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Ali Brodsky
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Ithaca, July 24, 2009

RE: Follow-up from testimony to the House Select Committee on Energy Independence and Global Warming – June 18 2009

Dear Ms Brodsky:

Thank you for the opportunity to clarify outstanding questions. You will find my answers below.

Sincerely,
Johannes Lehmann

Follow-Up Questions for the Record

Testimony of Dr. Johannes Lehmann
Cornell University, Ithaca, NY, USA

Before the
House Select Committee on
Energy Independence and Global Warming

July, 2009

1. Do you support EPA's accounting for international land-use changes in calculating lifecycle greenhouse gas emissions for biofuels?

   In principle, yes. However, the tools and information to account for such land use change are still to be improved through a thorough scientific discourse that considers the full spectrum of issues[1,2], which is beyond the scope of this testimony. Perceived or actual lack of information should not be seen as an excuse to disregard the issue. Proper accounting for indirect land use will guide appropriate development of sustainable biofuels which is a desirable step forward.

2. How energy intensive is the pyrolysis process? How would significant increases in energy prices change the cost structure of biochar?

   The pyrolysis process is maintained by the energy contained in the biomass itself. In practical terms, heat or gases generated from the pyrolysis are recycled to continue the process. Therefore, the pyrolysis is self-sustaining after it has been initiated[3]. For the start-up of the pyrolysis, either biomass itself or fossil fuels such as natural gas can be used. Over the entire life cycle including biomass production, harvesting, transportation and energy conversion, the pyrolysis process is net energy positive, and current estimates indicate that between two and 9 times more energy is generated than invested[4,5].

   Biochar as a product for soil improvement and sequestration will from a certain level onwards increase in value as energy prices rise, because many biochars have an energy value. Many types of biochar can be used as charcoal to be used as the sole energy source or co-fired in coal power plants. In addition, the pyrolysis process can be adjusted to produce more energy and less biochar. At current energy prices, however, the value of the biochar as a source of energy is less than the cost of producing it. The total costs are mainly a function of the pyrolysis process itself and of the biomass collection. Our current estimates indicate that less than 30% of the costs of producing biochar are a function of energy prices; labor and capital costs account for a larger total share of biochar production costs. Therefore, costs of biochar generation are only to a small degree dependent on energy prices.

3. Is your process commercially deployable at this time? What steps are necessary to take advantage of using biochar in the farming process?

   Biochar production is in a pre-commercial stage. Companies exist that have developed pyrolysis units that are mostly at prototype stage and must demonstrate their long-term viability in a full commercial environment. Demonstration projects of a variety of biochar systems designed for specific biochar platforms should be initiated. Individual farmers have taken the initiative to develop biochar systems, but pioneering the technology is typically out of reach without financial assistance by foundations or government programs. A serious effort is required by the US government to critically evaluate and develop demonstration projects, concurrent with international efforts including governments and non-governmental organizations. The International Biochar Initiative is a non-profit organization in the US seeking to assist and coordinate such efforts, and to help commercialize biochar production and utilization systems at all scales as a means to combat climate change while enhancing the earth's soils.

4. You note that biochar can demonstrate additionality due to the lack of existing global deployment of the technology and further highlight that sequestration can be measured and verified. How would you suggest verifying the amount of biochar in a field? What process would be most effective and who would pay to verify the additionality and measured emissions reductions resulting from using biochar?

   Biochar systems offer a high degree of control over the sequestered carbon, as the added carbon in biochar can be monitored. Verification of biochar presence can be done by analyses of soils. Currently, several approaches are possible that go beyond quantification of an increase of total organic carbon in soils, but include attribution of the carbon that is specific to biochar additions. Biochar has a unique chemical signature that can be distinguished from carbon originating from decomposed plant material already present in soil[6]. While direct quantification in soils is expensive, indirect approaches have recently been developed that are both inexpensive and rapid. Those include mid-infrared analysis calibrated to direct quantification[7].

