Fixed Carbon Biochar Potential of Palm Oil Empty Fruit Bunches as a Carbon Sequestration in Agricultural in Indonesia

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Outline

Introduction
1. Biochar as a carbon sequestration
2. Palm Oil Solid Wastes & Indonesia EFB Potential
3. Biochar and Energy Production, Characterization
4. Calculation of Carbon Sequestration
5. Nationally Potential Reduction, Agricultural Sector
6. Application Challenges

Conclusion
Biochar as a carbon sequestration

• Terra Preta Invention in the Amazon
• Lehmann (2006) : The Essential of Stability of Biochar
• Maturity/Stability Level of Biochar (Spokas, 2010)
• Shackley and Sohi explanation (2011)
The Essential Stability of biochar (Lehmann, 2006)
Biochar Stability Level Using O/C Ratio (Spokas, 2010)

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Characteristic Value</th>
<th>Application Stability</th>
</tr>
</thead>
<tbody>
<tr>
<td>O/C</td>
<td>&lt; 0.2</td>
<td>&gt; 1,000 Years</td>
</tr>
<tr>
<td></td>
<td>0.2 &lt; O/C &lt; 0.6</td>
<td>100 &lt; Years &lt; 1,000</td>
</tr>
<tr>
<td></td>
<td>&gt; 0.6</td>
<td>&lt; 100 Years</td>
</tr>
</tbody>
</table>
Biochar Carbon Sequestration Principles (Source: Shackley and Sohi 2009)

CO₂ in the atmosphere

Biomass of Plant

Soil carbon

Biochar

Pyrolysis (energy)

Fossil carbon
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Solid Wastes of POM, 60 T/Hour Capacity (Hidayat et al. 2017)

Biomassa Input (FFB):
• 1.644 T/day

Solid Wastes Output:
• 107 T Shell/day
• 256 T Fibres/day
• 379 T EFB/day

Biomass Utilization for Boiler:
• 100 T Shell/day
• 231 T fibre/day

Solid Wastes Left:
• 23 T Fibre/day
• 7 T Shell/day
• 379 T EFB/Day
## Indonesia EFB Potential

<table>
<thead>
<tr>
<th>Year</th>
<th>Area (Ha)</th>
<th>Total CPO Production (Ton)</th>
<th>Solid Wastes (Ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>EFB</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fibres</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Shell</td>
</tr>
<tr>
<td>2017</td>
<td>12.307.677</td>
<td>35.359.384</td>
<td>33.053.337</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>19,985,739</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9,992,869</td>
</tr>
<tr>
<td>2016</td>
<td>11.914.499</td>
<td>33.229.381</td>
<td>31.062.247</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>18,781,824</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9,390,912</td>
</tr>
<tr>
<td>2015</td>
<td>10.527.791</td>
<td>31.070.015</td>
<td>29.043.709</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>17,561,313</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8,780,656</td>
</tr>
</tbody>
</table>
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Biochar and Energy

• Pangala (2016) -> Produce biochar and energy environmentally
• Less than 1 hour
• No need input energy, just trigerring
• Produce economically
• Produce energy negative emission (as system)
• EFB Biochar rendemen 28%
## Characterization Result

<table>
<thead>
<tr>
<th>No.</th>
<th>Parameter</th>
<th>Unit</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>pH</td>
<td></td>
<td>10,20</td>
</tr>
<tr>
<td>2.</td>
<td>Iod absorption</td>
<td>mg/g</td>
<td>229,1</td>
</tr>
<tr>
<td>3.</td>
<td>Absorption of Blue Methylene:</td>
<td>mg/g</td>
<td>58,50</td>
</tr>
<tr>
<td>4.</td>
<td>Surface area</td>
<td>m2/g</td>
<td>216,90</td>
</tr>
<tr>
<td>5.</td>
<td>Porosity</td>
<td></td>
<td>Figure 5</td>
</tr>
<tr>
<td>6.</td>
<td>Elemental</td>
<td></td>
<td>Figure 6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No.</th>
<th>Parameter</th>
<th>Unit</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Volatile Matter (VM):</td>
<td>%</td>
<td>17,54</td>
</tr>
<tr>
<td>2.</td>
<td>Fixed Carbon:</td>
<td>%</td>
<td>68,17</td>
</tr>
<tr>
<td>3.</td>
<td>Ash Content:</td>
<td>%</td>
<td>14,29</td>
</tr>
<tr>
<td>4.</td>
<td>O/C</td>
<td></td>
<td>0,45</td>
</tr>
<tr>
<td>5.</td>
<td>VM/C</td>
<td></td>
<td>0,26</td>
</tr>
</tbody>
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Calculation of Fixed Carbon Sequestration

\[ \text{Calculation of Fixed Carbon Sequestration} \]

\[ \text{Calculation of Fixed Carbon Sequestration} = \text{Amount of Biochar} \times \% \text{Fixed Carbon Content} \times 3.67 \]

**Direct effects**
- Pyrolysis emissions
- C Labile
- Stable C in biochar (Fixed Carbon)
- Avoided CH4 from compost
- Avoided energy use
- Avoided N2O

**Indirect effects**
- Spot emission and Albedo
- Land use change
- Transport
- Others
- Enhancement of SOM
- Plant response and yields
- Others

**Net Balance**
- Land use change
- Transport
- Others

- **Direct effects**
  - Indirect effects
  - Net Balance
Agricultural potential annual reduction GHG (Fixed Carbon Content of EFB Biochar)
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Conclusion
Nationally Application Calculation of Potential Reduction in Agricultural

<table>
<thead>
<tr>
<th>Reduction Target</th>
<th>Agricultural Target Reduction (MT CO2e)</th>
<th>Total EFB Needed for 100 POM @60 T/day</th>
<th>Potential of Biochar EFB As Carbon Sequestration (MT/Annual)</th>
<th>Percent Potential Annual Reduction from Target</th>
<th>Years Needed for 100% Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>26%</td>
<td>8.00</td>
<td>37,900</td>
<td>1.42</td>
<td>17.73 %</td>
<td>5.6</td>
</tr>
<tr>
<td>29%</td>
<td>8.92</td>
<td>37,900</td>
<td>1.42</td>
<td>15.90 %</td>
<td>6.3</td>
</tr>
<tr>
<td>41%</td>
<td>12.62</td>
<td>37,900</td>
<td>1.42</td>
<td>11.25 %</td>
<td>8.9</td>
</tr>
</tbody>
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Conclusion
Application Challenges

• Study regarding biochar, understanding and socialization is still limited.
• Legally PP 61/2011 is not included in the Indonesian RAN GRK
• Paradigm of Biochar need to be shift
• Sustainable biochar is needed to build
Bruckman and Klinglmüller (2014), List of challenges

• High costs of biochar production
• Impacts on soil properties
• Proof of climate change mitigation potential
• Sustainability
• Health risks
• Development of a biochar market
Conclusion

• The potential for fixed carbon of EFB biochar as a carbon sequestration application in agricultural produces significant results reduction: 17.73%/year for 26% target; 15.90% /year for 29% target and 11.25%/year for 41% target reduction in agricultural sector.

• With this system carbon sequestration will be easy to verify and calculate initial applications using only simple laboratory test data of fixed carbon content and the amount applied to calculate equivalent GHG reduction.
Suggestion

• Further research regarding various potential reductions such as those presented by Scholz (2014) needs to be done to complement the overall calculation of the potential of this application.

• In Indonesia, a biochar application research center should be developed for various other sustainable biomass feedstocks.
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Thank You