CDM/JI Research Project for the Year 2007

Research Project on Methane Emissions Reduction by Composting Wastes from Palm Mill in Malaysia

Outline Version

March 2008
Daiwa Institute of Research Ltd

1. Project outline and objective

Malaysia is one of the highest palm oil producing country in the world but in the course of extracting the oil, a huge amount of biomass residue (EFB) and palm oil mill effluent (POME) are produced. This is a research to determine a business opportunity for applying the Japanese compost technology for decomposition and reduce the amount of greenhouse gas (methane) emitted from biomass residue and POME. The applied technology will be the fully automated linear compost system developed and used for animal waste and raw waste in Japan. The system would contribute to technical improvement in managing POME and wastes in Malaysia.

2. Description of the host nation

Malaysia, the host county, ratified the Kyoto Treaty in September 2002, designated the Ministry of National Resources and Environment (NRE) as DNA in March 2003, and in August of the same year the National Committee on CDM (NC-CDM) approved a national criteria concerning CDM. This shows how Malaysia prepared early to adopt the CDM and established the framework to do so.

As of January 2008, 25 CDM projects conducted in Malaysia have been registered at the UN CDM Executive Committee, out of which 16, the majority, concerns biogas energy. The others are six on landfill gas and three concerns energy efficiency.

3. The host nation and the palm oil industry

Palm oil and palm kernel oil are used in a wide rage of areas both edible, such as margarine shortening, and inedible, such as soap, and are the highest producing vegetable oil. (Chart 1) Looking at the global production of palm oil, Malaysia seized to be the highest producing country in 2006, giving the top spot to Indonesia, and now ranks second in global production league. (Chart 2)

Chart 1: Global production of vegetable oil (2006)

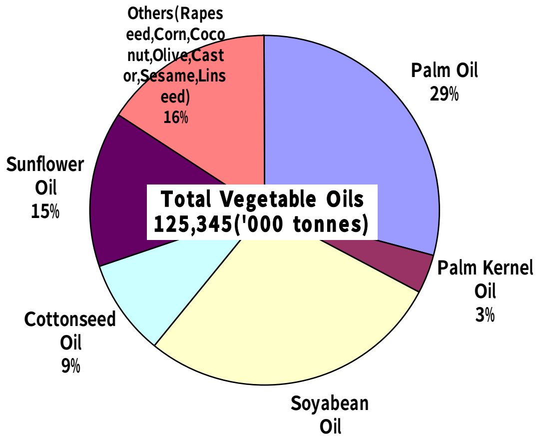
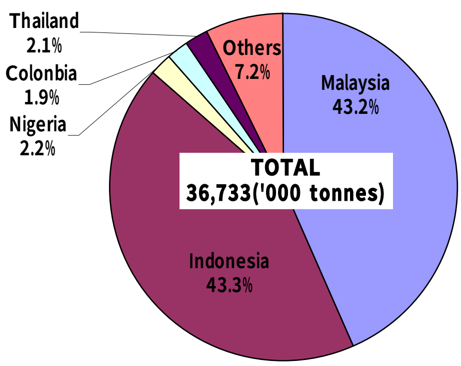


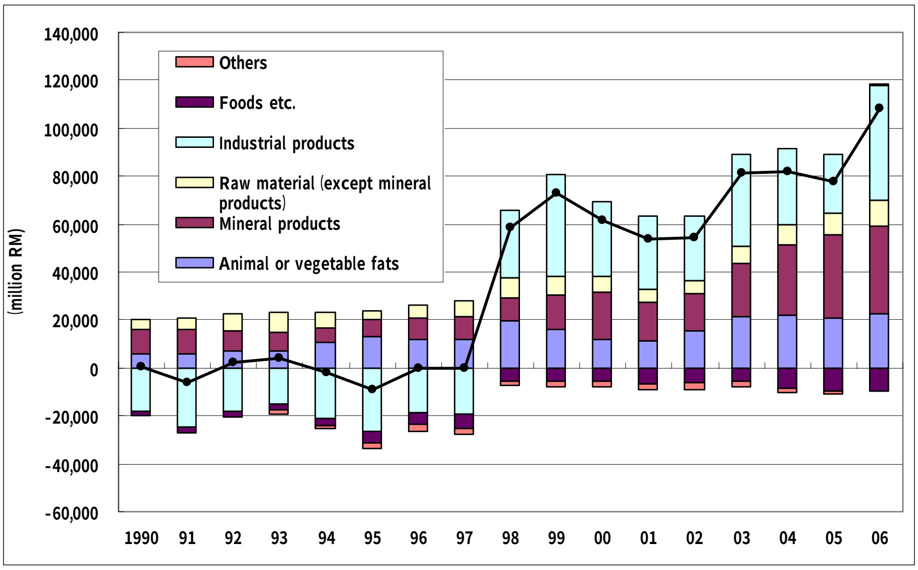
Chart 2: Palm oil production by countries(2006)



