From waste to fertilizers – insides from the practice

Co-composting of organic wastes with biochar and application of biochar compost

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Dong-Gill Kim[3], Daniela Castro-Herrera[1], Katharina Prost[1], Yonas Schäfer[1], Fantaw Yimer[3], Menfese Tadesse[3], Mersha Gebrehiwot[3], Zeleke Asaye[3], Katharina A. Werner[2], Elisabeth Grohmann[2], Nicolas Brüggemann[1]

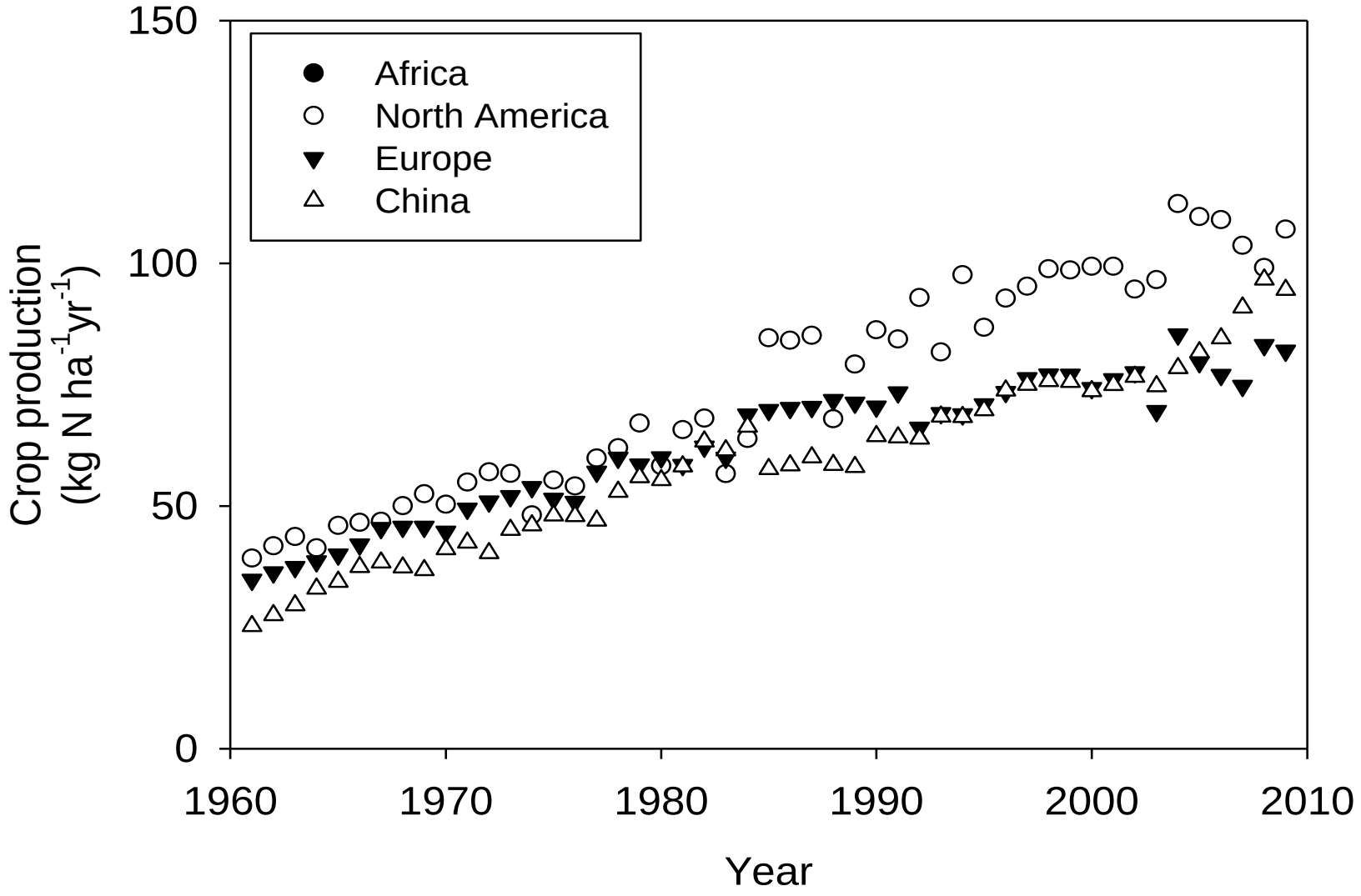
[1]Institute of Bio- and Geosciences—Agrosphere (IBG-3), Forschungszentrum Jülich, 52425 Jülich, Germany;[2] Faculty of Life Sciences and Technology, Department of Microbiology, Berliner Hochschule für Technik, 13347 Berlin, Germany; [3]Wondo Genet College of Forestry and Natural Resources, Hawassa University, Shashemene P.O. Box 128, Ethiopia

