The German Technical Cooperation's (GTZ) Thai-German Programme for Enterprise Competitiveness

"Field Survey on Sustainable Palm Oil in Thailand and Compliance with International Standards"

In cooperation with GTZ Germany (Sector Project), Prince of Songkhla University, SGS International and Southeast Asia Consult & Resource Co. Ltd

A Concise Report

กระทรวงพลังงาน MINISTRY OF ENERGY

E3 Agro Project

gtz Thai - German Programme for Enterprise Competitiveness

Cover photograph:
Oil Palm Plantation in Krabi

Field Survey on Sustainable Palm Oil in Thailand and Compliance with International Standards

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Table of content

List of Tables and their data sources

List of Maps and their data sources

List of figures and their data sources

Acronyms (Database of Abbreviations)

Abbreviation	Full Name/Expression
GTZ	German Technical Cooperation
ISO	International Organization for Standardization
SEA-C.R.	Southeast Asia Consult & Resource Company Limited
SKPI	Sustainability Key Performance Indicators
E3Agro	Energy and Eco-Efficiency in Agro-Industry
TG-PEC	Thai-German Programme for Enterprise Competitiveness
BMZ	Bundesministerium für Zusammenarbeit
DEDE	Thai Department of Alternative Energy Development and Efficiency
RSPO	Roundtable on Sustainable Palm Oil
CPO	Crude Palm Oil
OBA	Observer Based Assessment
SGS	Systems & Services Certification
FFB	Fresh Fruit Bunch
QWL	Quality of work life
EFB	Empty Fruit Bunches
PPP	Public Private Partnership
PAO	Provincial Administrative Organization
GPS	Global Positioning System
GHG	Greenhouse gases

CO2	Carbon Dioxide
CH4	Methane
N2O	Nitrous Oxide
ORT	Oil Extraction Rate
SOP	Standard Operation Procedures
SMP	Standard Management Procedures
TNI	Thailand National Interpretation
TOR	Terms Of Reference
BOD	Biochemical Oxygen Demand
IPM	Integrated Pest Management
FAO	Food and Agriculture Organization
IUCN	International Union for Conservation of Nature
ASEAN	Association of Southeast Asian Nations
HCV	High Conservation Value

1. Introduction

Study background information:

The Government of Thailand has set ambitious targets to promote renewable energy and energy efficiency. This includes the production of bio-fuels from tapioca and sugar cane as well as bio diesel from palm oil. To secure eco-efficient and sustainable production and thus keep exporting options open for marketing is a major concern of each investor in bio-fuel production.

The E3Agro Project ("Energy and Eco-Efficiency in Agro-Industry") supports the Thai Government in reaching its biomass energy and energy efficiency targets. The Project is part of the Thai-German Programme for Enterprise Competitiveness (TG-PEC) which is supported under a grant from the "German Federal Ministry for Economic Cooperation and Development (BMZ)". The Project is jointly implemented by the Thai Department of Alternative Energy Development and Efficiency (DEDE) under the Thai Ministry of Energy and German Technical Cooperation (GTZ).

Germany imports palm oil from Southeast Asia for its own bio-fuel industry. Recently, the production of bio-fuels has been extensively criticized as being not environmentally friendly but - on the contrary – being non-sustainable and environmentally destructive due to the poor standard of local production methods. GTZ has been approached for assistance by importers and users of palm oil, who are concerned about their green image and want to procure only bio-fuels which comply with sustainability standards. The E3Agro Project wants to use the increasing pressure from forthcoming sustainability standards to further promote energy and eco-efficiency in Thai agro-industry. Jointly with the Sector Project "Sustainable Use of Biomass Focusing on Bio-energy" it is commissioning a study to determine the performance of selected Thai palm oil mills in comparison to international sustainability standards.

Two mills have been selected for a case study, in order to facilitate production data but also general structural sector information for this study. It is imperative for these mills – being representative for most of the Thai palm oil industry – to be able to comply with future standards on the production of palm oil to keep their competitive edge. Standards currently being discussed focus on sustainable production of biomass for bio-fuels encompassing ecological, economical, social, as well as political issues as well as on the greenhouse gas reduction potential. The study will focus on these issues, especially on sustainable cultivation of land, protection of natural habitats and greenhouse gas reduction potential.

The study will use the standard developed by the **R**oundtable on **S**ustainable **P**alm **O**il (RSPO) – which is currently the most recognized for palm oil – and analyze in how far mills and their suppliers in Thailand comply with these standards. Special attention will be paid to the needs of smallholders. In addition to the RSPO, the study will make use of the greenhouse gas tool developed by the Dutch Cramer commission to assess the greenhouse gas reduction potential.

2. Methodology and participants

Methodology

The methodology applied in analyzing collected data is that of data triangulation. It consists of three distinctive data sources, i.e.

a. Quantitative data on all CPO production steps, including feedstock supply provided by factories and smallholders
b. Descriptive, qualitative data from the perspective of factories and smallholders covering all CPO production steps, including feedstock supply
c. **O**bserver **b**ased **a**ssessment (OBA) from the study team perspective in form of
    - Specific quantitative estimates on CO_2 options
    - Qualitative and quantitative observations from the study team's point of view
    - Quantitative descriptions of a greenhouse gas audit

To cross-reference the collected data, an intensive secondary data research was conducted during two months prior to the study launch.

Data collection

Data was collected by two teams in two phases. Team 1 consisted of the

- International consultant ***Southeast Asia Consult & Resource Company Limited*** (SEA-C.R.)
- Local expert team lead by *Dr. Aran H_Kittikun and Dr. Thira Eksomdhamet,* ***Department of Industrial Bio-Technology, Faculty of Agro-Industry, Prince of Songkhla University***

Team 2 consisted of

- Mr. Salahudin Yaacob of **Systems & Services Certification (SGS) Malaysia Sdn. Bhd.,** Mrs. Betina Jahn of **Systems & Services Certification (SGS) Germany GmbH** and Mr. Wechayan Thanabodepat of **Systems & Services Certification (SGS) Thailand Co. Ltd.**
- A support team by ***Southeast Asia Consult & Resource Company Limited*** (SEA-C.R.),
- As observer Mrs. Laura Meissner of **German Technical Cooperation (GTZ) Headquarters Eschborn**

The first phase, between May the 28th and June the 15th 2008, was conducted by team 1 and focused on structural descriptions, the CO_2 footprint and the supply chain of the industry sector. The second phase, between July 11th and July 16th, was responsibly conducted by Systems & Services Certification (SGS) and assisted by a team *from Southeast Asia Consult & Resource Company Limited* (SEA-C.R.). To validate the observations and assessments made both quantitatively and qualitatively by the teams, data collection results were introduced to the target groups in a Work-shop style feedback process to ensure that data used for this was in line and represented the true status quo of the target groups.

Data analysis

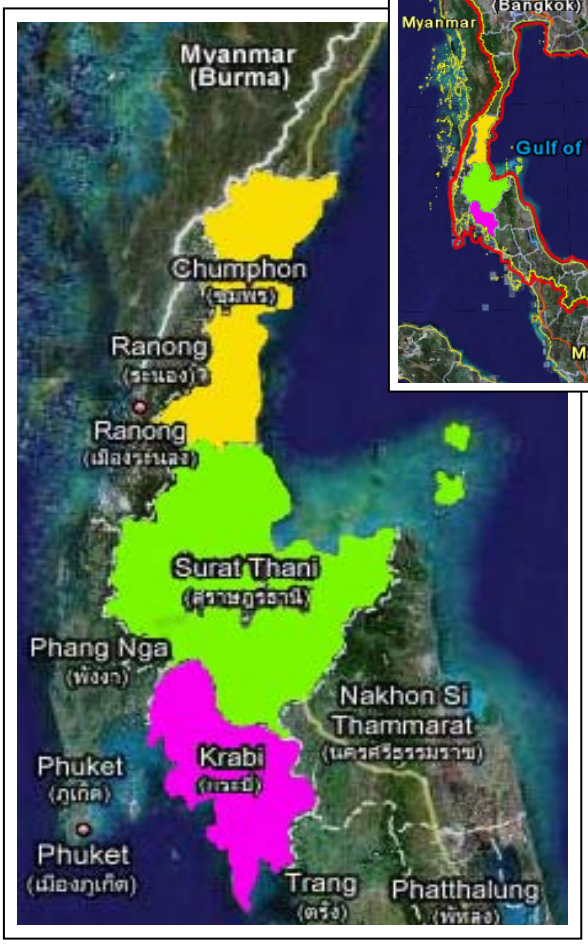
Data was analyzed based on three methods:

1. Contain analysis of quantitative and qualitative data
2. Triangulation, i.e. data triangulation by using documents, observations and discussions/interviews, as well as case triangulation by including reference groups or activity samples.

3. Structural description

3.1 Background information

Map 1: Study Area



In 2008, the only areas used intensively for oil-palm plantations in Thailand are located in the South of Thailand. This is mostly due to water and weather conditions, as the oil palm prefers a wet and tropical climate. The conditions for oil palm are good South of Prachuab Khiri Khan, with the northernmost Province being Chumphon. However, the province with the most extensive plantation is Krabi, followed by Surat Thani (see table below) and Chumphon being only recently more intensely used for oil-palm plantations; the other provinces can have some considerable areas of plantation (like Trang and Nakhon Si Thammarat), but are more dedicated to rubber plantations.

This study looks to assess the overall sustainability situation of the palm-oil industry in Thailand on the example of twp typical palm-oil mills and their supply chain in the South (see also chapter 2). Besides the two mills, 14 smallholders participated in this study.

The representative participants were individually selected (see chapter 3.2, below) to give the study a high reliability and confidence level while describing and analyzing the sector. The foci of this study are the provinces of Krabi and Surat Thani and to some minor extent Chumphon, as part of the feedstock of mill one is generated in this province. Besides this target area, the analysis includes other provinces only if indicated by collected data from participants of the study; and then only related to specific problems highlighted by the data.

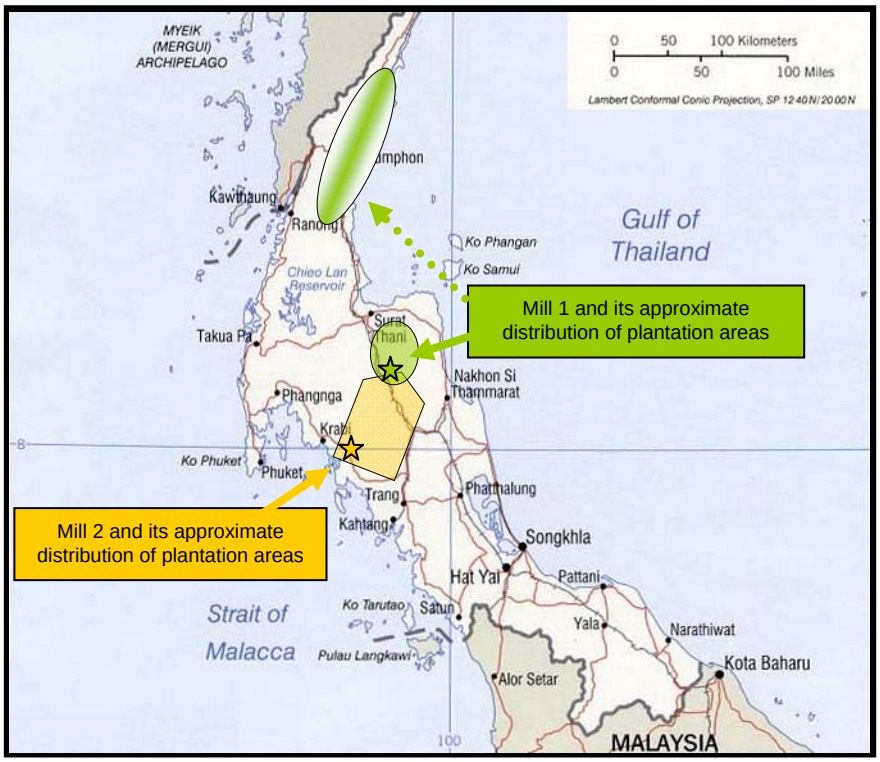
Participants in the study:

A. Mills

The mills were selected in cooperation between E_3Agro, Prince of Songkhla University and SEA-C.R. out of the 66 registered mills in Thailand. They are further referred to as mill 1 and mill 2 due to reasons of confidentiality. Their identity and location is known to E_3Agro, Prince of Songkhla University and SEA-C.R. They are located in Krabi Province and Surat Thani Province (see map below), respectively.

Mill 1 was chosen due to its potential to represent

- Smaller – medium sized mills interested in CPO export beyond its immediate geographical neighbors
- Mills with a *basic* waste water management system in place and trying to utilize waste from every process step
- Mills with no RSPO membership
- Mills with a good internal but rather isolated palm oil information network within the sector.



Map 2: Location and areas with plantations of participating palm oil mills

Mill 2 was chosen due to its potential in representing

- Larger – medium sized mills already engaging in CPO (Crude Palm Oil) export outside of Southeast Asia
- Mills with an advanced waste water management system in place and trying to utilize waste from every process step
- Mills with an existing RSPO membership
- Mills participating in some form of information network within the sector

Base-data of the mills:

Mill 1 was established and registered in 1979 with an initial registered capital of 100 Million Baht. The Mill wholly owns oil palm plantation areas with combined planting areas of more than 20,000 rai (3,200 hectares) in Surat Thani province.

Map 3: Aerial view of participating mill

In 1990, the company started co-operation with the Agricultural Promotion Department and initiated a policy of selling high quality seedlings to smallholders, including giving a buy-back guarantee to small holders. Thus the area of potential palm oil plantations for Mill 1 has increased to about 100,000 rai (16,000 hectares), mostly in and widely distributed throughout Chumporn province. Thus, the feedstock planting area owned and operated by The Mill is about 15 - 20% of the total area needed to cover its feedstock needs.

The crushing plant of mill 1 is capable of maintaining a throughput capacity of 45 tons of Fresh Fruit

Map 4: Aerial view of participating mill

Bunch (FFB) per hour. Mill 1 is currently building a factory with a throughput of 90 tons FFB/hour.

The Factory is certified for ISO 9000 quality management system, but not a member of the RSPO. Information on turn-over and number of employees was not made available during the first introductory visit.

Mill 2 was established and registered on April 21st, 1978 with an initial registered capital of 324,050,000 Baht. It currently has an oil palm plantation area of 44,471.56 rai (= 7,115.45 ha) excluding building sites, swamp reserves and nursery area (see table 1 below) and employs 924 officers, i.e. employees registered (see table 2 below). Mill 2 is in the unusual position of directly operating between 75 and 80 % of the plantation area need for its feedstock supply. The factory currently has production capacity of 75 tons per hour of FFB and 4.55 tons per hour of palm kernel seed. Its products include CPO, crude palm kernel oil, palm kernel cake, palm kernel seed. The factory is certified by various quality management systems such as ISO 9001: 2000, ISO 14001 and a member of the RSPO. In 2007 the mill generated an income of 638 million Baht.

