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Conceptual Paper

Geoengineering Zero Waste Biochar in Carbon Footprint

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By-product of biomass pyrolysis in an oxygen depleted atmosphere is called biochar which contains porous carbonaceous structure. Pyrolysis of biomass/waste for biochar production for soil application offers a direct method for carbon sequestration and bioenergy production. Sustainably produced biochar applied to soils may proactively sequester carbon from the atmosphere as because carbonizing biomass stabilizes the carbon that has been taken up by plants [1]. Biochar is zero waste due to the fact that it is more of a goal or ideal rather than a hard target. This zero waste provides guiding principles for continually working towards eliminating greenhouse gasses and reducing carbon footprint. Carbon footprint is a measure of the total amount of CO_2 and other greenhouse gas emissions that are directly or indirectly caused by an activity, or which are accumulated over the life span of a product, organization, person, city or state. It is measured annually, calculated to include all GHGs and expressed as tonnes of CO_2 equivalent (tCO_2e). To promote the development of cleaner production, lowering carbon footprint demands the immediate attention [2]. Now a day's biochar technology is considered as geoengineering solution because it has capability to reduce the atmospheric greenhouse gases.

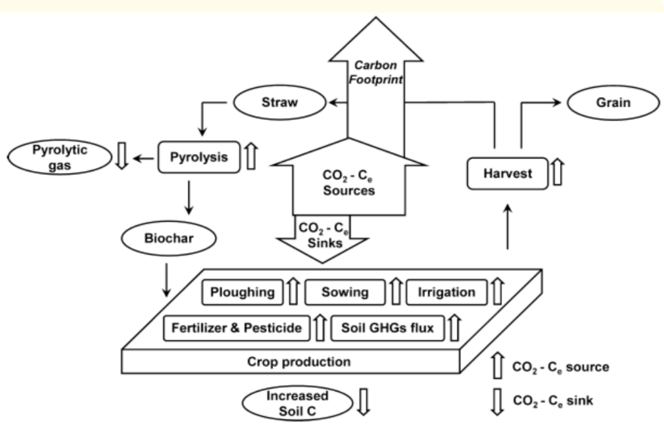

Figure: Carbon footprint budget in crop production under biochar amendment [3].

Carbon footprint assessment on biochar application provides an insight into its carbon mitigation potential. Present day uses life cycle assessment methods to determine the potential carbon footprint of producing biochar. Depending on the final application, biochar could be considered a raw material with a low carbon footprint. Most of the biomass are either burnt or end up in landfill, which produces large amounts of GHGs and also degrades the environment. Greenhouse gas emission is reduced by the conversion of biomass to biochar as this process locks up the carbon from the biomass into the biochar and thereby delaying the release of this carbon back to the atmosphere [4]. Carbon sequestration via biochar application can be seen not only as a strategy to mitigate the global climate change, but also as a source of profit via carbon credits. Based on biochar's potential, it is proved that the conversion of biomass into biochar decrease the carbon footprint of any production system in the world. The current availability of biomass in India is estimated at about 500 million tons/year [5] Of this, about 93 million tons of crop residues are burned in each year. These residues are either partially utilized or un-utilized due to various constraints. In Punjab alone, 70 to 80 million tons of rice and wheat straw are burned annually, releasing approximately 140 million tons of CO_2 to the atmosphere, in addition to methane, nitrous oxide and air pollutants [6]. Hence, conversion of these organic wastes to produce biochar using the pyrolysis process is one viable option that can enhance natural rates of carbon sequestration in the soil, reduce farm waste, improve the soil quality and finally can increase the carbon footprint.

Value of carbon footprint depends on different aspects of biochar viz. biochar feedstock source, crop yield response, biochar-carbon stability in soil, performance of biochar production system, and soil GHGs emissions alteration. In addition, biochar production using inefficient small-scale kilns is still very common rather than highly advanced industrial facilities. These very small aspects show the way to an ambiguity in carbon footprint value of biochar. In order to accelerate long-term soil carbon sequestration, all the biomass has to be converted to non-degradable zero waste, such as geoengineering biochar [7]. Some of the carbon in biochar produced under low temperatures is biodegradable and on the other hand carbon in biochar produced by high temperature pyrolysis is either recalcitrant or degradable at an extremely slow rate. Thus carbon footprint in biochar also depends on the quality of biochar. The more the stability of biochar, the lesser the value of carbon footprint. Based on conversion of sustainable procured biomass resource by low-emission and high-yield pyrolysis process, zero waste geoengineering biochar application can mitigate 12% of current anthropogenic CO_2-Ce emissions [8]. Based on energy-efficient pyrolysis technique, biochar application could potentially reduce carbon footprint of a production system, stemming from non-enhanced soil CH_4 and N_2O emissions and significant soil carbon sequestration. Biochar production without pyrolytic gas recycling through simple kiln-equipped pyrolysis method should be avoided. During the application of biochar, half-life of biochar-carbon and net electric energy input of biochar production are two critical factors which directly influence carbon footprint value [9]. Hence, biochar strategy had the potential to significantly reduce the carbon footprint, but the energy-efficient pyrolysis technique does matter.

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