

CHAPTER 7

ACTORS AND INSTITUTIONS IN INDUSTRIAL ECOSYSTEM OF CRUDE PALM OIL MILLS

7.1 Introduction

To transfer the developed model for an eco-industrial system from the design table in the previous section to reality, it is essential that the complex social, economic and political relations and institutions governing the implementation of the industrial ecosystem are analyzed in depth. As indicated in chapter 3, the concept of triad network model (developed by Mol, 1995) is used for analyzing these interactions among actors, who have or can have an influence on the application of the physical-technological model of the palm oil companies. Examination on the actor interactions in the policy, economic and societal arenas provides us with insight in the main push and pull (f)actors in enabling and constraining social environments.

7.2 Economic Network Analysis

The crude palm oil industry is part of an economic network of oil palm growers downstream industry and a variety of other actors. Central characteristic of the economic network is that relations between these actors are predominantly of an economic and financial nature. The economic network of crude palm oil industry is presented in Figure 7.1.

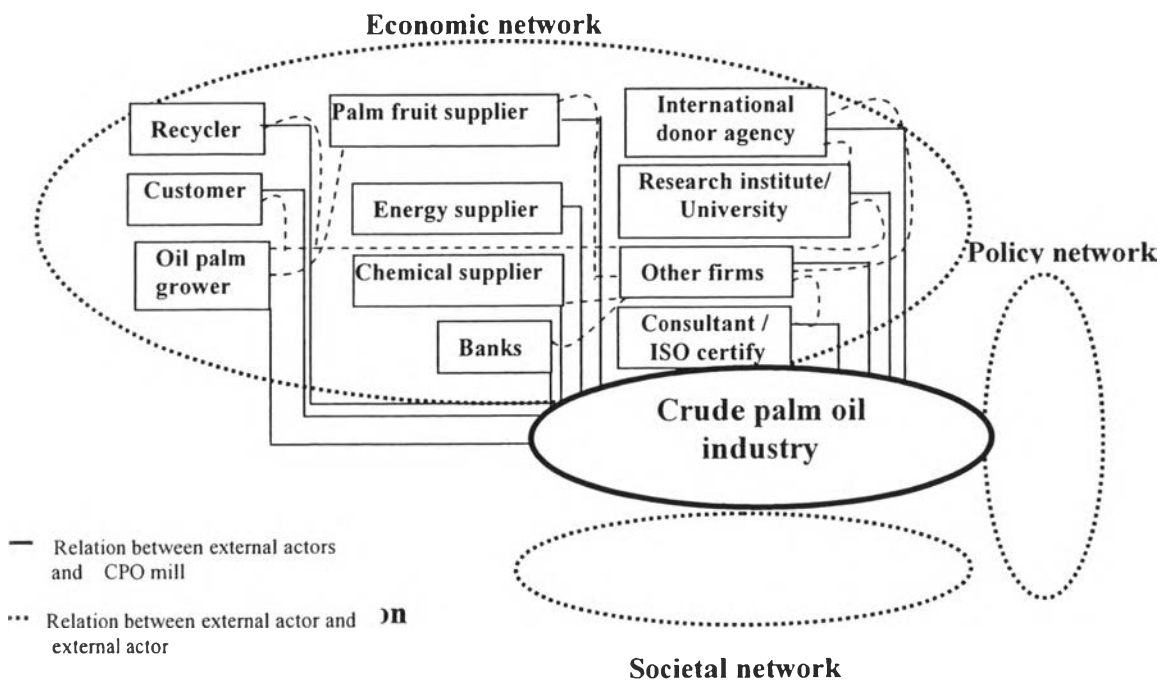


Figure 7.1 Economic networks relevant to crude palm oil factory.

The interactions of economic network consist of two main parts: vertical interactions and horizontal interactions. The horizontal interaction is the relationships between the mills with other crude palm oil mills inside the country.

7.2.1 Vertical Interaction

The crude palm oil industry is a part of an economic network of oil palm growers and downstream industry. This network primarily consists of the oil palm planters, the palm oil refinery industry, the customers of palm oil products and the consumers of palm oil and palm oil product, as shown in Figure 7.2. The actors that have influence on crude palm oil mill are oil palm planters, raw material suppliers (fresh fruit bunch supplier), customer, consumer, and recyclers (waste exchange aspect). Oil palm planters are divided into 3 main groups: registered company (mill owner planter, independent planter), small holding planter and cooperative.

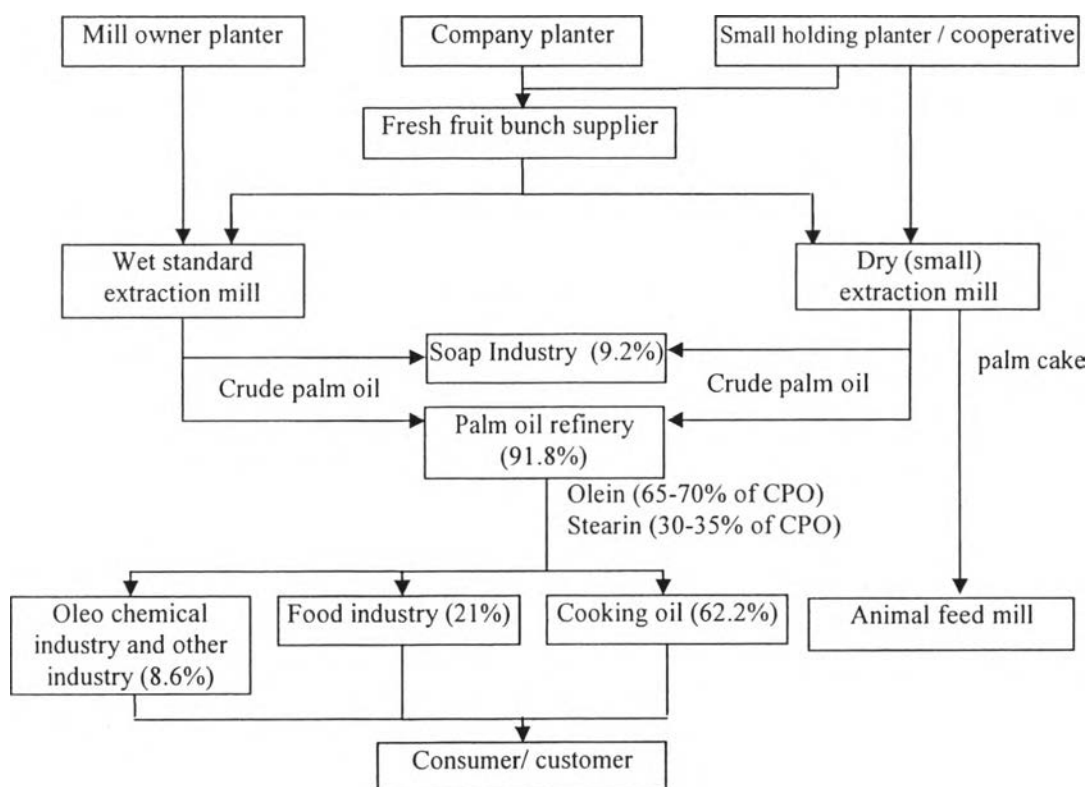


Figure 7.2 Marketing channel of oil palm and oil palm product (adapted from The Oil Palm news Letter, 2001)).

1) Oil palm planter

Oil palm planters have an influence on the application and introduction of cleaner production by millers via 2 aspects: the quality and quantity of raw materials (FFB) supply, and the reuse/ recycling of wastes from production processes.

- **Quality and quantity of raw materials (FFB)**

The production efficiency of FFB depends on the type of oil palm producer. They are divided into 3 groups as shown in Table 7.1:

- Registered companies that need to have a plantation area of a minimum of 1000 rais (36% of total oil palm planting area belong to registered companies).
- Small plantation owners (not registered) (48% planting area).
- A Cooperative member (16% planting area only/ mainly in Krabi Province).

Table 7.1 Distribution of oil palm grower and plantation area (2002).

