

Palm oil production for oil and biomass; The solution for sustainable oil production and certifiably sustainable biomass production?

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Approach

Research question:

Evaluate the concept of enhancing the sustainability of the palm oil production by a combined utilisation of palm oil and biomass residues to produce a certifiable sustainable biomass and oil.

Approach:

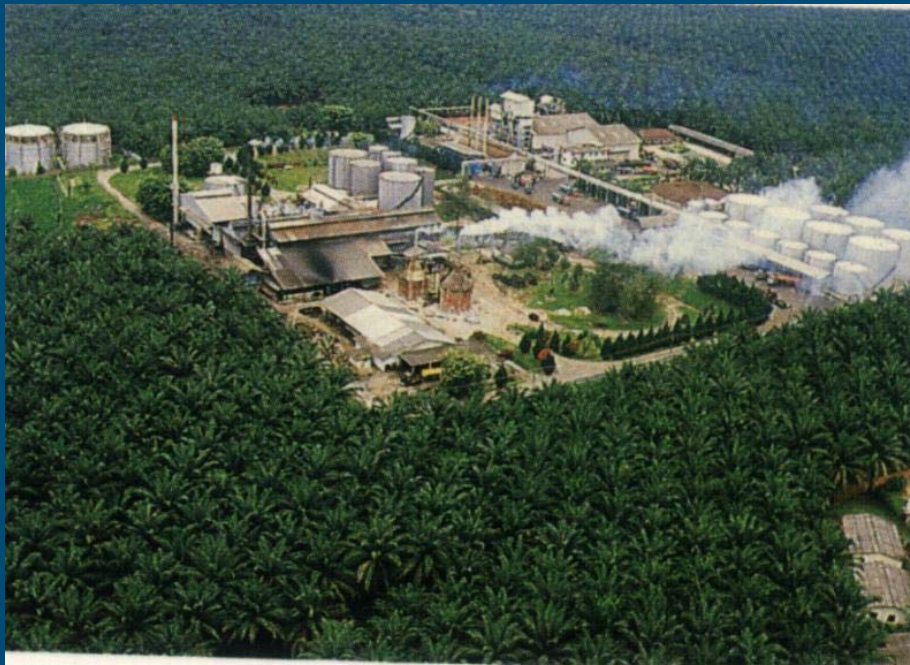
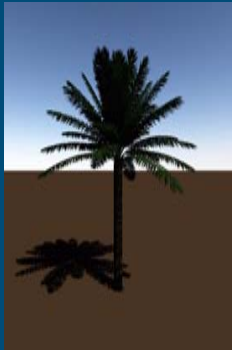
- Quantity end-products and by-products (gross)
- Current practical and proposed uses of the (by-)products + utilisation rate and utilisation efficiency
- Constraints on making by-products available for energy + products
- Conclusions

Oil Palm

- Oil Palm native species from West Africa
- 27 millions of tons a year, 23% of the World's vegetable oil production (2003)
- 7 million hectares (almost two times the size of The Netherlands)
- Extensive global expansion (from 2 to 7 million ha in last 20 years)
- 80% of the World production on account of Malaysia and Indonesia
- Palm oil and palm kernel oil are the only “products” from the production chain (theoretically 9% of the produced biomass), the rest is considered “waste”



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Oil oil products and by-products

Product	Where , when	DM, Per ton oil	World million tonnes DW
Crude Palm Oil (CPO)	Mill	1	25
Kernel oil (KO)	Mill	0.10-0.15	2.5
Oil Palm Fronds (OPF)	Field	1.65-2.0	41.5
Roots	Field, every 20/30 years	0.87	22
Trunks	Field, every 20/30 years	0.4-0.67	10 to 17
Empty Fruit Bunch (EFB)	Mill	0.32-0.42	8 to 10
Fibre	Mill	0.32-0.5	8 to 12
Shells	Mill	0.13-0.4	3 to 10
Palm Oil Mill Effluent (POME)	Mill	0.35-1.0	9 to 25
Palm Kernel Cake (PKC)	Mill	0.06	1.5
Products	Mill	1,1	28
Field by-products	Field	2.9-3.5	70 to 80
Mill by-products	Mill	1,2-2.3	30 to 50