In sub-Saharan Africa, little organic residues are returned to the farmland.

Decline in soil fertility & crop yield, and eventually to soil degradation.

Mineral fertilizers are neither available nor affordable in sufficient quantities.

Changes of crop productivity in 1961 to 2009



Data source: FAO STAT

Produced food crops only cover the food need for 20% of the households in SSA (Frelat et al., 2016).

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Editorial

$35 billion food importation into Africa

By Editorial Board
21 August 2017 | 3:50 am

As important as food is to the family, nation and the African continent, how much commitment is there to its availability in sufficient quantities, and acceptable quality as well as at affordable prices? The recent experiences in Somalia and South Sudan where

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How can smallholder farms enhance food security?

Biochar

+

Compost

=

???

How to produce biochar?

- a micro-gasifier cook stove

- A top-lit up-draft micro-gasifier (NOAH Stove)
- Eucalyptus wood chips
- Pyrolysis temperature between 500 and 600 ˚C
- Residence time of 40−50 min.

Biochar

How to get compost feedstocks without competition with other uses?

- Cattle manure
- Food waste
- Crop residues
- ….

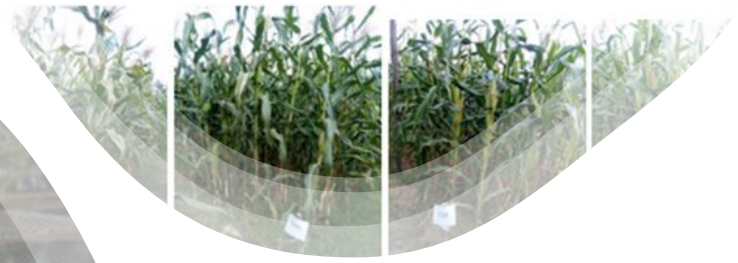
How to get compost feedstocks?

– An ecological toilet

How to get compost feedstocks? – An ecological toilet

How to generate biochar compost?

Biochar + human excreta + cattle manure + food waste + saw dust



Maize fields

Cabbage fields

Applying biochar compost in the fields

Main findings (1)

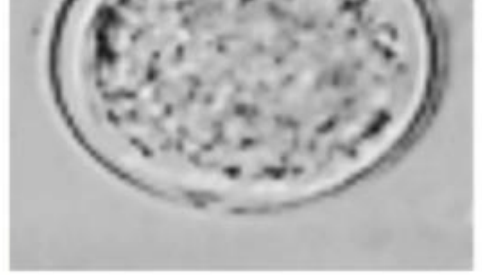
- **A micro-gasifier cook stove successfully produces-**
  - Heat for cooking (**fuel efficiency increase: 30%**)
  - Biochar (**conversion rate: 30%)**

- **Adding biochar into composting-**
  - Preserves P & K
  - Ca and Mg losses were low (<18%).
  - Reduces N_2O and CH_4 emissions by 51–71%.

Main findings (2)

- **Biochar compost was free of pathogens**
  - Meeting thresholds of German and European regulations for organic fertilizer

- **Biochar compost, compared to ordinary compost**
  - increased **crop yields by 41 – 71%.**
  - increased **soil organic carbon by 14 – 24%**
  - reduced **yield-scaled N_2O emissions by 27 – 38%**



Take home messages

- **Little inputs of organic matter & limited use of inorganic fertilizers in African smallholder farms**
- **Biochar compost can be produced: a cook stove, ecological toilet, & manures**
- **Better quality of compost; increasing crop yields & soil carbon; reducing greenhouse gas emissions**

Thank you for your attention!

