Paper II.3

BIOCHAR: A WAY FORWARD FOR INDIA AND THE WORLD

Robert Whitfield,
Action for a Global Climate Community

1. Introduction

Biochar can sequester massive amounts of carbon in the soil for hundreds to thousands of years[i]. It has the potential to be an efficient carbon sink whilst providing strong co-benefits. Pre-Columbian Amazonian Indians used it to enhance soil productivity and made it by smouldering agricultural waste. They called it "Terra Preta de Indio." Its modern equivalent is being developed using pyrolysis to heat biomass in the absence of oxygen.

Modern biochar production can be combined with biofuel production in a process that is energy positive - producing 3-9 times more energy than invested, and carbon-negative[ii] - withdrawing CO2 from the atmosphere and rebuilding geological carbon sinks. With temperature thresholds, or "tipping points", as close as ten years away for abrupt and irreversible climate changes, including catastrophic sea-level rise, the need for carbon negative energy sources is paramount.

This paper initially explains the nature and global significance of biochar, drawing heavily on the Climate Briefing Note prepared by the Institute for Governance and Sustainable Development.[iii] It then goes on to relate biochar to India in particular. In part it is linked with paper II.2 'Black Carbon and its relevance for India.' The Black Carbon (BC) paper outlines some options for radically reducing BC by encouraging a shift to clean cookstoves. One such clean cookstove solution is also a source of biochar, a solution providing multiple benefits. This is only one of the ways in which Biochar production in India could be increased, with all its associated benefits.

2. Biochar and environmental management

There are four complementary and often synergistic objectives which may motivate biochar applications for environmental management, namely soil improvement, waste management, energy production and climate change mitigation. They need to have either a social or a financial benefit, or both and as a result, there are a number of very different biochar systems of different scales[iv]. Originally biochar was promoted primarily by the soil community, who were drawn by its remarkable soil enhancement properties. Now however the significance of the climate change benefits offered by biochar is becoming the key driver. Biochar is now acknowledged as one of the main ways of decarbonising the atmosphere[v].

There has been much discussion in the press and the literature regarding the scope for Carbon Capture and Storage – that is sequestering CO2 gas. The scope for carbon sequestration with biochar however may be just as significant. In the developing regions of the world, where the bulk of the land and the best climatic conditions for biomass production exist, policy incentives to drive Carbon removals may be expected to result in the widespread adoption of biochar soil improvement based on pyrolysis technologies of a sophistication and scale adapted to local conditions[vi]. The potential role of biochar for the removal of carbon dioxide (CO2) from the atmosphere and storage in soil of very large quantities of Carbon appears to lie mainly in developing countries[vii]. A forest/soil drawdown scenario has been developed that reduces CO2 levels in the atmosphere by 50 ppm by 2150[viii].

3. Biochar and the soil

Biochar can be used as a soil amendment to increase plant growth yield[ix], improve water quality, increase soil moisture retention and availability to plants, reduce soil emissions of GHGs, reduce leaching of nutrients, reduce soil acidity, and reduce irrigation and fertilizer requirements[x]. These properties are very dependent on the properties of the biochar, and may depend on regional conditions including soil type, condition (depleted or healthy), temperature, and humidity. Modest additions of biochar to soil were found to reduce N2O emissions by up to 80% and completely suppress methane emissions[xi]
Conservation of energy is achieved through the avoidance of energy incurred in the production of excess fertilizers. Biochar can be used in the reclamation of degraded and spoiled lands (Acidic and Alkaline soils).

4. Biochar and India

In India, charcoal production has been a major feature for thousands of years. Research into pyrolysis is currently underway in several research centres. An NGO, Geo-ecology Energy Organisation (GEO) has been developing a number of biochar stoves[xii], and carrying out biochar soil improvement on a pilot basis[xiii]. Similarly, another NGO, Social Change and Development (SCAD) has been working with Mysore University, distributing their Anila pyrolysis stoves[xiv] and carrying out soil research with biochar. As yet however, active engagement with biochar in India is limited.

There would appear to be two distinct opportunities in India in relation to biochar. The first is the production of biochar on a non-domestic scale. This could either be in a fixed location, linked, say to a cement kiln; in a distributed system, where a lower tech pyrolysis kiln is used by each farmer, or small group of farmers and using the energy generated from such kilns for processing the harvest and producing electricity for local needs.; or thirdly in a mobile pyrolysis plant which could be driven to different sites, obviating the need to transport the biomass.[xv]

A major source of biomass is provided by agricultural crop residues. 69.9 million tonnes of crop residues are produced in India from the six major crops, which is made up of (in millions of tonnes) Rice (13.1), Wheat (15.4), Sugar(21.6), Ground Nut (3.3), Mustard (4.5), Cotton (11.8). As a traditional practice some farmers are burning this crop residue along with weeds, contributing to CO2 emissions. In many parts of the country however there may be a shortage of feedstock and great care would need to be taken to ensure that the feedstock used met the emerging sustainability standards. In any event, a major driver here would be the generation of carbon credits.