Type	Oil palm owner		Plantation area		No. of Plantation (rai/ planter)	FFB production (tonFFB/ rai)	% of total FFB product	Production cost (Baht/ton)
	No.	%	Rai	%				
Registered Company	174	0.71	533,419	36	3,066	2.9	43.3	1.04
Smallholder	16,600	68.28	703,695	48	42	2.2	42.4	1.2
Cooperative	7,600	31.11	232,481	16	31	2.2	14.3	1.2
Total (average)	24,400	100	1,469,595	100	-	(2.67)	100	-

Source: Ministry of Agriculture and Cooperatie, 2002

The structure of oil palm producer in Thailand is mostly smallholding planters. Over 99.3 % of total planters are smallholder and cooperatives, while their plantation areas are around 62% of total area. The commercial company accounts for only 1% of the total number of planters and 36.3% of the total plantation area. Most of the commercial companies own crude palm oil mill. The production efficiency of smallholder (2.2 ton FFB/ rai) is lower than that of commercial companies (2.9 ton FFB/ rai). The FFB produced from companies are account for 43% of total FFB production. Generally, palm planting by companies is known to be efficient, because they invest in all facility and maintenances including good irrigation systems. They also grow high quality and productivity oil palm breed. Accordingly, their yield is highest and easy recycling of organic solid wastes from milling back to plantations among other planters.

An improvement on palm oil breeds and FFB production per plantation area will reduce FFB production because the planter gets a higher yield of FFB with the same amount of production cost. At the same time, the high-yield FFB also increases CPO production. On the one hand, a high oil content of FFB can result in relatively low amount of waste generation per ton oil production. This can be seen as an improvement for environment. On the other hand, the cultivation of high oil content palm varieties requires generally more fertilizers and pesticides, contributeing to economic dependencies and environmental pollution.

Factory A owns an oil palm plantation area of about 3,200 hectare, which grows a high quality oil palm variety. The FFB harvested from his plantation area is only 30% of FFB processed in the mill. The remaining 70% is purchased from FFB suppliers. In 2003, Surajthani Province had 413,876 Rais of palm oil plantation, 1.12 million tons FFB or 2.8 ton FFB/rai. This is quite high, caused by the good soil condition. The prices of FFB depend on the quality of raw material i.e. oil content and ripeness of the harvested fruit. The price of FFB varies from 2.6 to 4.0 Baht/ ton FFB, depending on season and quality of FFB. Result from this survey in Thailand study in 2002 confirmed that the production efficiency of this mill is among the highest. The other 4 studied mills are located in Surajthani Province, Krabi province and Trang province. They also buy palm fruits directly from FFB suppliers. Since the quality of FFB affects production yield of the mill,

factory A, B and D, which have their own plantation area, have better means to control production efficiency by controlling FFB quality input. The raw material for these factories is a mix of FFB from the factory's own plantation and FFB purchased. This advantage is confirmed by comparing production efficiency: Factory A, B and D achieve higher production efficiency than factory C and E.

Currently, oil content in EFB is 17% on average (Department of Agriculture Technology, 2002) while Malaysia has a higher oil content of 22% (MPOB, 2003). The reason is to be formed in the lack of good palm breed. The agricultural research institute of SuratThani province carried out research for high quality strain of oil palm since 1985. The amount of produced high quality seeds has not been enough for spreading the planting area. Oil palm planters buy oil palm seeds from a seed supplier nearby, as recommend by other oil palm growers. They have little knowledge and information about the breeds and quality of FFB. Since FFB supply is less than demand, there is no incentive for oil palm grower to move to high yield and high quality oil palm seed. Farmers also lack expertise in gardening. There is limited research on oil palm tree and government officers cannot give good consultation because they do not have enough expertise themselves.

- **reuse/ recycle of wastes form production process**

Since small amount of products and the transportation cost of FFB to a mill are costly, most smallholders sell their products to FFB suppliers. There is no direct contact between millers and smallholding planters in terms of FFB purchasing. This is one of the most crucial barriers to reuse/recycle waste/by-products in agriculture sector. At present, little waste from palm oil factories is reused as fertilize in palm plantations. Interviews with mills' managers and planters indicated that only large cultivation holders that are located close to and are owned by factories reduce cost of commercial fertilizer by recycling waste from production processes such as wastewater, ash, EFB and bottom sludge from wastewater treatment plant to the plantation area. Their production cost is also lowest, because they save on fertilizers, chemicals and transportation. Major production cost for oil palm plantations are related to fertilizer and labor cost (harvesting cost), accounting for 30.03 % and 32.7 %(23 %) of total costs, respectively (Department of Agriculture Technology, 2002). The cost of production shows a rising trend due to increasing fertilizer costs. If waste from factories can be used as fertilizer in palm plantation, the cost for growing palm will be decreased.

Some cooperative planters reuse empty fruit brunch as mushroom cultivation in their plantation area. However, smallholders often do not recycle such wastes in the plantation, because they lack the required technical knowledge. They are often not aware that they can make use of waste from the factory. Table 7.2 summarizes the relationship between mills and different groups of oil palm planters.

Table 7.2 Relation between mill and different group of oil palm planter.

Oil palm planter	Relationship with mill	Distance from mill	Waste reuse/ recycle
Registered companies	Owned by palm oil mill	- Close to a mill	Reuse /recycle of wastewater and solid waste in plantation area
		- Far from a mill	No
Small holders	No relationship	- Far/ close	No
Cooperative members	Indirect relationship	- Far/ close	Reuse of empty fruit brunch fo mushroom cultivation

2) Fresh fruit brunch supplier

In the past millers purchased FFB directly from oil palm planters. At present the millers purchase FFB from FFB suppliers, contractors who directly buy FFB from farmers and sell it to factories. Generally, crude palm oil mills will contact various suppliers for buying FFB and vice versa supplier will contact various factories to sell FFB, without making fixed long term agreement. Both sides will negotiate the price. The supplier contacts many smallholders. The supplier responsible for harvesting the FFB from each plantations and transports these FFB to the factory. Most smallholders sell FFB to a supplier because this reduces transportation cost and labor cost for harvesting. Every day the purchasing manager of a mill contacts the various suppliers for the quantity of material that is needed for the factory. The reason why mills do not want to make long term agreements with suppliers is the constant changes in palm oil price in Bangkok, which depends on the price of palm oil in the world market. Moreover the price of FFB varies accordingly to season, ripeness (% oil content) and size of FFB. Oil palm production peaks during rainy season and is low in summer. The state of ripeness of the fruits at the time of harvesting will influence the yield and the quality of palm oil, as determined by the level of free fatty acid in the extracted oil. When the FFB is harvested, free fatty acid content in oil will gradually increase, making FFB less wanted and thus lower priced.

Factory A distinguished the quality of FFB via price setting according to 2 rates that are price for FFB and one for fallen palm fruit :

- FFB buying price will depend on oil content which varies from 13-18%. Oil content in FFB is estimated based on the factory's experience.
 - The price for FFB with oil content > 18% will be highest
 - The price for FFB with oil content < 18% will decrease accordingly.
- Factory A will buy fallen palm fruits for prices that are 30% higher than FFB. This higher price is caused by the weight of brunch stalks (EFB). This is about 27% of the FFB. In addition the processing of fallen palm fruits can obtain high oil production.

Some mills sell empty fruit brunch (EFB) at a cheap price to perform the trade only the suppliers whom they bought FFB. The suppliers will then sell the EFB back to the small holding planters/ cooperatives. There is no direct relationship between farmers and factories, because all trade is handled between the crude palm oil factory and the

supplier. This lack of factory- farmer relationship forms a barrier for reuse / recycling of solid waste from the factory, such as decanter, sludge, ashes and wastewater, at oil palm plantations. At present farmers use chemical fertilizer on their farms and they do not aware of the fertilizer value of factory waste. To apply industrial ecology concept in crude palm oil industry, a reorganization of the relations between mills and farmers seems to be essential.

3) Consumers/Customers

The main market for crude palm oil forms the local refinery factories that refine CPO to obtain pure palm oil suitable for consumption or for use as raw material by the downstream industry. Around 90% of all crude palm oil is sold to refineries; the remaining 10% goes to soap and detergent industry as shown in Figure 7.2. Millers generally sell their product to refineries in a forward contract, which specifies volume, quality and price of the product. The terms of contract may be 12 months or 3-5 months depended on the amount and price of product. They have fixed relations and long term agreement, but the price of crude palm oil is no part of such agreement and fluctuates everyday. The quality of palm oil product from the various millers does not differ significantly because they employ the same production technology, introduced from Malaysia. Oil refineries buy crude palm oil by using the following quality standard.

- Free fatty acid <5%.
- Moisture content <0.5%.
- Purity grade A >50-52%.
- Color bleaching ability by using cell 51/4 <2x30^yRed.

