3.3 Wastewater characteristics in the food industry

Industrial sector	Wastewater m^3 / ton product	BOD mg / liter	SS mg / liter
Canning industry	53	3,500	760
Flour	5-8	5,235	1,700
Rice, noodles	3	3,920	8,400
Liquor, Beer	15-18	29,000	7,800
Sugar	17	1,320	320

Source: Pranee, 1999.

[13] General approaches for waste management are: i) end of pipe treatment ii) source treatment iii) waste minimization. For details, see section 3.4.

[14] For details of waste treatment in the agro-industry, see Chapter 5, 6 and 7.

3.4 Environmental Management in SMEs Agro-industry

Three waste management concepts are generally used to analyze and describe how industries deal with environmental externalities: end-of-pipe treatment, environmental management systems and cleaner production. In section 3.4.1, these concepts will be introduced and their usefulness for small and medium-sized enterprises will be assessed. Based on these concepts a waste management categorization for small and medium-sized companies in the agro-industry will be developed in section 3.4.2, to be further applied in this study.

3.4.1 Waste management concepts

End-of-Pipe treatment (EoP)

The classical pollution control strategy is referred to as End-of-Pipe treatment, as the method is applied after waste is generated and industries are forced to treat their waste before discharge (Jorgenson and Wilcoxen, 1990; Sakurai, 1995; Luken and Freij, 1995; Hartl and Kort, 1997; Vigneswaran et al., 1999; Hilson, 2000). EoP strategies are used to reduce industry's impact on the environment. Landfilling, for example, limits the dispersal of contaminants, and airstripping of contaminated water transfers contaminants from water to another medium (air) (Huesemann, 2001). Most EoP treatment plants in industrial countries apply biological, physical-chemical or chemical processes to treat different kinds of industrial wastewater, solid waste, and air pollutants before discharging a remaining fraction to the environment. Obviously, in most manufacturing processes even the best precautionary measures need to be complemented by EoP treatment to be able to discharge the final part safely into the environment. In those cases, EoP treatment is the only suitable way of protecting the environment. These applications make EoP treatment one of the most popular among pollution treatment methods when handling unavoidable waste or emissions of pollutants from industrial production processes. This approach has been accepted and recognized widely as essential in putting a firm's operations in line with regulatory demands.

However, EoP measures have also been criticized for not making efficient use of limited resources, as they consume significant amounts of material and energy, capital and labor compared to other – more source oriented – measures (Dimitroff-Regatschnig and Schnitzer, 1998; Erkman, 2001). As such, EoP measures add costs to the manufacturing process, making the production process as a whole more expensive (Pargal and Wheeler, 1996). This is a crucial disadvantage, especially for SMEs in developing countries. Moreover, disposing waste from treatment facilities often creates new environmental problems, as has been witnessed in developing countries where such waste is often dumped into the nearby environment (Sakurai,

1995). Some scholars also claim that many conventional EoP systems are not only costly to operate and maintain, but also ineffective at reducing environmental damage (Hilson, 2000a, 2000b). In addition, the implementation of EoP treatment methods (and thus its environmental effectiveness) depends heavily on control and enforcements of environmental authorities. Various studies show that in developing countries, which mainly use command-and-control approaches to environmental policy and lack strong monitoring and enforcement capabilities, SMEs rarely install or operate EoP treatment systems and prefer to dump waste into the environment, sometimes by diluting the contaminants. EoP treatment, though, is often the only measure taken by SMEs in developing countries to reduce their impact on the environment. In conclusion, with regard to SMEs in developing countries, EoP treatment faces a number of problems.

Environmental Management System (EMS)

Environmental management systems (EMS) form part of an overall management system. In analyzing and describing these environmental management systems scholars and practitioners often point at organizational structures, planning activities, responsibilities, environmental practices, procedures, processes, as well as resources for developing, implementing, achieving, reviewing, and maintaining the company's environmental policy. Various studies characterize the process of developing and implementing an EMS as being composed of five elements: i) planning and organization, ii) initial review, iii) formulating an environmental policy statement and developing an action plan, iv) execution of the plan, and v) evaluation and reporting (e.g. International Trade Center, 2001; Van Koppen, 2002). Increasingly, EMS is accepted among companies and authorities in developed countries as a key tool to help reduce impacts on the environment and achieve sustainable production patterns. It has developed into one of the most well-known voluntary tools used by enterprises to improve their environmental performance, and ensure compliance with environmental legislation (DIW, 2003). Environmental considerations are systematically integrated into a company's overall activities via the development of environmental policies, the establishment of environmental objectives and targets, the definition of necessary procedures and responsibilities, the systematic monitoring of activities, the carrying out of periodic audits of the entire production system, and reviews at regular intervals. Examples of concepts, or tools, that are often applied within the framework of an EMS are eco-labels, life-cycle-assessments, environmental reports, and benchmarking initiatives. These activities are increasingly standardized through organizations such as the International Standardization Organization (ISO). The International Standardization Organisation has developed a series of global standards for systematic environmental management, known as the

ISO 14000 series[15] which include Environmental Management Systems (14001, 14002, 14004), Environmental Auditing (14010, 14011, 14012), Evaluation of Environmental Performance (14031), Environmental Labeling (14020, 14021, 14022, 14023, 14024, 14025), and Life Cycle Assessments (14040, 14041, 14042, 14043). A company can choose to have its EMS examined and certified (or verified) by a third party (a certification or verification body), but it can also opt to establish a non-certified EMS, which is more flexible. From the government's perspective, it is desirable that companies implement a standardized EMS. These standards do not set absolute requirements for environmental performance and do not bind a company to reach zero emissions. But the organizational structure, the records kept within an EMS, and the responsibilities taken by the company make it easier for the authorities to see how well the company is performing.

While EMS strives for continuous improvement of the production process and environmental performance, and at the same time enhances efficiency, product quality and the safety of employees, SMEs – especially in developing countries – face certain difficulties when applying EMS (United Nations, 1996). The three main difficulties are: i) the lack of financial support to develop, implement and continuously improve these EMS; ii) the lack of technical support, or access to information and resources within SMEs; iii) a number of other factors: lack of environmental infrastructure, cost of intellectual property rights in adopting environmentally sound technologies, and less competitive advantage for firms with EMS systems. In Thailand, EMS policy was introduced and developed by the Bureau of Industrial Environmental Technology. However, with limited human resources, lack of sufficient information and knowledge, and lack of environmental management sections in small firms, this Bureau has not been very successful in promoting EMS to SMEs and EMS has been rarely adopted by SMEs in Thailand[16].

Cleaner Production concept (CP)

Cleaner production is a broad concept which describes a preventive approach to environmental management. This not only minimizes industry's impact on the environment, but also increases its overall efficiency. Cleaner production is often interpreted as being in line with pollution prevention, eco-efficiency and waste minimization. It refers to strategies for producing goods and services with minimum

[15] ISO 14000 consists of two parts: i) Organizational evaluation: environmental management system, environmental auditing, and environmental performance evaluation; and ii) Product evaluation: environmental aspects in product standards, environmental labeling, and life cycle assessments (Cascio, Woodside and Mitchell, 1996).

[16] From an interview with Technical Experts (consultants), Department of Industrial Environmental Technology (MOInd) (July 2003).

environmental impact under present technological and economic limits. Protection not only of the environment, but also of consumers and of workers goes together with improving industrial efficiency, profitability, and competitiveness: a win-win strategy (UNEP, 2001). Industry has implemented various types of CP measures, such as good housekeeping, substitution of raw and auxiliary materials by less harmful ones, modifications of products to eliminate production steps or substances that have major impacts on the environment, making modifications to minimize waste and emissions, internal recycling, and external recycling (Eder and Fresner, 2001).

Designing CP measures usually follows the following standard approach: i) an audit of all the inputs and outputs of a company is conducted, in order to trace back environmental problems to their respective sources, ii) the company identifies technological and organizational problems which are at the source of these problems, iii) the weak points and inefficiencies of material and energy use are identified and subsequent options for economically and ecologically sound solutions are defined, and iv) modifications to the production process and/or products are implemented leading to less waste and fewer pollutants being released into the environment (Phuong, 2002).

In general, CP approaches were initially developed for large scale industries, and applying these to SMEs can cause difficulties. UNEP (2001), for instance, reporting on the barriers SMEs in Asia Pacific faced when implementing Cleaner Production, concluded that problems relate to: i) insufficient enforcement of environmental legislation, ii) limited access to financial incentives, iii) lack of an easy access to information on clean technologies, iv) limited outreach to smaller companies, and v) lack of transparency in the reporting on environmental impacts from their activities. Similarly, Frijns (2001) and Hilson (2000b) concluded that the main constraint on the implementation of CP measures is financial in nature. Even though CP measures are generally believed to lead to cost savings, the unavailability of capital for production process improvements often prevents small and medium-sized firms being able to implement these practices. Large scale firms may have sufficient capital to upgrade inefficient processes, but this is a luxury that small and medium-sized often cannot afford. To some extent, applying CP measures can incur higher short-term costs, not only due to investments in technology, but also due to the necessary revamping of organizational processes and the higher risk accompanying process modification. Especially for SMEs in developing countries, these investments are difficult to finance.

3.4.2. Waste treatment approaches of SMEs in the agro-industry

In spite of the impressive growth of SMEs in the agro-industry in the last two decades, for a long time the Thai government had not developed any policy dealing

with potential impacts this sector's activities would have on the environment. It is only recently that the state has started to recognize the likely environmental consequences of promoting SMEs, and has attempted to introduce various industrial environmental management concepts, as well as enacting laws to authorize or empower various agencies with direct and indirect responsibility for environmental management.

In order to systematize the diversity in industrial environmental management Van Koppen and Hagelaar (2002) have developed a model on the development stages of strategic environmental management in companies. Their model aims to clarify how environmental strategies differ among companies, as well as indicate feasible trajectories for improving company environmental management under different conditions. Three stages are defined: i) crisis-oriented, ii) process-oriented, and iii) chain-oriented. In the first *crisis-oriented* stage, the company is oriented to control the most urgent environmental problems, usually by means of waste treatment facilities. The control measures consist typically of end-of-pipe solutions, in reaction to environmental regulations. In the second *process-oriented* stage, the company deals with its environmental problems in a more systematic and less reactive way, by analyzing its production process as a whole, and striving for an effective and cost-efficient control of all relevant environmental issues. This stage is characterized by initiatives for waste and emission prevention (e.g. through cleaner production) and for the development of an internal environmental management system. The third stage is called *chain-oriented*. In this stage the company extends its environmental management beyond its own production process, to the entire product chain. It analyses the environmental impacts of the entire life cycle of its products (including raw material extraction, manufacture, retail, consumption and waste disposal), and aims at reducing the total of these impacts, for instance by better product design. Various internal and external pressures may push or pull companies from one stage of company environmental management into the next, although there is no automatic unfolding of the three stages for each company. These pressures may be, for instance, regulatory activities from governmental authorities, pressure from civil society, market pressure from customers/consumers, and financial pressure from investors or insurance companies. Industrial firms often react to these pressures by adopting waste management strategies. The three-stage model of Van Koppen and Hagelaar helps to identify what feasible strategies and options a company has for improving its environmental performance to meet such pressures.

For companies, the goal of waste management is usually to reduce or eliminate waste from their production processes at the lowest cost. The ultimate goal for those outside the company is 'zero pollution'. To analyze and apply waste reduction and minimization approaches for SMEs in the agro-industry under conditions specific to Northern Thailand, a set of more operationalized strategies and options are

summarized in Figure 3.2, under the heading of waste prevention and minimization. Options and measures for companies to deal with waste can be categorized in the following way; i) waste prevention and reduction at source, ii) on-site recycling, iii) off-site recycling, and iv) end-of-pipe treatment.

Waste prevention and reduction at source. From an environmental and often also an economic point of view the most preferable way of reducing waste is to reduce or eliminate waste at source. It starts with *source reduction*, a first step in a more preventive approach to waste management. The concept involves the use of processes, practices, or products to reduce or eliminate the generation of waste at source. It can consists of material substitution, process substitution, good housekeeping and equipment maintenance, water and energy conservation, life cycle analysis, and/or inventory control. For SMEs in the agro-industry in Northern Thailand, there are four strategies that are particularly appropriate: i) improved housekeeping, ii) input material change, iii) technological transformation, and iv) product change. *Improved housekeeping* can be implemented in many ways, by improving operating and maintenance procedures, and the handling of materials; changing management practices; and adopting stream segregation, waste segregation, production scheduling, inventory controls, and further training. These options call for a great deal of cooperation and discipline in the workplace to comply with environmental guidelines, as waste is being minimized without major technological changes being made and at a low cost. *Input material change* is used to reduce both the consumption of resources and the amount of waste generated during the production process. This measure can be implemented by purifying materials, substituting toxic for less-toxic materials, or by switching to renewable materials. *Technological transformation* is a measure that often incurs greater costs, as investment is needed to change or adapt the production technology used by the firms. This waste reduction measure can be achieved in many ways: through changes in design or layout, improved operating conditions, improved equipment or increased automation. The firm would need to select a suitable option depending on its financial conditions. The last strategy is *product change* by producing (slightly) different products. Products are redesigned to have less impact on the environment not only during the production process, but also while they are being used and/or when they become waste. Alternatively, the life time of a product can be extended.

On-site recycling: This strategy, which is sometimes called in-process recycling, means that materials are recycled before being turned into waste. This kind of recycling requires a good knowledge of the production process itself, and is implemented by using the reduce-reuse-recycle (3R) methods - also known as *waste exchange* steps. It is very popular and valuable for the firms to apply this together with good housekeeping measures. Reusing and recycling focus on reducing resource consumption, especially that of water and energy, with reducing costs as a secondary

goal. These actions are often not only beneficial to the environment, but also reduce costs, which in turn increases profitability.

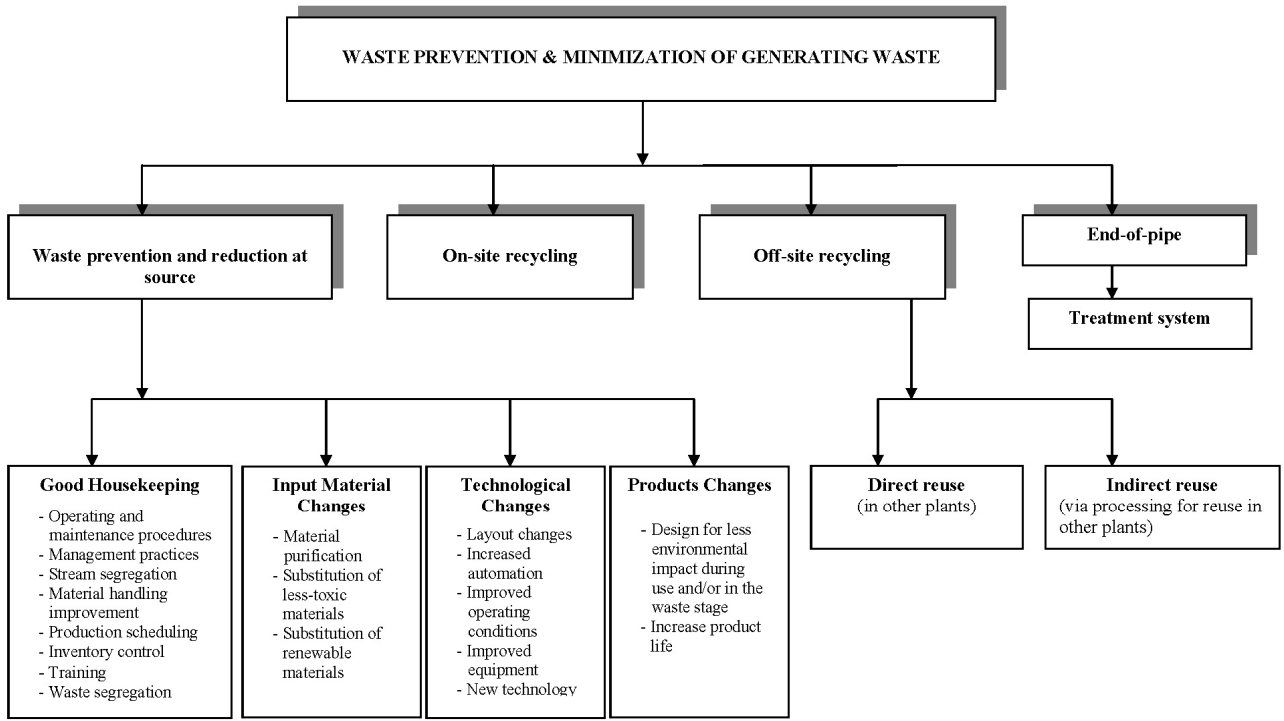
Off-site recycling: This is an additional option, which can complement other waste reduction strategies. Waste from the production process, which cannot be reused or recycled on-site, could be turned into raw material input for both direct reuse (by other firms) or indirect reuse (for reuse by other firms after further processing). This method reduces waste by turning it into valuable products for other firms, often at a profit. However, in many cases it is quite difficult for SMEs to effectively adopt this strategy.

End-of-Pipe treatment: In almost all cases, the goal of 'zero waste' cannot be achieved through source reduction or recycling. There will always remain some residues that cannot be prevented or reused. The remaining waste that requires treatment should of course be greatly reduced in volume, thus making treatment easier and less expensive. As this last strategy only increases the company's investment and operational costs, it is only applied when necessary to meet environmental standards. The waste should be treated according to the size of the factory, type and volume of waste, and financial considerations. After the waste has been treated, some waste usually needs to be disposed of, either directly to the environment (at low levels), or at a waste storage facility. If there are no other practical options, disposal at a facility should be carried out in an environmentally responsible manner, often in cooperation with the relevant agencies.

3.5 Epilogue

Thailand's environmental strategy on industrial waste management has recently changed from the adoption of 'passive environmental strategies', where waste is diluted and dispersed, to the introduction of 'reactive environmental strategies', which encompass End-of-Pipe approaches and on-site recycling practices. It now seems to be in the process of turning towards more 'proactive environmental strategies', where the focus is mainly on prevention of generating waste as well as waste reduction at source. This latter strategy uses practices such as good housekeeping, input substitution, better process control, equipment modification, technology change, on-site recovery/reuse, and product modification. Various actors and institutions – both within companies and those situated in the companies' social environment – play crucial roles in the implementation of these measures and management tools, as will become evident in the case studies in Chapters 5, 6 and 7.

Figure 3.1 Techniques and options for waste prevention and minimization of waste generated in industrial SMEs



Source: Adapted by the author from various studies on waste treatment approaches.

Chapter 4

The Institutional Environment of Greening Agro-food Processing Industry

Still, pollution regulation arrived in the developing world as an import. Instead of creating new approaches from scratch, most agencies adopted traditional command-and-control regulation with technical assistance from the OECD countries. Unfortunately, this particular import didn't always adapt well to local conditions. By the early 1990s, regulators in many countries had concluded that conventional methods were too expensive and often ineffective. Innovators began experimenting with new approaches, and some yielded excellent results. At the same time, many national economic reforms were proving to be effective in fighting pollution.

World Bank, 2000. *Greening Industry: New Roles for Communities, Markets, and Governments.*

4.1 Introduction

Initially, prescriptive regulation was often identified as the most effective means of protecting the environment from damages caused by modern industry. This reflected, and reinforced, a mindset that saw conflicts between business and environmental interests as inevitable. Governments have also applied economic mechanisms, using a combination of taxes and subsidies to deter environmentally damaging behavior and to promote good practices in industry. More recently, however, increasing emphasis - often in parallel with environmental agreements between government and industry, and the adoption of corporate environmental management tools - has been placed on encouraging businesses to be more and more innovative. This emphasis on the ability of businesses to solve environmental problems is part of a wider reassessment of relations between the economy and the environment. Pressures to meet environmental obligations, once widely depicted as threatening business growth, are increasingly viewed as offering profitable opportunities for innovative companies. However, this attitude towards environmental issues requires effective regulations to support the environmental institutions in implementing and monitoring potential problems.

This chapter elaborates in detail the environmental policy framework within the food processing industry in Thailand. The role of various actors and institutions are presented and analyzed. The state involvement in environmental management of the industrial sector, especially in the food processing industry, is presented first,

followed by the government's institutional role, and then the effects of legislation and certain policies related to the food processing industry. The chapter concludes with a brief account of the current requirements of an effective environmental management policy in Thailand.

4.2 Environmental and State Management of the Industrial Sector in Thailand

4.2.1 Thailand's administration and environmental management

State structures and organizations

The 1991 National Public Administration Act provided three basic levels of public administration in Thailand: central, provincial, and local. Provinces, districts and sub-districts are separated so that there are public administrative bodies all over the country. The provincial governors and district officers are the main authorities in the provincial administration and act as representatives of the central government in the provinces, while the administrative power is still centralized at the level of the national administration [1]. The Department of Local Administration, under the Ministry of the Interior (MOI), is in charge of provincial as well as local administration. Other ministries and departments of the central government also have their branch offices in the provinces (Figure 4.1).

At present, there are 2 types of local administrative organization in Thailand. The more common type that can be found in every province is composed of i) a Provincial Administrative Organization (PAO), which takes responsibility for all areas in the province, ii) a Municipality, consisting of an urban area with a crowded population and a high level of development, or iii) a Tambon (sub-district) Administrative Organization (TAO) whose jurisdiction is over the area of a particular sub-district outside the boundaries of the municipality. The second type consists of two special forms of local government, which are i) the Bangkok Metropolitan Administration, and ii) the City of Pattaya (MOI, 2004). At present, there are 75 Provinces, 2 'special' local governments, 20 PAOs, 2238 municipalities, and 6745 TAOs (ECT, 2005). Generally, a province is administratively divided into a number of districts, each led by a district officer responsible to the Provincial governor[2]. A district is divided into sub-districts (Tambon), led by sub-district chiefs, who are called 'Kamnan'. A sub-district consists of several villages, each of which is led by a

[1] The decentralization process started under the provisions of the 1997 Provincial Administrative Organization Act that created new local authorities to transfer administrative powers from the central government (MOI, 2004). For details, see section 4.3.2.

[2] Nowadays, provincial governors are known as 'Provincial governor CEOs', meaning that all administrative powers have been transferred to them from the central government, and that they are in charge of all provincial organizations.

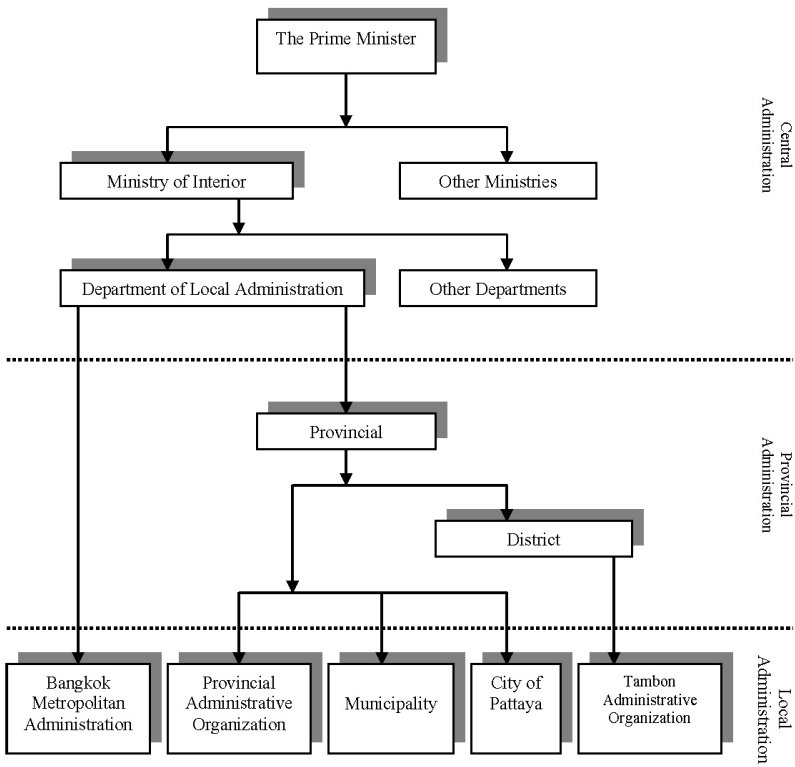
chief. This form of administration means that the central government delegates some of its power and authority to officers who work in the provinces and districts. These officers are working for various ministries and departments and carry out their work according to laws and regulations assigned by the central government. Presently, the provincial administration consists of 75 provinces (excluding Bangkok), 845 districts, 81 minor districts[3], 7,410 sub-districts and 70,340 villages (MOI, 2003).

The 1997 Provincial Administrative Organization Act started decentralizing public service functions to the local governments. This policy aims to make public services more efficient as well as being more responsive to the needs of the community. Local government in Thailand is organized in 6 different ways depending on location. Urban-based forms of local government are i) the Bangkok Metropolitan Administration, ii) the Municipality, and iii) the City of Pattaya. Rural-based forms are i) the Provincial Administrative Organization (PAO) constituting local government at a provincial level, ii) the Tambon Administrative Organization (TAO) constituting local government at a sub-district level, and iii) the Sukhapiban or Sanitary Committee, a local government in a rural center as a sanitary district.

The aim of decentralization is to allow local people to participate in local affairs under specified laws and regulations. They can elect their own leaders to run their own local government. Each PAO and TAO draws up its own development plan that details the problems facing its locality, and proposes solutions for these problems. The provincial administration has the authority of, and functions as, a local government, and the local government is essentially an appointed agent of the central government, through the Ministry of the Interior. This will be analyzed more in the following sections.

[3] Minor district, so called *King Amphoe*, is a government office at the district level, within the Provincial Administration, led by a minor district chief officer (*Huana King Amphoe*). Minor district offices have been established to provide an efficient service to people in remote areas, where the setting up of a District Administrative Office is not feasible.

Figure 4.1 Thailand's administrative structure.



The development of environmental management

Since the rise of worldwide environmental consciousness during the 1950s, there has been a lot of evidence suggesting that population growth, economic development, and technological progress have been the major causes of environmental problems. Since 1984, Thailand has also begun to express these concerns by making concerted efforts at managing the impacts of industrial activities on the environment. This was a time when the country's economy became more industrialized following the implementation of its first five National Economic and Social Development Plans (1961-1986) [4]. Its fifth Development Plan (1982-1986) began to address the importance of energy conservation and pollution reduction in Thai industries leading to a major structural shift in environmental management in 1992.

[4] Currently, Thailand is implementing its 9th National Economic and Social Development Plan (2002-2006).

The development of environmental laws in Thailand has been driven by both economic and engineering concepts. Based on engineering know-how, polluters are required to install wastewater treatment devices or to treat waste before disposing it into the environment. The application of economic concepts regarding the optimal use of limited resources without damaging the environment is fundamental to the requirement that factories shoulder the costs of waste treatment. Indeed, prior to 1975 Thailand had no comprehensive law to deal directly with environmental management problems, but there were many pieces of legislation relating to environmental management responsibilities and the jurisdiction of specific ministries or government agencies[5].

The National Environment Act of 1975 was promulgated to entrust the National Environment Board and the Office of the National Environment Board with the general responsibility for environmental issues, while the existing agencies involved in the promotion and maintenance of the quality of any particular resource continued to be responsible for that resource. This meant that the National Environment Board was only a coordinating body without adequate power to efficiently oversee matters relating to the environment. As a result, this law was abolished and has been replaced by the 1992 Enhancement and Conservation of National Environmental Quality Act, which contains provisions for the restructure of environmental authorities and the creation of three new agencies[6] directly responsible for environmental management: the Office of Environmental Policy and Planning, the Pollution Control Department, and the Department of Environmental Quality Promotion. These three agencies can work in a more efficient manner than before with the other units, which implement other environmental laws. Nevertheless, there remain certain problems in the enforcement of various laws, which will be described later.

4.2.2 State management of the industrial sector in Thailand

The history of industrial development in Thailand can be divided into five stages, from the 1st National Economic Plan (1961) up to now, by referring to the relationship between industrial development and attempts to solve environmental problems (PCD, 2002). The first stage of industrial development started in 1967,

[5] Factory laws authorize the Ministry of Industry to deal with factory pollution. Laws relating to public health empower the Ministry of Public Health and local government agencies to deal with solid waste management and any other environmental issues. Laws concerning natural resources authorize the relevant government agency or authority to deal with any problems with the resource they are responsible for. As far as court cases are concerned, the Civil and Commerce Code has been applied in most cases to sue for environmental damages. More details on organizational responsibilities are stated elsewhere in this chapter.

[6] Due to restructuring, these environmental units have been part of the Ministry of Natural Resources and Environment since October 2, 2002.

during the 2nd National Economic Development Plan. During that time most industrial investments were in the small-scale food industry in order to provide goods for the Thai population. The government tried to make the domestic food industry more technologically advanced so as to increase industrial production. During this stage environmental management for the industrial sector was still lacking.

The second stage in industrial development lasted from 1967 to 1976. During that period the Industrial Estate Authority of Thailand was established to develop and manage newly constructed industrial estates. The factories in these industrial estates were mainly producing export goods, especially for the metal industry. They used technology that increased the speed and quantity of production, while neglecting to pay enough attention to pollution. With as many as 20,000 factories all over the country, pollution control was sorely needed. However, this need for pollution control was only addressed when the Factory Act, as well as the Enhancement and Conservation of National Environmental Quality Act, were enacted by the government under the authority of the Office of National Environment Board in 1969 and 1975, respectively.

During the third stage, from 1977-1986, heavy industry was the focus of national development. The development of the chemical and petrochemical industries was promoted in the Central and Eastern parts of Thailand. At the end of this period there were more than 50,000 factories generating waste and pollutants, which were generally dumped into the main rivers and the atmosphere. Environmental problems had, as a result, become more critical. The government became more sensitive to these problems and the National Environment Board (NEB) was set up to take responsibility for dealing with environmental issues, while the Department of Industrial Works took responsibility for the pollution generated by factories.

The fourth period, from 1987-1996, was the period in which the concept of industrial zones was developed. The Eastern Seaboard industrial zone and the Northern industrial zone were established, however, without sufficient long-term planning regarding effects on the environment. This expansion of heavy industrial activity had a negative impact on the quality of life and the environment. In 1992, in response to the Rio declaration, the government amended both 'the Enhancement and Conservation of National Environmental Quality Act' and 'the Factory Act'. In the mean time, 'the Dangerous Substances Act' was also enacted to ensure that environmental pollution from the industrial sector could be brought under control. However, more than 100,000 registered factories still discharged pollution to the environment due to a lack of adequate enforcement and the limited budget for evaluating and monitoring environmental concerns.

During the most recent period, from 1997 onwards, there was an economic crisis in Thailand caused by the economic restructuring from a traditional dependency on agriculture to an increasingly industrialized economy, as explained above. The 8th and 9th Plans (1997-2001 and 2002-2006), have emphasized a shift in the development model from a localized approach to a holistic people-centered development approac[7] by undertaking area-based and community-based development (NESDB, 2001), and focusing on the agricultural sector as the strongest point of the Thai economy. The 8th Plan also established networks among small-scale industries in rural areas and arranged finance and other industry-related services in order to support the development of villages in rural areas, as well as the development of industrial communities. According to the main development model, the government has changed the direction of national development, to become a new agricultural industrial country. This is because of the need to build a firm base for long-term and sustainable economic growth by focusing especially on increasing the value added in agricultural products by using industrial processing technologies. At present, there are 4,082 (Note: this data will be checked for an update) enterprises dealing with this kind of industry. All of them are small and medium-sized industries (DIP, 2001). In addition, the 9th Plan focuses on public participation in every sector of the Thai society relating to national development planning. The main goal of this plan is not only to manage the environment and natural resources effectively, but also to promote sustainable development for the Thai economy.

The policy development explained above illustrates that environmental management and industrial development in Thailand have been developing a more symbiotic relationship over the last decade. The following sections present an overview of state policies concerning environmental management in the industrial sector implemented at the national, regional, and provincial levels.

National level

In order to manage industrial waste, which is potentially harmful to the environment, in 1979 Thailand established a Ministry of Science, Technology and Energy, which in 1992 was renamed the Ministry of Science, Technology and the Environment (MOSTE). MOSTE was responsible for matters concerning science, technology, energy and the environment under three main work units: the Pollution Control Department, the Department of Environmental Quality Promotion, and the Office of Natural Resources and Environmental Policy and Planning. In 2002, another

[7] A holistic people-centered development approach is a new concept for Thailand's national development in that it sees human beings as central to development. It focuses on the holistic development of human potential in its physical, intellectual and spiritual aspects, including popular participation of all development partnerships for the sake of self-sufficiency at community and local levels.

organizational restructure was implemented: a Ministry of Science and Technology and a new Ministry of Natural Resources and Environment (MNRE) were set up. All existing work units dealing with natural resources and the environment were transferred to MNRE, so as to better concentrate on their designated responsibilities.

Furthermore, in order to promote better management of the impacts of industry on the environment, the Industrial Estate authority of Thailand (IEAT) was established with the 4th National Economic and Social Development Plan (1977-1981) of the Royal Thai Government. The Plan was to decentralize industrial development away from the Bangkok Metropolitan Area to the regional zones, and the 5th Plan (1982-1986) emphasized the development of the primary and secondary cities in the different regions[8]. The Northern Region Industrial Estate (NRIE) at Lamphun Province was established in 1983 and was completed in March 1985.

Regional level

After the establishment of the NRIE by the IEAT, industrial pollution control and management could be partly ensured due to the availability of central wastewater and solid waste treatment systems within the Estate. The NRIE has also been awarded the ISO14001 certification[9] in recognition of its environmental management. However, environmental management outside the Industrial Estate Zones requires greater cooperation among the responsible agencies, particularly those charged with regional policies such as the Office of Environmental Policy and Planning (OEPP), which was set up in accordance with the 1992 Enhancement and Conservation of National Environmental Quality Act, the Department of Environmental Quality Promotion (DEQP) and the Pollution Control Department (PCD).

The OEPP is an organization with regional offices[10] determining and overseeing environmental planning and policies within the region. The Environmental Office Region 1[11] and the Environmental Office Region 2[12] operate in the Upper North, and they are also responsible for coordinating policies with other agencies that deal with natural resources and environmental management matters at a provincial level. OEPP works in coordination with the DEQP, which informs the public about environmental issues, and promotes and oversees the overall environmental quality all over the country, particularly in the development of projects aimed at increasing environmental awareness. The PCD is also responsible for monitoring and inspecting

[8] The other city is Rayong Province, located in the East of Thailand.
[9] From SGS International Certification AG, Zurich, Switzerland. Certificate No. 202135, October 18, 2000.
[10] There are 16 Regional Offices in Thailand.
[11] There are 16 staff responsible for works in the four Northern Provinces of Chiang Mai, Chiang Rai, Lamphun, and Mae Hong Son.
[12] The responsibility area covers Payao, Lampang, Phrae, and Sukothai.

the environmental quality all over the country, especially the monitoring of air quality, water quality in major rivers, and any other environmental concern upon request or in the event of any complaint being lodged.

Provincial level

The Provincial National Resources and Environment Office (PEO), set up in 2002, is a relatively new work unit responsible for natural resources and environmental management at a provincial level. However, it has been unable to satisfy its responsibilities due to staff shortages and an inadequate budget[13]. It therefore must seek cooperation from other agencies to manage various widely dispersed industries (see section 4.3).

There is another local government organization at sub-district level dealing directly with local environmental management. The Tambon Administrative Organization (TAO), recently instituted as a result of a devolution of administrative power and decision making to the local level. TAO is expected to play a crucial role in dealing with environmental problems at the sub-district level. However, TAO is a recently established organization led by a group of people's representatives[14], and hence has a limited capability to deal with all of its responsibilities, particularly in environmental management which is a relatively new concern for the local community. It will take some time for the Thai government to realize the goal of decentralization of environmental decisions to local communities.

4.3 Environmental Institutions, Legislation, Policies, and Other Related Agencies

This section first presents the environmental policy framework for environmental protection in Thailand, followed by a review of environmental organizations and legislation. Finally, the environmental policy instruments are presented.

4.3.1 Environmental policy framework

Environmental policies in Thailand can be distinguished into three hierarchical levels:

[13] From an interview with the environmental officer of PEO.
[14] Within a TAO there is a chairman or TAO president, an administrative assistant, and council members consisting of 2 representatives from each village, who are elected to the council.

National Environmental Policy

The 1992 Enhancement and Conservation of National Environmental Quality Act (the 1992 NEQA) is probably one of Thailand's most important pieces of legislation regarding the environment. It basically established Thailand's principle public sector institutions concerning the environment and pollution control, as well as the principle laws governing the environment. Section 5:79 of the Policy and Plan for Environmental Quality Enhancement and Conservation for 1997-2016, within the framework of the 1992 NEQA, authorizes the Ministry of Science, Technology and the Environment (MOSTE)[15] to formulate environmental quality management plans. The ministry is concerned with five major policy areas: natural resources, pollution prevention and the protection of natural and cultural heritage sites, urban and community environment, education and publicity for the protection of the environment, and technology for the environment.

The main policy directly relevant to this study is pollution control, which stresses the following measures:

i) The reduction and control of all pollution: for example, water, air, noise and vibration, solid waste, hazardous substances, etc., originating from urban, agricultural, industrial or other sources. This can be achieved by adopting the following measures: the application of a polluters pay principle, the development and installment of central treatment facilities, the establishment of industrial estates for industries having similar pollution by-products, the creation of environmental awareness among communities and business operators, the prescription of minimum standards concerning waste that can be discharged to the environment, the adoption of a monitoring and inspecting system, and effective law enforcement.

ii) The promotion of systematic and efficient management of hazardous substances and other waste matters by the development and extension of waste treatment technologies that can ensure sustainability and efficiency of their application.

iii) To manage pollution effectively, a unified administrative system is needed. When developing policies and action plans, legal, organizational and financial sectors should be coordinated. The private sector should be encouraged to participate with the public sector in investing in the management of pollution.

[15] This has recently become the Ministry of Natural Resources and Environment (MNRE).

Environmental Quality Management Plan[16]

This is the action plan within the framework of the National Environmental Policy to ensure that a sound environmental plan is implemented. Section 35 of the 1992 NEQA stipulates that any agency wishing to establish plans/programs relating to environmental improvements or protection must be in agreement with the Environment Quality Management Plan to ensure that there is ample cooperation with the many related agencies at different governmental levels. This plan encompasses major guidelines for the following measures: i) management of air and water quality, as well as the quality of other resources, ii) control of pollution at the point of origin, iii) conservation of natural resources and cultural heritage, iv) issuance of laws, ministerial rules, local governmental notifications, etc. for effective implementation[17], and v) monitoring, evaluation and analysis of environmental quality so as to enforce the relevant laws.

Action Plan for Environmental Quality Management at the Provincial level

Section 35 of the 1992 NEQA authorizes the regional and local administrative agencies to develop local/provincial plans for the management of natural resources and the environment. The plan will be a short term/annual work plan linked to the above Environmental Quality Management Plan. Specifically, there are two types of plan; one for provinces containing areas declared as environmental protection zones or pollution control zones, and one for provinces that do not contain such areas[18]. Each plan must contain analyses of environmental problems in that province, together with solutions to these problems, as well as programs/projects on the creation of environmental awareness, surveillance and protection, and rehabilitation and restoration. This cooperation among private, public, and civic sectors creates awareness of local environmental problems and identifies potential solutions in a participatory way. This can be regarded as a concrete example of decentralization of power to the local level.

[16] The Environmental Quality Management Plans for 1999-2016, declared on August 28, 1998, essentially aim to support the organizational improvement of the relevant agencies for a more efficient management of natural resources and the environment, and to propose a devolution of power to regional and local levels.

