Biochar in Agriculture
-Perspectives for Germany and Malaysia-

3rd Public-Newsletter – December 2014

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Editorial

Dear Reader,

Welcome to the third issue of the SAW-Biochar Public-Newsletter.
Within this newsletter we will keep you informed about the recent progress of our biochar research.

"Landmark in the Land of Ideas“

With its innovative approach "Optimized biochar from agricultural waste" the Leibniz Institute for Agricultural Engineering Potsdam-Bornim (ATB) was amongst the winners of the nationwide competition "Landmarks in the Land of Ideas" 2014. This year the competition was devoted to "Innovative country - Rethinking Rural Spaces". The initiative "Germany - Land of Ideas" and the German Bank honored ideas and projects in Germany that provide solutions to the challenges rural regions are facing. In several research projects (a.o. Biochar in Agriculture) ATB scientists address the question of how biochar can be used as a sustainable fertilizer to improve harvests at low-yield sites and sequester carbon in soil. On September 3, 2014 the ATB received the award in the context of a special biochar event at the institute. In addition to a panel discussion "Biochar Talk" where results from ongoing research projects on the topic were presented, guests were also invited to experience on-site research in ATB's biochar-lab.

Current research in the project "Biochar in Agriculture"

The following contributions summarize the respective research progress of the project partners in Germany and Malaysia. We present results of the impact of biochars, digestate and fertilizer add-ons on soil fertility in terms of yield potential, water holding capacity, nutrient dynamics and soil biology.

Deutschland – Land der Ideen/Bernd Brundert

Project Coordinator

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Short-term incubation studies on degradation of biochar in soil

*Giacomo Lanza**, Stephan Wirth*, Philip Rebensburg*, Peter Lentzsch* Jürgen Kern**, (*The Leibniz Centre for Agricultural Landscape Research, **Leibniz-Institut for Agricultural Engineering Potsdam-Bornim)*

Stability of biochar is a critical issue, discussing environmental and economical suitability of biochar as a soil amendment, because biochar in soil might be substrate for microbial activities and is affected by climatic conditions (moisture, temperature) as well as by soil properties. We decided to focus on the impact of readily available carbon and nitrogen on the degradation of biochar in soil. To overcome the difficulties intrinsic in field investigations and to obtain results rapidly, we performed dynamic incubation experiments under laboratory conditions, using a multi-channel, automated infra-red gas analysis system to detect CO_2 emission in soil-substrate mixtures over time. We studied pyro and HTC chars from maize silage, which were tested as in our previous experiments.

First, glucose was added in order to test the impact of readily available carbon on the degradation of biochar. The CO_2 emission in the soil-biochar+glucose mixture was higher compared to soil-biochar or soil-straw mixtures without glucose amendment, but lower compared to the soil-glucose mixture. Thus, an inhibition effect of biochar upon glucose metabolization was evident, which was higher for HTC compared to pyro char. The microbial population composition was mostly affected by glucose addition, but glucose-biochar interactions were apparent and need further study.

For the second investigation, calcium ammonium nitrate (CAN, 27% N) was added in order to test the effect of nitrogen on biochar degradation in soil. Nitrogen addition did not increase cumulative CO_2 emission in soil-biochar mixtures, but effects were evident in the decay dynamics, which will be further evaluated.

Pot Experiment on N-Fertilizer Leaching and Crop Uptake

Sherwin Lee Chan Kit, Rosenani Abu Bakar, Azni Idris, Che Fauziah Ishak, Khairuddin Abdul Rahim (University Putra Malaysia)

