

Interactive comment on “Biochar can be used to recapture essential nutrients from dairy wastewater and improve soil quality” by T. A. Ghezzehei et al.

Anonymous Referee #1

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This review reports on the authors' approach to solve the problem of agricultural waste disposal. This approach consists in using biochar obtained from “excess biomass” to remove “excess nutrients” in dairy wastewater. It is based on the experimental evidence of the biochar ability to remove ammonium and phosphate from dairy effluents.

The issue of agricultural waste management is relevant for the scientific community: however, the authors put under the same umbrella of “waste biomass” both plant biomass and effluents from livestock farms, which may be arguable. In fact, in my opinion, the pollution potential of these two “waste” categories is very different, and should not be given the same weight. A part from the fact that the nature of the “excess biomass” is not clearly specified, in this MS, in my opinion on the one hand it is a

C392

pity to char crop residues when it is well known the positive effect of their incorporation into soil on soil fertility (see the book “Managing crop residues” by Unger, 1994, as an example). On the other hand, when you burn or pyrolyze wood to obtain energy, you cannot call the wood as “waste”: it is a raw material or at least a by-product.

The knowledge of the biochar ability to remove phosphate and ammonium from aqueous solutions is not new: it was already reported by Yao et al., *Journal of Hazardous Materials* 190 (2011) 501–507; Ying et al., *EARTH AND ENVIRONMENT* Vol. 39, No.4, Tot No.286, 2011, Page 511-516; Hollister, 2011 (<http://dspace.library.cornell.edu/bitstream/1813/29126/1/cch92thesisPDF.pdf>) . The authors should have cited these papers.

In reading the manuscript I understand that the above mentioned authors' approach is based on two assumptions:

- The first assumption is that biochar used as soil amendment “increases soil productivity”. However, to increase soil productivity means that on a soil amended with biochar one can obtain higher crop yields. I am afraid this biochar property has not yet been fully demonstrated. In fact, given the importance of the assumption, the authors should have cited relevant references, which they did not. More precisely, they cited: Lehmann et al., 2006; Glaser, 2002. Actually, the Lehmann reference is a general review on biochar ability to sequester carbon. As far as the improvement of crop yield is concerned, Lehmann reports on an experiment on acid and infertile tropical soils: this does not seem to me a representative case of agricultural soils. Moreover, Lehmann admits that “some experiments show decreasing biomass production and crop yields at high concentrations” of biochar. Glaser studied the Terra Preta phenomenon and concluded that “black carbon can act as a significant carbon sink and is a key factor for sustainable and fertile soils, especially in the humid tropics”. This has nothing to do with the experimental demonstration of increased crop productivity following soil amendments with biochar!

- The second assumption is that nutrients in dairy waste, previously entrapped in biochar, will then be released when biochar is incorporated into soil: this assumption has yet to be demonstrated experimentally, too, as the same authors admit in Ch. 5 ("Knowledge gaps"). Instead, the same authors demonstrated that the opposite occurs (Sarkhot, D. V., Berhe, A. A., and Ghezzehei, T. A.: Impact of biochar enriched with dairy manure effluent on carbon and nitrogen dynamics, *J. Environ. Qual.*, doi:10.2134/jeq2011.0123, 2012)

The manuscript presents the authors' hypothesis to solve the problem of "agricultural waste disposal" (chapters 1 and 2), reviews the current knowledge on biochar properties in relation to soil application (chapters 3 and 4), and estimates the potential usefulness of the author's approach for solving the above mentioned problem (chapters 4 and 5). Within this framework, only a paragraph (4.1) is devoted to the reporting of experimental results on nutrient capture by biochar. In substance, the authors devote a large part of the manuscript to speculations based on assumptions that may not be true, whereas the reporting on the experimental part which should be the core of this MS(biochar can remove nutrients from dairy waste) is limited to a single laboratory experiment.

No mention was made of some properties of biochar that are viewed as harmful, I mean its polycyclic aromatic hydrocarbon (PAH) content (<http://pubs.acs.org/doi/abs/10.1021/jf205278v>): PAH are known as carcinogenic molecules. Since this paper is a review, the concern of adding large amounts of PAH to soil could have been addressed in the "constraints" section (paragraph 3.3)

Other comments

The title claims that "biochar improves soil quality": soil quality is a very general concept. No experimental data was given, connecting biochar enrichment and soil quality, to support this statement. "Recapture" is redundant: capture should be sufficient.

Technical terms should be more accurately chosen or explained:

C394

- confusion is made between "waste" and "by-products" (p 1102, line 24)
- agricultural runoff from dairy operations (p 1103, line29): "agricultural runoff" is something larger than "dairy effluents": it may include, but is not limited to, the effluents from livestock farms
- "flushed" manure: what is it? May be you mean "slurries"? Land spreading?
- "metric tons": the International System of Units uses the notation "t"

The description of Figure 1 at p.1103, lines 12-14 (a and b), does not match with the content of Fig. 1 (closed and open loop)

Some citations in the text body are missing in the reference section, for example: Energy information Administration, 2009 (p 1104, line8); The Manure Technology Feasibility Assessment Panel instituted by California Air Resources Board (CARB) (p. 1106, line 7)

I think it is inappropriate to compare the results that the authors obtained in a laboratory experiment with those referring to wetlands (p 1110, line 27 and following), because the scale is not the same: how long did it take for wetlands to remove given amounts of nutrients?

References:

"Perlack, R. D., Wright, L. L., Turhollow, A. F., Graham, R. L., Stokes, B. J., and Erbach, D. C.: Biomass as Feedstock for a Bioenergy and Bioproducts Industry: the Technical Feasibility of a Billion-Ton Annual Supply, 2005.": please specify the source of this citation.

I have not been able to find "Sarkhot, D. V., Ghezzehei, T. A., and Berhe, A. A.: Biochar for nutrient recapture from dairy wastewater: recovery of major nutrients, *J. Environ. Qual.*, 42, 1545–1554, 2013). [at least, not in *J. Environ. Qual.*]

Figure 1: the style of the lines in the figure caption does not match that in the picture

C395

Figure 2: coordinate axis: is it ammonium or ammonium-N? Is it phosphate or phosphate-P? The amount of added biochar should be reported in the figure caption. "ppm" should be substituted with "mg L⁻¹". The meaning of "manure dilution" is not clear: what does 100% manure dilution mean? How many replicates were done for each dilution?

Interactive comment on Solid Earth Discuss., 6, 1101, 2014.