Table 1: Mill 2 total plantation area	
Own plantation area	
Estate 1	7,462.56 rai (1,194.01 ha)
Estate 2	5,162.25 rai (825.96 ha)
Estate 3	3,062.62 rai (490.02 ha)
Estate 4	3,582.50 rai (573.20 ha)
Estate 5	3,852.37 rai (616.38 ha)
Subtotal company's plantation area	**23,122.31 rai (3,699.57 ha)**
Subsidiaries plantation area	
Sub-estate 1 (Subsidiary's concession land)	8,474.75 rai (1,355.96 ha)
Sub-estate 2 (Subsidiary's concession land)	12,874.50 rai (2,059.92 ha)
Subtotal subsidiaries plantation area	**21,349.25 rai (3,415.88 ha)**
Total planted area	**44,471.56 rai (7,115.45 ha)**

Table 2: Number of registered employees, Mill 2			
	2007	**2006**	**2005**
Mill 2 Office personnel	53	34	41
Mill 2 proper personnel	99	102	109
Plantation personnel	772	742	756
Total	**924**	**878**	**906**

Table 3: Income structure of Mill 2						
Product / Service	**2005**		**2006**		**2007**	
	Million baht	**%**	**Million baht**	**%**	**Million baht**	**%**
crude palm oil	353	84.25	588	87.63	541	84.80
Palm kernel oil	48	11.69	61	9.09	74	11.60
Others	17	4.06	22	3.28	23	3.60
Total of distribute	**419**	**100.00**	**671**	**100.00**	**638**	**100.00**

Feedstock sources of both mills

Although the principle set-up of the feedstock supply chain is identical with regard to types of smallholders involved, the two mills have a very different supply structure with regard to control over their supply, as shown in the chart below:

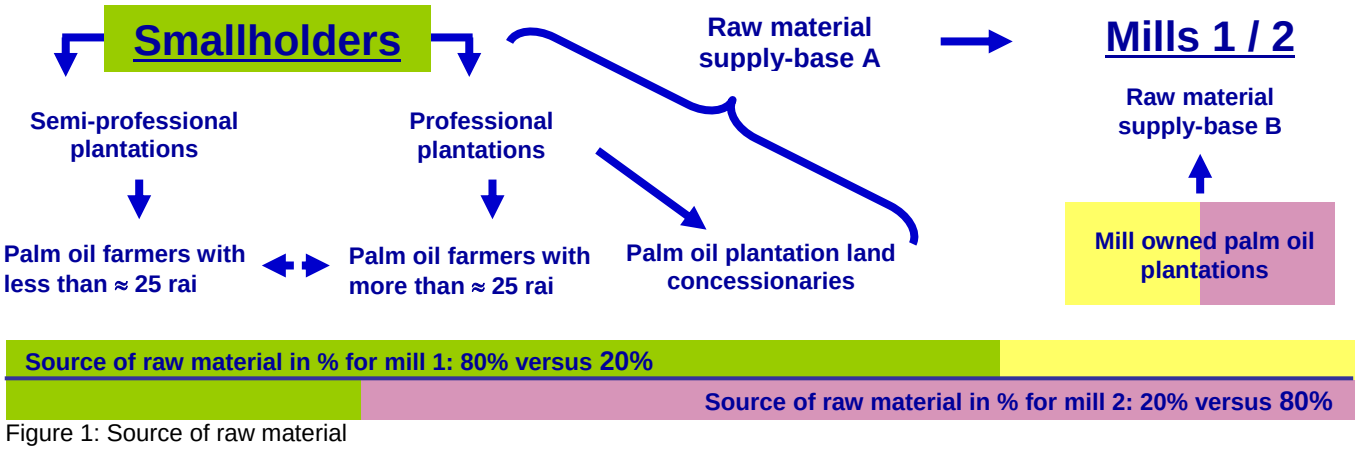


Figure 1: Source of raw material

3.2 Smallholders

The supply chain of the palm-oil mills consists of a number of smallholders that all contribute to the mills' feedstock. In line with the feedstock supply chain the following smallholders were asked to participate in the study. (Graph 1, below, gives an overview on the structure of the supply chain.):

- Plantation workers, i.e. legal and illegal migration workers from Myanmar, as well as Thai migration workers acting as small seasonal service providers (groups of skilled laborers). Representatives of these groups were chosen at random while visiting the other smallholders described below.
- Independent Thai farmers. Altogether ten small farmers, five for each of the feedstock supply chains of the two mills, were asked to provide us with data for this study.
- Two plantation land concessionaries, as well as
- Two factory owned plantations also participated.

Table 4: Smallholder plantations

Plantation	Area in Rai	Age of oil-palms
Smallholder 1	10	8
Smallholder 2	13	9
Smallholder 3	15	10
Smallholder 4	20	3,9
Smallholder 5	25	3,5
Smallholder 6	32	7
Smallholder 7	52	6
Smallholder 8	80	15
Smallholder 9	110	5
Smallholder 10	400	19-20
Smallholder 11	600	9,15,16
Smallholder 12	2,500	23
Smallholder 13	8,000	25-30
Smallholder 14	13,000	6-10

- Two feedstock middle-men (Thai: laan the) and independent service providers were interviewed for *control- and comparison data only*, as they potentially collect feedstock from an unlimited number of sources and from as far as 150 kilometers away and only occasionally contribute to the mills' feedstock supply chain.

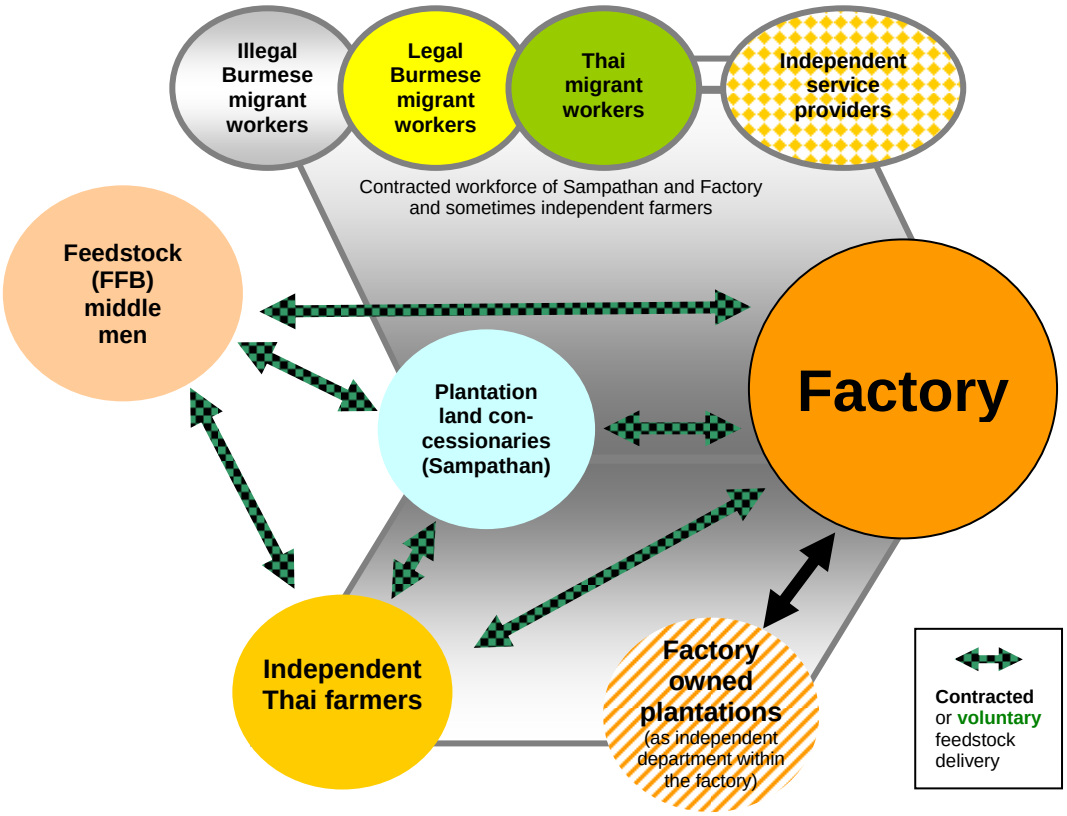


Figure 2: Structural relationship of stakeholders

3.3 Plantation

3.3.1 Methods of plantation and fertilizer cycles

Palm oil plantations in the target area normally follow the same pattern in their plantations, which are:

- Prepare new plantations:
  - 2 plowing cycles within one month
  - Prepare holes to plant saplings
  - Fill the whole with about 2 kilograms of fertilizer (0-3-0)
  - Plant the saplings (about 22 trees per rai/138 trees per hectare)
  - Watering through rainfall
- Maintaining plantations:
  - Fertilizer; mostly oil-based chemical fertilizer (between 1 and 4 times/year) and some plantations add biological fertilizer once a year
  - Weeding through mechanical and chemical devices
  - Pruning (palm fronds) once a year
- Harvests (after 3-4 years of planting the saplings):
  - Harvesting in 15-20 days cycles throughout the year with peak-season from March to May
  - Transport palm fruits to factories

- Replanting of new palm trees after approximately after 20 years of harvests
  - Uprooting of old trees by back-hoe or tractor
  - Cutting the uprooted trees into smaller pieces
  - Plow the pieces under
  - Enter normal planting cycle (see above)

The table below shows frequency and amounts of fertilizer per ton of yield and area of plantation. Those farmers/plantations that also use biological fertilizer do so to improve their soil quality and thus a better effectiveness of their industrial fertilizer. Biological fertilizer normally consists of manure and/or compost; when available cut palm-fronds, empty fruit bunches (less often) or plowed under pieces of palm trunk are added to improve soil quality. Some smaller plantations keep local pork (a cross breed of wild boar and pork) in their plantations to provide natural fertilizer. However the extent is limited, as the animals eat all the loose palm oil seeds that can normally be sold per kilogram. Besides, unchecked populations easily and always damage the roots of the palm-trees through digging and basking habits in the long run. Larger plantations therefore never use this source of natural fertilizer.

Table 5: Frequency of fertilizer use

Plantation	**Tilling/land preparation (times/year)**		**Amount Kg/ton of yield**		**Amount Kg/rai**	
	Chemical fertilizer	Biological fertilizer	Chemical fertilizer	Biological fertilizer	Chemical fertilizer	Biological fertilizer
Smallholder 1	4	1	2	20	44	440
Smallholder 2	2	1	3	3	66	66
Smallholder 3	1	1	2	2	44	44
Smallholder 4	3	-	9	-	198	-
Smallholder 5	1	-	5	-	110	-
Smallholder 6	3	-	4	-	88	-
Smallholder 7	2	1	2	20	44	440
Smallholder 8	2	1	2	2	44	44
Smallholder 9	2	-	3	-	66	-
Smallholder 10	3	-	3	-	66	-
Smallholder 11	1	sometimes	2	-	44	-
Smallholder 12	2	sometimes	3	-	66	-
Smallholder 13	1	sometimes	4	-	88	-
Smallholder 14	1	sometimes	7.2	-	158	-

3.3.2 Herbicide / Pesticides and Bio-pesticides / herbicides

The use of herbicides and pesticides can be described with two typical approaches. The first one represents smaller plantations. These do not use chemical pesticides but instead resort to solely birds of prey (barn-owl) for the first 3 years after planting to control rodent population and after that support the birds with mouse and rat-traps, sometimes protective netting. Weeds are fought by mowing areas between the trees and intensive weeding around the tree base. Some smallholders use chemical herbicides in small quantities as a supportive measure to weeding. The work of weeding is regularly outsourced to service providers.

The second group consists of the land concessionaries or factory run plantations. Here the approach to chemical pesticides and herbicides is somewhat different due to the extent of the plantations. The main tool to combat weeds is the use of herbicides. Only one large smallholder uses mowing as an additional tool in weed control. Concerning pesticides, rodent population is

controlled through chemicals in the first three years after planting of palm-trees. As the poison has a direct negative effect on the yield, pesticide use is abandoned after that to be replaced by barn-owls, traps and netting. Other pests than rodents are very rare which was attributed by the interviewees to the relative good soil quality in their plantations.

Table 6: Use of pesticides and herbicides

Plantation	Barn-Owl for rodent control	Land preparation (times/year)			Amount in kg, liters or gallon (=3.785 liters)		
		mowing	herbicide	Pesticide (first 3 years of planting, only)	Petrol in liters (mowers)	Herbicide (in gallon,)	Pesticide (kg/rai/year - first 3 years of planting, only)
Smallholder 1	x	1	1		4	1	
Smallholder 2	x	1	-		18	-	
Smallholder 3	x	1	-		15	-	
Smallholder 4	x	1	-		50	-	
Smallholder 5	x	2	1		50	1	
Smallholder 6	x	2	-		60	-	
Smallholder 7	x	2	1		18	12	
Smallholder 8	x	-	1		-	13	
Smallholder 9	x	-	1		-	15	
Smallholder 10	x	1	1		Outsourced service (350 baht/rai)	8	
Smallholder 11	x	-	1	12	-	25	6.6
Smallholder 12	x	-	1	12	-	100	6.6
Smallholder 13	x	1	1	12	Outsourced service (12 baht/tree)	5	6.6
Smallholder 14	x	-	1	12	-	250	6.6

3.3.3 Land-ownership

Most plantations own their land outright. However, the Thai land-title regulations are rather complex and offer a wide variety of land-ownership, which makes the distinction between owned and long-term rental land sometimes difficult. The table below gives a short overview on the different land-title deeds issued in Thailand.

Table 7: Land title deeds in Thailand

Land-title	Unrestricted / Selling buying	Land has to be put to use	Registered ownership	Ownership can be applied for	Can be inherited	Can be borrowed against	Can be mortgaged	Officially registered land markers	Can apply for whole ownership	Land-users can initiate ownership process
Wholly owned	X	X	X	X	X	X	X	X		
NoSo 3 ko	X	X	X	X	X			X	X	
NoSo 3		X	X	X						
SoPoKo		X	X		X			X		
NoSo 2		X	X		X			X	X	X
SoKo 1		X		X				X	X	X
NoSo 5		X	X	X	X			X		

Most rental land available to plantations is land from the forestry department of the Thai Ministry for Agriculture and Cooperatives and is mostly rented out to land-brokers, the so-called Sampathan

(land concessionaries) or the mills directly. The amount of land in rai (0.16 hectare) rented out by the forestry department in the provinces of Krabi and Surat Thani was not revealed to this study by the relevant departments. Reasons given were mostly difficult access to the data, as they were centrally administered in BKK and one would have to obtain permission from there. The land-ownership status of participating smallholders is as follows:

Table 8: Type of land ownership of participating smallholders

Plantation	Type of land ownership (Land-ownership security decreases from left to right: Chanod = wholly owned, SoPoKo = simple land-use right)							Rented land
	Chanod	NoSo 3 Ko	NoSo 3	NoSo 5	NoSo 2	SoKo1	SoPoKo	
Smallholder 1	X							
Smallholder 2	X							
Smallholder 3	X							
Smallholder 4	X							
Smallholder 5	X							
Smallholder 6	X		X				X	
Smallholder 7	X							
Smallholder 8	X		X					
Smallholder 9	X							
Smallholder 10			X				X	
Smallholder 11			X					
Smallholder 12			X					X
Smallholder 13			X			X		X
Smallholder 14			X				X	X

3.3.4 Land-use and land-infringement / encroachment

The land-use in Krabi and Surat Thani Province is relatively diverse with a number of agricultural activities. However, palm-oil production is the largest agricultural sub-sector in both provinces (see tables below). There is still unused land, mostly in the form of fallow lands or forests. Some small areas are still in their original forest cover, while most forest land has been used and disturbed more or less extensively in the past and some areas are classified as degraded forest lands, outright. The degraded forest lands are rented out to concessionaries by the forestry department.

Table 9 : Land use in Southern Thai Provinces

Province	Residential area (rai)	Paddy land (rai)	Upland field crop (rai)	Land under fruit tree and tree crop (rai)	Land under vegetable and ornamental plant (rai)	Pasture land (rai)	Waste land (rai)	Miscellaneous land (rai)	Total land (rai)
Krabi	18,473	58,318	-	1,149,136	1,207	2,320	14,873	4,519	1,248,846
Surat Thani	97,530	158,955	2,764	2,307,973	10,580	13,729	47,691	82,440	2,721,662
Chumphon	56,442	128,084	24,903	1,634,921	21,728	5,447	7,239	42,124	1,920,888
Phangnga	13,758	11,181	-	807,699	-	2,839	2,880	2,757	841,114
Trang	30,836	67,553	-	1,362,461	2,343	2,974	12,939	17,837	1,496,943
Songkhla	58,039	407,718	3,738	1,517,780	16,220	5,745	64,293	59,380	2,132,913
Patthalung	51,208	395,193	3,024	683,436	14,530	13,821	10,756	47,317	1,219,285
Nakorn si thammarat	90,175	848,928	10,048	1,697,423	31,538	35,913	91,574	225,467	3,031,066
Satul	13,977	84,822	-	439,619	5,826	10,075	7,027	18,965	580,311
Yala	20,555	65,231	-	1,082,065	-	2,953	14,824	8,060	1,193,688
Narathiwat	26,821	109,337	-	1,210,720	7,577	13,397	13,045	7,554	1,388,451
Pattani	38,236	184,095	1,792	509,263	4,676	12,257	3,074	6,383	759,775
Phuket	1,054	1,314	-	131,464	376	2,207	-	2,698	139,113
Ranong	8,617	23,913	-	412,806	1,584	1,576	16,773	6,036	471,305

Concerning land-use the study found a number of contentious issues. One worrisome trend is the increasing replacement of rubber plantations with oil palm plantations. Another issue is that some smallholders were unable to hold onto their rented land after the expiration of their first contract period. Another problem issue is the strong recent increase in land prices. Both issues are linked to on-going land-infringement.