The refineries are mostly located in Bangkok Metropolitan region, near the end-users. There are only 13 refineries in Thailand and some of them have integrated into crude palm oil and palm cultivation in order to lower costs and reduce uncertainty in raw material supply. The consumption of refined palm oil in Thailand is classified direct consumption as cooking oil and the local industrial use. The price is government controlled (minimum price fixed) and the competition in the market is for both product differentiation and price. The price of pure palm oil is cheaper than other kinds of vegetable oil and palm oil is favored among restaurants and consumers. Around 95% of refined palm oil is consumed locally. The remaining 5% is sold to neighboring countries like Laos, Myanmar and Cambodia (Ministry of Commerce, 2004).

The big refineries have to be certified for ISO 14000 and HACCP in order to have a good image in the market. However, customers play at the moment a minor role in pushing the refineries to take both product qualities and environmental performance into account via ISO certification. Currently the production capacity of refinery is higher than the crude palm oil supply and lower than market demand. Our crude palm oil case studies show that local customers and consumer have minor influence on the environmental performance and ISO certification of extraction mills.

Thai palm oil industry has to enhance the production efficiency for meeting increasing demand in the future and for competition in the world market, due to their higher production cost compared to Malaysia and Indonesia. Thailand is a member of Asian Free Trade area (AFTA) and WTO. Within the year 2003, Thailand had to reduce import tax of palm oil from 20% to 0-5% following to AFTA agreement. Because,

Malaysia excused itself from including CKD-CKB cars in the list of free trade product, Thailand decided to delay entering palm oil into this list, claiming that the industry was not ready for competition. The Siam Commercial Bank Research Institute Report (2000) concluded that the impact on the palm oil complex could cause some planters and palm oil millers to close their plantations and mills because they cannot competition in the market. In 1999, the government introduced “A Development of Oil palm and Palm Oil Plan 1999-2003” involving many stakeholders such as Ministry of Agriculture and Cooperatives, Ministry of Industry, Ministry of Commercial and Government bank. The objective of this plan was to promote production and marketing, to prepare the sector for international market competition and to improve the product quality and production efficiency continuously. Options to reduce oil loss in production wastes and recover oil from wastewater were among the first priorities to implement. Another option was the application of the waste exchange concept. The reuse/ recycling of waste and value-added products was believed to bring significant benefits through selling by-products, saving disposal cost and improving environmental performance of the industry.

4) Electricity suppliers

Electricity is the dominant source of energy for production process. The electricity generated by the cogeneration plant is sufficient for the plant operation and other uses. Only during the shutdown and the startup of mills, millers are using electricity from the electricity generation authority of Thailand (EGAT). The electricity net is state-owned and the state has a monopoly position. Therefore, millers are unable to sell generated electricity to other companies in the local neighborhoods or to local communities. The electricity and fuel cost of palm oil mills is less than 1 % of production cost. Consequently there is no incentive for millers to recover and reuse biogas from wastewater treatment systems in production process. Only if they can sell additionally generated electricity to EGAT, the investment of anaerobic digestion tanks to recover biogas for electricity generation will be possible for these factories. Currently, 2 crude palm oil mills have register with DIW for setting up a power generation plant using biogas. There are still in construction.

5) Chemical suppliers

The companies buy chemicals on the local market from different sellers. Buying is done on spot purchase basis, depending on the price.

6) Recyclers

Recycling activities include cement and brick factories (factory that used solids fuel), activated carbon factories, livestock feed production mills, concrete block factories and oil palm cultivation. Most of by-product/waste from crude palm oil production can be sold to other industrial sectors or to the agricultural sector.

Waste exchange in industrial sector

For waste reuse/ recycle in other industries, the mills sell by-product to recycler with a low prices. If miller could produce product from such wastes, they would earn profit from these value-added product such as: activated carbon from palm shell, animal feed from decanter cake. However they lack of technology and access to the information. These are the important barrier for waste exchange concept in Thailand. The reason is

there is no cooperation among millers, government institutes and research institute/university.

The millers sell shells at a cheap price of 500 Baht/ton to various factories that use shell as solids fuel in burner. These factories include a cement factory, a brick factory and a charcoal factory. Since the price of shells per unit of caloric value is much cheaper than fuel oil, a cement factory located in Nakornsri Thamrat Province has a long term agreements with some crude palm oil factories in the neighbourhood for buying shells. Under the present reuse of shells, this is not an economically feasible option. Conversion of the shell to a higher value added product, such as activated carbon, is another option for turning the by-product to a resource. For commercial palm kernel shell activated carbon made in Nigeria, trade name MIDAC, sell at price range 1,000-1,526 USD/ton. The application is for color adsorption, particulate coagulation and dechlorination in distillers, bottling companies, plant and oil refineries, chemical industries and used in water purification equipment and water filter cartridges. In Thailand, the study of production of activated carbon from shell at lab-bench scale confirms that it is technically possible (iodine adsorption meet the industrial product standard). However there is a need for the study of cost-effective development for commercial scale production and to study the most desirable method of producing activated carbon by adjusting process conditions to control precisely the properties of the end product. Thailand also lacks technology for the design and construction of the machine and equipment for activated carbon production. Moreover at present there are many local brands of activated carbon from coconut shell, which are of higher quality than activated carbon from palm kernel shell.

The decanter cake generation from all crude palm oil mills is about 140,000 ton/year. At present, such waste is not reused/ recycled and is thus disposed as waste everyday. Decanter cake contains high oil and protein content and can be reuse as animal feed substitute. Recycling of decanter cake as animal feed for cows has not been adopted yet in Thailand. Farmers in these areas are afraid of negative effects from this by-product, because they do not have experience in reuse of this waste as animal feed. The potential option for reuse the decanter cake as animal feed is to reduce the moisture content of the sludge to lower than 10% moisture content. Otherwise this waste will ferment and produce bad smell, if keep for longer than 24 hour. In this case mill could recover heat from exhaust gas to dry it. This option have already applied by Malaysian palm oil mill.

Waste exchange in agricultural sector

Interviews with mill's managers and recyclers proved that offsite reuse and recycling of non-products have not been practiced in the all studied mills that is located far from plantation. For instance, only farmers in Krabi and Surajthani province reuse empty fruit bunch as media for mushroom cultivation. At present, oil palm cultivation cooperatives in Krabi and Surathani Province practice the growing straw mushroom. Knowledge of these practices does not yet seem to have spread to other provinces. Cooperative and small householder plantation owners do not know that wastewater from factory contain high fertilizer and can be reuse to the plantation area for reducing cost of fertilizer. Cow farms closed to mills do not know that decanter sludge contain high fat and mineral and can be reuse as feed for livestock. There are several kinds of institution barriers such as: lack of research and development institutes; lack of direct government

support; lack of cooperation between mill and planter. Since most of present waste exchange recycler practices technology themselves due to there is no technical data on the reuse and recycle of such waste. Conversion of the waste/ by-product to valued added material such as organic fertilizer will directly solve part of environmental problems and turning the by-product to a resource for another industry.

The decanter cake generation from all crude palm oil mills is about 140,000 ton/year. At present, this waste is disposed as waste everyday. Decanter cake contains high oil and protein content and could be reuse as animal feed substitute. Using of decanter cake as animal feed for cows has not been adopted yet in Thailand. Farmers in Thailand are afraid of negative effects from this by-product such as: diseases; its compositions; nutrition values. Farmers have no experience in reusing this waste as animal feed. For using decanter cake as animal feed is the factory has to dry it so that it contains only 10% moisture content.

For recycling of wastewater in plantation areas, interviews with mills' manager and planters indicate that only mills that are located in plantation can recycled their wastewater for irrigation. The important barrier for mills that are located far from planter is the transportation cost. Small holding planters surrounding the mills do not recycled the wastewater in their plantations cause they do not aware about the fertilizer value of such wastewater. They also afraid of the bad effect since the color of palm oil wastewater is black.

The important technical barrier for waste exchange is lack of know-how and access to information. This is an important problem of reuse and recycle of waste in other industries and agricultural sector. Using palm oil sludge as animal food, or wastewater for irrigation can not be implemented due to farmers' lack of knowledge about quality and amount of waste and returning profit. The factories also could not provide these data because there is no direct relationship between millers and oil palm planters. Even there is information on waste application in plantation area returned from farmer after using the waste. Farmer have no incentive to applied such waste/ by-product in their plantation area. The case studies show that it is hard to find cooperation between research institutes/ university and recycler especially planters. This limits opportunities of recyclers in accessing new techniques or options to reuse/recycling solid waste from the mills.

