

International Biochar Initiative Response to November 2010 NRDC Report: *Biochar: Assessing the Promise and Risks to Guide U.S. Policy*

IBI has prepared this document in response to a new National Resources Defense Council (NRDC) report authored by Steve Brick, former Executive Director of IBI, entitled, *Biochar: Assessing the Promise and Risks to Guide U.S. Policy*. The report provides an overview of biochar production pathways, feedstocks, the state of the industry, and highlights key risks and benefits of biochar concluding with recommendations of a research agenda to support biochar policy development in the United States. A copy of the report is available at: https://www.nrdc.org/energy/files/biochar_paper.pdf.

While we completely agree with Mr. Brick's conclusion on the need for a strong research agenda to move the field of biochar forward, we find instances of statements used as fact with no references to justify their inclusion in the document. We find this report to leave out large bodies of published biochar results—these exclusions more easily make the case for some of Mr. Brick's assertions. In this response we counter some of the statements from the report as seen below, but emphasize that on the whole, IBI supports the document's recommendations for increased funding for technical demonstrations and a coordinated national field trials program.

Carbon Loss through Biochar Soil Application

Mr. Brick is correct in stating that soil tillage is known to cause sudden release of CO₂ from soils and to accelerate decomposition of soil organic matter, however, the statements below overstate the issue of tillage loss when adding biochar to soils:

- Page VI, Executive Summary: "Carbon loss from tillage"
- Page 9, Potential Benefits and Risks: "Soil disturbance can result in loss of soil carbon. If land that has been managed by conservation tillage is disced or plowed to incorporate biochar, the loss of soil carbon could be significant"

Biochar does not need to be applied every year, so adding biochar does not remove land from no-till management in the long term and in fact should enhance no-till practices. Additionally, best management practices may indicate other ways to apply biochar than discing: for instance, biochar can be banded in rows, using well-established techniques, or top dressed on perennial pastures or other perennial vegetation, such as spaces between fruit trees in orchards.. Subsurface banding is also possible. The USDA is also developing new equipment that functions similarly to no-till planters that can apply biochar or biochar mixtures deep into the subsoil. More information and references can be found in the IBI publication, *Guidelines for Application of Biochar to Soil* (2010).

Due to the chemical nature of biochar, it is a lot more resistant to degradation than other forms of organic matter. Thus, we expect events such as tillage to cause negligible loss of biochar carbon compared to carbon in biogenic soil organic matter, although of course it is also important to maintain existing soil carbon stocks as much as possible.

Carbon Sequestration/Recalcitrance in Soil

Mr. Brick makes some general remarks on the lack of data on terrestrial carbon sequestration and biochar recalcitrance in soil as well as the difficulty of doing carbon accounting, but he provides no back up references for these assertions:

- Page V, Executive Summary: "the concerns that have been raised about terrestrial carbon sequestration in general";
- Page V Executive Summary: "insufficient data on the recalcitrance of biochar... in soils";

- Page 9, Potential Benefits and Risks: “more research is needed to validate long-term carbon sequestration claims.”

First, while terrestrial carbon sequestration in general may have an associated risk of permanence due to the instability of organic matter in soil, biochar is a very different material. Biochar typically has both a labile (easily degraded) and a stable fraction. There is no doubt that the stable fraction of biochar is at least one, if not two or more magnitudes of order more stable in soil than uncharred biomass. The stable fraction of a biochar material is relatively easy to determine for carbon accounting purposes and to test and measure in soil after it has been applied.

In a recent article, biochar experts Christoph Steiner, PhD and Goodspeed Kopolu, MSc, describe the advantages of biochar as a carbon offset and some Monitoring and Verification advantages that biochar has: “Biochar production transforms carbon from the active (crop residues or trees) to the inactive carbon pool. Therefore issues of permanence, land tenure, leakage, and additionality are less significant for biochar projects.” (Kopolu, G. , Steiner, C., 2010)

Furthermore, while the exact lifetime of biochar materials in soils may be difficult to determine, based on historical practices, we can be confident that biochar is highly recalcitrant. Biochar carbon in *Terra Preta* soils of the Amazon has been dated up to several thousand years old. The Amazon is a tropical climate where organic matter degradation is very rapid due to constantly high temperatures and moisture levels. In Australia, estimates of mean residence time for naturally occurring biochar carbons are 1,300 – 2,600 years (Lehmann et al., 2009).

