Biochar Can Help Save the World.

D. Nathaniel Mulcahy and David L. Mulcahy
7 July, 2010
www.WorldStove.com

A recent letter (June 8, 2010, in CommonDreams.org) by Rachel Smolker, codirector of BioFuelWatch, entitled, "Charcoal Ain't Gonna Cool the Planet (Duh!)", questions the utility of producing and using biochar. Her letter, is basically a repetition of statements that BioFuelWatch presented prior to and at the COP 15 meetings, in December 2009, entitled: "Biochar for Climate Change Mitigation: Fact or Fiction?" (http://www.biofuelwatch.org.uk/docs/biocharbriefing.pdf) Our response to those 2009 presentations was, naturally entitled, "Biochar for Climate Change Mitigation: Fact, NOT Fiction*"* answered the major points of the the BioFuelWatch COP 15 paper and can be seen on our website http://worldstove.com/wp-content/uploads/download/biochar_for_climate.pdf At that time, our response was sent to BioFuelWatch and other possibly interested sites including national and international agencies. Discussion and debate is a healthy part of scientific inquiry, but, if BioFuelWatch disagrees with, or believes that they can disprove, any of our above mentioned responses to their original presentations, their replies would be more useful than the mere repetition of old arguments. However, we appreciate the opportunity to present our latest responses.

Rachel Smolker's 2010 paper states that biochar proponents claim that biochar can, "…cure just about everything -- from global warming (1) to soil infertility (2), agrichemical [sic] runoff (2), even dirty toilets (3)."

[At risk of distracting the reader, we prefer the phrase "climate change" since diverse changes will occur throughout the world, not merely uniform warming.]

1.WorldStove replies: Can biochar mitigate climate change? Biochar is 80% carbon, and can be sequestered for long periods of time, thus reducing atmospheric greenhouse gases thus mitigating climate change. Furthermore, among greenhouse gases, methane is one of the most effective, (23 times more potent than CO2) and in the United States, the largest single source of methane are the municipal landfills. (Marinelli, 2008; see also Cabanas-Vargas and Stentiford, 2006.) But, in the production of biochar in LuciaStoves, a WorldStove product, for example, methane production is generally below detection limits. Converting organic waste to biochar, instead of adding it to landfills, would thus greatly reduce landfills as a source of methane, and also free up landfill space.

2.WS: Does biochar influence soil fertility and agrochemical runoff? Agricultural soils in the southeastern U.S. Coastal Plain region have meager soil fertility and "… biochar additions to the Norfolk soil caused significant fertility improvements" by reducing the quantity of nutrients lost to leaching. This retains soil fertility, reduces agrochemical runoff (Novak et al. 2009), and this, in turn, reduces the demand for fertilizers. As pointed out by Glaser, Bruno, et al. (2002) and Tryon (1948), biochar has been demonstrated to greatly improve water and nutrient retention in sandy soils. In clay soils, already rich in water- and nutrient retaining capacities, biochar can reduce these capacities. But also soils rich in particular clays can benefit from biochar (Glaser et al. (2002). Obviously, just as not all biochars are the same, neither are all soils. For the most recent review see Major, et al. (2009).

3.WS: "Even dirty toilets" The point here, is not "dirty toilets", but the "absence of toilets," dirty or otherwise. In Port au Prince, Haiti, after the recent earthquake, where approximately 1.3 million persons found themselves without any sanitation facilities, WS designed and built some simple toilets which mimic the commercially available "No Mix toilets" found in many countries. Like those commercial units, WS's toilets separated urine from feces but, unlike the others, also directed the urine and feces onto separate biochar filled compartments.

Urine soaked biochar will can be used in garden soils. Since, "Urine contains large quantities of nitrogen (mostly as urea), as well as significant quantities of dissolved phosphates (soon to be one of the next shortages limiting food production) and potassium, the main macronutrients required by plants. See http://en.wikipedia.org/wiki/Urine . Biochar also absorbs odors, thus improving the quality of life for inhabitants.

Other points raised by Rachel Smolker (2010):

RS states , "There are no peer-reviewed comprehensive field studies of modern biochar lasting more than a year yet published!

WS replies: Soils of temperate rainforests in coastal British Columbia contain charcoal fragments dating back to deglaciation, approximately 13 000 y (Lertzman et al., 2002). plotted charcoal mass vs. time since last fire determined by ^{14}C dating of individual charred particles, and found that charcoal mass decreased exponentially with increasing time since the last fire. From data given by Gavin et al. (2003), Preston and Schmidt (2006) calculated that carbonized wood in forest soils had an average half-life of 6623 years, assuming that all fires initially produced similar amounts of BC. This is in striking agreement with Preston & Schmidt (2006) statement that "… the high end for the half-life of Pyrogenic Carbon (PyC) may be expected to be in the kY (thousand Year) region (maybe 5–7 ky), for cold, wet environments, and for the PyC fraction with more recalcitrant structure. At the other extreme, a half-life in the order of 100 y (Bird et al., 1999) may be not unrealistic for some fraction of PyC from boreal wildfire, with less thermal alteration and especially with surface exposure (unpublished field observations

from Canadian and Siberian boreal forest sites)" See also Lehmann, et al. (2009) Introduction.

RS also states that: "Biochar itself breaks down over time into fine dust which can easily become airborne, like soot. These particles also cause lung disease when inhaled."