The second opportunity is in the rural areas, helping to replace the traditional cooking fires discussed in PaperII.2. The individual amounts of biochar may be small, but such traditional fires are numbered in the tens of millions. Community based social marketing could grow to make a significant contribution to biochar production, although linking such activity into a system of formal incentives may prove problematic[xvi].

A research programme is recommended to determine the potential for pyrolysis based cookstoves in India would involve a number of components:

a) A study of the different regions in India, assessing the nature of the local feedstocks, the local cooking traditions and the nature of the local soil and building on the National Biomass Resource Atlas[xvii]

b) Different pyrolysis stove designs could then be tested to establish the optimum solutions in the different regions of India

c) Determination of the optimum way of accounting for, and being credited for the carbon sequestration in the soil

d) A coordinated programme of communication, capacity building and deployment of the stoves could be launched, potentially with EU support.

e) The establishment of institutional linkages for developing micro-enterprises for production / dissemination of stoves and monitoring and service centres.

5. Conclusions

Biochar has the potential, in rural India, to make a major contribution to soil improvement, public health and climate change mitigation.

A broad study of the potential of biochar in India is advocated. In particular, a multifaceted research programme is recommended. An appropriate programme of promotion and deployment of pyrolysis stoves can then be launched, in the light of the research results.

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[i] Zaelke, D. *Significant Climate Mitigation Is Available from Biochar* IGSD/INECE Climate Briefing Note, p1 December 2008, available at http://igsd.org/docs/Biochar%20Note%2015%20Dec%202008.pdf
[ii] Lehmann, J, *Bio-energy in the black*, 5 Front Ecol Environ 381, 385 (2007) available http://www.css.cornell.edu/faculty/lehmann/publ/FrontiersEcolEnv%205,%20381-387,%202007%20Lehmann.pdf.
iii Zaelke, D. Supra Note i
[iv] Forthcoming publication: Lehmann, J. & Joseph, S. *Biochar for environmental management – an introduction*, in Biochar for Environmental Management, eds Lehmann, J & Joseph, S. Earthscan London
[v] Forthcoming publication: Read, P. *Policy to address the threat of climate change – a leading role for biochar*, in Biochar for Environmental Management, eds Lehmann, J & Joseph, S. Earthscan London
[vi] Forthcoming publication: Read, P Supra Note iii
[vii] Forthcoming publication: Read, P Supra Note iii
[viii] Hansen, J. *Target Atmospheric CO2: Where Should Humanity Aim?* *http://biocharfund.com/images/hansen%2C%20target%20atmospheric%20c02.pdf*
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[ix] Lehmann, J, et al Nutrient availability and leaching in an archaeological Anthrosol and a Ferralsol of the Central Amazon basin: fertilizer, manure and charcoal amendments, 249 PLANT & SOIL 343, 355 (2003) available at http://www.css.cornell.edu/faculty/lehmann/publ/PlantSoil%20249,%20343-357,%202003%20Lehmann.pdf. ; in Zaelke,D. Supra Note i
[x] Steiner et al, *Long term effects of manure, charcoal and mineral fertilization on crop production and fertility on a highly weathered Central Amazonian upland soil*, 291 PLANT & SOIL 275, 287 (2007) available at http://www.css.cornell.edu/faculty/lehmann/publ/PlantSoil,%20online,%202007,%20 Steiner.pdf. ("The application of charcoal significantly reduced leaching of applied mineral fertilizer N. The increased ratio of uptake to leaching due to charcoal application indicates a high efficiency of nutrients applied with charcoal.")

[xi] Lehmann - Bioenergy in the Black, Supra Note ii at 384. ("In greenhouse experiments, NOx emissions were reduced by 80% and methane emissions were completely suppressed with biochar additions of 20 g kg-1 to a forage grass stand.")
[xii] http://e-geonews.blogspot.com/2008/11/biochar-food-security-nutrition.html
[xiii] Down to Earth -
http://www.downtoearth.org.in/full6.asp?foldername=20080515&filename=sci&sec_id=12&sid=6
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[xiv] http://www.bioenergylists.org/en/taxonomy/term/1375
[xv] Zaelke,D. Supra Note i
[xvi] Forthcoming publication: Read, P. Supra Note iii
[xvii] Ministry of New and Renewable Energy National Biomass Resource Atlas http://mnes.nic.in