Fighting Global Warming by increasing Soil's Organic Matter

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Climate change is a serious challenge to humanity and sustainable development which can be curbed to a large extent by increasing the soil's organic content. Field experiments were conducted at three experimental stations in Southwestern Nigeria viz: International Institute of Tropical Agriculture, Ibadan; Institute Agricultural Research and Training, Ikenne and University of Agriculture, Abeokuta) to monitor the impact of phosphate rock addition with and without legume biomass on Soil's organic matter. The fertilizer treatments consisted of four rates of Ogun phosphate rock (0, 30, 60 and 90 kg P ha^{-1}) and triple super-phosphate at 40 kg P ha^{-1}. Legume treatment consisted of mucuna and cowpea. The experiment was laid out in randomized complete block design with three replicates. Soil samples were collected and analysed for organic carbon. The data collected was subjected to statistical analysis. There was significant increase in organic carbon with addition of Ogun Phosphate rock in all the three sites Plots receiving 90kg P ha^{-1} of Ogun phosphate rock significantly increased Organic carbon content by 13% over control plots while an increase of 8.6% was observed on plots treated with mineral P fertilizer at Ikenne but no significant effect was observed at Ibadan and Abeokuta during the first field trial. Effect of Legume incorporation with Ogun Phosphate rock on soil organic matter was significant in all the three sites at 1% probability level. A significant increase of 30% in organic matter was observed with plots treated with mucuna biomass and phosphate rock at 90 kg P ha^{-1} during the first field trial at Ibadan (1.70%) over plots receiving only mucuna biomass (1.19%). Incorporation of phosphate rock into the soil proves a viable means of maintaining fertility of the soil and reducing atmospheric carbon through carbon sequestration.

Keywords: Phosphate rock, soil organic matter, carbon sequestration

Graphitic Carbon Yield in Biochar

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The word "charcoal" covers a continuum of materials of continuing interest, but covers a wide spectrum of properties. Biomass is composed C, H and O in which the carbon has aliphatic and aromatic bonds. Charcoal is characterized by having graphitic bonds and can be viewed as an amorphous graphite at 450 ºC which becomes more crystalline with further treatment.

The carbon-oxygen bond is almost impossible to break under thermo-chemical conditions found in charcoal production. Therefore, the fundamental formula for woody biomass, normalized for carbon:

$CH_{1.4}O_{0.6}$

indicates that there are only 0.4 carbons, or 40% of the biomass on a molar basis, which are not already bonded to oxygen, and therefore available to become true graphitic carbon in charcoal. This translates to about 21% yield on a bone-dry ash-free weight basis.

Perspective on the various charcoals can be further understood on a triangular diagram with C, H and O as the vertices. Biomass, torrefied wood and the various charcoals lie on a line in which progressively more CH_2O volatiles ("tars") are removed at higher and higher temperatures, according to

$CH_{1.4}O_{0.6}$ - x CH_2O ==> $C_{(1-x)}H_{(1.4-2x)}O_{(0.6-x)}$

where x varies from 0.3 to 0.6 as successive CH_2O are removed. A number of charcoals are described in these terms. Freshly formed charcoal is highly absorbent and can re-absorb these tars, depending on their method of removal or combustion. This adds another variable to the charcoal making process.

The charring process can also be viewed as the continuous removal of the principle components as processing proceeds to higher and higher temperatures. The principle components of biomass are the cellulose, hemicellulose and lignin, (typically ~50%, ~25% and ~25% for most biomass). Their progressive decomposition with temperature are shown by their thermogravimetric traces. Hemicellulose decomposes most easily in the range 270-310 ºC. Cellulose decomposes in the narrow range 330-350 ºC. Lignin decomposes over a broad range from 280 to 400 ºC. The decomposition of biomass is endothermic up to ~300 ºC, but becomes exothermic to the endpoint at ~425 ºC, at which all of the carbon is graphitic. Heating beyond that point requires further heating.

Biochar (charcoals for soil amendment and CO_2 mitigation) focuses new interest on the properties and yields of different production methods and we must be able to evaluate the various charcoals on the basis of: Yield; energy content; volatile content; graphitic carbon content; porosity; pH; growth enhancement and permanence in the soil.

Biochar: Delivering a Gigaton Offset

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Growing plants draw down CO_2 from the atmosphere to produce biomass containing carbon. When plants die the carbon contained in biomass is released back to the atmosphere as CO_2 as the biomass decomposes. Created through a process called pyrolysis, biochar locks in and stabilizes this C that would otherwise be released back into the atmosphere as CO_2. As such, the production of biochar represents an exciting and important opportunity to remove CO_2 from the atmosphere.

During pyrolysis, biomass is heated in an oxygen-deprived environment, causing thermal decomposition of the plant matter to produce biochar. Beyond the benefits of capturing carbon, pyrolysis by-products can be used to deliver energy products like heat and electricity. Further, biochar can be returned to the soil, where it continues to store this carbon while improving soil quality. By using biochar in their fields, farmers can increase agricultural production without increasing cropped area and reduce use of inputs such as fertilizers and water.