- Palm replacing rubber

The profit per rai of rubber plantation has over the years fallen considerably when compared to the profit per rai of oil palm plantation[1]. In addition, rubber is much more labor intensive than palm oil. As a result, more and more rubber plantations are replaced with oil palm, impacting positively on the price of rubber, but aggravating the temporary situations of oversupply of palm-oil fruit during the peak-season of March to May. With an increase of oil palm plantations, some participants were worried that the period of oversupply might extend into other months and the overall value of their crop might deteriorate.

Table 10: Area of Palm Oil Plantation

Province (data 2007 and 2008)	Estimated area of plantation (rai)	Estimated Palm Fruit production (tons/year)
Krabi	834,437	2,049,589
Surat Thani	832,285	1,770,157
Chumphon	693,622	1,356,638
Nakorn si thammarat	117,164	132,198
Prachuap Khiri Khan	103,142	149,290
Trang	102,064	207,942
Satul	95,782	148,681
Phangnga	89,531	170,644
Ranong	63,923	107,402
Narathiwat	35,830	31,714
Songkhla	19,588	37,052
Patthalung	8,894	4,347
Pattani	7,686	-
Yala	4,732	1,439
Phuket	1,133	1,421

- Rental land

Some participants have invested in rented land under a concession contract of 15 years with the forestry department. When their concessions were up for renewal, the forestry department refused to extend the contracts. Instead they distributed the land – in this case 20,000 rai of oil palm plantation - to poor or landless Thai farmers, to freely use, but not own lots measuring 8 rai or 1.28 hectares/family. For the former concessionary the loss in investment is considerable, as oil palm carries fruit from the 3rd or 4th year until it reaches 25 years of age. Thus, the time for the return of investment was cut from a maximum of 22 years to just 12 years. The remaining 10 years of potential harvest would now go to the new users who were given the land.

If the landless poor were interested in continuing the plantation, they would now face another problem: the minimum size of a profitable plantation is by all participating smallholders estimated at being at least 25 rai (4 hectares). With only 8 rai available to the new holders of the land, they would probably have to cut down part of the plantation to make room for additional non palm-oil related farming activity in order to support their family on the given land; alternately, they might sell their land, which is in fact a miniature oil-palm plantation, to the highest bidder and look to move and purchase land elsewhere.

- Increase in land prices

Due to the strong increase in demand for palm-oil over recent years, the income of the sub-sector has increased considerably. The result is an increase in land demand for plantations. As the available land for new plantations is limited infringement on other types of land is increasing.

[1] On average between 1500 to 2000 more per rai for palm oil in August 2008

Occurrences of wrongfully issued land title deeds or other related problems have been reported by all participating smallholders. Typically two title-deeds would be issued for the same area or would cover overlapping areas of land. Some smallholders fear that they one day might face a competing claim to the land that they have cultivated for almost a generation. The pressure on land prices is such that many sell their small plots now to start anew in another province, were land is still relatively cheap. According to the smallholders, the province currently facing the most pressure on land-acquisition for new plantations is Chumphon Province.

3.3.5 Land and soil conditions, land erosion

Table 11: General soil conditions in Krabi and Surat Thani Oil-Palm Orchards

Province	Soil layer	pH	EC 1.5	Organic material %	P %	K %	CA %	MG %
Krabi	Top-soil	4.95	0.04	1.71	34	123	275	58
	Lower soil	4.64	0.03	1.54	3	60	189	38
Surat Thani	Top-soil	4.79	0.05	1.62	6	104	437	67
	Lower soil	4.54	0.04	0.61	3	70	318	56

The soil conditions in the Thai Oil-Palm orchards are surprisingly similar throughout Southern Thailand. A table of average soil conditions is given below. No data was made available to the study on the impact of the oil palm plantations on the soil conditions. None of the participants had invested in a soil analysis of their plantations, as they 'would have to use fertilizer anyway'. However, while using chemical fertilizers soil conditions can be expected to deteriorate over time, as bio-organisms in the soil are affected by the salinity of the chemicals. In consequence the soil is compressed in on itself to the lack of soil loosing activities of small organisms in the soil. This in fact is acknowledged by some plantations and they add organic fertilizer to their orchards once a year (see also next chapter). Land erosion occurs frequently in sloping areas due to changes in the soil composition, removal of soil covering vegetation and inappropriate tree planting techniques. However, some smallholders reported on investigating new planting techniques for the second generation of oil-palm.

3.3.6 Working and living conditions, income

Working and living conditions at the plantations vary considerably, depending on skill and extent of employment. The tables below show the main different types of workers on the plantation as well

Table 12: Worker on Plantation

Type of worker	Origin of migration			Time		Approximate salaries (Baht/month)
	Local	Northeast of Thailand	Myanmar	Short term	Long term	
Unskilled hand; mostly young (various educational degrees) people to help wherever and whenever needed	x	x	X	x	x	Job by job
Skilled laborer; all ages with educational background and experience in the field of oil-palm plantation	X	X		X		30,000-50,000
Dependent contract worker; all ages with experience in the daily running of oil-palm plantations		X	X	X	X	5,000-9,000
Service provider; groups of laborers that provide specialized skills packaged in services, for example pruning		X		X		8,000-12,000
Seasonal worker additional local work-force for peak-seasons	X			X		8,000-10,000

as the working and living conditions for each member of the feedstock supply chain. Most of the workforce is not recruited locally. Within the fourteen smallholders' plantation about 90% of the employed work force consisted of dependent contract workers. The remaining 10% were skilled laborers or service providers. Seasonal workers needed for the high season between March and May are recruited locally, only. Most of the dependent contract workers will either bring or found a family while at their plantation. However, social services are mostly limited to the workers themselves and not extended to their families.

Table 13: Different social benefits available

Type of worker	Social insurance	Scholar-ship	Quality worker life (QWL)	First aid	Lodging	Electric city (50 free units)	Water tab	Trans-portation within the plantation	Trans-portation outside of the plantation
Unskilled hand			X						
Skilled laborer	X	X	X	X	X	X	X	X	X
Dependent contract worker	X		X	X				X	
Service provider	X		X	X					
Seasonal worker			X						

The study estimates that about 85% of the workers at the smallholders were from the Northeast, while the remaining 15% were from Myanmar. (This per-cent distribution can change drastically when compared to provinces bordering onto Myanmar. Smallholders estimated that here the percentage of Myanmar workers can be up 50% in some cases.) Conditions for migrant workers are difficult, as they are transported into a different cultural setting (even within Thailand) with a different Thai dialect and festivities.

Housing facilities provided for are normally designed for one to two persons and are appropriate in layout and design. However, as most immigrant workers have to take care of a family, living conditions get crowded very quickly. As a solution most rent their own spaces outside of the provided living quarters, thus increasing their cost of living. A minority tend to build their own dwellings, normally thatched shacks, also at their own costs. This happens mostly in cases where workers are entrusted with the care-taking of outlying plantation areas. In some cases this has consequences for children of migrant workers, as their access to education is restricted.

Contract workers are also in constant search of work, as in most cases their employment is limited in time and restricted to a single goal or duty in the plantation. This is a considerable disadvantage as they have no truly fixed income and social benefits guaranteed to fully employed staff are not available to them. The chances to ever attain the status of full employment are very slim even after continued contractual work for the same plantation owner over many years, as it is available to only about 5 % of all personnel employed at the plantation.

Table 14: Average income of smallholders

Plantation	Area in Rai	Age of oil-palms	Yield Ton/rai/ harvest	Income (baht/rai)
Smallholder 1	10	8	3	18,000
Smallholder 2	13	9	3 ton//13rai	1,385
Smallholder 3	15	10	3	18,000
Smallholder 4	20	3,9	10 ton//20rai	3,000
Smallholder 5	25	3,5	4 ton /25rai	1,500
Smallholder 6	32	7	4	24,000
Smallholder 7	52	6	6	36,000
Smallholder 8	80	15	4	24,000
Smallholder 9	110	5	4	24,000
Smallholder 10	400	19-20	1	6,000
Smallholder 11	600	9,15,16	2	12,000
Smallholder 12	2,500	23	3	18,000
Smallholder 13	8,000	25-30	4	24,000
Smallholder 14	13,000	6-10	3	18,000

The smallholders can be separated into two major types of plantation, which are full-time palm oil plantations on the one hand with a minimum of 24 rai (3.84 hectares) of plantation; and on the other hand smaller plantations that are managed out of offices via telephone and on week-ends, where owners have other full-time jobs and use palm oil as a source of additional income. As a general tendency it can be said that the former plantations are much better managed and maintained, while the latter ones are maintained with very little regard to the yield/rai. However, the study found exemptions where the opposite was true and high yields were achieved on small areas and low yields on larger areas (see table above). Thus the income scale for plantations can vary considerably.

3.3.7 Use of wastes

Palm fronds from pruning are used as bio-fertilizer through natural composting in the plantations. Old trees are also use as bio-fertilizer, however, there are cut into smaller sections and then simply ploughed under during the preparation for planting new saplings, or the cut pieces are left above soil and distributed between fruit-bearing trees and simply left to rot in the open.

Empty fruit bunches (EFB) are also used as natural fertilizer and are transported from the mills to their plantations by ten-wheeler. Smallholders have to by EFB from the mills at the cost of 700-800 Baht per ten-wheeler. A PPP project to introduce EFB dehydration in order to facilitate co-generation has been initiated by GTZ in Thailand. Some of the contract workers in the plantations use EFB for mushroom cultivation, especially if the plantation is located within reach of open water, as the cultivation depends on a moist environment throughout the year.

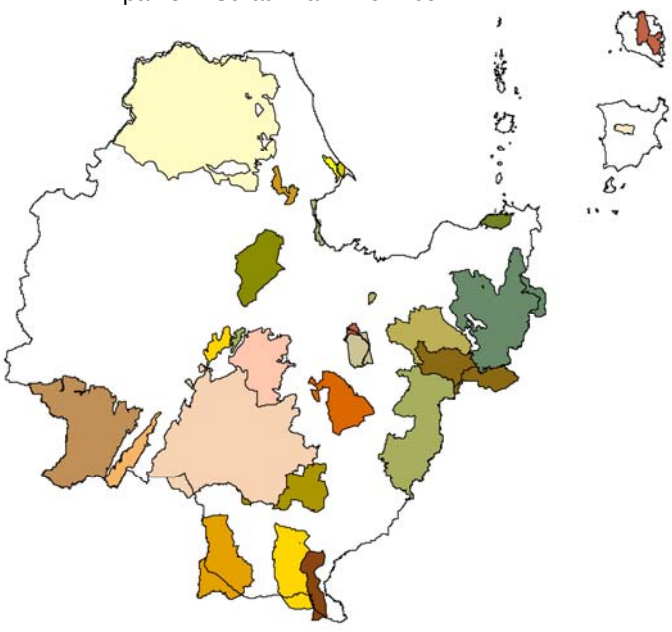
Waste-water is as much as possible brought back into surrounding plantations via pipes as fertilizer. Shells, fibers and decanter cakes, i.e. bio-mass from the CPO production process, are used for co-generation, bio-gas plants, animal feed and fertilizer.

3.4 Environmental impact

3.4.1 Background information

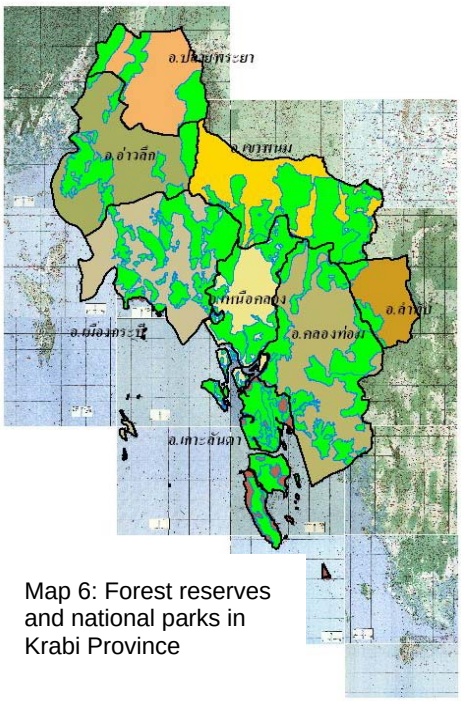
Surat Thani Province has a total land area of 8,057,168 rai (1,289,146.88 hectares) of which 6,262,089 rai of land (1,001,934.24 hectares) are forest cover, including national parks. According to the provincial administrative organization (PAO) 1,881,875 rai (301,100 hectares) or 30.05% of the province's land area are covered in healthy forests and 40,098 rai (6,415.68 hectares) are mangrove forests. The provincial government has classified the remaining forest area of 4,340,116 rai (694,418.56 hectares) as degraded.

Map 5: Forest reserves and national parks in Surat Thani Province



In comparison, Krabi has a total land area of 2,942,820 rai (470,851.2 hectares) with 45 forestry reserves on 1,415,952 rai of land (226,552.32 hectares), including national parks. According to the provincial administrative organization (PAO) 544,444 rai (87,111.04 hectares) or 18.50% of the provinces land area are covered in healthy forests and 218,216 (34,914.56 hectares) rai are mangrove forests. The provincial government has classified the remaining forest area of 653,290 as degraded.

The classification of a combined area of 4,993,406 rai (798,944.96 hectares) as degraded forest in both provinces means that this forest can be leased out to interested parties from the forestry department for agricultural use. Following the Thai land-title deed regulations (see chapter 3.3.3) this designated degraded forest can potentially become private property if the land-leaser/user follows the process steps of registration.



Map 6: Forest reserves and national parks in Krabi Province

3.4.2 Impact of fertilizers

As elaborated in the previous chapter 3.3 two types of fertilizer are used in the oil-palm plantations, chemical fertilizer and biological fertilizer. The latter is produced locally but only available in limited amounts that can be composted from bio-wastes on the plantation. The empty fruit bunches (EFB), however, are purchased with the palm seeds by the mills and are therefore not available to the plantations (see also chapter 3.8 on life-cycles).

Thus the current system of using chemical fertilizers represents one of convenience and routine. Impact on the local environment has not been observed by the target group. Nonetheless, the fact that many plantations use biological fertilizers to 'improve their soil quality' indicates that palm-oil plantations are no exception in the negative impact of prolonged use of chemical fertilizers:

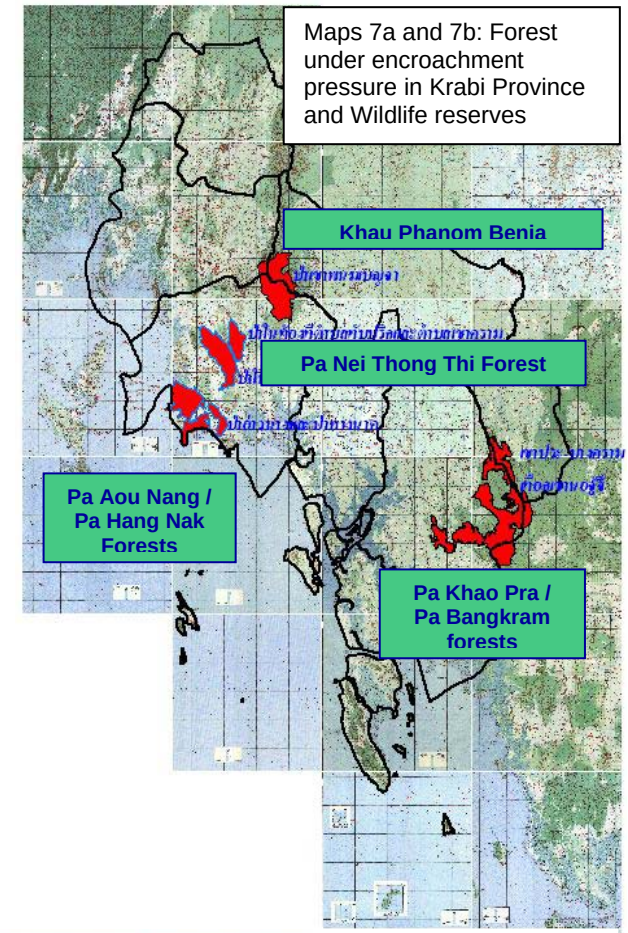
- Small organisms in the top-soil get killed, which
- Reduces the amount of fertilizer produced naturally, which
- Increases the need to use more fertilizer, which enhances the cycle of diminishing soil quality and in the end leads to the compacting of the top soil.