A second pot experiment was carried out to determine the effects of oil palm empty fruit bunch (EFB) biochar on nitrogen (N) fertilizer recovery, crop uptake, and N leaching using ^{15}N labelled fertilizer. The pots were placed in an open field with Latin square experimental design. There were five different EFB biochar rates; 0 (control), 5, 10, 20, and 40 t/ha with five replications. Clayey soil (20 kg per pot – air dried) was used for this experiment and was incubated for one month in the pot before planting maize seeds as test crops. A container was placed under each pot to collect leachate. EFB biochar was applied at the top 20 cm of the soil one week before planting. Only one seedling was allowed in each pot and was fertilized on the 7th day after germination with ammonium sulphate [$(^{15}NH_4)_2SO_4$], triple superphosphate (TSP), and muriate of potash (MOP) at the rate of 60:30:60. Leachate collections were done every time after rain for measuring total volume leached, pH, nitrate (NO_3^-), and ammonium (NH_4^+) concentration. This collection started from the day the maize seeds were planted until the maize reached 30 days old. After that, tissue samples were harvested for analysis of dry matter weight, ^{15}N content, total N, P, K, Ca, and Mg, while the pot soils will be analysed for ^{15}N content, total C, N, P, exchangeable cations (K, Ca, and Mg), pH, electrical conductivity (EC), and cation exchange capacity (CEC). These analysis are still ongoing. Simultaneously, a lab incubation to study the effects of EFB biochar on nitrous oxide (N_2O) emission is still ongoing too. Findings from the first pot experiment is intended to be published soon, but there are additional analysis required to be done first.

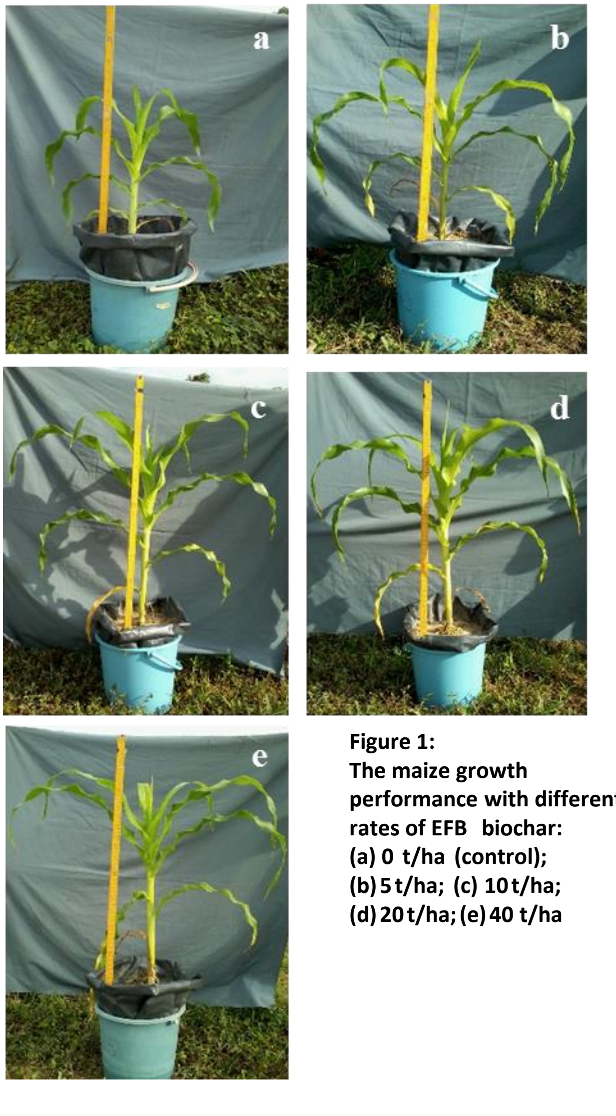

Figure 1: The maize growth performance with different rates of EFB biochar: (a) 0 t/ha (control); (b) 5 t/ha; (c) 10 t/ha; (d) 20 t/ha; (e) 40 t/ha

Welfare analysis

Claudia Kemfert, Isabel Teichmann (German Institute for Economic Research)