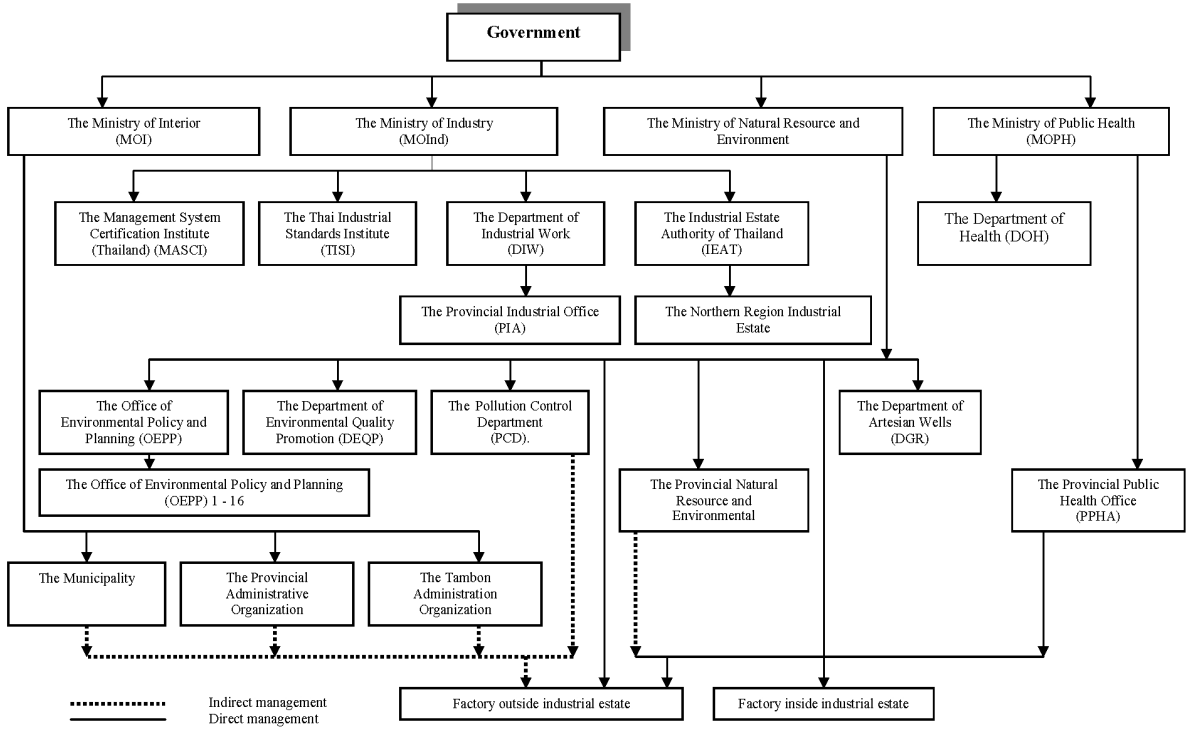
[17] This guideline has led to a proposal to develop a new Environmental Code, which would consolidate all laws related to the environment.

[18] Area declared in Section 59 of the Enhancement and Conservation of National Environmental Quality Act, B.E. 2535 (1992).

4.3.2 Government environmental organizations and other agencies: Institutional framework

Thailand has no specific law for industrial environmental management. However, certain provisions of related laws can be applied to deal with industrial impacts on the environment, such as The Factory Act, The Hazardous Substances Act, The Groundwater Act, etc. It is clear that there are agencies working on controlling the environmental impacts of industrial activities. Having recognized the need for close supervision and proper application of various environmental management concepts to specific industries, the Thai government has authorized various agencies the responsibility for studying, researching, managing and controlling industrial pollution. Apart from governmental organizations there are also other actors that need to be involved in the formulation of environmental management policies. Figure 4.2 shows the government agencies and other actors involved in the environmental management of the food processing industry. The roles and functions of different governmental environmental organizations and other actors are presented in the following sections.

Figure 4.2 Governmental environmental organizations and other actors involved in the environmental management of the food processing industry in Thailand.



Source: Compiled by the author, based on data from the Ministry of Interior, the Ministry of Natural Resources and Environment, the Ministry of Industry and the Ministry of Public Health, 2005.

National level:

The Ministry of Natural Resources and the Environment (MNRE)

This is a new governmental organization established in October 2002, following the Bureaucratic Restructuring Act, B.E. 2545 (2002). It is made up of nine work units within three organizations. It was detached from the former MOSTE to oversee environmental matters, while the present MOST is still responsible for planning, promotion, and development in science and technology. The mandate of MNRE is the protection, conservation and rehabilitation of natural resources and the environment, as well as the management of these resources for sustainable uses. Its main functioning organs in the field of environmental protection are PCD, OEPP/OER, DEQP, and DGR. The 1992 NEQA is the legal reference for MNRE's operations. Its responsibilities, related to the industrial environment via many departments, consist of monitoring and implementing environmental protection in general.

The Ministry of Industry (MOInd)

The main tasks of MOInd are to promote and develop the industrial sector, including the promotion of investment and entrepreneurs' capacity building. There are nine departments in the MOInd. Certain government agencies under this Ministry are also charged with controlling industrial pollution such as DIW and IEAT/NRIE. MOInd can be regarded as another governmental organization working to safeguard the environment, particularly through the 1992 Factory Act. The responsibility of environmental management of industrial companies lies with the Department of Industrial Works (DIW), which will be described in the following section.

The Ministry of Public Health (MOPH)

The MOPH is a state agency working for improvements in general public health, and health protection and treatment. However, it has certain work units that deal indirectly with the food industry's production process and environmental protection. One of these is the Food and Drug Administration (FDA). The 1992 Public Health Act authorizes the FDA to grant approval for Food Safety Standards, and Food and Drug Certificates as well as monitoring the Good Manufacturing Practice (GMP) to protect consumer safety.

The Ministry of the Interior (MOI)

The Ministry of the Interior has authority over local authorities via the Department of Local Administration. The MOI aims to decentralize administrative powers to local

governmental organizations, such as the aforementioned PAO and TAO, especially in the field of local environmental management which is a core function of these local agencies. PAO and TAO cooperate with the related authorities when implementing environmental policies at the local level.

Provincial Level:

Central state agencies are normally responsible for national policies but implementation at the local level depends on the local agencies, which act in agreement with central government policy. The agencies involved in environmental management can be separated into those that act at a policy level and those that focus on implementing these policies.
Provincial Level: *Policy level*

The Office of Environmental Policy and Planning (OEPP)/The Office of Environmental Region (OER)

The OEPP, under MNRE, is an agency responsible for establishing plans and policies on natural resources and environmental management at the regional level. The 1 to 16 regional offices, called OER, oversee 25 main watershed areas of the country. The OER 1 to 4 are designated to supervise the development of plans and policies[19] related to improving national environmental quality, such as the preparation of EIA, the management of the Environmental Fund, and coordination with the Provincial National Resources and Environment Office.

The Department of Environmental Quality Promotion (DEQP)

This department supports other governmental organizations. It works to promote greater communication with the public about environmental affairs, so that they can become more environmentally aware. It also compiles useful data and information relevant to environmental management that can be accessed by all interested parties. It can therefore play a coordinating role between the government, private, and civic sectors to support environmental sustainability.

The Department of Artesian Wells (DGR)

Formerly a part of the Department of Mineral Resources, it came under the auspices of MNRE in 2002 with the main task of implementing the 1977 Groundwater Act. This act aims to prevent both water pollution and the overuse of groundwater. It

[19] Part of the area for which these 4 offices are responsible overlaps with the Central Region, because it is delineated by main watershed boundary.

collects a groundwater fee from users, especially in the industrial sector, to put into the Groundwater Development Fund. In theory, it could contribute greatly to combating the problem of natural resource depletion, groundwater in particular, in the industrial sector. In practice, however, SMEs are usually not required to pay, as DGR staff levels are insufficient to implement the Act[20].

Provincial Level: *Implementation level*

The Provincial Natural Resources and Environment Office (PEO)

PEO is a new agency in MNRE, created to oversee local natural resources and the environment in each province[21]. It was created by reallocating work that was formerly done by various different governmental organizations so as to better coordinate policy implementation relating to natural resources and the environment. Its present responsibilities include monitoring the Environmental Impact Assessments (EIA) of various projects dealing with all kinds of problems related to natural resources and the environment. As such, it coordinates its activities with various public agencies at the policy and local implementation levels, and with local communities. Being a newly established agency PEO has been assigned a limited role and budget, and it is not yet able to play the role set out for it in the Environmental plan[22].

The Pollution Control Department (PCD)

This is a major state agency dealing directly with pollution control with the authority to establish environmental standards and measures for controlling pollution at source. It also provides the data with which MOInd applies and sets effluent standards for industry. One of the main functions of PCD is to monitor national environmental quality and to prepare an annual report on the state of the environment. Its other responsibilities include monitoring levels of pollution, preventing, controlling and remedial measures associated with pollution problems, and developing effective procedures for dealing with air, water and noise pollution, hazardous substances, and toxic waste. This is all done at the local level. It can respond to any complaints about pollution problems, especially industrial pollution, although PCD itself has no authority to enforce environmental regulations. Therefore, to effectively control industrial pollution, it needs to cooperate with many other agencies, DIW in particular.

[20] For example, at present there are only 4-6 officers in charge of the northern area (OEPP, 2004).
[21] There are 75 agencies in the country excluding Bangkok.
[22] From an interview with OER officers, October 2003.

The Department of Industrial Works (DIW)

DIW is a major governmental organization prescribed by the 1992 Factory Act to play a key role in industrial waste management before emitting any effluents into the environment. It does so by helping to develop the capacity and efficiency of factories in this area. It is also authorized to monitor pollution in accordance with the 1971 and 1990 Machinery Registration Acts, the 1992 Hazardous Substances Act and the 1992 Gaseous Substances Prevention Act. It has many departments which take responsibility for various aspects of environmental protection, such as the Faculty Environmental Technology Bureau (FETB), which promotes the use of cleaner technology in the industrial production process and analyzes and tests pollutants and hazardous substances. There is also the Hazardous Substances Control Bureau (HSCB), which works to prevent any harm coming from hazardous substances which may be created by industrial activities, and the Faculty Control and Inspection Bureau (FCIB) 1-4[23], which has the important task of inspecting the overall management of all factories. However, the fact that DIW's responsibilities cover such a wide area has resulted in an inability to carry out these responsibilities comprehensively and consistently[24].

The Northern Region Industrial Estate (NRIE)

The Industrial Estate Authority of Thailand (IEAT) was established by the 1979 Industrial Estate Authority Act to promote and control industrial activities in various industrial estate zones, with emphasis on the prevention of any adverse effects on the environment by ensuring the installment of adequate waste treatment facilities in industrial estates. The NRIE office was created to oversee the industrial estate at Lamphun which has a central wastewater treatment system that collects wastewater from 65 plants for treatment in 7 aerated lagoons covering an area of 75 rai. The estate also has two incinerators so as to manage solid waste effectively. The industrial pollution management system at Lamphun Industrial Estate could well be applied elsewhere. However, as this study concentrates on SMEs factories in rural areas, it will not be examined any further here.

The Provincial Industrial Office (PIA)

The PIA is a subdivision of MOInd and is located in every province. It includes DIW's representatives in the Industrial Work Section. The main responsibilities of PIA are issuing and revoking factory licenses for each enterprise in the province,

[23] The division of responsibilities between the four are according to zones in the country; FCIB 2 oversees the northern region zone and is responsible for inspecting and testing pollutants in each province of its industrial division.
[24] From interviews with government officials and factory managers.

controlling, checking and developing health and safety in factories, and controlling and checking the factories' production processes according to the 1992 Factory Act. PIA officers are responsible for overseeing factories' production activities, including waste treatment and other environmental issues, at a provincial level. At present, inadequate staff levels, compared with the scope of their responsibilities, is the main obstacle to implementing and monitoring industrial environmental management satisfactorily.

The Provincial Public Health Office (PPHA)

The PPHA is a subdivision of the Food and Drug Administration (FDA), at the Ministry of Public Health, which is in turn responsible for implementing many laws, including the 1967 Drug Act and 1979 Food Act. FDA's main responsibility in the food processing sector is to grant food safety certificates to food processors. When assessing food safety, it needs to inspect the various stages of the production processes on a regular basis. At present, it also has to inspect all food factories listed in the 57 categories to ensure that they satisfy the Good Manufacturing Practice standards, another measure for reducing environmental pollution. At the provincial level, PPHA is responsible for monitoring the regulations.

The Thai Industrial Standards Institute (TISI)

The TISI, a subdivision of the MOInd, is authorized with inspecting industrial product standards in accordance with the 1968 Industrial Standards Act. It deals indirectly with pollution control because certain industrial standards, similar to those for exporting products, require the control of pollutants at source. It cooperates with other agencies such as FDA/PPHA, and MASCI in implementing product standardization. Its other responsibilities are to support the development of product quality at the domestic level, which in turn would safeguard the environment and protect the consumer.

The Management System Certification Institute (Thailand) (MASCI)

With the advent of globalization, many requirements for exporting are stipulated in various international standards and treaties. To meet these requirements, the MASCI has been established in coordination with MOInd with the authority to issue the certification necessary to export products, particularly food products, which require high standards to ensure food safety. MASCI is an independent organization operating under the aegis of the Industrial Development Foundation with financial support from the Thai government for the first three years of its operation. MASCI operates as a public-private organization under a Board of Directors and a certification sub-committee, which comprises of representatives from interested

parties and experts from the public and private sectors. Therefore, the operation of MASCI is independent, impartial and non-discriminatory, in accordance with the international standards (ISO/IEC Guide 62). The relevant standards MASCI focuses on are ISO 9000, ISO 14001, and TIS 18000, which was previously the responsibility of the TISI. It also deals with activities aimed at preventing industrial pollution, as well as other standards, e.g. HACCP, GMP, OHSAS, and QSME. At present, there are many applications for certification from an increasing number of industries, although most of them are not small or medium-scale food processing companies.

District and communal level

Local agencies and organizations are vital to the development of an efficient environmental management policy because they can work in association with local communities and SMEs, and also because they can better understand the roots of problems in their area. All these features can help reduce pollution at source. As a consequence, many national governments have adopted the idea of decentralization to protect their own environment more effectively. In Thailand, various acts, such as the 1992 Enhancement and Conservation of National Environmental Quality Act, the 1992 Public Health Act, the 1994 Tambon Council and Tambon Administrative Organization Act, have been passed authorizing local agencies to manage the environment.

The Municipality

Municipalities were established under the 1953 Municipality Act and have various responsibilities in the field of environmental management, namely the maintenance of cleanliness in community areas and the management of community refuse and solid waste in accordance with the municipal environmental management plan. With respect to factories (mostly small-scale industrial plants/home or household industries), the municipal government has the responsibility to monitor and control the amount of pollution they discharge into the environment as well as build a central community waste treatment system, with funding from the Environmental Fund[25].

The Provincial Administrative Organization (PAO)

PAO[26] was set up under the 1997 Provincial Administrative Organization Act, with responsibility at the provincial level and hence overlapping with the jurisdiction of

[25] The Chiang Mai Municipality constructed a central wastewater treatment system in 1997 to reduce pollution problems in the Ping River. However, most factories are located outside the municipal area and industrial wastewater discharge to the river remains a problem.
[26] PAO officials are elected. Its council is led by the leader of the political party that holds the majority of seats in PAO council.

various municipalities and TAO's. If there is any overlap, it can work in cooperation with the two other types of government organizations, but it can also work independently. Currently, PAO appears to play little role in environmental conservation, due to limited information, human resources, technological instruments and a lack of cooperation with environmental agencies.

The Tambon Administrative Organization (TAO)

TAO was set up under the 1994 Tambon Council and Tambon Administrative Organization Act and authorized with cleaning streets, water bodies and public places, managing refuse and solid waste, protecting natural resources and the environment, and maintaining waterways[27]. Performing these duties, the TAOs should be the most effective way of managing the environment since there are now 6745 TAOs operating in both urban and rural areas. However, they still fail to cooperate adequately with other environmental agencies, due to the aforementioned factors. It is clear that the TAOs need more time to carry out their responsibilities effectively in this area.

All of the organizations listed above involved in implementing Thai environmental legislation face various constraints, such as limited resources (both budgetary and human) compared with the scope of their responsibilities, a lack of cooperation among environmental agencies, and a lack of knowledge in implementing environmental rules and regulations. These are the weaknesses of environmental implementation that need to be improved to fully protect the Thai environment.

4.3.3 Environmental legislation

The agencies mentioned above operate within a legal framework that ensures that industrial operations and activities will not create negative impacts on the environment or the health of people living in neighboring communities. The most comprehensive laws they have to implement are The 1992 Enhancement and Conservation of National Environmental Quality Act, the 1992 Public Health Act, and the 1992 Factory Act. Since food safety is an issue in the food processing industry, other laws it has to observe are the 1967 Drug Act, the 1979 Food Act, and the 1968 Industrial Standards Act. Other laws concerning pollution control are the 1971 and 1990 Machinery Registration Acts, the 1992 Gaseous Substances Prevention Act, the 1992 Poisonous Substances Act, the 1979 Industrial Estate Authority Act, the 1992 Public Cleaning and Orderliness Act, the1992 Public Health Act, and the 1983 Maintenance of Canals Act. Moreover, food processing utilizes

[27] One interesting duty of TAO is to give primary approval for permits to operate factories that may have adverse effects on the environment. There are 11 types of such factories listed, and food processing is not one of them.

natural resources as raw materials, so the industry has to observe additional laws including the 1977 and 2003 Groundwater Acts, and Local Government Laws. All the relevant agencies are empowered to issue companies with warnings to control industry's environmental performance.

These laws related to the improvement and protection of environmental quality are implemented by many governmental organizations (Box 4.1). There are four separate categories of laws.

(i) Laws involving the management of environmental problems which require the preparation of an Environment Impact Assessment (EIA), the instalment of wastewater and other waste treatment facilities, or the management of garbage or solid waste. An example is the 1992 NEQA, which provides for the issuance of ministerial orders or notifications[28].

(ii) Laws involving application for, issuance and revocation of permits or licenses to undertake activities that might have adverse effects on the environment, such as those laws determining the duties of factory owners who hold permits, the types of factories that need licenses to operate and applications for permission to handle waste treatment. An example of this type of law is the 1992 Factory Act, which governs the subsequent enactment of eight different ministerial regulations[29].

(iii) Laws involving penalties for any harm done to the environment, such as those laws forbidding the disposal of toxic substances into water bodies, relating to the disposal of hazardous industrial waste[30], prohibiting the discharge of certain sub-standard waste[31], or requiring the installation of equipment to inspect waste before discharging it into the environment[32].

(iv) Laws relating to court procedures in environmental damage cases like the case of industrial discharge that adversely affects human health, and in

[28] For example; Notification of the Ministry of Science, Technology and the Environment issue 4/1996. Subject: Type of factories and industrial estates designated as pollution sources which require effluent control before discharge to public water bodies or the environment, dated January 3, 1996.

[29] For example; Notification of the Ministry of Industry issue 22/1985. Subject: Duties of license holder for factory operation, dated May 31, 1985.

[30] For example; Notification of the Ministry of Industry issue 6/1997. Subject: Standards and controls in factory management procedures, dated November, 1997.

[31] For example; Notification of the Ministry of Science, Technology and the Environment issue 5/1996. Subject: Standards to control wastewater discharge from housing estates, dated January 3, 1996.

[32] For example; Notification of the Ministry of Industry. Subject: Requirements for various factory types to install equipment or special automatic devices to monitor air quality before emitting waste to the environment, dated December 11, 2001.

which legal actions for compensation can be taken under the Civil and Commercial Codes.

The laws and regulations relating to SMEs in the food processing industry are limited: the Factory Act requires the factory owner to obtain a permit from the Ministry of Industry before the factory can be opened or before it can be expanded or altered. Other laws also apply to specific industries such as the Food Act, Drugs Act, Cosmetics Act, Hazardous Substances Act, etc. Other relevant laws are the Machinery Registration Act, the Industrial Product Standards Act, the Labor Protection Law, Tax Rebate for Export Goods produced in Thailand Law, the Building Construction Control Act, the Energy Conservation Act, the Natural Resources Acts, etc. These laws are enforced to safeguard the health and safety of the workers and communities, as well as to protect the environment.

Box 4.1 Environmental legislation and related agencies in Thailand

Main responsible agency	Acts
1. Ministry of Natural Resources and Environment (MNRE)	1.1 The Enhancement and Conservation of National Environmental Quality Act, B.E. 2535 (1992)
	1.2 The National Park Act, B.E. 2504 (1961)
	1.3 The Mineral Act, B.E. 2510 (1967)
	1.4 The Maintenance of Canal Act, B.E. 2526 (1983)
	1.5 The Wildlife Preservation and Protection Act, B.E. 2535 (1996)
2. Ministry of Industry (MOInd)	2.1 The Industrial Estate Authority Act, B.E. 2522 (1979)
	2.2 The Factory Act, B.E.2535 (1992)
	2.3 The Industrial Standard Act, B.E. 2511 (1968)
	2.4 The Machinery Registration Acts, B.E. 2514 and 2533 (1971 and 1990)
	2.5 The Gaseous Substance Prevention Act, B.E. 2535 (1992)
	2.6 The Hazardous Substances Act, B.E. 2535 (1992)
	2.7 The Groundwater Act, B.E. 2520, 2546 (1977, 2003)
3. Ministry of Public Health (MOPH)	3.1 The Public Health Act, B.E. 2535 (1992)
	3.2 The Public Cleaning and Orderliness Act, B.E. 2535 (1992)
	3.3 The Food Act B.E.2522 (1979)
	3.4 The Drug Act B.E. 2510 (1967)
4. Ministry of Interior (MOI)	4.1 The Municipality Act, B.E. 2496 (1953)
	4.2 The Provincial Administration Organization Act, B.E. 2540 (1997)
	4.3 The Tambon Council and Tambon Administrative Organization Act, B.E. 2537 (1994)
	4.4 The Control of Advertisement through Amplifiers Act, B.E. 2493 (1950)
	4.5 Local Government Laws
	4.6 The Land Development Act, B.E. 2543 (2000)
5. Ministry of Transports and Communication (MOTC)	5.1 The Navigation in Thai Waters Act, B.E. 2456 (1913)
	5.2 The Land Traffic Act, B.E.2522 (1979)
	5.3 The Land Transportation Act, B.E. 2522 (1979)
	5.4 The Motor Car Act, B.E 2522 (1979)
6. Ministry of Labor and Social Welfare (MOLSW)	6.1 The Labor Protection Act B.E. 2541 (1998)
7. Ministry of Agriculture and Co-operatives (MOAC)	7.1 The Royal Irrigation Act, B.E. 2485 (1942)
	7.2 The Fishery Act, B.E. 2490 (1947)
8. Ministry of Justice (MOJ)	8.1 The Penal Code, B.E. 2499 (1956), Sections 237, 239, 375, 380, 396
9. Ministry of Energy (MOE)	9.1 The Energy Development and Promotion Act B.E. 2535 (1992)
10. Ministry of Science, Technology and Environment (MOSTE)	10.1 The Energy Conservation Promotion Act B.E. 2535 (1992)

Source: Compiled by the author. Data based on Thailand's Law and Regulations, 2005.

4.3.4 Environmental policy instruments

Thailand, as in many developing countries, has employed a conventional approach to environmental policy. In particular it has adopted a command-and-control system that uses laws, standards, and regulations in a top-down structure to implement policy. It also applies the Polluter Pays Principle (PPP), which is a market-based instrument to control pollution. Thailand currently manages the environment by implementing environmental standards, monitoring and inspecting factories, enforcing environmental laws, and promoting technological development, training and education, economic instruments, product (food safety) standards, and EIA.

Environmental Standards:

After the enactment of the 1992 NEQA, MOSTE, the agency formerly in charge of environmental protection, began to establish reference standards for air and water pollution, both quality and quantity. There are two kinds of standards; i) environmental quality standards that focus on general environmental issues such as air and water quality; and ii) emission standards that focus on the source of the pollution (air stack, wastewater pond, etc.). This Act also authorizes local government agencies in various provinces to establish their own environmental standards to suit their area. These can be quite different from the 'normal' standards. These standards are a useful tool when monitoring and inspecting the environment, as well as when enforcing environmental laws. However, it has been found that the enforcement and implementation of environment quality standards are still less than satisfactory in the industrial sector (MNRE, 2004). The reasons for this are discussed in section 4.4. Nevertheless, after the structural reform of various state agencies involved with environmental issues in 1992, certain criteria have been redefined to keep abreast of changing situations and circumstances.

Monitoring and Inspecting Factories, and Enforcing Environmental Laws:

MOSTE, MNRE, and MOInd are the monitoring authorities at the national level with DIW, NREP, PCD, IEAT and PPHA being the agencies that implement environmental policy. The inspection centers are at the central and local level. Environmental quality standards suited to local circumstances are set up. Monitoring and inspecting factories, as well as enforcing relevant laws, are important in controlling producers/polluters' behavior, to see whether they are treating the environment in a responsible way. However, budgetary constraints, together with low staff levels, compared with the amount of work they have to process has forced the implementing agencies to limit their work to just the major environmental problems.

Effective enforcement of laws is needed to deal with environmental problems. The 1992 NEQA provides a broad policy framework setting many standards for implementation. Other relevant laws must be used in conjunction with this Act when defining violations. This puts needless constraints on the smooth management of the environment. Although a number of ministerial notifications have been subsequently issued, the lack of effective enforcement has meant that polluters/industrial sector have not had to meet the requirements of environmental laws.

Inspection is an effective measure to protect the environment. Following the enactment of environmental laws, MOSTE/MNRE have taken their responsibility for routinely inspecting the factories and their production processes by delegating the EIA monitoring tasks to PCD, PEO, and NREP. The MOInd has also authorized DIW to inspect various factories. MOPH has authorized the PPHA to monitor the food processing industry. However, there are still many complaints about pollution problems, indicating the inability of government authorities to fully protect the environment. Serious inspection is normally carried out when there is an obvious problem or in response to complaints from the local communities.

Environment Technological Development:

This involves the development and implementation of production technology that uses fewer inputs with minimum effluents, the selection and promotion of cleaner technology or other green treatment technologies, for which the National Master Plan on Cleaner Production was approved by the government in 2002. These are important tasks for MOInd, MNRE and MOSTE, in cooperation with other governmental agencies and the mass media. There are also regular training programs in cooperation with international organizations, such as the training workshops in Cleaner Technology, ISO 9000 and ISO 14001 standards, and the Environmental Management System (EMS) for SME program, etc. In addition, the establishment of the National Food Institute (NFI) as an independent body to foster technological development in the food industry is also valuable. This institute has initially gained support from the Department of Export Promotion (DEP), the food industrial sector of the Federation of Thai Industries (FTI), the National Science and Technology Development Agency (NSTDA) and MOInd.

Economic Instruments:

Economic instruments are accepted mechanisms for implementing environmental policies, in which the 'polluter pays principle' is a core concept. There are many economic instruments used to protect the environment in Thailand, such as pollution charges, tradable permits, product charges, resource taxes, etc. The Environmental Fund and Tax Promotion are other economic instruments creating incentives to

reduce pollution. However, these instruments are not so effective with SMEs. The Environmental Act provides various alternative measures such as Tax Exemption for import duty paid on necessary machines or materials which are not available domestically, Income Tax Exemption for foreign experts who supervise waste treatment systems, and the Environmental Fund which provides loans, upon approval of the Fund Committee, for use in environmental management. However, limited manpower in relation to the tasks involved means that economic instruments are still not implemented adequately (DIW, 2002). SMEs in the food processing industry are exempt from some charges, such as resource taxes, due to the government policy of supporting SMEs, which was explained in Chapter 3.

Product (food safety) Standards:

GMP, HACCP, ISO 9000, ISO 14000, TIS 18000[33], and BRC[34] are food safety standards. These are both directly and indirectly related to environmental protection. GMP and HACCP are the main certifications used to guarantee food safety. The others deal with industrial environmental management. These standards are international requirements guaranteeing product quality as well as environmental management performance. Recently, FDA/PPHA, TISI and MASCI have taken on the responsibility of implementing these standards. Although these standards have been promoted in the industrial sector, there are few industries which apply for them. At present, only GMP is strictly monitored, the others being more self-regulatory. The number of food processing companies certified with ISO 14000 in the country is quite low; in total 43 companies (TISI, 2005), and all of these are large-scale firms.

Environmental Impact Assessment (EIA):

EIA is designed to analyze and assess the possible environmental impacts, both negative and positive, of any development programs/projects, whether they are for economic gain, related to the construction industry, or for any other purpose, including those involving environmental pollution prevention/remediation. Thailand requires all large-scale projects to undertake an EIA, and grants are only approved for those projects passing EIA criteria. At present, it is not a requirement for SMEs to apply for EIA, although certain SMEs have a significant impact on the environment.

[33] The Thai Industrial Standard 18000 (TIS) is an industrial standard that guarantees the health and safety of Thai industrial products.

[34] The British Retail Consortium (BRC) is an international standard which requires higher standards than GMP and HACCP. It is required by some retailers, such as Tesco Lotus, for food exported from Thailand to European Countries.

4.4 Epilogue

It is apparent that there was a major shift in environmental policy in Thailand 15 years ago with the 7th NESD Plan, as a result of increasing natural resource depletion and environmental degradation. MOSTE was created as the main environmental agency at the policy level and it was central to the development of the 1992 NEQA. With the enactment of this Act, several governmental organizations/agencies have been established at regional and local levels to implement various environmental laws, supervise EIAs of development projects, and collect data in order to develop effective plans/programs to solve environmental problems or protect the environment (MNRE, 2004). Nonetheless, the policy and implementation efforts seem to have been not so successful and still contain weaknesses for the following reasons: i) the lack of a strong environmental legal framework, as priority is often given to economic development without due regard being paid to environmental issues; ii) conflicts in policy implementation and the lack of cooperation between various state agencies; iii) the question of overlapping responsibilities of various state agencies involved in environmental management; iv) inadequate manpower, budget and technology; v) the lack of rigorous implementation of environmental laws and regulations; vi) the lack of active cooperation between the general public and industrial entrepreneurs in environmental affairs.

Recognizing the above shortcomings, the Thai Government in 2002 stated the need for a structural reform of governmental organizations that places the emphasis on dealing with environmental degradation problems in the 9th Plan by proposing the following measures: i) adopting a holistic environmental management process stressing local participation so as to create environmental awareness, enforcing relevant laws, and developing nationwide databases; ii) developing waste treatment facilities which are acceptable to local communities, developing pollution control technology, improving environmental standards to be comparable to international standards, and making management and administration more efficient; iii) revising environmental laws by including economic instruments and social measures to help ensure sustainable environmental management; iv) conserving and restoring the natural and cultural environment so as to support the community as well as to protect the environment. All these policy initiatives should be handled in conjunction with greater coordination between all the organizations involved in environmental management.

Chapter 5

Fruit-Vegetable Processing in Northern Thailand[1]

5.1 Introduction

Thailand is an agricultural country. Its northern region in particular produces a large volume of fruit and vegetables, which needs to be packaged and stored. Canned and processed fruit and vegetables are leading the food industry in terms of their contribution to value-added. The northern region of Thailand has a significant industrial share of small and medium-sized fruit and vegetable processing companies[2] (MOInd, 1990, Department of Industrial Work, 2004), because its climate and land conditions are favorable for almost every kind of vegetable and fruit tree cultivation.

This empirical chapter starts with an introduction in this section. Section 5.2 provides profiles of the four companies studied[3]. Section 5.3 analyzes environmental impacts on fruit and vegetable processing, which is followed by an analysis of potential environmental improvements through the model for prevention and minimization of waste (section 5.4). The roles of various actors and institutions in implementing this model are analyzed within economic, policy, societal, and family networks in section 5.5. The last section, section 5.6, consists of a conclusion, as well as recommendations to enhance performance.

5.2 Fruit-vegetable Processing Companies: Case studies A, B, C and D

The fruit and vegetable processing factories selected for this case study are located in the rural upper northern region of Thailand. Two small-sized and two medium-sized companies in Chiang Mai province[4] were selected and the differences in their

[1] Some data was used to formulate a paper presented at Enrich international conference on 'Managing the Environment in Transitional Economies: Asian Perspectives', September 26-27, 2002, Beijing, China. And the earlier draft of the chapter was presented at AGITS international conference on 'Changing Environmental Governance in Asia. Globalization Industrial Transformation and New State-society Relations', October 11-12, 2003, Chiang Mai, Thailand.

[2] The number of registered fruit and vegetable processing companies located in each region is: Central 50, Northeast 531, North 241, South 55, and East 241 (DIW, 2004).

[3] The interviewed were all conducted between 2002 and 2003.

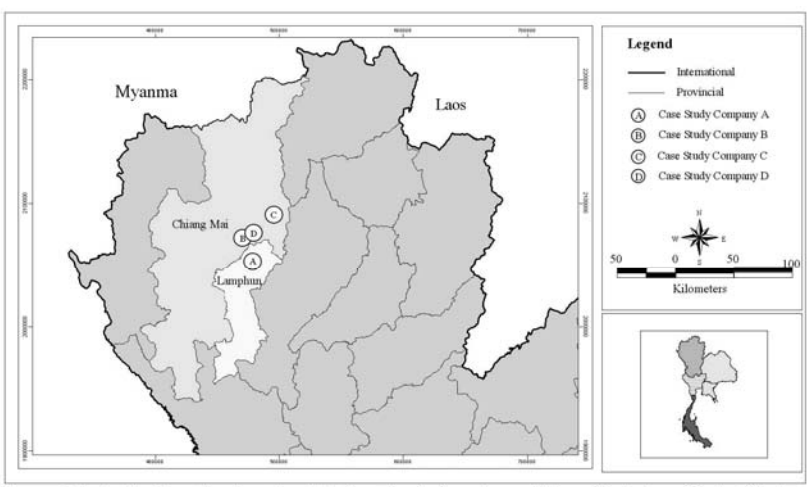
[4] The number of registered fruit and vegetable processing companies located in the Northern region is: Chiang Mai 43, Chiang Rai 18, Lampang 9, and Lamphun 1 (DIW, 2004). This data counts on a number of fruit and vegetable in which its production process produce a lot of waste, so fruit dried processing company is under counted.

performance were compared. The four case studies are selected to represent the diverse nature of the fruit and vegetable processing industry in various regions of Thailand by using the listed criteria:

- The selected cases are small and medium-scale industry, which produce fruit and vegetable processing products with a reputation on their products and have the potential to expand production into the export markets in the future;
- The companies located in rural area, which are now surrounded by residential communities;
- The companies have labor and capital capacity with comparable production capacity;
- Each factory employs different production technology and is representative of a wider group of enterprises;
- Willingness of the selected companies to share experiences and corporation on environmental improvement.

It was hoped that these comparisons could show us possible areas for improvement in production processes and management.

Map 3 The fruit and vegetable processing case study companies in Northern Thailand



Source: Adapted by the author based on data from Geo-informatics and Space Technology Center (Northern Region), Thailand.

5.2.1 Geographical profiles

Each factory in this study is located on its own land in the periphery of Chiang Mai City. Site selection criteria consisted of isolation from community settlements, adequate spacing, and ease of transportation of both raw materials from source, as well as finished products to market. However, on the fringe of the factory area there is usually a rural community, which provides a useful labor source. One exception is the fruit and vegetable company C that has to recruit its workers from a neighboring province (Lamphun), due to the absence of a nearby human community and the presence of a large farming area. Nevertheless, the sites of these factories are progressively becoming closer to other communities as a result of an urbanization process of rural areas in which more and more people settle in former rural areas. This means that it will become more difficult in the future for factories to expand their land area and scale of operation.

Apart from the above-mentioned criteria for factory site selection, infrastructure is another decisive factor, particularly the electricity service, as most processing plants are situated in suburban areas and hence cannot benefit from the allocation of electric power for industrial purpose as in the case of various industrial parks. Every factory in this study had to face major problems, due to power failures, necessitating the installment of its own power reserve or back-up system. This was particularly true for companies C and D, which employ high-level technology for their production and waste treatment processes and thus have a large demand for electricity.

As every factory is located outside the service area of the Water Work Authority, each has to depend on its own groundwater supply and pays water charges by volume used, monitored by a water meter, to the Department of Artificial Wells (DGR), which is then contributed to the Groundwater Development Fund[5]. The expense incurred by the factory for this includes the electricity payment[6] and groundwater fee[7] per cubic meter at the rates set for industrial use. The water will be treated to

[5] The Groundwater Development Fund has the corporate objective to conserve and develop groundwater, a natural resource, for the overall protection of the environment.

[6] The Provincial Electricity Authority has established different payment rates for eight categories of users. Industrial users will be charged at the rates according to the average energy demand in the defined period, specifically as small, medium, and large scale users. For each category, the rates will also be progressive in blocks of unit use and time of use whether on-peak or off-peak. In addition, 7% value added tax is charged.

[7] Groundwater charge is payable four times a year to the Department of Artificial Wells, previously known as the Groundwater Resource Department. The rates are different for rural areas and urban (including its periphery) areas. Factories in rural areas with no public water service will be entitled to a reduction from the 3.50 baht/litre^2 groundwater charge, at varying levels depending on the size and type of industry. The factories under this study pay, on average, groundwater charge at 1.05 baht/ litre^2.

satisfy the quality standards for different utilization purposes such as water for cleaning raw materials and equipment, and for cooling at a stabilized temperature. This water has to satisfy certain criteria with regard to sediments, pH level, and chlorine treatment. For water that will enter the consumption process, namely that is used to prepare syrup or pickling, its quality must be treated to an acceptable standard through carbon of resin filtration. Wastewater from the production process of each factory, except factory A, was drained to a pond for treatment before being discharged to public water bodies. Factory A hires an agent to drain off the wastewater and then dispose of it elsewhere, as the company owns no treatment facility.

5.2.2 Socio-economic profiles

Factory A was established 25 years ago by the owner and his wife, operating as a household industry. Factory B was originally a family business, but has now been operating for 20 years as a joint-venture among siblings. Factory C was set up 15 years ago as a registered company from the beginning and presently has a clear division among different business sections. Factory D was established 13 years ago and has operated in a similar nature to C. Companies A and B produce mainly for the domestic market, have a low investment capital (no more than 10 million bath), and employ no more than 50 permanent workers. Companies C and D are medium-sized industries with 10-15 million bath investment capital and more than 50 workers. Fruit and vegetable company C was established under the Board of Investment privilege program to operate a business of processing agricultural products for the international market. Companies C and D both employ high-technology production processes, mainly with imported machinery. Their major export markets are in Asia, followed by the USA, Canada and certain EU countries.

All factories, with the exception of D, use fruits and vegetables grown in northern Thailand as raw material inputs. Factory D produces a wide variety of products and hence has to procure raw materials from other regions of the country. The procurement of raw materials is generally undertaken by each company itself, including its purchase from wholesalers who deliver a specific quantity at a specific time. The exception is fruit and vegetable company C, which procures its raw materials through contract farming, in which contract farmers are provided with Genetically Modified seeds[8], fertilizer, and pesticides. Company C then purchases all the contract farmers' produce at guaranteed prices. Other raw materials, such as salt, sugar, and chemicals, including packaging materials for each factory, are supplied by various suppliers as they are produced in the central region of Thailand.

[8] In Thailand, apart from the need for an import license for the raw materials, no legal permission is needed to use GM seed in cultivation. However, in this case it is only used in contract farming, and the products are mainly exported on the international market.

Most factory workers have completed compulsory education, and receive a daily wage of 130-200 baht/day depending on gender, skill, work experience, hours worked and level of responsibility. Most are uneducated, but specialized in one specific process or task. Those with greater experience are multi-skilled and capable of doing various tasks at the same time. The number of workers in each division varies with the nature of the work involved and the urgency to complete the work at that time. At the peak of the fruit and vegetable season, the demand for labor may be twice the normal labor requirement. This increase in demand for labor is usually satisfied by temporarily hiring female workers, who will work for a lower wage. As well as factory workers, each company employs some office workers, who are bachelor degree graduates in relevant fields, are paid a salary starting at 6,000 bath/month or above, and receive social welfare benefits. They make up over 5percent of all the workers in each company. Meanwhile, the principal administrators of these companies are the owners, relatives of the owners, or their co-investors.

5.3 Environmental Impacts of Fruit-Vegetable Processing

5.3.1 Production and environmental profiles

***Input*:** All the companies in this study are in the fruit and vegetable processing business, using such raw materials as mango, lychee, longan, peach, garlic, etc., which are grown in the northern region of Thailand. The only exception is the fruit and vegetable company C, which puts an emphasis on baby corn products and hence depends on various input sources. Meanwhile, fruit and vegetable company D, which also processes outputs according to order, may require different raw materials from elsewhere, although still from domestic sources. Other raw material inputs are sugar, salt, vinegar and chemical additives, such as Glacial Acetic Acid, Sodium Benzonate, Ascorbic Acid, Sodium Metabysulfite, Hydrogensulfite, and Calcium Chloride, to enhance crispiness. Factories A and B depend on gas and electricity as their main energy input while C and D use fuel oil/bunker oil and electricity. All factories pump groundwater from their own wells for use.

***Production Technology*:** The production processes of all factories are summarized in Figures 5.1 and 5.2. These show differences in levels of technology and types of machinery, as well as packaging processes. Fruit and vegetables are prepared for further processing, namely by peeling, pitting, rotten and unusable parts being removed, etc., and then cleaned[9]. At this step, if the products are to be pickled or

[9] Fruit and vegetable companies A and B order fruits and vegetables that have already been partially cut and prepared to simplify their production processes and to minimize waste that

preserved in syrup, factories A and B will add another prior process by soaking the prepared raw materials in brine at various concentration levels for 15-30 days before preserving them in syrup and packing them in a glass jar or a plastic box. Canned products are subject to a similar process, except for the last step, when fruit or vegetable pieces are filled into cans before the adding of heavy or light syrup. Then the cans are sealed and pasteurized for a time and at a temperature suitable for the product. After being pasteurized, the cans are cooled off and dried. Finally, they are labeled and packed in bulk containers.

would have otherwise occurred at their factories, such as water use, peels and leaves and other residues.