Once this effect sets in, up to 50% of the fertilizer will be washed away by rainwater, because it cannot permeate the soils any longer to get to the roots of the oil palms. At this stage a direct effect will be measurable in streams and rivers which will be flooded with fertilizer run-off. Along streams and rivers this contributes to a poorer overall bio-diversity of plants and especially smaller organisms and animals. This affect has indeed been observed by the study team in both provinces.

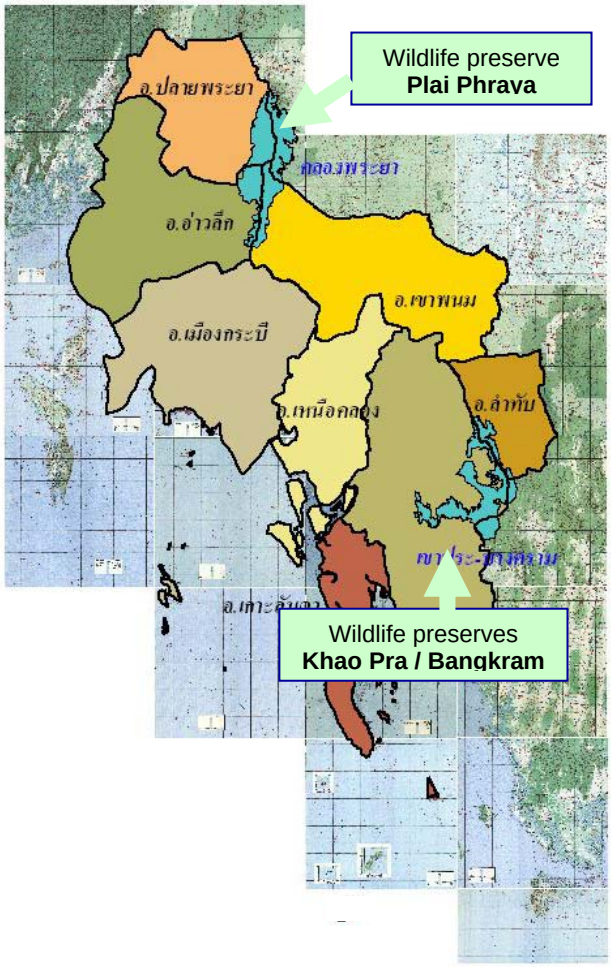
3.4.3 Impact Pesticides/Bio-pesticides

The impact of pesticides and herbicides is even less pronounced than the impact of chemical fertilizer, as plantations use them relatively sparingly. The overall problem here is rather that also in combination with biological pesticides and herbicides the tendency is to create large areas of mono-culture that tend to destroy bio-diversity.

3.4.4 Irrigation and impact on water-table



Maps 7a and 7b: Forest under encroachment pressure in Krabi Province and Wildlife reserves



During the first three to four years of after planting, an oil-palm needs on average approximately 300 liters of water/day. After that the overall amount decreases somewhat, but none of the participants of the study was able to provide us with clear amount. If we calculate an average of 250 liters/tree/day, a typical plantation is in need of 5,500 liters or 5.5 hectoliters of water/day/ray. This amount of water is high, but local rainfall and groundwater levels reaching to the tree roots are sufficient to water the plantation. In none of the participating smallholders did we find any irrigation systems. However, this does not mean that there is no impact on the water table.

Although participants reported no impact, our team was able to observe that areas close to streams were used for mushroom cultivation based on irrigation from local open water sources. During the field visitations in **the rainy season** quite a few bridges were running over almost dried out ditches or small streams. The study team's GPS often referred to streams that had disappeared and were completely taken over by vegetation. The study's conclusion is that the water table is getting lower, probably due to 2 reasons:

Table 15: Total number of occurrences of forest encroachment in Krabi Province in 2006

8 Districts concerned	38 sub-districts concerned	88 communities concerned
Krabi City	8	25
Khlong Tom	7	12
Kao Phanom	4	8
Nuea Khlong	4	7
Ko Lanta	3	5
Lamthap	2	5
Aou Luek	6	11
Plai Phraya	4	15

- An increased hardening of top soil that makes it more difficult for rain water to permeate into ground water bearing layers.

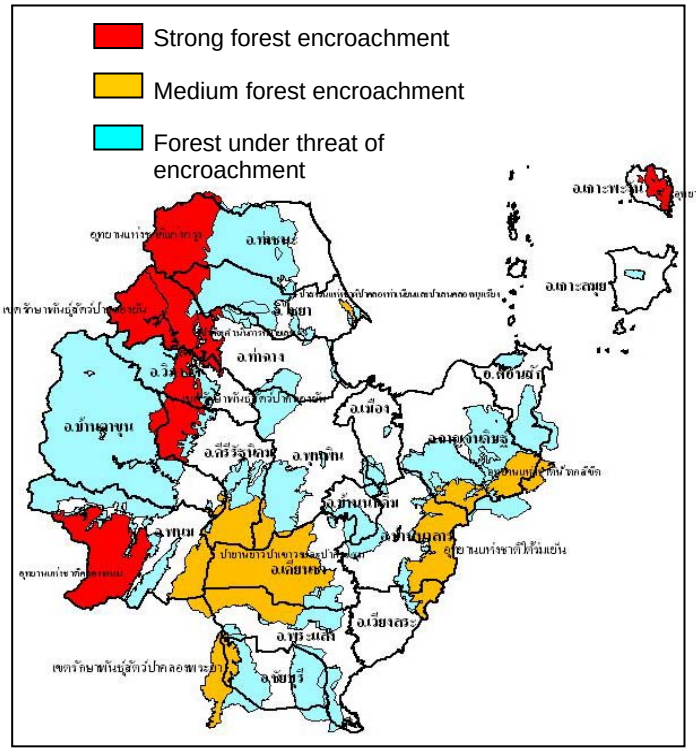
- A heightened rain water run-off in the plantations due to the same hardened top soil and thus less time for the vegetation to absorb water after rainfalls, which then has to depend more on groundwater.

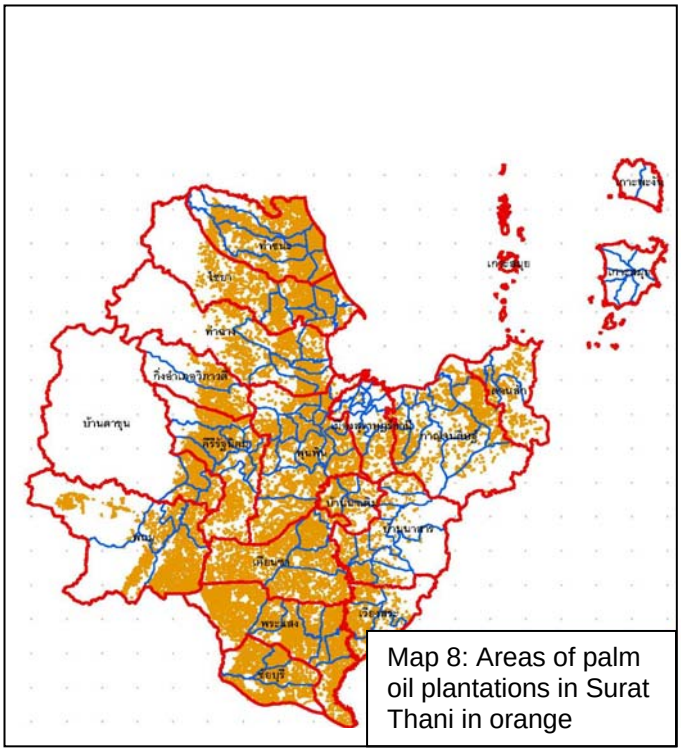
3.4.5 Impact on forests / bio-diversity

Although not directly observed within our target group, it was acknowledged that the impact of palm oil production on forests in the two provinces is considerable due to encroachment. Maps in this chapter show the pressure that is created by the expansion into forests and wildlife reserves.

Krabi, for example has documented the cases of known forest encroachment in the year 2006. Altogether 88 communities were affected. The number is probably higher. Forest encroachment is also a direct threat to protected wildlife, as the instances of encroachment in wild life preserves show. Krabi and Surat Thani share boundaries at the Plai Phraya wildlife preserve. The park is altogether 95,988 rai (15,358.08 hectares) in extent, of which 59,988 rai are located in Krabi and 36,000 rai in Surat Thani. A second preserve in Khao Pra / Bangkram extends over 139,688 rai (22,350.08 hectares) of which 17,500 rai extend into neighboring Trang Province.

Both preserves are under acute threat of encroachment. One of the reasons for the encroachment is the forest administration structure and its forest classification system into different types of forest. There are the so-called healthy forests, which often constitute core areas of national parks and there are forest reserves consisting of agricultural, community, and degraded forests. The latter types are forests open to use by the population. Agricultural forests can be sustainably harvested for forest products (mushrooms, bamboo shoots, herbs, etc.), community forests are open to sustainable use by adjoining communities and degraded forests are forest areas rented out for agricultural purposes.





Map 8: Areas of palm oil plantations in Surat Thani in orange

Especially the legal framework on degraded forests are at the root of pressure on forests in general, not only because degraded forests can be cut down to be replaced by agricultural monocultures, but also because they can be legally owned with land-title deeds, if proper application procedures are followed. Even though they might be initially in a ‘degraded condition’,

they are still at least partially intact provide local population with some base resources. Thus they can act as a buffer zone between agricultural land and its habitation and other healthier forest types. Once they are turned into monocultures the local communal resource base decreases and temporary infringement on healthy forests becomes common place and later turns easily into encroachment.

3.5 Supply chains

3.5.1 Structure of supply / Management practices & structures

Mill 1 is supplied by smallholders 1, 2, 6, 7, 8, 11 and 13, the latter one being the mill's own plantation. The factory itself is one of the earliest palm-oil mills established in the South, long before Palm oil became a major industry in the area. This is the reason that the mill is located very close to the city but relatively far way from the plantations of its supply base.

Table 16 : Structure of supply

Mill	Through-put capacity (ton/hour)	Source of raw material	
		Smallholder	Estate
Mill 1	45	80%	20%
Mill 2	60	20%	80%

Most of the mill's raw material is supplied by independent contractors and farmers (≈ 80%). The mill has no plantations in its vicinity which increases its raw material transportation cost considerably. Another draw back to its current location is the relatively dense traffic. This has many independent plantations decide against delivery to this mill due to the extra time and fuel costs for traffic congestion. The mill can off-set the disadvantage of its location only through offering a higher factory gate raw material price. It is also forced to accept qualitatively inferior feedstock due to these disadvantages. Thus, plans are considered to relocate the mill in the future to a more cost-effective location.

Mill 2 is supplied by smallholders 3, 4, 5, 9, 10, 12 and 14, the latter one being the mill's own plantation. The location of the mill is in the center of a large area dedicated to oil-palm plantations and right next to a central transportation lane for fruit-bunches in and out of the area and linking two districts. The mill grows or controls ≈80 % of its raw material and only ≈20% are from independent farmers. Thus, this mill is in a very good position to introduce measures improving yields in its plantations. It has also more leverage to make outside raw material suppliers perform to the standards set by the factory concerning plantations and superiority of feedstock quality.

Table 17 : Supplied Mill

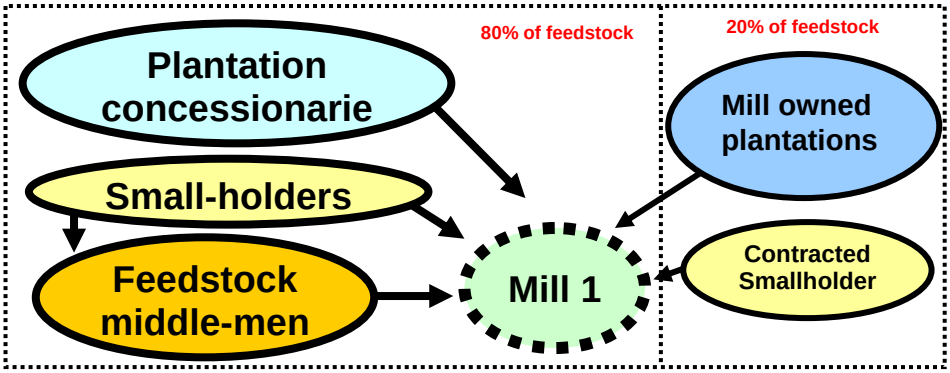
Mill 1		Mill 2	
Smallholder	Area	Smallholder	Area
Smallholder 1	10 rai / 1.61 ha	Smallholder 3	15 rai / 2.41 ha
Smallholder 2	13 rai / 2.09 ha	Smallholder 4	20 rai / 3.22 ha
Smallholder 6	32 rai / 5.16 ha	Smallholder 5	25 rai / 4.03 ha
Smallholder 7	52 rai / 8.38 ha	Smallholder 9	110 rai / 17.74 ha
Smallholder 8	80 rai / 12.90 ha	Smallholder 10	400 rai / 64.51 ha
Smallholder 11	600 rai / 96.77 ha	Smallholder 12	2,500 rai / 403.22 ha
Smallholder 13	8,000 rai / 1,290.32 ha	Smallholder 14	13,000 rai / 2,096.77 ha

Raw material or supply-base management practices in the two mills are as follows:

Mill 1 has regular plantation controls only in the mill owned plantations. FFB are controlled for quality at the collection point within the mill. Within the factory plantations trees are managed in line with a tree management plan giving time-lines for activities in the plantation and how to use bio-

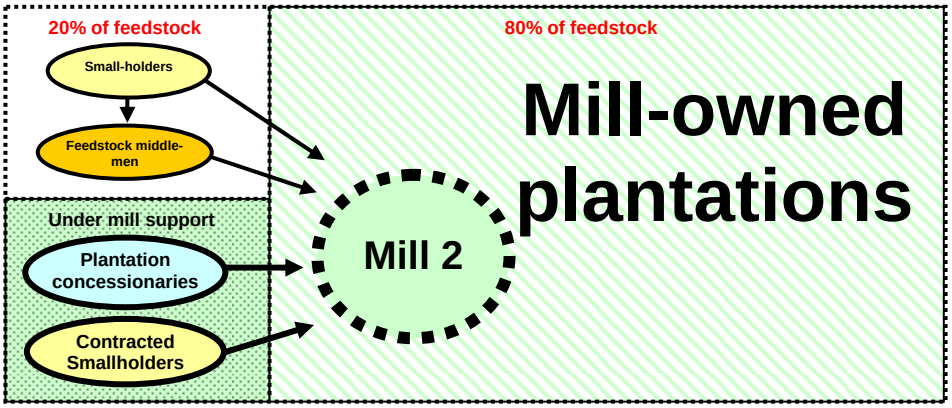
waste. There is a harvesting training for the plantation employees detailing assessment of ripeness and method of harvesting. The training results are sporadically audited by a mill employee. There are no other trainings available for employees in the mill owned plantations.

Figure 3: Mill Feedstock



Regarding raw-material not from mill plantations, a responsible management team follows up via telephone on availability of raw material with smallholders known to the factory to guarantee sufficient supplies on a day to day basis. There are no checks on standard application on raw material delivered from outside of factory plantations. The main focus is to get as much raw material as possible, which is checked at the factory gate for weight of delivery. At the FFB collection point a mill employee assesses and grades the raw material for pricing. There is no responsible mill liaison officer to regularly contact known farmers on other issues besides availability of FFB. The only training provided by the mill to smallholders is an oil palm planting training whenever farmers buy saplings from the mill to make or extend plantations. These saplings are provided by government or affiliated agencies.

Figure 4: Mill – owned Plantations



All plantations of **mill 2** are lead by responsible officers who are knowledgeable in management, planting, maintenance and harvest. So all FFB brought to the mill from its own plantations are grown to a common standard in line with mill specifications. On the plantations two main groups of personnel share responsibilities; the first one is responsible for fertilizers, herbicides and pesticides and harvests and receives regular trainings in line with mill requirements and specifications. The second one is the group of temporary contract workers that take care of plantation maintenance, for example pruning and weeding. As no specific skills are need for these activities, a special training is not provided.