We have completed our study on the technical greenhouse-gas mitigation potentials of biochar soil incorporation in Germany (Teichmann 2014). The analysis has revealed that the amount of greenhouse-gas emissions that can be avoided per tonne of dry-matter feedstock that is turned into slow-pyrolysis biochar (t CO_2e/t DM feedstock) strongly hinges on the type of feedstock and the assumed conventional feedstock management. As illustrated in the figure, the greenhouse-gas mitigation balance for biochar obtained from biomass with low water content is more favourable than that for biochar from wet feedstocks. In particular, we have found a negative greenhouse-gas mitigation balance for sewage sludge, liquid cattle and swine manure, sugar-beet leaf and potato haulm, and digestates. The main reason is the high amount of energy required to dry these feedstocks. Moreover, feedstocks that are used energetically in the baseline scenario (i.e. industrial wood waste and short-rotation coppice) also tend to save fewer emissions when they are turned into biochar than when they are directly combusted. This effect is most pronounced when these feedstocks are diverted from replacing fossil fuels with high carbon intensities. The remaining feedstocks covered by the study are associated with a positive greenhouse-gas mitigation balance. The driving factors are the amount of carbon sequestered by biochar soil incorporation and the emissions that are avoided due to the substitution of fossil fuels by the pyrolysis oils and gases.

Effects of biochar on the Soil-Plant-System

Frank Ellmer, Heiko Vogel, Katharina Reibe (Humboldt-Universität zu Berlin)

To analyze the effects of different biochar types (pyrolyzed wood, pyrolyzed maize silage (Pyro-char), hydrothermal carbonized maize silage (HTC-char) and treated HTC-char) on the collembolan *Protaphorura fimata* we exposed 150 individuals for 5 weeks to 2.5 kg defaunated soil mixed with the different biochars in pots. Three spring wheat seedlings per plot were planted. There were no significant differences between the treatments regarding shoot and root biomass and the abundance of *P. fimata*.

In a second experiment we varied the amount of treated HTC-char. Therefore we added treated HTC-char to raise the organic carbon content to 1 %, 2 % and 4 %. With increasing amounts of treated HTC-char the abundance of *P. fimata* declined, whereas shoot biomass of spring wheat increased.

A third greenhouse pot experiment was set up to test Pyro-char and Collembola interactions. Soil or soil-char mixture was inoculated with or without Collembola. Pyro-char altered root morphology and resulted in thicker roots with a higher volume. This was not apparent when Collembola are present.