For routine assessment of biochar sequestration, however, modeling approaches should on the medium term be used that are much cheaper than routine direct measurements and help to address the spatial heterogeneity in any soil environment (though some verification will always be possible and necessary). These may be sufficiently reliable, because biochar properties are well reproducible with modern pyrolysis units. In comparison, the relatively complex interactions between plant litter quality, plant growth, and stabilization of plant residues is already relatively well constrained to provide viable strategies for carbon accounting[8]. Biochar decomposition in soil is less dependent on environmental properties than crop residues for example, as its stabilization relies less on interaction with soil minerals[9]. However, this needs to be demonstrated in practice, and price structures for monitoring and verification need to be developed with a deployment of the first biochar systems at scale of implementation. Before sufficient demonstration projects exist, confidence in the practicality and cost effectiveness is low. Supporting demonstration projects is a critical role that government can play at this initial phase of evaluating deployment of biochar systems.

5. How much additional cost per acre would be required to utilize biochar in farming techniques? What economies of scale exist with pyrolysis that could drive down that cost?

   The question about the cost of biochar production can not be answered with any confidence at present, since no commercial biochar plants exist in the US that provide biochar in sufficient quantity. Some companies are starting to develop the capacity. For individual farmers, large-scale distributors may not be the answer to their request for biochar to sequester carbon, as transportation costs (and from a certain distance also energy investments) are prohibitive. In many situations, the biochar may need to be generated locally. However, since biochar systems are in theory able to connect multiple value streams, such as waste management, energy generation, climate change mitigation and soil fertility enhancement, the revenue from all of these value streams has to be considered[10] and established for biochar production and utilization systems at various scales. These include on-farm systems that can generate biochar for local utilization, and larger-scale, cooperative systems that could generate biochar for sale. If biochar is able to address a soil fertility constraint on farms, the costs will be born by the increase in crop productivity[10]. Waste management through pyrolysis may reduce costs to a farm or community, and the resulting biochar may constitute added value.

6. In your testimony you wrote, "The distributed nature of biochar systems and the potential for variability between systems create significant opportunities for sustainability, but also hurdles to widespread adoption, regulation, and financial viability." What are the existing hurdles and what steps can be taken to reduce those hurdles?
   The large number of different feedstock types available in the US, the variety and scale of pyrolysis conversion technologies, the combination of value streams as outlined above, and the large number of possible applications to different soils and plants generate a significant number of different options to implement biochar systems. A concerted endeavor is necessary to establish the benefits and constraints for each of those combinations. Moving forward, individual biochar platforms are likely to be developed and demonstrated with certain types of biochars generated from feedstocks under conditions where sufficient information exists or can be generated for replication, and applied to soils and crops for which the agronomic benefits have been tested. This methodical development may initially constrain the number of biochar systems, but would enable identification of viable and sustainable application of the technology in a timely fashion.

7. Are there any long-term issues or concerns with biochar remaining in the Earth's soils for hundreds of years?
   So far, no adverse effects have to my knowledge been found for char-type materials that reside in soils for long periods of time. In fact, many if not most soils globally already contain some portion of char. This information stems from a global analysis of all soils archived at the World Soils Information Center (ISRIC) in The Netherlands[11], and a continental analysis of Australian soils[12]. However, these chars have been generated from a certain range of feedstocks largely including grasses and trees. It must be critically evaluated whether feedstocks that lie outside these better-known materials are also

suitable for biochar production, such as animal manures, a wide range of crop residues, food residues or municipal and industrial byproducts.

8. A contentious issue currently being discussed around the climate bill is the possibility of carbon offsets in the agriculture industry and the sequestration of carbon in the land and plant life. Can you say how credible these types of projects are as offsets and if there is a reliable way to measure how much carbon actually rests in a farm plot or an animal burp, for example?