Source: Based on Malaysian Oil Palm Statistics 2006, Malaysian Palm Oil Board & Ministry of Plantation Industries and Commodities.

Looking at Malaysia's trade balance, animal and vegetable fats (mainly palm oil) have long been a surplus item, though not constituting a large portion, and has supported the Malaysian economy for a long time (Chart 3). There are currently 425 palm oil mills and 66 refineries (Chart 4).

Chart 3: Trade Balance Trend



Source: Compiled from Key Indicators 2007, Asian Development Bank and Inequality in Asia, Asian Development Bank, 2007.

Chart 4: Oil mills and refineries (2006)

	Palm oil mill		Refineries	
	No. of mills	Extraction capacity	No. of refineries	Refining capacity
peninsula	259	53,337,000	40	11,866,400
Sabah	121	27,910,200	19	8,986,800
Sarawak	45	9,056,400	7	2,342,000
Sabah & Sarawak	166	36,966,600	26	11,328,800
Malaysia	425	90,303,600	66	23,195,200

Note: Includes mills that have stopped operation and under construction or being planned.

Extraction capacity is FFB ton /year. Refining capacity is ton/year.

Source: Malaysian Palm Oil Board & Ministry of Plantation Industries and Commodities, Malaysian Oil Palm Statistics 2006, 2006.

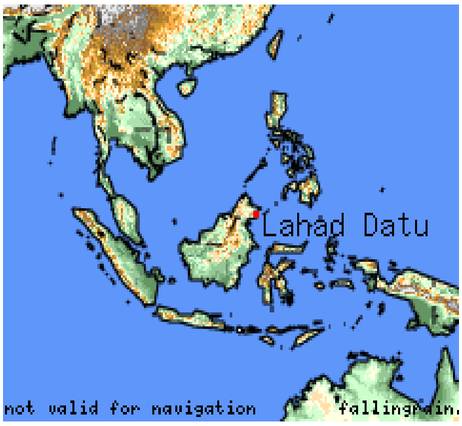
4. The outline of the project

4.1 Project location

Sawit Kinabalu, which is the counterpart in this project, is located in Sabah and owns eight palm mills, one oil refinery and one research facility in Sabah. They also own 73,591 ha of palm plantation. (Chart 5).

The mill where the project will be conducted is the Sebrang Palm Oil Mill in the city of Lahad Datu owned by Borneo Samudera Sdn. Bhd., which is a subsidiary of Sawit Kinabalu Bhd. The description of the mill is provided in chart 6.

Chart 5: Operational bases of Sawit Kinabalu



Source：Home page of Sawit Kinabalu

Chart 6: General description of Sebrang Mill

Name of the mill	Sebrang Palm Oil Mill
location	P.O.Box 60211 91111 Lahad Datu, Sabah, Malaysia
Capacity of the mill	90Mt/Hr
Operational hours/day	16Hrs/day-2 shift
FFB treatment volume/day	1,000Mt
FFB treatment volume/year（2006）	332,800Mt

4.2 Current situation of the effective use of palm oil mill waste and effluent

Biomass wastes emitted from palm oil mills are generally as listed in chart 7.

At the Sebrang Mill, palm kernel shell (PKS) and fiber are used as the biomass fuel for the boiler which provides the electricity and process steam used in the mill. However, EFB, which is high in moisture and low calorific value, is left as waste including for mulching at palm plantations.

As for POME, it is treated for water quality in eight open lagoons (consist of cooling ponds, anaerobic ponds, aerobic ponds), then released to rivers.