WS There is no evidence published which suggests that, once in the soil, biochar particles are likely to be inhaled.

RS states that there is not already a supply of biomass available for biochar. In her words: "But in reality there are no mountains of wastes and residues lying about."

WS replies: In Egypt, **20 million tons rice straw per year** are burned (Esawy et al. 2009) and, in the United States, landscape debris **32 million tons a year**, comprises more than 13 percent by weight of all solid waste generated (Marinelli, 2008) and another **345 million oven dry tons of Forest litter, are available from accessible areas** (Rummer et al. 2003). Globally, just **30% of the crop waste from the five major food crops would globally provide 600 million tons of crop residue** safely available for charring without reducing soil fertility or increasing danger of erosion. (Strand and Benford, 2009). In terms of carbon sequestration, being very conservative, this would result in 120 million tons of biochar, 96 million tons carbon, or 352 million tons of CO2 (not to mention dramatic reductions of methane production, and improvements in drought resistance in many areas of the world). Happily, there are, in fact, mountains of wastes and residues lying about.

In conclusion, we refer to a 2009 interview by New Scientist (see Vance (2009) and James Lovelock. JL stated, "There is one way we could save ourselves and that is through the massive burial of charcoal. It would mean farmers turning all their agricultural waste - which contains carbon that the plants have spent the summer sequestering - into non-biodegradable charcoal, and burying it in the soil. Then you can start shifting really hefty quantities of carbon out of the system and pull the CO2 down quite fast."
New Scientist: "Would it make enough of a difference?"
Lovelock: "Yes. This scheme would need no subsidy: the farmer would make a profit. This is the one thing we can do that will make a difference..."

We, at WorldStove do not pretend that, by themselves, pyrolyzing stoves and biochar will reverse climate change, but they definitely will help. Meantime, they will improve the quality of life for some of the poor in the world, and, yes, in some cases they will reduce soil infertility, agrochemical runoff, even dirty toilets.

D. Nathaniel Mulcahy has a M.S. degree in Mechanical Engineering, specializes in fluid dynamics, has been director of research and development at a major corporation and is owner and director of WorldStove LLC.

David Mulcahy has a PhD in plant biology, taught ecology at the University of Massachusetts, Amherst, MA, for many years, and is director of research at WorldStove LLC.

REFERENCES:

Cabanas-Vargas, D.D. and E.I. Stentiford 2006. Oxygen and CO Profiles and Methane Formation During the Maturation Phase of Composting. Compost Science & Utilization, (2006), Vol. 14, No, 2,86-89

Esawy M., M. Ibrahim, P Robin, N. Akkal-Corfini and Mohamed (2009) Rice Straw Composting and Its Effect on Soil Properties Compost Science & Utilization 17(3):,146-150.

Gavin, D. G., Brubaker, L. B., and Lertzman, K. P.: Holocene fire history of a coastal temperate rain forest based on soil charcoal radiocarbon dates, Ecology 84, 186–201, 2003

Glaser, Bruno, Johannes Lehmann, and Wolfgang Zech, 2002. Ameliorating physical and chemical properties of highly weathered soils in the tropics with charcoal – a review. Biology and Fertility Soils 35:219-223.

Johannes Lehmann, Claudia Czimczik, David Laird and Saran Sohi (2009) Stability of Biochar in the Soil. Introduction in Biochar for Environmental Management - Science and Technology. Edited by Lehmann, J and Joseph, S. Earthscan Press.

Lertzman, K., Gavin, D., Hallett., D., Brubaker, L., Lepofsky, D., and Mathewes, R.: Long-term fire regime estimated from soil charcoal in coastal temperate rainforests. Conserv. Ecol. 6(2), 5, http://www.consecol.org/vol6/iss2/art5, 2002.

Major,J; C. Steiner; A. Downie; J. Lehmann. 2009. Biochar Effects on Nutrient Leaching. pp271-287 in Biochar for Environmental Management: Science and Technology. Lehmann, J ,S. Joseph, editors. Earthscan publishing London.

Marinelli, Janet, 2008. Greening your fall garden cleanup. National Wildlife; Oct/Nov2008, Vol. 46 Issue 6, p20-21

Landscape debris comprises more than 13 percent by weight of all solid waste generated in the United States--or an astonishing 32 million tons a year.

Novak, Jeffrey M.; Busscher, Warren J.; Laird, David L.; Ahmedna, Mohamed; Watts, Don W.; Niandou, Mohamed A. S. 2009. Impact of Biochar Amendment on Fertility of a Southeastern Coastal Plain Soil. Soil Science 174: 105-112

Preston, C.M. and Schmidt, M. W. I., 2006, "Black (pyrogenic) carbon: a synthesis of current knowledge and uncertainties with special consideration of boreal regions", Biogeosciences, 3, 397– 420.

Rummer, B., et al. 2003. A strategic assessment of forest biomass and fuel reduction treatments in Western States. Washington, DC: USDA Forest Service. 18 p.

Strand, Stuart; Benford, G. 2009. Ocean Sequestration of Crop Residue Carbon: Recycling Fossil Fuel Carbon Back to Deep Sediments. Environmental Science and Technology, 2009, 43, 1000-1007

Tryon, EH, 1948. Effect of charcoal on certain physical, chemical, and biological properties of forest soils, Ecological Monographs 18: 81-115. 1948.