Raw material from other sources than the mill's plantations is produced under different standards which are suitable for the small holders, but at the same time are still acceptable for the mill. There is a tightly controlled policy in place at the mill to reward a small holder's raw material supply that is in line with factory standards and expectation of FFB quality with a better price for their product at the factory gate.

To enforce this policy, there is a knowledgeable liaison and extension office in place at the factory which oversees regular contact with the farmers and documents in detail their supply history. The altogether eight personnel regular visit their most trusted and reliable (independent) suppliers and are at hand with expert advice on oil-palm issues ranging from planting to harvest. The extension team is also responsible for the control and purchase of raw material from smallholders. Although there is no official and regular training for smallholders delivering to the mill, the mill provides cost free opportunities to interested farmer and community groups to visit mill plantations and to demonstrate at the site their methods and best practices.

3.5.2 Competition between mills and feedstock middle men

No mill can actually refuse FFB that are brought to their gates; even at times of oversupply this is difficult, simply because the smallholders might not send their products to this particular mill in the future. And as FFB are in high demand the prospect of having to accept some low grade raw material is better than the prospect of potentially loosing a future supplier.

Table 18 : Deteriorating oil-content over time and condition

Time	**Oil content**					
	Ripe loose fruit	Ripe FFB fruit	Almost ripe FFB fruit	Green (unripe) FFB fruit	Overripe FFB fruit	Watered FFB
1 day to factory gate	21.6	18.6	18.03	16.32	17.08	11
2 days to factory gate	21.5	18.5	17.93	16.22	16.98	10.9
3 days to factory gate	21.4	18.4	17.83	16.12	16.88	10.8
More than 3 days	20.6	17.6	17.03	15.32	16.08	10

Knowing this, the feedstock middle men erect FFB collection points within the plantation heartlands. The farmers sending their raw material there get the same or a little less than they would get at the factory gate, but save a lot of transportation cost. The collection points themselves use big 10 wheeler trucks that can transport up to 40 tons (with trailer) at a time, thus keeping their advantage of lower transportation cost. This however is not sufficient to make a decent profit.

Most middle-men, therefore water the collected FFB over night. This increases their weight and gives them a higher price per FFB at the factory gate. For the mills, besides paying for 'water', another ill-effect is that with increased moisture in the FFB, ripe fruits often drop off wet bunches leaving many FFB with a majority of substandard unripe fruit with lower oil content. (The dropped off ripe fruits are subsequently sold for a higher price to the factory as the ripe fruit has a higher oil content). Another draw-back is that over time and with every handling of the FFB, the oil-content of the fruits decreases and the presence of free radicals in the CPO increases.

Mills and middle-men often compete socially for their raw material supply base, i.e. they get actively involved in communal affairs to build moral debts with the smallholders to bring their harvest to them and no other. Another option is to use political clout within the local administrative organizations to induce farmers to send their crops.

Table 19 : Percent of free radicals due to handling

Handling	**Free radicals in %**
Only harvesting and one loading	0.025
Harvest and some re-loading	4.70
Harvesting and many re-loads	15.20
Standard percentage of CPO in comparison	3-5

3.5.3 Supply transport and distances

There are three main support lines to the mills:

1. The smallholders send raw material by themselves
2. Raw material (FFB) middle men deliver to the mill
3. Independent harvesters (local service providers) harvest at plantations and take the raw material to the mills

Table 20: Transport

Plantation	Distance to mill (km)	Transportation	Petrol (liter) (7 km/liter)
Smallholder 1	7	Owner transports himself, Pick-up truck loading 3-4 tons	1
Smallholder 2	2	Owner transports himself, Pick-up truck loading 3-4 tons	0.28
Smallholder 3	10	Owner transports himself, Pick-up truck loading 3-4 tons	1.43
Smallholder 4	200 m	Outsourced harvester	0.03
Smallholder 5	4	Outsourced harvester	0.57
Smallholder 6	5	Outsourced harvester	0.71
Smallholder 7	1	Outsourced harvester	0.14
Smallholder 8	25	Owner transports himself Pick-up truck loading 3-4 tons	3.57
Smallholder 9	16	Owner transports himself Pick-up truck loading 3-4 tons	2.29
Smallholder 10	10	Outsourced harvester	1.43
Smallholder 11	35	Outsourced harvester	5
Smallholder 12	40	Owner transports himself Ten-Wheeler truck loading 15 tons	5.71
Smallholder 13	8	Owner transports himself Ten-Wheeler truck loading 15 tons	1.14
Smallholder 14	50	Owner transports himself Ten-Wheeler truck loading 15 tons	7.14

The distances to the mill are not always the shortest possible. For example, farmers harvest and send their FFB to the nearest mill only if it offers the best price. If there are locally larger price differences offered for FFB by different mills, farmers might choose to transport their raw material over long distances.

Though the decision is – according to our study target group – normally not only based on a cost benefit analysis by the farmer: will the cost and time for the additional transport distance erase the possibly better price at a mill farther away? The price is the overriding concern and decision-maker, but sometimes other considerations might play a role, such as moral or social indebtedness for a favor received from a mill/mill-owner in the past. However, all participants in the study did not report on deliveries to the FFB middle men.

Some factories offer special financial incentives for harvesters to make them deliver their raw material to a specific mill. Both mills of this study have (at least) one officer responsible for contacting all holders of raw material and entice them to bring their FFB especially to their mill.

3.5.4 ISO 9000 0r ISO 14000 compliance / other standards

Mill 1

ISO 9001:2000; the mill is a member of the 'Quality of work life (QWL)' development project

Mill 2

ISO 9001:2000; ISO 14001; the mill is a member of the 'Quality of work life (QWL)' development project; the mill exports kosher CPO to Israel

Supply base

None of the participants of the study was applying any international standards. Some smallholders were producing under local mill defined standards.

3.6 Brokers in the palm-oil sector

Brokers consist of persons or groups of persons that wield special influence in the local area of palm oil production, due to social, political or economic clout. They have access to and can provide all human resources essential for the sector, for example, skilled and unskilled laborers for plantation maintenance and specialists, outsourced services, harvesters, transportation, sales brokerage, etc. as a kind of one-stop-service.

Table 21: Price example for a broker's service:

Harvesting labor cost (Baht/ton)	Loose fruits (Baht/ton)	Broker (Baht/ton)	Total (Baht/ton)
200	**100**	**50**	**350**

Brokers are always very well informed about all plantations in their area and thus are able to provide plantation owners with exactly the services that they need at exactly the right time. Plantations do not have to call; the services are offered at the plantation gates. If an agreement is reached, the broker himself will pick up the agreed upon payment in person and distribute it to his crews at the site after subtracting his own remuneration. For example, a plantation is able to outsource the harvesting process to a broker in its entirety: cutting of FFB, collecting of loose ripe fruit, loading, transportation, FFB price negotiations and actual sales to be visited later by the broker and being paid in line with prior agreements in an open book process.

The office for agriculture in Krabi (สำนักงานเศรษฐกิจการเกษตร) informed us that in 2006 from the total harvest of 1,999,141 tons of FFB about 50%, i.e. 999,570 tons were harvested through the brokerage system at a profit of 49,978,500 Baht. This is a considerable amount of money for an investment-free enterprise having as its 'only cost-factor' to keep up its network of connections. As human resources get scarce and the number of illegal workers mostly from Myanmar is increasing rapidly, it is quite possible that, in the near future, there might be conflicts between the rivaling brokerage networks not only in Krabi, but throughout the South. No brokers participated in this study, but they will have to be part of any attempts to improve the sectors options in producing under sustainability standards.

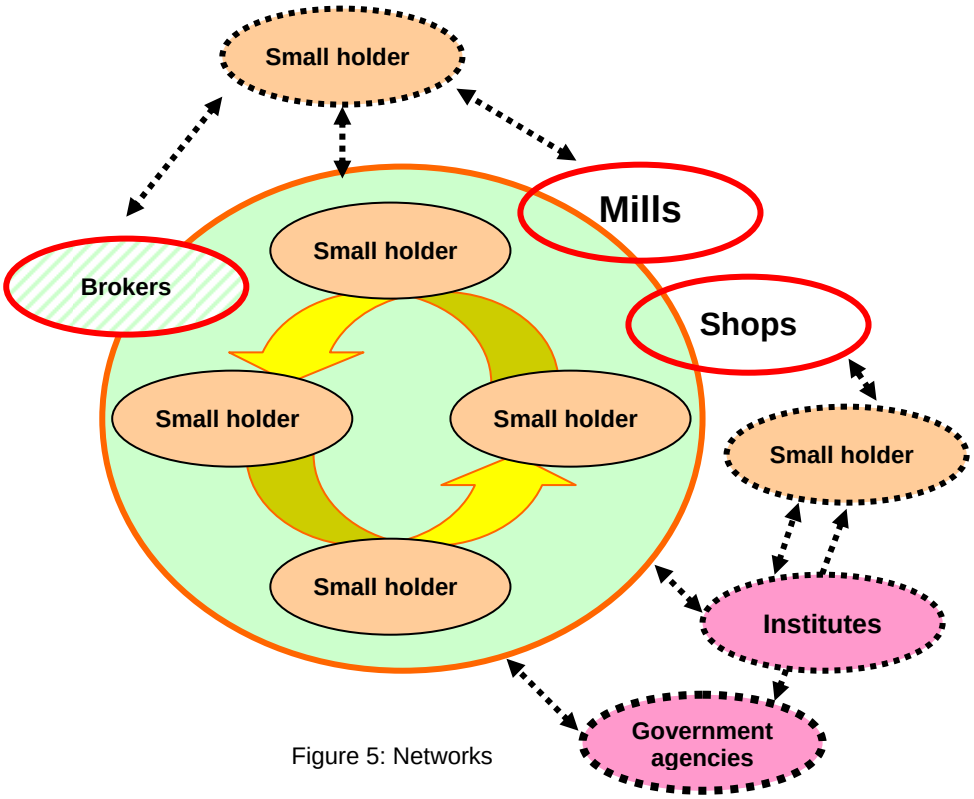


Figure 5: Networks

3.7 Networks

All participating smallholders were members of informal networks, especially concerning prices, plantation maintenance, raw material, like fertilizer and pesticides, but also for FFB prices at factory gate. These informal networks are contacted regularly by vendors and / or mills offering pesticides, fertilizers and palm tree saplings together with information on standard plantation procedures.

These informal networks exist for mutual benefits and can be said to sometimes outright include vendors and even mills. Palm oil related institutes or government agency are less engaged with these networks and there is only a limited exchange of information between them, normally restricted to specific tasks of the involved agencies, for example census and / or research.

There are smallholders that are not being members of any formal or informal networks. This concerns mostly smallholders that do not engage as palm oil farmers directly, but rather manage their plantations via telephone or brokers. If these smallholders wish to receive information, they have to actively search it out. Exemptions are here to some extent the vendors and mills, which are interested to sell products or buy FFB respectively. However, very often these needed contacts are managed by a broker.

4. CO_2 footprint (summative)

4.1. Introduction

This study determined the GHG emissions from oil palm plantation and crude palm oil (CPO) production in Krabi and Surat Thani. The report accounted for the GHG emissions from plantations to the extraction in two mills. For this study, case-specific data from a field visit to 14 plantations and two palm oil extraction mills were used for calculation. This chapter gives the summative results for both mills and their supply chains combined. The detailed calculations are given in the annex. The basic operating principle of the participating mills is shown in the figure below.

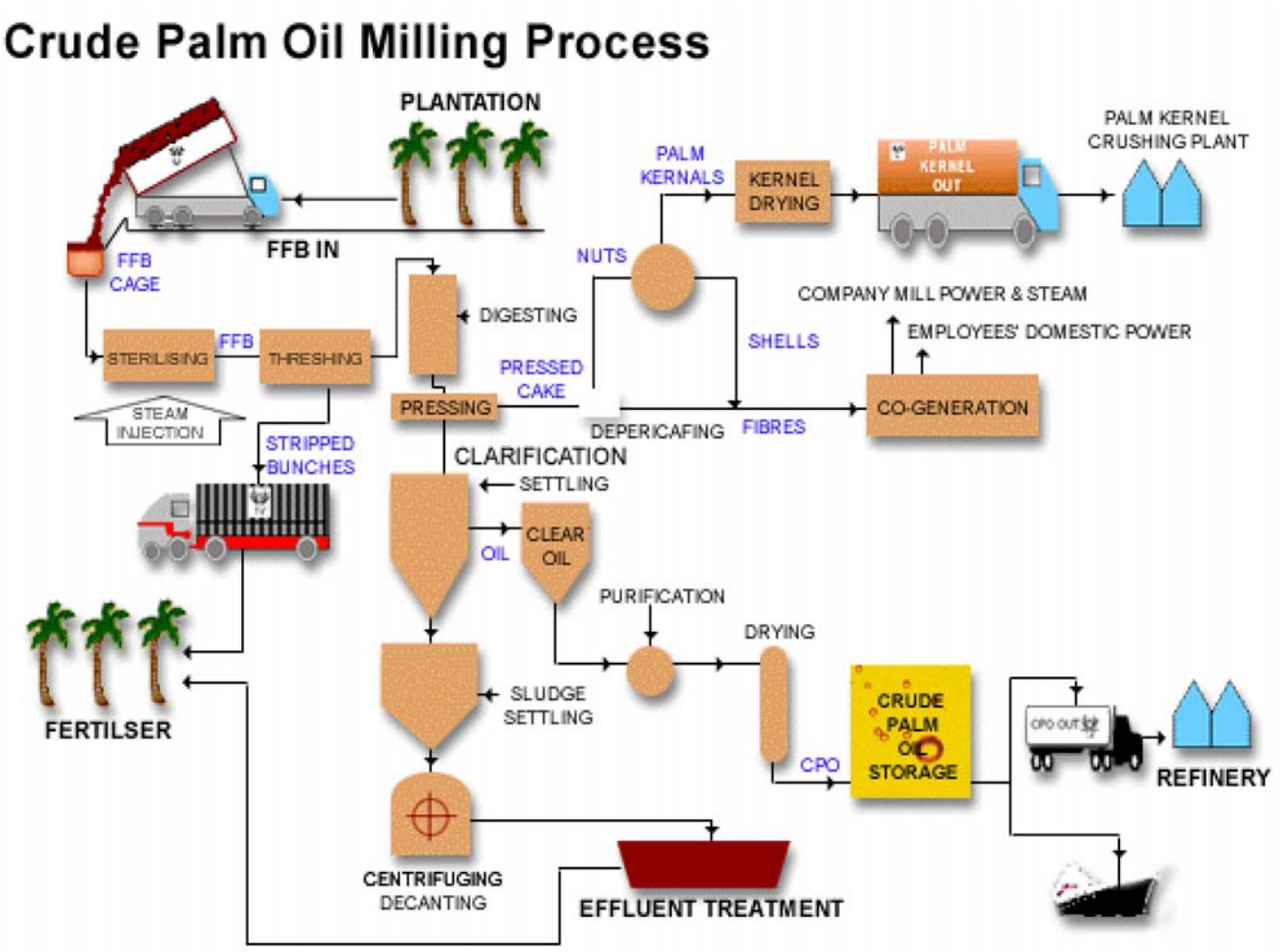


Figure 6: Crude Palm Oil Milling process

4.2. Carbon Footprints of Thai Palm Oil Industry (Crude Palm Oil Production)

The three most important GHGs produced in the palm oil industry are carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O). One family with 4 hectares of land will emit CO2 from fertilizers and fuel for transportation equivalent to 882.54 ton CO2/year. Mill 1 with the capacity of 162,200 t-FFB/year generated CO2 37,402 tonCO2/year, mill 2 with the capacity 123,732 t-FFB/year generated CO2 45,488 tonCO2/year. The major CO2 emission at the mill is from the wastewater which accounted 96-97 %.