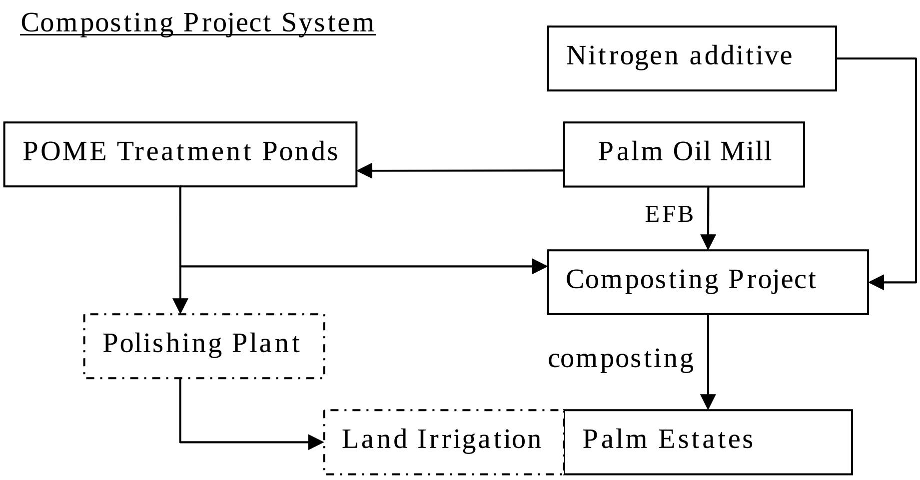
Chart 7: Different types of biomass wastes

	Emission ratio per FFB (%)	Water (%) or COD/BOD (ppm)
EFB (empty fruit bunches)	22-23	60-65
PKS (shell)	6.0-7.0	8.0-10.0
Fiber	10.0-12.0	40.0
POME	50-60	BOD (ppm)：25,000-30,000 COD (ppm)：50,000-90,000

4.3 Definition of the project technology

The technology used in this project was developed by the National Institute of Livestock and Grassland Science, which is part of the National Agriculture and Food Research Organisation to treat cow and raw wastes, and was jointly mechanized by the Institute and Okamoto Seisakusho. This large-scale equipment that treats 100 tons/day and is operational as a fully automated compost plant will be converted to a composting system for EFB, which are the waste generated in palm oil mills.