Figure 5.1 The production processes of fruit and vegetable processing companies A and B

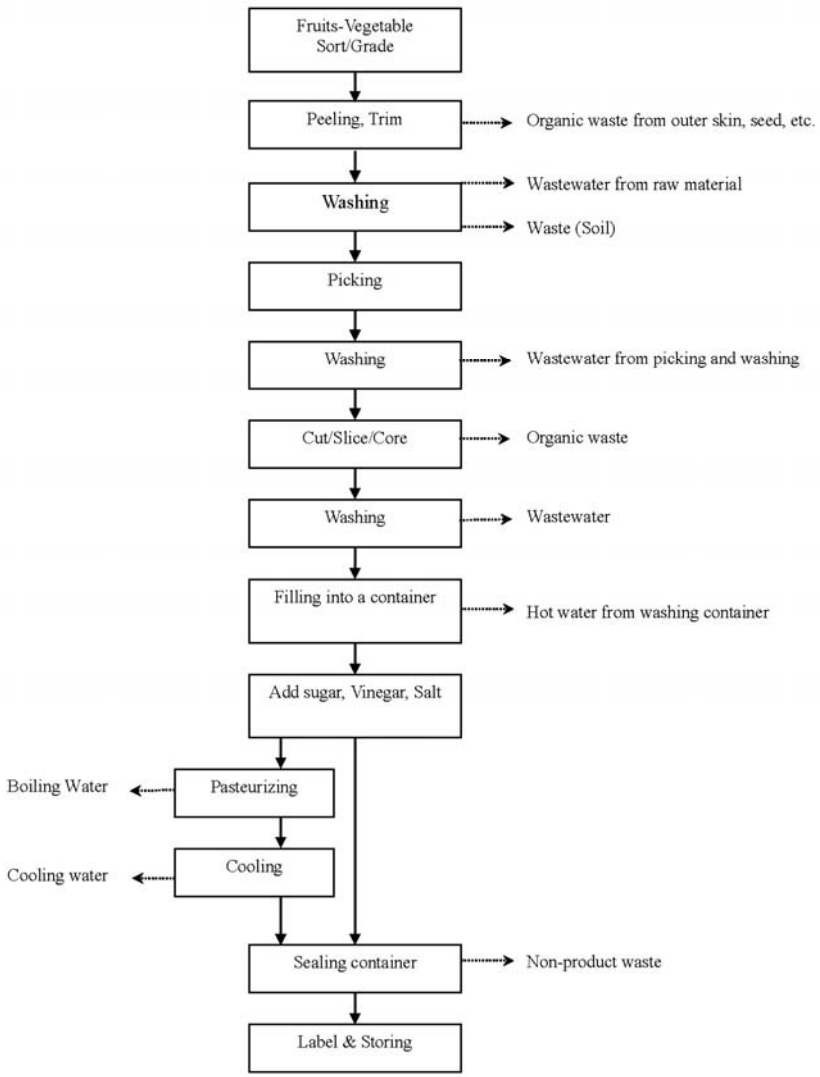
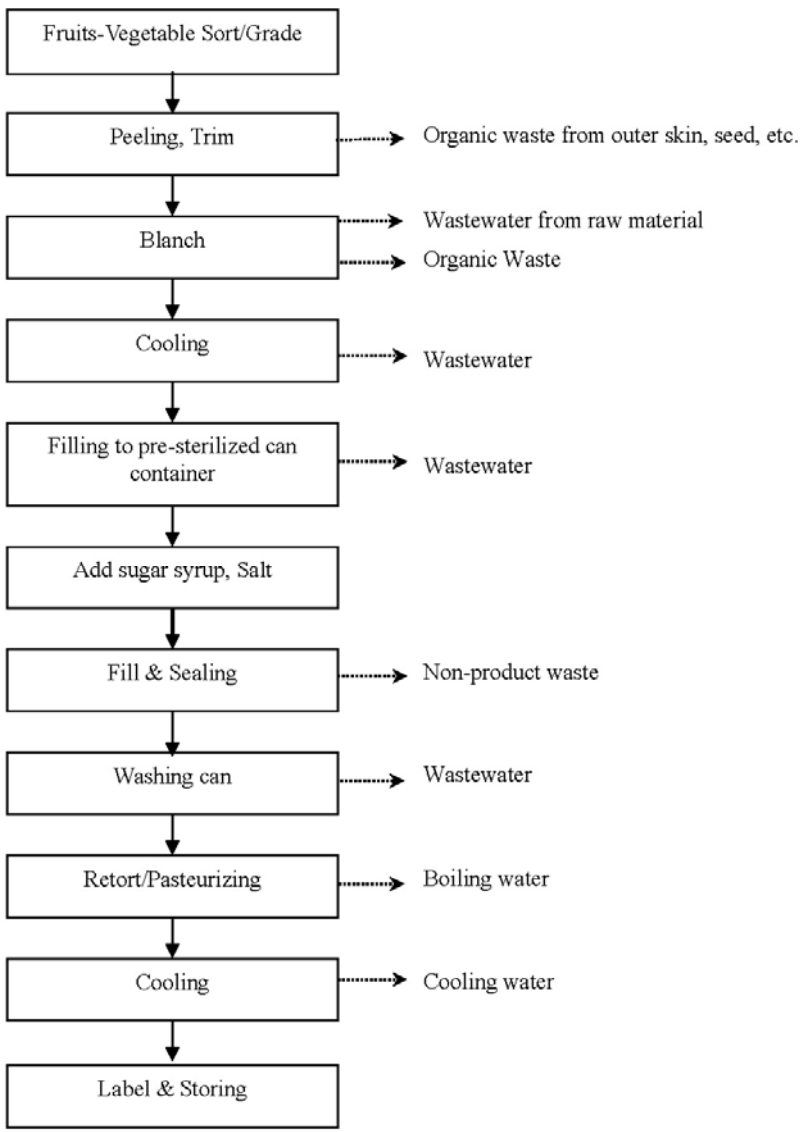


Figure 5.2 The production processes of fruit and vegetable processing companies C and D



5.3.2 Environmental implication

It was found that the major industrial waste was wastewater, which also varied with the production capacity, factory size and types of technology used. Water usage in the fruit and vegetable processing industry is for canned fruit: 2.5-4.0 (cubic meters per metric ton of product); for canned vegetables: 3.5-6.0; for frozen vegetables: 5.0-8.5; for fruit juices: 6.5; jam: 6.0 (Environmental Engineering Department, 2002). Raw material cleaning, pickling brine, and the cleaning of tools and equipment all produce wastewater. This wastewater is then drained into a collecting pond. It is obvious that the crucial problem is not only the quantity of water used, but also its quality as it is concentrated with a large amount of salt in brine water. In the case of factory A, some wastewater is directly drained off into a public area behind the factory site, while some polluted wastewater (covered with fungi) is kept in the collecting pond to be disposed of once a week by a private firm. Factory B has an oxidation pond, but it does not carry out a wastewater quality check before it releases wastewater into a public area near the factory. Factory C has a closed wastewater treatment system in which all the wastewater is treated by separation/filtration of solid waste before entering an activated sludge process for sedimentation, and after a quality check the water is drained into public waterways. The sludge or sediment is removed once a month for utilization as freshwater in nearby farms. Factory D has an open wastewater treatment system in which all wastewater after the infiltration process will be treated. Here, the water is subject to aeration, and microorganisms are added[10] to reduce malodor and to accelerate the breakdown of sludge. The remaining solid waste will settle into a sediment and the treated wastewater is transferred to a resting pond before being drained into public waterways. Every six months, the company removes the sludge, which is then used as a fertilizer at a nearby fruit orchard.

Apart from wastewater, the other main waste is solid matter coming from cutting, trimming, or other preparation, such as peeling, seeding, pitting. Solid waste is managed and treated differently in each factory. Companies A and B engage private firms to remove the waste for disposal elsewhere. Solid waste from fruit and vegetable company C is collected by a local agricultural cooperative for use as animal feed and that from fruit and vegetable company D is removed to be used as fertilizer for perennial trees in farmers' fields. Other solid waste, such as metal and plastic scraps, is sold for recycling. The remaining processing waste and garbage is taken away by private firms hired for this purpose, for disposal at garbage dumps in

[10] Effective microorganism (EM) technology, developed by Professor Dr. Teruo Higa of the University of the Ryukyus, Okinawa-Japan, has been introduced in Thailand since 1983 to reduce malodor of wastewater. See more at http://cwds0.tripod.com/em.html.

town. The factories sometime burn part of their waste and garbage on site, which can cause air pollution as well.

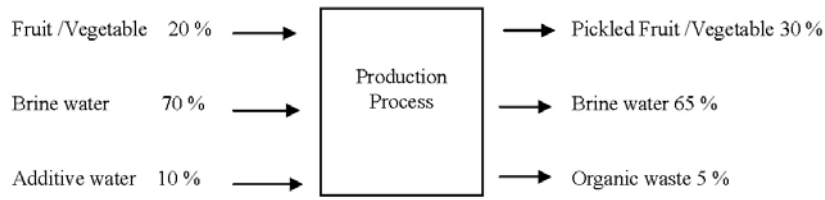
It should be noted that part of the wastewater that receives no treatment is normally released into nearby public waterways in a haphazard manner, giving rise to water quality problems in both surface and groundwater as well as flooding in low-lying areas.

Table 5.1 Balance of input and (all) output materials (without water and energy) of fruit and vegetable processing companies in Chiang Mai Province

Materials / Food Industries	Inputs	Outputs	
	Raw material	**Product**	**Waste**
Company A	Fruits/Vegetables Sugar Vinegar Salt Chemical Jar, Wrapping Materials	Dried fruits Chutney fruits Pickles fruits Pickles vegetables Salted fruits Salted vegetables	Waste fruit Waste vegetables Waste water Wrapping materials
Company B	Fruits Sugar Vinegar Salt Chemical Wrapping Materials	Dried fruits Chutney fruits Pickles fruits Pickles vegetables Salted fruits Salted vegetables	Waste fruits Waste vegetables Waste water Wrapping materials
Company C	Vegetables Fruits Salt Chemical Can, Wrapping Materials	Fresh vegetables Fresh fruits. Brine vegetables Canned tropical fruits	Waste fruits Waste vegetables Waste water Air pollution Heat Wrapping materials Sludge from treatment plant
Company D	Vegetables Fruits Sugar Vinegar Salt Chemical Can, Wrapping Materials	Fresh fruits Brine vegetables Canned tropical fruits Vegetables in water	Waste fruits Waste vegetables Waste water Air pollution Heat Wrapping materials Sludge from treatment plant

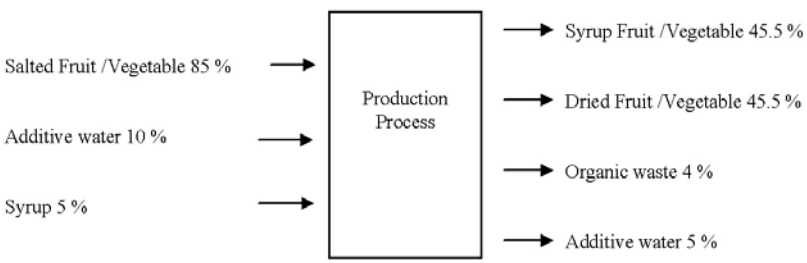
Source: Compiled by the author based on 2003 data interviewed and observation.

Figure 5.3 Balance of input and output material (by volume with water) of pickled fruits /vegetables



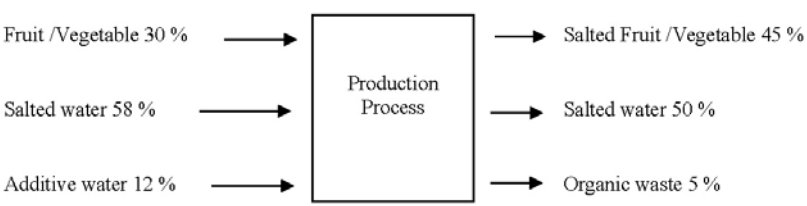
Source: Compiled by the author based on 2003 data interview and observation.

Figure 5.4 Balance of input and output material (with water) of dried and syrup fruits /vegetables



Source: Compiled by the author based on 2003 data interview and observation.

Figure 5.5 Balance of input and output material (with water) of salted fruits /vegetables

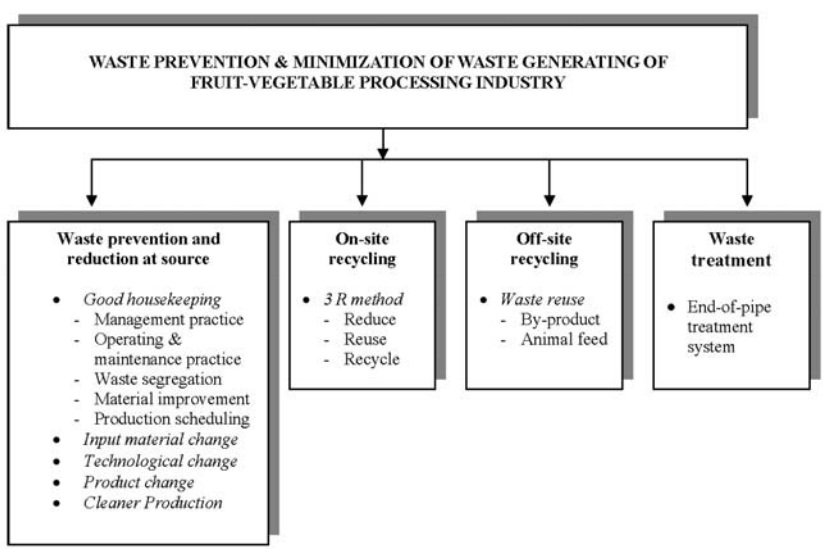


Source: Compiled by the author based on 2003 data interview and observation.

5.4 Environmental Improvements of Fruit-Vegetable Processing Companies

The fruit and vegetable industry generates large volumes of effluents and solid waste. The effluents have a high organic content and include cleansing and bleaching agents, salt, and suspended solids, such as fibers and soil particles. They may also contain pesticide residues from the washing of raw materials. The solid waste consists mainly of organic materials, including discarded fruits and vegetables. Malodor can result from poor management of solid wastes and effluents. As described in section 5.2, different factories have different ways of handling industrial waste depending on the product and production volume, as well as technological differences. This section describes in more detail potential waste management procedures in the fruit and vegetable processing industry. These procedures are outlined in the following diagram[11] in Figure 5.6.

Figure 5.6 The waste prevention and minimization of waste generating of fruit and vegetable processing industry



[11] This diagram is adapted from techniques and options for waste prevention and minimization of waste from the experts with cleaner production concept in industrial processes. The diagram consists of good housekeeping, input material change, technological change, product changes, direct reuse, indirect reuse, and treatment systems to prevent and minimize waste at source.

5.4.1 Waste prevention and reduction at source

Good housekeeping: The prevention and reduction of waste at source in fruit and vegetable processing can be successful without major technological changes and with low investment by implementing good housekeeping practices. Good housekeeping calls for cooperation and discipline in the workplace to comply with environmental guidelines, in which waste is minimized. Cleaner Production is another measure for pollution prevention as it does not only reduce waste at source, but also reduces potential risks to people and the environment. Waste minimization at the factory site starts with certain procedural guidelines being drawn up, together with the use of good housekeeping principles in the prudent use of raw materials, water and energy resources. Management practices, operating and maintenance procedures, stream and waste segregation, material handling improvements, and production scheduling are valuable methods to introduce good housekeeping. Reductions in wastewater volumes of up to 95 percent have been reported through the implementation of good housekeeping practices (CMU, 2002). The following possible measures should be considered when practicing good housekeeping: the removal of solid waste without using water; cleaning raw fruit and vegetables without water (using vibration or air jets, etc.); the removal of waste before cleaning with water; minimizing the use of water when cleaning floors and machines; using countercurrent systems where washing is necessary; using a half-opened valve as a water tap; separating and re-circulating processed wastewater. Some of these measures have already been implemented successfully. For example, dry peeling methods could reduce the effluent volume by up to 35 percent; pollutant concentration could reduce organic load by up to 25 percent; the use of steam instead of hot water could reduce the quantity of wastewater going for treatment, although the tradeoff with an increase in energy use should be taken into consideration (CMU, 2002). These practices should be regularly assessed and subsequently implemented in any effective waste management program.

Input Material Changes: Input substitution of raw materials, such as procuring clean raw fruit and vegetables or using fruit and vegetables in a ready-to-use form can reduce the concentration of dirt and organics (including pesticides). This could also reduce costs in resource consumption, especially the volume of water which is used for preparation.

Technological Changes: Traditionally, technology used in the fruit-vegetable processing production consumes a large quantity of water and energy resources. Improving equipments or providing a new technology to substitute the old one is another strategy to improve efficiency, product quality and thus energy and water saving. If large technological changes mean greater investments, equipment

modification with little changes in existing technology is sometimes preferable. In the traditional production process that uses many labours, layout changes and increased automation are valuable in order to increase productivity and reduce cost.

Product change: In the food processing industry, it is important to extend a product's life, by preservation, for consumption. Improving traditional production processes with new technologies is valuable in making a long-life product, which translates to more profit for both producers and consumers, as well as promoting food safety and respect for the environment. However, this measure needs close cooperation between producers and (food) experts/scientists, with supporting information from related authorities.

5.4.2 On-site recycling

Another way of reducing waste is to reuse or recycle waste. The main concerns are water and energy consumption, which can be decreased using the 3R (reduce-reuse-recycle) method as has been shown in many research studies (CMU, 2002, DIW, 2002). Wastewater used in the last step when cleaning raw materials can be reused and recycled to clean utensils and floors. Moreover, it has been shown that the reuse and recycling method could not only reduce water consumption, but at the same time could also reduce wastewater generated during production. For example, recirculation of process water from onion preparation has reduced the organic load by 75 percent and water consumption by 95percent; similarly the liquid waste load (in terms of BOD) from apple juice and carrot processing can be reduced by 80 percent (CMU, 2002). If these measures are combined with good housekeeping in production processes, it could help to reduce water use as well as waste management costs.

5.4.3 Off-site recycling

In addition to on-site recycling, off-site recycling is another viable way of preventing and reducing waste. One of the measures that could be considered would be to reuse concentrated wastewater and solid waste in the production of by-products. Another possible measure would be to use solid waste, which typically has a high nutritional value (particularly waste from peeling and coring), as animal feed.

5.4.4 Waste treatment

Wastewater: A major part of the industrial waste generated by the factories in this study was wastewater. This was a result of washing and cleaning raw materials, brining/pickling processed fruit or vegetables before adding syrup, and the cleaning of equipment and infrastructure. Wastewater from different activities contains different effluents and contamination levels, as shown in Figure 5.3-5.5. However,

wastewater from all sources was drained into the same resting and treatment ponds. Because cleanliness is the basic requirement among various quality control measures to meet industrial standards for food products, it is often unavoidable to use large quantities of water in the production processes to assure food safety. However, in this study it was observed that most factories use water excessively and imprudently in every stage of production due to a lack of effective planning and controls. Low water costs, resulting from the fact that the companies pump groundwater from their own wells, also contributed to excessive water use. Although water for cooling processes may be reused, this method has only been used on a small- scale and by some factories. If water use can be cut down in certain production processes (such as cleaning) and the treated wastewater can be reused, both the demand for fresh water and the wastewater volume can be minimized.

Recycling or reusing water can be difficult to implement at small factories, which normally have an incomplete wastewater treatment system on site. Although there is a central wastewater treatment facility in Chiang Mai City[12], this facility only serves to treat liquid wastes originating from domestic and household industrial sources in the urban and municipal area. Most fruit and vegetable processing plants are located in suburban or rural areas far from the central treatment facility, making any connection of their wastewater drainage pipes with the facility impractical. Moreover, the construction of a common facility is not feasible as, unlike industrial estates, different factories are not clustered into a tight economic area. Consequently, end-of-pipe treatment technology is the only viable way of treating wastewater before reusing it (for crop irrigation, fish pond farming, etc.). The appropriate system for this type of factory would be an activated biological treatment sludge system[13]. Beneficial organisms are added to the system to accelerate the digestion and sedimentation processes as well as to reduce malodor. Wastewater from brining and pickling processes needs appropriate management, such as the use of solar still[14] or reverse osmosis to eliminate the salt before draining it into the treatment system (Environmental Engineering Department, 2002). As research shows, activated sludge treatment could decrease bad smell and reduce BOD by about 91-95 percent[15] (CMU, 2002). After treatment, the water will be kept in a resting pond, before being removed for irrigation use or discharged to public waterways.

[12] The Chiang Mai wastewater treatment plant has been used since 1997 to reduce pollution problems in the Ping River.

[13] An activated biological treatment sludge system composes of these components: aeration tank, sedimentation tank, and sludge recycler.

[14] A solar still is a very simple device for distilling water, powered by the heat of the sun. See more in detail in http://solar-powered.helpdesk-station.com/solar-tube/Solar-still.html.

[15] BOD of wastewater is between 1350-1500 mg/l, BOD loading is 0.8-1.0 kg., BOD/0.4 kg. sludge detention time is between 3-5 hours.

Solid waste: Inorganic solid waste can be reused or recycled in order to maximize the use value of resources. Furthermore, factory laborers should be taught about good housekeeping and the importance of reducing waste of inorganic raw materials. To save energy, every factory should take measures to control energy leakage. If an advanced production technology is being used, the company can introduce technological changes to reduce energy consumption. For example, the use of hot water for rotation not only saves energy (needed for boiling) but also fresh water consumption. Another possibility is to install a regulator to control the consumption of electricity (so that it does not exceed a specific level) as the electricity for industrial use is charged at progressive rates for different blocks (DIW, 2002). This technological device can save electricity costs for the company, and reduce the country's energy consumption[16].

Organic waste: Organic, decomposable solid waste consists of peels, pits/seeds, pulp or residues after juice-squeezing, vegetable bits and residues from dressing, and sludge from wastewater treatment. Organic waste that is perishable needs timely management. Certain companies handle this problem by having farmers supply prepared or ready-to-be-processed raw materials so as to simplify the production process and reduce costs, by reducing fresh water use, labor costs, and residues. This is an example of clean technology which helps reduce waste from the production processes. Nevertheless, consideration must be given to the spread of effluents into the environment without control. In addition, solid waste can be processed into bio-fertilizer, through fermentation of organic waste and sludge, which can be sold in the marketplace or distributed to the company's contract farmers. This process can save production costs, reduce malodor (from rotten produce), prevent the transmission of diseases (for example, by kitchen flies which occur in the case of waste disposal at garbage site or fruit orchards) and eliminate the problem of sludge disposal.

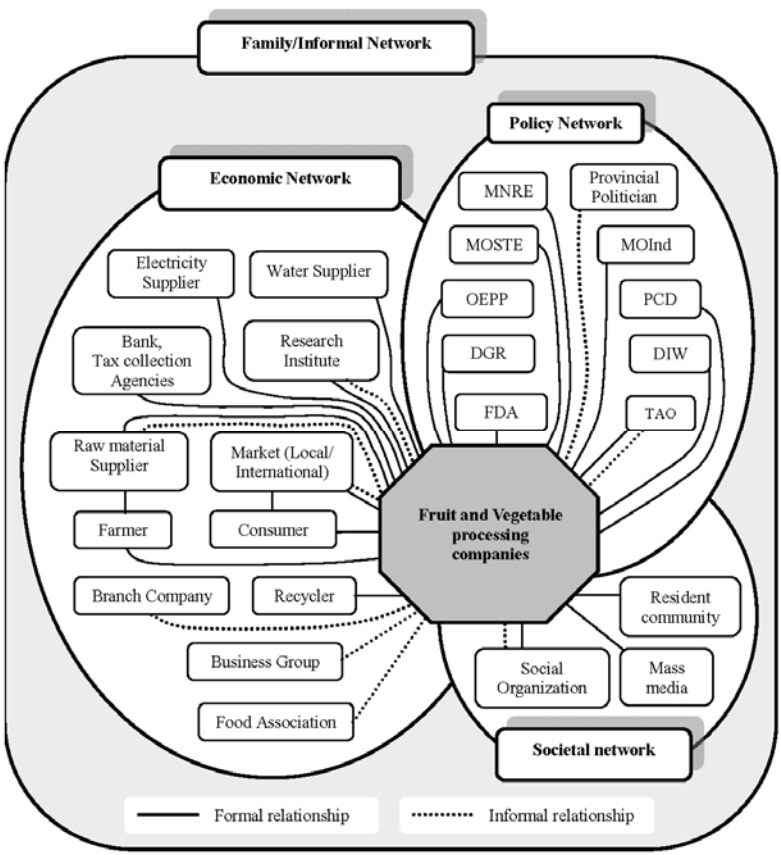
5.5 Actors and Institutions in Environmental Reforms of Fruit-Vegetable Processing Companies

The previous description and recommendations on ways to improve the environmental performance of fruit and vegetables processing companies are primarily theoretical. In practice, there are a number of factors triggering, facilitating, enforcing, or sustaining the entrepreneurs' decision to take or not take certain measures. In recognition of the influence of the socio-economic context of an industrial firm on business decision-making, it is crucial to understand the roles of

[16] There are some governmental projects to support the industrial sector to reduce energy costs. For example, the 'Project of Energy Efficiency Helping SMEs' helps SMEs save on the costs of electricity projects. SMEs need to contact and consult with the Electricity Generating Authority of Thailand and the Department of Industry Promotion to start their plan.

certain actors and institutions in the decision making of fruit and vegetable processing firms, regarding the use of production methods and technology, as well as its management. This socio-economic influence on companies can be portrayed through the analysis of the 'quartet-network', which consists of economic, policy, societal, and family/informal networks of the firm (Figure 5.7).

Figure 5.7 Network embedding fruit and vegetable processing companies



5.5.1 Economic network

In the economic network, the following interactions will be analyzed: i) the relationships of fruit and vegetable processing companies in a product chain by looking at the vertical interactions from input suppliers, producers, customers and consumers; ii) the relationships between different fruit and vegetable processing companies, either directly or via branch association; and iii) the interactions between fruit and vegetable processing companies and other economic agents and research institutes.

Vertical interactions from input suppliers to producers, recyclers, and consumers

Input Supplier. Input suppliers for fruit and vegetable processing companies include farmers, suppliers of raw materials and chemicals, water suppliers, and electricity suppliers.

Farmers. In this case study, most of the inputs are fruit and vegetables cultivated in the northern part of Thailand. The companies A and B order fruit and vegetables in season and process them all year round. They have an unofficial (spoken rather than written) contract agreement with farmers to send raw materials in a ready-to-use form[17] with the same quality all year round. The ordering and delivering depends on the companies' efficiency of production, which in turn varies according to market demand. The farmers are paid directly in cash. By using ready-to-use raw materials, producers can reduce organic waste from the primary process of preparing raw materials. As such, part of the responsibility for taking care of the environment is turned over to the raw material suppliers or farmers. Fruit and vegetable company C has different relations with farmers. They have a kind of contract farming[18] in 4 provinces in the North[19]. They provide selected seeds and fertilizer to the farmers to guarantee a certain quality. In this way, the companies are supplied with quality raw materials with fixed prices for their processing all year round. The contracted farmers cannot sell the products in the normal marketplace, but only to the company. Fruit

[17] Ready-to-use form of raw materials refers to fruit or vegetables that have no rotten or disqualified parts, have been made ready for further processing, namely by peeling, pitting, etc., and then cleaned.

[18] The company provides the contracted farmers with a carefully designed cultivation plan, advice on site selection, proper plant protection and input supply (e.g. seed, fertilizer, etc.), as well as financial assistance under close care and supervision, which are offset when they sell the vegetables to the company. In the beginning, the farmers who are willing to sign these contracts are selected by company agents. Product quality is regularly assessed before entering upon a contract for the next crop period.

[19] The company selected 4 provinces from the North due to the high fertility of the land and the large number of farmers there compared with other provinces. (interview with the manager of the company, February, 2003).

and vegetable company D buys fruit from farmers nearby the firm. The main products of this factory are made from lychee and longan, which are mainly cultivated in Chiang Mai, Lamphun and Chiang Rai. The company orders stock depending on the quantity of fruit needed and their production efficiency. However, sometimes they produce products by special order for larger companies, which forces the producers to order special kinds of fruit from the farmers. In all these cases, a higher quality of raw material means a higher efficiency, as well as less waste from the production process and lower costs for treatment of waste.

Raw material and chemical suppliers. Other raw materials such as sugar, salt and chemicals are purchased from the domestic market under contracts, in which the amount and quality of raw material, the supplying schedule and the price are indicated. The companies order raw materials from different suppliers with different contracts depending on price and quality. The amount of raw materials varies with the quantity of production and is paid for in cash.

Water suppliers. The water used by these companies is supplied from their own groundwater wells. However, they still have to pay the Department of Artesian Wells for any water consumed. This price, though, is quite low and does not provide the producers with enough incentive to minimize water use. Water use is monitored, but only for calculating the necessary payment, not for auditing or minimizing water usage. All the companies stated that they need to use a large amount of water to reach the Good Manufacturing Practice (GMP) standard[20]. On the other hand, because of the large electricity bill, which results from the amount of electricity used to pump the groundwater, companies C and D tried to reduce their costs by using the cooling water to clean equipment and infrastructure. However, this forms only a small amount of the whole water consumption of the companies and the electricity bills are still high.

Electricity supplier. Electricity is produced and distributed by the Provincial Electricity Authority. The government decides on the price. The price of electricity[21] varies depending on the kind of business, the voltage level and demand hours, following progressive tariffs. The price is cheaper for higher voltage and off-peak time[22] use. Due to these criteria and the large electricity bill, which adds up to

[20] Good Manufacturing Practice (GMP) comes from general principles of food hygiene, which is an international standard for food processing. This regulation is implemented by the Ministry of Public Health.

[21] The normal tariff schedule is applicable to a business enterprise, business enterprise cum residence, industrial and state enterprise or the alike, including its compound, with a 15-minute maximum integrated demand up to 30 kilowatts through a single Watt-hour meter.

[22] Peak time use (TOU) is Monday – Friday from 09.00 AM to 10.00 PM. Off peak time use is Monday – Friday from 10.00 PM to 09.00 AM, and Saturday, Sunday and Normal Public

around 30-40 percent of the total production costs, producers are eager to save electricity to reduce their costs. Some companies, such as companies C and D have tried to contribute to the current Saving Energy Program[23] of the governmental department[24]. But they said that it is not clear as to how effective this program is. It is noticed that energy costs has played a role in energy saving systems and water consumption in these companies.

Recyclers. Recyclers play an important role in the reduction of waste by reprocessing waste. Examples of recyclers are agricultural co-operatives and compost producers.

Agricultural co-operatives. Agricultural co-operatives could play a role at local level in minimizing organic waste. Waste from outer skin, seed, and so on can be used as animal feed. Company C donates up to 60 percent, in total raw material weight, of its organic waste to a local agricultural co-operative in Chiang Mai Province. The cooperative is more than happy to accept this kind of waste, which companies provide free of charge. Not only can companies reduce waste this way, but they can also create a positive image within the neighboring community.

Compost producers. At present, there is no compost or fertilizer manufacturing company that composts organic fertilizer from the non-product solid waste generated by the companies. All organic waste from the fruit and vegetable companies B and D are returned to the surrounding fields and gardens free of charge. In fact, farmers usually use a natural compost consisting of leaves and plants together with a chemical fertilizer after harvesting. This situation shows the demand and possibility of reusing non-product solid waste from the companies for composting. It is a good opportunity both for companies to reduce organic waste and for farmers to have organic fertilizer for improving soil structure in a low cost manner.

Consumers/Customers. The consumers of the studied companies can be divided into 2 groups. For fruit and vegetable companies A and B, the consumers are located in the domestic market, especially in the northern and central part of Thailand. In general, these companies distribute their products directly to the market themselves. They also make use of some superstores' suppliers to deliver products directly to superstores or retailers in local markets. Some companies also have their own shop to sell products at the factory (fruit and vegetable company A) or at the main office (fruit and vegetable company B). Consumers can buy the product directly from the original producer at special prices. Therefore, in the domestic market there is little need for food certificates, such as HACCP[25] except for some guarantees about

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Holiday (excluding substitution holiday) from 00.00 AM to 12.00 PM.

[23] See in 12.

[24] This program run by the Ministry of Energy.

[25] Food certification for the domestic market in Thailand is approved and implemented by the

product quality[26], such as the healthy food logo from the Ministry of Public Health, prizes from governmental organizations, provincial brands, etc, which all products from these companies have. This means that their products are above the minimum standard required by these organizations. It should be noted that effective environmental management is needed to attain these qualifications. Since July 2003, all fruit and vegetable companies have needed to pass the GMP standards. However, if they want to export products to overseas markets, they have to apply for higher certificates. That means that they would need to change their production processes and fulfill time conditions set out by ISO 9000 standards or join the environmental management system (EMS) of ISO14000.

Fruit and vegetable companies C and D, however, export their goods to customers in the international markets. Fruit and vegetable company C has a fixed contract with an international retailer, which holds less than 50 percent of ownership in the company[27]. This means that the company needs to rigorously enforce effective quality control. Fruit and vegetable company D has a main office in Bangkok, which exports their products under fixed contracts, and the products are distributed by an overseas distributor to international markets in Asian countries, EU, and Japan. Occasionally this company receives subcontract work for special orders from some exporting companies in the central part of Thailand as well. In order to export to international markets, they need at least a HACCP certificate[28]. Without this they cannot export their products to countries such as the European Union, North America, Japan, and other Asian countries[29]. At present, most of their products have a HACCP certificate, which is strictly checked by themselves[30] and by government officers. As well as

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Thai Food and Drug Administration, the Ministry of Public Health. The Thai FDA examines food, drugs, cosmetics, medical, narcotic substances, devices and potentially hazardous household substances to ensure that these products are safe, efficient and of a suitable quality.

[26] The logo on the label, for food, means that they have been checked by the relevant government organization about their production processes and product quality. Some criteria of the checklist are linked to environmental pollution control. For example, the factory needs to be in a good condition and to be well managed environmentally.

[27] The investment laws in Thailand restrict the amount of capital that can be contributed to the partnership. For private companies, foreign participation is generally allowed up to a maximum of 49 percent. For more details, see the Civil and Commercial Code of Thailand.

[28] HACCP (Hazard Analysis Critical Control Point) is a system used to identify and control contamination in food processing. In Thailand we do not enforce HACCP standards. However, the exporting industry has to pass this standard in order to export to countries such as Japan, USA, Canada and EU countries. This standard shows a willingness to embark upon more environmentally friendly practices.

[29] So as to guarantee quality and safety of production when exporting to countries such as Japan, Canada, New Zealand and Australia a ISO 9000 certification is required; and U.S.A. requires HACCP certification for fishery products from Thailand. However, the main markets are Asian countries, which only need HACCP for canned fruit produce from Thailand.

[30] All the studied companies, except for fruit and vegetable company A, have a quality control section, which checks product quality.

this, in order to keep the certificate, they need to reapply for the certificate every 3 years. Although no domestic retailers require the HACCP certificate right now, the above international requirements imply that certain customers can force the companies to improve the standard of their production processes. Customer power can thus play a role in promoting production processes that are friendly to the environment via product requirement.

Horizontal interactions between producers or via branch association

Fruit and vegetable companies A and B compete with each other and have many other competitors supplying similar products and of a similar size to the domestic market. They do not cooperate on common interests such as marketing, technology development, information exchange, or waste treatment. They have learned to manage their businesses by themselves. Fruit and vegetable company A has no incentive to improve its performance to protect the environment, except for passing the GMP standard. In contrast, fruit and vegetable company B exchanges information with the Federation of Thai Industries (FTI), governmental agencies and a consultancy company about marketing, technology development, products and packaging development, and waste (water) treatment. The interests of company B are best served by seeking cooperation on technology development and wastewater treatment issues. As part of the Chiang Mai Food Industry Group, in association with FTI, fruit and vegetable company B is investigating new technologies in many areas, and this encourages the company to further develop production technology as well as waste management. When developing a wastewater treatment system, the company consulted with experts from Chiang Mai University and a consultancy company to design a wastewater management system that suited their specific needs. Nowadays, the company has an appropriated wastewater management system, which is being monitored by a consultancy agency. Furthermore, as a result of sharing marketing information with other companies in the food industry, this company has expanded its product line to include animal-product processing, which is explored in the next chapter.

Fruit and vegetable companies C and D do not collaborate with each other on technology development in production processes or waste treatment. Although both of them have their own wastewater treatment system, they use different technology to treat the wastewater. However, they have tried to improve their processing technologies and product quality by learning from other similar companies' experiences. For example, fruit and vegetable company C shares information about technology and waste treatment with other enterprises that produce the same product for overseas markets. It also exchanges information with its branch company in Japan for marketing trends. Fruit and vegetable company D has a long experience in exporting and has learned a lot about marketing from other companies on marketing

within their association group, and on technology development via a two-monthly journal of the group. The exchanged information is related to marketing, such as the prices of raw materials, especially local fruits, trends of overseas markets and so on. We can see that both fruit and vegetable companies C and D could profit from relationships with other processing companies regarding economic and environmental aspects.

The interaction between the companies and other economic agents and research institutes

Economic Agents. The term 'economic agents' refers to banks, tax agencies, insurance companies, the Thai chamber of Commerce and the Federation of Thai Industries. The companies have to follow State Bank legislation on interest rates on loans and other activities dealing with currencies. With respect to our analysis the most interesting point is the establishment of SME Bank[31], reorganized from the Small Industry Finance Corporation in 2002, for supporting SMEs with profitable projects. This opens up new opportunities for industry to get loans for their investment. However, investment in environmental management only provides indirect benefit in the long term, so there is no real incentive for companies to get loans to improve their environmental management. By Law, the companies are responsible for paying taxes, including value added tax (VAT), import duty, export duty, personal income tax, etc. The companies, which import raw materials and equipment, have to comply with Export Tax and Import Tax laws. The studied companies pay tax directly to the related governmental agencies, twice a year for business tax and every time when exporting and importing for export and import duty. So far, no existing tax law or regulation provides the companies with enough incentive to adopt cleaner production and/or pollution prevention measures.

Insurance companies supply companies with health insurance and general risk insurance. Although some insurance companies have a kind of industrial insurance[32] – Business Protection – for damage to property, machinery or health problems, this does not relate to the risk of environmental problems, such as floods from excessive wastewater discharge, etc. This means that all the companies in this study are not insured for any environmental damage they may cause.

[31] SME Bank of Thailand is a bank for small and medium-sized enterprises, upgraded and expanded from the Small Industry Finance Corporation into a special-purpose bank for investment in SMEs. The amount of credit given would depend largely on the potential of each project.

[32] SMEs in Thailand can be insured for major property, product or energy damage, and casualty, etc. However, they are not covered for public liability insurance yet.

Being members of the Thai Chamber of Commerce and the Federation of Thai Industries, the studied companies receive economic information. The companies indicated that they wanted more support relating to various subjects from the association. One possibility is to cooperate more with related environmental agencies and research institutes when developing environmental and other programs. Chiang Mai Province, finally responding to the need for one, has now formed an organization[33] for the food industry to provide much more information relating to marketing, technological support, innovation, training programs and so on.

Research institutes. The companies receive technical services and investment consultancy from government research institutes, such as the Thailand Institute of Scientific and Technological Research (TISTR), the Health Systems Research Institute (HSRI), the Industrial Water Technology Institute (IWTI)[34], the National Food Institute (NFI), the Safety Technology Center (STC)[35], the Institute of Industrial Energy (IIE), the Thailand Environment Institute (TEI), and the National Science and Technology Development Agency (NSTDA). They also receive cooperation from other research institutes such as the research centers at Chiang Mai University (CMU)[36] and Mae Jo University (MJU), the Scientific Research Centers, the Joint Graduate School of Energy and the Environment[37], Energy Environment Safety and Health, and the Asian Institute of Technology (AIT). These institutions are always willing to give free advice in order to improve the efficiency of existing processes, increase productivity, and promote product reuse and recycling. Several programs, for example, “Energy Saving Project” (the Faculty of Engineering, CMU cooperating with the Ministry of Energy), “Management of Industrial Pollution Project” (the Faculty of Engineering, CMU cooperating with the Ministry of Industry), “Environmental Management System for Small and Medium-sized Enterprise” (the Faculties of Engineering at CMU, Kasetsart University (KU) and

[33] Chiang Mai Food Industry Group was established in October 2003 to strengthen the food processing industry in Chiang Mai Province.