- Application of biochar-compost to soil can be part of such strategies.

- This combination has proven to act synergistically in improving crop productivity and soil quality in addition to lowering the need for chemical fertilizers.

- ***Using neglected waste resources, like human excreta can therefore be one possible option of filling this gap.***

Problem and aims

To our knowledge, no studies combining thermophilic composting of **human excreta (HM)** from ecological sanitation and **biochar (BC)** exist to date.

- To undertake **a thermophilic composting experiment** of HM together with other organic waste and BC to produce a pathogen-free and nutrient-rich organic fertilizer.

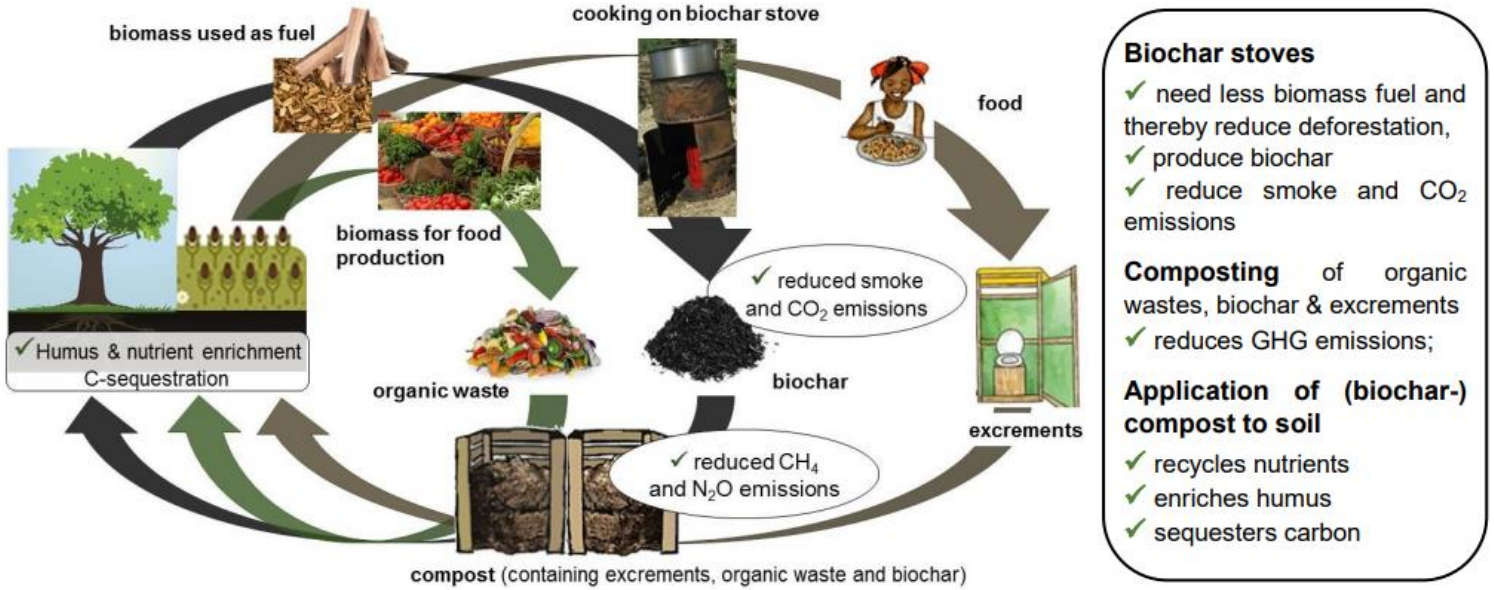
- Evaluate the effect of BC addition and the type of manure (HM and cattle manure) on the composts' **key nutrients, its chemical and physical characteristics, its ammonia and greenhouse gas (GHG) emissions** and Maize yield.

Approaches/Methods

We conducted a 185-d thermophilic composting experiment with HM, and with CM, mixed with kitchen scraps, teff straw, sawdust, and BC in composting boxes.