4.3. CPO production chain

A. Oil palm plantation

The first step in the CPO production chain is the land use to establish oil palm plantation. However, the land use is not taken into account in this case. Only the production of the fresh fruit bunches is considered. The GHG-emitting inputs for the production of fresh fruit bunches(FFB) at an oil palm plantation are from fertilizers and fossil fuel. Fertilizers applied at an oil palm plantation cause GHG emission during production and N_2O emissions from their application to the field. Most of the harvest is done manually and transported to the mill by truck required fossil fuel energy which emits GHGs. In general one family owns 25 rai (4 hectares) of land for oil palm plantation and there are 22 palm trees per rai. A nine year old palm needs 3.5 kg of urea, 1.5 kg of rock phosphate and 4.0 kg of potassium chloride tree/year (Rankine and Fairhurst, 1999). The FFB are harvested eighteen times / year. In Krabi the average yield of FFB is 2.683 t-FFB/rai, while in Surat Thani it is 2.460 t-FFB/rai/year (Office of Agricultural Economics, 2008).

B. Transportation

The FFB must be transported to the extraction mill as soon as possible, normally within 24 hours. Otherwise, the oil will be deteriorated in to fatty acid. The plantations are not very far from the mill, average distance is 20-50 km. So the GHG emission is from the fuel used for transportation.

C. Palm oil mill

At the mill, GHG emissions arise from using of electricity, fossil fuel and the palm oil mill effluent or wastewater. Mill 1 has a production capacity of 162,200 t-FFB / year with an OER of 16%, electricity consumption of 13.7 kWh / t-FFB and generated wastewater 0.5 m^3 / t-FFB. Mill 2 produces 123,732 t-FFB / year with an OER of 18.74%.; Electricity consumption is 18.21 kWh / t-FFB and generated wastewater 0.8 m^3 / t-FFB.

Carbon footprint for mill 1 and its supply chain

One family generates CO_2 from

1 Fertilizers = 842.80 kg CO_2/year
2. Transportation of fertilizers = 39.74 kg CO_2/year
3. Total CO_2 emissions 882.54 kg CO_2/year

Carbon footprint for transportation of FFB to the mill = 143.06 kg CO_2/year

(2652 families needed for mill 1)

Carbon footprint of the palm oil mill 1 (in Surat Thani)

1. Electricity use = 1,178,501.40 kg CO_2/year
2. Fuel consumption = 106,531.20 kg CO_2/year
3. Waste water = 36,117,900 kgCO2/year
4. Total CO2 emissions = 37,402,932.6 kgCO_2/year

Total CO_2 emissions of plantations and the mill 40,122,823.72 kgCO_2/year (40,122.82 tonCO_2/year)

Carbon footprint of for mill 2 and its supply chain

One family generates CO_2 from

1. Fertilizers = 842.80 kg CO_2/year
2. Transportation of fertilizers = 39.74 kg CO_2/year
3. Total CO_2 emission = 882.54 kg CO_2/year

Carbon footprint for transportation of FFB to the mill = 143.06 kg CO_2/year
(2016 families needed for mill 2)
Carbon footprint of the palm oil mill 2 (in Krabi)

1. Electricity use = 1,196,427.8 kgCO_2/year
2. Fuel consumption = 143,204.40 kg CO_2/year
3. Waste water = 44,148,568.80 kgCO_2/year
4. Total emissions = 45,488,201.04 kgCO_2/year

Total CO_2 emissions of plantations and the mill 47,555,810.06 kgCO_2/year (47,555.81 tonCO_2 / year)

4.4. The two mills and their supply chain in comparison

For the two participating mills, it can be said that all technological and infrastructure advantages are with mill 2. It has the better technology applied in its CPO production and its supply chain is better organized and more easily controlled in terms of FFB quality. However, as the waste water amounts for the overwhelming majority of the CO_2 footprint, mill 1 is doing better with a smaller amount of waste water. When the CPO yield was taken into consideration mill 1 generated 1.55 tonCO_2/ton of oil and mill 2 generated 2.05 tonCO_2/ton of oil. However, the OER of mill 2 was higher than mill 1. The result indicates that mill 1 is more environmentally friendly mill because it has the better management process for electricity use and wastewater generation.

4.5. Carbon footprint in comparison with fossil fuels

Using 1000 L of diesel from fossil fuels will generate 2.6034 tons CO_2. In comparison, the production of palm oil (CPO) as from mill 1 and 2 generate 1.55 and 2.05 tons CO_2/ton oil, respectively. Thus, burning of fossil fuel produces more CO_2. Even including a further CO_2 generation to produce bio-diesel from CPO, current CPO production in the two mills would already save overall CO_2 emissions for the country.

4.6. Options for improvement

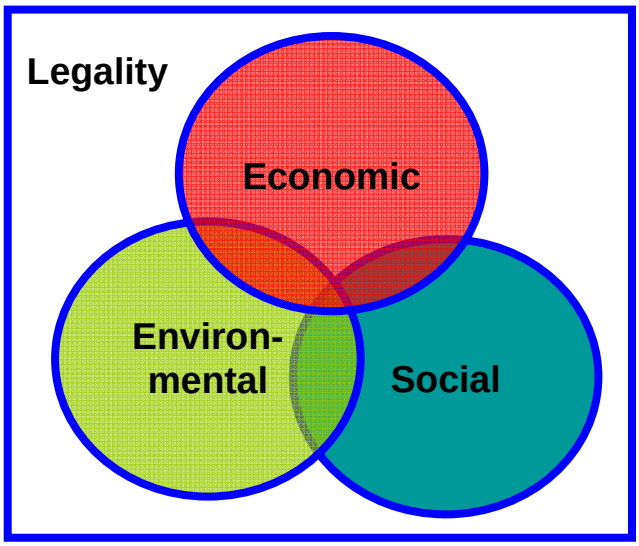
Major options to improve the carbon footprint are given by

- Reduction of using oil based fertilizers. Oil palm plantation requires fertilizers and good agricultural practice. Increasing use of bio-fertilizer and use of decanter cake and treated wastewater from the mill as fertilizers will minimize the use of chemical fertilizers.
- Reduction of electricity use by energy management. The electricity use in a palm oil mill comes from two sources either buying from the utility or generating from steam turbine in the mill. The mill must try to minimize the use of electricity from out source and increase the boiler efficiency. The mill has to minimize the steam blow down, preheat of combustion air and feed water, control burnt-out and use “economizers”.
- Co-generation of electricity and heat. Many industries require heat for processing steps. To have the heating unit in the plant is high cost. It is a good opportunity for the palm oil mill to sell heat to other industries since coherent generation of heat and electricity needs fewer funds than individual generation.
- Reduction of wastewater and using closed digester system for treatment. More than 95% of CO2 emission is from wastewater. The reduction of water use in the mill can be done through cleaner technology- reduce, reuse and recycle. If the closed digester system is used to treat wastewater and produce biogas for electricity generation more than 95% carbon emission will be reduced.

5. Sustainability performance under the RSPO test audit

The roundtable on sustainable palm oil or RSPO for short consists of eight management or operational principles to produce crude palm oil (CPO). They are comprised of legal, economically viable, environmentally appropriate and socially beneficial management and operations practices within a legal framework.

Figure 7: RSPO framework



A team of SGS International conducted an informal test-audit on the model mills and their supply chains as identified by this study. The main tasks of the audit were

- To look at the current status of oil palm
- industry in Thailand with regard to RSPO requirement
- To identify possible gaps between existing status quo and RSPO requirements (key performance indicators)
- To recommend a possible way forward

The main results of the test audit are summarized below as sustainability key performance indicators, in some cases together with comments by this study.

5.1. Principle 1: Commitment to transparency

Table 22: Sustainability Key Performance Indicators (SKPI) 1: Commitment to transparency		Remarks
Mills	Supply Chain	
Strength: - General awareness of the importance of providing adequate information as far as stakeholder requests are concerned	Strengths: - Many of the plantations (large companies and smallholders) had clear land title	The commitment to transparency was best observed by mill 2. Mill 1 had many reservations and even refused to participate in the stakeholder feedback WS out of fears to reveal confidential information. Other mills may have a similar perspective in a market with more than 60 mills, but only limited raw-material supply throughout most of the year.
Weaknesses: - Lack of clear publicly available management documents - particularly pertaining environment and social aspects of the mill / plantation	Weaknesses: - Some farms/ plantations with unclear land title	
- Often lack of general documentation		

5.2. Principle 2: Compliance with applicable laws and regulations

Table 23: Sustainability Key Performance Indicators (SKPI) 2: Compliance with applicable laws and regulations		Remarks
Mills	Supply Chain	
Strength: - Boundary markers exist for all estates and farms with clear land title. - Detailed maps were found.		Very often laws and regulations concerning palm-oil production in Thailand are not clear due to missing

Weaknesses: - Lack of a complete list/ register of laws and regulations. - No system to monitor compliance with laws and regulations. - No records of communication/ consultation with local communities. - Grievance mechanism is verbal and not documented. - Lack of general documentation.	government policies concerning standards. Responsibilities for the sector are often divided between several departments or even ministries simultaneously, which tends to complicate the development of unified government policies.

5.3. Principle 3: Commitment to long-term economic and financial viability

Table 24: Sustainability Key Performance Indicators (SKPI) 3: Commitment to long-term economic and financial viability	
Mills	Supply Chain
Strength: - Planning exists in the form of budgets and reports	Strengths: - Some annual plans: annual budget is determined by the upper management. The budget allocation considers an estimation on expenses for harvesting, replanting and other general operations
Weaknesses: - Lack of clear management plan that includes budget consideration covering social and environmental aspects of the overall operation. - Often lack of general documentation.	

5.4. Principle 4: Use of appropriate best practices by growers and millers

Table 25: Sustainability Key Performance Indicators (SKPI) 4: Use of appropriate best practices by growers and millers	
Mills	Supply Chain
Strength: - General awareness of the importance of working environmentally and ecologically efficient - A basic technological standard in waste management is already installed - The importance of monitoring is understood	Strengths: - Standard Operation Procedures (SOP) for crop production and field maintenance were consistently implemented in plantations - Smallholders show awareness and knowledge of field maintenance and harvesting procedures - Some farmers perform soil analyses to observe the nutrient status of the land
Weaknesses: - Inadequate procedures and implementation of training for workers particularly on health and safety aspects of the operation.	Weaknesses: - Lack of SOPs where health & safety, environment and social management procedures were concerned Inconsistency in implementing BMP for soil fertility. - No buffer zones allocated along streams and rivers. - Improper handling of agrochemicals. - Lack of protection cloths e. g. gloves. - Improper storage of agrochemicals. - No management plans for IPM

5.5. Principle 5: Environmental responsibility and conservation of natural resources and

Table 26: Sustainability Key Performance Indicators (SKPI) 5: Environmental responsibility and conservation of natural resources and biodiversity		Remarks
Mills	Supply Chain	
Strength: - Measures are implemented which try to avoid waste/waste water and waste of resources by recycling - The concept of eco-efficiency is understood ion its basics	Strengths: - Measures are implemented which try to avoid waste and waste of resources by recycling	Here often a lack of documentation was the reason for non-compliance. Participants are very open to learn more on this topic through training. The problem seems to be a failure of the formal network, as all smallholders are interested in environment aspects of their operation.
Weaknesses: - Lack of documentation of environmental & biodiversity aspects of the plantation and impact of plantation and mill operation. - Sometimes domestic waste from the workers quarters were not properly collected and disposed off in an environmental friendly manner. - Lack of adequate procedures and implementation for re-using of chemical containers to ensure compliance with health and safety regulations. - Lack of assessment and monitoring of energy use for the whole operation.		

5.6. Principle 6: Responsible Consideration of Employees and of Individuals and Communities by Growers and Millers

Table 27: Sustainability Key Performance Indicators (SKPI) 6: Responsible consideration of employees and of individuals and communities affected by growers and millers	
Mills	Supply Chain
Strength: - Employees had a labour contract. - Transparency in prices: FFB prices were displayed at the mill's gate on daily basis. - Weighbridge tickets were issued to each supplier. They clearly show the tonnage of the FFB delivered and its quality / price paid.	Strengths: - Many of the plantations (large companies and smallholders) had clear land title
- No child labour or employment of minors was found. - No detection of engagement or support of discrimination based on race, caste, national origin, religion and gender.	
Weaknesses: - Lack of social impact assessment that identifies potential impacts and implements measures to mitigate negative elements. - Inadequate description of procedures to ensure open and transparent communication with stakeholders. - Lack of identification of indigenous groups and local communities within and surrounding of the planted area that identify their legal status pertaining to the oil palm plantation operation.	

5.7. Principle 7: Responsible development of new plantings

Table 28: Sustainability Key Performance Indicators (SKPI) 7: Responsible development of new plantings		Remarks
Mills	Supply Chain	
Strength: - First attempts to establish new plantings in cooperation with the supply chain - Preference for new plantings based on clear land title-deeds	Strength: - No open burning for re-plantation was detected - Old oil palm trunks felled were chipped, stacked and left to rot on site- no burning.	The target group has – as yet – only very limited re-planting experience and practice, as almost all existing plantations are not yet old enough to be replaced.
Weaknesses: - Missing awareness that an impact assessment has to be carried out before a new planting is done.		

5.8. Principle 8: Commitment to continuous improvement in key areas of activity

Table 29: Sustainability Key Performance Indicators (SKPI) 8: Commitment to continuous improvement in key areas of activities	
Mills	Supply Chain
Strength: - Improvement is very welcome and it is understood that it has to be continuous. - Good ideas for improvement are already being discussed informally.	
Weaknesses: - No continuous improvement programme in the plantation and mill operation. - Smallholders do not document their thoughts for improvement.	

6. Summary & Recommendations

During the study it became obvious that almost all participants had never heard of the RSPO standard and in some cases even lacked an understanding of sustainable development (as opposed to *sustained* development). Nonetheless, the study team could observe basic forms of standards, i.e. standard management or operation procedures (SMP/SOP). However, the objectives of the SMP or SOP observed at the sites were based on considerations other than RSPO. Below we give some of the core objectives observed with the target groups.

Shared denominators among smallholders

Among the smallholders a number of factors decide on their respective interest to produce under standards. While everyone welcomes the prospect to potentially increase the value of their crops through certification and additional export options for the CPO produced from their feedstock, more practical issues have priority. For example the convenience of work within the plantation is considered an important factor when it comes to change. Secondly the easy access to capital through their crop and thirdly the overall amount of feedstock harvested in their plantations are considered important factors in decision-making for or against adaptation.

Shared denominators among mills

The mills have a different perspective on feedstock issues. For them, the ability to control planting and harvesting is the foremost issue in cooperation with smallholders in order to ensure not only a high quality of feedstock, but also a high level of efficiency in feedstock production and delivery. Secondly, the documentation of this very process is considered another priority.

Denominators shared by both

The overriding denominator both target groups share is the price of the raw material. Beyond that, both groups of stakeholders share two issues of interest. The first one is advancement in technology for their respective mill and plantation. The second shared interest is a functioning network to promote their respective interests and find solutions to their problems.

Status Quo:

Looking at the status quo, we can observe that a number of factors are already in place (see also previous chapter) to strongly support the development of a national Thai RSPO interpretation. But, some convincing needs to be done. For example, one of the participating mills and their supply chain refused to attend the final feedback workshop on the study results – in spite of having initially agreed to appear. This, we were told informally, out of fear to actually meet with a direct competitor and compare performances. Although the competition in this sector is at times fierce, it is possible to unite some mills in a cooperation to improve performance, as the E3Agro bench-marking project has shown in their latest gathering in June 2008. This momentum needs to be kept up.

What is ready?

- Mills that work with a high efficiency are ready to improve their performance
- A supply chain that wants to keep their competitive edge to join
- A leading mill ready to initiate first steps for a national interpretation of the RSPO (mill2)
- An informal and formal network for information dissemination

What is missing?

- An understanding that neither better technology nor a controlled supply chain always mean a better carbon footprint, but that both have to go hand in hand
- Additional technology and/or other tools to promote true sustainable development further and beyond what is already in place in the mills
- Opportunities for training to enhance management techniques
- A true understanding of standards and their impact and benefits
- Benchmarks that are ready to be used throughout the sector
- A government organization or cooperation that supports the sector in their attempts for standardization
- Access to the market that would purchase certified products.

What can be possible next steps?