There are several opportunities to overcome this barrier to these implement a zero waste industrial ecosystem for sustainable and increasing competition to the world market. Currently CPO mills are increased to 26 factories in year 2004 causing total production capacity of CPO more than FFB harvested. Thus factories have to compete for buying raw material for production. These resulting in high production cost of CPO product. Sale profits from producing and selling CPO product are therefore decreased. Especially in 2005, Thailand will have to reduce the importing tax of CPO from Malaysia to 0% according to the agreement of AFTA. Factories could adapt themselves to survive and competition with Malaysian palm oil by increase production efficiency and selling more by-product as an additional income.

Local institutions such as university, research institute and private company can play role in training, applying research, academic studies and dissemination of information. Successful utilization of by-product / waste demonstration project will convince producer and waste recycler to know the significant of using more by-product /

waste. In case of reuse / recycle waste in agricultural sector which has no knowledge and information of these waste, the Ministry of Agricultural and Cooperation should do more research and provide these knowledges of using and benefit of waste to the planters. Especially the use of compost produced from palm oil sludge, ash and partially treated wastewater instead of chemical compose which will reduce the compose importation. Ministry of Agricultural and Cooperation should provide grants in research in Waste demonstration project to academic institution for research and publication. For waste exchange with other industries, the government should organize a waste exchange center under DIW for access the information on quantity and quality of such waste. Moreover the factory should investigate and use experience from other countries which will increase value added product of by-product / waste before selling. These are what CPO mills should do if there is CT demonstration project from the research of DIW.

7.2.2 Horizontal Interaction between the Producer and Other Crude Palm Oil Companies

The competition between CPO mills in the same province is that they have to buy materials from the same source. Factory owners in the province have a meeting every month to exchange information and to agree on setting price and quality of fresh fruit bunch purchasing from the FFB suppliers. There is a standard price for FFB and an agreement with factory owners to buy FFB that has a good quality (not rotten) so that the supplier must control the quality of FFB. However in the area where many mills are located close to each other, these factories seriously compete on raw material supply for production process, especially since production of these mills is only 67% of the production capacity. Department of Industrial Work has setup rules for the registration of new factories by allowing only factories that are located in their owned plantation areas.

At present, Thai millers have to improve their production process to be able to compete with other countries such as Malaysia and Indonesia. Factories have to increase production effectiveness and at the same time improving their environmental performance. They have to increase the margin by implementing projects on reduction of oil loss in waste steam, selling waste to other industrial sectors and recovery of biogas from wastewater, and selling electricity to EGAT. Since there is little competitive on product market and production technology is not different among millers, they can and do share expertise on manufacturing technology and waste treatment. There is an informal network of managers and engineers who collaborate on clean technology projects. In addition there are personal contacts between millers. They share information on cleaner technology especially cost-benefits of clean technology investment options. In some cases, mill managers visit another mill in order to observe and collect data on clean technology option. Some networks were created since members participated in clean technology project organized by DIW, university/ research institutes and NGOs, and supported by international donor agencies. These networks and relationships can be further used for environmental improvement within factories.

7.2.3 The Interactions between Mill and Other Economic actors

Relevant economic agents in the economic network include banks, research institutes, international donors and insurance companies. Bank and insurance companies have not provided any incentives for companies to apply clean technology and pollution

prevention measure. The relationship of a company with research institute and international donor agencies, are analyzed below:

Research Institute.

Research institutes/ universities that conduct research and development on cleaner production are mostly financially supported by the government or International donor agency. Their main activities have been training, outreach projects and demonstrations. Most research has involved several actors, such as government institutions, NGOs, consultants and millers. At present factory A has collaboration with several academic agencies to conduct research within the factory. Academic agencies take initiatives by supporting such research with technology and man power. Meanwhile, the factory partially contributes to the budget for such research. These projects do not have financial support from other institutes. Most of research is emphasised on waste treatment and waste recycling, which are the current environmental problems of this factory. This joint research help company A to improve its environmental performance. This collaboration does not get happen in the other case-study industries yet.

For other waste reuse/recycle options, such as biogas recovery systems, activated carbon from palm kernel shell and reuse of fly ash for concrete block, academic agencies can play important roles in conducting research and helping the companies to implement the proposed cleaner production measures. But at the moment no such initiatives are taking place. They can provide reliable technical information by demonstrating equipment or pilot systems and training government agencies, palm oil mill employees and palm growers setting for the application of by-product and wastes. These activities need financial support from government, companies, etc. and also financial support in terms of low interest loan to factories for the implementation of clean technology to improve their environmental performance of the company.

International Donor Agencies. In the past 8 years, several international donor agencies have been initiating activities in waste minimization, good housekeeping, source reduction, recycling, reuse etc. Some of these international donor agencies are the GTZ (assisted with the project on environmental Advisory Assistance for Agricultural Industry, together with the Industrial Work Department), and the Carl Duisberg Gesellschaft South East Asia program Office. The activities for strengthening these initiatives are anticipated with additional assistance from the Danish Cooperation for Environment and Development (DANCED) via establishment of a national clean technology center (MOSTE) that promote clean technology in Thai industry, including the CPO industry. This initiative has produced results in CPO industry leading to increased saving and additional profits while substantially reducing wastes. The environmental performance of crude palm oil industry has been improved due to the introduction of environmental management systems (EMS) by DIW. Results show that most mills know clean technology and have implemented environmental management systems and cleaner production methods (DIW, 1997 and DIW, 1999).

7.3 Policy Network

Palm oil is one of the 15 fast track industrial products with AFTA agreements in 1996. By 2003, the tariff rates have been brought down to 0-5 percent in 5 years. When the Thai palm oil market has to open up to foreign competition, palm oil industry will be strongly affected because the production costs of Thai crude palm oil are higher than Malaysia's. The tool that the government has used to support the domestic producers of CPO from the competition in the world market is the cleaner production. The implementation of cleaner production activities supported by the government and involved stakeholders on a voluntary basic in a bottom – up approach were often more successful (Visvanathan Kumar,1999). The main activities have been training, outreach projects and demonstration. Data from this study in 2002 showed that 75% of factories engaged in clean technology. Most of clean technology option application are in order to increase production efficiency by reduce oil loss in wastes.

This section will analyze the current legislation and governmental authority that involve in environmental management policy of the industry and proposed industrial ecosystem. Policy institutions at different levels (including central, provincial, and local level) related to environmental management of crude palm oil industry is presented in Figure 7.3.