   The measurement of carbon in farmland and soils is very reliable. Adequate methods and expertise exist to perform these measurements with confidence. The challenge lies in the financial viability of performing such measurements with sufficient frequency and spatial intensity. Methods for monitoring changes in vegetation are available and are sufficiently inexpensive. Monitoring of soil using traditional measurement methods is likely to remain too costly for widespread utilization in an offsets regime, and is not able to detect the small changes in concentrations likely to occur over short periods of time. However, there are credible efforts under way to demonstrate that a combination of process modeling and verification using novel, inexpensive and rapid techniques may indeed be feasible[8]. For individual types of changes in practice (e.g., implementation of minimum tillage, biochar conversion of crop residues, compost management etc.), greenhouse gases balances beyond carbon dioxide have to be quantified using a life-cycle approach. Such a comprehensive view will ensure that carbon sequestered in soils or vegetation is not compensated by emissions at a different location or time (e.g., through changes in energy requirements, fertilizer use, nitrous oxide emission etc.). In my opinion, the collective expertise and tools exist to address these challenges, even if the framework for implementation still has to be refined, and supporting policies developed. As we gather information about carbon flows and changes in agriculture, these tools can and should be improved.

9. Where would you put Biochar? What uses do you see in addition to agricultural use? Is there a problem with such long residence times in the soil? Does it build up to levels that would alter plant growth or cause farmers problems?

In addition to the use of biochar as a soil amendment, it has been shown to potentially possess value in composting or digestion processes. Beyond agricultural use, biocarbons produced at low temperatures similar to biochars may also enter markets as a substitute for activated carbons that require more energy in its production and are therefore more expensive.

The long residence time is primarily seen as an advantage of biochars. As outlined earlier in this document, historic accumulation of natural chars over the past millennia have not revealed any negative effects on soil functions, but rather beneficial effects.

Similar to any soil amendment such as composts, animal manures or mineral fertilizers, we would expect that below a certain quantity, the optimum response is not achieved. The same will be observed for a quantity that is above the optimum amount of application. And we would expect that optimum to depend on soil, crop and biochar type. Biochar-like materials have been quantified in soils to make up over 50% of soil organic carbon or 5-10% by soil weight (over 100 tons per hectare) and dated to several thousand years before present[13], without detrimental effects on soil health. However, it would be premature to generalize these results. Rather it is necessary to conduct due diligence analyses on relevant soils and crops before wide-spread application of biochar. Such testing is straightforward and agricultural services and academic institutions have the tools and knowledge to provide the required information within a relatively short period of time.

10. Where are the existing Biochar production facilities and what are the findings for production and use?

Fully commercialized facilities for the production of biochar do not exist in the US. Several companies are making considerable efforts to fill this gap, but have not fully reached a demonstration stage. Therefore, the amounts and types of biochar necessary for full evaluation are not yet available. Research institutions are working together with the nascent commercial sector to evaluate and critically examine the available biochar products under a range of soil and crop conditions. The results from these investigations are communicated through conferences[14] and scientific publications. Since biochar research has emerged only a few years ago, the existing record in scientific publications is not a good indication of the current research activity. A small number of biochar demonstration projects on farms exist in the US and several are under development[15], showing promising results and providing optimism that, with the proper policies and development assistance, these systems will prove valuable to a range of goals and environmental and agronomic benefits. In moving forward, there is a critical need for coordination and support. Only the International Biochar Initiative has been efficient in providing a platform for communication and development in the US, and institutional leadership is required to develop biochar into a viable and sustainable environmental management option.

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[14] The next conference co-sponsored by the International Biochar Initiative and organized by the Center for Energy and Environmental Security (CEES) at the University of Colorado is the North American Biochar Conference, Boulder, CO, August 9-12, 2009; the upcoming international biochar conference is planned for mid-2010 in Rio de Janeiro, Brazil, organized by EMBRAPA. Special symposia at society conferences have become routine events by now.
[15] At the IBI website under www.biochar-international.org, many of the projects are featured and a registry is under development, both for the US and world-wide.