Controlled experiments where biochar decomposition is monitored are underway, but results extending over centuries are not now available. However, applying scientifically robust mathematical models to describe the degradation of organic matter in soil, and using data available to date, multiple independent estimates show that biochar has a mean residence time in soils on the order of 1,300 to 4,000 years (Cheng et al. 2008, Liang et al. 2008, Kuzyakov et al. 2009).

In summary, a good deal is known about the stability of biochar in soil. Certainly there is enough information to make conservative estimates in most cases that are suitable for basic carbon accounting. Additionally, since biochar has a unique signal in soil, it can easily be sampled for and measured, reported, and verified over time.

Biochar Loss During Transport and Application/Black Carbon Emissions

Mr. Brick is correct to point out the risk of biochar loss during transport and application and cites one report where researchers found wind loss to be a large issue:

- Page IV, Executive Summary: “the risk of fugitive black carbon emissions during biochar transport must be addressed.”
- Page 9, Potential Benefits and Risks: “because of its high carbon content, fugitive biochar is a black carbon emission, a potent climate forcer”;
- Page 9, Potential Benefits and Risks: “at least one study has reported significant losses of biochar during transport and application (Husk and Major, 2010)”.

It should be emphasized that the report referred to above documented the first time that this biochar was applied and the researchers acknowledge that better practices must be developed. Dust is a certainly a concern with biochar application, and best practices require that biochar applications be done during periods of low wind to prevent the blowing of fines. Agricultural techniques already exist to apply powdered fertilizers and other amendments and several techniques are available to help keep wind losses to a minimum: biochar can be pelleted, prilled, mixed into a slurry with water or other

liquids, mixed with manure and/or compost, or banded in rows. The optimization of biochar application to soil is important, and the farm technology and best practice methods are currently available.

We find the assertion that biochar dust particles are equivalent to black carbon emissions to be somewhat puzzling. Small particles of black carbon are emitted during the incomplete combustion of fossil and biomass fuels. When deposited on snow and ice, they are able to absorb heat and energy. While biochar can fractionate into small particles, it is not accurate to call them “emissions” as they are not a combustion product. In general, the smallest black carbon particles associated with biochar production and application are much larger, in the millimeter range, than the particles associated with global warming, in the nanometer range. It is possible for biochar particles to continue to fractionate into particles in the nanometer range, and this is a potential concern. However, after biochar has been incorporated in soil and has resided in it, studies have shown that it intimately interacts with other soil constituents (Glaser et al., 2000; Liang et al., 2008) and parts of it will likely be integrated into soil aggregates (Glaser et al., 2000), although the time required for this to happen under different environments and soil management systems is not known.

Thus application of biochar would result in little opportunity for long-range transport and deposition of nanometer-sized particles into the sensitive Arctic and mountain regions.

Biochar Stoves and Smaller Scale Systems

Biochar-producing stoves and smaller farm and village scale systems are important components of successful biochar implementation. These systems not only produce biochar, they also displace dirty technologies like smoky, inefficient stoves and open field burning to dispose of agricultural waste, but Mr. Brick seems to feel that the dispersed nature of these small systems reduces their value for carbon emissions reduction:

- Page IV, Executive Summary: “small systems should likely not be thought of as frontline tools to combat climate change” ;
- Page 5, Biochar Conversion Systems: “Soil remediation and carbon sequestration through biochar production are among the attributes claimed for pyrolyzing stoves. But, there is good reason to be cautious about these claims, especially with respect to the carbon benefits.”

Stating that small systems (including stoves and mobile or fixed community scale systems) should not be thought of as frontline tools to combat climate change, misses the opportunity to fully utilize these systems for multiple benefits. While measuring the GHG impact of small cook stove systems is admittedly challenging, methodologies already exist to do so under the Clean Development Mechanism and the Gold Standard crediting protocols, and will be even stronger as they are revised (Johnson et al. 2010 and Whitman and Lehmann, 2010). Modeling approaches being developed by Whitman et al. (unpublished data in review) begin to capture the full GHG effects of biochar stove systems and could provide a better sense of the most critical parameters to measure to accurately estimate GHG impacts.