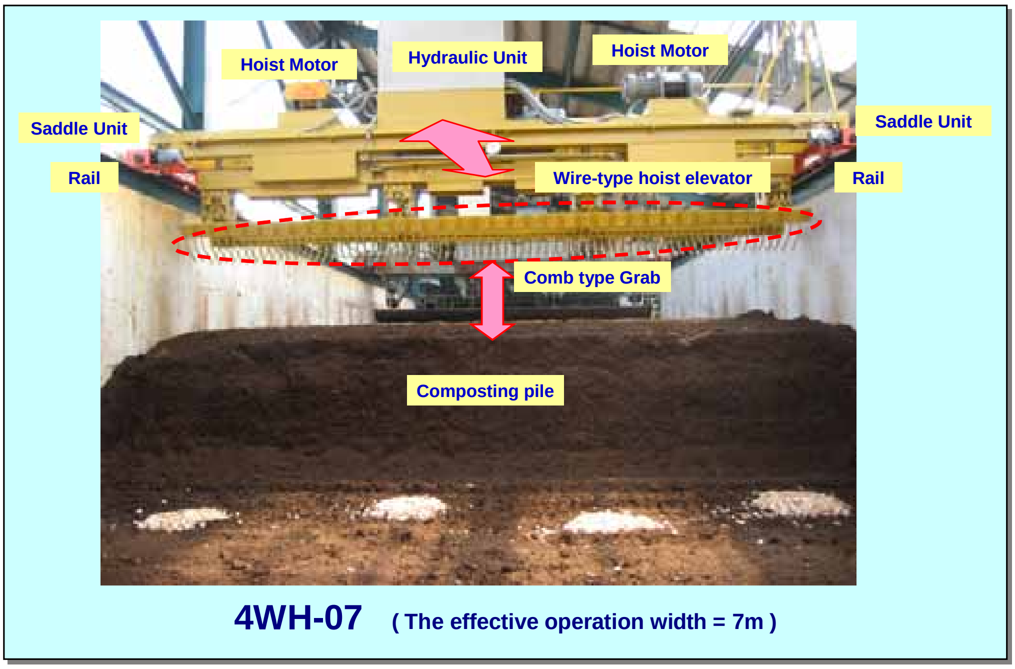
(1) Process flow



(2) Plant specifications

Equipment to introduce	Indoor linear turner composting system
EFB treatment amount	400m^3/day（27,821ton/y）
POME treatment amount	426m^3/day（127,704m^3/y）, COD：50,000ppm
Composting period	48days
Compost pile area	7,680 ㎡（4 lanes）
Major equipment	Linear crane turner, suction ventilation odor control system
Housing area	270m×184m

Linear Crane Turner



4.4 Baseline scenario and proof of additionality

(1) Application of methodology

"Avoidance of methane production from decay of biomass through composting" AMS.III.F/ Version 5 will be applied.

(2) Establishing the baseline

The baseline scenario, as defined in AMS.III. F/Version 5, is the situation where, in the absence of the project, EFB, which is biomass waste, are dumped and left to decay within the project boundary and methane is emitted to the atmosphere. It is also a situation where POME and POME sludge are treated in open anaerobic lagoons and the generated methane is not collected but emitted into the

atmosphere.
In order to clarify the baseline scenario, alternative scenarios to the project are defined as follows.

Treatment of EFB and/or biomass wastes
Scenario EFB-1: EFB are used for mulching palm plantations
Scenario EFB 2**:** EFB are left as wastes in palm plantations
EFB is dumped in palm plantations and left to decay naturally as is the custom (common practice).
Scenario EFB 3: EFB are used as biomass fuel for power generation and/or steam generation.

Treatment of POME
Scenario POME 1: Closed digester tanks are installed POME in tanks is anaerobically fermented to collect the generated, then the biogas is flared or used as energy for boilers and gas engines.
Scenario POME 2: Aerobic lagoons are erected to control methane generation from anaerobic ponds.
Scenario POME 3: Treat POME in the existing open lagoons (aerobic and/or anaerobic lagoons)
POME is treated in open lagoons in most palm oil mills in Malaysia. (common practice)
Scenario EFB-POME 4: Making compost by utilizing dumped EFB. POME will be used for humidification. (The project scenario without CDM)

(3) Baseline scenario and evidence of additionality
Additionality will be proved by comparing to the situation where this project is not adopted, in accordance with the "Tool for the demonstration and assessment of additionality (version 04)".

(a) Investment barrier analysis
Scenario EFB 1: Because of the treatment cost of mulching as well as limited workforce, mulching has to be considerably limited.
Scenario EFB 3: EFB have high moisture ratio of 60-65% when generated as mill waste and are difficult to use as fuel. There have been a few cases where excess electricity is generated and sold to affiliated electricity companies. But economic barriers are very high and just as the project itself, CDM credit has to be considered.
Scenario POME 1: Economically not feasible unless it is a national or a CDM project.
Scenario POME 2: Economically not feasible.
Scenario EFB-POME 4: Business feasibility of the project is seen from the IRR point of view. In terms of the IRR, business feasibility of the project is negative without CDM credit even when fertilizing the palm plantation with compost could reduce the cost of chemical fertilizer by 5%. On the other hand, if CDM credit sales are taken into consideration, this project is feasible as a business as the table below shows. So there is an investment barrier in carrying out the project.

The relationship between CER value and IRR

CER value ($/CER)	Business duration	0	8	10	12	14	16
IRR (before tax)	10yr	(—)	▲1.80%	2.17%	5.73%	8.98%	12.03%
	21yr	(—)	7.04%	9.92%	12.55%	15.03%	17.40%
IRR (after tax)	10yr	(—)	▲1.80%	1.62%	4.44%	7.16%	9.75%
	21yr	(—)	5.82%	8.37%	10.72%	12.93%	15.03%

From the above, scenario EFB 1, scenario EFB 3, scenario POME 1, scenario POME 2 and scenario EFB-POME 4 cannot be the baseline scenario.

(b) Analysis of technological barriers

Scenario EFB-POME 4: This composting project will utilize an advanced composting technology with the following characteristics.