[34] The Industrial Water Technology Institute (IWTI) was established with the aim of continuously creating expertise in water management for factories.

[35] The Safety Technology Center is a division of the Factory Control and Inspection Bureau, Department of Industrial Work.

[36] Chiang Mai University research institutes consist of the Institute of Science and Technology Research and Development, the Multiple Cropping Centre, the National Research Centre for Environmental and Hazardous Waste Management, the Centre for Waste Treatment and Utilization, and the Institute for Small and Medium Enterprises Development.

[37] JGSEE is one of the seven centers of excellence in graduate education and research supported by the Thai Ministry of University Affairs under its Higher Education Development Project. It is a consortium of five academic institutions led by King Mongkut's University of Technology Thonburi, with King Mongkut's Institute of Technology North Bangkok, Chiang Mai University, Sirindhorn International Institute of Technology at Thammasart University, and Prince of Songkhla University as collaborating partners. Established in 1998, the School is funded by the Budget Bureau through an ADB Loan Program and by the Energy Policy and Planning Office.

Chulalongkorn University (CU) cooperating with the Ministry of Industry) are financed by the Thai government through related government agencies and the Thailand Research Fund (TRF). All enterprises involved in such programs are selected by sector, size, and their willingness to join the program. At present, none of the studied companies have been involved in any of the above projects. They have only been involved in general meetings, training, and consulting on a case-by-case basis. If the projects were extended to reach all small-sized food processing enterprises, the companies in this study would be able to improve their environmental management. The efficacy of any program involving cooperation between research institutes and government agencies with improvement in production as its goal can be shown by the success of the Waste Minimizing Program in Cannery and Vegetable/Fruit Preservation in the Northern Part of Thailand. This program was a result of research by the Department of Environmental Conservation, CMU. It shows that both waste and production costs could be reduced by joining the program[38].

5.5.2 Policy network

In this section, the roles of actors and policy institutions at different levels will be analyzed to see how they can regulate the fruit and vegetable processing companies and encourage them to prevent and minimize waste from their production processes.

At the national level, the state agencies related to environmental management are the Ministry of Natural Resources and Environment (MNRE), the Ministry of Science, Technology and the Environment (MOSTE) and the Ministry of Industry (MOInd). At the regional level are the Office of Environmental Policy and Planning (OEPP), the Pollution Control Department (PCD), and the Department of Industrial Work (DIW). At the provincial level are the Department of Artesian Wells (DGR) and the Provincial Food and Drug Administration (FDA). Finally, at the local/commune level there is the Tambon Administrative Organization (TAO).

The environmental management of production activities in Chiang Mai province is under direct and indirect management of FDA, DIW, MOSTE, and MNRE (national level). In general, the role played by MOSTE and MNRE concentrates on appraising Environmental Impact Assessment (EIA) reports and introducing legislation related to environmental protection. None of the companies in this study are covered by EIA's requirements. The implementing and monitoring of environmental management of production is primarily the responsibility of each department at the provincial level. To begin with, the companies have to apply for a license approved by MOInd and MOSTE before being able to set up their factories. All of the

[38] See details of the program at www.eng.cmu.ac.th.

companies in this study had to seek approval for their waste treatment plants[39] to make sure that the amount of wastewater discharged into the public waterways or into the environment is below the accepted standards set by the pollution control law[40]. The license is applied for once only but no regular checking takes place, unless there is a complaint from the local community about pollution levels. This highlights a weakness in the regulatory and monitoring capacity of related government agencies. For their products, the companies have to apply to FDA for approval of a safety label that guarantees food safety. FDA also monitors GMP and HACCP standards, which is indirectly linked to the companies' environmental performance. Since July 2003, all food-processing companies have had to reach the GMP standard (which is not as strict as HACCP). To prepare the food industry for reaching the GMP standard, the provincial FDA organized two to three meetings to inform companies about GMP. All of the companies in this study attended the meetings and prepared for the strict checking, after they had been advised and trained at their factories. Fruit and vegetable companies C and D are overqualified for GMP because their products are exported with HACCP approval. While this study was still in progress, fruit and vegetable company B was continuing to improve its performance so as to reach the GMP standard. However, fruit and vegetable company A's performance was quite poor. It did not have a clear strategy as to how to reach the GMP standard, even though the owner had attended many meetings about GMP organized by related agencies. According to the owner, the main obstacle for the company was the cost of making the necessary improvements in the infrastructure.

OEPP and PCD are responsible for monitoring environmental pollution in the companies' neighborhood and DIW works inside the companies. Due to a lack of human resources and an overload of work, monitoring is irregular, probably only once a year or less. None of the interviewed managers have been inspected or warned by OEPP or PCD for 1-2 years. Nevertheless, the companies are still aware of the regulations, so they regularly monitor and maintain their manufacturing processes and waste treatment so that they are in line with MOInd, MNRE and FDA regulations and standards. TAO, the new government agency established in 1997, has complete authority to manage and monitor environmental protection at a local level. So far, it has not played any role in monitoring industrial environmental pollution, except to negotiate certain disputes between companies and communities over environmental problems.

[39] By the Enhancement and Conservation of National Environmental Quality Act, B.E. 2535 section pollution control, the owner of the point source of pollution has the duty to construct, install and bring into operation an on-site facility for wastewater treatment or waste disposal as determined by the pollution control official.

[40] According to law, wastewater discharged from factories is restricted to a set standard. This standard is monitored and enforced by the Department of Industrial Work and the Pollution Control Department.

The owners of fruit and vegetable companies A and B, particularly the latter, attended meetings, conferences and practical seminars managed by governmental agencies at least 2-3 times per year. They have tried to improve and adapt their practices to satisfy environmental regulations. Fruit and vegetable company C works with consultants from the Faulty of Engineering of CMU to manage its environmental section. The system is partly complete, although they mainly focus on wastewater treatment. They have tried to develop and use technology to reduce waste through close contact with research institutes. In addition, they have used resources from environmental agencies to improve their treatment technology, and exchanged know-how with research institutes to adapt their production processes to be more environmentally friendly. In the case of fruit and vegetable company D, a chief of the technical section is responsible for environmental protection activities, which consist of managing and maintaining the wastewater treatment plant, collecting wastewater from the plant and every 3 months, sending a sample for wastewater quality testing to the Science laboratory at CMU, and after treatment monitoring wastewater discharge to the earth pond. After one complaint from local residents via TAO, they have had more contact with environmental officers and a consultant in order to solve this problem.

It has become clear that government agencies have tried to change their policy-making, from a top-down command-and-control attitude towards more cooperation with the industries in reducing pollution. In order to support and strengthen the environmental performance of the food-processing industry there have been many studies and projects carried out with the cooperation of the industry, environmental authorities and research institutes. Examples of such projects are; the Waste Minimizing Program in Cannery and Vegetable/Fruit Preservation, the Environmental Management System for Small and Medium-sized Enterprises, the Energy Saving Project, the Management of Industrial Pollution Project, the Project of Industrial code of Practice for Pollution Prevention in the Food Industry, the Capability Building on CP in Thai Food Industries (a project to promote socially responsible environmental management and increase market opportunities). The next step, which could be more profitable, is to publish the results of such studies and projects and expand this kind of cooperation as an example to other factories.

In conclusion, for all cases it can be stated that the relation between the government and the fruit and vegetable processing industry on environmental reform has changed from neglect to participation in environmental policy-making, with frequent contact between companies and environmental policymakers. In that sense, the rules of environmental policy-making have changed considerably. It can be said that the producers are now being forced to spend more resources and time on environmental policies and reforms.

5.5.3 Societal network

In this study, it is found that there was some public pressure exerted on the companies. To analyze the societal network involving fruit and vegetable processing companies we have to focus on local residents, the mass media and social organizations.

Resident communities. Although all companies are located in rural areas, they are surrounded by residential communities that expand to the suburbs. So far, there have been no direct complaints from surrounding residents to the TAO or other environmental government officials. There are probably several reasons for this. First, in the case of fruit and vegetable companies B, C and D, many people in the surrounding areas work as permanent or temporary workers. Second, the companies are involved in community affairs. Fruit and vegetable companies C and D, for instance, give organic waste to farmers. Fruit and vegetable company B provides groundwater to the surrounding households for free (the company pays electricity costs for pumping the groundwater). Fruit and vegetable company D often deals with environmental problems within the community, such as dredging the canals and waterways. Third, compared to other industries, these companies cause less serious environmental problems both in quantity and quality. The exception to this is fruit and vegetable company A, which has a conflict with its neighborhood caused by wastewater being discharged without any treatment. Moreover, the wastewater pond always overflows during the rainy season. There have been complaints from local residents about bad smell from the wastewater ponds of fruit and vegetable companies A, B, and D, and sometimes from organic waste from fruit and vegetable company D. The number of complaints was limited, just 2 or 3 times on each topic. Most of the complaints were sent directly to the company involved, but some of them were sent to the TAO where the company is located. These complaints were solved at the local level by contacting the companies directly. In the case of fruit and vegetable company A, the company solved the problem by draining wastewater from the pond during the rainy season before it overflows. Fruit and vegetable company B moved their factory to a new location and treated wastewater before draining. Fruit and vegetable company D hired a consultancy company to solve problems at their wastewater plant. And to prevent a conflict with the surrounding community, fruit and vegetable company C designed its own wastewater treatment plant with a closed system and monthly checks of the quality of wastewater. All this was a direct result of pressure from the local communities. The companies were forced to be more environmentally friendly.

Mass media. At present, the mass media, such as television, radio and (local) newspapers do not play an important role in the environmental improvement of the fruit and vegetable processing industry. They just make general reports about environmental issues around the country. The owners of all the companies in this study stated that the mass media, especially at the local level, do not provide them with enough information. They felt that they needed more information about marketing, technology, training programs, meetings on related topics and so on. The media could also report on related industrial-environmental issues such as results of research, technological development and innovations. It has been suggested by environmental experts that environmental agencies at a local level should collaborate with the mass media to report and introduce good practices in reusing and recycling waste, cleaner production and environmental performance (MOInd, 2003). This is the way to help both producers and residents learn about how to reduce waste with little cost.

Social organizations. Social organizations in Chiang Mai province consist of NGOs [41], Consumer groups [42] and Women's associations. So far, these organizations [43] have taken little responsibility for environmental issues. Their concern for the environment is very general, and they are only prepared to take action on environmental issues that relate directly to their specific interests. For example, The Chiang Mai Consumer Society Rights will take action in response to consumer complaints about the quality of food and products. If the complaints are linked to food safety issues, they will then contact and pass the issue on to Public Health officers to solve the problem. They do not have the authority to punish any transgressors, and so their role is more one of liaising between the community and the relevant government authorities, as well as putting pressure on companies to change or improve their production processes.

[41] There are many NGOs on environmental issue in Chiang Mai province, such as For Chiang Mai group, the Chiang Mai Consumer Society Rights, the committee for protection of Ping River and environment, Project for the development of alternative agriculture producers-consumers network in upper northern Thailand, Urban development institute foundation, etc. However, they do not focus specifically on environmental issues from the industrial sector.

[42] This group received some financial support from the Ministry of Public Health, and is thus limited in its actions against the governmental rules. But it's helpful in playing a role as supporter in training people for environmental perception, also as a coordinator between governmental organizations and the firms.

[43] They have no authority to check up and monitor regulations by themselves. Therefore, as soon as there is a complained case, the most they can do is to inform the relevant officer.

5.5.4 Family/Informal network

The fruit and vegetable processing companies in this study have formal relationships with all the actors in the above three networks. However, in Thailand, as in many Asian countries, there is a blossoming of informal relationships as well (Fulop and Richards, 2003). Therefore, it would be useful to analyze the family/informal network.

All of the companies in this study, except fruit and vegetable company C, utilize kinship ties and family members in the running of their businesses. Although each business is being run by 1-3 family members, the companies have been able to expand their production efficiently to new domestic and international markets, as well as to include new products. In each company, family members are fully involved in the decision making and planning processes. For example, fruit and vegetable companies A and B have introduced new technologies in their production processes, fruit and vegetable companies A, B and D have added new products to their production line, fruit and vegetable companies B and D have improved their environmental performance, and so on, all with input from family members. The only exception is fruit and vegetable company C. It has a formal relationship in operating and managing its company with 49 percent of investment coming from aboard. Although the company hires a professional manager to run the business, the board of the company still consists of family members. It can be concluded that the strong benefits of kinship ties in the other companies are trust, loyalty and effective communication between members in running the companies. In these companies family members seem to be trusted more than outsiders.

Although the informal relationships with outside agencies, such as raw material suppliers, retailers, business groups or associations, and governmental authorities, are difficult to investigate, it is possible to analyze them in order to understand their contribution. For instance, fruit and vegetable companies A and B have informal relationships (spoken rather than written contracts) with their raw material suppliers, in which the companies trust the suppliers to deliver quality goods on time. Fruit and vegetable company B has an informal relationship with experts from research institutes, which has helped the company not only develop its products, but also improve its environmental performance. Fruit and vegetable company C has close contact with certain government authorities, which are advantageous in consultations, receiving timely information and negotiations in any environmental conflict with communities. Finally, fruit and vegetable company D has reliable informal contracts with fruit farmers, which guarantees a supply all year round. In all these circumstances strong and informal relationships are useful in motivating fruit and vegetable processing companies in Thailand to improve their environmental performance in an appropriate way

5.6 Conclusion

The fruit and vegetable processing companies in this study have addressed environmental issues in different ways. The companies' activities are varied, but are greatly helped by the cooperation of many institutions from the companies' networks. The relationships between the various actors, as well as the value attached to environmental issues by key persons such as owners, managers and employees, have played an important role in changing attitudes towards waste reduction and prevention. Some of the relationships, however, have had a negative impact on environmental improvement or made it harder for the company to act in an environmentally friendly way.

In the past, all fruit and vegetable processing companies used large amounts of water (both fresh and ground), and discharged wastewater from their production processes with little or no treatment to public areas. This practice is still obviously done in some cases as environmental awareness is quite low, and many producers still feel that it is not their responsibility to protect the environment. This attitude is common among small-scale factories. Medium-scale companies, however, recognize that environmental issues need to be addressed not only to satisfy government regulations, but also to please consumers. Medium-sized fruit and vegetable processing companies either have their own separate environmental management section or include one in the engineering section. Some companies have adopted CP and EMS (although these are still at a preliminary stage) so as to reach the HACCP standard, which will enable them to export to international markets.

Chapter 6

Animal and Meat Processing in Northern Thailand[1]

This chapter presents four case studies[2] of small and medium-sized animal processing companies in Chiang Mai and Lamphun provinces. The chapter starts with an introduction to the animal processing industry. Section 6.2 provides a geographical and socio-economic outline of these companies. Section 6.3 describes their production processes from an environmental point of view, as well as looking at environmental/waste problems. The roles of various actors and institutions within economic, political, societal, and family networks in implementing models of waste prevention and minimization are analyzed in section 6.5.

6.1 Introduction

Although the animal processing industry has been a leading industry generating enormous value-added to agricultural products, it has not seen many improvements in technology due to a lack of public interest to promote or develop both production technology and the environmental management concerning industrial wastes. However, recent concerns about food safety and a growing awareness of the environmental implications of this industry's activities have led to an increase in research of environmental management issues in the animal processing industry in Thailand.

The animal processing industry in Thailand has been developed so as to preserve the quality of fresh products and to add value to the meat of such animals as cattle, buffalo, chicken, pig, etc. A large number of swine, in particular, have been raised and have contributed to an ever-increasing income from the sale of various pork products. Table 6.1 demonstrates the export value of animal in Thailand from 2002-2004. Swine showed a significant contribution to the export value, especially with regard to processed meat exports, which has generated quite a substantial income for the country.

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[1] An earlier draft of this chapter was presented at the AGITS international conference on 'Environmental Governance in Asia: Regional Perspectives on Institutional and Industrial Transformations', November 26-27, Kuala Lumpur, Malaysia.

[2] The interviews were all conducted between 2003 and 2004.

Table 6.1 Statistics of animal export (2002-2004)

(Million Thai Baht)

Year	Dairy	Beef	Buffalo	Swine	Chicken
2002	3,597.64	1,457.59	35.10	1,179.42	45,216.79
2003	4,715.72	1,775.09	59.42	1,227.25	25,749.76
2004	3,354.21	726.36	30.47	1,079.62	19,164.81

Source: Department of Livestock Development, 2005.

Northern Thailand is a region where swine is popular, either for direct consumption or for processing into many varieties of meat products, as shown in Table 6.2 (Department of Livestock Development, 2004). Each processed pork product has its unique features. Of the 591 registered animal processing factories in Thailand, 62 are located in the northern region[3] and 50 plants are concentrated in Chiang Mai and Lampang provinces[4] (DIW, 2004). This study selected four animal processing companies in these provincial areas and their periphery as case studies. Selection criteria were:

- The selected cases have labor and capital capacity typical for small and medium-sized enterprises, with comparable production capacity;
- Each factory employs different production technology and is representative of a wider group of enterprises;
- The companies produce a variety of products and have the potential to expand production into the export markets in the future;
- Willingness of the selected companies to share experiences and coordinate on environmental issues.

The selected four cases -as shown below- represent the diverse nature of the animal processing industry in various regions of Thailand.

[3] The number of registered animal processing companies located in each region is: Central 311, Northeast 149, North 62, South 38, and East 31 (DIW, 2004).

[4] The number of registered animal processing companies located in the Northern region is: Lampang 27, Chiang Mai 23, Chiang Rai 1, Phayao 5, Uttaradit 2, Lamphun 1, Phare 1, Nan 1, and Mae Hong Son 1 (DIW, 2004).

Table 6.2 The animal processing industry in Thailand (2003)

Type of Industry	Number of Factory			
	Small-scaled	Medium-scaled	Large-scaled	Total
(1) Slaughtering	-	-	219	219
(2) Roasted, pickled, smoked	2	15	25	42
(3) Animal feed product	1	233	174	408
(4) Extracted animal oil	-	3	3	6
(5) Animal food packaging	-	3	11	14
(6) Eviscerated	-	18	26	44
(7) Produced egg product	1	3	6	10
Total	4	275	464	743

Source: Adapted by the author based on 2004 data provided by Department of Livestock.

6.2 Animal Processing Case Study Companies: Geographical & Socio-economic Profiles

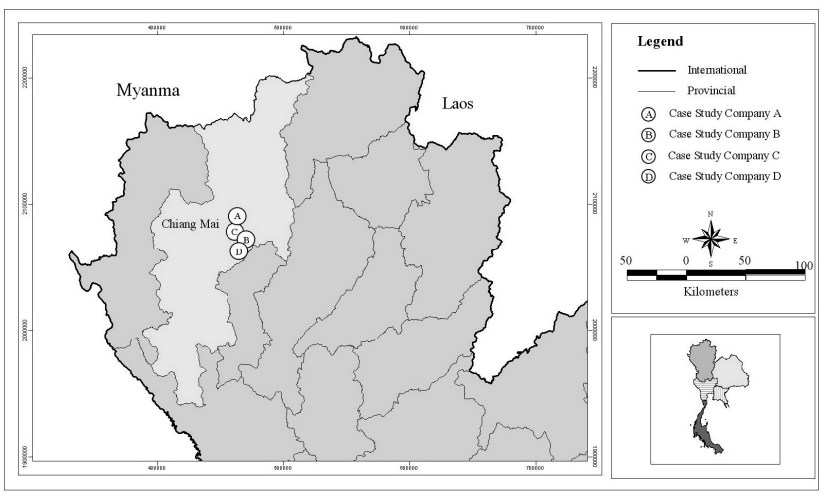
6.2.1 Geographical profiles

All processing plants are located on the companies' own land in rural areas about 5-20 kilometers away from major towns. The first thing that owners looked at when selecting a location was that it was relatively isolated from human settlements. Next in importance was how convenient it was to transport both raw materials from source and processed products to the market. Finally, access to all basic infrastructure, as well as availability of labor from the local neighborhood, was assessed. Certain meat companies, such as B and D, also provide lodging for non-local labor. No community is situated within 2-3 kilometers of meat companies A, B, or C. This was a high priority for plant location, because these companies had had frequent conflicts in the past with the neighboring communities about waste discharge and malodor, when their respective cottage industries expanded to a larger, commercial scale. There were cases of communities filing complaints to the relevant government agencies. As a result of pressure from surrounding communities and more stringent local laws, these companies were forced to relocate their manufacturing plants in more rural areas. Meanwhile, meat company D was established more recently with the purpose of slaughtering livestock. It was decided to locate the slaughtering house in an area remote from any community so as to avoid conflicts, which may arise from the unique nature of the processing activities. Although all locations selected for processing plants are in rural/urban fringe areas, they all have access to transportation, communication, electricity, and telephone facilities. However, they are not supplied with water, which is needed in the production process.

Because plant locations are outside the service area of the Water Work Authority, all companies have to rely on groundwater sources on site. Raw water is tested for its quality and treated properly before utilization. For the same reason of remoteness, the companies are immune from the operations of the Groundwater Resource Authority[5] and all of them only have to pay the electricity cost for pumping water.

No matter how isolated the plant locations are, their garbage is still collected by local government agencies. Nevertheless, each company still arranges its own waste management, depending on the nature of the waste. Generally, organic waste is managed locally, and wastewater is treated before being released to public water bodies (see below).

Map 4 The animal and meat processing case study companies in Northern Thailand



Source: Adapted by the author based on data from Geo-informatics and Space Technology Center (Northern Region), Thailand.

6.2.2 Socio-economic profiles

Meat company A processes such products as fresh and dried noodles, pork balls, beef balls, and Vietnamese pork sausages. It is a family business and has been operating for 12 years. Initially, it operated on a small scale within a community in Lamphun province. As it grew, the company decided to move the processing plant to its own

[5] Although there is meant to be a groundwater charge, the relevant government authorities fail to collect such water fee from the processing plants in this study, as the companies are so isolated.

land about 15 kilometers away. However, a community has built up near their processing plant, and conflict with this community over environmental issues has begun to grow. This company now employs about 50 employees from nearby settlements, who commute to work. Its processing plant is quite small and uses simple and traditional production technology. The company has an investment capital of less than 10 million baht. The products are only sold on the local market.

Meat companies B and C both process "Nham", a local fermented pork sausage. They are both medium-sized businesses with investment capital of less than 20 million baht, and they are both jointly shared by siblings. Firm B started 20 years ago as a small-scale family business. Within the first 10 years, though, they had expanded to the extent that they were starting to face waste management problems. It then moved the processing plant to a more rural area on the periphery of town. The new processing plant was equipped with imported machinery and advanced production technology. Presently, it employs 20 workers, some of which commute to work while others have lodging within the factory compound. Meat company C started off as a vegetable and fruit processing company before expanding into processing animal products such as "Nham", and "Sai Ua", which is a kind of northern spicy pork sausage. Five years ago, it took part in an animal processing modern technological development project, carried out by a government research institute. Initially, it rented an area from the raw material supplying company to facilitate its transportation and processing activities, but it now has plans to move the processing plant to its own land to accommodate the increase in production capacity. Currently, it employs about 20-25 workers who live in the neighborhood and can easily commute to work. Both meat companies B and C supply their products to the domestic market, covering Northern Thailand as well as other regions and both are considering exporting their products to other Asian countries in the near future.

Meat company D operates a slaughterhouse which supplies part of its output to meat company C. It is a medium-sized company with an investment capital of over 20 million bahts. It is part of an integrated business group which breeds piglets for sale, produces sows, farms pigs for slaughter and slaughters pigs to sell as pork meat. It has operated for 10 years, slaughtering pigs from the family's farms for meat sale. It is the first slaughterhouse in the Northern region that employs an electrocuting system and that uses a suspension rack, both of which are imported technologies. The slaughterhouse unit was built in a remote rural area so as to avoid any conflicts which might arise with neighboring communities. Presently, the company employs 75 workers, half of which commute to work, the rest being non-local residents that have lodging in the factory compound. As well as slaughtering pigs from its family's farms for sale in markets in the northern region, it also provides a pig-slaughtering service to other small pig farming companies. It also has plans to export its products to other Asian countries, because of the prevailing market demand and the capability of the company to double its production capacity.

The labor situation is quite similar for all the companies in this study. There is a comparable proportion of male to female workers, except in the case of the slaughterhouse, which employs relatively more male workers owing to the fact that more physical strength is needed. All the workers have little schooling but have been trained on the job to perform their tasks to a skillful level. Average wage is 150 baht per day, but vary according to levels of responsibility, working hours, length of employment, and gender. Male workers receive a higher income than female workers for the same job. All companies hire foremen/managers who are well educated, with specialized skills concerning agro-industry or plant manufacturing to assure quality control of their products. Table 6.3 summarizes the main socio-economic characteristic of all the companies in this case study.

Table 6.3 Main characteristics of the case studied companies

Company	Industrial size		Technology	Product	Market
	Labor (Person)	Investment (Million bath)			
A	50	< 10	Low (Traditional)	- Fresh & dry noodle - Pork & Beef ball - Vietnamese pork sausage	Local & nearby domestic
B	20	< 20	Medium	- Nham fermented	Domestic (Northern & Central)
C	20-25	< 20	Medium	- Nham fermented - Sai Ua	Domestic (Northern & Central)
D	75	> 20	Medium-High	- Fresh pork - Chilled pork - Boiled blood	Domestic (Northern)

Source: Compiled by the author based on 2003 data interviewed and observation.

6.3 Environmental Impact of Animal Processing Companies

6.3.1 Environmental Profiles

Input: All of the companies in this study process animal products (mainly pork) to be sold on the open market. Meat company D also processes meat as a raw material for other industries as well as for household consumption. They all have regular suppliers, which can easily be replaced if they provide less than adequate quality. The exception to this is perhaps meat company C, which is supplied by meat company D, a company that already exercises strict quality control over its production. The majority of these supplies are already partly processed – that is, they have been dressed, partitioned and/or cleaned – which helps reduce the preparation stage of processing quite substantially. Meat company D is supplied live pigs. Two-thirds of these supplies come from the same business family, and one-third come from other sources. The pigs are then slaughtered for sale as carcass or pork meat.

Water for processing activities comes from groundwater sources, and is pumped up and subjected to two types of treatment. Water for washing and cleaning purposes will be treated for sediment removal and treated with chlorine before pumping to the storage tanks. Water for food processing will be further subjected to filtration and disinfection. Before being used, both types of water will receive a quality control inspection from a relevant government agency, apart from regular inspection once every two months performed by a private agency that each company hires for this purpose.

The remaining supplies are chemicals such as Potassium Nitrate and Sodium Nitrate, and fresh components like herbs. These will be ordered from various suppliers, and in response to market demand, as well as to meet the food safety standards required by law, high quality products are generally desired.

Production Technology: The production processes of companies A, B, C, and D are shown separately in Figures 1, 2, 3, and 4 respectively. These show differences in inputs, technology, and the nature of production.

With meat company A, the processing involves cleaning, grinding, mixing all the ingredients, boiling, and packing the products for sale on the market. Labor is the main production input with the use of simple tools and low-level technology. Meat companies B and C are supplied fresh pork meat which is partially cut and separated into usable raw materials, such as rump portion, ears, and pork skin. These inputs will be cleaned, ground, mixed with spices, packed and then fermented for 3-10 days before being sold on the market. Both companies use

imported machinery that has been modified to be used in conjunction with labor in the production process. Meat company D begins with confining the pigs in a waiting area, then spraying the animals with water to be ready for slaughtering, for 2-4 hours. The pigs are then given an electric shock, killed with a knife and dipped in boiling water. The next stages are carcass dressing, cleaning, and cutting into portions before packing or chilling to be ready for delivery to the market. The production technology in this case involves imported machinery and is not over reliant on human labor.

Figure 6.1 The production process of animal processing company A

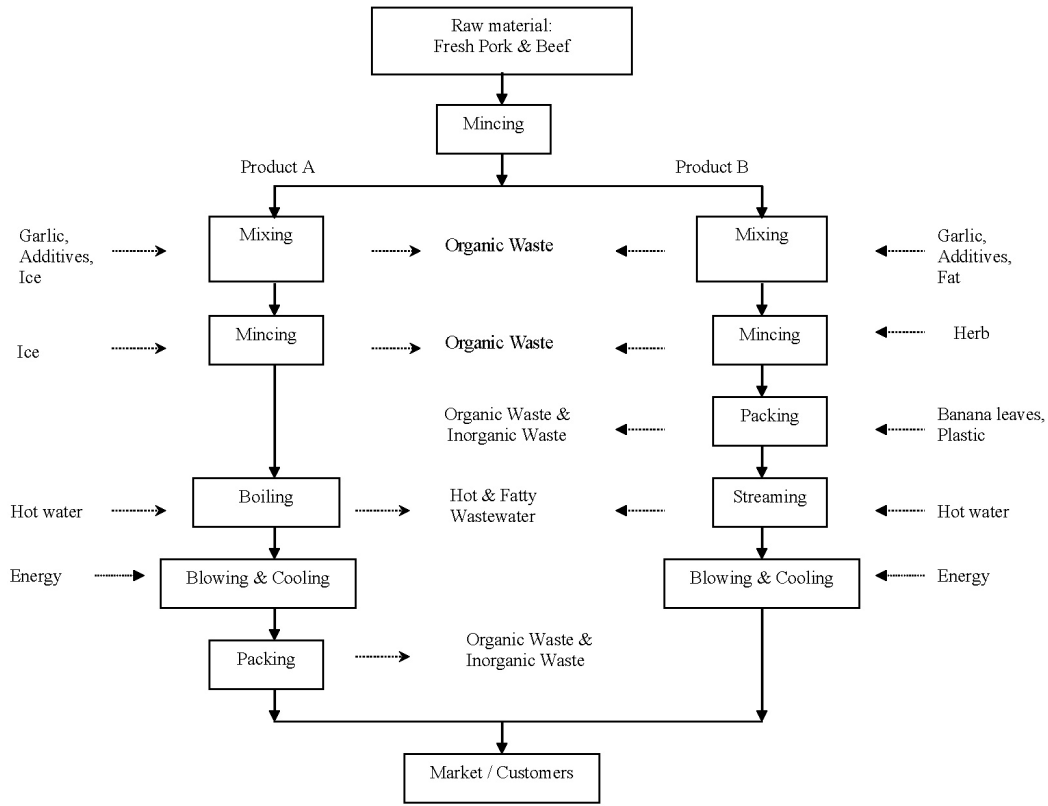


Figure 6.2 The production processes of animal processing companies B and C

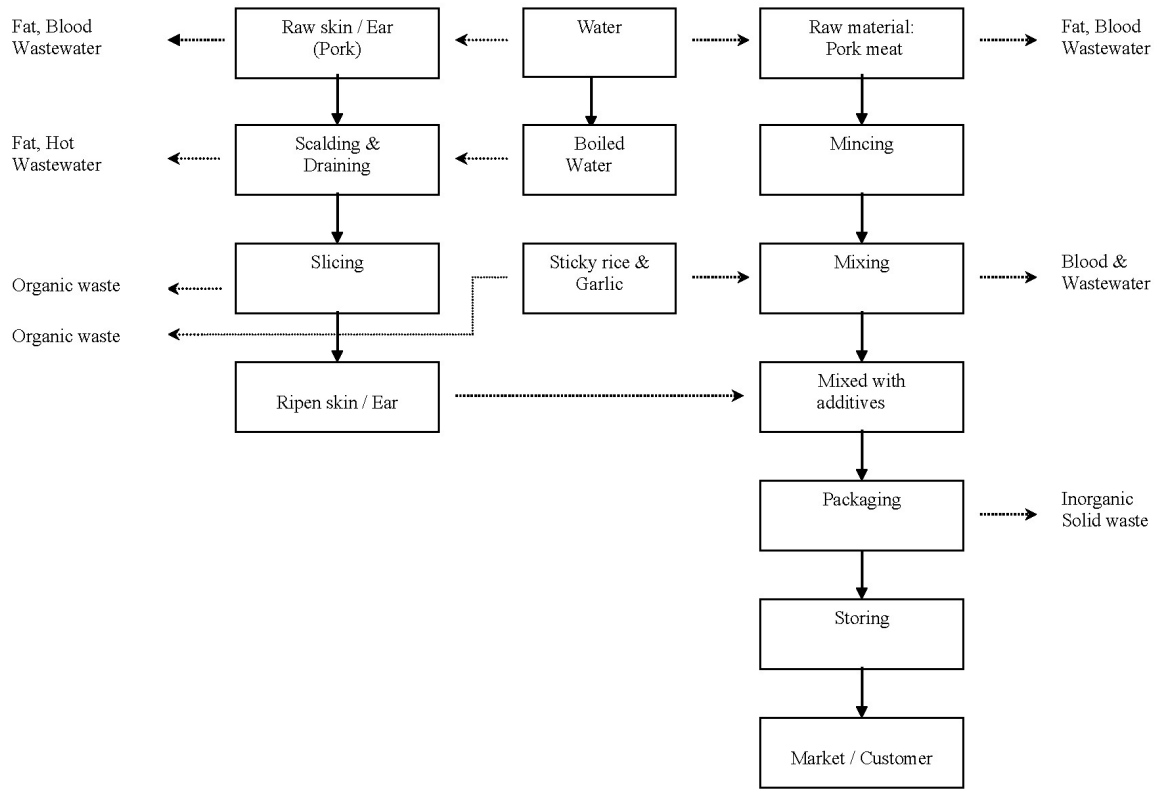
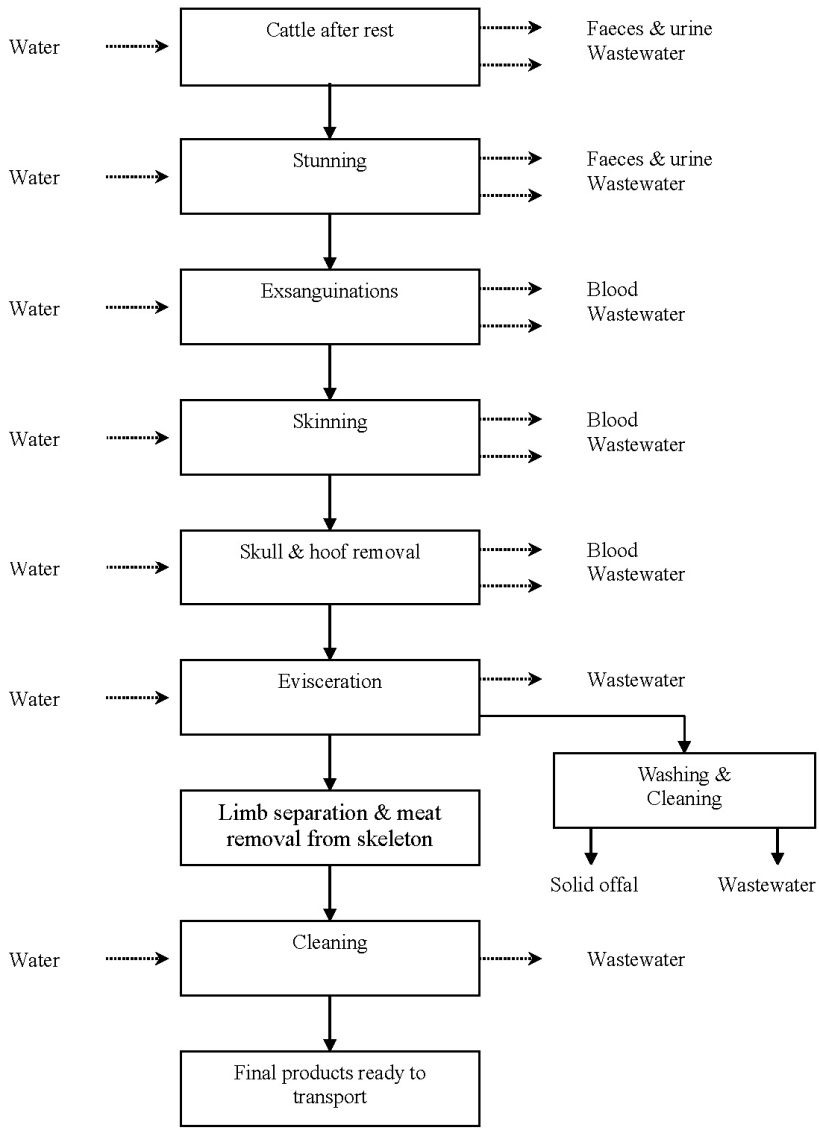


Figure 6.3 The production process of animal processing company D



6.3.2 Environmental Implications

From analyzing the production process of all case studies, it is found that most of the waste generated by the animal processing industry is in the form of organic waste and wastewater. Organic waste from meat companies A, B, and C, despite the fact that they buy partially pre-processed raw materials, includes residues from dressing pork meat such as meat scraps, bloodstains, and bristles. Meat company D also has to deal with organic waste from animal excreta. Part of the organic waste can be processed for sale. For example, blood can be hard-boiled and internal organs can be sold as raw materials to ready-to-eat food vendors. The remaining meat and fat scraps can be sold to distributors. Some of the organic waste from meat companies A, B, and C are also given or sold to be used as animal feed. Meat company D, however, has an enormous amount of hog bristles that needs to be disposed of. Currently, it removes such bristles daily and buries them as a landfill in the neighboring longan orchard. Animal excreta are washed away into a wastewater pond, which is then treated.

The wastewater generated by animal processing contains many impurities, including fat, blood and excreta. The amount of wastewater varies with the size and production capacity of each manufacturing plant, as well as the management practices employed at each site. The quality and estimated volume of wastewater attributable to the animal processing industry in Thailand are shown in Table 6.4. Meat company A treats its wastewater by filtering solid substances, draining the water into an aeration tank, adding air and micro-organisms to reduce malodor, allowing sedimentation, and then draining the water into a storage pond behind the factory. The water is further treated to improve the water quality, and finally released to a public water body. In the case of meat company B, wastewater is collected in a tank that traps fatty substances first. The trapped fatty substances are removed once a week for disposal as garbage. Then, the wastewater is drained into an aeration pond so that air and microorganisms can be added, as well as for sedimentation to occur. The sediment or sludge is removed monthly and water quality is monitored every 3 months, by sending a sample to CMU test center[6]. The treated wastewater is drained and kept in a storage pond behind the plant for 3-4 weeks before eventually being released into a public waterway next door.

[6] Chiang Mai University test center, Science and Technology Service Center (STSC), is a laboratory in the Faculty of Sciences which tests wastewater quality for the public. These results can be used as a record for governmental authority inspectors/monitoring.

Table 6.4 Wastewater characteristics in the animal processing industry in Thailand

Industry	Flow	BOD	TSS	COD	pH	Grit	Nitrogen	Phosphorus	Heavy Metals	Chlorine Demand
Meat Product	Intermittent	High - Extremely high	High	High - Extremely high	Neutral	Absent	Present	Present	Absent	High

Note: Volume of wastewater varies to industrial sector, volume of manufacturing, production process, and time of production.
Source: Pannee, 1999.

Meat company C, at the time of the present investigation, was still renting a plant on meat company D's premises for its processing activities and hence shared company D's wastewater treatment system. However, company C employs a tank that traps fatty substances and disposes these substances before the wastewater enters company D's water treatment system. This treatment system comprises of a ditch surrounding the whole manufacturing plant. Water used to spray animals to reduce their stress, remove animal excreta, and clean and wash animal pens, meat and utensils collects in this ditch. The wastewater runs through 4-5 natural ponds which serve as resting tanks. Microorganisms are added to reduce malodor of the water, but the water is treated in no other way. Water in the ponds percolates in the soil, evaporates and is then used for aquatic plant growing and fish raising with feed coming from meat scraps. However, water quality is monitored by DLD authorities[7] every 6 months. For solid wastes, like small amounts of plastic or paper, the company simply collects, categorizes, and burns them. However, the burning of plastic and foam coming from packaging has become a source of air pollution.

Summary of environmental problems and impacts

In this study, the following environmental impacts were observed: i) uncontrolled and abundant use of groundwater, ii) discharge of wastewater, iii) solid waste treatment, and iv) obsolete technology.

Uncontrolled use of groundwater: These companies use a large amount of groundwater, which is pumped from their own wells free of charge, except for the cost of electricity at the industrial rate. Without any cost for water and the call for hygienic food processing, uncontrolled and abundant use of groundwater is the main environmental problem in the animal processing industry. None of the factory owners seemed intent on reducing the amount of water used. According to the companies' managers, product hygiene is more important than saving or controlling the use of water. This approach will affect the environmental

[7] In practice, the Department of Animal Development takes responsibility for monitoring wastewater from slaughterhouses, whereas other industrial sectors are monitored by the Department of Industrial Work.

consequences of using groundwater in general. The meat and poultry processing industry uses an estimated 150 billion gallons of water annually (WRRC, 2004) due to the necessity for hygiene and quality control. This also results in a large amount of wastewater being generated.

