Biochar in Conservation Agriculture
Improving Crop Yield and Storing Carbon

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Overview

I. Introduction
II. Performed work in Zambia
III. Future work and outlook
What is biochar?

"Engineered" Charcoal:

- Product of airless combustion of organic waste (pyrolysis)
- "Almost" pure carbon (60-90%)

Open fire charcoal
Low carbon content
Not stable in soil
High ash content

Biochar
High carbon content
Stable in soil
Low ash content
The big question: biochar a serious wedge?

20% of annual agricultural waste into biochar:

Carbon emissions reduced by 10%

Based on Lehmann and Joseph, 2009
Multiple advantages of Biochar

- Mitigation of Pollutant Emission
- Mitigation of Climate Change
- Energy Production
- Soil improvement and Landuse
- Waste Management
Perspective: example for rice waste

- Indonesia: 30 mill tons/year of rice husk
- No useful application
- 15 mill tons C stored as biochar?
- Enough to compensate whole Norwegian carbon emissions (14 mill tons C)
- Technology immediately applicable
Biochar in Indonesia, Malaysia, Zambia, Nepal – Four projects at Norwegian Geotechnical Institute and University of Life Sciences

- Applied and mechanistic biochar research
- Laboratory and field tests
- Combination soil science, socio-economic science, implementation

- Norwegian Embassy / CFU – this project in Zambia, start Oct 2010
- "Excellent Researcher Personal Stipend", Zambia/Nepal/Indonesia, 2012-2017

http://biochar.ngi.no
Biochar in Zambia: Performed work

- Pot trials, 5 soils, 2 biochars
- Field trials, 6 stations, 2 biochars
- Biochars: corn cob biochar, charcoal dust, 350-400 C
- Small-scale farmers
- Crop: maize
Biochar and Conservation Farming: a happy couple!

• Conservation Tillage: planting basins, only 10-12% tilled
• Strongly reduces amount of biochar (and fertilizer) needed
Pot trial University of Zambia (128 pots)

1. 0.5% biochar + full fertilizer 43 g biomass
2. 2% biochar + 50% of fertilizer 34 g biomass
3. Only fertilizer 27 g biomass
4. Only 2% biochar 12 g biomass
5. Control 5 g biomass
Look Biochar Works

Kaoma, Western Zambia

Control maize char 4 t/ha

charcoal 4 t/ha

Biochar Works in poor, sandy soil at low nutrient status and low water holding capacity.
NRDC: good soil
(not acidic, good nutrient and water holding capacity)

No effect of biochar

Control  Charcoal 4 t/ha  Maize Char 4 t/ha
Harvest relative to control plots

- Sandy & acidic soils
- Acidic soils
- Good soils

3 times increase
2 times increase

Sandy & acidic soils
Acidic soils
Good soils

http://biochar.ngi.no
Why is biochar so effective?

- Compensation of acidity

<table>
<thead>
<tr>
<th>Soil/char</th>
<th>pH, no biochar</th>
<th>pH, 5% biochar</th>
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<tr>
<td></td>
<td></td>
<td>6.8</td>
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<td></td>
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<td>6.2</td>
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<th>Plant available water (vol%)</th>
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<tr>
<td>without BC</td>
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<tr>
<td>with 5% BC</td>
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- Compensation of acidity
- Nutrient sponge (CEC doubled in poorest soils)
- Water sponge: could be most important effect
Next phase 2012-2015

- Expanding field trials to 18 farmers in Kaoma, Mongu and Mkushi
- Exploring the possibility of reducing fertilizers
- Focusing on groundnuts and cotton in addition to maize
- Exploring the feedstock and possibilities for biochar production in a larger scale
- Socio economic evaluations
Generating biochar: traditional versus modern processes

Traditional Kiln

High-tech pyrolysis

http://biochar.ngi.no
Small-scale stoves (around US$30-50)

Foundation Miombo joining Zambia project
• Award-winning Peko Pe stove

Advantages
• Biochar → Soil Fertility
• Cleaner cooking
• Utilizing corn/rice husk, less need for wood

Other possibilities:
• Medium-scale unit:
  • Energy generation (electricity) and biochar generation combined
Life cycle assessments in a "nutshell"

- Calculates negative and positive impacts over the whole life cycle
- Compares potential environmental impact between alternatives


AC = Activated Char

Cleaning the Grenlandsfjords
Socio-economic evaluations of biochar

- LCA for “side effects” of different biochar production technologies and use
- Social acceptance of biochar use in conservation farming
- Cost-benefit evaluations for use in a CFU setting
Advantages in a climate context

Mitigation
• Carbon storage: Biochar in CDM?
• Reduced need for deforestation in farming
• Reduced nitrous oxide emissions

Adaptation
• Drier climate in many parts of Africa: water sponge

Perspective
100.000 small scale farmers (5 ha 1 tonnes pr year) – 50% of all CFU farmers in Zambia
• 2 mill t CO₂ tones pr year - Zambia gets climate neutral or 5% of Norwegian CO₂ emissions
Challenges for biochar

Seems to good to be true, but…..

• Is it really stable?
• Toxic compounds in biochar
• Competition between biochar feedstock and food crops
• Competition for feedstocks
• Increased deforestation just for making biochar?
• Sufficient incentive for the extra work required?
• No large capital investment possibilities
Outlook – biochar in Africa

- Biochar is mitigation and adaptation
- Biochar regards carbon as a resource rather than a waste
- Local fertilization solution: spontaneous adoption by farmers?
- Traditional and directly applicable technique