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ROLE OF BIOCHAR IN SOIL HEALTH AND MITIGATION OF CLIMATE CHANGE

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Introduction

Biochar is the carbon rich product obtained when biomass, such as wood, manure or leaves, is heated in a closed container with little or no available air. It was earlier known as agrichar and discovered in sub-soils of fired forest in amazonian region (Brazil) and known as terra preta. The soils of the Amazonian region (current day Brazil) are known to be extremely fertile. Soil scientists have discovered that ancient Amazonians burnt crop residue and converted into a product similar to charcoal (known as *terra Preta).* They produced it by smoldering agricultural waste (i.e. covering burning biomass with soil) in pits or trenches. This product was then applied and mixed with topsoil which gave the soil its dark colour and fertility.

Methods of biochar production

Different processes arc made use of in its production.

Slow pyrolysis -Relatively low reactor temperatures (450- 650°C), operating at atmospheric pressure and very low heating rates, ranging from 0.01-2.0°C/s.

Fast pyrolysis - Very rapid feedstock heating leads to a much greater proportion of bio-oil and less biochar.

Intermediate pyrolysis - A hybrid of slow and fast pyrolysis.

Carbonisation - A number of pyrolysis processes that most closely resemble traditional, basic methods of charcoal manufacture, and which produce biochar of the highest carbon content. Further. It is of two types:

- **Hydrothermal carbonization:** Biochar is obtained by applying high pyrolytic temperature (200–250°C) to a biomass in a suspension with liquid under high atmospheric pressure for several hours.
- **Flash carbonization:** A flash fire is lights up at an elevated pressure at the underneath of a packed bed biomass. The fire travels in an upward direction through the carbonization bed against the downward flow of air supplied to the process.

Gasification - Gasification is the process by which any carbonaceous material is converted into a stream of carbon monoxide and hydrogen in a high temperature and controlled-oxygen environment. The biomass feedstock to some extent is oxidized in the gasification chamber at a temperature of about 800°C at atmospheric or elevated pressure.

Properties of fresh biochar

- High mineral content, especially Ca (for low pH soils), K. Mg and P with relatively higher solubility.
- Reactive surfaces that can complex soil organic and mineral matter and toxic substances.
- A high concentrations of oxygenated functional groups especially carboxylic and phenolic.
- A high redox potential.
- High micro/meso pore volume for adsorption of gases and liquids.
- Soluble or easily oxidized surface organic molecules (especially aliphatic) that are produced in low temperature pyrolysis.

What makes biochar work

- During formation, the porous, amorphous biochar structure adsorbs bio-oils, nitrogen, phosphorus and other nutrients.
- Very high surface area.
- In soil, biochar is extremely resistant to decomposition.
- Soil micro organisms and H_20 inhabit micro pores.
- Nutrient leaching and volatilization are inhibited.
- Nutrients are bioavailable to plants**.**

Potential functions of biochar

Improve soil health: Its application to soil improve physical, chemical and biological properties of soil. Biochar is beneficial in increasing soil health. Biochar acts as a habitat for many beneficial soil micro organisms, thereby increasing the soil microflora and fauna. Modest additions of biochar to soil reduce nitrous oxide emissions by up to 80% and eliminate methane emissions, which are both more potent greenhouse gases than CO_2. It has also been shown to reduce leaching of nutrients through sands soils depending on application rate, feedstock, pyrolysis temperature, soil moisture content and soil texture. For plants that require high potash and elevated pH, biochar can be used as a soil amendment to improve yield. Thus, biochar can improve water quality, reduce soil emissions of greenhouse gases, reduce nutrient leaching, reduce soil acidity, and reduce irrigation and fertilizer requirements. It is proposed as a soil amendment in environments with low carbon sequestration capacity and previously depleted soils, especially in the tropics.

Waste management technique

Farmers bum most waste biomass at the farm level by a technique called as slash and burn. This farm waste can be collected to produce biochar. This would prevent the harmful release of greenhouse gases at the same time it would be ecology clean and efficient way to manage waste related problems.

Mitigate climate change

Global warming can be debated, but the increase in atmospheric CO_2 levels is clearly measured. The earth is very capable of existing with much higher CO_2 levels, but current human society probably can not. The only current reasonable method for human action to remove significant amounts of atmospheric CO_2 is through biochar for carbon sequestration due to its following properties:

- It has carbon in recalcitrant form and can hold it in soil for hundreds of years.

- Due to high retention power, it reduces N_2O and CH_4 emission from soil.
- Otherwise easily decomposable OM can change in to resistant form by converting to biochar.

Miscellaneous uses of biochar

Due to its light weight, high nutrient content and water retention power. It can be used as plant growth medium in Following:

- Urban gardens
- Roof & terrace gardens
- Floatigation

Improves growth, development and yield of crops

By improving soil health, biochar improves growth & development of crops. It was experimentally found that biochar application improve germination and biomass of lettuce. Increases height and yield of maize crop when applied in conjunction with inorganic fertilizer. Van Zwieten *et al*., (2010) reported that yield of wheat crop increased by 250 per cent when 10 t ha^{-1} biochar applied inorganic fertilizers. Chan *et al*., (2008) reported 320 per cent increase in radish yield when 20 ton biochar is applied with 100 kg ha^{-1} nitrogen.

Methods of biochar application

- Biochar can be applied to soil by different methods including broadcasting, spot placement, deep banding etc. But method of biochar application depends on farming system, available machinery and labour.
- Biochar by hand application is well known, but is not viable on large scale because of labour intensity and human health concern.
- Mixing of biochar with compost and/or manure is best method of biochar application

Conclusions

- It sequester carbon for longer period.
- It improves physical, chemical and biological properties of soil.
- Mitigate climate change by reducing emission of GHG.
- Act as sink of heavy metals.
- Improves yield of crop, when applied in combination with other organic/inorganic fertilizers**.**

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