Discharge of wastewater (Quantity and quality): As a large amount of water is consumed in every step of the production process, the discharge of wastewater is also high. In general, the volume of wastewater generated by the meat processing industry is 80-95 percent of the total amount of freshwater consumed (MRC, 1995). In the United States, the estimated volume of freshwater consumed in the meat processing industry ranges from 1,100 to 4,400 gallons per live weight ton of slaughtered animal (UNEP, 2000). The average amount of water used to slaughter a pig is 60-100 gallons per animal and 80-95 percent of water used in abattoirs is discharged as effluent (WRRC, 2004). It means that the companies in this study consumed more than 4,800-8,000 gallons per workday[8]. Moreover, the wastewater normally contains organic materials, including cellulose, protein, amino acids, fats etc. In the case of slaughterhouses, it can also contain parasite eggs, amoebic cysts and pathogenic bacteria (FDA, 2001 and WRRC, 2004). Untreated or only pretreated wastewater, which is discharged directly to water bodies and the ground may have an organic pollution as high as 8,000 mg/L BOD with suspended solids at 800 mg/L or more (MRC, 1995). This might contaminate the environment and eventually endanger human health, via the consumption chain.

Solid waste: Solid waste that consists of organic and inorganic matter, especially suspended solids of 100-500 mg/l of wastewater (World Bank, 1998), is generated and dumped into the environment after the production process. Although there are regulations in place that control the quality and quantity of waste before discharge to the environment, and the fact that the treatment process does not require advanced technology, there are still cases of waste being discharged without being properly treated.

Obsolete technology: Obsolete technology is still being used in both the production process and in waste management in every small and medium-sized enterprise in Thailand due to the need to limit costs and to a lack of incentives to protect the environment. Animal meat processing industries still use low technology and energy from wood and gas in general. Although the companies in this study use adaptive technology together with manpower for manufacturing processes, they still consume a huge amount of energy in some processes. Regarding the slaughterhouse case study, it is the only factory in northern Thailand that uses a semi-mechanical production process. The rest of them use low technology in their production processes. This can imply that, in general, slaughterhouses consume a huge amount of energy, both in electricity and fossil fuel forms. Another problem

[8] This is an estimated amount.

is that the technology used in waste management is not suitable for the waste generated by their production processes. All the companies in this study still use (with irregular monitoring) obsolete and simple technology for their waste treatment, and it is obvious that the rest of this industry is operating without adequate waste treatment facilities (DIW, 2002). The total waste, therefore, from this industry is very significant and to a major extent insufficiently treated.

Table 6.5 Balance of input and output materials (without water and energy) of animal processing companies in this case study.

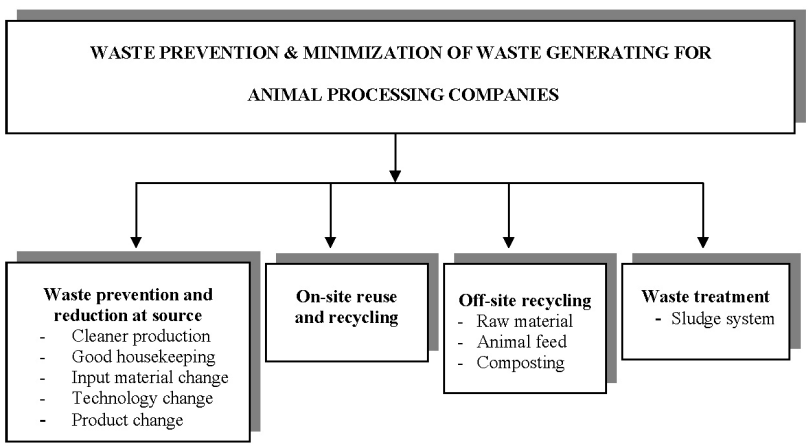
Materials / Food Industries	Inputs	Outputs	
	Raw material	**Product**	**Waste**
Company A	Fresh pork and beef Flour Pepper Salt Chemical Wrapping Materials	Beef Ball Pork Ball Vietnamese pork sausage	Fat Waste vegetables Waste water Wrapping materials Air pollution Heat Sludge from treatment plant
Company B	Fresh pork, ear, skin Sugar Salt Garlic, chili Chemical Wrapping Materials	Nham fermented	Fat Waste vegetables Waste water Wrapping materials Air pollution Heat Sludge from treatment plant
Company C	Chilled pork Fresh ear, skin Sugar Salt Chemical Garlic, chili Wrapping Materials	Nham fermented Sai Ua	Fat Waste vegetables Waste water Air pollution Heat Wrapping materials Sludge from treatment plant
Company D	Pig Wrapping Materials	Fresh pork Chilled pork Boiled blood	Organic waste Waste water Air pollution Heat Wrapping materials Sludge from treatment plant

Source: Compiled by the author based on 2003 data interview and observation.

6.4 Options for Environmental Improvement

As described in section 6.2.3 each company employs different measures for waste management, depending on the amount and type of industrial waste and the adopted technologies, both for processing and for waste treatment. This section deals particularly with the management of waste generated by animal processing activities, and proposes a waste prevention and minimization of waste model, as illustrated in Figure 6.4.

Figure 6.4 The waste prevention and minimization of waste model for the animal processing industry



6.4.1 Waste prevention and reduction at source

Good housekeeping: Improvements in housekeeping practices will enable companies to prevent and reduce waste at a low cost and without changing current production technologies. The general concept of good housekeeping needs all employees in the company to observe routines and regulations related to issues such as cost reduction, product image, and environmental awareness. Improvements at every stage of the production process, such as operation and maintenance, management practices, material handling, management of raw materials, stream and waste segregation can reduce waste significantly. These improvements in operation and monitoring reduce not only the volume of water used but also the volume of wastewater generated during the process. Moreover, cooperation with various actors and institutions and better on-the-job training can further reduce waste in the animal processing industry. Factory workers can be trained and educated about ways of reducing waste, as well as energy saving and leakage control, particularly in the case of temperature control in pre-production

and pre-marketing storage in order to prevent product decay. Energy saving, however, is an issue that deserves much attention since it is related to the question of food safety which is the main concern of the food processing industry. It is important that suitable technology is used to regulate temperature and control electricity consumption. Adjustment of operating hours in certain manufacturing plants may also help to reduce energy cost and consumption, particularly the shift to off-peak periods when the price of energy is lower than in the peak periods[9].

Moreover, the application that emphasizes pollution prevention principle such as purchasing cleaned or partially processed raw materials can reduce the waste that these companies generate. It is also important that raw materials are kept clean when being transported to the plant site, in order to avoid repetitive cleaning and hence save water. Chilling or freezing of partially processed raw materials before processing could also reduce the need for further cleaning and hence reduce water use and wastewater.

Input Material Changes: Input material change is another strategy to reduce waste whereby pollutants from raw materials are substituted for renewable materials. Certain manufacturers may choose to use raw materials that have already been partially processed. This could reduce the amount of steps involved in the production process, which could in turn reduce costs. For example, it results in a reduction in the waste management load and the water necessary for cleaning. This could be successfully done by making on-schedule contracts with suppliers.

Technological Changes: Improved equipment, increased automation, improved operating conditions, and the implementation of new technologies may result in waste reduction. Although technological changes require large investments, the producers attain a higher efficiency that has both economic and environmental benefits. In the long run, it reduces costs of the production process and saves energy. Imported equipment that has been modified is a possible alternative to increase productivity, reduce costs in the long term, and ensure quality control for food safety.

Product change: Redesigning products to lower their environmental impact both during and after use, as well as to increase product life, are options for waste prevention and reduction. In the food processing industry, product life usually extends until the products are consumed. However, changing or adding a new technology in some step of the production process could possibly extend the

[9] See Chapter 5 for details on progressive electricity rates for the food processing industry in rural areas.

products' life[10], benefiting not only producers but also consumers. This alternative needs a close cooperation between producers and food scientists.

6.4.2 On-site recycling

Apart from the above options, another strategy for waste reduction is by-product recycling within the company. In the animal processing production line, some meat scraps remain useful as raw materials or by-products for the local market, and are very popular traditional food. The use of by-products from animal processing companies, which can be around 10-15 percent of the total turnover, not only reduces waste, but also gives the opportunity for higher economic returns.

6.4.3 Off-site recycling

An additional strategy to minimize the waste generated at source is to reuse and recycle off-site. Although in the animal processing industry it is impossible to recycle water, due to the high level of contamination, there are some products which it is possible to recycle. In general, waste from animal processing comprises of useless meat scraps; bristles, hair or feathers; organic waste or unused parts of ingredients, like herbs, and vegetables; used wrapping or packing materials like banana leaves; sludge from the wastewater treatment process, which needs to be handled as early as possible before rotting. Organic waste could be used as: i) a raw material at other animal processing plants ii) a raw material in animal feed, and iii) compost for fertilizer. One of the companies in this study now uses organic waste from its raw materials production as food to raise fish in its factory compound and uses other organic waste as fertilizer in a nearby farmland. This is regarded as an efficient management method that also helps to reduce conflicts with the neighboring communities. Better management could also be applied to fatty substances and sludge from the waste management processes. Rather than passing the burden of waste management to the public, these could be reused.

6.4.4 Waste treatment

Wastewater: The animal processing industry has to use huge quantities of water in its production process so as to provide clean and safe food. The first priority is given to reducing the uncontrolled use of a large amount of (ground) water consumption. This water becomes wastewater after use since it has been contaminated with animal blood, fat, meat scraps, and dirt from utensil, tools, floor, and, in some cases, animal pen cleaning. In practice, all wastewater will be drained into a single drainage and eventually to resting ponds without any

[10] Apicharee (2000) has successfully studied and experimented with the use of some specific bacteria, which changes the preparation process of raw materials through fermentation (meat/animal processing). The quality of this product is ensured.

separation of wastewater. This practice limits the ability to recycle wastewater which would save costs and energy. It was observed in this study that water was used in a wasteful manner, without any proper plans or controls for water utilization being implemented. This is because water is drawn from underground sources within the factory compounds and the only cost incurred is the cost of electricity for pumping the water[11]. A reasonable plan for control of water utilization and management can help to reduce electricity costs and save water. These alternatives, together with good housekeeping, could help reduce costs as well as conserve valuable resources.

In practice, each factory has to employ end-of-pipe treatment technology before releasing the treated wastewater (that has a high organic content) for other uses, such as crop farming or fish raising. The appropriate treatment system for the cases under study should be the sludge system using activated biological treatment technology, which combines aeration, to reduce malodor from the decaying process, and microorganism addition to accelerate sedimentation. The water used in such a treatment process should rest in a storage tank for a certain period of time, before it can be reused or released to public water bodies.

Inorganic waste: Inorganic waste from packaging, such as plastic, paper, wire, could be separated to be reused or recycled so as to minimize costs or maximize economic returns. Although the overall volume is not so significant, this solid waste is often disposed elsewhere as garbage and there seems to be no attempt to manage it properly. Sorting inorganic solid waste into different categories and accumulating it until the quantity is large enough to be sold on the market would be more profitable than disposing of it as garbage.

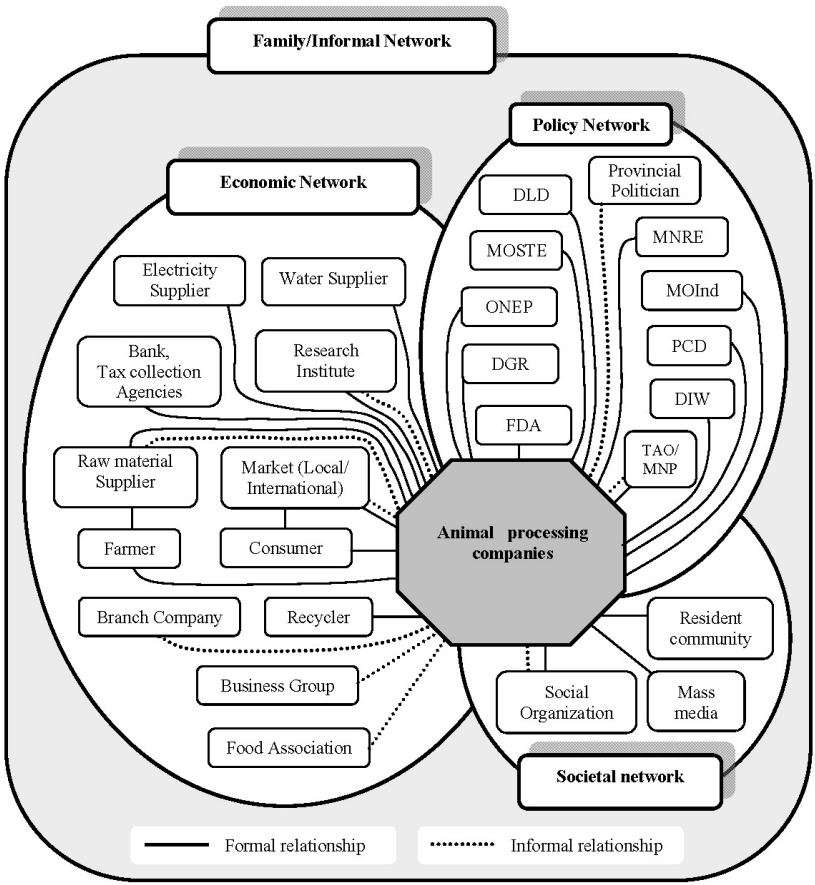
6.5 Actors and Institutions in the Animal Processing Companies

These recommendations on alternative ways to improve the production process of various animal processing firms, by using the prevention and waste minimization concept[12], are primarily theoretical. In practice, there are many factors that trigger, facilitate, enforce, or sustain the entrepreneur to make changes to the production process and reduce environmental pollution. In this section, the roles of various actors and institutions in the decision making process of animal processing firms in relation to production methods, technology, and management policies are examined, through an analysis (Figure 6.5) of the economic, political, societal, and family networks which the firms have to deal with.

[11] See Chapter 5 for details on groundwater charges for natural resource conservation.

[12] The prevention and waste minimization concept is based on cleaner production technology and uses 3P-Pollution Prevention Pays. Its idea is to prevent pollution at source in the manufacturing processes, rather than remove pollution after it is created. It proposes 4 goals: i) reduction of environmental burden; ii) conservation of resources; iii) improvement of technologies; and iv) reduction of costs.

Figure 6.5 Network embedding animal processing companies



6.5.1 Economic network

In the economic network, the following interactions will be analyzed: i) the relationships between animal processing companies in a production chain, by looking at the vertical interactions from input suppliers to producers and consumers; ii) the relationships between animal processing companies, directly and via branch association; and iii) the interactions between animal processing companies and other economic agents and research institutes.

Vertical interactions from suppliers to producers, recyclers, and consumers

Input Suppliers. Suppliers in the animal processing industry include farmers, and suppliers of raw materials, chemicals, water and electricity.

Farmers. From the studied cases, only meat company D has a relationship with farmers, by providing a pig-slaughtering service to other small pig farming companies. They signed an informal contract[13] on non-schedule relations with the small farms to send pigs for slaughtering, and have a normal contract with their own company group that sends pigs regularly. So they sometimes face problems of overcrowding of pigs, an overload of work, and large waste from the production process when a large amount of pigs comes in at the same time. Waste from production processes such as blood and internal organs are given back with the carcasses to the farmer, because they can all be sold in the domestic market. The rest of the waste is managed by the company.

Raw material suppliers. Meat companies A, B, and C are supplied two kinds of raw material: herbs and (fresh) pork meat, which come from the northern part of Thailand. These companies order herbs regularly from different domestic suppliers. The quality and prices of these products are compared by the quality control section, for which the factory manager is ultimately responsible. They have fixed contracts with their suppliers for fresh meat, with set quality conditions and fixed prices. This means that they can control the quality of raw materials, which is essential for producing higher quality products. These contracts with suppliers result in not only higher efficiency but also less waste, as there are fewer steps required in the preparation process, which results in turn in lower costs for waste treatment.

Chemical suppliers. Meat companies A, B, and C order chemicals from domestic suppliers by contract. They check and control the quality, delivering schedules, and the prices of these chemicals. Due to the unique nature of their products, which are closely examined for percentage of chemical usage, the use of higher quality

[13] An informal contract is an unsigned or non-paper contract, it depends on mutual trust. This will be analyzed in the family/informal network.

chemicals leads to higher quality products, which will then gain the approval from the related officers, markets and consumers as well.

Water suppliers. Water needed for the production process of all the companies in this study is mainly supplied from their own groundwater wells. By law, they have to pay for water consumption to the related department at the rate of food industry, every month. However, at the moment they pay nothing for water consumption due to poor monitoring and enforcement by the related government agencies. This explains why no auditing for minimizing water usage in the factories takes place. The companies use a large amount of water to reach a hygienic standard, as it is free of charge. The only concern of the companies is how to save electricity. Most companies are not aware that the electricity bill, which amounts to around 30 percent of the production costs, includes electrical usage during production and in pumping groundwater. Therefore, by reducing water usage, they could also reduce their electricity costs.

Electricity suppliers. The electricity service, managed by the Provincial Electricity Authority, has a progressive rate for electricity price, varying according to demand. As mentioned before, the higher voltage and off-peak time use (TOU) are the main index to the cheaper rate for electricity price of industrial use. Some companies tried to reduce electricity costs by joining the governmental energy saving program and some tried to change their production process to save electricity. For example, meat company D was contacted by the Electricity Authority to join the energy saving program but after getting initial information, the company decided not to adopt that program and tried to reduce electricity costs by itself. It needed more cooperation, but the company believed that the suggestions made by the Electricity Authority would not be effective[14]. As with meat companies A, B, and C, it was informed by the relevant authorities on how best to reduce electricity consumption, and it has made changes to its production process. However, the results of these programs are not clear, as no concerted effort has been made to record how much electricity is used, or to implement good housekeeping practices.

Recyclers. Recyclers play a major role in the reduction of waste. They include farmers and retailers.

Farmers. The nearby farmers play an important role in minimizing organic waste from the production process. For example, waste from meat companies A and B is used to feed animals. In the case of company A, the organic waste, such as meat scraps, is distributed to one farmer in the morning and another in the evening. The farmers' payment varies by weight of waste. This arrangement benefits the company both economically and environmentally. Meat company B gives part of its organic waste, such as pieces of cooked-pork's ear and meat scraps, for free to

[14] From an interview with meat company D's manager (July, 2003).

the nearby farmer every day and uses the rest for feeding the company's pets (dogs). It has been clearly shown that meat companies can recycle some organic waste. Although there is much concern world wide relating to the safety of recycled meat (such as mad cow disease), at present this area is not regulated.

Meat companies C and D, which were located in the same area at the time of this study, used their waste for fish raising in nearby ponds. They got a favor from the farmers surrounding the factories by giving fishes, two or three times a year. However, in the case of company D, the biggest problem comes from hog bristles, which are hard to manage. The company tried burning these bristles, but that resulted in conflicts with the surrounding community due to the amount of smoke, smell, and ash produced. At present, the company manages this problem by giving the waste free of charge as fertilizer to neighboring gardens every day. The manager of meat company D said that the waste could enhance the soil and the farmers told him that it reduces their fertilizer costs. This option could solve the company's waste problem, and both of them could benefit from managing waste in this manner. However, there has been no research of whether this is the best solution for solving and managing these kinds of waste. At present, the relevant agencies have made no recommendations about the proper management of this waste, and this is a critical question for waste management scientists[15].

Retailers. Some of the organic waste from the production processes of meat companies B, C, and D are sold as by-products to retailers. These by-products, for example pieces of Nham from meat companies B and C, or boiled blood and internal organs from meat company D, are used as raw materials by food vendors, who are very popular in the northern region[16]. The companies sell these products to the vendors every day, usually with informal contracts, except in the case of meat company D, which has days off two times a month, because of regulations[17] related to Buddhism[18]. This means that the problem of waste from the animal processing industry is not as bad as it could be because the companies can profit from such a waste minimization program.

Consumers/Customers. The consumers of all the companies in this study are in the domestic market in the northern and central part of Thailand. Meat company A's consumers are ready-to-eat food vendors and local market sellers who do not need

[15] From an interview with the slaughterhouse's experts (December, 2004).
[16] These by-products, which are used as raw materials for a wide variety of specific foods, did not seem to be used outside the northern region of Thailand.
[17] The regulation is the Notification of Ministry of Interior section 5 issue 9, B.E. 2539, which declared that, relating to the Law of Animal Slaughter Control and Sale of Meats (B.E. 2535), the Ministry of Interior is responsible for giving permission to slaughter animals.
[18] In Buddhism, it is believed that no Buddhists should kill any living things on the Buddhist holy day. Therefore, according to the Law of Animal Slaughter Control and Sale of Meats, B.E. 2535, it is prohibited to slaughter animals on these days.

guarantees, such as food safety certificates, about product quality. On the basis of a relationship spanning more than ten years, they have grown to have confidence in the quality of meat company A's product. However, in response to recent concerns about food safety that have been expressed by end-consumers as well as regulatory agencies[19], the company has tried to adapt and strictly control their production line to meet higher standards so that it can get at least a GMP certificate. This shows how consumers can play a role in enforcing and triggering businesses' management policies so that the businesses perform to a higher environmental standard.

Meat companies B and C have tried to export on the international market, but the biggest problem they have faced is the unique character of their products. So, following the advice of research institutes, they have adapted their products using new technology. Higher quality products should make them more acceptable to international markets, especially in the Asian market. However, domestic customers do not play a role in pushing the companies to take into account quality of products or the environment, for instance via HACCP and ISO certification.

Meat company D, the exceptional case, has a very high standard product, which is well known in the northern region. Its consumers are local markets, large supermarkets, and food-processing companies, which all demand a high quality product. It is applying for HACCP and ISO certification in order to be able to export its product on the international market. At the time of this study, it was in the process of expanding its production, importing new machinery, and improving its waste treatment system[20]. Its by-products from the production process are greatly sought after by food vendors. Both of them can profit from this relationship, with environmental sound outcomes. It can be expected that the company's plan of application[21] could improve the public image of the company among customers in the domestic and the international market.

Horizontal interactions between the producers and other animal processing companies or enterprises, or via branch association

Meat company A does not have much competition from neighboring companies. However, after being warned about the quality of its product by provincial FDA officers, the company decided to improve the production process so as to reach the GMP standard. Improvements have been made to the production process and the environmental policy by sharing knowledge with other food processing companies

[19] The Thai government promoted 'B.E. 2547 as the Year of Food Safety', The Ministry of Public Health has launched many projects, such as the Clean Food Good Taste Project and the Food Safety Project, related to food safety issues in response to concerns about consumers' health.
[20] From observation between July-October, 2003.
[21] The company plans to build a new wastewater treatment plant (data from interview, 2003).

and consulting with relevant government officers at the provincial level. Most of these relationships are handled on a personal level, according to the owner who is a politician and a well-known personality in the local community.

Meat companies B and C are located in the same province and compete with each other. There are also many other competitive companies of a similar size or smaller offering a similar kind of product on the domestic market. They do not cooperate with each other on common interests such as marketing, technology development, or waste treatment. They tend to manage their businesses by themselves. However, they are involved in many programs supported by private associations, such as the Federation of Thai Industries (FTI) and the Chiang Mai Food Industry Group, and government agencies. These programs, such as the SMEs Development and Innovation of Technology Program, the Cleaner Technology for SMEs Program, the Preparing for Passing GMP Check up Workshop, and so on, helped them in sharing experiences about marketing, production efficiency, saving energy, and reducing environmental impacts (DIW, 2002, PCD, 2003, and CMU, 2001). This expertise is shared at meetings, conferences, fairs, contests, workshops, and training programs that are organized both at the local and national level.

Meat company D, which employs different production technology to the other companies in this study, developed their technology by exchanging know-how and technological information with an associated company in the central part of Thailand[22]. It employs a professional manager, who has a lot of experience in the animal slaughtering industry, to manage and run the factory. The manager is central to the company's success, and is always eager to foster positive relations with other companies and to share expertise with them. The company itself is a member of FTI in the animal processing sector. Information exchanged within this association can benefit the company greatly. Meanwhile, as it is a raw-material supplier for meat company C, it also exchanges information about GMP and environmental issues,[23] such as wastewater treatment, with meat company C. This can be clearly seen in the modern technology and environmental management of company D. At present, it is making changes to the production line so that it can start exporting its product in the near future.

[22] The slaughterhouses and animal (pig) farms are mainly located in the central part of Thailand (Phitsanulok Municipality, 2001).

[23] The Excise Department has launched an (environmental and human health) improvement project, the Safety Slaughterhouse, under 'the Food Safety from Farm to Consumers Project' to complement governmental (food safety) policy. This project pressures the slaughterhouse firms to comply with GMP and the standards of raw materials transportation from January 1, 2006.

The interaction between the companies and other economic agents and research institutes

Economic Agents. The economic agencies related to these companies are private banks, governmental banks, tax agencies, insurance companies, the Thai Chamber of Commerce, and the Federation of Thai Industries. All companies have to follow the laws and legislations on interest rates on loans, and currency issues, which are regulated by State Banks. After the financial crisis in 1997, there have been many recovery programs supporting SMEs, especially in the food processing sector, but these programs tend to promote economic growth and do not address environmental concerns. At present, there are no loan programs offering incentives for environmental investment. For example, one studied enterprise said that he had to pay for the total cost of his waste management system without any incentives from the government. Although he knew that long-term benefits would be derived from investment in environmental management, he still hoped that the government could help him indirectly by adjusting the tax rates he has to pay, such as VAT, import-export duty, personal income tax, and local tax[24], etc. All companies except meat company A, regularly join support programs about marketing or other economic issues, i.e. innovation technology program, marketing training programs, human resource management programs, etc. However, they said that they still need more information and training about new technologies and innovation linked with environmental issues. This could occur at the regional level with cooperation between the commercial branch association and governmental and non-governmental agencies related to both economic and environmental topics. Financial support for these kinds of programs should provide more incentives for making the production processes more environmentally friendly.

Research institutes. As mentioned above, meat company A had to improve their production and environmental performance to reach the GMP standard. To achieve this they needed consultancy on technology and investment from governmental research institutes, such as from the National Food Institute of Thailand (NFI), the Institute of Food Research and Product Development (IFRPD), and the Institute for Small and Medium Enterprises Development (ISMED), etc. Meat companies B and C also tried to change their production technology to expand into the export market. For this they need more certification. They have contacted and consulted experts from CMU, MJU, KU, and TISTR. This cooperation has resulted in the development of a well known biological product[25], which the companies have profited greatly from both in the domestic market and in the export market,

[24] Local taxes, such as property tax, house and land tax, local development tax, etc., are collected by the local authority (TAO) where each company is situated.

[25] In general 'biological product' is a product produced from organic raw materials. However, in this case it means that this product is a safe food product, using safe organisms in the fermentation process, the quality of which can be trusted.

especially with regard to other Asian countries. In the case of this cooperation between the private sector and research institutes, the government subsidized some of the expenses for innovatory technology. Meat company D also consults with experts from MJU about its production line management, although it generally consults with other companies in its sector.

All the available evidence shows that the companies try to manage their business by building personal relationships with research institutes. There are many research institutes that they can consult; not only the research and scientific centers in local universities but also the National Food Institute. In general, the companies paid nothing for these research consultants, except in specific cases, such as the construction of a wastewater treatment plant, in which case experts from private consultancy companies are hired. The meetings and projects mentioned above help increase the manufacturers' environmental awareness, which together with government regulations direct their environmental management policies. It has been shown that they could not only improve their production efficiency but also reduce environmental impacts by cooperating with research institutes. This product development regarding food safety benefits both the government and customers.

6.5.2 Policy network

In this section, the roles of various actors and political institutions at different levels will be analyzed to see how they can govern and encourage the prevention and minimization of waste in the animal processing industry.

The environmental management of production activities in the animal processing industry is monitored by FDA, DIW, ONEP, REO1, OPNE, (local) EXD, and the local authorities (DPA and Municipality or TAO) at the provincial-regional level and EXD, MOSTE and MNRE at a national level. Small and medium-sized companies need to deal with MOInd when setting up their company, and with FDA for reaching the GMP standard and getting their products certified as safe. When setting up slaughterhouses, the Ministry of Interior[26] is also involved. DIW and PCD have to make regular checks on pollution control inside and outside the companies' plants. However, due to limited personnel and a high number of factories in the region, this monitoring is either non-existent or irregular. The new local authority, TAO, is meant to manage and monitor environmental protection in general. Unfortunately, they are very new and have no experience in solving environmental problems. So they need training programs from environmental agencies in order to play a more important role in environmental issues at the community level. All of the relevant authorities also concede that they could not

[26] The Department of Provincial Administrative (DPA) and the Municipality are the authorities in charge of slaughterhouses at the provincial level, but TAO was responsible for the company studied here.

monitor and regulate every company due to the lack of personnel, especially in the local authority. As a result, various projects have recently been developed in this area stressing the importance of cooperation with various involved actors, especially in the industrial sector. These programs, such as the Capability Building on Cleaner Production in Thai Food Industries Program, the Environmental Management System for Small and Medium-sized Enterprises, the Waste Minimization Program, the Management of Industrial Pollution Project, the Energy Saving Program, etc., have been started and processed with the cooperation of all the involved authorities at every level.

Company-governmental agencies interaction: Although meat company A has a manager taking responsibility both for machine maintenance and wastewater treatment, and the owner has a good relationship with governmental officers, the company has still received two or three warnings from the Public Health officer (relating to product standard[27] and hygiene of the production process[28]). Moreover, the company received an informal warning from DIW and TAO, acting on complaints from the local community, for malodor from their wastewater ponds. It has also had trouble reaching the GMP standard, for which it needs to improve its environmental performance. The company is trying to become more environmentally friendly, both to reach the GMP standard and also to reduce friction with the local community. It has made improvements in the production process by consulting with other companies in GMP and wastewater treatment technology issues. It also needs to consult with relevant governmental officers to find possible areas for environmental performance improvement, especially in managing its wastewater treatment plant. The owner of the company claimed that a lack of financial incentives from the government was a major obstacle to improving their environmental performance[29]. The relevant authorities confirmed that no direct financial incentive or subsidy is given for improving the environmental performance of a private industrial company[30]. A more cooperative and less command-and-control relationship between the company and policy-agencies might have better environmental results.

Meat company B had received complaints from the local community and warnings from municipality officers. It designed a new factory and wastewater treatment plant in consultation with Industrial Work, provincial FDA officers and experts from the university. The treatment plant uses advanced technology at a suitable cost for small animal processing companies. The factory manager controls and manages the plant with advice from the owner. The environment authorities,

[27] It was discovered, through testing by the local FDA, that the company had added a chemical ingredient above the permitted level.
[28] From complaints by local consumers.
[29] The owner said that the improvements needed to be made required a large investment.
[30] For information about the Environmental Fund see www.deqp.go.th.

including university researchers and undergraduate students in related sciences[31], regularly monitor its production and wastewater[32]. The company gained useful knowledge and information from environmental agencies and research institutes, and were able to adapt the production process and wastewater treatment to be more environmentally friendly. This case shows the progression of governmental policy from command-and-control, through the use of laws and regulations, to being more cooperative with the relevant company. In addition, it reveals the adaptation of the company from keeping the authorities away, enabling closer cooperation.

Being a new business, meat company C rents factory space from meat company D, and uses the same wastewater treatment technology and facility. This company manages its organic waste by removing fat before draining wastewater to the main sewage, but at the moment company D is mainly responsible for wastewater treatment. Meat company C plans to move to a new building, and has designed its own wastewater treatment system, with advice from private consultants. By attending various meetings and training programs, the owner of this company has been able to develop a good relationship with experts from various institutes, and as a result has been able to improve its production process. Four years ago, the company developed a new high quality product, which is now well known for its use of new technology. This company is very pleased to cooperate with research centers and governmental agencies, such as university research institutes, food institutes, etc., and regularly joins many activities dealing with technology exchange. This case shows how governmental agencies, research institutes and companies can cooperate to promote environmental issues.

The factory manager of meat company D is responsible for both production and environmental management. The simple management of wastewater designed and implemented by the owner resulted in complaints from local communities to the manager on environmental issues, i.e. flooding from wastewater ponds, malodor, smoke and ash from burning hair, etc. The communities made the same complaints to the TAO authority as well. The company tried to solve these problems after receiving informal warnings[33] from the authorities. These problems were solved by making a higher dike at the wastewater ponds and giving away organic waste as compost fertilizer free of charge. Moreover, the company has tried to improve its environmental performance by regularly observing the production process in the municipality's slaughterhouse in preparation for meeting the GMP and HACCP

[31] This company cooperates more with local universities and authorities, both to train students and to hold inspection tours of the animal processing company. The manager informed me that normally the company is visited once or twice a month by the related authorities on food and environmental issues, and twice a year by students from local universities.

[32] The monitoring is done by the relevant authorities and sometime aided by sample testing by students from local universities.

[33] The company pays a large amount in taxation to the local agency, which situated it favorably with the community and the local authority.

standards. In addition to cooperating with other environmental authorities[34], the company has also tried to become involved in energy saving programs and waste minimizing programs to improve its performance.

In general, we can see that all the companies in this study comply with laws and regulations about food processing and they try to cooperate with environmental agencies as much as possible. Although some companies tried to avoid the regulations at the beginning, they have found that they cannot neglect these rules due to pressure from the relevant authorities. Finally, they have to adapt their performance to a win-win situation. For example, although none of the companies have a separate environmental section, all of them have a person responsible for environmental management. The main scope of environmental protection activities consists of managing waste, maintaining the wastewater treatment plant, checking the quality of the wastewater, and managing wastewater after treatment. This is how they can adhere to governmental regulations as well as be more popular with the local community and consumers. In addition, the companies have tried to cooperate with governmental projects/programs, such as energy saving programs and food safety programs. As mentioned above, this shows that the relationship between the animal processing industry and the government on environmental reform is changing from neglect to greater cooperation on environmental issues.

6.5.3 Societal network

In this section the societal network, which consists of local communities, social organizations, and the mass media, is analyzed so as to understand its influence on company policy.

Resident communities. All of the companies in this study have realized that their activities have an impact on the environment, and this might lead to friction with the surrounding communities. This is one reason why they initially set up their companies in remote areas, away from any sizeable community. However, there have still been complaints about environmental issues. In this study, the surrounding communities have complained to governmental agencies at a local level about malodor from the wastewater treatment plant, noise from the production process, floods from the wastewater ponds, and damage done to roads by the companies' heavy trucks. After receiving these complaints, sometimes as many as one or two a month, the local authorities have tried to solve these problems as soon as possible. Firstly, the authorities contacted the companies directly asking for more cooperation. If there were further complaints, they would start to monitor the companies on a regular basis. In some cases, though, complaints were made directly to company employees. The companies responded to these complaints by trying to solve the problem as soon as possible to avoid

[34] Programs launched by the Energy Authority of Thailand in 2003.

conflicts with the communities. For example, meat company A reconstructed their wastewater plant for more efficiency to stop malodor, meat company B treated their wastewater longer and checked the water quality more regularly before draining, meat company C plans to move to a new site that has a well-organized wastewater treatment plant, and meat company D reconstructed their wastewater ponds and moved organic waste to be buried in the communities' orchard everyday free of charge. All this shows the willingness of companies to improve their environmental performance by cooperating with the authorities and the local communities. It also shows how communities can force companies to become more environmentally friendly.

Social organizations. At present, for local social organizations such as the Local Communities Groups[35], the Chiang Mai Consumer Group, the Lamphun Environmental Group[36], the Hug Chiang Mai Group[37], etc., waste management is not a major issue. They take actions on environmental issues in general, such as forest and soil destruction, water pollution in major rivers, building conservation, etc. However, they do address some of the issues raised in this study. For example, the Chiang Mai Consumer Group looks at food safety issues, and the Lamphun Environmental Group is concerned about water pollution in the Ping[38] and Kuang[39] rivers. These organizations sometimes encourage the relevant environmental agencies such as FDA, MOInd, and ONEP to pressure companies to make environmentally friendly choices. It can be argued that these social organizations are able to present the communities' concerns to the relevant governmental authorities, and therefore are useful in putting pressure on the companies indirectly to improve their environmental performance.

Mass media. Local and central mass media consists of radio, television, newspapers, and public leaflets. At the moment, they do not address specific environmental issues relating to the animal processing industry. Instead, they report on environmental problems around the country in general. They do not follow up on these reports and offer few solutions to these problems. Permission has now been granted enabling communities to establish and broadcast community radio or people media[40]. Although the main purpose of broadcasting is not focused

[35] Each community formed an organization called "the Community Group" to take care of the environment in general.
[36] Local people, supported by experts in environmental and health issues, formed the organization to protect them from environmental pollution from the Northern Industrial Zone.
[37] "Hug" means "love" in Northern Thai. So this group could be called "Love Chiang Mai City Group".
[38] Main river of Chiang Mai Province.
[39] Main river of Lamphun Province, which has been polluted by the Northern Region Industrial Estate.
[40] Community radio - free channel - is permitted to broadcast to the community based on "the Constitution of the Kingdom of Thailand B.E. 2540: Section 40". The main purpose of it is a public service to benefit the public in education, culture, state security, and other public

on the environment, this could be a new channel to promote environmental awareness in the community. Another way of informing the communities could be community broadcasting via a chief or president of the TAO, which broadcast every morning in every sub-district. Although NGOs criticize this initiative of the government and its so-called top-down policy[41], this still could be a valuable tool educating people about environmental issues as well.

6.5.4 Family/Informal network

Informal relationships, which have a unique characteristic in East and Southeast Asian culture, have an often hidden impact on business behavior. The complex relationships of all the actors involved in the animal processing industry can be explained via a family/informal network analysis of inside and outside agencies.

Inside agencies (In-group member/Kinship). With all of the companies in this study, the company is managed and controlled by family members. Family members are involved at all levels as the companies expand, even members of the extended family. Although in some cases, such as in meat company B, the interaction is regarded as being more individualistic (competitive) than collectivist (cooperative), the family members are still loyal to each other and communicate effectively. Meat companies B and D are supplied with raw materials by companies from the extended family. Meat companies B and D feel that they can trust these companies to supply quality raw materials on time. This relationship can help ensure raw material quality, which is related to a minimization in waste. In all of the cases studied, the relationship comes first and holds a value that is greater than money. The companies also regard business relationship networks as a commercial investment or a form of insurance.

Outside agencies (Out-group member). Outside agencies refers to researchers and other employees working at governmental agencies, politicians, business leaders, and business groups or associations. These connections can offer support, and protect businesses, as well as give access to confidential information dealing with regulations and business issues. For example, the owner of meat company A as a local politician has a good informal relationship with various social networks and organizations[42]. This offers him access to information, which sometimes relates to regulations that benefit his business. In response to complaints from local communities, he was warned informally by the relevant authorities. So as not to

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interests, including fair and free competition for the Thai citizen.

[41] In general, the main objective of this broadcasting channel is to transform the government's view.

[42] Pongsapich (2001) stated that as a result of Thai government policy to control economic activities in the country, many Chinese descendants have become construction contractors, who have then gradually become involved with politics, both locally and nationally. This, in turn, is beneficial when running a business.

harm the good relationships he has, he felt a lot of pressure to improve his company's environmental performance. Others companies also have these informal relationships with local organizations, governmental authorities and social community groups. Moreover, strong informal links are made with suppliers and customers, i.e. wholesalers and subcontractors. All these relationships could lead to an increase in environmental awareness, and could serve to improve the way companies behave.

6.6 Conclusion

Although at present most of the animal processing industries in Northern Thailand served the domestic market, more and more companies will probably expand into the export market in the future. To do this, they have to comply with environmentally friendly production requirements to meet international standards. The case studies of meat processing firms which consume a high quantity of water and generate highly contaminated wastewater from their production processes, have shown that they are impervious to pressure from local authorities, resident communities and consumers/markets, and continue to harm the environment. The investigated case studies show how various pollution prevention and treatment methods can be integrated to improve the environmental performance of companies. Good housekeeping and cleaner production are needed to reduce costs and minimize waste. Selling by-products that would normally be waste and organic waste as fertilizer or fish feed is another way to make companies more environmentally friendly. This not only improves their environmental performance, but also increases their income. Using swine waste to produce compost is another environmentally friendly solution. These measures are supported by experts from research institutes that encourage SMEs to improve their environmental performance. In addition, all companies still need EoP technology to treat their waste before discharging it into the environment, along with strict monitoring by the local authority. However, this monitoring is sometimes lacking due to time and resources being limited. Environmental policy should be based on available technology, criteria of environmental protection, and the environmental awareness of companies. The benefits of these activities could motivate the company to make further improvements in their performance.