There are numerous biochar stove projects being undertaken around the world to improve cooking as well as sequester carbon. In terms of sequestration ability, the benefit is in the number of users utilizing a simple and inexpensive technology. Based on work done by Dr. Paul Anderson and Dr. Paul Taylor, a typical household uses 5 kg fuel/day which yields 700g C sequestered per household/day. If this is put into a full year, each household could sequester 250 kg C per year. Four households would yield one ton carbon sequestered a year (Taylor, P, Anderson, P, Wever, P, 2010). The potential for scaling up is enormous – it is estimated that two billion people still cook and heat their homes with primitive stoves or open fires, burning wood, straw, dung, or coal. As clean biochar stove projects become more widespread, the impact of these numbers increases substantially.

The mitigation potential of biochar cook stove projects could be an excellent inroad to achieving the many, potentially more important, co-benefits of such a system. These benefits could include soil improvement and decreased indoor air pollution, increased food security, and improved respiratory health, among others. Providing these benefits can thus help build resilience at a household level, making the projects attractive on many fronts beyond simply their climate change mitigation potential. Indeed, development must be at the core of climate change mitigation projects that are implemented in the developing world, because manipulating the way some of the poorest people in the world would live, solely in order to reduce GHG emissions so countries and firms in the global north can continue to emit, is clearly unacceptable. This is particularly important for biochar projects, because they may involve altering the stocks and flows of biomass upon which people (and natural systems) depend (Whitman et al., 2010).

References:

- Anderson, P, Taylor, P, Wever, P (2010) CHAB Micro-Gasification for 1Gt CO²/yr Mitigation-Sequestration, presentation at IBI2010, September 12 – 15, 2010, Rio de Janeiro, Brazil.
- Cheng, CH, Lehmann, J, Engelhard, M. (2008) Natural oxidation of black carbon in soils: changes in molecular form and surface charge along a climosequence. *Geochimica et Cosmochimica Acta*, 72, 1598-1610.
- Glaser, B., Balashov, E., Haumaier, L., Guggenberger, G., Zech, W., 2000. Black carbon in density fractions of anthropogenic soils of the Brazilian Amazon region. *Organic Geochemistry* 31, 669.
- Johnson, M., Edwards R. and Masera O. (2009). Improved stove programs need robust methods to estimate carbon offsets. *Climatic Change*, Volume 2, Numbers 3 – 4, 641 – 649.
- Kopolo, G. , Steiner, C., (2010), Biochar: Building Synergies between Agriculture, Renewable Energy Production & Carbon Sequestration, Outreach, Dec. 3, 2010.
- Kuzyakov, Y, Subbotina, I, Chen, H, Bogomolova, I, Xu, X. (2009) Black carbon decomposition and incorporation into microbial biomass estimated by 14C labeling. *Soil Biology and Biochemistry*, 41, 210-219.
- Lehmann, C.J., Czimczik, C., Laird, D., Sohi, S. (2009) Stability of Biochar in the Soil. In: Lehmann, C.J., Joseph, S. (Eds.), *Biochar for environmental management: science and technology*. Earthscan.
- Liang, B, Lehmann, J, Solomon, D, Sohi, S, Thies, JE, Skjemstad, JO, Luizão, FJ, Engelhard, MH, Neves, EG, Wirick, S. (2008) Stability of biomass-derived black carbon in soils. *Geochimica et Cosmochimica Acta*, 72, 6096-6078.
- Major, J (2010) Guidelines for Biochar Application to Soil, International Biochar Initiative.
- Whitman, T and Lehmann, J. (2010) Systematic under- and overestimation of GHG reductions in renewable biomass systems: A Letter. *Climatic Change*, November 2010.
- Whitman, T, Scholz, S, Lehmann, J. (2010) Biochar projects for mitigating climate change: an investigation of critical methodology issues for carbon accounting. *Carbon Management*, Volume 1, No. 1. 89 – 107.