Sustainable Waste Management in Palm Oil Mills

Tjandra Setiadi ¹) and Udin Hasanudin ²)

¹) Centre for Environmental Studies
Centre of Resource Efficient and Cleaner Production Indonesia
Institut Teknologi Bandung, Bandung, Indonesia

²) Department of Agro-industrial Technology,
Faculty of Agriculture, University of Lampung,
Jl. Sumantri Brojonegoro No. 1, Bandar Lampung, Indonesia

tjandra@che.itb.ac.id
Country Profile - Indonesia

• Area : 1,904,000 km²
• Population : 246.9 millions (2012)
• Growth rate : 5.6 % (2013)
• GDP per capita : USD 3,420 (2012)

(source: http://data.worldbank.org/country/indonesia)
Palm Oil In Indonesia

• Largest Crude Palm Oil (CPO) producer in the world since 2006

• 45.5 % of the world’s CPO are from Indonesia
Indonesia Production

Indonesia Exports

Source: http://ers.usda.gov/
Mass Balances for 40 ton FFB/hour

FFB – Fresh Fruit Bunches; POME – Palm Oil Mill Effluents; EFB – Empty Fruit Bunches
Waste from Palm Oil Activities
Plantation

Oil palm trunk

Oil palm frond

Root

FFB - Fresh Fruit Bunches
POM - Palm Oil Mill
EFB - Empty Fruit Bunches

Waste POME

Biomass waste

Palm kernel shell

FFB

POM

EFB

POME
Current Practices in Indonesia POM
BIOMASS UTILIZATION IN PALM OIL MILL

ffb

Steam electricity

Boiler

Fiber

Kernel shell

EFB

Boiler ash

Boiler

FFB

Palm tree
The anaerobic ponds emit a huge amount of the strong greenhouse gas, i.e. methane and the effluent of the ponds contains nutrients responsible for pollution of surface and ground water
Land Application for Palm Oil Mill Effluents

- **POME**, either in fresh or treated form, contains a high level of plant nutrient. When the BOD level is brought down to below 5,000 mg/l, the treated POME is **allowed to utilize for land application in oil palm plantations**. Studies by various groups have demonstrated that such an application has been **beneficial to oil palm**, besides the saving on fertilizer cost extensively.

- However, **controlling the ground and surface water pollution** is the key factor for successful of the land application.
SUSTAINABLE WASTE MANAGEMENT

Possible Options

- Biogas from POME → existing energy system or for electricity generation
- Dewatered EFB → heat and/or electricity or organic diesel
- EFB → incineration → mulch or fertilizer
- EFB → co-composting with POME
- The recovered remnant oil → supplement for CPO production or used to produce bio-diesel

Possible Options

Palm Plantation → Fresh Fruit Bunches → Crude Palm Oil Extraction → Crude Palm Oil → Refining Process

Possible Options

Root → Oil Palm Frond → Oil Palm Trunk → Empty Fruit Bunches → Excess Palm Kernel Shells → Remnant Oil from EFB → Liquid Waste Palm Oil Mill Effluent
Electricity Generation from POME

The benefit of methane capture from POME and their impact to reduce global and local environmental burden
The potential of electricity production and CO$_2$e emission reduction from POME at palm oil mill with capacity 45 tons of FFB/hour

**INPUT**
- Capacity: 45 Ton FFB/h
  900 Ton FFB/day
- COD Influent: 45000 mg/l
- Flow rate: 630 m3/day
- COD load: 28350 kg COD/day

**BIOGAS PLANT**

**BIOGAS Production**
- CH4 Production: 8930.25 m3/day
- CH4 Concentration: 65%
- Biogas Production: 13739 m3/day
  572 m3/h
- LHV: 23 MJ/m3
- Potential electricity production: 3.66 MW
- Eff. Conversion: 35%
- Electricity production: 1.28 MW

**OUTPUT**
- COD Effluent: 4500 mg/l
- COD removal: 90%
- Flow rate: 630 m3/day
- kg DOD rem: 25515 kg CODr/day

**CO$_2$e Emission Reduction**
- 133.95 tons CO2/day
Integrated Solution for zero-waste effluent and palm oil solid waste