- All-weather, indoor type automatic linear crane turner, computer controlled, makes 24hours continual unmanned operation possible. (one monitor is necessary)
- Suction ventilation system is used on the compost pile for the first 1/3 of composting pile pneumatic ventilation system for the last 2/3 when the ingredients have become relatively stable, for odor control such as ammonium, to maintain good indoor environment. According to sample analysis, the ratio of carbon to nitrogen of the compost made of EFB is high (around 70%), but by adding nutrients, such as animal waste, in addition to POME and POME sludge when necessary, it is possible to keep high temperature for fermentation.
- By maintaining high temperature fermentation for a long time, it became possible to produce good-quality compost and reduction of POME can be achieved through water evaporation. It is estimated that it is possible to cut 70% or more of the total amount of POME.

The above technology does not exist in Malaysia as of now and even system establishment costs are high without acquiring CDM credit. Hence it can be seen that there is a technological barrier.

(c) Analysis of propagating barrier

Outdoor and indoor compost projects using EFB and POME are being conducted. But there are only one or two examples of outdoor system, which does not reduce methane adequately, and management and maintenance as well as labor conditions are difficult. On the other hand, the indoor system is not economically feasible and there are examples only under limited conditions.

As have been seen, scenario EFB 2 and scenario POME 3 are not inhibited from any barriers, and consequently, these two scenarios, which are seen as common practice, will be used as baseline scenarios.

Scenario EFB-POME 4, which is the scenario for this project, faces three barriers, which proves that there is additionality to the scenario.

4.5 GHG emission reduction calculation

(1) Applied calculation

ERy = BEy －（PEy＋Leakage）

- ERy Emission reductions in the year “y” (tCO2e)
- PEy project activity emissions in the year “y” （tCO_2e）
- Leakage leakage in the year “y”（tCO_2e）

BEy ＝ BE_{CH4}, swds, y－MDy, reg＊GWP_CH_4＋MEPy, ww＊GWP_ CH_4

- BEy The baseline emissions in the year “y”(tCO2e)
- BE_{CH4}, swds, y methane generation potential of solid wastes such as EFB in the year “y” that have been composted by the project in the “x” years since the beginning of the project（tCO_2e）
- MDy, reg＊GWY_CH_4 amount of methane destroyed or burnt according to regulations. (tCH_4)
- MEPy, ww methane generating potential of POME (tCH_4)
- GWP_ CH_4 GWP for CH_4（21 tCO_2e / tCH_4）

MEPy, ww ＝Qy, ww＊CODy, ww, untreated＊Bo, ww＊MCFww, treatment＊GWP_ CH_4

- Qy,ww volume of the POME or compost watering in the year “y” (m^3)
- CODy,ww,untreated chemical oxygen demand of the POME（t/m^3）
- Bo,ww methane producing capacity for POME（0.21kg CH_4/kgCOD）
- MCFww, treatment methane correction factor for the POME treatment system in the baseline scenario (value of 1.0, MCF higher value as per table III.H.1)

$BE_{CH4,}$ swds, y is calculated by applying the methodological tool, “Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site “.

$$BE_{CH4,}\ swds,\ y = \varphi \cdot (1-f) \cdot GWP \cdot (1-OX) \cdot 16/12 \cdot F \cdot DOCf \cdot MCF \cdot \Sigma \cdot \Sigma W_{j,x} \cdot DOC_j \cdot (1-e^{-kj}) \cdot e^{-kj \cdot (y-x)}$$

EB recommendation value: K value of EFB=0.035 is used as coefficient

(2) Calculation results

Chart 8: Emission reduction amount

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	
28,968	29,822	30,647	31,443	32,213	32,955	33,673	34,365	35,034	35,680	
Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21
36,303	36,905	37,487	38,048	38,590	39,113	39,655	40,124	40,595	41,049	41,488

4.6 Environmental impact and contribution to sustainability

(1) Evaluation of environmental impact and other effects on environment

This business is not applicable to the 19 businesses defined in the environmental orders related to 1987 environmental impact evaluation and so it is not necessary to evaluate the impact on environment.