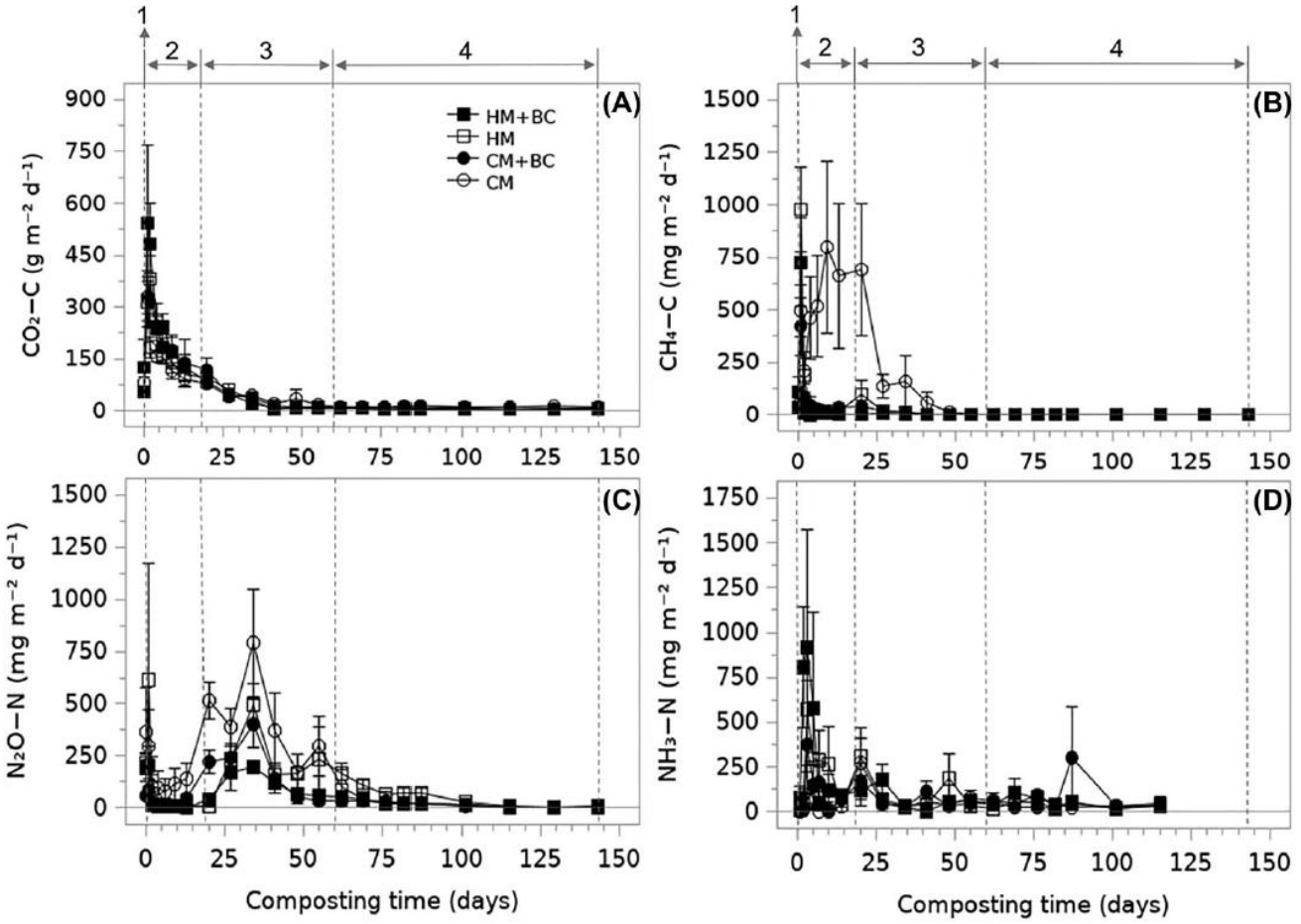
The treatments were:

1) HM-Compost (HM);
2) Biochar-Compost from HM (HM-BC);
3) cattle manure compost (CM);
4) Biochar-compost from CM (CM-BC).



These were tested in field trials and compared to mineral fertilizer (MF) and a control without fertilizer (C) on basis of N contents of the compost.