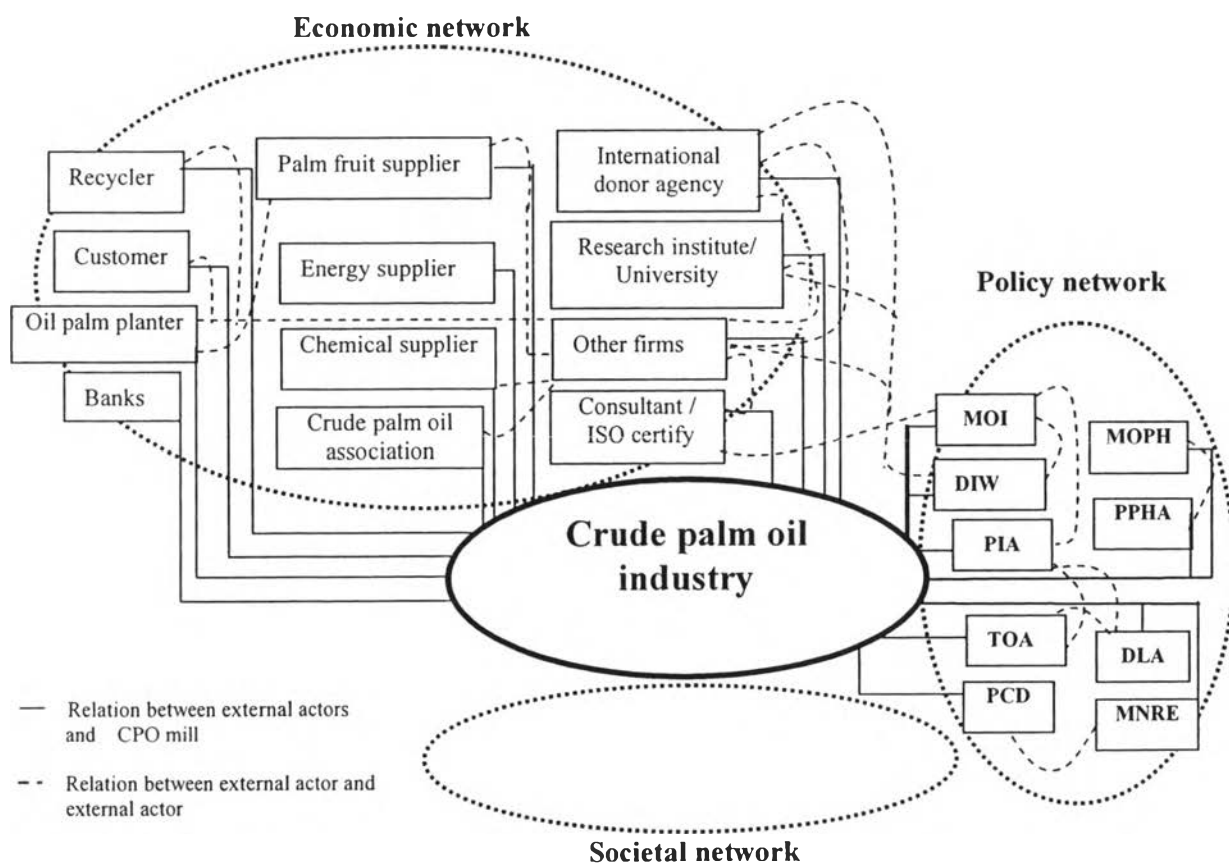


Figure 7.3 Policy networks relevant to crude palm oil mill.

MOI=Ministry of Industry; DIW= Department of Industrial Works; PIO=Provincial Industrial Office);
 DLA=Department of Local Administration; TAO=Tambol Administration Organization; MNRE= Ministry of Natural Resource and Environment; PCD= Pollution Control Department; MOPH= Ministry of Public Health;
 PPHO= Provincial Public Health Organization

The government institutes that have a relationship with crude palm oil millers and have direct/ indirect impacts on environmental management of the millers can be divided into three levels:

- National level
- Provincial level
- Local level

7.3.1 National level

The government institutions at Federal level that have both a direct or indirect effect on environmental improvement of CPO miller are summarized in Table 7.3:

Table 7.3 Government institutions related to environmental improvement of crude palm oil industry (2004).

Level	Institutes	Responsible unit	Responsibility
Central	DIW (under MOInd) PCD (under MNRE)	- The Factory Environmental Technology Bureau - The Factory Control and Inspection Bureau 4 - Water Quality Management Bureau	- Research and development of industrial production, including clean technology in CPO industry. - Regulating industrial production including the pollution from CPO production - Setting emission/effluent standards from industry - Take actions on public complaints related to pollution from CPO production
Provincial	PIA (under MOInd and Provincial Governors) PPHA (under MOPH and Provincial Governors) Provincial Governors	- Representative of the Factory Control and Inspection Bureau 4 - Representative of the DOH - Head of the Provincial Governors	- Regulating industrial production including the pollution from CPO production - Responsible for issuing, shutdown and revoking factory licenses - Provision of public health of both workers and community - Regulating provincial governor and Local governor - Having authority for revoking factory licenses
Local	DLA (under MOI and Provincial governor)	- PAO and TAO	- Protect and maintain the environmental quality of the provincial/ sub-district area - Take action on public complaints and responsible for primary inspection

MOInd has a direct relationship with millers in two aspects: (1) developing and introducing clean technology for crude palm oil industries and (2) enforcement and monitoring of pollution from crude palm oil production. The Clean Technology Unit (CTU) under Factory Environmental Technology Bureau is responsible for the development and introduction of clean technology to crude palm oil industry. For regulation of the pollution from CPO production, the Factory Control and Inspection Bureau 4 have representatives at the provincial level (PIA). PIA is responsible for regulating the discharge and other nuisances from the millers.

The Factory Environmental Technology Bureau of DIW is the important actor that has direct influence on clean technology application by crude palm oil industry. It has established 3 programs to promote the adoption of concepts and practices of clean technology in such industry. The relationship of this government agency with the millers

started in 1994. The project “Environmental Advisory Assistance to the Industry” is implemented by the Department of Industrial Work (DIW) and supported within the framework of the Thai-German Technical Cooperation Program by the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, with contracted academic agencies for carrying the research activities. GTZ supported all research grant and technical resources in this program during 1994-1997. Five millers joined this project. Another project is “Impact Assessment Guideline for the Palm Oil Industry” granted by GTZ, implemented by a consultant company during 1998-1999. Eleven CPO mills joined this project. The output of these projects results in the development and implementation of cleaner production methods as well as the application of waste management in the palm oil industry (DIW, 1997; DIW, 1999). The last project is “Cleaner production for crude palm oil industry” granted by DIW, carried by an NGO during 1999-2000. Five mills joined in this project.

Research related to clean technology granted by other government institution are;

- “Pollution prevention for Thai industry” granted by PCD to an academic agency; during 2002-2003. Six CPO mills joined this project.
- “A feasibility study on co-generation from palm oil mill bio-mass”; granted by Ministry of Science, technology and Environment; during 2001-2002. Five CPO mills joined this project
- “Developing environmental performance indicators for competitiveness for Thai industry”: granted by Thailand Research Promotion Institution, studying by a NGO during 2000-2001. 10 CPO mills joined this project.
- “Cleaner production for CPO industry”; granted by Thailand Research Promotion Institution, carried by academic agencies in 2003. An CPO mill joined this project.

Factory A, B and C manager, joined the Environmental Advisory Advice for Industry conducted project by DIW, said that they can establish CT workgroup in the factory when they know the advantage in improving of production efficiency by reducing waste, which make more benefit. Therefore the factory makes doing CT a target and task every year which really reduce in production expense.

The result of interviewed mill managers of 15 factories showed that they know clean technology from the DIW’s projects and all millers have applied good house-keeping for reduction of oil loss in wastewater. Factories A, B, C and D have cooperated in several clean technology projects for improving their environmental performance through many clean technology options. After they got benefit from implementing the first clean technology project, they were continued increase their production efficiency by reducing resources used, reuse/ recycling of waste in production process and trying to cooperate in other clean technology projects. Factory A, B and C have improved their production efficiency and at the same time improved their environmental performance by investment in clean technology equipment such as decanter, automatic fuel feeder, secondary brunch stripper etc. Factory E has never been involved in these projects. The manager implements good house-keeping by introduction of the Environmental Management for Crude Palm Oil Industry Guideline prepared by DIW and PIA officers.

7.3.2 Provincial level

At the provincial level, Provincial Industrial Agency (PIA) is responsible for regulating the discharges and other nuisances from the crude palm oil factory. PIA play an important role on environmental improvement of CPO mill. PIA contacts with the mill owner or manager. The PIA organizes an inspection at the company when the mill has submitted for five-year license and takes action in public complaint. Since PIA official have to inspect all activity of factory operation such as machine & equipment condition; mill operating; safety and waste treatment, so factory's environmental management is only a part of the inspection process. The PIA has to submit report of the inspection of all factories in the province to the Factory Control and Inspection Bureau once a year. The PIA also plays a role in environmental performance improvement of the millers by introducing good-house-keeping and good maintenance practice at the factories. Besides the enforcement of pollution control, they create environmental awareness of the millers by warning them to improve their wastewater treatment plant in rainy season in order to prevent pollution effect to the community. The effluent standard limits BOD concentration in discharge wastewater to a maximum of 20 mg/ L. The wastewater effluent standard which applies to the industry is too stringent. Almost CPO mills are prohibited to discharge wastewater to environment because they cannot treat their wastewater to meet the standard. The factories surrounded with oil palm plantation can reuse their wastewater for irrigation but those in the communities have to collect their wastewater in ponds and when the production capacity increased, they will buy more land to expand the wastewater treatment plant to prevent the overflow of wastewater in rainy season. For pollution control aspect, the millers have to conduct their environmental measurement themselves and submit the environmental monitoring report to the PIA every 3 months.