This project will not only decrease the amount of methane emitted from dumped EFB and POME but will use about 70% of POME for composting, and will decrease the amount of POME deposited into rivers. In addition, this project will lead to improvement of soil condition by application of compost product as an organic fertilizer. These are the cobenefits brought by this project, which would contribute to the sustainable development of Malaysia.

(2) Contribution to sustainability

(a) High quality compost

The compost produced by this project will be created indoors with high-powered mixing and sucking system using Japanese technology will be of high quality and can substitute the chemical fertilizers that are currently used.

(b) Economic efficiency of replacing chemical fertilizers

The high quality compost will be able to replace the chemical fertilizers that are currently used. As a result, costs will be cut as a result of decreased use of expensive chemical fertilizers. In the future, when production becomes stable, the compost can be sold, creating a business opportunity.

(c) Avoiding harmful effects on children and grandchildren by replacing chemical fertilizers

There is a possibility that sustaining palm plantations may not possible as many years of using chemical fertilizers could turn the earth barren and production ratio of palm could decrease. Chemical fertilizers may also have harmful chemical effects on children and grandchildren. It will be possible to avoid such possibilities by composting.

(d) Technology transfer

The compost technology developed in the stock-raising sector in Japan would be transferred.

(e) Engineering training and job creation

Transfer of compost technology would provide training in engineering as well as create jobs.

(f) Efficient use of land

If all POME should be utilized in the end, land occupied by aerobic and anaerobic lagoons could be used more efficiently for other purposes.

These are the benefits of reducing greenhouse gas emission and would contribute to maintaining the development of Malaysia.

5. Towards implementation

5.1 Operational framework

Chart 9: Operational arrangement

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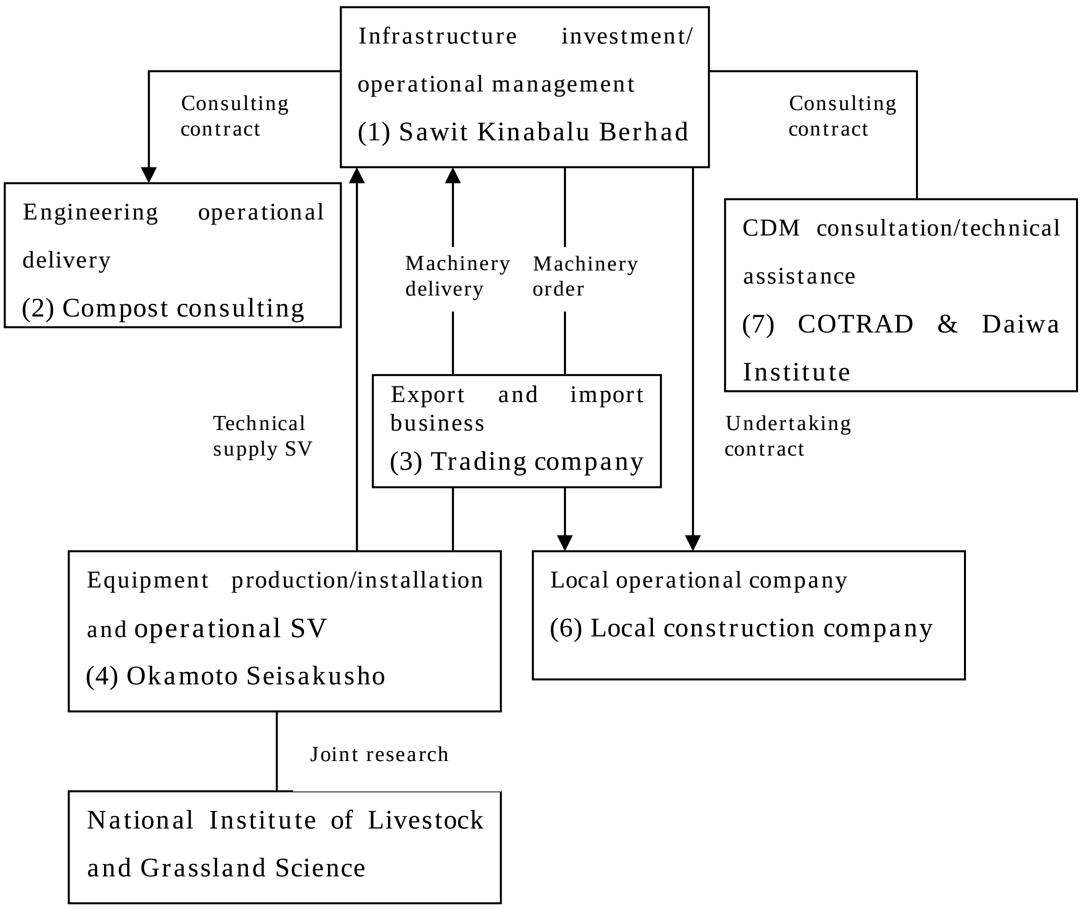