Results (1)



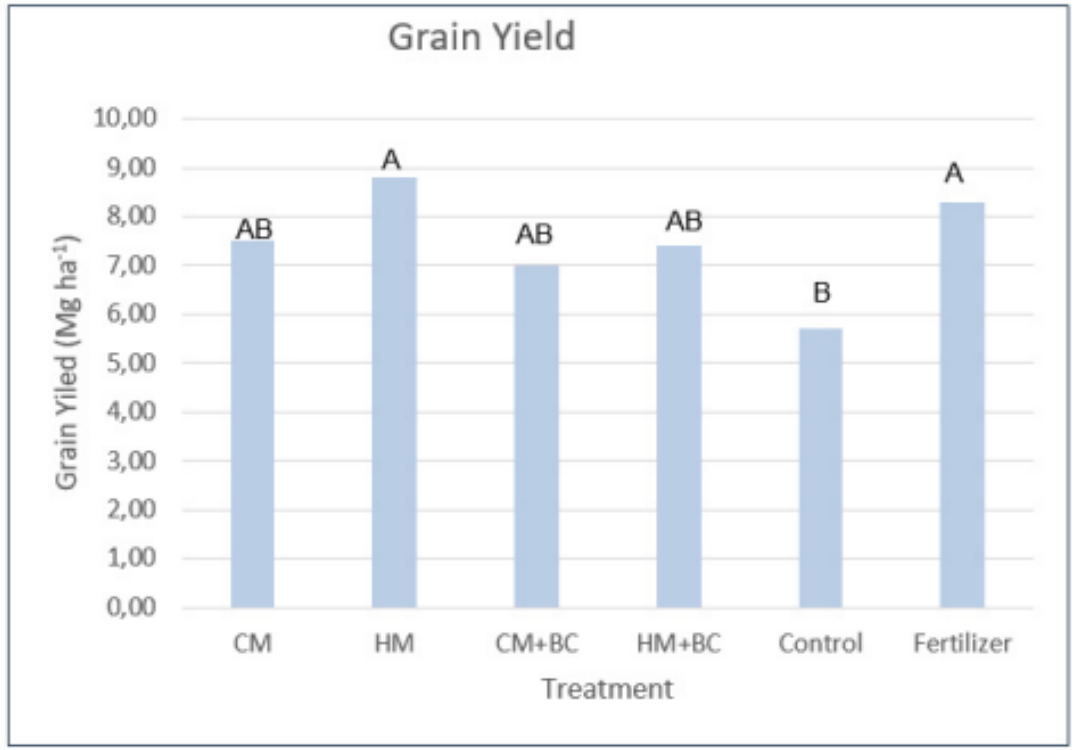
- BC significantly reduced non-CO_2 GHG-emissions (51-71%).
- The P and K were preserved during composting, whereas Ca and Mg losses were low (< 18%),
- Addition of BC led to a relative reduction of TOM losses by 18−23% and of TOC by 33−42%, and N (49−100%), and decreased the amount of extractable NO_3 (32−36%) in the final compost, attributed to the higher amount of remaining TOM and TOC in the BC-amended composts mainly due to the BC's stability against microbial degradation during composting.

Results (2)

- For the field trials all organic amendments significantly increased total biomass and yield with 18–35 % (35 % in HM treatment and 18 % in the CM-BC treatment), compared to the control, attributed to increased nutrient availability and soil moisture.

- No yield difference was observed between mineral fertilizer and the compost treatments.

- Agronomic nitrogen use efficiency (ANUE) was significantly (< 0.049) different with treatments,



CM = Cattle Manure Compost,
HM = Humanure Compost
CM+BC = Cattle Manure + Biochar Compost
HM+BC = Humanure + Biochar Compost
Fertilizer = Mineral NPS Fertilizer
Control = Without Fertilization

Results (3)