- Information dissemination on RSPO and interpretation of its requirement
- Industrial players in Thailand to subscribe to RSPO and study the benefits and implication
- Statement of commitment from the authorities in the industry
- Active participation in RSPO development
- Establishment of Working Groups to address specific issues and establish formal communication with RSPO Board
- Assistance to smallholders
- Development of National Interpretation for Thailand
- Carry out field test of the Thailand National Interpretation (TNI)
- Finalization and endorsement of the TNI
- Implement certification scheme for oil palm industry in Thailand
- Strengthening groups or cooperatives of smallholders
- Organize a campaign to explain benefits for participants in tangible terms
- Development of a method and procedure of data collection that is truly useful for participating target groups and that supports overall efforts of the sector to develop sustainably
- Initiate a pilot project in form of a PPP that helps to introduce RSPO in Thailand

7. Attachments

Annex 1(x):

8 RSPO Principles and its 39 criteria

Principle 1: Commitment to transparency

1. Are the oil palm growers and millers **provide adequate information** to other stakeholders on environmental, social and legal issues relevant to RSPO Criteria, in appropriate languages & forms to allow for effective participation in decision making?

2. **Are Management documents publicly available?** (except where this is prevented by commercial confidentiality or where disclosure of information would result in negative environmental or social outcomes.) For example: Land titles/user rights, Health and safety plan, Plans and impact assessments relating to environmental and social impacts, Pollution prevention plans, Details of complaints and grievances, Negotiation procedures, Continuous improvement plan

Principle 2: Compliance with applicable laws and regulations

3. **Is there a compliance with all applicable local, national and ratified international laws and regulations?**

4. **Can the right to use the land be demonstrated?**

   Are there maps of an appropriate scale showing extent of recognized customary rights?

   Are there copies of negotiated agreements on the use of land for oil palms detailing process of consent?

Principle 3: Commitment to long-term economic and financial viability

5. Is there an **implemented management plan** that aims to **achieve long-term economic and financial viability**? Is there a documented business or management plan (minimum 3 years) and an annual replanting program, and where applicable for the latter, projected for a minimum of 5 years with yearly review?

Principle 4: Use of appropriate best practices by growers and millers

6. Are the **operating procedures are appropriately documented and consistently implemented and monitored**? (Standard Operating Procedures for estates and mills are documented, a mechanism to check consistent implementation of procedures is in place and records of monitoring & the actions taken are maintained)

7. Are there practices maintain **soil fertility** at, or where possible improve soil fertility to, a level **that ensures optimal and sustained yield**?
    Records of fertilizer inputs are maintained?
    Evidence of periodic tissue and soil sampling to monitor changes in nutrient status?
    A nutrient recycling strategy is in place?

8. Are there **practices to minimize and control erosion and degradation of soils?** Are there maps of fragile soils available?
    Is there a management strategy for plantings on slopes above a certain limit (needs to be soil and climate specific)?
    Is there a road maintenance program?
    Is there a subsidence of peat soils minimized under an effective and documented water management program?
    Is there a management strategy in place for other fragile and problem soils (e.g. sandy, low organic matter, acid sulfate soils)?

9. **Are there practices to maintain the quality and availability of surface and ground water?**
    Is there an implemented water management plan?
    Is there a protection of water courses and wetlands, including maintaining and restoring appropriate riparian buffer zones?
    Is there a monitoring of effluent BOD?
    Is there the monitoring of mill water use per ton of FFB?

10. **Are pests, diseases, weeds** and invasive introduced species effectively managed using appropriate Integrated Pest Management (IPM) techniques?
    Is an IPM plan documented and current?
    Is there a monitoring extent of IPM implementation including training?
    Is there a monitoring of pesticide toxicity units (a.i./LD 50 per ton of FFB or per hectare)?

(Due to problems in the accuracy of measurement, monitoring of pesticide toxicity is not applicable to smallholders.)

11. **Are agrochemicals** used in a way that does not endanger health or the environment? (There is no prophylactic use of pesticides, except in specific situations identified in national Best Practice guidelines).
    Is there a justification of all agrochemical use?
    Are there records of pesticide use (including active ingredients used, area treated, amount applied per ha and number of applications)?
    Is there documentary evidence that use of chemicals categorized as World Health Organization Type 1A or 1B, or listed by the Stockholm or Rotterdam Conventions2, and paraquat, is reduced and/or eliminated?

[2] For example: Aldrin, Chlordane, PCB, DDT and Hexachlorabenzene.

12. Are selective products being used that are specific to the target pest, weed or disease and which have minimal effect on non-target species? However, measures to avoid the development of resistance (such as pesticide rotations) are applied).

13. Are **chemicals being applied by qualified persons** who have received the necessary training and should always be applied in accordance with the product label?

    Are appropriate safety equipments provided and used?

    The storage of all chemicals should be as prescribed in FAO or GIFAP Code of Practice[3]?

    Is there an application of pesticides by proven methods that minimize risk and impacts?

    Are pesticides applied aerially only where there is a documented justification?

    Is there a proper disposal of waste material, according to procedures that are fully understood by workers and managers?

    Is there specific annual medical surveillance for pesticide operators, and documented action to eliminate adverse effects?

    Are pregnant and/or breast-feeding women working with pesticides?

14. **Is there an occupational health and safety plan documented**?

    Is there a health and safety policy, which is implemented and monitored?

    Have all operations where health and safety is an issue been risk assessed and are procedures and actions documented and implemented to address the identified issues?

    Are all workers involved in the operations have been adequately trained in safe working practices?

    Are there adequate and appropriate protective equipment available to laborers at the place of work to cover all potentially hazardous operations, such as pesticide application, land preparation, harvesting and, if it is used, burning?

    Are responsible personnel identified (for health and safety plan)?

    Are there records of regular meetings between the responsible person and workers where concerns of all parties about health, safety and welfare are discussed? Are records detailing the occurrence and issues raised kept?

    Are there accident and emergency procedures and can instructions clearly understood by all workers?

    Are there accident procedures available in the appropriate language of the workforce?

    Are there assigned operatives trained in First Aid present in both field and other operations and first aid equipment are available at worksites?

    Are there records kept of all accidents and periodically reviewed?

    Are workers covered by accident insurance?

    Is there a recording of occupational injuries?

15. **Are all staff, workers, smallholders and contractors appropriately trained?**

[3] Curtail use of dangerous pesticides where control is difficult; ensure use of protective equipment and techniques: provide guidance for workers on safety measures; provide extension service to smallholders and farmers; protect workers and bystanders; make available full information on risks and protection; protect biodiversity and minimize impacts on environment; ensure safe disposal of waste and equipment; make provisions for emergency treatment for poisoning)

Is there a formal training program that includes regular assessment of training needs and documentation of the program?

Are there records of training for each employee kept?

Is the training program appropriate to the scale of the organization?

Principle 5: Environmental responsibility and conservation of natural resources and biodiversity

16. **Are all aspects of plantation and mill management**, including replanting, t**hat have environmental impacts identified**? And are plans to mitigate the negative impacts and promote the positive ones made, implemented and monitored, to demonstrate continuous improvement?

    Is there a documented impact assessment?

    Where does the identification of impacts require changes in current practices in order to mitigate negative effects, is there a timetable for change developed?

17. Is the status of **rare, threatened or endangered species and high conservation value habitats**, if any, which exist in the plantation or which could be affected by plantation or mill management identified? And is their conservation taken into account in management plans and operations? (Information should be collated that includes both the planted area itself and relevant wider landscape-level considerations (such as wildlife corridors).)

    Is data on presence of protected areas that could be significantly affected by the growers or millers collected and available collected on?

    Is data collected concerning the conservation status (e.g. IUCN status), legal protection, population status and habitat requirements of rare, threatened, or endangered species that could be significantly affected by the growers or millers?

    Is there an identification of high conservation value habitats, such as rare and threatened ecosystems, that could be significantly affected by the grower or miller?

If rare, threatened or endangered species, or high conservation value habitats, are present, appropriate measures for management planning and operations will include:

Are there any legal requirements relating to the protection of the species or habitat are met?

Is there any damage to and deterioration of applicable habitats?

Is there control of any illegal or inappropriate hunting, fishing or collecting activities; and developing responsible measures to resolve human-wildlife conflicts (e.g., incursions by elephants)?

18. **Is Waste reduced, recycled, re-used and disposed of in an environmentally and socially responsible manne**r?

    Is there a documented identification of all waste products and sources of pollution?

    Is there a Safe disposal of pesticide containers?

    Is a waste management and disposal plan developed and implemented, to avoid or reduce pollution?

19. **Is the efficiency of energy use and use of renewable energy maximized**?

    Is there a monitoring of renewable energy use per ton of CPO or palm product in the mill?

    Is there a monitoring of direct fossil fuel use per ton of CPO (or FFB where the grower has no mill)?

20. **Is the use of fire for waste disposal and for preparing land for replanting avoided?** (Except in specific situations, as identified in the ASEAN guidelines or other regional best practice.)

21. **Are there Plans to reduce pollution and emissions, including greenhouse gases, developed, implemented and monitored**?

22. **Are aspects of plantation and mill management**, including replanting, **that have social impacts identified in a participatory way?** And plans to mitigate the negative impacts and promote the positive ones are made, implemented and monitored, to demonstrate continuous improvement?

    Is there a documented social impact assessment including records of meetings?

    Is there evidence that the assessment has been done with the participation of affected parties?

    (Participation in this context means that affected parties are able to express their views through their own representative institutions, or freely chosen spokespersons, during the identification of impacts, reviewing findings and plans for mitigation, and monitoring the success of implemented plans.)

    Is there a timetable with responsibilities for mitigation and monitoring, reviewed and updated as necessary, in those cases where the assessment has concluded that changes should be made to current practices?

    Is there particular attention paid to the impacts of out-grower schemes?

23. Are there **open and transparent methods for communication and consultation between growers and/or millers**, local communities and other affected or interested parties?

    Are there documented consultation and communication procedures?

    Are there nominated management officials responsible for these issues?

    Is there maintenance of lists of stakeholders, records of all communication and records of actions taken in response to input from stakeholders?

24. Is there a mutually agreed and d**ocumented system for dealing with complaints and grievances**, which is implemented and accepted by all parties?

    Are the system resolves disputes in an effective, timely and appropriate manner?

    Is there a documentation of both the process by which a dispute was resolved and the outcome?

    Is the system open to any affected parties?

25. Are there any **negotiations** concerning **compensation for loss of legal or customary rights** dealt with through a documented system that enables indigenous peoples, local communities and other stakeholders to express their views through their own representative institutions?

    Is there an establishment of a procedure for identifying legal and customary rights and a procedure for identifying people entitled to compensation?

    Is there a procedure for calculating and distributing fair compensation (monetary or otherwise) established and implemented? (This takes into account gender differences in the power to claim rights, ownership and access to land; differences between transmigrants and long-established communities; differences in ethnic groups' proof of legal versus communal ownership of land.)

    Is the process and outcome of any negotiated agreements and compensation claims documented and made publicly available?

26. **Do payment and working conditions for employees** and for employees of contractors always meet at least legal or **industry minimum standards** and are sufficient to provide decent living wages?

    Is there a documentation of pay and conditions?

    Are labor-laws, union agreements or direct contracts of employment detailing payments and conditions of employment (e.g., working hours, deductions, overtime, sickness, holiday entitlement, maternity leave, reasons for dismissal, period of notice, etc) available in the languages understood by the workers or explained carefully to them by a management official?

    Are adequate housing, water supplies, medical, educational and welfare amenities provided for growers and millers provided to national standard or above, where no such public facilities are available or accessible (not applicable to smallholders)?

27. Does the **employer respects** the right of **all personnel to form and join trade unions** of their choice and to bargain collectively? (Where the right to freedom of association and collective bargaining are restricted under law, the employer facilitates parallel means of independent and free association and bargaining for all such personnel.)

    Is there a published statement in local languages recognizing freedom of association?

    Are there documented minutes of meetings with main trade unions or workers representatives?

28. **Are children not employed or exploited**? (Work by children is acceptable on family farms, under adult supervision, and when not interfering with education programs). Are children not exposed to hazardous working conditions?

    Is there a documentary evidence that minimum age requirement is met?

29. Is there any form of **discrimination** based on race, caste, national origin, religion, disability, gender, sexual orientation, union membership, political affiliation, or age?

    Is there a publicly available equal opportunities policy including identification of relevant/affected groups in the local environment?

Is there evidence that employees and groups including migrant workers have not been discriminated against?

30. **Is there a policy to prevent sexual harassment** and all other forms of violence against women and to protect their reproductive rights developed and applied?
    Is there a policy on sexual harassment and violence and records of implementation?
    Is there a specific grievance mechanism established?

31. **Are growers and mills deal fairly and transparently with smallholders and other local businesses**?
    Are there current and past prices paid for FFB publicly available?
    Are the pricing mechanisms for FFB and inputs/services documented (where these are under the control of the mill or plantation)?
    Is there evidence available that all parties understand the contractual agreements they enter into, and that contracts are fair, legal and transparent?
    Are there Agreed payments been made in a timely manner?

32. **Do growers and millers contribute to local sustainable development wherever appropriate?**
    Are there demonstrable contributions to local development that are based on the results of consultation with local communities?

Principle 7: Responsible development of new plantings

33. Is there a **comprehensive and participatory independent social and environmental impact assessment** undertaken prior to establishing new plantings or operations, or expanding existing ones, and the results incorporated into planning, management and operations?
    Are there independent impact assessments undertaken through a participatory methodology including external stakeholder groups?
    Are there appropriate management planning and operational procedures?
    Where the development includes an out-grower scheme, are the impacts of the scheme and the implications of the way it is managed given particular attention?

34. **Are Soil surveys and topographic information used for site planning** in the establishment of new plantings, and the results are incorporated into plans and operations?
    Are soil suitability maps or soil surveys adequate to establish the long-term suitability of land for oil palm cultivation available?
    Is topographic information adequate to guide the planning of drainage and irrigation systems, roads and other infrastructure available?

35. **Are new plantings since November 2005, have not replaced primary forest or any area required to maintain or enhance one or more High Conservation Values**?
    Is an HCV assessment, including stakeholder consultation, conducted prior to any conversion?

Are dates of land preparation and commencement recorded?

36. **Is extensive planting on steep terrain, and/or on marginal and fragile soils, avoided?**
    Are maps identifying marginal and fragile soils, including excessive gradients and peat soils, available?
    Where limited planting on fragile and marginal soils is proposed, are plans developed and implemented to protect them without incurring adverse impacts?

37. **Are there no new plantings established on local peoples' land** without their free, prior and informed consent, dealt with through a documented system that enables indigenous peoples, local communities and other stakeholders to express their views through their own representative institutions?

38. **Are local people compensated for any agreed land acquisitions and relinquishment of rights**, subject to their free, prior and informed consent and negotiated agreements?
    Are there documented identification and assessment of legal and customary rights?
    Is there an establishment of a system for identifying people entitled to compensation?
    Is there an establishment of a system for calculating and distributing fair compensation (monetary or otherwise)?
    Are communities that have lost access and rights to land for plantation expansion given opportunities to benefit from plantation development?
    Is the process and outcome of any compensation claims documented and made publicly available?

39. **Is the use of fire in the preparation of new plantings avoided other than in specific situations**? (As identified in the ASEAN guidelines or other regional best practice.)
    Is there no evidence of land preparation by burning?
    Is there a documented assessment where fire has been used for preparing land for planting?
    Is there an evidence of approval of controlled burning as specified in ASEAN guidelines or other regional best practice?

Principle 8: Commitment to continuous improvement in key areas of activity

40. **Do growers and millers regularly monitor and review their activities and develop and implement action plans that allow demonstrable continuous improvement in key operations?**
    Is there a action plan for continual improvement based on a consideration of the main social and environmental impacts and opportunities of the grower/mill?
    Does it include a range of indicators covered by these principles and criteria?
    As a minimum, these include: Reduction in use of certain chemicals, environmental impacts, waste reduction, pollution and emissions, social impacts?