We believe that this gigaton offset opportunity will be delivered through a relatively small number of "platforms". Each platform represents a distinct configuration of feedstock, pyrolysis technology, biochar and energy products. Revenue streams may be derived from tipping fees or cost savings associated with the feedstock

processing (e.g. diverting material from landfill), biochar sales as an agricultural or horticultural product, sale of energy products and revenues from Carbon Offsets.
These platforms will be extremely diverse in nature and each will pose particular challenges both to project operators and protocol development. This presentation will identify key platforms and present a preliminary assessment of the offset potential of ach platform, the likely scale of the offset potential for each platform and an analysis of challenges that face the developers of each platform.

Identifying Challenges and Advantages of Biochar Production in Climate Change and Agriculture School Advocacy Programme for Young Farmers in Lagos

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Background
The school advocacy programme is an initiative of the Ministry to get young people practically engaged in Agriculture, protecting the environment using environment friendly ways in waste management, sustainable use of our natural resources and provide adequate agricultural trainings for young farmers which are vehicles of change for larger society, improving their awareness on mitigation of the impact of climate change in different schools, in Lagos Surveillance report found out that most of the youth under the programme are not aware of the importance of biochar use in mitigating the impact of climate change in the state.
Objectives: To assess the knowledge of youths on biochar production, in mitigating the impact of climate change and integrate biochar training into the climate change school advocacy programme for young farmers in the state.
Methods: 300 youths were trained from 6 educational districts on biochar production a carbon rich product from biomass, such as wood, manure or leaves, and other waste generated in the school communities littering the environment with high Global warming potential (GWP). Each groups produced biochar in the environment used to sequester carbon and serve as renewable energy production and serves as a valuable soil enhancer, thereby discouraging rainforest destruction, restore depleted soils, and put the Earth back in the black.
Agriculture and environment trainer provided youths sound, reality based information that increases their awareness about biochar. Agricultural fields, demonstration plots, posters and handbills with information on biochar and climate change were produced and distributed to youths.
Sessions encouraged youths to recognize the importance of biochar in mitigating the impact of climate change protecting the environment for food security and the future of the states' environment.
Result: According to the study, youth were interested in innovative approaches and technologies in mitigating and adapting to climate change. Only about 35 percent of the young men and 39 percent of the young women understands the concept of climate change. It was also determined the relationship between agriculture and climate change, methods and technologies for combating and mitigating climate change, by using biochar for carbon sequestration in a stable soil carbon pool and reducing green house gas emission GHG.
Conclusion: Integrating biochar production technologies into the school advocacy programme will help in combating climate change, ensure sustainable environment and favourable soil environment that is safe and friendly for plants environment and soil living organisms. Since youths are the future of tomorrow there is the need to train them on the importance of biochar in reduction of emission from waste and carbon sequestration while combating different environmental problems and climate change.

Greenhouse gas Mitigation by Different Types of Biochar

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In this study untreated soils were compared with three different types of biochar in terms of emission of carbon dioxide (CO_2) and nitrous oxide (N_2O). Untreated soils were sand (C = 1.3%), Terra Preta (C = 4.4%) and peat (C = 13.2%). Thermal conversion of poplar and pine wood yielded biochar from hydrothermal carbonization (HTC) (C = 56.9%), from fluidized bed gasification (C = 75.4%) and from pyrolysis (C = 79.9%). Biochar substrates were mixed with the carbon-poor sand for simulating real conditions after application of biochar to farmland. Emission rates of CO_2 and N_2O were measured from the rewetted substrates by gas chromatography after incubation in 125 ml glass vessels in an atmosphere of air for 72 hours.
The carbon content of the soils showed a clear relationship to the CO_2 emission, ranging between 0.6 mg CO_2-C kg^{-1} h^{-1} for pure sand and 17.5 mg CO_2-C kg^{-1} h^{-1} for peat. The C emission rate of the biochars ranged between 1.0 and 8.3 mg CO_2-C kg^{-1} h^{-1} and did not correspond with their total C contents. Since the CO_2 emission rates of the biochars under study were higher than that of the pure sand their carbon stability might be questioned. Long-term incubations are running to get more information about the carbon stability of these biochars.
Although considerable contents of total N and extractable ($CaCl_2$) nitrogen were found in the biochars under study, enhanced N_2O release could not be observed within our 72 h incubation experiment. N_2O emission rates in the three biochar/sand mixtures decreased from 31.6 µg N_2O-N kg^{-1} h^{-1} (sand) to 12.1 µg N_2O-N kg^{-1} h^{-1} (sand/pyrolysis biochar), 3.5 µg N_2O-N kg^{-1} h^{-1} (sand/gasifier biochar) and 0.6 µg N_2O-N kg^{-1} h^{-1} (sand/HTC biochar).
Since N_2O has a global warming potential 298 times higher than that of
CO_2, this positive effect of biochars may play an important role in mitigating CO_2 equivalents, which has to be taken into account for a balance of greenhouse gases emitted after biochar is applied to soil.
The use of biochar in soils opens the question of possible ecotoxicological side effects. First bioassays with invertebrates had shown that the contact with extracts from HTC biochar did not affect the reproduction of the nematode *Caenorhabditis elegans*.