The Use of Bio-Compost in Oil Palm Plantation—Sime Darby’s Experience

Scope of Presentation

1. Rationale of Composting
2. Overview of Sime Darby Bio-Compost Project
3. Production of Bio-Compost
4. Expected Agronomic Benefits
5. Future Bio-Compost Development
### Rationale of Composting

**Two main by-products of palm oil mill**
- POME
- EFB

**Issues dealing with these by-products**
- Environmental pollution
- Operational problems

### Rationale of Composting (cont)

<table>
<thead>
<tr>
<th>Common Practice</th>
<th>Problem Associated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treated to bring down BOD</td>
<td>Long retention time (90-120 days)</td>
</tr>
<tr>
<td>Land applied</td>
<td>Large area requirement</td>
</tr>
<tr>
<td>Water discharged</td>
<td>High cost for treatment</td>
</tr>
<tr>
<td>Mulching</td>
<td>High emission of CH₄</td>
</tr>
<tr>
<td>Manage the disposal of EFB &amp; POME in sustainable approach</td>
<td>Too bulky</td>
</tr>
<tr>
<td>Recycle the mill waste by converting into fertiliser</td>
<td>Difficulty in transportation</td>
</tr>
<tr>
<td>Reduce dependency on inorganic fertiliser</td>
<td>Laborious</td>
</tr>
<tr>
<td></td>
<td>Losses of nutrients</td>
</tr>
</tbody>
</table>

**POME - Environmental concerns**

**EFB - Operational issues**

**Bio-Compost - New expectation for more sustainable practices**
Rationale of Sime Darby Bio-Compost Project

Sustainable Waste Management
• Abundance biomass 5.2 million MT of POME and 1.8 million MT EFB annually
• Utilizes 100% EFB, 30-50% POME, 100% decanter and boiler ash

Risk Management i.e. Cost Savings (Long Term)
• Less dependent on costly inorganic fertilizers
• Enable effective budgeting and cost control as the buy back price is pre-determined at fixed increment annually

Greener Carbon Footprint for Palm Oil Production
• Composting process under aerobic condition, eliminates emission of methane (GHG), which entitles for registration as CDM project – additional revenue from carbon credits.
• Improved carbon intensity of palm oil production, 60-70% reduction of carbon emission

Legal Compliance
• Stricter Environmental Quality Act 1974 for wastewater discharge
• Enforcement of no waterways discharge of treated effluent

Voluntary compliance (RSPO)
• Principle 5, Waste is reduced, recycled, and disposed of in an environmentally and socially responsible manner
• Criterion 5.4, Plans to reduce pollution and emission, including greenhouse gases, are developed, implemented and monitored
Overview of Sime Darby Bio-Compost Project

- Commenced in 2003 in Lavang Mill, Sarawak
- Today 22 composting plants operated by 4 concessionaires
- Capacity of 600,000 tonnes Bio-Compost annually
- Potential Certified Emission Reduction 225,000 tonnes CO₂eq
1. Rationale of Composting

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Expected Bio-Compost Quality

- Product quality is a fundamental requirement, the concessioners have to comply the following obligations:
- Nutrient Value:

<table>
<thead>
<tr>
<th>Nutrient level (%)</th>
<th>N</th>
<th>P₂O₅</th>
<th>K₂O</th>
<th>MgO</th>
<th>Aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td>GNV (%)</td>
<td>1.8</td>
<td>0.5</td>
<td>3.4</td>
<td>0.8</td>
<td>6.5</td>
</tr>
<tr>
<td>MANV (%)</td>
<td>1.6</td>
<td>NA</td>
<td>3.0</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

- Moisture Content: < 50%
- CN ratio: < 30
- Product form not meeting the specified criteria- fibrous form will be rejected for reprocessing
Expected Fertiliser Value