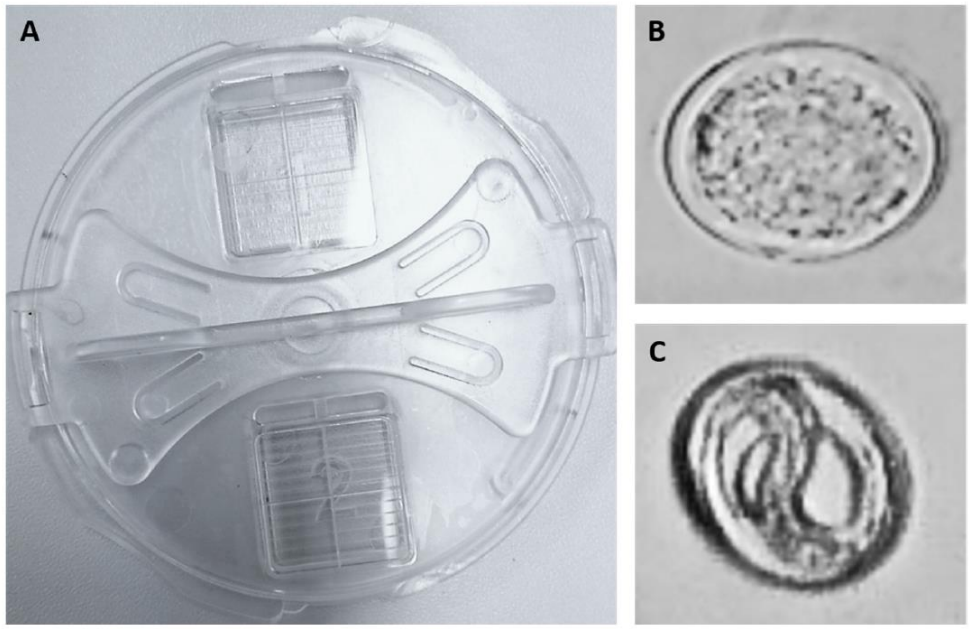


Figure 2. Mini-FLOTAC counting chamber (**A**); light microscopy of *Ascaris suum* egg before larvation, isolated from female worms (**B**); larvated *A. suum* egg after development in 0.1 M H_2SO_4 at room temperature for 28 days (**C**) (Photos: Khaliel El-Said).

- The amount of detected *Escherichia coli* (*E. coli)* was below the thresholds of German and European regulations for organic fertilizer. *Salmonella* and *Ascaris* eggs were not detected.

- **Thus, the matured compost was free of pathogens at the end of a 6-month composting period.**

Future plan: to scale-up and translate it to a business, create job for women and youths.

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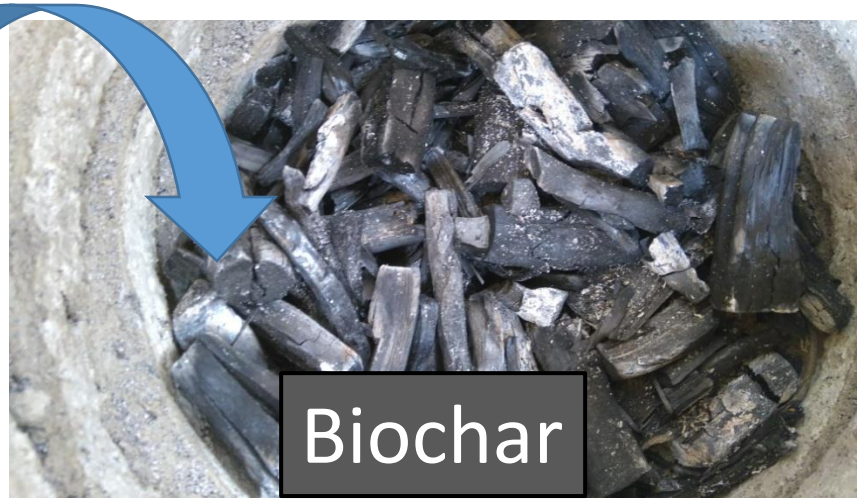
References: Asaye et al., 2022. Land, 11: 784; Daniela et al., 2021. J. Environ. Qual. 51:19–32; Werner et al., 2023. Sustainability, 15: 4624.

What is a biochar cook stove?

Biochar cook stove,
Provide by Marius Bierig



A cook stove provides heat for cooking and produces biochar at the same time.

How biochar cook stove works?