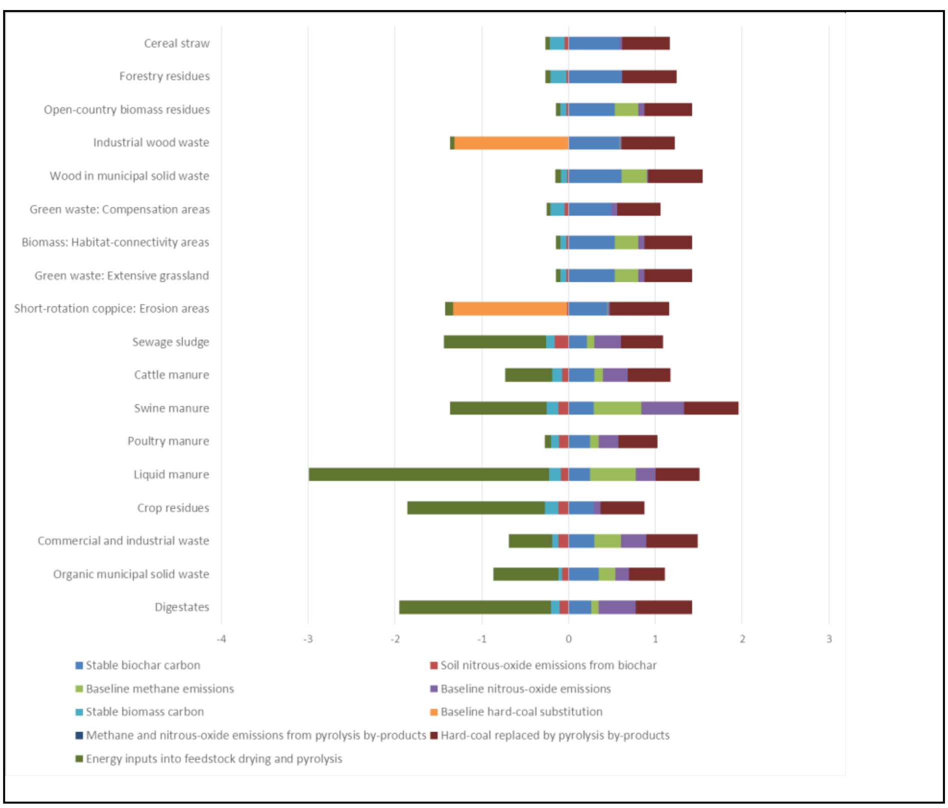

Figure 2:
Components of total net avoided GHG emissions (t CO_2e/t DM feedstock). Source: Teichmann (2014).
Reflecting the case of hard coal and process-heat recovery, without GHG emissions from transports and soil additions. Conventional feedstock management: D = Decomposition on site; C = Composting & land spread; E = Energetic use; M = Manure management & land spread

Call for Papers – International Biochar Symposium 2015

During the last years the application of biochar to arable land has been suggested as a method to improve soil fertility and plant growth, reduce greenhouse gas emissions and sequester carbon for decades or centuries. But holistic scientific research to identify environmental as well as economic potentials of biochar in the tropics and especially in the temperate zones is limited and needs to be improved. Furthermore, biochars may differ substantially in their chemical, physical and biological properties and therefore in their fate after soil application depending on the biomass material and conversion technology used. Hence, the identification of biochar properties responsible for positive (and negative) impacts on soil fertility, greenhouse gases and carbon sequestration is needed, followed by the development of methods to optimize these biochar properties and soil improvement. The projects "Biochar in Agriculture – Perspectives for Germany and Malaysia" (www.atb-potsdam.de/biochar) and APECS (Anaerobic Pathways to Renewable Energies and Carbon Sinks) (www.atb-potsdam.de/apecs) focus on these research questions. Within this symposium the results of both projects and related research results by other scientists shall be presented and discussed.

Authors interested in presenting at the conference are requested to submit a 200 to 300 word abstract. Conference organizers will select papers for oral presentations and posters from the set of abstracts received.

The deadline for abstract submission is January 31, 2015.

Please submit your abstract online at http://www2.atb-potsdam.de/biochar2015/regform.htm

Conference Topics:

- Production and post-treatment of biochars
- The influence of biochars on the Soil-Plant-System
- The influence of biochars on soil C and N dynamics
- The influence of biochars on soil biota
- Integrated Assessment of biochars

Invited Speakers:

Dr. Silvia Baronti, BIMET-CNR, Florence
Dr. Maria Luz Cayuela, CSIC, Murcia
Prof. Dr. Annette Cowie, New South Wales Government
Prof. Dr. Lars Elsgaard, Aarhus University
Prof. Dr. Bruno Glaser, MLU, Halle-Wittenberg
Prof. Dr. Henrik Hauggaard-Nielsen, DTU, Copenhagen
Prof. Dr. Johannes Lehmann, Cornell University, Ithaca, NY
Dr. Ondrej Masek, University of Edinburgh
Prof. Dr. Yong Sik Ok, Kangwon National University
Hans-Peter Schmidt, Delinat-Institute Switzerland
Dr. Saran Sohi, University of Edinburgh
Prof. Dr. Franz Zehetner, BOKU, Vienna
Dr. Lukas Van Zwieten, New South Wales Government

Scientific committee:

Dr. Rosenani Abu Bakar, UPM, Malaysia
Prof. Dr. Frank Ellmer, HU Berlin
Dr. Tinia Mod. Ghazi, UPM, Malaysia
Prof. Dr. Azni Idris, UPM, Malaysia
Dr. Monika Joschko, ZALF, Müncheberg
Prof. Dr. Martin Kaupenjohann, TU Berlin
Prof. Dr. Claudia Kemfert, DIW, Berlin
Dr. Jürgen Kern, ATB, Potsdam
Dr. Peter Lentsch, ZALF, Müncheberg
Dr. Andreas Meyer-Aurich, ATB, Potsdam
Dr. Jan Mumme, ATB, Potsdam
Dr. Stephan Wirth, ZALF, Müncheberg