Factory A and B are under regulation of Surathani Provincial Industry Agency (PIA). Factory C, D and E are under regulation of Krabi, Chumporn and Trang PIA. The interviews of the PIA officials and factory managers showed that the enforcement mechanism is ineffective due to lack of manpower and capacity building at PIA. The number of officers working for Industry Unit responsible for environmental monitoring and control in Surathani, Krabi, Chumporn and Trang provinces are 2, 1, 2 and 1 persons, respectively. For Surathani province, from a total of 884 factories, 207 factories are causing environmental impacts. The enforcement mechanism suffers from inadequate staff and weak monitoring. PIA takes factory inspection only when a mill submits for license or is complained by citizen. PIA together with factory owner takes inspection at the factory. During inspection, PIA officials check overall factory operation including safety and environmental aspects. They take wastewater sample from the wastewater treatment plant and check the data on wastewater analysis from the influent and effluent of such wastewater treatment plant in the factory environmental monitoring report. However, if there are any complaints on environmental impact from millers, the PIA has to take more frequently until the problem can be solved. PIA official takes wastewater samples to analyze and decides on action in case of non-compliance. If mill have impact to the surrounding people, PIA has ordered mill to improve the environmental performance by construct more pond in time interval limit. PIA can shut down the mill operation if the mill cannot solve the complaint. In case of mill that has not solved their environmental impact, PIA can revoke its license.

7.3.3 Local level

According to the new constitution as specified in TAO Act, TAOs has the authority to protect and maintain the environment. TOA collect land tax from mill. TAO has responsible for monitoring and take action on the pollution from CPO production and also on public complaint. However, TAO suffer from human resource, so this authority has not transfer from PIA now. At present, TAO play role in mill environmental improvement by acting as formal representative of citizen. For a serious impact of a case study mill, wastewater overflow from treatment plant caused impact to the water consumption in canal, citizen complained to TAO. TAO took primary inspection by observation of the waste treatment plant of factory and sampling water in canal surrounded the factory. Consequently, TAO reported to PIA for further detail inspection in the factory. For other case studies, TAO take action on the complaint by take primary inspection together with the factory manager and the factory improve their environmental performance. However in the near future, PIA has to transfer their responsibility on factory monitoring and control to TAO. Their challenge task is to maintain the sustainable of environmental resource and at the same time keep on the factory growth without conflict with the surrounding community.

Result from interview factory managers can be concluded that the principal external actor who stimulates firms to improve its environmental performance is community and government authorities. The industry has to comply with legislation such as effluent standards. If they discharge the wastewater to the waterway, local communities who affect from such waste complain directly to PIA or to TOA, then PIA take inspection and order the mill to improve their pollution. A growing awareness of the impact of the pollution to resident people, Company A, B and C introduces appropriate waste management systems and also move beyond control technology to consider clean technology. The promotion of cleaner production has been implemented in this factory through the support of government and international donor agencies as described in previous sections. The mill has implemented clean technologies through these various joint projects. The result is an increase of production efficiency and reduction of environmental impact to the community and the environment.

7.4 Societal Network Analysis

The societal network of crude palm oil companies consist of surrounding communities, employees, NGOs and the mass media as shown in Figure 7.3.

7.4.1 Community

The local communities play an important role in environmental improvement of companies. They are directly affected by pollution and they have rights to complain to local authority or central government. The World Bank (2000) states that where formal regulators are absent or ineffective, informal regulation can be implemented through community groups or NGOs. The agents of informal regulation vary from country to country-local religious institutions, social organizations, community leaders, citizens' movements or politicians-but the pattern is similar. Their effects on environmental performance of the Thai palm oil industry are the same as an other polluting industries the other developing countries.

7.4.2 Community

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Factory A is located close to a community, about 10 km. from Surajthani municipality. The factory is surrounded by small household plantation area, which mainly as coconut trees. There is a small community located surrounding the factory. There are about 4,000 people living in this sub-district, among which 50 peoples earn their living by working in this mill. Four heads of villages surrounding the mill, the head of the sub-district, and the TAO's chairman were chosen for in depth interviews. All the interviewees reported that the pollution impact from the factory on the environment is decreasing during the last 10 years because the factory improved the wastewater treatment plant and implemented measures to prevent the impact of wastewater to community.

During the last decade, the water quality of the channel surrounding the mill is deteriorated due to wastewater overflow from the wastewater treatment plant in rainy season. Since palm fruit productivity is highest in the rainy season, the high production of the mill is also generating high quantity of wastewater that accumulates in the pond system. Consequently the citizens cannot use water from the channel for consumption, because it has not only black color, but also affects their health. The first complaint by community to the Provincial industrial agency was in 1993. The citizens surrounded the factory and with the most impact suggested to the head of the village to complaint via report this to the head of district. He passed the complaint to the head of provincial administration and then to the PIA (Figure 7.4). PIA inspected the wastewater treatment plant and the channel near the factory and ordered the factory to improve its wastewater treatment plant and prohibit draining wastewater into the watercourse. The complaint on pollution happened again in 1997 (Table 7.4). Citizens complained via report on bad smell from wastewater treatment plant and solids waste accumulation in factory. Following these complaints, PIA ordered the mill to improve its environmental performance. The mill constructed more ponds for treating wastewater and disposal solids waste from the factory everyday. The third complaint by the community on wastewater overflow to the channel was in 2001. After TAO is established in 1999, citizens reported the impact to the TAO. TAO has authority to take preliminary inspection at the impact area and report to PIA for further inspection. At present TAO puts pressure on the mill to increase awareness on environment by visiting the mill.

Community complaints for many years resulted in environmental performance improvements of the factory. This is confirmed by the mill management, which concluded that the important factor for improving the production efficiency and also the environmental performance of the mill was pressure from the community and

government regulators. The improvement is started by investments in the wastewater treatment plant, until the land is became limited factor. Finally, the mill joined in the CT project set up by the government and implemented in CT options by installing new machine and reuse/recycle wastewater in the production process. This is confirmed by the 2002 factory survey (of Chapter 5) which showed wastewater generation and BOD loading of the mill were equal to 0.5 m³/ton FFB and 30.7 kg./ ton FFB, respectively. Compared to the result in 1994 (Kittikhun, 1999) that presented the wastewater generation from the mill was equal to 1 m³/ton FFB.

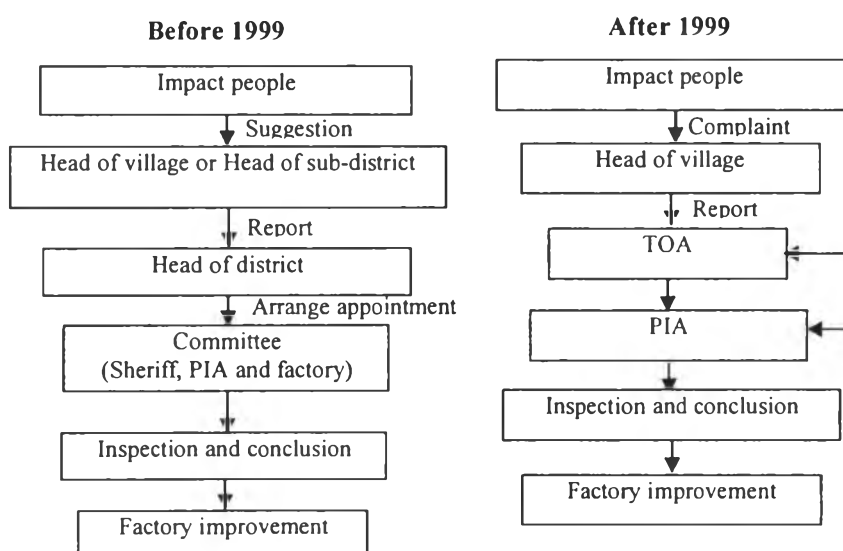


Figure 7.4 Chart of environmental regulations following environmental complaint.

Table 7.4 Activity on environmental improvement of factory A (PIA,2004).

Activity	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Official complaints by community											
Joined in CT project set up by government								
Joined in other CT projects						
Wastewater treatment plant construction		---	---			---					

At present the relations between factory A and the community are much better, as expressed by donation of public utilities such as equipment and accessory for school, welcoming of the citizens for factory visits, and the fact that workers from surrounding communities are increasingly employed.

There is increasing public concern and participation in the management of the environment. In the past, democracy in Thailand is not able to provide public participation. The 1997 Constitution represents a revolution in Thai politics. It is often referred to as a true people's constitution (Jarusombat, 2002). On the issue of the environment, the 1997 Constitution supports enables and stimulates public participation

in environmental management and conservation. There are three Clauses related to the rights of communities and individuals to co-manage natural resources and the environment.