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Fertiliser Equivalent</th>
<th>Quantity (Kg)</th>
<th>Value (RM)</th>
<th>Value (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>Ammonium Sulphate</td>
<td>42.0</td>
<td>38.60</td>
<td>12.50</td>
</tr>
<tr>
<td>P₂O₅</td>
<td>Rock Phosphate</td>
<td>8.9</td>
<td>5.80</td>
<td>1.90</td>
</tr>
<tr>
<td>K₂O</td>
<td>MOP</td>
<td>28.3</td>
<td>48.10</td>
<td>15.50</td>
</tr>
<tr>
<td>MgO</td>
<td>Kieserite</td>
<td>15.4</td>
<td>12.50</td>
<td>4.00</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>105.00</td>
<td>33.90</td>
</tr>
</tbody>
</table>

The “Unexpected”

1. Weather-dependent
   - Open composting system is weather-dependent will result in high surface runoff & soggy conditions, thus making operation difficult

2. High Moisture Content
   - Damages to air permeable sheets, moisture content in bio-compost can increase up to 60%
   - High nutrient leaching losses
   - High variances in moisture content could lead to wide variances in the bio-compost nutrient levels

3. Low and Inconsistent Nutrient Value
   - Poor quality of POME and the over-application of POME
4. Delay in Bio-Compost Application

- Lack of logistic support for field application.
- Bio-compost is not applied immediately and dumped by roadside.
- High nutrient losses (N & K)

5. Labour-intensive operation

- Manually applied at 2-3 points at the outer periphery of palm circle
- High moisture content (60%) leads to heavier bio-compost weight, lower productivity

6. Low POME uptake

- Composting plant can utilize about 30% of POME generated by the mill
- The excess 70% POME will have to be treated separately in a ETP

Mitigating the “Unexpected”

- Closed System of Composting

- Weather independent
- Better control of moisture
- Better nutrient content
- Reduce surface runoff & soggy conditions
Mitigating the “Unexpected” (cont)

- Mechanized Bio-Compost Application : Giltrap

- Mechanized Bio-Compost Application : MTG
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Expected Agronomic Benefits

- Improves soil chemical properties
- Improves soil physical properties
- Reduces inorganic nutrient input
- Ameliorates growth limiting factors
Expected Agronomic Benefits (cont)

Effect of Bio-compost on FFB yield in immature oil palm planting.

<table>
<thead>
<tr>
<th>Treatments Bio-compost Kg/palm/year</th>
<th>Additional Inorganic N/K₂O Kg/palm/year</th>
<th>Mean FFB Yield* (Year 1 &amp; Year 2) % Over Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.0/2.0</td>
<td>100</td>
</tr>
<tr>
<td>25</td>
<td>1.0/2.0</td>
<td>117</td>
</tr>
<tr>
<td>50</td>
<td>1.0/2.0</td>
<td>123</td>
</tr>
<tr>
<td>75</td>
<td>1.0/2.0</td>
<td>123</td>
</tr>
</tbody>
</table>

* Harvesting commenced at 25th month from planting

Source: K.P Ong (2008)

Expected Agronomic Benefits (cont)

- **Bio-Compost** is expected to give similar benefits as EFB
- It has been established that the application of EFB would increase FFB yield by 7 – 75% depending on the soil type as compared to the use of inorganic fertiliser.