1	Sawit Kinabalu Berhad	Contractor of this project.
2	Local Compost consultant(undecid	In introducing equipment to palm mills in Malaysia, engineering, operational management, operational delivery, etc are often consigned to a

	ed)	local consultant. This project will also hire a consultant which will be chosen based on past records, and it will be ideal to choose a company that has the capacity to cooperate in technical transfer and localization of the production in the future.
3	Trading company (undecided)	Local production is in the view but as long as the machinery is produced in Japan and exported, it is necessary to have a trading company as the intermediary.
4	Okamoto Seisakusho Co. Ltd	Okamoto Seisakusho develops and creates machinery for automated feeding system and automated composting system for Japanese livestock industry. The composting system that will be introduced was jointly developed with the National Institute of Livestock and Grassland Science.
5	National Institute of Livestock and Grassland Science	National Institute of Livestock and Grassland Science is a research institute which is under the National Agriculture and Food Research Organisation. As this will be the first time the composting system will be applied for EFB and POME, it will be necessary to gain the support of the Institute.
6	Local operational company (undecided)	A local operational company that has the capacity to carry out the engineering and building construction of this project will be chosen.
7	COTRAD & Daiwa Institute	Consigned by Sawit Kinabalu, they will provide support consultations (drawing up PDD, UN registration, etc) in view of CDM.

5.2 Plans for funding

(1) Underlying conditions

Duration of project	21years
Machinery infrastructure	Depreciation at the time of acquisition；20% Annual depreciation；14%（fixed instalment method）
Corporate tax	28%
Carry-over period of losses	Unlimited
Rate	１RM＝33 yen、US$1＝120 yen

(2) Cost balances

(a) Cost of acquiring equipment

	expenses（thousand yen）	expenses（thousand RM）	Notes:

1. Machinery	137,800	4,180	Linear turner, ventilation system, control system, etc
2. Public works construction	114,000	3,450	Building, engineering, etc
3. Initial cost of additives	2,000	60	enzyme
4. Others	89,000	2,700	Planning, SV, marine transportation, etc
Total cost of acquiring equipment (at the time of acquisition)	342,800	10,390	
Cost of overhauling （in the 11th year）	20,000	600	

(b) Management cost for sustaining operation

	expenses（thousand yen）	expenses（thousand RM）	Notes
Cost of additives	3,000	90	Cost of fuel（light oil）
Machinery maintenance and management cost	4,100	125	Cost of machinery×3%
Labor cost	5,000	150	overseer 1 person（@1,000/year） Workers: 2 shifts×5 people（@ 400/year）
General management cost	1,200	35	Total of the above×10%
total	13,300	400	

(c) Business profit

	expenses（thousand yen）	expenses（thousand RM）	Notes:
Reduction of fertilizer cost	13,200	400	5% of the current fertilizer*

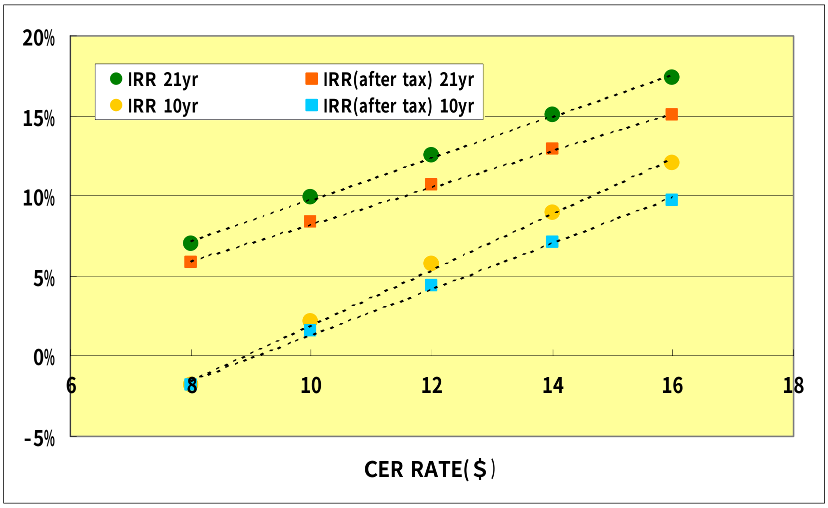
*Compost will aim for self consumption in plantations for the time being and regard the reduction in chemical fertilizer costs as business profit.