The interview of key persons such as local community leaders, factory's managers, local authority officials and PIA officials in several other provinces with crude palm oil industry that are located close to the communities are concluded the same as factory A. The detail of complain statistic of all case study is shown in Table 7.5. Factory C, located in densely populates area (5,000 peoples), showed not only serious bad smell from wastewater treatment plant but also particulates from chimneys. Regarding the complaints, the surrounding inhabitants suffering from environmental impacts made complaints to the Head of sub-district /local authorities, and then PIA investigated the factory and ordered it to improve the source of pollution. Following community complaints, Factory A and C implemented many CT options in order to improve the environmental performance of the mill. Since three years, no complaints have been received. Factory D is surrounding with oil palm plantations and had no complaints from communities until this year (2004). In 2003 the factory increased the production capacity with small improvement of the wastewater treatment plant and bad smell from wastewater treatment plant affected the surrounding community. In contrast, factory E did not apply any CT options, There are often complaints by communities that are located down-stream. Factory E received complaints on serious wastewater contamination in canal water due to wastewater overflow in rainy season. PIA stopped the mill operation and ordered to improve their wastewater treatment plant. The factory owner decided to construct more ponds for keeping its wastewater. However after 3 years, there were still complaints.

7.4.2 NGOs

The environmental NGO community in Thailand is significant. There are over 70 NGOs registered with DEQP. Environmental NGOs are involved in a variety of activities varying from population and community development to natural resource protection and pollution control. The role of NGOs at present is very limited in pollution from industry. Most NGOs in Thailand focus on natural resource issues rather than on industrial pollution. As in many developing countries, NGOs generally lack financial resources, manpower and research capacity. Most of them are poor and depend on external support, few have a long-term, professional staff. Most are poorly networked and spread across a large array of environmental issues. And most have little access to the media (So and Lee, 1999). Of those environmental NGOs that focus on industrial pollution, virtually all are heavily supported by the business community. This includes the Thailand Environmental Institute, the Thailand Environment and Development Network, Magic eyes and the Thailand Business Council for Sustainable Development (Rock, 2001). This mean that they have rather cooperative relations with industries, in stead of adversarial and conflictional strategies.

Table 7.5 Complaint statistic of 5 selected crude palm oil industry (PIA,2004).

Activity	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Factory A: in community												
Complaint on WW	—				—				—			
Join in CT projects			
WWTP construction	---					---						
Factory B: far from community												
Complaint (no)												
Join in CT project			
Factory C: in community												
Complaint on bad smell and particulates matter			2			3	2					
Join in CT projects			
WWTP construction						change boiler			biogas			
Factory D: plantation area												
Complaint on bad smell												—
Join in CT projects											
Factory E: far from community												
Complaint on WW; leachage		—				—					—	
Join in CT projects												
W W T P construction			---			---						

NGOs concerned with environmental reforms of the crude palm oil industry are active in environmental training and dissemination on environmental information. They do not engage with individual companies, or get involved in policy-making and implement to the process. Thailand Environment Institute (TEI) action-oriented policy research on cleaner production technologies and other environmental issues, carry out studies on CT project on crude palm oil industry, supported by the Thailand Research Fund. However, a study on waste exchange for this industry is not available.

7.4.3 Employee

At present most employees are local people. Mills that locate in community use employees as an early warning system. If there is any environmental impact or complaint from the community, they have to report it to the manager. The manager aims to improve the pollution source before the situation becomes worse. However, most employees don't have knowledge on environmental pollution, so they often do not take any action themselves on environmental improvement of the factory. The engineering and manager staffs are not local resident and stay in the municipality that locates far from the mill.

7.5 Major Actors on Environmental Improvement of CPO mills

Result from network analysis, it can be concluded that the actors which play important role in clean technology implementation of crude palm oil industry in Thailand

are DIW, PIA , community international donor agency, university and other crude palm oil mills,. These actors have relationship with policy maker within the company. Customer, palm fruit supplier, bank, PCD, local authority, NGOs and mass media play minor influence on clean technology adoption of the mill. Oil palm growers and consumers have no influence on clean technology application but they interact on finance sector of a company. Table 7.6 summarizes the actors that have effect on CT application.

Table 7.6 Ranging of the actors that influence on clean technology application.

Impact on CT application	Policy actors	Economic actors	Societal actors
Major actor	DIW (CT unit) PIA (Provincial level)	Research institute/University Other CPO firms International donor agency,	Community
Minor actor	TAO (Local authority) PCD	Crude Palm Oil Association Oil palm planter Palm fruit supplier Customer (refinery)	Employee NGOs Mass media
No influence	PPHA	Bank Consumer Utility and chemical supplier	

The economic actors that play an important role on research and development, especially on clean technology application, are international donor agencies and research institutes/ universities and other CPO firms. These actors influence on policy maker and building capacity of employee in the mills. In the past 8 years, several international donor agencies working with several institutions such as: DIW; PCD; research institute; university; NGOs have been introducing environmental management system and clean technology. Result from this study show that the environmental performance of crude palm oil industries has been improved due to the introduction of these projects.

The crude palm oil case studies show that local customers and consumer have minor influence on the extraction mills to take account in environment and in triggering companies to get certify in ISO 14000 certification. Since crude palm oil is raw material for local palm oil refinery and soap manufactory and their products are local consumed. Moreover palm oil is the cheapest cooking oil in country, so there is no incentive for factories to get eco-labels or ISO 14000 certification.

Results from the 2003 survey study, the principal external actors who stimulate firms to improve their environmental performance are community and government authorities. Community surround the factory play an important role in environmental improvement of a mill by influence on policy maker of the mill. A growing awareness of the pollution impact to surrounding people, some companies introduce appropriate waste management systems and also move beyond control technology to consider clean technology. Surrounding people can complain directly to central government at provincial level via mail or telephone. In some case, effected people can make suggestion through local government. Then PIA have pressure the mill to improve their environmental performance in order to reduce the environmental impact.

Most NGOs in Thailand focus on natural resource issues rather than on industrial pollution. As in NGOs concerned in environmental reforms of the crude palm oil industry are those that are active in environmental training and dissemination on environmental information. This actor influences on building capacity of the company.

7.5 Barriers and Opportunities to move CPO Industry to more Sustainability

The alternative is described will be central in the network analysis in this section. In this alternative a number solutions of chapter 5 and 6 are implemented. This scenario consists of 2 parts:

1. CT implemented in the crude palm oil factory
 - Reuse/recycle of wastewater in production process such as wastewater from sterilizer condensate, excess steam condensate.
 - Employ decanter and separator in series to recovery oil from wastewater
2. Waste exchange and produce value add product
 - Shell will serve as raw material for commercial activated carbon
 - Decanter sludge will be use as raw material for animal feed.
 - Ash, sludge and wastewater will be applied as source for fertilizer in plantation area.
 - Recovery biogas from wastewater and use as fuel for electricity generation or substituting existing energy source in the palm oil mill

There are 2 main conditions for implementing this scenario. The first and most important condition is that these measures resulted in a process modification. It increases oil production efficiency while at the same time reduce in environmental impact from production process. The second scenario is waste exchange and produce value added product that is minimized waste discharge to the environment and make crude palm oil industry more sustainable. The new uses of the existing steams result in a better use of their potential and are economically feasible. In analysis the role of the network actors related to crude palm oil industry will be discuss on barrier and opportunity for CT implementation and to approach a zero waste industrial ecosystem of crude palm oil industry in Thailand.

The principle actors of cleaner production are the companies, which control the production process. Their operations are influenced strongly by politics and policy-makers, by their economic actors, and by society actors.

7.5.1 Policy barrier and opportunity

Environmental policy Barrier

There are several governmental institutes do research and development of clean technology introduction to crude palm oil industry as mentioned in section 7.2.2.1. There is an overlap and not clear for their responsibility. There is no specific institute that takes responsibility in this task. At provincial level, the enforcement mechanism suffers from inadequate staff and weak monitoring on environmental aspect and report capability. Local authority is not authorized to monitor and enforce factories to improve their

environment performance. Local authority takes action on complaints by reporting to the PIA, causing the decreasing in the audit by the community.

The most important barrier in pushing CPO industry to move to sustainable is the lack of government unit to support the research and technology information to develop the palm oil industries. The result of producers' and farmers' lacking of knowledge and know-how making it unable to reuse / recycle waste in production process and in other industry and agricultural sector.