Organizing committee:

Dr. Andreas Meyer-Aurich
Dr. Jan Mumme
Dr. Jürgen Kern
Dr. Anja Sänger
Helene Foltan

Conference Website:

http://www2.atb-potsdam.de/biochar/biochar_symposium_en1.htm

Conference Contact:

biochar-symposium2015@atb-potsdam.de

International Biochar Symposium 2015

Biochar – Contribution to Sustainable Agriculture
28 – 29 May 2015,
Potsdam, Germany

Biochar network

Coordination and dissemination; Life cycle assessment and farm economic evaluation of biochar
Dr. Andreas Meyer-Aurich
Dr. Anja Sänger
(Leibniz-Institut for Agricultural Engineering Potsdam-Bornim)

Research station Berge
Dr. Andreas Muskolus
(Institute of Agricultural and Urban Ecological Projects)

Gas flux measurements at the research station Berge
Dr. Jürgen Kern
Christiane Dicke – PhD Student
Giacomo Lanza – PhD Student
(Leibniz-Institut for Agricultural Engineering Potsdam-Bornim)

Effects of biochar on the Soil-Plant-System
Prof. Dr. Frank Ellmer
Heiko Vogel
Katharina Reibe – PhD Student
(Humboldt-Universität zu Berlin)

Impact of biochar on soil biota and microbial activities
Dr. Peter Lentzsch
Dr. Monika Joschko
Dr. Stephan Wirth
Philip Rebensburg – PhD Student
(The Leibniz Centre for Agricultural Landscape Research)

Effects of biochar on the dynamics of soil aggregation
Prof. Dr. Martin Kaupenjohann
Frederick Büks – PhD Student
(Technische Universität Berlin)

Field experiment with biochar in Selangor, Malaysia
Prof. Dr. Azni Idris
Assoc. Prof. Dr. Rosenani Abu Bakar
Assoc. Prof. Dr. Tinia Idaty Mohd. Ghazi
Dr. Mohd Amran Mohd Salleh
Sherwin Lee Chan Kit – PhD student
(University of Putra Malaysia)

Welfare analysis
Prof. Dr. Claudia Kemfert,
Isabel Teichmann – PhD Student
(German Institute for Economic Research)

Char materials (Pyro- and HTC char)
Dr. Jan Mumme
Dr. Mamadou Diakité
(Leibniz-Institut for Agricultural Engineering Potsdam-Bornim)

Impact of biochar application on soil nematodes
Stefanie Menzel – PhD Student
(Humboldt-Universität zu Berlin)

Publications:

Reibe, K., Götz, K.-P., Döring, T.F., Roß, C.-L., Ellmer, F. (2014): “Impact of hydro-/biochars on root morphology of spring wheat” Arch. Agron. Soil Sci., DOI:10.1080/03650340.2014.983090

Reibe, K., Roß, C.-L., Ellmer, F. (2014): “Hydro-/Biochar application to sandy soils: impact on yield components and nutrients of spring wheat in pots” Arch. Agron. Soil Sci., DOI: 10.1080/03650340.2014.977786

Teichmann, I. (2014): “Climate Protection Through Biochar in German Agriculture: Potentials and Costs.“ DIW Economic Bulletin 4(4): 17-26.

Teichmann, I. (2014): „Klimaschutz durch Biokohle in der deutschen Landwirtschaft: Potentiale und Kosten.“ DIW Wochenbericht 1+2/2014: 3-13.

Reibe, K., Ellmer F. (2013): “Einfluss von Biokohle und deren Behandlung auf die Ertragsbildung von Kulturpflanzen.” Mitt. Ges. Pflanzenbauwissenschaften Band 25, 315-316.

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