Annex 2(x): Detailed calculations for the two mills and their supply chains

Carbon footprint of mill 1

1. Conditions

1.1 Oil palm plantation

1.1.1 One family owns 25 rai or 4 hectare (22 trees/rai) 9 years oid palm oil.

1.1.2 FFB yield 2.460 ton/rai or 15.37 ton/ha (Source: Office of Agriculture Economics, 2008)

1.1.3 Fertilizer use (Source: Rankine and Fairhurst, 1999)

Urea	3.5 kg/tree/year
Rock phosphate	1.5 kg/tree/year
Potassium chloride	4.0 kg/tree/year

1.1.4 Fuel-diesel

- Loading of fertilizer : 50 km (2 times/year)

1.2 Transportation

- FFB to palm oil mill: 40 km (18 times/year)

1.3 Palm Oil Mill

1.3.1 FFB	13,500 ton/month
1.3.2 Oil extraction rate	16%
1.3.3 Electricity use	13.7 kWh/t-FFB
1.3.4 Fuel consumption	0.25 liters/t-FFB (diesel)
1.3.5 Waste water	0.5 m^3/t-FFB
1.3.6 Shell	0.05 %
1.3.7 Fiber	0.11%
1.3.8 Empty fruit bunch	0.23%
1.3.9 Workers	100 persons
1.3.10 POME yield	3.125 m^3/t-oil
1.3.11 CPO production	2,160 ton/month

1.4 CO_2 emissions factor

1.4.1 Fertilizer (Source: Renewable Fuels Agency, 2008)

- Urea emissions factor = 1.33 $kgCO_2/kgN$
- Rock phosphate emissions factor = 0.095 $kgCO_2/kgP_2O_5$
- Potassium chloride emissions factor = 0.333 $kgCO_2/kgK_2O$

1.4.2 Fuel (Source: Defra, 2007)

- Fuel used (diesel) emission factor = 2.6304 $kgCO_2$/ liters
- Distance traveled (diesel) emission factor = 0.1987 $kgCO_2$/km

1.4.3 Electricity (Source: International Energy Agency Data Service, 2006)

- Emission factor = 0.531 $kgCO_2$/kWh

1.4.4 Waste water (Source: Reijnders and Huijbregts, 2008)

- Emission factor of 1 kg CH_4 = 24.5 kg CO_2

2. Calculation CO_2 Emissions

2.1 Plantation

One hectare = 6.25 rai or 137.5 trees

One family = 4 hectare or 550 trees (22 tree x 25 rai)

One rai = 2.447 tons-FFB/year

13,500 t-FFB = 882.71 hectares = 221 families

162,000 t-FFB = 10,592.52 hectares = 2,652 families/year

2.1.1 Fertilizer

One family requires fertilizer:

Urea = 3.5 x 22 x 6.25 kg/ha/year

Rock phosphate = 1.5 x 22 x 6.25 kg/ha/year

Potassium Chloride = 4.0 x 22 x 6.25 kg/ha/year

CO_2 emissions :

Urea = 3.5 x 22 x 6.25 x 1.33 = 640.06 $kgCO_2/kgN$

Rock phosphate = 1.5 x 22 x 6.25 x 0.095 = 19.59 $kgCO_2/kgP_2O_5$

Potassium Chloride = 4.0 x 22 x 6.25 x 0.333 = 183.15 $kgCO_2/kgK_2O$

Total CO_2 emissions (Fertilizer) = 640.06+19.59+183.15

= 842.8 $kgCO_2$/ family/year ……(a)

2.1.2 Fuel (Loading of fertilizer)

Where : from fertilizer shop in town to the plantation

One family = 50 km (2 times/year) or 200 km/year

CO_2 emissions (average diesel cars) = Total units travelled (km) x Distance traveled (diesel) emission factor ($kgCO_2$/km) = 200 x 0.1987

= 39.74 $kgCO_2$/family/year ……(b)

Total CO_2 emissions (Plantation) = (a)+(b) x 2,652 family

= (842.8+39.74) x 2,652 family

= 2,340,496 $kgCO_2$/year ……(1)

2.2 Transportation of FFB to palm oil mill

One family = 40 km (18 times/year) or 720 km/year

CO_2 emissions (average diesel cars) = Total units travelled (km) x Distance traveled (diesel) emission factor ($kgCO_2$/km) = 720 x 0.1987

= 143.06 $kgCO_2$/family/year

Total CO_2 emissions (Transportation) = 143.06x 2,652 family

= 379,395.12 $kgCO_2$/year ……(2)

2.3 Palm oil mill

2.3.1 Electricity

CO_2 emissions = Amount used per year (kWh) x emission factor ($kgCO_2$/kWh)

= (13.7 kWh x 13,500 t-FFB x 12 month) x 0.531

= 1,178,501.4 $kgCO_2$/year ……(c)

2.3.2 Fuel consumption

CO_2 emissions (diesel cars) = Total units used per year (liters) x Fuel used (diesel) emission factor ($kgCO_2$/liters) = (0.25 liters x 13,500 t-FFB x 12 month) x 2.6304

= 106,531.2 $kgCO_2$/year ……(d)

2.3.3 Wastewater

- Biogas yield from POME= 28 m^3/m^3
- Methane gas composition in the biogas mixture = 65%
  (Source: Chong and Philip, 2001; Shirai and Suzuki, 2002)

Methane emission = CPO production x POME yield x Biogas yield x Methane gas composition

= 2,160 x 3.125 x 28 x 0.65

= 122,850 kg methane/month

= 1,474200 kg methane/year

CO_2 emissions (POME) = Methane emission x emission factor of 1 kg CH_4

= 122,850 kg methane x 24.5 kg CO_2

= 3,009,825 kgCO_2/month

. = 36,117,900 kg methane/year ……(e)

Total CO_2 emissions in the palm oil mill = (c) + (d) + (e)

= 1,178,501.4 + 106,531.2 + 36,117,900

= 37,402,932.6 kgCO_2/year ……..(3)

Total CO_2 emissions of mill 2 = (1) + (2) + (3)

= 2,340,496 + 379,395.12 + 37,402,932.6

= 40,122,823.72 kgCO_2/year

= 40,122.82 tonCO_2/year

Carbon footprint of mill 2

1. Conditions

1.1 Oil palm plantation

1.1.1 One family owns 25 rai or 4 hectare (22 trees/rai) 9 years old palm oil.

1.1.2 FFB yield 2.683 ton/rai or 16.77 ton/ha (Source: Office of Agriculture Economics, 2008)

1.1.3 Fertilizer use (Source: Rankine and Fairhurst, 1999)

Urea	3.5 kg/tree/year
Rock phosphate	1.5 kg/tree/year
Potassium chloride	4.0 kg/tree/year

1.1.4 Fuel-diesel

- Loading of fertilizer : 50 km (2 times/year)

1.2 Transportation

FFB to palm oil mill : 40 km (18 times/year)

1.3 MILL 2

1.3.1 FFB	10,311 ton/month (123,732 ton/year)
1.3.2 Oil extraction rate	18.74%
1.3.3 Electricity use	18.21 kWh/t-FFB
1.3.4 Fuel consumption	0.44 liters/t-FFB (diesel)
1.3.5 Waste water	0.8 m^3/t-FFB
1.3.6 Shell	0.05 %
1.3.7 Fiber	0.13%
1.3.8 Empty fruit bunch	0.22%
1.3.9 Workers	105 persons
1.3.10 POME yield	4.27 m^3/t-oil
1.3.11 CPO production	1,932.28 ton/month (23,187.36 ton/year)

1.4 CO_2 emissions factor

1.4.1 Fertilizer (Source: Renewable Fuels Agency, 2008)

- Urea emissions factor = 1.33 kgCO_2/kgN
- Rock phosphate emissions factor = 0.095 kgCO_2/kgP_2O_5

- Potassium chloride emissions factor = 0.333 $kgCO_2/kgK_2O$

1.4.2 Fuel (Source: Defra, 2007)

- Fuel used (diesel) emission factor = 2.6304 $kgCO_2$/ liters
- Distance traveled (diesel) emission factor = 0.1987 $kgCO_2$/km

1.4.3 Electricity (Source: International Energy Agency Data Service, 2006)

- Emission factor = 0.531 $kgCO_2$/kWh

1.4.4 Waste water (Source: Reijnders and Huijbregts, 2008)

- Emission factor of 1 kg CH_4 = 24.5 kg CO_2

2. Calculation CO_2 Emissions

2.1 Plantation

One hectare = 6.25 rai or 137.5 trees

One family = 4 hectare or 550 trees (22 tree x 25 rai)

One rai = 2.683 tonnes-FFB/year

10,311 t-FFB = 674.20 hectares need 168 families

123,732 t-FFB = 8090.4 hectares need 2,016 families/year

2.1.1 Fertilizer

One family requires fertilizer:

Urea = 3.5 x 22 x 6.25 kg/ha/year

Rock phosphate = 1.5 x 22 x 6.25 kg/ha/year

Potassium Chloride = 4.0 x 22 x 6.25 kg/ha/year

CO_2 emissions :

Urea = 3.5 x 22 x 6.25 x 1.33 = 640.06 $kgCO_2$/kgN

Rock phosphate = 1.5 x 22 x 6.25 x 0.095 = 19.59 $kgCO_2/kgP_2O_5$

Potassium Chloride = 4.0 x 22 x 6.25 x 0.333 = 183.15 $kgCO_2/kgK_2O$

Total CO_2 emissions (Fertilizer) = 640.06+19.59+183.15

= 842.8 $kgCO_2$/ family/year ……(a)

2.1.2 Fuel (Loading of fertilizers from shop to farm)

One family = 50 km (2 times/year) or 200 km/year

CO_2 emissions (average diesel cars) = Total units travelled (km) x Distance traveled (diesel) emission factor ($kgCO_2$/kg) = 200 x 0.1987

= 39.74 $kgCO_2$/family/year ……(b)

Total CO_2 emissions (Plantation) = (a)+(b) x 2,016 family

= (842.8+39.74) x 2,016

= 1,779,200.6 $kgCO_2$/year ……(1)

2.2 Transportation of FFB to palm oil mill

One family = 40 km (18 times/year) or 720 km/year

CO_2 emissions (average diesel cars) = Total units travelled (km) x Distance traveled (diesel) emission factor ($kgCO_2$/km) = 720 x 0.1987

= 143.06 $kgCO_2$/family/year

Total CO_2 emissions (Transportation) = 143.06x 2,016 family

= 288,408.96 $kgCO_2$/year ……(2)

2.3 Palm oil mill

2.3.1 Electricity

CO_2 emissions = Amount used per year (kWh) x emission factor ($kgCO_2$/kWh)

= (18.21 kWh x 10,311 t-FFB x 12 month) x 0.531

= 1,196,427.8 $kgCO_2$/year ……(c)

2.3.2 Fuel consumption

CO_2 emissions (diesel cars) = Total units used per year (liters) x Fuel used (diesel) emission factor ($kgCO_2$/liters) = (0.44 liters x 10,311 t-FFB x 12 month) x 2.6304

= 143,204.44 $kgCO_2$/year ……(d)

2.3.3 Wastewater

- Biogas yield from POME= 28 m^3/m^3
- Methane gas composition in the biogas mixture = 65%

(Source: Chong and Philip, 2001; Shirai and Suzuki, 2002)

Methane emission = CPO production x POME yield x Biogas yield x Methane gas composition = 1,932.28 x 4.27 x 28 x 0.65

= 150,165.2 kg methane/month

= 1,801982.4 kg methane/year

CO_2 emissions (POME) = Methane emission x emission factor of 1 kg CH_4

= 150,165.2 kg methane x 24.5 kg CO_2

= 3,679,047.4 $kgCO_2$/month

= 44,148,568.8 $kgCO_2$/year ……(e)

Total CO_2 emissions (mill 2) = (1) + (2) + (3)

= 1,779,200.6 + 288,408.96 + 45,488,201.04

= 47,555,810.06 $kgCO_2$/year

= 47,555.81 tonCO_2/year

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Annex 3(x): Excerpts from the terms of reference (TOR) for the study

…

2. Objective

The overall objective of this study is to

- Determine the sustainability performance (status quo) of two selected palm oil mills and their supply chain in the South of Thailand
- Compare this performance with existing local and international sustainability standards (gap analysis)
- Identify measures needed for farms to be able to comply with sustainability standards
- Identify and prioritise measures how to improve eco efficiency of palm oil production
- Identify information from the "test audits" which is useful for the development of the sustainability standards and the greenhouse gas tool used.

The study should be executed with participation of all concerned stakeholders within the palm oil production and value chains of the two mills.

3. Methodology

The local consultant will execute the study in a participatory approach with all concerned stakeholders through individual discussions, but can possibly include joint meetings with various stakeholders. Secondary data will be used as available.

He will closely cooperate with the E3Agro Project team and report regularly to its Principle Advisor. The selection of appropriate palm oil mills for the study will be done jointly. Test audits will be conducted on selected farms to assess the sustainability performance and compare the conditions on farms with the standard criteria. Test audits will be conducted with the two mills and on 15-20 farms. The actual number will be determined in cooperation with the consultants.

To ensure participation, workshops with local stakeholders will be held at the end of the testing on audit sites.

4. Scope of work

- Prepare work plan including data to be collected, institutions and stakeholders to be involved
- Select representative palm oil mills for field study, with strong interest in sustainable palm oil production and good potential for further cooperation, jointly with E3Agro
- Review available information, on site data collection and evaluation
- Conduct field test audits of standard and carry out workshop at the end of the field test audit
- Plan, conduct and carryout meetings with stakeholders
- Prepare a report and present to involved stakeholders
- Incorporate their comments into the report
- Prepare final report/analysis
- Present results in a workshop in Thailand with interested parties beyond stakeholders (government, NGOs, private sector)

5. Deliverables

- Work plan to carry out the assignment
- Data collection, analysis and presentation of findings
- Two catalogues of key sustainability performance indicator comparing status quo in Thailand with demands from sustainability standard development
- Analysis addressing most important issues including various topics/issues for further discussion with stakeholders
- Final report (about 35 pages)
- 1 interim report (brief)
- Agendas and reports on stakeholder meetings (as attachment to the report)

6. Final Report

The following issues should be addressed in the final report:

- Overall sustainability performance focusing on ecological, economical, social and political aspects
- Specific sustainability performance concerning cultivation of land
- Specific sustainability performance concerning protection of natural habitats
- Overall Co2 balance of plantations and mills and their greenhouse gas reduction potential
- Comparison of sustainability performance of the surveyed Thai palm oil production with requirements of standard
- Recommendations on measures needed for farms to be able to comply with sustainability standards
- Recommendations on the development of the sustainability standards and the greenhouse gas tool used.
- Current and future improvement options for sustainability of the Thai palm oil sector
- An up-date on the latest standard development efforts in Europe and Asia

The final report has to consider:

B. Plantation:
    a. Methods of plantation
    b. Structure of supply
    c. Smallholders/Land ownership
    d. Working and living conditions
    e. Income
    f. Land and soil conditions (general, before and after plantation)
    g. Use of waste (especially palm fronds)

C. Environment:
    a. Fertilizers
    b. Pesticides/bio-pesticides
    c. Soil degradation
    d. Erosion
    e. Land-use
    f. Land infringement
    g. Impact on water-table

    h. Irrigation
    i. Impact on biodiversity

D. Supply chains:
    a. Brokers
    b. Transport
    c. Supply distances
    d. Ownership
    e. Networks

E. Mills:
    a. Management practices
    b. Energy efficiency
    c. Waste management (disposal and utilization)
    d. Biomass power/Bio-gas use
    e. Co2/methane emissions
    f. Waste-water treatment
    g. Production performance in terms of oil loss
    h. ISO 9000 or 14000 compliance

F. Life-cycles and other issues:
    a. Life-cycle of fibres
    b. Life-cycle of shells
    c. Life-cycle of EFB (Empty Fruit Bunches)
    d. Fertilizer cycles
    e. Mushroom farming
    f. Fuel efficiency
    g. EFB dehydration
    h. Decanter cakes

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http://en.wikipedia.org

Web site from European Platform on Life Cycle Assessment, European Commission – Joint Research Centre Institute for Environment and Sustainability
http://lca.jrc.ec.europa.eu

Web site from Forest Stewardship Council (FSC)
http://www.fsc.org

Web site from The Energy Center and the associated EPFL's Energy Systems Management Chair
http://cgse.epfl.ch

Web site from Rainforest Alliance
http://www.rainforest-alliance.org

Web site from Roundtable on Sustainable Palm Oil (RSPO)
www.rspo.org

Web site from Department of Alternative Energy Development and Efficiency
www.dede.go.th

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http://www.ldd.go.th

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Web site from Office of Agricultural Economics, Thailand
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