Leibniz Centre for
Agricultural Landscape Research
(ZALF)

Effects of Biochar and the Use of TLUD-reactors in Rural Areas for Cooking and Soil

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Challenge

On-farm crop residues are often left unutilised or not efficiently used. Often they are left to be decomposed by microbes or burnt on fire or, sometimes, in-situ used by livestock. Crop by-products, like maize cobs and residues from primary processing, especially from threshing and shelling, have a high percentage of lignified structural components and therefore are suitable for thermochemical conversion. A pyrolysis-treatment of these residues can provide thermal energy for cooking applications as well as for biochar production, which can be used as a soil amendment to improve soil structure and cation exchange capacity as well as to contribute to carbon sequestration (table 1). Biochar has a high porous structure and adsorption ability, it increases microbial abundance (Figure 2):

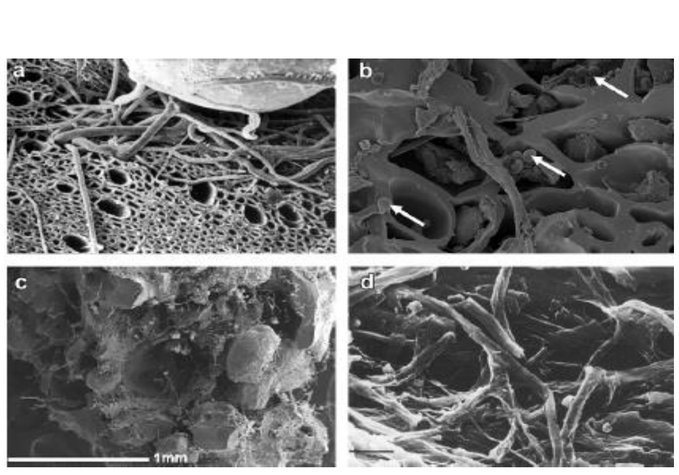

Fig. 2: Visual observation of spatial association and colonization of biochar by microorganisms *(Lehmann et al. 2011)*

Research area

Understanding the impact of biochar amendment needed to increase soil fertility and crop productivity by comparison of farming areas and site conditions (data of field trials with soybean and grains in China and Germany and different maize cropping systems in Tanzania).

Results

In Tanzania the effect of biochar soil amendment on maize grain yield production depended on the water supply (Figure 3). Under low irrigation frequency, only the higher rate of biochar (10 t/ha) increased grain yield compared to the control by 65%, according to Duncan test (α=0.05), though ANOVA was insignificant (P-value=0.053). Under high irrigation frequency, biochar amendment did not affect grain yield production (P-value=0.210). In China in 2016 on a sandy soil we did not observe a significant improvement in both crop growth (soybean) and productivity by biochar application. There were derived insights on the mechanism behind. In further studies at site at ZALF in Müncheberg, Germany (soil type: loamy sand) biochar application had no impact on plant biomass - but biochar improves nodulation within biological nitrogen fixation (figure 4).

Fig. 1: Residual wastage vs. biochar production in a TLUD

The TLUD for small farm level

A top-lid-up-draft (TLUD) barrel-reactor was developed at the University of Hohenheim and iteratively adjusted (in the project of Trans-SEC) for the use at grass-root level (village level), which led to a cooking extension of the device. It can be built from scrap material (oil drums) locally available and is capable of sustaining high temperatures of up to 365°C . The drum has a top lid which is fixed to the barrel by clamp, and a central pipe with a diameter of 10 cm perforated with a dense array of 10 mm holes made throughout its height. Test results from the UPS farmers group in one of the case study villages showed that after pyrolysis for about two hours from 15 kg of maize cobs about 4.4 kg of biochar (29 %) could be produced.

	Total (g kg^{-1})			Available (mg kg^{-1})				C/N	CEC_{eff} (cmol+/kg)	pH (H_2O)
	C	N	S	Ca	K	Mg	P			
Biochar	415.08	3.75	0.58	8893	1151	471	326	110.63	22.68	8.41
Soil	9.18	0.99	0.23	2103	1080	954	419	9.26	4.85	6.26

Tab. 1: Soil and biochar (from black cherry) chemical properties

Benefits of biochar

- According to soil types and water regimes we found different yield responds after biochar application
- Recommended rates of 5-10 tons biochar per hectare
- Positive impact of biochar on symbionts (nitrogen fixing) of plants
- Underlining roles of biochar on sandy soil by mediating nitrogen availability with biological nitrogen fixation manifests its potential to influence Nitrogen cycling and legume plant growth by associated ways.

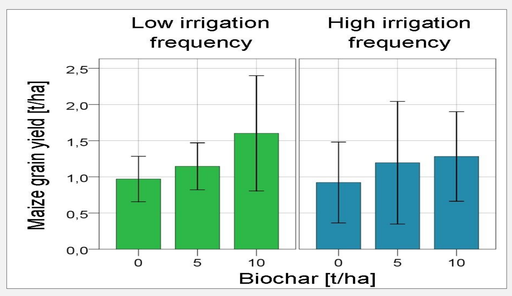

Fig. 3:
Effect (yield) of biochar soil amendment on maize grain in Tanzania

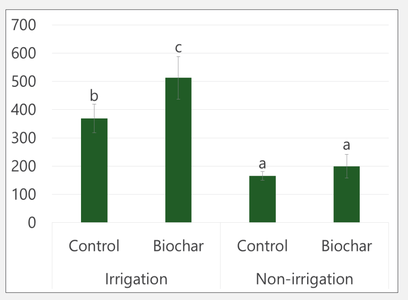

Fig. 4:
Effect (nodule number) of biochar soil amendment on soybean in Müncheberg

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