Utilisation now and options

Product	World production Million ton DM	Prod/ha	Composition	Current or <i>possible</i> uses
Crude Oil	41,638	5,70	crude fibre 45%; protein 5.8%	Mulch, pulp, fibre, feed
Roots	21,954	3,01	Wood?	Mulch
Trunks	16,907	2,32	-	Mulch, <i>fibre board</i>
Empty bunch	8,075	1,11	45-50% cellulose; 25-35% hemicellulose and 25-35% lignin	Mulch, fuel, bunch ash, <i>fibre board, pulp, paper</i>
Fibre	8,075	1,11	65% cellulose; 19% lignin	Fuel for mill, <i>fibre board</i>
Shells	3,281	0,45	-	Fuel for mill, activated carbon, briquette, <i>particle board</i>
Effluent	8,832	1,21	95-96% (w/v) water; 0.6- 0.7% (v/v) oil; 4-5% (w/v) total solids including 2-4% suspended solids	Methane production, fertilizer, feed, <i>soap</i>
Kernel oil	1,514	0,21	8.3% oil, 17.5% crude fibre, 14.5-19.6 % protein	Feed, fertilizer

Utilisation *rate* Malaysia, 1999=89%

Biomass	Quantity produced (Million tons)	Quantity utilised (Million tons)	utilised (%)	Method of utilisation
Pruned fronds	27.2	25.8	95	Mulch
Trunks/frond replanting	1.4	1.1	80	Mulch
Fibre	3.6	3.2	90	Fuel
Shell	2.4	2.2	90	Fuel
POME	1.4	0.5	35	Nutrient source & organic fertiliser
EFB	3.4	2.2	65	Mulch & bunch ash
Total	39	35		

Level of utilisation = 89%. Source: Gurmit (1999)

Utilisation rate and efficiency is low



Utilisation efficiency

- “The palm oil industry is one of those rare industries where very little attempt is made to save energy” Husain et al (2003)
- Malaysian methane emission from open of effluent ponds amount to 225.000 tons (1999) = 5,17 million tons of CO₂.
- Piling up of waste biomass = CH₄ production, eutrophication of surface water, illegal burning (CO₂), soil mining of plantation

Palm oil electric potential:

- Malaysia:
 - Palm oil mill residues 18 million tons = 3197 GWh
 - Effluent 31.5 million tons = 1587 to 2250 GWh
 - Total Malaysian electric potential is 15000 GWh.

- World electric potential = 30000 GWh = 8333 TJ

Palm oil is major biomass source in Malaysia

- ◆ There are abundance potential biomass resources in Malaysia, suitable for energy production
- ◆ **Oil palm residues** are the major potential for power generation amounting to about **2400 MW**
- ◆ **Paddy residues** are also potential biomass for power generation estimated to give about **156 MW**
- ◆ **Bagasse** is mainly used in sugar mills to generate power and steam for their own consumption
- ◆ **Wood waste residues** is declining due to modern equipment used and recycled for other products

Pro

- People

 - Local electricity and bio-gas production

 - Local employment

 - Lower fossil fuel imports

 - Less env pollution

- Profit

 - More income per ha

 - Lower cost of recycling nutrients

- Planet

 - More money better management = better soil fertility = sustainable system

 - Slowing deforestation

 - Lower methane emissions

 - Easier recycling

 - Less burning

Contra

■ People

Local use of biomass not possible = local demand for (fossil) fuels

Labour is often restricted

Will biomass that is based on a controversial palm oil system be considered sustainable?

■ Profit

Logistics too expensive

Nutrients exported in the biomass have to be replaced at a cost.

Returning ash and digestate are essential to prevent depletion = a cost

■ Planet

Recycle everything!!

Soil carbon has to be replaced on poor forest soils

Utilisation instead of recycling = loss of soil fertility = reduced sustainability of plantation = more pressure on virgin forest

Conclusions

- There is a large potential to use by-products at least 100 million tonnes
- Net potential is much larger than current use up to 30000 GWh = 8333 TJ
- 25 to 50 % of the by-products may be available for energy export (corresponding roughly to 30-60 million tons dry weight biomass)
- Move from waste to resource!
- Logistics!
- Balance – recycling (C and nutrients) – profit –
- The recognition that utilising by-products for added value is beneficial to the sustainability of palm oil production is essential for certifying the sustainability of the palm oil biomass energy and products.
- Multi-stakeholder involvement needed. Include outsider (non-food) industries involved in energy and fibre products

Issues that should be addressed:

- How much biomass is needed for mill operations?
- How much nutrients have to be returned (nutrient and carbon recycling)?
- Which systems that generate energy and products fit? (low nutrient off-take?)
- Evaluation of the competitive potential to supply new biobased markets (energy, products and carbon fixation)
- Logistics?
- Information on countries outside Malaysia?
- Move from waste to resource: make your case to the world!