Finally, there is a lack of environmental policy within factory. The result of factory survey founded that 33% of factories applying EMS have clean technology working group, resulted from the demonstration project of DIW.

Environmental policy opportunity

This due to the political structure does not support environmental protection. In addition, the command and control does not give incentive to companies that located far from community to invest in environmental technologies or to go beyond compliance. Thailand uses the economic instrument according to Polluter Pay Principle focusing on user charges but has not brought the Emission charge (EC) to use in industrial factories although they have done the feasible study. Sricharoen, 2002 reported over 80% of surveyed factory agree to the emission charge implementation policy and willing to pay EC. The main reason of the agreement of such factories associates to the existing restriction of palm oil wastewater discharge to environment. Especially factories closed to community facing with overflow problem.

According to the new constitution as specified in TAO act, there should be a support for local authority to involve in solving the problem of environmental impact from industries by cooperated with PIA to enforce factory of compliance the law and monitor the factories.

7.5.2 Technical Barriers and Opportunities

Technical Barriers

Result from the analysis of actor networks shows that there are many technical barriers of CT implementation within crude palm oil mill. The policy maker and employee (human factor), are the most important barrier for adoption or application of such CT options. These technical barriers refer to lack of 4 needed facilities: (1) knowledgeable personnel, (2) willingness to change the technique, (3) know-how, and (4) access to information.

The factory's owner is the most important actor for making decision on clean technology. It would be easier for them to try to make more profit with existing process. Some lack the technical resources especially most mill that employ only an engineer for operating the production. The barriers of clean technology adoption in a company are mainly due to human factor. All employees have their specific duty in production line that keeps them available for additional responsibility. In addition they face the difficulties in identifying environmental problems, solving and implementing the appropriate solution through clean technology approach.

Lack of relationship between millers and recycles especially oil palm planters is the important barrier for waste exchange concept in Thailand. Lack of cooperation between millers and research institute/ university is also a important barrier to waste exchange barrier.

The important technical barrier for waste exchange is lack of know-how and access to information. This is an important problem of reuse and recycle of waste in other industries and agricultural sector. Using palm oil sludge as animal food, or wastewater for irrigation can not be implemented due to farmers' lack of knowledge about quality and amount of waste and returning profit. The factories also could not provide these data because there is no information returned from farmer after using the waste. There is no directly contact between mill and farmer. Farmer have no incentive to applied such waste/ by-product in their plantation area. The case studies show that it is no direct cooperation between research institutes/ university and recycler especially farmer. This limits opportunities of recyclers in accessing new techniques or options to reuse/recycling solid waste from the mills.

Technical Opportunities

Successful demonstration project on reducing oil loss in wastewater and recovery of biogas from wastewater making several CPO industries do CT option because they can follow and receive benefit from the investment.

Second, Thai CPO mill can learn experiences on production technologies and cleaner production from other countries and choose the right technology according to the conditions of each factory in the country. Even though there is still no equipment development and production unit for CPO industries but more advance equipment are adapted for factories to choose, which they always prefer more production efficiency or energy-saving equipments rather than reducing waste technology.

7.5.3 Economic Barriers and Opportunities

Economic Barriers

Clean technology. Economic constraints refer to one main point that is poor influence from customers and consumers. The crude palm oil case studies show that local customers and consumer play no role yet in pushing the extraction mills to take account in environment nor in triggering companies to get certify in ISO 14000 certification. Unfamiliarity with eco-labeling of Thais customer and consumers give further evidence of this constraint.

Second, Crude Palm Oil Association (CPOS) plays minor role in environmental improvement of mill. It should act as representative of the industry and link between government institutions and CPO mills. It could also be strengthen in training and data assess of clean technology for CPO mill.

Waste exchange. Lack of financial support is barrier for waste exchange. Production of value-added product from waste need high investment cost for install new

equipment or machine. In Thailand most of machines are import, so the capital cost for such projects are quite high.

Economic Opportunity

Currently, National master plan on cleaner production supports tax incentive and soft - loans for clean technology production. This makes the factories required loan to think of environmental management. From case studies, most factories have enough funding source to operate and only need loan in the construction period. However several CPO factories are public listed company and because of low interest rate, they tend to require more loans.

Waste exchange work on the promise that one industry's wastes can be reused or recycled another industry's operation. Since the crude palm oil industry is a combination of extraction factory and oil palm plantation and most of waste from factory is suitable for reuse in plantation area as soil conditioner. So the farmer could potentially play a major role in the operation of a reuse and recycle of waste from crude palm oil factory.

7.5. 4 Informal regulator barrier and opportunity

Informal regulator barrier

The role of NGOs at present in Thailand is very limited in pollution from industry. Thai Environmental Institute is representative as environmental NGOs to be one of the committee in National Environmental Broad. However their work is limited and cannot participate in direct negotiations with state representatives and economic agents. Both NGOs and CPOA do not play role in planning of The National palm oil policy.

Informal regulator opportunity

Community surround the factory play an important role in environmental improvement of a miller. They can complaint directly to central government at provincial level or make suggesting to local government. If no action taken from PIA, they have complaint to central authority at national level such as PCD, MOI or Prime minister's Complaint office. Local community is significantly influence palm oil industries to comply with environmental regulations.

7.6 Conclusion

During the past 10 year, crude palm oil mills have improved their environmental performance gradually due to among other local community complaint about environmental deterioration. At present the conflicts related to environmental pollution in the company's area are not severe. This is confirmed by the report of Sricharoen (2002) which concluded that the important factor influencing to environmental management policy of factories are community and regulation by 53% and 40% respectively. It reflects the power of public on the level of environmental management. The factories surrounded with community always have an acceptable environmental management level. Moreover these factories usually improve their environmental performance by

implementing in clean technology rather than by add on technologies. Results from interviewed factory managers show that mills that are located close to communities have better environmental performance than those located far from community. The principal policy actors who stimulate firms to improve their environmental performance are community and During the past 10 year, crude palm oil mills have improved their environmental performance gradually due to among other local community complaint about environmental deterioration. At present the conflicts related to environmental pollution in the company's area are not severe. This is confirmed by the report of Sricharoen (2002) which concluded that the important factor influencing to environmental management policy of factories are community and regulation by 53% and 40% respectively. It reflects the power of public on the level of environmental management. The factories surrounded with community always have an acceptable environmental management level. Moreover these factories usually improve their environmental performance by implementing in clean technology rather than by add on technologies. Results from interviewed factory managers show that mills that are located close to communities have better environmental performance than those located far from community. Community surround the factory play an important role in environmental improvement of a mill by influence on policy maker of the mill. NGOs concerned in environmental reforms of CPO mill are those that active in doing research. Mass media has influence on decision-making of the factory owner. However mass media does not play role in environmental performance of the factories. Governmental or formal regulators use the political process to influence the strictness of enforcement. Department of Industrial works (DIW) under Ministry of Industry (MOInd) is the main agency which is directly responsible for the formulation and operation of environmental policies including clean technology. At provincial level, PIA has responsibility for regulation the discharges and other nuisances from the factory. The economic actors that play an important role on research and development, especially on clean technology application, are International donor agencies and research institutes/ universities and other CPO firms.

Result from triad network analysis, it can be identified the barriers for the adoption of cleaner production within Thailand. These barriers are classified to technical barrier, economic barrier, and policy barrier.

Technology barrier

- Lack of know-how and access to information. This is an important problem of clean technology application in industry and also reuse and recycle of waste in production process and in other industries.
- Lack of willingness to change the technique.
- Lack of knowledgeable personnel.

Economic barriers

- Lack of relationship between mill and research institute/ university and also with farmer.
- Crude Palm Oil Association play no role on planning of national crude palm oil policy and environmental improvement of mills.
- Customers / Consumers are not influence on the CT application of the mills. Since they are not aware of the sustainability of the product.

Policy Barriers

- Lack of specific government unit to support the research and technological information to develop the palm oil industries, especially the plantation system.
- The political structure does not support CT adoption in the factory. At provincial level, the enforcement mechanism suffers from inadequate staff and weak monitoring on environmental aspect. Local authority is not authorized to monitor and enforce factories to improve their environment performance. The command and control does not give incentive to companies to invest in environmental technologies or to go beyond compliance.

To overcome these barriers and move palm oil industry more sustainable, the national policy frameworks and institutional structure for the achievement of clean technology and waste exchange should be reform.