EFB-POME compost production

Remarks:
1. Thresher
2. Bunch Crusher
3. Mini Thresher
4. Bunch Shredder
5. Hopper
6. Transport from mill
7. Heap making
8. Mixing
9. Spraying heap using POME
10. Maturation
EBF-POME co-composting plant shown that about **13.06%** of POME still remain and need to be treated or utilized for land application.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Unit</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFB</td>
<td>Ton</td>
<td>1</td>
</tr>
<tr>
<td>Volume of POME</td>
<td>m³</td>
<td>0.7</td>
</tr>
<tr>
<td>EFB</td>
<td>ton</td>
<td>0.23</td>
</tr>
<tr>
<td>Volume water in FFB (moisture 60%)</td>
<td>m³</td>
<td>0.138</td>
</tr>
<tr>
<td>Total POME spraying to EFB heap (3 m³ of POME/ton EFB)</td>
<td>m³</td>
<td>0.690</td>
</tr>
<tr>
<td>Total water evaporated, assumption</td>
<td>m³</td>
<td>0.657</td>
</tr>
<tr>
<td>Evaporation rate 51 l/ton EFB/day*) **)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total non evaporated water</td>
<td>m³</td>
<td>0.171</td>
</tr>
<tr>
<td>Total weight of compost (65% of EFB)</td>
<td>ton</td>
<td>0.150</td>
</tr>
<tr>
<td>Total water in compost (moisture 60%)</td>
<td>m³</td>
<td>0.90</td>
</tr>
<tr>
<td>Total Leached production</td>
<td>m³</td>
<td>0.081</td>
</tr>
<tr>
<td>Total un-utilized POME</td>
<td>m³</td>
<td>0.010</td>
</tr>
<tr>
<td>Total wastewater produced</td>
<td>m³</td>
<td>0.091</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>13.06</td>
</tr>
</tbody>
</table>

*) Schuchardt et al., 2002.

**) Assumption: effective evaporation conducted for 8 weeks (56 days)
Palm Oil Industries as an Eco-Industrial Cluster
Case Study: Riau Siak Hulu Cluster
Source: IGES Report, 2008
1. PT Multi Palma Sejahtera POM (45 t FFB/h) non plantation
2. PT Sinar Agro Raya POM (45 t FFB/h) non plantation
3. PT Inti Indo Sawit Subur Buatan I (60 t FFB/h)
4. PT Sinar Siak Dian Permai POM (90 t FFB/h)
5. PT Meridan Sejati Surya POM (45 FFB/h)
6. PTPN V Sei Pagar (30 t FFB/h)
### POTENTIAL SOURCES OF RAW MATERIAL IN SIAK HULU (IGES Study, 2008)

<table>
<thead>
<tr>
<th>No</th>
<th>Palm Oil Mill</th>
<th>FFB, ton/year</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Indo Sawit</td>
<td>210,000</td>
</tr>
<tr>
<td>2</td>
<td>Sinar Agro</td>
<td>150,000</td>
</tr>
<tr>
<td>3</td>
<td>Multi Palma Sejahtera</td>
<td>150,000</td>
</tr>
<tr>
<td>4</td>
<td>Sinar Siak Dian Permai</td>
<td>250,000</td>
</tr>
<tr>
<td>5</td>
<td>Sei Pagar PTPN V</td>
<td>150,000</td>
</tr>
<tr>
<td>6</td>
<td>Meridan Sejati Surya</td>
<td>150,000</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>1,530,000</strong></td>
</tr>
</tbody>
</table>

- **CPO**: 336,600 ton/year
- **Solid waste**
  - **EFB**: 351,900 ton/year
  - **PKS**: 91,800 ton/year
  - **MF**: 198,900 ton/year
- **Liquid waste**
  - **POME**: 918,000 ton/year
The Possible Eco-Industrial Cluster

PLANTATION

Biomass waste

POM

Power generation

Value added products

UTILIZATION OF WASTE

CPO & DERIVATIVES

LOCAL DEMAND & EXPORT

Industrial & economic DEVELOPMENT
Conclusions

• The benefits of POME utilization for biogas production and composting are the renewable energy production, saved POME treatment cost in pond systems, total utilization of the POME nutrients, reduced cost for EFB transport and utilization, and higher FFB yields in the plantation. With the process of mulch or compost production from EFB in combination of POME, with or without biogas production before, it is possible to realize a sustainable process in palm oil mills with zero waste.

• In palm industries cluster, significant amount of biomass waste generated and disposed leading to environment and local health issue. Introduction of new technologies, cluster management system, market orientation are essential for a successful transformation of these biomass waste
West Hall
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Thank You.....