PROGRESS & CHALLENGES IN UTILIZATION OF PALM BIOMASS

SHAHRAKBAH YACOB

ADVANCED AGRIECOLOGICAL RESEARCH SDN. BHD.

- Plantation areas ≈ 282,000 hectares (Malaysia & Indonesia)
- Provides agronomic advisory services & research activities in tropical tree crops

www.aarsb.com.my
Malaysian Palm Oil Industry

- Introduced in late 19th century from Africa
- The highest oil producing crop (actual ~ 3900 kg/hectare)
- The largest commodity in Malaysia, 4.17 million hectares
- USD $9.11 billion in export earning in 2006
- Palm oil the largest vegetable oil in the global oils and fats market
- Wide range of palm-based products for export – palm oil, palm kernel oil, palm kernel cake, oleochemicals and finished products
Palm Biomass Output (2006)

**Pruned fronds** - during harvesting/maintenance pruning ≈ 43.3 million tonnes

**Utilization** – returned to field as soil mulching and soil/water conservation practices

**Recycling** of nutrients, **increase** soil organic content and **improve** soil properties

**Palm trunks/canopy** - after 25 years during replanting pruning ≈ 9.4 million tonnes

**Utilization** – pulverized and returned to field as soil mulching
Palm Biomass Output (2006)

Total fresh fruit bunch processed ≈ 79.3 million tonnes

- Empty fruit bunch (EFB) ≈ 17.4 million tonnes
- Fiber ≈ 10.7 million tonnes
- Shell ≈ 4.3 million tonnes
- Palm Oil Mill Effluent (POME) ≈ 53.1 million tonnes
- Palm kernel oil (PKO) ≈ 2.0 million tonnes
- Crude palm oil (CPO) ≈ 15.9 million tonnes
Palm Biomass Today

Empty fruit bunch
≈ 17.4 million tonnes
1. Soil mulching, reduce input of inorganic nutrients & increase soil organic content
2. Compost, EFB + POME (latest application)

Palm Oil Mill Effluent
≈ 53.1 million tonnes
1. Biologically treated and discharged
2. No commercial applications
3. Compost, EFB + POME (latest application)

Shell
≈ 4.3 million tonnes
Fiber
≈ 10.7 million tonnes
1. Fuels for steam boiler to generate electricity via steam turbine & for FFB sterilization
• Intensive R & D, led by Malaysian Palm Oil Board (MPOB), universities and private R & D companies
• Diversification of products from palm oil industry
• Ensuring the sustainability of the industry
  1. Additional revenues
     - New commodities, value-added products
     - Only 10% of the total palm biomass commercially utilized
  2. Conservation of environment
     - Stricter DoE wastewater quality discharge
     - Threat of global warming (methane emission from anaerobic treatment of POME)
  3. Renewable energy
     - Depletion fossil fuel reserves
     - Fluctuating fossil fuel prices
     - National Biofuel Policy
1. Exploitation of Carbon from Palm Biomass
   - Palm Biomass: EFB, shell & fibre
   - Polymer & composite materials

2. Renewable materials
   - Palm Biomass: EFB & POME
   - Oleo chemical Industries
   - High valued commodities

3. Environmental products
   - Palm Biomass: EFB & POME
   - Certified Emission Reduction through methane mitigation projects under Clean Development Mechanisms (CDM)
Palm Biomass: Carbon Exploitation

- Several available technologies developed by MPOB
- Abundant and consistent supply of lignocellulosic materials (EFB, shell & fiber)
- Established technologies for downstream processing
- Wide application in various sectors – furniture, automotive, building
Palm Biomass: Carbon Exploitation

Among value-added products released in 2006 by MPOB

<table>
<thead>
<tr>
<th>Product</th>
<th>Raw material</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Porosity Carbon Powder</td>
<td>EFB</td>
<td>Adsorbents</td>
</tr>
<tr>
<td>Carbon Glassy</td>
<td>EFB</td>
<td>Electrodes</td>
</tr>
<tr>
<td>Electrical Carbon Brushes</td>
<td>EFB</td>
<td>Conductor</td>
</tr>
<tr>
<td>Agrolumber/polymeric composite</td>
<td>Fibre</td>
<td>Building, furniture industries</td>
</tr>
</tbody>
</table>
Palm Biomass: Renewable Materials