Chapter 7

Fruit Wine Processing in Northern Thailand

This chapter presents five case studies[1] of small and medium-sized fruit (herbal) wine processing companies in Thailand. Section 7.1 is an introduction to the liquor distillery industry in Thailand and a look at the emergence of the fruit wine industry. Section 7.2 shows the environmental impacts of wine processing, which is the focus of this study. Section 7.3 examines the economic, geographical, and environmental profiles of the studied cases in the fruit wine industry. Section 7.4 presents environmental improvement models for the prevention and minimization of waste generated by the wine companies. Then, section 7.5 analyzes the role of various actors and institutions involved in the fruit wine processing industry. This is followed by a conclusion.

7.1 Introduction

In recent years food processing has been promoted as a way of generating extra value for farm outputs. The fruit-processing industry discussed in Chapter 5 is one such example. These products are produced by such food preservation techniques as drying or dehydrating, pickling in brine or syrup, candying, juice extraction, or processing into powder form for instant drinks. Juices and instant drinks are connected with the beverage industry, which has grown rapidly and continuously since 1997 (NFI, 2001). However, the tight competition in the international market and the exercise of trade barriers by some importing countries have compelled Thailand to venture into new product lines to enlarge the export volume and value of the beverage industry (Table 7.1). Liquor distillery is a segment of the agro-food industry, which has grown substantially in the past three years as a result of government promotion (MOInd, 2004). This government support coupled with the rising trend in drinking for health reasons has increased the importance of this industry.

[1] The interviews were all conducted between 2004 and 2005.

Table 7.1 Exported fruit wine in Thailand (1997-1999)

Unit: LT, Million Baht[2]

Product	1997		1998		1999		% Change between 1977-1999	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Fruit wine**	720,494	32.96	439,240	33.79	668,616	52.79	6.59	29.38

***Fruit wine products:* Champagne, Sparking Wine, Wine with alcoholic content of 21% or less, Vermouth and wine made from fresh grapes.
Source: The National Food Institute, 2001.

7.1.1 The distillery industry in Thailand

For many generations, Thai people have fermented cereal grains, herbs and fruits to produce "Chae", an alcoholic spirit similar to European grape wines[2]. Formerly, the production of "Chae" liquor[3] was limited to a few large companies[4] and small companies were excluded from this industry.[5] This was not the case with spirits coming from many other countries, which have since become internationally famous, such as Japan's Sake, Mexico's Tequila, and Russia's Vodka. With the liberalization of alcohol spirit production and a state policy of promoting community enterprises, qualified individuals or community groups[6] have been entitled since 2000 to apply for permission to produce "Chae" alcohol locally[7]. Since then there has been a phenomenal increase in the number of "Chae" distilleries from the traditional eight large businesses, which concentrated on exporting to Asian markets (NFI, 2001), to the present 6,086 community "Chae" distilleries (EXD, 2005) (Table 7.2). Among these new distilleries, 1,993 are engaged in fruit wine production and 225 of these are located in the northern provinces of Thailand. This increase in the number of spirit

[2] These products vary according to the type of fruit used, the length of the fermentation period, and the winemaking formula used in each producing region.
[3] Satho, Krachae and Ou are types of Thai fermented liquor similar to wine, which Thai people produce from seasonal rice, fruit, and herbs. Surachae refers to liquors with less than 15 percent alcohol content. Sato, which is similar to Japanese Sake, is considered to be a national liquor now that the Thai government allows people to produce it.
[4] It was illegal to produce this product, as the Government only gave concessions to a few large companies.
[5] The Excise Department could grant a permit to private enterprises to produce alcoholic spirits for distribution. But this industry was characterized as a monopolistic market with few firms receiving the concession. Local communities producing "chae" spirits from fruits were excluded.
[6] See qualifications in Box 7.1.
[7] According to the Excise Department's Notification, local "chae" spirit is defined any spirit, which is not distilled, which is produced from such raw materials as sugar, rice, or fruits, and with an alcoholic content no more than 15 percent.

producers might well lead to many undesirable consequences, in particular it might lead to environmental problems.

Table 7.2 Registered distillery and fruit wine companies in Thailand (2001-2004)

	Number of Registered Companies				
	2001	**2002**	**2003**	**2004**[8]	**Total**
Distillery	8	8	4398	1388	6086
Fruit wine	Not permitted	898	935	160	1993

Source: The Excise Department, 2005.

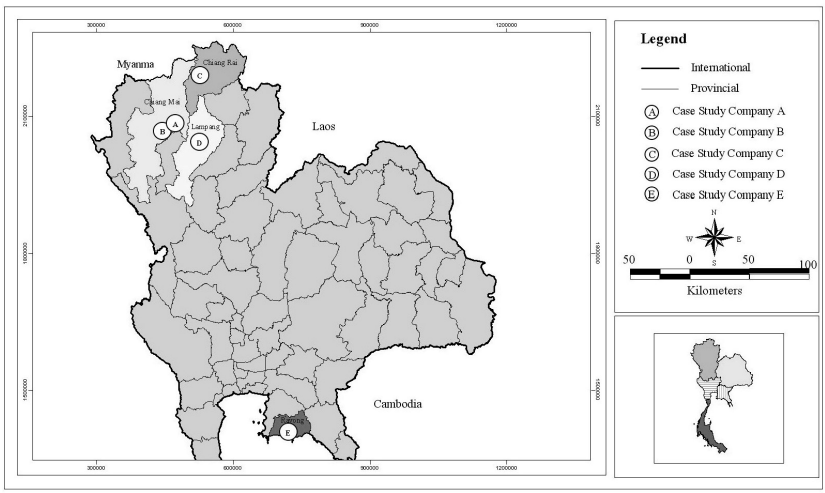
7.1.2 The fruit wine industry in Northern Thailand

Wines made from Thai fruits possess many unique characteristics that make them different from foreign grape wines. The current Thai government is intent on promoting the Thai fruit wine industry to reduce imports and increase export earnings, and also to strengthen local communities. This policy has led to a growth in the number of community fruit wine distilleries in Northern Thailand[9]. These establishments may be registered as community cooperatives, agricultural cooperatives, or other legal entities. The fact that these distilleries are small-scale industrial undertakings scattered in rural and urban community areas and that they are newly introduced into such areas in large numbers, has led to concerns about the impact of this industry on the environment. This, along with the need to develop preventive measures to ensure a sustainable fruit wine industry, is why this current research is of so much interest.

[8] It is noted that the number of registered companies in 2004 is lower because the Finance Ministry's Notification criteria had changed. For details, see Box 7.1.

[9] These community distilleries produce no more than 2,000 liters per year, employ no more than 7 workers, and have no more than 5 horse-power machinery.

Map 5 The fruit wine processing case study companies in Northern Thailand



Source: Adapted by the author based on data from Geo-informatics and Space Technology Center (Northern Region), Thailand.

Fruit wines are made from local fruit varieties that have unique features, and therefore produce unique final products. This can be used as a key selling point when trying to expand into the export market. For this reason, it was decided to study five fruit wine distilleries, each of which satisfied the following criteria:

- All the distilleries in this study have been established following the adoption of the government's policy to promote community enterprises, which are small-scaled companies, as defined in Box 7.1, and so they have comparable production capacity and are located in local community areas;
- All distilleries exploit a diversity of local fruits;
- They are distinct from one another in terms of production technology, manufacturing plant management, and products;
- They produce a variety of wines, each having its unique features favorable for future export promotion.

Consequently, the five cases in this study are expected to be representative of the community distillation industry in the northern region of Thailand, and the study results should lead to recommendations about environmental management of small and medium scale fruit wine companies, which make up the majority of distilleries in Northern Thailand.

Box 7.1 Criteria for distillation license under the policy of promotion of community enterprises, covering the following particulars:

1. Being either cooperative, farmer's group registered as local cooperative, legal body, group of ordinary people, or farmers' organization;
2. Using machinery with combined horse-power lower than 5;
3. Employing no more than seven workers.

Source: Adapted by the author, based on the Finance Ministry's Notification dated 6th October 2000.

Box 7.2 Requirements for "Chae" distillery concerning quality and environmental management:

1. Establishment of machinery and/or production process in such a way that it assures hygienic and healthy conditions.
2. Establishment of a closed system of industrial waste collection and/or treatment to control odor.
3. Prohibition of wastewater discharge (under the Ministry of Industry standard) into the area external to the manufacturing plant.
4. Development towards an international environmental standard * within three years of the official commencement of business.

Source: Adapted by the author, based on the Ministry of Industry's Notification dated 3rd April 2000.
**Note:* It is not specified which environmental standard should be implemented.

7.2 The Fruit Wine Processing Industry's Impact on the Environment

From observation and interviews with individuals involved in winemaking in various establishments, we can see that all wineries use a similar production process, as shown in figure 7.1. The only thing that differs is the type of yeast[10]used. The wine production process starts with sorting fruit, followed by grinding, squeezing or boiling, adding chemicals, filling a starter for the fermentation process, racking and aging, and finally bottling, labeling and sending the product to the customer. The type of machinery and technology used, and the means of distribution differ between the companies. Also, depending on the locality, the fruit inputs might vary, and the number of workers varies according to the production scale. There is invariably a lot of organic waste generated during the process of sorting raw materials, peeling, skinning, crushing etc. This waste also includes sediments which are removed from the fermentation tanks every 10-15 days.

[10] The type of yeast used in the fermentation process varies according to the type of fruit and technological knowledge.

Figure 7.1 The fruit wine production process in Thailand

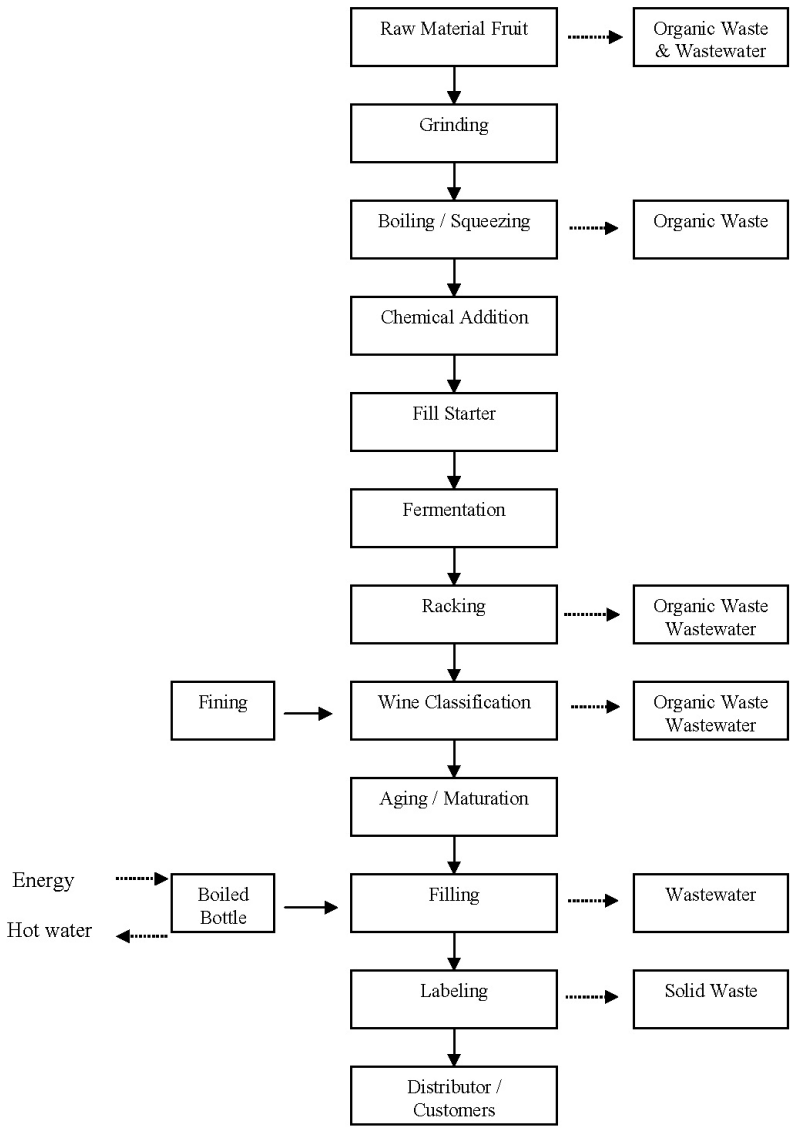


Table 7.3 Balance of inputs and outputs (excluding water and energy) of fruit wine processing companies in Thailand

Materials / Food Industries	Inputs	Outputs	
	Raw material	**Product**	**Waste**
Fruit wine companies	Fruits by season / (Thai) Herb Sugar Salt Chemicals Yeast Bottle Cork Wrapping Materials	Fruit wine Herb wine	Waste fruit Waste water Air (Odor) pollution Hot water Waste from sediment Organic solid waste Wrapping materials

Source: Compiled by the author based on 2004 data, interviews and observations.

Another problem is wastewater, generated when cleaning raw materials, washing equipment and utensils, and cleaning infrastructure. In many cases, large amounts of water[11] are used only once so as to maintain hygiene and/or quality. Worldwide research has shown that the amount of wastewater generated varies between wineries, but can be as much as 2 to 14 liters for every liter of wine produced. This figure does not take into account evaporation during ageing (Van Schoor and Rossouw, 2001). This is in spite of the fact that the traditional way of making wine does not use a large amount of water. However, because of the need to conform to hygienic standards and the uniqueness of the fruit used, it is not always possible to limit water usage in the production of Thai wines. During the production process, all the wastewater is drained into a collection pond and then treated in various ways in each winemaking plant. This will be discussed in the next section. With a total amount of more than 6000 firms all over the country, many of which are surrounded by resident communities, we can see that a significant amount of waste comes from wine production**.**

Solid waste consists of broken glass, cork chips, aluminum foil, scrap paper, raw material containers, etc. This waste is sometimes managed on-site, by burning, but is usually removed by external garbage collectors, without any company effort to monitor the effects on the environment. Another serious issue, usually ignored by winemaking operators, is the matter of malodor, coming from the fermentation process. During the present research, we had personal experience of this problem. This can lead to conflicts with the local community if the plant is located close to residential areas.

[11] From the interviews it was discovered that the companies in this study used around 1000-1200 liters per day during the winemaking season. It is noted that the amount of water used might vary with the amount and type of raw material.

7.3 Geographical, Socio-economic and Environmental Profiles of the Fruit Wine[12] Companies

Table 7.4 Socio-economic and geographical characteristics of the studied fruit wine companies

Fruit wine company	Type of business (Ownership)	Location (Distant from urban area: km.)	Market	Production volume (liter/year)
A	Community cooperative	<1	Domestic (local)	20,000
B	Community cooperative	<1	Domestic & International	50,000
C	Company	3	Domestic & International	200,000
D	Institute	>20	Domestic	40,000
E	Company	>5	Domestic & International	5,300,000

Source: Compiled by the author based on 2004 data, interviews and observations.

7.3.1 Wine company A: Longan, Lychee and Herb wines

Economic & Geographical Profiles

This wine producer is a community cooperative, which previously made fruit wine from longans, a local major fruit in that area. Three years ago it started to distill wine for the marketplace upon receiving state promotion and permission to produce alcoholic spirits. The plant is located in a residential area of a district in Lamphun Province and thus favored with the entire requisite infrastructure. The processing technology is simple with a small-scale investment and only 2-6 workers needed to operate it[13]. The business is clearly organized under the supervision of a president, vice president, and marketing section[14].

The group has chosen longan as its main raw material, as the fruits are readily available locally, and in this way it can also help the fruit growers, who are also group members. It also buys other inputs from group members, and anything that they cannot provide is supplied by wholesalers. In this way the company guarantees that the product is of an appropriate price and quality.

[12] Winemaking is regarded as a type of local "Chae" spirit production and the products must be labeled with the name of the fruit used.
[13] The number of workers varies with the production season; however, it is a legal requirement that permanent workers do not exceed seven.
[14] This type of personnel classification is one feature of community cooperatives that helps them gain access to various government supports, such as interest-free or low-interest lending schemes.

Its major market outlet is the plant location itself, due to the fact that it has been officially selected by the Community Development Department as a case of 'Strong Community'[15] and hence has enjoyed a large number of visitors to the site. Other marketing channels include OTOP trade exhibitions and promotion, organized frequently and widely throughout the country. Its main market is the domestic one and the company has no plans to produce for the international market.

Environmental Profile & Environmental Implications

The plant is located on land that the group has rented from a private individual. The group received some financial support in the form of a loan at a special interest rate from the government to construct the processing plant and storage area, which has a simple design but still meets official requirements[16]. Its production staff has received government training. Tools and equipment are mostly simple and some are modified from traditional local ones. There is no standard wine-aging room where temperature[17] is regulated, which reflects on the quality. This is one of the reasons that there is little demand for the product to be sold on the export market.

Although the winery is located in a residential area, it draws free groundwater for cleaning raw materials. The company pays only for the electricity needed to pump the groundwater into storage tanks[18]. However, it purchases drinking water that has GMP certification for use in its fermentation process. Because of the tight space and waste disposal regulations[19], wastewater from the production process has to be drained into a public area behind the plant, but not before the solid waste has been removed by straining and the wastewater has been treated with microorganisms to reduce malodor.

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[15] 'Strong Community' is a good example of the promotion of sustainable development within local communities by the Thai government. It provides a guide to self-reliance through the One Tambon One Product project (OTOP). For more details, see http://www.mfa.go.th/web/847.php?id=801.

[16] Generally, approval for manufacturing plant construction is under the authority of the Department of Industrial Works. Winery plants, however, are under the supervision of the Excise Department, which has the authority to grant licenses for alcoholic spirit production. This latter Department, therefore, stresses the quality of wine products and does not exercise strict rules over the processing plants themselves.

[17] In certain other countries, wines are fermented and aged in rooms with suitable temperatures. Red wine is usually fermented in a room measuring 21-32°c with temperatures being controlled at 18-21°c. Meanwhile, white wine should be fermented at 7-18°c with temperatures being controlled at 7-15°c. In Thailand, however, the climate is quite warm, or even hot, all year-round. To make standard quality wines, aging should take place in a controlled temperature room at the optimal temperature range.

[18] This is different from the previously studied sector, fruit and vegetables, which has to pay for groundwater use. Non-payment is due to the lack of human resources in monitoring and implementing the regulations of the groundwater conservation act.

[19] For details see Box 7.2.

Initially, all decomposable solid waste in the form of fruit skins, pits, or other refuse was processed by the local community into organic fertilizer for fruit orchards. This process was supported by various academic institutes, which provided training for the community. However, the transport of such waste turned out to be quite costly, so now the organic fertilizer producers rely on other sources instead for their raw materials. Now the winery has to hire the Municipal Office to dispose of solid waste.

7.3.2 Wine company B: Lychee, Strawberry, Makiang, Mayom and Honey wines

Economic & Geographical Profiles

This wine distillery is located in a suburb of Chiang Mai Province on the new ring road. It is therefore ideally situated as far as transportation is concerned, as well as being close to a residential area. It is owned as a cooperative by a group of 68 farmers with a small-scale investment, and has been in operation for 3 years. The distillation plant is situated on the land of the cooperative chairman, who also owns a frozen seafood business. This facilitates the construction of a standard wine processing plant that meets the official requirements. The president of the Wine Makers' Cooperative is an expert who has for a long time taught at wine production training courses organized by various academic institutes.

Seasonal raw materials for winemaking generally come from fruit grown by the group members, although some materials are also supplied from other sources. The group does produce wines under its own trade name, but it also receives orders to produce wines under other names. Its wines have received many awards at various national contests. The group also receives support from the government, such as having its wine promoted at an international conference in 2003[20].

At present, this wine distillery has 8 employees[21], 5 being general workers and 3 being food scientists. All employees live in the neighborhood and can commute to work easily. The wine is sold domestically under a government promotion scheme[22]. Samples of their wine have also been exported by dealers to Japan, Singapore, and Bangladesh. The products are certified by The Excise Department, which oversees matters concerning alcoholic beverage production.

[20] The APEC Summit Meeting was held in Bangkok, Thailand in October 2003.
[21] The number of existing workers is more than the regulations stipulate. The surplus worker is temporarily hired during the peak working period.
[22] One Tambon One Product (OTOP) is a government scheme promoting self-sufficiency in local communities.

Environmental Profile & Environmental Implications

Not only is the plant building constructed to meet official standards[23], but the production processing is also of a high standard. This is due to the fact that the group's core leader is an expert in wine making. He has introduced much foreign technology, such as must, winepress, wine vat, etc., and combined this with appropriate local knowledge to produce high quality wines. Since the winery is located near the town center, the water needed for the cleaning and production processes comes mainly from the public water supply. However, water for fermentation comes from commercial sources to ensure the sterilization standard. Water consumption varies with the winemaking season[24], and the demand for water is expected to increase with the growing market and scale of production.

Wastewater is subject to a filtration process and then left to rest without any special treatment, before it is released to public waterways. The business operator justifies this by stating that the amount of wastewater is small, and that the manufacturing system is technically adequate and in compliance with official regulations. In addition, the production process does not continue all year round but only in the winemaking season, 3-4 months per year. However, the amount of water consumed (not including the water used for fermentation that becomes wine[25]) is around 1000 liters per day[26], which still forms a significant environmental concern, especially in the dry seasons.

Organic waste, such as peels, seeds and pulps, is collected in garbage bags to be collected and disposed of by the responsible public organization. They are paid to take an average total of 10 bags two to three times a week to a landfill in a place specified by TAO. The sediments or solids taken out of the fermentation vats are given to group members who use them as ingredients for home-made insect-repellant to be used at fruit orchards. Small amounts of inorganic solid waste such as glass bits and paper are handled properly; instead of being burnt they are sold to recycling companies once a month.

[23] The Excise Department implements the standard requirements for wineries by referring to the standards set by the Department of Industrial Works and hence it requires all wineries to meet ISO requirements, which are not specified, within 3 years of the official commencement of business. All the companies in this study are presently in the exemption period. See Box 7.2 for further information.

[24] From an interview, the amount of water consumed cannot be shown exactly because the group runs two businesses at the same time. The other business is a frozen seafood business, which also use a large amount of water.

[25] The proportion of water for fermentation: wine product is 100: 90-95, where the product volume varies due to aging/maturation process loss.

[26] Estimated value, based on an interview with the manager of the company (October, 2004).

7.3.3 Wine company C: Santol, Thai-tokay, Lychee, Herb and Red fruit wines

Economic & Geographical Profiles

This winery is located in a valley area 45 kilometers from Chiang Rai city. The company is quite far from any residential areas, and is located on the owner's farmland, where the fruits that are the raw materials are grown. It was initiated by six educated professionals, with diverse scientific and technological backgrounds, who cooperated on research in increasing the value of their farm outputs (like mango, santol, lychee etc.) by processing fruit into wines. The production was small during the experimental stage – for about 3-4 years. But the products won many prizes from various contests and became well-known. Three year ago, they started making wine for the market on a commercial scale.

At present, the winery is still regarded as having a small-scale investment[27] with a total of 9 employees[28], including 6 workers and 3 specialists: a plant manager, a wine maker, and a food scientist. The wine has been distributed and sold domestically through a marketing agent. The business is planning to increase its production by 70 percent in 2004, and to make wines under other trade names for export to Japan and the Middle East.

Environmental Profile & Environmental Implications

Western technology is employed in the laboratory. The processing machinery has been modified in certain aspects to accommodate Thai fruit, which is different from the grapes used in other wine producing regions. With periodical and constant advice and training provided by various academic institutes concerning production processes and environmental management, this firm has quite a good plant management. For example, organic waste from the winemaking process is used by the farm manager as fertilizer in his fruit orchard[29]. This helps to reduce its impacts on the environment, as well as save farm production costs. A wastewater treatment system has been installed, so the company is well-prepared for the future. However, at the moment this wastewater treatment system is still underutilized due to the small amount of wastewater. The governmental authority that oversees the production process, from the granting of a winemaking license to the distribution of products, is the Excise Department, whereas it is the Department of Industrial Works that oversees the plant building design as well as the implementation of a viable environmental management

[27] Small investment enterprises set up by the community enterprise promotion policy can operate under the laws that allow private or cooperative groups to produce and distribute "Chae" spirits without any limit with regard to investment funds and manufacturing size.
[28] Same as Fruit wine company B.
[29] The orchard is owned by six owners, as described above.

policy. The firm must be able to meet all the official requirements within 3 year of starting business[30].

As it is located in a rural area remote from any public water supply, the winery has to rely on its own groundwater source for water used in the production process. There have been no shortages of water for the orchard as there is a stream running through this land. The raw water is simply filtered before being used for cleaning, or in the general production process, but water used in the fermentation process needs to be treated so that it is of a drinkable quality. The only cost involved in the utilization of water is for the electricity needed to pump the groundwater. The rate of water use can be regarded as moderate for the winemaking industry[31], and peaks seasonally when the raw materials are widely available. The aging period of the wines, until they are ready for filling, lasts most of the year. It is observed, however, that the company has an imprudent use of water due to its low cost.

The inorganic waste like paper, solid scraps, and bottles is handled in two ways. Those materials that can be burned are burned once a week on-site. This is still practical due to the small volume of waste and the company's relatively isolated location. The remaining refuse is collected as garbage to be disposed of by the public sector once a week. At present, there exists no conflict with neighboring communities concerning industrial waste, but problems are anticipated in the future when the company enlarges its scale of production.

7.3.4 Wine company D: Pineapple, Makiang and Herb wines

Economic & Geographical Profiles

This winemaking plant is located in a state higher learning institution on the outskirts of Lampang Province about 20 kilometers away from the city. It was originally intended to be a training site for students majoring in agro-industry from The Rajamangala Institute of Technology when Thailand began its educational and technical cooperation with Germany 20 years ago. There was a period when this training facility also instructed other individuals on technological issues. Later with the improvement of production technology and cooperation with a network of other academic institutions, the facility was promoted as an educational model[32]. It started making wines to be sold on the market 6 years ago.

[30] This is regarded as a weakness from an environmental point of view, since a license is granted before the establishment of an environmental management policy.
[31] The major use of water in the wine industry is for the cleaning of raw materials and instruments. The water consumption for a small to medium scaled production line amounts to about 800-1000 liters per day. (Source: an estimated value, from an interview with the manager of the company, October 2004).
[32] This is one way to produce wine legally for sale.

The workforce at this winery is made up of employees of the educational institute, who are involved in the production activities all year-round, and part-time workers during the peak season. The raw materials come from fruit grown in the college farm as well as from other growers. The fruits are selected depending on seasonal availability and cost, so as to get the best quality inputs for a low price. In many cases, raw materials are supplied by former students at the institute. They grow fruits of a desirable quality and according to the criteria set by the institute.

The finished wines in every production and distribution lot are sent to The Excise Department for quality and standard certification. The distribution is generally made through the educational institutions network, ending at the domestic market. The main constraints to the expansion of production capacity are the limited wine-aging space and the employees' lack of time, as they have other responsibilities at the institute. This winery is, in that respect, less competitive compared to other private or cooperative wine-makers. However, its advantage lies in the greater technical knowledge of its employees, who are regularly involved in wine production training and are constantly looking for ways to apply their knowledge.

Environmental Profile & Environmental Implications

The fact that this winery is a training and educational facility as well as a model wine distillery ensures that its plant is constructed properly, and that its tools, equipment, and technology are of a high standard, supported by both national and international agencies. Some of these technical and processing aspects have had to be modified from the western models, to accommodate the making of wine from tropical fruits.

Water for cleaning raw materials, tools, equipment, plant infrastructure, etc. comes from the filtered water supply system of the institute. Water needed for the fermentation process is supplied by public utilities. This water is then treated on-site to the standard acceptable for winemaking.

Wastewater from all stages of the production process is drained into a treatment pond, which was built to be used communally by various food processing plants in the vicinity[33]. The treatment system involves filtering, to remove fruit residues and sediments, releasing filtered wastewater into an activated sludge pond, and then permeation of water into the subsoil. There is an engineering section to handle technical problems with the machinery, should they arise. However, in general the plant foreman will oversee the removal of sediments and sludge from the system once a month to maintain the activated process. The sediments and sludge are dried in the nearby landfill site of the institute.

[33] The institute processes many other agricultural products besides wine.

Organic waste, such as fruit skin, peel, or pulp from raw material preparation, including sediments removed from wines during the fermentation stage, will be dumped into the garbage pit of the institute to decompose naturally. Sometimes, organic waste is given to other research units in the same institute for use in experimental projects concerning organic fertilizer or extraction of pesticide substances. Any remaining indecomposable waste will be collected in garbage bags to be disposed of by the local government agency once a week.

7.3.5 Wine company E: Mangosteen and Herb wines

This winery is not located in northern Thailand but was selected for this study so as to examine how geographic location may influence decision making. It was also selected because it uses local fruits from the eastern region as raw materials, and through cooperation with international agencies, has the potential to expand into the export market. It is hoped that the findings from this case study can help identify areas for improvement so as to ensure the sustainable development of the wine industry.

Economic & Geographical Profiles

This winery is situated in the fruit orchard compound of the owner of the company, in a remote rural area of Rayong Province in eastern Thailand. The company also manages a resort. It started to produce wine in order to utilize the excess fruit that they were producing. The winery is a small-scale operation[34], but with the cooperation of The Ministry of Education, it has been established as a technological training center for short-term training and educational programs. It has been selling wine on the domestic market for three years, and plans to expand into the export market soon, having already organized introductory campaigns in some Asian countries.

Since the business chooses to focus on a local fruit[35], namely mangosteen, as a raw material, the winery is only active on a seasonal basis, particularly during harvest time. Consequently, there is no need to employ regular workers. Sub-contract workers are used instead. However, there is a plant manager who supervises 2 permanent employees to help oversee quality control during the wine fermentation process, as well as being responsible for general plant management.

[34] Classification of operational size according to the Notifications of the Finance Ministry concerning permission for private entity to undertake an alcoholic beverage production business, dated 6 October 2000 and 21 December 2000.

[35] There are many fruit species indigenous to the eastern region such as santol, lambutan, durian, etc. but some may not be considered suitable for making wine. This winery at the moment focuses only on mangosteen as a raw material.

Environmental Profile & Environmental Implications

This winery started its business with cooperation from the government, and therefore its processing plant was constructed in a technically appropriate manner and equipped with imported machinery and technology. It has a standard temperature wine-aging room giving the finished products an internationally acceptable quality. This has also been promoted by the government. On the issue of industrial wastewater, although the company reported that it has applied for ISO 9001-2000, GMP and HACCP to meet with international standards[36], the company still does not have a complete wastewater treatment system. As its plant is located quite far from any residential areas, there have been no conflicts with local people concerning the wastewater. All industrial wastewater is drained into a pond behind the plant site and is allowed to permeate the soil without any prior treatment. Organic waste is put in a pit behind the plant to decompose into fertilizer, which is later used in the fruit orchard. Other inorganic waste is collected and transported to a residential area, from where there is a regular garbage collection service.

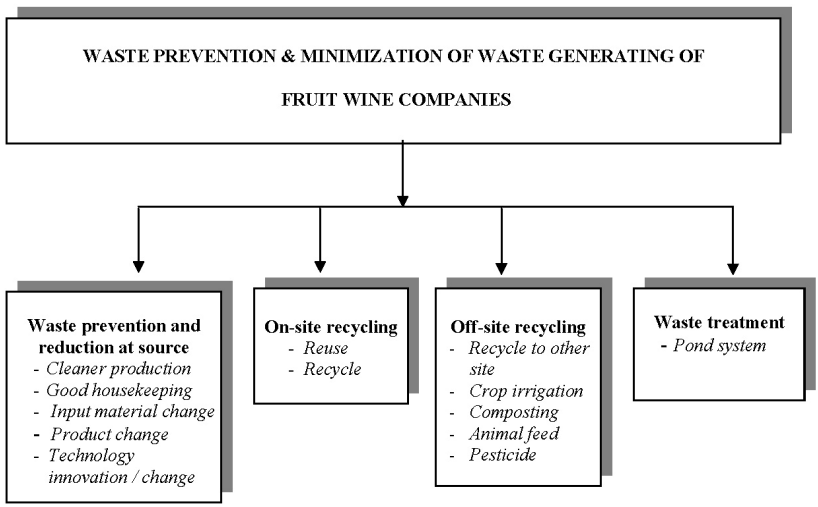
Water for raw material preparation and general cleaning is drawn from a groundwater source in the orchard land, and is treated primarily by filtration. The company buys the water for fermentation from a commercial source so that it is of a suitable quality, which in turn ensures that the wine is of a desirable quality. It is ordered when needed.

7.4 Environmental Improvements to the Fruit Wine Processing Companies

This section will make general recommendations concerning treatment techniques and possible improvements to existing environmental management in the wine processing industry. The possible environmental approaches to the prevention and minimization of waste, as shown in Figure 7.2, have grown out of the concept of prevention at source, or cleaner production. Cleaner production, and the concept of minimization of waste and emissions, is an application of an integrated preventive environmental strategy to prevent wastes and emissions at source, to conserve energy and raw materials, to eliminate the use of toxic materials and to improve working conditions. This means, in practice, that all potential pollution must be dealt with at the associated stage of production to prevent or minimize any impacts on the environment, which might be more difficult to cope with later on. Though it is hard to find specific reports about environmental performance and strategies of the winemaking industry in either Thai or international literature, there is information showing that this concept can be applied to this sector (Pranee, 2000). Four areas of the practical application of this cleaner production concept are discussed next.

[36] Data from SME Development Bank of Thailand, 2004.

Figure 7.2 The prevention and minimization of waste in the fruit wine processing industry



7.4.1 Waste prevention and reduction at source

Good housekeeping: To prevent or reduce waste without changing the current production technology is only possible through improved housekeeping. Good housekeeping of companies requires all employees to comply with environmental guidelines, routines and regulations in which generated waste and the resources used are kept to a minimum. Improving management of raw materials and products, reduction in raw material and product loss, and provision of training to the employees are essential to the successful implementation of good housekeeping. For example, during the preparation process, workers have to be careful not to consume too much water, as this will become wastewater later. Step scheduling when cleaning equipment can reduce waste generation. Improvements in monitoring and operating for all phases of the production process are also effective measures to reduce waste. In other words, good practices need to be implemented at every step. To follow this, employees, both permanent and occasional, should be trained, as good housekeeping will not be successful without the cooperation of both the workers and management.

Another option is the waste reduction by segregation method, which decreases the quantity but increases the quality of waste generated from the production process. For example, inorganic solid waste commonly found in the winemaking industry

consists of cork chips, metal bits, paper scraps, broken glass, parts of paper containers, etc. Although the overall volume is not so significant, there seems to be no attempt to manage this inorganic waste properly. In most cases, the burnable items such as pieces of paper and foam and wrapping plastic are burned, potentially harming the environment. The results from burning such substances as CO_2, NO_2, and CFC affect the whole of the surrounding atmosphere. In other cases, this solid waste is disposed of elsewhere as garbage. Sorting inorganic solid waste into categories and accumulating it in large enough quantities so that it can be sold on the market might be a profitable way of reducing waste.

Input Material Changes: Another strategy relates to changing input materials, which means to purify or reduce pollutants from used raw materials by replacing problematic raw materials. In the production process, organic waste is found in the form of skin, peels, seeds, pits, rotten parts of fruit, and sediments removed from the fermentation tanks. Proper management, regarding input materials, may start with accepting only raw materials that have beforehand been cleaned, sorted, or partially dressed to a certain standard in order to minimize waste that would be generated during preparation.

Technological Changes: Another alternative is production process change by improving equipment or replacing old machines. This will not only improve production efficiency and product quality but also reduce energy consumption. For example, a prototype of a wine-aging machine that has been modified by a branch of the Rajamangala Institute has demonstrated that it can save energy. In addition, the Institute also invented wine pasteurisation machines, which not only improve the quality of the wine, but also save energy. According to the fact that large technological changes mean greater investments, equipment modification with little changes in operational technology is sometimes preferable, especially for SMEs. To produce wine of an internationally recognized quality, wine makers in Thailand must have wine fermentation and wine-aging facilities with temperature controlling devices. These types of facilities consume a lot of energy all year-round. To save costs and to minimize overall energy consumption, specific technologies can be used. Alternatives include the installment of a thermostat to regulate the flow of energy[37], the installment of a heat-insulator in the fermentation and aging rooms, or even the adoption of water-cooling fermentation vats[38]. All these can help reduce energy use significantly. The use of water meters to measure the volume of water used and the volume of wastewater generated is also a minor technological production change that can be very profitable.

[37] There are energy saving campaigns run by both the Electricity Generation Authority and private machinery and tool production industries.
[38] A technology adopted by the model winery in the 4th case study.

7.4.2 On-site recycling

The second possible strategy for minimizing waste is recycling water for some of the steps in the production process, perhaps simply by planning water input use while maintaining standard and quality. Simple techniques to recycle water in certain stages of the production process can save operational costs, and might become an incentive for overall resource conservation. For instance, during preparation, where fruit is cleaned at least 2-3 times before mixing, the cleaning water at the last step could be recycled to be used in the first step, or used for cleaning utensils or the floor afterwards. Using the generated wastewater from bottle washing to wash the cask could also reduce water consumption. These alternatives could be arranged together with good housekeeping, to achieve cost reduction and resource conservation.

7.4.3 Off-site recycling

If on-site recycling is not feasible, off-site recycling could be a viable option. Organic and inorganic waste will inevitably be generated during the wine production process. But organic waste in the form of fruit skin can prove valuable for use in animal feed, compost, or natural pesticides. A quite common practice is supplying farmers with this organic waste, which can then be used to make organic fertilizer or natural pesticides. Currently, the volume and composition of organic waste are not monitored at any of the companies in this study, which make it difficult to manage relationships with other sectors such as farmers or composting groups. In addition, cleaner production strategies, which decrease the quantity but increase the quality of wastewater, should be adopted by the wineries to reduce the use of chemicals and water to the absolute minimum. It is also possible to use wastewater for irrigation. If the winery is committed to implementing cleaner production strategies, it could be possible to irrigate vineyards with its wastewater (Van Schoor and Rossouw, 2001). In this manner, the wastewater can be utilized as a resource and does not negatively affect the soil and groundwater. If, however, the water quality does not comply with all the parameters for vineyard irrigation, the winery could still consider using the wastewater to irrigate grass, and/or gardens in the vicinity of the winery. As research and experimental studies in wastewater utilization have suggested, water from treatment plants could be used for sprinkling trees or reusing for fish culture, if there is an adequate volume (Liquor Distillery Organization Excise Department, 2004).

7.4.4 Waste treatment

Wastewater: The agro-processing industry, as a whole, typically uses enormous amounts of water in its production process to ensure maximum cleanliness and hygiene, and the winemaking industry is no exception. The major water problem in the wine industry appears to be the uncontrolled use of groundwater due to the absence of costs, apart from electricity costs. Another equally important problem is the discharge of untreated wastewater due to the lack of any adequate treatment systems. The volume of wastewater is too small or too irregular to install an advanced treatment system. Consequently, any approach to wastewater management should be simple. Wastewater that cannot be recycled could be managed by using a simple end-of-pipe treatment, such as a pond system, which needs a minimum of skill and supervision (DIW, 2002). This can be preceded by another simple approach to removing solid matters: filtration (Pannee, 1999), a form of primary treatment. In the resting pond, microorganisms could also be added to activate and accelerate the decomposition process in either a closed or open system. If the winery has a lot of land and is located far away from any communities, such wastewater may be allowed to permeate the soil. However, those winemaking plants located near residential areas must treat their industrial wastewater to acceptable standards, before releasing it into public water bodies (MOInd, 2003). In addition, certain chemicals can be used to make by-products that are more environmentally friendly. For example, using K-OH instead of Na-OH, or phosphoric acid instead of citric acid, can make it possible to use the wastewater for irrigation. Wastewater must be treated to allow its reuse, whether it be in the winery, for agricultural crop irrigation or to be discharged to a waterway. Studies of wineries in South Africa show that crop irrigation is possibly still the best way of treating wastewater (Van Schoor and Rossouw, 2001). This option is very useful, but in practice, there are few treatment systems in Thai wineries because the costs, both of investment capital and the labor skills needed for maintenance, are prohibitive.

Solid waste: Reusing and recycling (both direct and indirect) measures are the most appropriate way of managing inorganic solid waste, which is presently managed in an unsystematic and improper manner. This strategy, together with good housekeeping practices, not only minimizes production costs but also maximizes the value of these resources. Reducing waste at source and minimizing energy use by improving housekeeping, followed by on-site and off-site recycling not only decreases waste but also increases company profits. Recently, a wine boom in Thailand has caused the volume of empty wine bottles to increase sharply. Wine bottles come in a great variety of different colors and in a wide range of shapes. This makes them difficult to recycle and causes increasingly more serious environmental

problems. The green wine bottle recycled by a Japanese wine company[39], is a good example for Thai wineries of what can be achieved in this area. For example, recycled wine bottles[40] can reduce both waste and import costs for wine bottles (Japan Echo Inc., 1999). These practices should be valuable to wine producers, both from an economic and environmental point of view.