(3) Evaluation of business feasibility

Internal rate of return (IRR) was calculated with (1) and (2) as preconditions, by using the GHG reduction volume calculated in the previous section, and with the CER value of $0 or $8 to $16 (Chart 10). The above IRR uses the project IRR figure which does not take borrowing into account.

When the CER is $0, IRR would be minus and the project is not feasible as business. On the other hand, according to conversations at Sawit Kinabalu, fund raising interest in Malaysia is 6.5% or more, and the minimum condition to carry out a business is ERR>10%. When evaluating the IRR for business duration of ten years, the CER value must be more than $16, which means that it is necessary to improve the profitability by cutting costs.

Chart 10: The relationship between CER value and IRR



(4) Issues for consideration in the future

As calculated in the previous section, economic justification for the project is weak based on the conditions used in the FS. However, by solving the problems mentioned and improving the accuracy of various cost data, it would be possible to increase business opportunities.

By putting the issues for the future into the following three groups, let us consider the way forward.

(a) Cost reduction by localizing

The equipment cost calculation is based on the assumption that machinery will be produced in Japan and then exported. As for construction fees, they seem to be based on the construction fees in Japan and the average local price in Malaysia.

In the future, cost reduction will be pursued by increasing localized areas upon consultations with the local consultant and the local operational company.

(b) Sample test using POME

Only the sample tests of EFB were conducted in this FS. By using ammonium and uric acid in place of POME, the FS showed that this is a realistic project as well as the_characteristics of reaction.

Conducting a sample test using POME in Malaysia would make it possible to learn the characteristics in accordance to reality and to acquire the data on implementation effectiveness. As of now, the benefit of reducing the POME treatment cost is not considered as business profit, but by acquiring a trustworthy data, it may be possible to appropriate it as business profit.

(c) Increase in the compost value

(c)-1 Clarification of the benefit of using compost as a fertilizer

As a result of the sharp increase in the oil price, the cost of chemical fertilizers is also increasing rapidly. Profitability of the project would increase dramatically if there were a considerable benefit in replacing chemical fertilizers by compost fertilizer.

In this FS, a conservative figure of 5% (figure quoted by a local palm businessman) was used as reduction effect to calculate the economic benefits, but it is necessary to confirm the benefit of converting to composts by using them on palm trees in testing plantations.

(c)-2 Improvement of the compost quality

Based on the samples, following observations are made on the quality of the generated compost.

- Applied technology enables adequate aerobic fermentation resulting in composts that have good enough quality to be used in palm plantations. (There are cases where local compost techniques do not enable adequate aerobic fermentation.)
- Nitrogen additive enhances fermentation, thereby improving the C/N ratio, resulting in composts with higher quality than those produced with local technology.
- However, it is likely to take another three to six months of composting to completely dissolve EFB, which is hard to break down, and to produce composts that have the quality to be used in farming and gardening. This would not be cost effective.
- Consequently, the composts produced in this compost plant are medium in quality and can be used as supply material for the factories producing final products or as mixing ingredient for agricultural or gardening material.

The possibility of improving the compost quality by adding an acquirable source of nitrogen (animal waste) will be examined to increase the benefit of cutting the use of chemical fertilizers.

(c)-3 Consideration of the compost sales possibility

This FS assumes that all generated composts would be consumed in-house, but Sales route for composts and securance of the source of profit should be studied.. The possibility of a higher profit from sales than the benefit of chemical fertilizer cost reduction through in-house consumption will be examined.