- Low volume but high value commodities
- Requires intensive capital and operational expenditures
- High end technologies – chemical reactions & separation processes
- Potential raw materials:
  1. Extraction of functional groups during RBD Olein and BioDiesel production
  2. Organic acids & lignocellulosic materials from POME and EFB
• Requires reliable and economical separation technology

• CPO rich in Vitamin E (600 – 1000 ppm)

• Recovery of functional groups – carotene, sterol, squalene, Vitamin E (tocopherols & tocotrienols)

• Destroyed/denatured by chemical & physical reactions

Palm Biomass: Renewable Materials

Crude Palm Oil

Degumming

Bleaching

Deodorization

Removal of Functional Groups

RBD Olein

BioDiesel

Trans-esterification
Palm Biomass: Renewable Materials

• Bioplastics – Polyhydroxybutyrate (PHB) & Polylactate (PLA)
  ➢ PHB technology
    1. Fermentation of POME to produce organic acids
    2. Fermentation of organic acids to produce PHB polymers
  ➢ PLA technology
    1. Sugar production from EFB (enzymatic reaction)
    2. Fermentation of sugar to produce L-lactic acids
    3. Polymerization of L-lactic acids into PLA resin

• Technologically proven, yet to be scaled up
Palm Biomass: Environment

- POME is the largest by-product, no commercial application
- Chemically, 95% water and 5% solid
- Treatment facility – anaerobic, facultative and aerobic
  - Biogas emission - 28m³ /m³ POME, with 35 - 45% METHANE content
  - Untapped renewable energy & UNCONTROLLED RELEASED (GLOBAL WARMING)
Palm Biomass: Environment

- **Biogas Technologies**
  - Anaerobic treatment of POME
  - Tested technologies – UASB, MABR, anaerobic filter and fluidized bioreactors
  - Limited large scale application

- **Compost/Organic Fertilizer Technologies**
  - Utilization of EFB & POME – zero discharge system
  - Two commercially available systems:
    1. Windrow systems
    2. Rapid composting system

- **Qualify for Certified Emission Reduction (CDM Methane Avoidance Projects)**
Palm Biomass – Challenges

• Economic feasibility of Palm Biomass Based Products
  ➢ Demand for palm biomass based products?
  ➢ Willingness of end-users to higher price for green products?
  ➢ Competitiveness of the products?

• Priority
  ➢ Food or Fuel?

• Environmental Sustainability
  ➢ Non-sustainable oil palm plantation?
  ➢ Deforestation?
  ➢ Threat to biodiversity?

• Shift of paradigm
  ➢ Increase input : product ratio?
  ➢ Increase energy efficiency?
  ➢ New concept of palm oil mill?
Palm Biomass – Present Carbon Cycle

- Oil Palm Plantation
- Fruits
- Pruned Fronds/Trunk
- CO₂
- Energy
- Soils
- Compost/Organic Fertilizer
- Fiber/Shell
- POME
- EFB
- CPO
- Food
Palm Biomass – Future Carbon Cycle

Oil Palm Plantation

Pruned Fronds

CO₂

Energy

External Inputs

Soils

Fossil Fuel

Fruits

Fiber/Shell

POME

EFB

CPO

Trunk

New Cluster of Industries

Composite/Polymer

New chemicals

Biofuels

New Carbon Sink

Food
OUTLOOK FOR PALM OIL INDUSTRY

Continue to lead in providing the needs of the growing world population without compromising with the needs of global environment

“Great Potential & Enormous Opportunities”

Pioneer • Innovate • Sustain
Palm Oil Industry

Palm Oil Producers

Indonesia 41%
Malaysia 45%
Others 27%

World Vegetable Oils

Palm Oil 32%
Soyabean 29%
Palm Oil 14%
Rapeseed 8%
Sunflower 8%
Groundnut 4%
Cottonseed 4%
Others 27%

Palm Oil Producers:
- Indonesia 41%
- Malaysia 45%
- Others 27%
- Thailand 2%
- PNG 1%
- Nigeria 2.4%
- Colombia 2%

World Vegetable Oils:
- Palm Oil 32%
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