Organic waste: Organic waste consists of peels, pits/seeds, residues after juice squeezing, residues from dressing, sediment from aging, and sludge from the wastewater treatment. This organic waste is best managed by, in addition to improving housekeeping, off-site recycling like producing by-products such as animal feed, fertilizer or pesticides, as mentioned above. Using waste as livestock feed can greatly reduce waste disposal costs. Composting and land spreading are environmentally responsible alternatives to land filling, and can be a more profitable way of managing by-products.

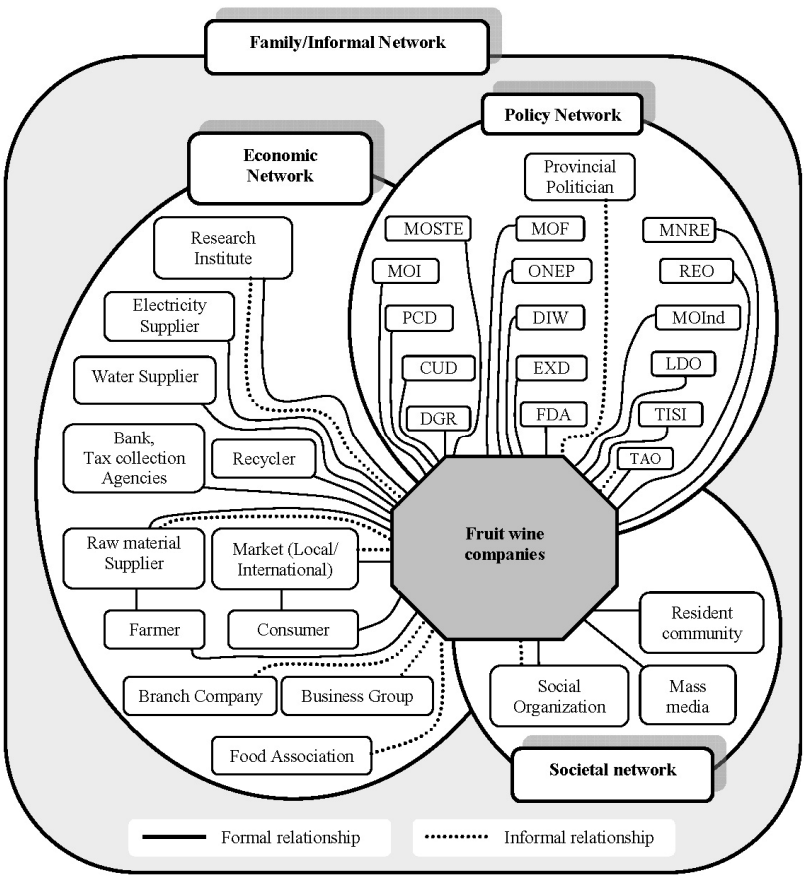
7.5 The Role of Various Actors and Institutions in the Fruit Wine Processing Industry

In addition to implementing the prevention and minimization of waste concept to improve their environmental performance, wine producers have to deal with various actors and institutions, which also have an impact on the environment. All institutions involved in the wine production process influence the outcome of any environmental management policy. In this section the role of various actors and institutions in the wine production industry is analyzed, based on the quartet-network model, through the analysis of economic, political, societal, and family networks in which the companies are engaged. The Quartet Network of the wine companies is presented in Figure 7.3.

[39] A top Japanese producer of Western-style spirits set the ball rolling in May 1999 when it began to use so-called "ecology bottles" for wine on the domestic market, manufacturing 100 percent of its green wine bottles from recycled glass (Japan Echo Inc., 1999).

[40] Beer bottles boast a 95 percent recycling rate, and the standard 1.8-liter bottles used for sake and other spirits have nearly the same rate, with an 85 percent recycling rate. These types of bottles have long held top honors in the recycling field. Green wine bottles are notoriously difficult to recycle, and until recently nearly all of them ended up in garbage dumps.

Figure 7.3 Networks embedding wine processing companies



7.5.1 Economic network

The economic network of wine companies can be analyzed by looking at the following relationships: i) the relationships between wine companies in a production chain by looking at the vertical interactions from input suppliers to producers and consumers; ii) the relationships between different wine companies, as well as via branch association; and iii) the interactions between wine companies and other economic agents and research institutes.

Vertical interactions from input suppliers to producers, recyclers, and consumers

Input Suppliers. Input suppliers for wine companies are, as well as farmers, the suppliers of raw materials, chemicals, water and electricity.

Farmers. The main input for all of the wine companies in this study is fruit, usually a fruit that is indigenous to the area. The wine companies A and B, which are cooperatives, have regular contracts with their group members, who send them ripe fruit to be made into wine. This guarantees that not only are these companies supplied with quality raw materials on time, and at fixed prices, but also that they have an opportunity to lower organic waste through strict quality control measures. Some of wine company A's group members were trained to compose fertilizer from waste, which they did for some time, but high transportation costs to the decomposing site coupled with the seasonal nature of wine production rendered this option unviable, and they have since stopped this operation. Wine company B's members use some of the organic waste to make natural pesticides and organic fertilizer.

Wine company D has a flexible relationship with farmers, from whom it orders high quality raw materials on an irregular basis. They also have informal contracts with farmers from the Central region of Thailand, who supply the company with herbs which are rarely found in the North. Wine companies C and E have no relationship with farmers because they use their fruits from their own fields as raw materials. This gives them the opportunity to control production cost, pesticide use, the quality of inputs as well as manage organic waste. Furthermore, they can compost the waste and then use it as an orchard fertilizer.

Local farmers who supply fruit to the companies can play a role in reducing the amount of waste generated during the preparation process. Organic waste, such as outer skin and seeds, has been supplied free of charge, as animal feed, by wine company A's group members as well as the nearby farmers who supply wine company D. Both groups of farmers benefit from this activity. In the same way, wine companies C and E also use this waste for composting, which they then spread on their fields. This both fertilizes the soil and manages waste. Another area where wine producers and farmers can cooperate is with the management of wastewater from the fermentation and racking processes. Twice a month all the companies, except wine company A, reuse this kind of waste to make pesticides or fertilizer. Unfortunately, it is difficult to estimate how much wastewater is reused in this way, as the volume of waste depends on the number of wine vats in each plant, and there no attempt has been made to calculate this accurately.

Raw material and chemical suppliers. All the companies in this study order other raw materials and chemicals from domestic suppliers with contracts stipulating desired quality, supplying schedule and prices for all the materials. It is noticeable that some raw materials such as yeast, which are important to produce a quality wine, have been ordered from specific international suppliers to ensure that the wine produced is of a high quality. Materials that are exclusively used in the wine industry, i.e. cork and wine bottles, are ordered from either domestic or international suppliers.

Water suppliers. In the wine industry, water is used in two ways. Firstly, it is used to prepare and clean raw materials, as well as clean the processing plant. All the companies in this study, except wine company B which receives water from a public water supply, use groundwater from their own wells without incurring any water costs. This does, however, increase their electricity costs[41]. As is the case with other food processing sectors, they use a large amount of water to ensure that their products are hygienic, without considering environmental concerns with regard to water consumption. The main reason for this is that they can use groundwater for free. Water is also used in the fermentation process. All the companies buy fresh water individually from commercial sources to ensure that it is of a sufficiently high quality. This part of the water consumption is strictly controlled by the companies, which shows that the attitude towards managing water consumption differs according to what it is used for. This implies that if the water consumed for preparation and cleaning cost more, there would be more of an incentive to reduce that part of water consumption.

Electricity suppliers. The Provincial Electricity Authority provides electricity to all users in different provinces. The price of electricity depends on the type of business, the voltage level and when it is used (peak or off-peak hours)[42]. Wine company A, which seems to be more locally oriented and uses simpler technology for making wine, has lower electricity costs. In this case there is no incentive for the producer to reduce electricity costs, as they are already quite low compared with the cost of investing in new technology. The other companies, however, have a higher electricity bill because they have special rooms for wine fermentation. As a result, there is a need for them to reduce electricity use to save costs. Although the rooms' temperature is automatically controlled at 15-20° C[43], they try to turn off the electricity at winter time and in some cases they have installed insulation to make a further saving on energy costs. High energy costs have been a powerful motivating factor, encouraging the companies to make further efforts at saving energy[44].

[41] The same is true of the fruit and vegetable and animal- processing sector.
[42] For details, see Chapter 5.
[43] The temperature of the wine storage room depends on the type of wine and the room's environment.
[44] At present, no energy saving project has been launched for the wine industry.

Recyclers. Recyclers play a significant role in reducing waste and in turning the material flow of waste into useful products. This includes compost producers and retailers that play a crucial role in reusing waste or making by-products from waste.

Compost producer. Local compost producers could reuse organic waste generated during any part of the production process, from preparation to aging. At present, there is no local compost company using organic waste from the wine companies to make organic fertilizer. Previously, wine company A gave its organic waste to a local compost producer, but the transportation costs and unpredictable volume of waste made this an unviable option and it has since stopped doing this. Wine company D gives organic waste to a composting plant that is a part of the Soil Department of the Institute. The final compost is returned to the pilot field, which has been planted by their students. The rest of the wine companies return their organic waste to their orchard gardens as fertilizer. A special case is wine company C, which has a composting site on its field. This site is managed by the agricultural manager, who stays in close contact with the manager of wine production to transfer waste to the field. This arrangement continues all through the winemaking season. These experiences show how the wine companies can manage their organic waste in an environmentally friendly way.

Retailers. Inorganic waste generated by the wine production process of all the companies in this study (for example, pieces of cork, plastic, labels, boxes and broken bottles) are collected and sold to different retailers every month. This is done on a regular basis, and shows how managing waste effectively can also be profitable for the companies.

Consumers/Customers. The wine business has been promoted by the Government so as to strengthen local communities and to produce wine for import substitution. All the companies in this study deliver to customers in the local and central part of Thailand. After years of promotion, the growth rate of the domestic market is declining and some of the companies have tried to expand their production to the export market, citing the unique characteristics of "herbal wine". At present, wine companies B, C and E have contacts with dealers and sell their products on the export market[45] to such countries as Japan, Singapore, Vietnam and the United States. To be able to sell on the international market, wine companies have to produce a product of an acceptable quality. At the moment, only wine company E has tried to apply for such international standards as ISO 9001-2000, GMP and HACCP.

[45] The exported wine products are distributed by dealers in other brands and some are sold at exhibitions or festivals.

At present, although consumers know that modest drinking of wine is good for the health, the fact that in 2003 some drinkers in the Eastern part of Thailand were killed by poisoned wine has harmed the Thai wine industry[46]. In order to regain market confidence, all of the companies emphasized the importance of receiving certificates from the relevant governmental agencies[47] as a guarantee of the quality of their product. The certificates, for example the winning prize in any wine contest at a national[48] or international level[49], OTOP product champion 5 star[50], or being designated as a provincial brand, represent not only the quality of the products but also the environmental performance of the producer. This case shows how consumers can have an impact on the choices made by producers, and can encourage the companies to produce quality products in an environmentally friendly way.

Horizontal interactions between the producers and other wine companies, enterprises, or via branch association

All companies compete with each other on the domestic market, although some of them appeal to different sections of the market. Wine company A seems to be a leader in wine making cooperatives at the local level in the North because of its strong management. This firm has become a center of training in winemaking, to visitors as well as to other wine cooperatives. Wine companies B, C and E supply a higher quality product, that is fruit and herbal wine, on both the national and international markets. Wine company B, with a skilled professional in wine making, supplies an agent, which then sells these products on the international market. Wine company B also exchanges marketing and technological information with its local wine group membership.

Wine company E, being one of the leading groups of herbal wine producers, as well as being a training center cooperating with the Ministry of Education[51], is planning on cooperating with certain international governments in the area of training and technology transfer. At present, wine companies C and E are members of the Fruit Wine and Distilled Liquor Producer Association of Thailand. However, being a

[46] It has been proven that the poisoned wine was contaminated by drug traffickers. The liquid contained solvents with narcotic effects that proved lethal when consumed excessively. The wine production process itself was not a factor (Bangkok Post, July 3, 2003).
[47] The national certificates are handed out by Provincial agencies, the Excise Department, the Government Savings Bank, the Small and Medium Enterprises Bank, the Bank for Agriculture and Agricultural Cooperatives, the Community Development Department, Assumption University, and the Ministry of Industry.
[48] National wine contests have been organized by Assumption University since 2002.
[49] One type of wine of a case study won the International Food and Hospitality 2002 in an International Wine Contest.
[50] Production methods, quality control, packaging and designs are all considered when assessing companies for this certificate. The 5 star certificate is awarded for the highest quality.
[51] This cooperation is between the Non-Formal Education Department and the company.

member of this association has given wine company C little perceptible advantage. Wine company C does not cooperate on common interests such as marketing, technology development, information exchange, or waste treatment with other members of this association. The members of this association only interact with each other when involved in wine exhibitions or contests that are organized by the wine association together with governmental agencies at least once a year. Wine company C only takes part in wine exhibitions and keeps the relationship going to maintain its membership status. In contrast, wine company E, whose director is an executive board member of the association, has used its membership to promote its business as a leader among wine producers. The company was assisted with valuable marketing and technological information, which helped it develop newer technology and better promote its business on the market**.** It is no surprise that this company has shown a rapid export growth. These cases show that, in general, the Fruit Wine and Distilled Liquor Producer Association of Thailand, which has been formed since 2003, plays a negligible role in strengthening the fruit wine industry in Thailand.

Wine company D sees itself as a training service and does not perceive profit to be a major goal. It therefore only supplies its products to special markets at branch institutes in other provinces. As mentioned, it has a laboratory for the institute's students and related organizations. Some of the students have become wine producers after completing their training. This company has a diverse but close relationship with other wine companies, involving education, training, consulting, and exchanging information and technology.

In short, there is now little horizontal interaction between companies with the exception of wine company D. If they would share each other's experiences and information, they could benefit both in economic and environmental terms. Information sharing about key issues such as marketing, technological developments and waste management would undoubtedly strengthen this industry.

Interaction between the companies and other economic agents and research institutes

Economic Agents. Economic agents that interact with wine companies are private and state banks and tax agencies. The relationship between companies and state banks has benefited this kind of industry greatly. The state banks such as the Small and Medium Enterprises (SME) Bank of Thailand, the Government Saving Bank, the Bank for Agriculture and Agricultural Cooperatives (BAAC), and the Export-Import (EXIM) Bank of Thailand, provide short-term loans in order to stimulate this industry and to meet the government policies of freeing distilled liquor and strengthening local communities. However, these loans are usually not enough for the companies, so they need additional credits from private banks, which have a higher

interest rate. While up to now no environmental conditionalities exist, this is a potential area to stimulate companies' environmental responsibility by putting environmental conditionalities on loans from state banks as an incentive for companies to meet at least the minimum environmental standards.

In addition, all companies have to pay local tax, excise tax, as well as export and import tax to the relevant authorities, based on their turnover. At present, no existing tax law or regulation provides incentives to encourage the companies to apply waste minimization measures.

Research institutes. All of the companies in this study have been advised by consultants, and received training in production technology from various research institutes. At a local level, the training of production technology is provided by the Rajamangala Institute of Technology. The research centers from Chiang Mai University (CMU) and Mae Jo University (MJU) can give advice on marketing, the production process and waste management technology. In addition, various institutes and research centers at the national level such as the Institute for Small and Medium Enterprises Development (ISMED), the Institute of Food Research and Product Development (IFRPD), the Technology Promotion Institute (TPI), and the Fermentation Research Center for Value Added Agricultural Products have many educational and training programs to help this industrial sector. The programs cover issues such as marketing, product and packaging development, production technology, and waste management technology. The companies in this study contacted and consulted with the research institutes very often when starting the company, but much less later on, only if they had problems or needed some specific advice. These relationships were conducted on a personal basis and mostly at the local level. In general, the government covers all the costs and expenses of this work done by the research institutes. The companies paid nothing for the consultancy. They sometimes had to pay to attend certain seminars or training courses that had incurred extra costs for raw materials. It can be seen that the companies benefit greatly from these relationships both in economic and environmental terms.

7.5.2 Policy network

In this section, the roles of various actors and political institutions at different levels will be analyzed to investigate how they can govern and promote waste minimization in the wine industry.

The government agencies related to environmental management in the wine industry at a national level are the Ministry of Natural Resources and Environment (MNRE), the Ministry of Science, Technology and Environment (MOSTE), the Ministry of Industry (MOInd) and the Ministry of Finance (MOF). At the regional level the

Office of Natural Resources and Environmental Policy and Planning (ONEP), the Regional Environmental Office region 1 and 13 (REO1, 13), the Pollution Control Department (PCD), the Department of Industrial Work (DIW), the Liquor Distillery Organization Excise Department (LDO), the Custom Department (CUD), and the Excise Department (EXD) (the 2nd and 5th Regional Excise Bureau) are related to this area. At the provincial level the Provincial Excise Office (PEXD), the Department of Groundwater Resources (DGR), the Office of Provincial Natural Resources and Environment (OPNE), and the Provincial Food and Drug Administration (FDA) have responsibility in this area. Finally, at the local/community level the Tambon Administrative Organization (TAO) plays an important role with respect to environmental policy and management.

These government agencies have the authority to monitor and control wine companies. Setting up a wine company, which according to regulations can only be a small-scale enterprise[52], has to be approved by MNRE, MOInd, MOF and EXD[53] at the regional and provincial levels. In theory, DIW and PCD have to monitor pollution regularly inside and outside the firms. In practice, however, there is no monitoring of the wine industry. The absence of monitoring is caused by a lack of personnel, especially when compared with the large number of factories. In addition, the industry is strictly controlled by EXD, which enforces the excise tax law[54], so other government agencies let EXD take responsibility for all issues, including the environment. Furthermore, the wine industry is a new industrial sector emerging at a community level, and it was assumed that these enterprises would not cause any serious pollution. The TAO, who is responsible for environmental protection, has no right to act on any abuse unless there are complaints from the community.

Certain agencies such as the Thai Industrial Standards Institute (TISI)[55], test these products to guarantee product safety. All wine producers have to send wine samples from each batch produced to these authorities[56]. As a further precaution, officers from EXD randomly choose some bottles of wines from shelves on the marketplace as samples to test the product quality as well as to guarantee consumer safety.

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[52] According to the Finance Ministry's Notification dated 6th October 2000.
[53] The Excise Department is responsible for Liquor manufacturing.
[54] The Excise tax law is based on the Liquor Act B.E. 2493.
[55] Exporter wine companies, to assure the customers of the standard of their wine, must apply for a certified label, namely IS2089-2544, dated on November 22, 2001. In addition to overseeing community products MOInd cooperated with MOF and EXD to formulate the regulations for the standard of community product to guarantee the quality of communities' products including wine and distilled liquor. The checking of these samples is the responsibility of other agencies.
[56] The legal authorities are the Thailand Institute of Scientific and Technological Research, Assumption University, the National Food Institute, the Chemical Research Institute of Rajamangala Institute of Technology, the Suranaree University of Technology, Chiang Mai University, Khon Kaen University, and Ramkhamhaeng University.

The interactions of wine companies with government agencies are complex and vary from case to case. Wine company A has an advantage over many other competing community groups of the same size and product category on the local market. It has received much support from the local authority (TAO) via many channels; for example it has received no-interest loans, short-term loans, training, marketing and technological information, and so on. The company showed how it had strengthened the local community, which is the main goal of the government policy to stimulate this industry. This case shows how a governmental policy in community development can succeed.

Wine company B, in name a cooperative group, formed the group by using the expertise of the manager who is a professional in wine production and a trainer whose services are in great demand. It used the close relationship with related government agencies to manage its firm, such as consulting to set up the cooperative group**,** constructing the firm to meet the minimum standards according to environmental regulations, promoting its product as a leading brand of local wine, etc. The government officers also benefit from their cooperation with this company that involving in the trade show as well as being a visit center for training program of wine production with the company.

Wine company C is similar to wine company E in that it causes very few environmental problems at its site. It has consulted with the relevant authorities since starting business. Wine company C has many consultants from a local university, who stay in close contact with the local authority. It aims to be an environmentally friendly factory. Although it has neither received complaints from the community nor any warnings from the relevant authorities, the company has made further improvements to its environmental performance, such as by improving its wastewater treatment plant. The owner of wine company E has a very close personal relationship with government officers, which he values greatly. This company has now become a winemaking training center. In addition, this relationship promotes greater cooperation on technological issues between the Thai and foreign governments[57]. To maintain the advantage of having a good relationship with the government, the firm has to perform in an appropriate way in order to keep the status of a training center for the Ministry of Education.

Wine company D, which is part of an institution promoting technology transfer, has become an education training center model. Due to the responsibility it has, it arranges regular educational and training programs, both for the authorities and the public. On the other hand, as a producer, it has a strong relationship with the

[57] From an interview with the owner of wine company E (October, 2004).

authorities, which have confidence in the firm, both in its product quality and its environmental management. This implies that the company takes advantage of resources such as information and knowledge from other research institutes and environmental agencies to run its business in an environmentally friendly and profitable way.

This analysis illustrates that the role of public authorities is mainly focused in stimulating the wine companies to develop economically. Like the former industrial sectors, environmental issues are not of primary importance when the government evaluates what support is needed. The wine companies, with pressure from consumers, however, have to adapt and improve themselves with respect to environmental standards in general, without much support from the public authorities.

7.5.3 Societal network

In this section the societal network, which consists of local communities, social organizations, and the mass media, are analyzed to understand the influences of these actors in putting pressure on the wine companies to behave in an environmentally friendly way.

Resident communities. Taking advantage of being a new industrial sector, all of the wine companies in this study have organized their firms as much as they could, with the limited resources available, to comply with the relevant laws and regulations. Selecting a site at a remote area and setting up wastewater treatment plants (like wine companies C and E) show how some companies try to avoid potential conflicts with local residents. This is why these companies have not received any complaints from surrounding communities. Similarly, wine company D made great efforts to reduce any environmental impacts from its production process, even though the firm is located far from any residential areas.

Wine companies A and B, however, are located in suburban areas surrounded by local communities. They have used public infrastructure, such as public waterways and the wastewater sewerage system, to drain wastewater generated during the production process. Wine company A's manager said that it received some direct complaints about malodor during the peak period of production and that the draining of wastewater has an adverse effect on the Kuang River[58]. In order to solve these problems, following consultation with certain research institutes, aerobic bacteria have been introduced to the wastewater pool before draining to reduce malodor. This is a simple solution, but not the best, for a company with a limited budget. However,

[58] From an interview with the owner of wine company E (October, 2004).

it shows how public pressure can influence the environmental performance of a company. Wine company B, fortunately, has not received any complaints yet, because it is located in a new settlement area, where the residential communities are not as strong. In the future, however, as more people or businesses move to the area, it might well have to improve its own environmental performance following complaints from the community.

Social organizations. Despite being a new industry, winemaking is a hot topic of interest and concern, especially regarding safety, moral, and environmental issues. These issues are related to the quality of the product, the increasing number of alcoholic drinkers, and an emerging amount of community producers whose environmental performance needs to be monitored. Social organizations around the wine industry consist of Consumer groups and local NGOs. The National Consumer Society Right pressures the Ministry of Public Health to deal with all food issues. After a case of wine poisoning[59], the group pressed for stricter monitoring of product quality. This led to more precise monitoring of production and marketing by the producers and the implementation of more stringent regulations[60] by the government. The government also strengthened policies associated with the cottage industries. The other social organizations, local NGOs, are concerned with the deterioration of natural resources such as water pollution in local waterways. Although the winery is not a heavily polluting industry, it does have an impact on water resource problems, both in quality and quantity. In one case, a complaint from a local NGO led to more environmental concern being shown by the wine firm and the relevant authorities, partly because the company is made up of community residents. These cases show that social organizations can often play a role in forcing wine companies to improve their environmental performance.

Mass media. The mass media such as radio, television, newspapers, and public leaflets do not play a key role in reducing specific environmental impacts of the winemaking industry at present. Most of the reported issues and media coverage relate to market promotion, such as wine exhibitions and wine contests. However, the coverage of the poisoned wine case mentioned earlier highlighted concerns about safety issues in the wine industry. Furthermore, the media sometimes expresses consumers' concerns regarding wine quality. This forces the relevant authorities to monitor companies more strictly and more often than usual. In brief, the mass media, especially at the local community level, can play a role in encouraging wine companies to be more environmentally friendly, but only when there are clear and serious problems.

[59] The Kuang river is the main river of Lamphun province, which has been badly polluted with industrial waste from industrial estates.
[60] As former reference.

7.5.4 Family/Informal network

The economic, political, and societal networks are not the only networks that the companies are involved in. The family/informal network also contributes to give a clearer explanation of business behavior.

As this is a new emerging industry in Thailand, none of the wine companies in this study have inherited their businesses from previous generations. They formed and now operate their businesses as first generation enterprises. However, there are some obvious personal and kinship ties. For instance, wine company E is managed and controlled by family members. The others are managed and run by members of a group who had personal relationships before forming their businesses. Companies A, B, and D still use informal contracts, or what they called 'spoken agreements', when ordering raw materials, which suggests that they can trust each other without any written agreement. This kind of personal relationship is preferred to formal contracts.

In addition, informal (personal and kinship) relationships are found among various actors, such as business partners, government officers, and professional institutes. These connections do offer support, protection and access to confidential information, which is important when dealing with regulations or other business issues[61]. For example, wine company A has been established, supported and organized via informal connections with the local authorities, who gave the company important information, as well as promoting it in various projects. This is not surprising, because the members of the cooperative are also members of the same political group within the local authorities. It is clear that these connections benefit the company greatly, especially when compared with other local wine companies. Wine company B has personal connections with agencies that have for a long time organized wine training programs. These connections help the company improve every aspect of its production process. Wine companies C and E are members of a formal wine association, which shares information. Both companies, especially wine company E, have strong informal connections with politicians at a local and national level. These connections also help them stay informed. Finally, wine company D, uses a strong relationship with its institute partnership around the country as well as the connection with its trainees and government officials to maintain a healthy business.

[61] Pongsapich (2001) cited that there are strong relationships between economics and politics in Thai society, and that the development concept 'Nationalist capitalism' had been used by the government since 1945.

7.6 Conclusion

At present, after being initiated as a community project to substitute imported products, the winemaking industry has strengthened and expanded in production capacity. The case studies above show that there is an opportunity for the wine producers to use the unique characteristics of their product, herbal fruit wine, to gain advantages over their rivals both in the domestic and international markets. They can promote the positive effects on the health of their product, combined with a more environmentally friendly production process to increase their market share. To sell on the international market, they might need to meet international standards such as HACCP and ISO 14000. There is much pressure being put on the companies to reduce water consumption and not to discharge untreated wastewater into public waterways. For example, environmental authorities are working with the industry to monitor the companies' production processes as well as the amount of waste generated so that these meet regulations, especially after the three years exemption period. Market/consumer requirements of quality products also put pressure on the winery companies to comply with environmental rules.

In practice, some fruit wine companies that plan to expand into the export market have accepted waste reduction at source and waste treatment approaches in their production. For instance, cleaner production measures (e.g. optimization of water flow within the production process), onsite reuse (e.g. composting the organic waste) and waste exchange methods are all solutions to minimize the environmental impact of the production process. Recycling inorganic waste (e.g. broken glass, pieces of cork, pieces of paper and boxes) is another environmentally friendly method that is also profitable. In some wine companies these improvements have already been implemented, showing that they are technically and economically feasible. However, in order to apply all the above solutions the companies have to increase their cooperation with various actors and institutions. Authorities (e.g. TAO, EXD), economic agencies (e.g. economic groups, research institutes) and social organizations (e.g. NGOs, community groups) could play an important role, in cooperation with wine producers, in improving the industry's environmental performance.

Chapter 8

Greening Food Processing SMEs in Thailand: Conclusions

8.1 Introduction

The Thai government recognizes that the food industry is an important industrial sector, and since the 1997 crisis the development of small and medium-sized enterprises has been central to the government's policy on economic recovery. Various strategies have been implemented to stimulate and support this industrial sector, and especially the small and medium-sized companies, within the Agricultural-Food Development Plan. However, the Thai food industry is also believed to have a major impact on the environment. Due to the fact that the formal environmental regulatory and policy system is institutionally weak, the Thai food industry has had major impacts on the environment all over the country, leading to growing social conflict with the surrounding communities in rural areas. Several waste management and treatment approaches have been developed and introduced in Thailand, but their implementation and environmental success depends very much on specific local circumstances. Given the complexity of the environmental challenges, and the limited capacities and resources of SMEs in the food industry and environmental authorities especially at the local level in Northern Thailand, a number of questions arise which this thesis has sought to address: how do actors, institutions and social structures influence the waste management and environmental performance of these food processing companies, and what are suitable strategies to improve the environmental performance of these small and medium-sized companies in Northern Thailand.

In analyzing case study companies in three agro-food sectors in Northern Thailand (as reported in the three former chapters), this study has aimed to answer these research questions. This final concluding chapter begins with an evaluation of the institutions that affect the strategies for improving the environmental performance of agro-food industry in section 8.2. This section discusses the similarities and dissimilarities between the three sectors (fruit and vegetable, meat, and fruit wine processing industries) and evaluates the constraints and opportunities in applying waste prevention and minimization approaches and technologies in the food processing industry in Northern Thailand. Subsequently, the section builds on these outcomes from the case studies and elaborates more general lessons for the ecological modernization of agro-food processing industry in Thailand. Section 8.3 analyzes the application of various pollution control measures, looking at the constraints on such measures as well as their potential, on SMEs in the food industry in Northern Thailand. This concluding chapter ends with an evaluation of EMT

application and a reflection on the policy of greening SMEs in the food processing industry in Thailand.

8.2 Comparative Evaluation

There are many factors involved in determining the environmental performance of industrial firms, to understand how they perform, and so it is necessary to analyze those factors involved in the firms' industrial environmental institutions. The case studies revealed some example of opportunities and constraints towards environmental improvement of their production processes. The following sub-sections illustrate these issues. The first part evaluates the integrated approaches and waste treatment measures implemented by the companies, and the possibilities of changing these SMEs into zero waste industrial firms. Then, in the second part, there is an analysis of the institutional environment and regulations. The institutional arrangements, organizational structures, and policies related that are of crucial importance in the adaptation in environmental performance of these firms, are analyzed based on the Ecological Modernization Theory. The core dynamics, mechanisms, institutions and actors to shift the unsustainable industrial system to a more sustainable one are examined.

8.2.1 Comparative analysis of environmental reforms

Chapters 5, 6 and 7 present the results of the thirteen case study companies in three sub-sectors of the Thai agro-food processing industry. Together these clearly illustrate the environmental impacts from food industrial activities. They also show the challenges facing governmental agencies that aim to make these companies more environmentally friendly. The kind of challenges these case study companies face and the way they respond to them can be characterized by a number of parameters. Table 8.1 identifies and characterizes how these three food processing sub-sectors have dealt with the environmental challenges they have faced. We can identify both similarities and differences in the ways they have met these challenges.

Table 8.1 Summary of environmental reforms implemented by SMEs in the food processing industry

Sub-sector / Topic	Fruit and vegetable processing companies		Meat processing companies		Fruit wine processing companies	
	Small-scale	**Medium-scale**	**Small-scale**	**Medium-scale**	**Small-scale**	**Medium-scale**
Degree of implementing end-of-pipe treatment	Low	Medium-low	Low	Medium-high	Low	Medium-low
Implementation of new environmental approaches (CP & EMS)	Low	Medium-high	Low	Medium-low	Low	Medium-high
Frequency of complaints (formal & informal)	High	Medium-low	High	Medium-high	Medium	Low
Cooperation with other entrepreneurs on environmental issues	None	Medium-low	Low	Medium-low	None	None
Cooperation with the government on environmental issues	Medium-low	Medium-high	Low	Medium-low	Medium	Medium-high

Source: Compiled by the author based on data from 2002-2005.

Similarities of the cases studied

All case studies are food processing SMEs, which are located in suburbs or rural areas in the northern part of Thailand. The case studies have the characteristics of small and medium-scale firms of developing countries. Input raw materials, such as fruits, vegetables, herbs and livestock, are processed with simple or semi-advanced technologies to be turned into final products that are mainly sold in the domestic market. The crucial environmental problems for all of these companies are resource depletion (especially water and energy) and environmental degradation, which have been caused by overuse of resources and discharge of wastewater, air waste and solid waste from their production processes. This investigation has revealed a number of similarities between the sub-sectors and companies in the way they dealt with these environmental problems:

Environmental technology: In general, the management and treatment of solid waste and wastewater is characterized by an insufficient use of environmental technology, especially in the small-scale firms of every sub-sector.

Resources: All case study companies have limited resources, both financial and human, for making environmental investments.

Information/knowledge on environmental reform: All case study companies showed: i) inadequate knowledge on proper processing of operations, such as preparation

processes and wastewater circulation, and ii) a lack of information and knowledge on newer cleaner treatment approaches within firms, such as CP and EMS. .

Environmental practices: Most of the case studies are similar in the following ways: i) lack of environmental section or personnel with responsibility for environmental management in the firm, ii) lack of environmental planning towards the future, and iii) no strong implementation of environmental regulations and hardly any monitoring by the authorities.

Institutional environment: The network analysis reveals an inadequate cooperation between entrepreneurs in treatment technologies and environmental management and no active civil society that actively brings environmental issues to the attention of companies. All cases showed a lack of incentives to encourage the implementation of waste reuse and recycling due to cheap natural resources (such as free or low-priced groundwater, and low prices of energy). There is also no strict enforcement and control on pollution prevention and environmental protection by governmental agencies.

Dissimilarities of the cases studied

Despite the similarities, this study also showed differences between industrial production units, especially in terms of scale (small and medium), and in terms of industrial sub-sector (fruit and vegetable, meat and fruit wine). The dissimilarities on environmental management were as listed:

- The small-scale firms of every sub-sector have implemented end-of-pipe treatment systems to a similar degree, but the medium-scale firms have implemented these systems to a greater degree due to more regular monitoring and control from the authorities. It is noted that in some medium-scale meat and wine processing firms, there is some pressure from the international market to implement end-of-pipe treatment systems through HACCP certification schemes.
- More recent environmental approaches, such as cleaner production and environmental management systems, are more readily accepted in medium-scale firms of some of the sub-sectors due to stronger economic and policy pressures.
- Frequency of (formal & informal) complaints varies with the waste management technology used, the volume and type of waste, and the location of the company.
- Although most of the studied companies cooperated with other entrepreneurs and governmental actors on environmental reforms less than was necessary, there were major differences in the degree of participation of these actors among the sub-sectors, as shown in Table 8.1. These differences will be explained through the network analyses in the next section.

The similarities and differences between these companies illustrate that in most cases there are more opportunities for greening industrial performance than are actually implemented. Although any generalization of the potential for improving environmental management from these cases should be taken with care, the value of the case studies lies in understanding the range of possibilities to control pollution and the necessary conditions for successfully applying these possible options. Reducing pollution can be achieved through various end-of-pipe treatments, waste exchange and prevention and minimization of waste generated. In addition, these possible strategies need to be combined and integrated. Table 8.2 lists feasible options for waste and wastewater management that can be applied in each sub-sector.

Prevention and minimization at source: Good housekeeping is the first step to preventing waste generation at source, as it requires little investment and is therefore a suitable option for medium and small-scale firms in all industrial sub-sectors. Better process control is the best measure to reduce water consumption. Dry cleaning methods before using wet clean up, high-pressure spray wash during clean up, and minimization of spills and leaks at the production line are all options for minimizing water consumption and the volume of wastewater. Applying cleaner production measures, such as using ready-to-use raw materials, is another option to reduce both waste and freshwater usage – and thus the amount of wastewater discharged from the production process. These practices have proved to be successful both in economic and environmental terms, as shown in some of the small-scale fruit and vegetable and meat processing firms in this study. By applying such measures, producers managed to benefit economically (by reducing cost of wastewater treatment and cost of fresh water use) as well as improve their environmental performance and reduce the amount of natural resources they used. For the fruit wine processing companies, applying ready-to-use raw materials proved less relevant due to the nature of their production process. However, other cleaner production measures are very useful, such as waste reduction by segregation and, if possible, technology change. To conclude with, waste prevention and minimization can be applied at firms of various sizes and in various sub-sectors.

Reusing and recycling waste, and making by-products: Due to the organic nature of most of the waste, reusing and recycling – both on-site and off site - of waste generated from the production process is an essential environmental strategy for most of the companies. Wherever possible and appropriate, the organic solid waste can be used as a source of nutrients for fish culture, as raw material to feed livestock, to produce 'agrochemicals' such as compost, fertilizers and even insecticide, or can be sold as a by-product. Even inorganic waste, such as broken glass, pieces of cork, pieces of paper and boxes, can be recycled off site. These recycling practices are environmentally friendly methods that serve the economy well. Often additional income is generated by recycling, or good relations are maintained with raw material

suppliers by providing them with free 'waste'. The remaining un-reusable waste should be treated in a proper way to protect the environment. Often these remaining fractions of waste are collected by governmental or private waste utility companies to be dumped at a landfill. While these options prove to be very feasible for solid waste, they are not always applicable for wastewater. In fruit and vegetable and fruit wine production, wastewater could be reused for gardening and farming, but this was not possible for meat processing wastewater due to the high organic load of the wastewater, unless proper and controlled treatment facilities were installed.

End-of-Pipe technology: Regardless of the possibilities and the actual implementation of the two former strategies of dealing with environmental impacts, the application of end-of-pipe treatment systems remains an important and often applied strategy, especially for dealing with wastewater. To successfully apply these options, regular checking of wastewater for contaminants, as well as systematic monitoring of final wastewater discharge is essential. The essential point on waste treatment technology is that it should combine advanced approaches, with technologies fit for small-scale firms with limited resources. To apply such end-of-pipe options, small-scale firms need external assistance in applying advanced technologies that are suited to their scale, financial resources and industrial sector.

Table 8.2 Feasible options in waste management for three agro-food sub-sectors

Sub-sector / Kind of Waste	Fruit-vegetable processing company	Meat processing company	Fruit wine processing company
Wastewater	- Prevention and minimization at source: good housekeeping, re-circulation of process water, using dry methods for cleaning raw material, input material change, and technological change - Reuse and recycle: gardening, farming, and fish raising - Waste treatment: screening, activated biological treatment sludge system	- Prevention and minimization at source: good housekeeping, input material change, technological change, and product change - Reuse: for fish ponds - Waste treatment: screening, end-of-pipe technology (applied sludge system combine with microorganism and regular check)	- Prevention and minimization at source: good housekeeping, re-circulation of process water, using dry methods for cleaning raw material, input material change, and segregation - Reuse and recycle: crop irrigation - Waste treatment: screening, simple end-of-pipe technology (pond system with microorganism adding)
Organic Waste	- Prevention and minimization at source: good housekeeping, better process control, and input material change - Reduce and recycle: bio-fertilizer and animal feed	- Prevention and minimization at source: good housekeeping - Reuse and recycle: by-product recycled, animal feed, and bio-fertilizer	- Prevention and minimization at source: good housekeeping, and better process control - Reduce and recycle: bio-fertilizer and pesticide, animal feed
Solid Waste	- Prevention and minimization at source: good housekeeping and technological change - Reuse and recycle of waste and by-product	- Prevention and minimization at source: good housekeeping and technological change - Reuse and recycle of waste	- Prevention and minimization at source: good housekeeping - Reuse and recycle

Source: Compiled by the author based on data from 2002-2005.

8.2.2 Comparative analysis: the role of networks

Companies rarely introduce environmental improvements simply from internal commitments. In most cases, external actors and institutions are motivating, triggering, stimulating and forcing companies into environmental reforms. With respect to Thai small and medium-sized companies in the food industry, there are many significant relationships that relate external actors and institutions with the industrial systems. In this study, the 'quartet-network' model has been applied as an analytical tool to understand why and how the various environmental reform options have or have not been introduced in the small and medium-sized companies in the food processing industry. The quartet-network analysis has helped us to understand the existing relationships among institutions and actors involved in economic, political, societal, and informal domains, which might contribute to greening the food processing industry. In this section, we will summarize the conclusions of the network analyses and compare the similarities and differences of the roles various networks play in encouraging these companies to adopt environmental reform.

The network analyses of interactions and relationships among institutions and actors within and across the agro-food sub-sectors provide insight into the influences that trigger – or do not trigger – the greening of SMEs in the food industry. Such analyses further help us to generate ideas for designing new environmental management policy options to improve the environmental performance of these companies through the introduction of feasible options, which have been introduced in the former section. The similarities and differences in the roles various networks play in improving industrial environmental performance are summarized in Table 8.3, and are analyzed in detail in this section. The recommendations follow in the next section.