Effect of EFB application on FFB yield in mature oil palm

<table>
<thead>
<tr>
<th>Soil Series</th>
<th>M/ha</th>
<th>%</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Akob</td>
<td>3.40</td>
<td>13</td>
<td>Gurmit et al., 1981 (UP)</td>
</tr>
<tr>
<td>Bungor</td>
<td>2.5-6.4</td>
<td>10-24</td>
<td>Golden Hope 1985</td>
</tr>
<tr>
<td>Malacca</td>
<td>8.27</td>
<td>75</td>
<td>Lim &amp; Chan 1990 (Guthrie)</td>
</tr>
<tr>
<td>Rengam</td>
<td>3.1-4.98</td>
<td>7-20</td>
<td>Chan et al., 1993 (Guthrie)</td>
</tr>
<tr>
<td>Tavy</td>
<td>3.92-11.19</td>
<td>16-53</td>
<td>Chan et al., 1993 (Guthrie)</td>
</tr>
<tr>
<td>Seremban</td>
<td>7.36</td>
<td>36</td>
<td>Chan et al., 1993 (Guthrie)</td>
</tr>
<tr>
<td>Harimau</td>
<td>6.05</td>
<td>29</td>
<td>Chan et al., 1993 (Guthrie)</td>
</tr>
<tr>
<td>Prang</td>
<td>3.98</td>
<td>17</td>
<td>Chan et al., 1993 (Guthrie)</td>
</tr>
</tbody>
</table>
In the topsoil, organic carbon increased from 1.49% to 2.5% and 2.73% when EFB was applied at 150 and 300 kg per palm per year respectively.

In the sub-soils, organic carbon had also increased significantly but only with the application of EFB at 300 kg.

There was also an increase in total nitrogen with EFB application.

Application of EFB increased the soil pH by TWO units with application of EFB at 300 kg per palm per year and a one unit increase with EFB at 150 kg in the 0-60 cm soil layer, compared to use of chemical fertilisers.

The application of EFB reduces the exchangeable Al contents in soils up to 60 cm depth.

Source: Rosenani et. al 2009
Field Application

1. Rates of application
   • 50 – 100 Kg/palm/year
   • Depending on soil, terrain and accessibility

2. Supplementary inorganic fertiliser
   • Rate of application depending on the bio-compost quality, application efficiency, foliar result and observation made by Agronomist during visit.
Bio-Compost
Moisture: 50%
Bulk density: 300 – 400 kg/m³
Nutrient content: N - 1.8%, P₂O₅ - 0.5%, K₂O - 3.4%

Bio-Compost Pellet
Moisture: 10 - 20%
Bulk Density: 700 – 850 kg/m³
Nutrient Content: Based on formulation

Future Bio-Compost Development

Process Flow: Bio-Compost Pellet
### Future Expectation: Enriching Bio-Compost Pellet

#### Plant Nutrient Formulation
- Specific growing phase, nursery, immature and mature phases
- Specific environments, peat and marginal soils
- Corrective application, for nutrient deficiency symptoms

#### Growth Enhancement Formulation
- Phosphate Solubilizing microbes, solubilise the fixed phosphate and improve availability to the plant,
- Mycorrhizae, enhances root development, increases the absorption surface of the root
- Azospirillum and Azotobacter, symbiotic relationship for nitrogen fixation via roots

### Expected Benefits of Bio-Compost Pellet

<table>
<thead>
<tr>
<th>Balanced nutrient content</th>
<th>• Formulated to the specific nutrient content requirements</th>
</tr>
</thead>
</table>
| Ease of handling and application | • Lower bulk volume for application  
• Less hygroscopic  
• Application rate could be reduce by half |
| Storage | • Requires much less storage space compared to bio-compost  
• Minimal deterioration in quality if prolong storage is required |
Conclusion

The conversion of EFB and POME into bio-compost offers an attractive solution for sustainable waste management to the oil palm industry.

Composting system reduces GHG emission and minimizes the risk of water pollution from POME.

The use of bio-compost could reduce the use of inorganic fertiliser thus reduce the total manuring cost.

Further research on enriched compost and effective application rate will add value to bio-compost.

Our Sustainability Journey

1985
- Introduced Zero burning

1990
- Biological control for IPM

1992
- Elected to UNEP Global 500 Roll of Honour for commercialisation of zero burning practice

1994
- EMS - ISO 14001

2002
- Founding member of RSPO

2003
- POME/EFB Composting

2004
- First GlobalGAP certification

2008
- Achieved RSPO certification

2011 and beyond
- Largest producer of certified sustainable palm oil, leading total sustainable production, food safety, CSR, and GHG reduction

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Thank You