Table 8.3 The roles of various networks in greening SMEs in the food industry

Industrial company / Networking	Type of Processing Sector					
	Fruit and vegetable		Meat		Fruit wine	
	Small-sized	Medium-sized	Small-sized	Medium-sized	Small-sized	Medium-sized
Economic	Weak	Medium	Weak	Medium	Weak	Weak
Political	Weak	Weak	Weak	Medium	Weak	Weak
Societal	Medium	Medium	Medium	Medium	Medium	Weak
Family	Medium	Weak	Medium	Weak	Weak	Weak

Source: Compiled and analyzed by the author based on data from 2002-2005.

Economic networks

From an economic perspective, the network analysis focuses on economic interactions related to economic rules and resources between economic agents in and around the three industrial sub-sectors. The economic rules and institutions, such as profits, ownership, patents, liability, trust, negotiations, cooperation, and the economic resources, such as raw materials, scientific and technical knowledge, financial means, specific products, human resources, and access to networks or relationships, can help us to understand the functioning of the whole network with respect to its contribution to sustainability. Our economic network analyses in Chapters 5, 6 and 7 examined the vertical, horizontal and other relations between economic agents.

In analyzing vertical interactions in which food processors are engaged, two dimensions are relevant. Firstly, domestic markets and consumers are core actors in SME value chains, and secondly larger domestic food processing companies or foreign companies and markets may accelerate the pace of environmental reform carried out by small and medium-sized enterprises. The fact that most of the medium-sized companies try and would like to export their products to international markets, means that international standards of food safety, for example HACCP, ISO 9000, and ISO 14000, and environmental management are becoming increasingly important for these companies. These standards put pressure on medium-sized companies of all sub-sectors to become greener, as we witnessed in the case study sectors. In the case of small-scale companies, the international market is not relevant and the domestic market and local consumers rarely insist on any environmental requirements and conditions at present. However, the increasing domestic awareness on food safety issues and standards could play a significant role in the near future in putting pressure on industrial firms, as the examples of meat company A and fruit wine company B shows.

In analyzing horizontal interactions a limited amount of cooperation and associations could be identified that played a role in improving environmental performances of SMEs. Food processing firms and small-scale ones in particular, are generally in competition with each other, which limits cooperative efforts. However, the network analysis identified a commonly felt need for support and advice concerning finance and expertise, as seen in the fruit and vegetable and meat processing sectors. This would open up possibilities for further horizontal cooperation. The exception is the fruit wine processing sector, which, as a new food processing sub-sector, receives ample support from the government. However, assistance for construction, operation, and maintenance of wastewater treatment systems and composting plants, seems to be useful to all industrial companies of all sub-sectors, but cannot be identified yet. Moreover, information and technology exchange on production processes and waste

treatment technologies are useful to increase production efficiency and reduce loss via waste steams. Also here there seems to be a world to win. The cause of these missed opportunities seems to lie rather in the lack of an institutional setting and arrangement to exchange information, than in unwillingness to exchange sensitive information.

Furthermore, beyond the horizontal and vertical relations, economic prices for natural resources such as water and energy, as well as economic sanctions on non-implementation of environmental standards and regulations, can encourage the SME producers – fruit-vegetable and meat processing companies in particular – to apply appropriate waste management approaches and technologies. These economic incentives are shown to be effective in encouraging producers in the meat processing sector to recycle more, and change their performance on waste management. In addition, R&D institutes, universities, and consultants are other agents that play a role in improving the efficiency of existing processes, improving production and waste management technology, and promoting product reuse and recycling. Many programs, generally encouraged and supported by government policies, serve to strengthen SMEs in all sub-sectors, but the emphasis of the program varies on firms' characteristics, such as production process, and type and volume of waste. The fruit wine processing sector, in particular, has an advantage over other sub-sectors, as the former companies have to invest less to improve their performance on environmental reform. Nonetheless, information on best practices in reuse and recycling of waste, and the application of cleaner production technology, encourage and motivate producers to make improvements.

Policy networks

From a political and policy-making perspective, the relationships between the government and other public actors, and private actors (in specific policy areas) have been analyzed to understand the dynamics of policy networks influencing environmental transformation of SMEs in the food industry.

The overarching strategy of the agro-food companies towards governmental authorities seems to be one of insulation, keeping government officials as far away from them as possible. In general, there is one prominent actor in the policy networks of the food processing industry that plays a role in pushing case study companies into making environmental improvements: environmental authorities. According to our findings, the policy institutions utilize traditional command-and-control strategies and disperse environmental responsibilities over many ministries, but have a limited focus on implementation. So, overall these policy agencies play a limited pole in changing polluter behavior. The case studies showed that local (environmental) authorities – especially the TAO and PAO organizations – do not play a very

significant role in furthering implementation or monitoring of environmental regulations, because of their priorities and limited human and financial resources. But in incidental cases environmental standards and strict enforcement have created (economic) incentives for improving producers' environmental performance. This gives evidence that in principle companies can be encouraged to further improve their environmental management through better monitoring and proper enforcement of regulations. Fruit and vegetable company A and meat companies A, B, and C have aimed to improve their environmental performance after they experienced warnings from the relevant authorities. The authorities' methods of implementing these changes, however, with emphasis on a traditional command-and-control strategy based on end-of-pipe technology, is perhaps not the best solution if the authorities' resources are still limited. Our policy analysis showed that environmental issues could be better addressed through greater cooperation between governmental authorities and polluters, which could also benefit the companies economically (which happened with fruit and vegetable companies B and C, meat company D for example).

At present, the fundamental regulations, such as applying for a license when setting up the factory, applying for approval of a wastewater plant, and applying for product quality control certification (GMP standard), are implemented. However, irregular monitoring and lack of strict enforcement creates weaknesses in implementing environmental pollution control as illustrated in our case studies. These weaknesses can be overcome by empowering the local environmental authorities to play a role in dealing with industrial environmental problems, as stated in the decentralization policy of the Thai government (for further details, see section 8.3). Moreover, food safety policies that deal with product quality control can encourage companies to become more environmentally friendly. For example, GMP, along with other related food certificates, can be used as an additional factor in moving the food processing industry in a sustainable direction. For medium-sized firms which aim to export to the international market, HACCP certification is another such standard that can make them change their production processes. This is how a policy instrument based on access to the international market can have a beneficial influence on environmental institution reform in Thailand.

This might lead to the conclusion that further involvement of authorities and governmental agencies at every level – especially through a new channel, TAO – may have positive effects on the greening of SMEs in the food industry. The policy analysis also seems to show that SMEs can change their strategy of isolation, as with fruit and vegetable companies B and C and meat company D, into one of inter-organizational collaboration, with a more cooperative attitude towards authorities. With respect to these cases, governmental authorities stressed exchange of information and greater consultation, replacing the traditional control and

enforcement strategies. Moreover, the fruit wine companies felt in this case that they were a new sub-sector, receiving full support from the government. The resources, such as financial loans, production technology, and environmental information, were provided easily to stimulate this industry to become more environmentally friendly. The fact that not for all wine companies this turned into more collaborative arrangements with authorities is illustrative of the diversity of approaches of local authorities towards one sector.

Societal networks

In general, the influence of civil society agents and institutions on improving the environmental performance of food processing companies in Thailand is limited. The case studies showed a number of constraints limiting community action. The main constraint on community action is the fact that members of the community profit economically from the companies. They are employees, they receive free organic waste, or fresh fish from wastewater pond, and so on. There is also a low level of overall environmental awareness and limited access to environmental information from the authorities, which further limits the communities' role. However, the network analysis showed that in some circumstances community-driven regulation and implementation does have a role to play and has the potential to increase in the future in the case of a direct environmental impact on the community. This was illustrated in the cases of some of the fruit and vegetable and meat companies. Complaints from the local communities put pressure on the studied firms, and forced some of the companies in this case study to improve their environmental performance at their new factory sites (fruit and vegetable companies A and B, meat companies B and C). However, there is still much scope for expanding the communities' role in forcing the implementation of environmental laws and regulation via TAO, provincial and national governmental authorities.

Local NGOs, and mass media are not very relevant in turning food SMEs in Northern Thailand into more environmentally friendly directions. As SMEs have relatively minor effects on the environment, when compared to the sheer size of other social problems, local NGOs give hardly any priority to industrial environmental issues concerning SMEs. The mass media, such as television, newspapers, and radio, sometimes pay attention to environmental issues, but do not play a major role in making rural populations aware of the impacts small and medium-sized food companies have on the environment. But they could potentially play a role in raising the environmental awareness within communities and industries, and through that facilitate the introduction of various technological options.

Informal/Family networks

Finally, let us take a look at the family network. The family network analysis focuses on the informal relationships that are sometimes the main reason for an actor's, in this case the food processing companies, behavior. The informal ties between various actors are examined and analyzed to understand and specify how they contribute to making companies more environmentally friendly.

The unique characteristics of the Thai cultural informal relationship among institutions and actors involved in the food processing industry suggests that these informal ties can be used to communicate with polluters. These informal relationships make a major contribution to changing the companies' environmental performance, as seen in the cases of fruit and vegetable companies B and C and meat companies A, B, and C. The flexible, unwritten, noncommittal, and unofficial contacts, which characterize informal relationships, make the companies feel more comfortable when dealing with local environmental authorities. Although this informal relationship between governmental authorities and industrial firms is less important, or less trusting, when compared to family ties, it is still seen as a useful new channel to encourage environmental reform. With short lines of communication and access, it gives small and medium-sized food-processing companies a number of advantages. The limited role of third parties can be strengthened by using the potential of this kind of communication.

Comparing networks

The case study companies in the three sub-sectors show how the food processing industry can be made more environmentally friendly, although there are differences in factory management, location, environmental awareness and network constellations. From the quartet-network analyses, we can see that the economic and societal networks are more important than the policy and family networks in triggering environmental reform. The primary driving force for 'ecologizing' the food processing companies' behavior came from food processing producers themselves, from markets/consumers and from resident communities, rather than from national or local governments. This is probably due to the fact that worldwide developments towards food safety and sustainability has influenced most global and local food industries, and SMEs in Thailand are no exception. The awareness of environmental, social health and food safety issues among industrial communities is rapidly increasing in Thailand. Moreover, the local authorities' inability to implement regulations or monitor companies satisfactorily explains why policy networks have had such a limited role in influencing the food processing firms' environmental performance. Nevertheless, the family network analysis showed how informal relationships among actors and institutions within the network can encourage

industrial firms to be more environmentally friendly, but their independent role in influencing company behaviour is marginal. This network rather seems to strengthen and facilitates the other networks, than having a major influence on greening businesses on its own.

A second conclusion that can be drawn is that the differences in environmental performance, and also the differences in the role the various networks play in greening for companies, is as large within one sector as across sectors. We have witnessed major differences between companies of one food sub-sector in how policy and social networks work and not work in pressing food companies towards better environmental performance. Company size, locational patterns, and company profiles, are some of the variables that explain these intrasectoral differences. In that sense, Table 8.3 is of relative value, as sectoral characteristics are only one of the relevant characteristics to divide companies for understanding greening processes.

What becomes also evident from our analysis is that there are many possibilities, institutions and actors that can be involved in initiating and introducing appropriate options to the food processing companies. The involved actors, such as environmental authorities (especially at the local level), economic agencies (for example, consumers, economic groups, research institutes) and social organizations (NGOs, community groups) that do not yet play much of a role, have a clear ability to play a crucial role in the future (in cooperation with food producers) in making the food processing industry more environmentally friendly. In addition, informal relations among actors can play a valuable role in supporting and facilitating changes in polluters' behaviour through a hidden, but strong, relationship within the family network. I will explore this in the next section.

8.3 Potential for Future Pollution Control

The comparative analysis of these case studies has provided a better understanding of the complexity of successes and failures in practices of industrial environmental reform relating to the food processing industry and their institutional environment. As has been argued in the chapter on methodology, the selected case study companies and the case study sub-sectors can be considered to be representative of the entire food processing sector in Thailand. The variety in size, production processes, production technology, site location and economic circumstances, and waste management practices, make that these 14 cases have much wider relevance. However, the qualitative nature of our study does not allow us to make any quantitative statements as to the degree of success and failure of environmental reforms. The representativeness of the case studies and its relevance for the wider agro-food industrial sector in Thailand should rather be seen in qualitative terms: the kinds of problems companies face, as well as opportunities they have when

introducing environmental reforms, and the mechanisms, actors and institutions that trigger – or fail to trigger – the introduction and implementation of better environmental performance in the entire Thai agro-food sector will not differ fundamentally from the findings of our case studies.

With this in mind, this section will use the insights of the three empirical chapters to outline more general future improvements and directions for industrial pollution control. I will organize this section again around the four networks introduced in Chapter 2.

8.3.1 Renewing environmental policy

As discussed in Chapters 3 and 4, the existing environmental command and control approach in Thailand has recently shifted towards a more cooperative approach, among others through the introduction of cleaner production and environment management systems. This seems to mark the turn from a *'passive environmental strategy'* via a *'reactive environmental strategy'* towards a more *'proactive environmental strategy'*. However, the fact that environmental protection in Thailand is primarily a state responsibility and top-down environmental policy is still implemented in practice means that environmental authorities still play an important role in environmental reform in Thailand. A number of strategies can be formulated to improve the working of [policy networks, building upon exiting tendencies.

Regulatory approach

Strengthening the present regulatory system: As analyzed (in Chapter 4 and in the case studies) Thailand's main environmental policy has poor inter-agency collaboration, limited resources for monitoring and enforcement, and high conflicts of interest among institutions. To overcome the weaknesses of the existing environmental policy towards SMEs in the food processing industry in Thailand, strengthening of the present regulatory system is essential. For example, improving the existing systems of environmental monitoring, facilitating greater collaboration between the relevant agencies and eliminating the overlapping responsibilities, improving financial and human resources and strengthening the capacity of existing environmental staff, and enhancing efforts for stimulating cleaner technology and environment management system implementation in industrial SMEs would greatly improve the industry's environmental performance.

Improving decentralization in environmental policy-making: Decentralization is one of the strategies the Thai government is using to increase the efficiency of the existing environmental management of industrial firms. Local organizations can play an important role as they are aware of the specific local circumstances. Although the

government had transferred responsibilities and authority for decision-making, finances and management to local authorities (PAO and TAO) in 1994, the local authorities have not been able to monitor or implement local environmental management effectively. Decentralizing environmental policy-making can have a positive effect on SMEs' environmental performance when a stronger focus is placed on repairing the weaknesses and limitations of local staff in knowledge, information, resources and capacities. Moreover, improving participation among environmental institutions and actors, such as local authorities, central environmental agencies, industrial firms, and resident communities, is crucial to enhance the effectiveness of local environmental policy and management.

Market-based approach

Economic instruments are only marginally introduced in Thailand and almost completely limited to pollution charges, which depend heavily on a command-and-control approach with an end-of-pipe treatment system. Besides pollution charging, there are more economic instruments that can be used for environmental reform, especially with SMEs in the food processing industry in Thailand.

Limited natural resources – groundwater and freshwater in particular – for industrial use should be properly priced and paid for. At present, many companies are using water free of charge or are paying a low rate for this water. If they had to pay for water, they would probably reduce their consumption. This would be good for the environment. In addition to removing or decreasing subsidies for water and energy, depletion charges on resources use in progressive rate makes sure that companies pay more attention to reduce resources consumption. These measures might also influence pollution levels through lower air emissions, and better recycling and reuse possibilities of higher concentrated wastewater.

In general, small-scale firms have no wastewater treatment plants and are located far away from each other in rural areas, so they cannot use a common wastewater treatment plant. This means that wastewater from their production processes is released directly to public waterways. In this case, economic instruments such as implementing a user charge for the use of common wastewater treatment, or a user charge for discharging wastewater to public waterways or disposing of solid waste, might motivate the polluter to pay more attention to pollution prevention. The mentioned measures are all examples of applicable economic instruments for SMEs in the food processing sector in Northern Thailand, which could be implemented with little investment, though they need additional governmental activities.

There are also a number of potentially positive economic incentives, such as tax differentiation for environmental friendly materials or substances, deposit-refund

systems, financial support for companies that convert to a cleaner production system, subsidies for green technology, awarding system for the greenest industrial firm, and funding for eco-labeling systems, etc. All these instruments can play a role in encouraging SMEs to change their environmental performance under globalizing situation which come through Thailand's economy up to the present. But for all, an ex ante evaluation needs to be made on the transaction costs for the government and the effects on company environmental performances.

8.3.2 Activating economic networks

While we saw in our case study companies that some economic actors play a role in motivating food processing SMEs into environmental reforms, the potential to further activate economic network actors is large. From the literature on ecological modernization we have learned that banks, tax agencies and insurance companies, for example, could all play a role in supporting environmental improvement issues financially. It would be very useful to assess at which level and on which subjects these financial institutions can support processes of environmental reform in the Thai SME food sectors. The issues that need more support – financially, but also in other ways – are the application of cleaner technology in the production process, a higher food safety standard which would lead to a better environmental performance, and eco-labeling. Also, the further strengthening of collaboration between economic actors within the food industry, through meetings, workshops and associations, could help build up collective environmental services and facilities, information exchanges, technology transfer, as well as enhancing the international competitiveness of SMEs on environmental performance. Other key agents, such as customers and consumers – both in domestic and international markets – can also put pressure on firms to be more environmentally friendly, as the literature from OECD countries shows. High economic growth figures, leading to a large middle class, and the increasing exports of food products are especially helpful in the development of consumer/customer pressure for environmentally friendly products. Labeling and certification systems are then needed to meet such a demand.

8.3.3 Public participation

As shown in some of the case studies, local communities can play a role in initiating the implementation of environmental regulation. However, the potential for greater public involvement is much larger. To empower public participation on industrial environmental issues, many mechanisms need further development and implementation. Due to the fact that the overall environmental awareness of communities, especially in rural areas, and access to environmental information are still limited, these communities need to be more properly informed about the dangers of industrial pollution. Strengthening public involvement by increasing their access

to environmental information (such as industrial pollution and performance data) is essential. These data can be provided by local authorities, by companies, through the mass media and by independent NGOs. Further support in the development and maturation of environmental NGOs – or the strengthening of other local NGOs in environmental dimensions and agendas – might be another useful strategy. Helping the media raise environmental awareness is another option. If these strategies are to be implemented, authorities, communities and industrial companies need to share information about environmental issues and support the building of a civil society that is more conscious of environmental threats.

8.3.4 Informal relationships

Most of SMEs in the food processing industry in Thailand start as household companies, in which one or two family members run the business. Access to information and resources goes then often via informal relationships. We saw in the case studies that SMEs use personal relationships to provide and obtain information on and resources related to governmental policies, market trends, and business opportunities. These personal relationships could also be applied and strengthened to support improvements in waste management approaches in the food processing industry.

In Thai culture, the strong relations within a family network are very important and could be made to play a role in encouraging environmental reforms. The relationships among relatives and in-laws, but also with friends, where trust and loyalty are very important, could be activated as a channel to exchange and share information about technology and policies relating to environmental management, and to motivate companies to green production methods. Small-scale companies, in particular, would feel more comfortable about changing their performance through this kind of relationship. And in local rural communities these informal networks might work better than the formalized policy and economic networks. In activating such informal/family networks one always has to be aware on the potential detrimental effects, for instance on policy implementation and enforcement, subsidy granting, competition rules etc.

8.4 Ecological Modernization in Thailand

In this final section Ecological Modernization Theory, which is used as the theoretical framework for studying greening Thailand's SMEs agro-food processing industrial sector in order to close to a sustainable one, is evaluated for its application. As the former summarized and analyzed of the case study companies revealed their opportunities and constraints in environmental reform, based on EMT approach. The following parts try to evaluate the application of EMT in Thailand current situation;

what are the main drivers and mechanisms of these in Thailand compare with in Europe; and how this application could be applied to similar industrial sectors in Thailand and in other developing countries.

First, the Ecological Modernization Theory, as cited in Chapter 2, emphasizes the use of advanced environmental technologies, such as cleaner production technology, as instruments for a realistic simultaneous economic development and environmental protection in the process of ecological reforms. The environmental technologies emphasized for Thai SME food industries prolongs still heavily along an end-of-pipe technology path. The implementation of EoP treatment methods depends heavily on how serious environmental authorities control industrial pollution from firms and enforce environmental regulations. The studied cases (see Chapter 5, 6, and 7) reveal many constraints on the implementation of EoP on SMEs agro-food processing. The opportunity for using cleaner production technologies in food processing have been noticed but is not yet dominant.

A changing governmental role in environmental management and policy-making to more preventive environmental policies, more participation, and more decentralization is another main idea of EMT. This changing role of state agencies gives also more room for other actors (industries, communities, local authorities) to participate in environmental restructuring, by sharing the responsibility of environmental tasks over more partners. In Thailand, in spite of the emphasis on decentralization of environmental tasks to local authorities (TAO), a development towards more consensual or negotiated policy-making is stagnating. Several initiatives on more voluntary and market-oriented certification schemes point to a changing governance style away from merely top-down command and control (see also below), and recently Thailand witnesses a process of restructuring environmental organizations[1] and decentralizing some tasks from central government to local government (PAO and TAO), including responsibilities on environmental protection. However, the implementation and monitoring tasks that are delegated to lower levels face severe constraints of resources (shortage of information in environmental management, lack of experience in policy-making and regulatory negotiations, limited financial support, and poor expertise on environmental issue). And at our SME food companies, it was rather the absence of environmental authorities than consensual styles, which prevailed. So while sprouts of political modernization can be identified, stagnation rather than swift development seems to prevail.

Third, the increasing role of (global) economic and market dynamics and agents in response to environmental change is in its initial stage in Thailand. Economic actors

[1] See details of the governmental re-organization in Chapter 4.

and networks become slowly more relevant for SME food production and several voluntary certification schemes influence SME and large scale food producers (e.g. GMP, HACCP, ISO, HALAL, and GAP). We also noticed a growing role of consumers in triggering food safety issue. Pointing to ecological modernization-like developments

Fourth, environmental activism or public involvement in environmental restructuring and reform of the food sector hardly occurs in contemporary Thailand, although it is pronounced as a right of Thai citizens to involve in these issues in the Constitution. Recently, environmental NGOs focus only on individual industrial firms in urban residential areas. There is also a lack of participation on rule-making process and enforcing environmental regulation. However, with the changing environmental policy of Thai government (as mentioned in this study), more room is given for social participation. Currently the only effective form of participation of the public in food processing is via complaints. Ideas listed in ecological modernization on a much more active role of environmental NGOs is probably also not very likely regarding such small firms.

In conclusion, we can identify various mechanisms of environmental restructuring but these mechanisms follow only partly the ideas of ecological modernization as formulated for western European countries. This has partly to do with our subject of analysis (small and medium sized food companies in rural areas) but partly also with the fact that Thailand is in some major economic, political and cultural dimensions very different from Europe. Comparisons with other Asain countries (such as from the studies of Phuong (2002) and Dieu (2003) on Vietnam) is perhaps more realistic and useful. This puts comparative studies on environmental reform between Asian countries on the research agenda.

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APPENDICES

Appendix 1: List of Interviewees

At National and Regional Level

- Experts in environmental management of the Ministry of Industry
- Expert in environmental management of the Pollution Control Department
- Experts in food processing technology from the National Food Institute
- Experts in food processing technology from Chiang Mai University
- Experts in environmental engineering from Chiang Mai University
- Experts in food processing technology from Mae Jo University
- The officer of the Northern Region Industrial Estate at Lamphun Province

At Provincial Level

- Director of the Environmental Office Region 1
- The officers of the Environmental Office Region 2
- The officers of the Ministry of Public Health at Chiang Mai and Lamphun Provinces
- The officers of the Provincial Industrial Office at every location of case study companies
- The environmental officers of the Provincial National Resources and Environment Office
- Tambon Administrative Organization officers at every location of case study companies

At Enterprise Level

Fruit and vegetable processing companies:

- The owner of Fruit and vegetable processing companies A, B, C, and D
- The manager of Fruit and vegetable processing companies A, B, C, and D
- Employees of Fruit and vegetable processing companies A, B, C, and D

Animal and meat processing companies:

- The owner of Animal and meat processing companies A, B, C, and D
- The manager of Animal and meat processing companies A, B, C, and D
- Employees of Animal and meat processing companies A, B, C, and D

Fruit wine processing companies:

- The owner of Fruit wine processing companies A, B, C, D, and E
- The manager of Fruit wine processing companies A, B, C, D, and E
- Employees of Fruit wine processing companies A, B, C, D, and E
- Head of engineering section of Fruit wine processing company D

Appendix 2: Interview Guideline (for case study)

1. General information of firm:

    1.1 Geographical profile
        a) Name (of interviewee and position)
        b) Address (of firm)
        c) Distance from urban area
        d) Total area (of firm)

    1.2 Economic profile
        a) Firm's owner
        b) Year of establishment
        c) Total investment
        d) Type of business (household/company/joint-venture)
        e) Type of product
        f) Production capacity and annual production
        g) Market

2. Production technology:

    2.1 Production process
        a) Manpower (total staff and worker, educational level, responsibility and wage)
        b) Production process (method and detail of product)

    2.2 Technological dimension
        a) Machine and equipment (automatic/semi-automatic/manually)
        b) Production facility improvement or modification (year of installed/re-installed/old)

    2.3 Input raw material
        a) Type and demand (unit)
        b) Source (domestic/imported; farmer/supplier)
        c) Energy/Electricity (quantity and cost)
        d) Water (source; quantity; and cost)

    2.4 Output and waste
        a) Type (of product and by-product) and quantity (unit per day/time)
        b) Type of waste and quantity

3. Environmental implication:

3.1 Waste treatment facility
   a) Type of treatment facility (organic waste; wastewater; and solid waste)
   b) Capacity

3.2 Waste management
   a) Waste management section (have/none; responsibility)
   b) Monitoring and implementing (by company) (how and frequency)
   c) Monitoring and implementing (by environmental authority) (how and frequency)

3.3 Environmental management (have/none; plan to apply)
   a) Activity (source of initiation/supporting; frequency)
   b) Monitoring program (detail and frequency)
   c) Type of (environmental) product certificate

4. Network relationships (categorized and classified relationship) (kind of relation, contact frequency, kind of resource, kind of exchange, etc.)
   4.1 Economic actors
   4.2 Political actors
   4.3 Societal actors
   4.4 Informal actors

5. Future direction of firm (related to environmental protection issue)
   5.1 Plan/Program (time and cost of investment)
   5.2 Source of assistant (private/government/NGOs)
   5.3 Need and suggestion for environmental improvement

SUMMARY

Since Thailand introduced its policy of national development planning in 1961, the agro-food processing industry has grown continuously. It has become a high income generating industrial sector in the country's economy and proved particularly strong during the economic crisis in 1997. For this reason, the Thai government adopted a special policy to promote the ago-food processing industry's contribution to the overall recovery of the economic crisis in the country. However, these and other attempts from the government to turn Thailand into a new industrializing country have contributed to an increase in the pressure on the available natural resources and tremendously affected the deterioration of the environment. The government's strategy to encourage the micro-sized agro-food processing industry to develop further into small and medium-sized enterprises has also affected the environmental situation due to a lack of appropriate environmental planning and poor environmental management of the production processes of these industries. The adoption by the Thai government of end-of-pipe waste treatment as the principal management strategy to deal with environmental pollution resulting from industries, in combination with the insufficient awareness about the need for preventive action at source and the lack of strong enforcement on the existing environmental regulations, have also contributed to the continued increase of environmental pollution over the last 30 years.

Experiences in environmental management in many different countries have learnt that the strategy of preventing environmental problems is more effective than the attempts to eliminate environmental problems afterwards. Therefore, to solve the problems resulting from increased industrial pollution management of the production processes should preferably be combined with prevention at source. Each approach has various appropriate strategies to reduce the quantity of industrial waste released from the firm into the environment and to achieve environmental benefits in combination with economic ones. Nevertheless, the usefulness of this strategy is linked to the specific context in which it is applied. Some strategies are applied successfully in certain circumstances and a failure in others. This thesis deals with the potentiality of these environmental strategies to contribute to greening small and medium-sized agro-food processing industries in Northern Thailand. The main objectives of the research are to analyze which actors, institutions and social structures influence the environmental performance of the agro-food processing industry; and to develop strategies to improve the environmental performance of agro-food processing industry in Northern Thailand. To achieve these objectives, the following three research questions were formulated:

- Which actors, institutions and social structures are involved in the agro-food processing industrial networks?
- How and to what extent do these actors, institutions and social structures influence the environmental performance of the SMEs agro-food processing industry?
- What are the appropriate strategies for waste prevention and management, and what kind of approaches can make SMEs agro-food processing in Northern Thailand more environmentally friendly?

In order to answer the research questions, and against the background of an ecological modernization framework, two models are introduced and combined. First, a conceptual model for analyzing waste prevention and minimization of waste generation of food processing industry is elaborated. This model was developed by integrating different concepts used in environmental pollution management: cleaner production technology, integrated environmental management systems, and end-of-pipe treatment. This model of environmental management is combined with a so-called 'quartet-network' model to identify the key societal (f)actors and institutions that influence the performance of SMEs in agro-food processing industries. The quartet-network model enables us to identify and analyze the relevant economic, political, societal and family/informal social actors and institutions that can – or do – play a role in introducing various elements of waste prevention and minimization. Together the models provide the analytical tools to investigate the greening of small and medium-sized agro-food industries.

These tools have been applied in empirical research by studying 13 selected SMEs in agro-food processing industries in Northern Thailand. The different case-studies covered three major sectors of food-processing in the region: fruit and vegetable processing firms, meat processing companies, and fruit wine producers. All cases were selected on the basis of five elements characteristic for SMEs in the agro-food processing industries of Northern Thailand: a) being a small and medium-sized industry in the rural areas, b) applying simple technology, c) exploiting inputs and resources in a wasteful manner, d) lacking appropriate environmental management strategies, and e) having a high potential for rapid economic growth. The selected industries were investigated via in-depth case-study research on the following aspects: locational and environmental profiles, production processes; waste management; and social relations, interactions and structuration between institutions and actors. The case study data were analyzed to understand the role of different societal institutions and actors, including their interrelations, both inside and outside the industries.

The empirical research revealed various constraints and opportunities to implement environmental reforms in agro-food processing SMEs. The case studies clearly illustrated the limited successes of these SMEs in the three sub-sectors in environmental management due to the following constraints: a) limits in the financial and human resources available for environmental management, b) lack of incentives for investing in environmental improvement and management, c) lack of awareness among consumers/customers about the need for more environmentally friendly production processes and products, d) the lack of support from the private and public institutions around these SMEs, e) the lack of sufficiently skilled staff at the level of local authorities caused by their overload of tasks and their inexperience in enforcing environmental regulations, and f) the lack of attention to these environmental problems from societal institutions, such as local communities, environmental NGOs and the media.

Furthermore, the empirical research also found out that the most appropriate options for SMEs in agro-food processing industries in Northern Thailand to fight environmental pollution are those that apply preventive measures in the production process and reduce waste at source. In order to implement these options, closer relationships between the institutions and actors involved in greening these food

processing industries needs to be established. Accessing the possibilities for greening these food-processing SMEs needs the involvement the following elements: a) economic agents' participation, b) environmental policies transformation, c) public participation with environmental awareness, and d) technological adaptation. According to the research results, the quartet-network model is helpful in analyzing the functioning of the agro-food processing industrial system and their possibilities for environmental reform. But the Ecological Modernization Theory, as it was developed in and partly for Western Europe, cannot be simply transferred to the situation of greening SME food processing industries in the context of Thailand.

Samenvatting

De agro-industrie in Thailand heeft een permanente groei gekend sinds de introductie van nationale ontwikkelingsplannen in 1961. Deze activiteit heeft zich ontwikkeld tot een centrale inkomensgenererende industriële sector in de economie van het land en vooral van groot belang tijdens de economische crisis in 1997. De Thaise regering heeft daarom een gericht beleid ontwikkeld om de bijdrage van de agro-industrie aan het herstel van de nationale economie te versterken. Echter, deze en andere pogingen van de overheid om Thailand te ontwikkelen tot een moderne geïndustrialiseerde staat hebben tevens bijgedragen aan een verhoging van de druk op de beschikbare nationale hulpbronnen en geresulteerd in serieuze milieudegradaties. De regeringsstrategie om micro-industrieën in de agro-industrie te stimuleren en te laten ontwikkelen tot kleine en middelgrote ondernemingen heeft de milieusituatie verder verslechterd vanwege het ontbreken van een adequate milieuplanning en zwak milieumanagement bij deze industriële productieprocessen. De keuze van de Thaise overheid voor 'end-of-pipe' oplossingen als de voornaamste industriële milieustrategie in combinatie met een onvoldoend besef van de behoefte aan preventieve actie en een gebrek aan effectieve handhaving van de bestaande milieuregulering heeft eveneens bijgedragen aan een toename van de milieuvervuiling gedurende de laatste 30 jaar.

Ervaringen met milieubeleid in veel andere landen heeft duidelijk gemaakt dat een preventiestrategie bij milieuproblemen effectiever is dan pogingen om ze achteraf ongedaan te maken. Het verdient daarom de voorkeur om de toename van de industriële milieuproblemen op te lossen door management van het productieproces te combineren met preventie aan de bron. Verschillende strategieën kunnen benut worden om de industriële milieubelasting te verminderen en het bereiken van deze milieuwinst te combineren met economische voordelen. De bruikbaarheid van dergelijke strategieën is echter nauw verbonden met de specifieke context waarin zij worden toegepast. Sommige strategieën zijn succesvol benut in bepaalde omstandigheden en een mislukking in andere. Dit proefschrift behandelt de mogelijkheden van dergelijke milieustrategieën om bij te dragen aan het verduurzamen van kleine en middelgrote agro-industrieën in Noord Thailand. De belangrijkste doelstellingen van dit onderzoek zijn te analyseren welke actoren, instituties en sociale structuren de milieuprestaties van agro-industrieën beïnvloeden en om strategieën te ontwikkelen voor het verbeteren van de milieuprestaties van deze industrieën in Noord Thailand. Teneinde deze doelstellingen te bereiken, zijn de volgende drie onderzoeksvragen geformuleerd:

- Welke actoren, instituties en sociale structuren behoren tot de agro-industriële netwerken?
- Hoe en in welke maten beïnvloeden deze actoren, instituties en sociale structuren de milieuprestaties van kleine en middelgrote ondernemingen binnen de agro-industriële sector?

- Wat zijn geschikte strategieën voor preventie van milieuproblemen en welke benaderingen maken kleine en middelgrote ondernemingen binnen de agro-industriële sector meer milieuvriendelijk?

Voor de beantwoording van deze onderzoeksvragen zijn twee conceptuele modellen geïntroduceerd en gecombineerd, tegen de achtergrond van ecologische modernisering. Ten eerste is een conceptueel model uitgewerkt voor de analyse van het voorkomen van milieuproblemen en het reduceren van de vervuiling voortgebracht door de agro-industrieën. Dit model was ontwikkeld door verschillende concepten te integreren die worden gebruikt bij milieumanagement: schone productietechnologieën, geïntegreerde milieumanagement systemen en afvalverwerking. Dit model is gecombineerd met een zogenaamd 'kwartet-netwerk' model om de sleutel (f)actoren en instituties te identificeren die de milieuprestaties beïnvloeden van kleine en middelgrote ondernemingen binnen de agro-industriële sector. Het kwartet-netwerk model stelt ons in staat om de relevante economische, politieke, maatschappelijke en familiale/informele sociale actoren en instituties te identificeren, die een rol (kunnen) spelen bij het introduceren van verschillende elementen van preventie en minimaliseren van milieuproblemen. Bij elkaar verschaffen deze modellen de analytische instrumenten om het verduurzamen van de kleine en middelgrote ondernemingen binnen de agro-industriële sector te bestuderen.

Deze instrumenten zijn gebruikt voor een empirische studie van 13 geselecteerde kleine en middelgrote ondernemingen binnen de agro-industriële sector in Noord Thailand. De verschillende casestudies vertegenwoordigen drie belangrijke sectoren in de voedselverwerking in de regio: groenten en fruit verwerking, vlees verwerking en fruitwijn productie. De casestudies werden geselecteerd op basis van vijf elementen karakteristiek voor kleine en middelgrote ondernemingen binnen de agro-industriële sector van Noord Thailand: a) behoren tot de kleine en middelgrote ondernemingen binnen de agro-industriële sector in rurale gebieden, b) gebruik maken van eenvoudige technologieën, c) inputs en hulpbronnen op een verspillende wijze gebruiken, d) ontbreken van geschikte milieumanagement strategieën, en e) beschikken over een groot potentieel voor snelle economische groei. De geselecteerde industrieën werden bestudeerd op de volgende aspecten: fysiekinfrastructurele- en milieuprofielen, productieproces, milieumanagement, sociale relaties (interacties en structuratie tussen instituties en actoren). De gegevens voorkomend uit dit onderzoek zijn geanalyseerd om de rollen te begrijpen van de verschillende sociale instituties en actoren, met inbegrip van hun onderlinge relaties, zowel binnen als buiten de industrieën.

Het empirisch onderzoek maakte duidelijk dat er verschillende beperkingen en mogelijkheden bestaan voor het implementeren van milieuverbeteringen bij kleine en middelgrote ondernemingen in de agro-industriële sector. De casestudies illustreerden helder het gebrek aan milieuprestaties van deze bedrijven vanwege: a) beperkingen in de beschikbare financiële en menselijke hulpbronnen voor milieubeheer, b) gebrek aan

prikkelingen voor het doen van investeringen in milieuverbeteringen, c) gebrek aan besef bij consumenten van de noodzaak van meer milieuvriendelijke productieprocessen en producten, d) gebrek aan steun van private en publieke instituties in de omgeving van deze kleine en middelgrote ondernemingen, e) gebrek aan voldoende getraind personeel bij de lokale autoriteiten als gevolg van een overbelasting aan taken en een gebrek aan ervaring in het handhaven van milieuregelingen, en f) gebrek aan aandacht voor milieuproblemen bij maatschappelijke instituties, zoals lokale gemeenschappen, milieu NGOs en de media.

Verder toonde het empirisch onderzoek aan dat het toepassen van preventieve maatregelen in het productieproces en het reduceren van vervuiling bij de bron de meest bruikbare opties zijn om milieuvervuiling te bestrijden voor de sector. Om deze opties te realiseren moet een nauwere samenwerking worden gerealiseerd tussen de betrokken private en publieke instituties en actoren. Realiseren van de potentiële milieuverbeteringen bij deze ondernemingen vereist: a) participatie van de economische actoren, b) transformatie van het milieubeleid, c) participatie van een milieubewust publiek, en d) aanpassingen in de technologie. De resultaten van dit empirisch onderzoek tonen aan dat het kwartet-netwerk model bruikbaar is voor de analyse van het functioneren van het agro-industriële systeem en hun mogelijkheden voor het bereiken van milieuverbeteringen. Het onderzoek maakt ook duidelijk dat de ecologische moderniseringstheorie, zoals ontwikkeld in en gedeeltelijk voor West Europa, niet simpelweg kan worden gekopieerd naar het noorden van Thailand bij het verbeteren van de milieuprestaties van kleine en middelgrote ondernemingen binnen de agro-industriële sector.

About the Author

Ajchara (Poonyarit) Wattanapinyo was born on August 25th, 1962 in Phitsanulok Province, Thailand. She obtained her Bachelor degree (BS Geography) from Chiang Mai University in 1982 and started her career as a junior lecturer at Geography Department, Faculty of Social Sciences, Chiang Mai University since 1983 onwards. In 1990, she obtained a Mater Degree in Urban and Regional Planning, from Chulalongkorn University, Bangkok, Thailand. In September 2001, she came to Wageningen University to start her PhD thesis in the AGITS project parallel with working as an Assistant Professor at Chiang Mai University.

For many years population and economic growth are forcing and increasing pressures on the environment, both in developing and developed countries. The disturbance of the natural balances in soil, water, and air and the accumulation of waste in the environment affect the potential for sustainable development. Within the context of institutional weaknesses of the current formal environmental regulatory system in Thailand, however, the unexpected environmental impact and risk from the (industrial) development have spread over the country with growing social conflicts around resident communities in rural areas. To sustain the development on agro-food processing industrial sector in Thailand, this book provides a methodology to analyze and access the possibility in stimulating the core actor to adapt environmental performance close to a more environmental one. An analytical tool, the *quartet-network* based on the *Ecological Modernization Theory*, is used to analyze the institutions and actors involving in industrial network via food-processing case study companies in Northern Thailand to clarify how and to what extent that the (SMEs) agro-food processing industry in Thailand could adapt their environmental performance, which are in the nature of industrial polluters in general, to be more sustainable way.