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Production of Biochar from Agricultural Residues: Turning Bane of Agriculture to Boon

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INTRODUCTION

The increasing industrialization and population is adding to the pollution of soil which ultimately effecting the agriculture. In recent times, agriculture is facing challenges like adaptation to the climate, contribution to the climate change mitigation, increasing productivity and income of the farmers, ensuring the food availability to the increasing population and sustainable management of left-outs of crops. These challenges are increasing burden on the natural sources like water and soil. These challenges are further degrading the soil at an alarming rate (Li et al., 2023). Globally, the annual production of crop residues is approximately 5280 mega tones in 2020-21 (Shinde et al., 2022). In India, crop residues derived from biochar has an estimated value of approximately $500 billion (Anand et al., 2022). The different techniques used for crop residues are open combustion and composting. The former is highlighted by the emission of pollutants such as H_2S, SO_2 and NH_3 which causes air pollution (Alhazmi and Loy, 2021). Recent researches are focused on development of new technologies for using crop residues to achieve global net- zero carbon emission goals.

The thermochemical degradation of crop residues to produce several value added products. Among all the degradation techniques, pyrolysis is the most favorable technique that involves use of organic biomass to degrade into biochar, bio-gas and bio- oil. On the basis of heating rate, pyrolysis temperature, residence time and heating method, pyrolysis can be classified into flash pyrolysis, fast pyrolysis, slow pyrolysis, vaccum pyrolysis, hydro- pyrolysis and microwave pyrolysis (Li et al., 2023). The different raw material used as feedstock for the production of biochar are crop residues, organic waste like manure, sewage sludge, wood, bamboo and municipal waste.

Crop residues have advance on other type of biochar feedstocks as it has low ash content and high calorific value. The characteristics of biochar such as high carbon content, high surface area, gross calorific value, pore volume (PV), stability and carbon exchange capacity (CEC) makes it useful for various applications (Wang and Wang, 2019). Recently, biochar gain much attention from the researchers worldwide as a cost- effective, environmental friendly and soil conditioner.

History of biochar

Although the concept of biochar in modern world is new but the roots of biochar are found in 'Terra Preta' region of Basin of Amazon. The terra Preta soils are also known as black soils which are believed to be created by the indigenous people of these areas. The soils of these regions are black up to 2 meters of depth and highly fertile for the production of crops. The main component of these soils is charcoal known to exist in these soils for 1,000 years or longer (Glaser et al. 2001). The characteristics like high amount of organic matter, neutral pH, high quantity of char and porous structure of these soils makes these soils highly productive as compared to the adjacent areas. One of the different theories behind the creation of these regions is technique similar to the modern times slash and burn technique of agriculture. The human settlements near these areas are evident that these regions are created by the human beings. Other regions similar to 'Terra Preta' regions are 'Plaggen soil' and 'Maori gardens' in New Zealand (Calvelo Pereira et al., 2014). In 19th century there are also mention of biochar in some agricultural and horticultural books which recommends that biochar is a valuable soil amendment for soil improvements by improving water and nutrient retention in soil. The increasing degradation of soil makes the researchers to think about a sustainable, eco-friendly and low cost option to remediate soil and biochar draw attention due to its characteristics and applications.

Crop residues

In India, on an average 500 million tons of crops residues have been produced every year and approximately 92 million tons are burnt to supply to the air pollution (Bhuvaneshwari et al., 2019). Various processes have been explored for the sustainable management of these crop residues and biochar technology was found to be effective for the same. The raw material as feedstock for the biochar production plays an important role as it determines the characteristics and quality of the final product (Tomczyk et al., 2020). Crop residues have high calorific value, fewer voids and low ash content as compared to the wood biomass, sewage sludge and compost. Crop residues are mainly composed of cellulose, hemicellulose and lignin which make them an ideal feedstock for the production of biochar. The various agricultural residues used as feedstock are sugarcane bagasse, wheat straw, rice straw, rice husk, peanut shell and corn straw and cobs.

Biochar and agriculture

The soil health is deteriorating rapidly due to overexploitation and overuse of chemical fertilizers. Biochar made from the different agricultural residues can be applied to improve the soil health and conditioning of soil. It can be a boon for the farmers as a as a new technique in modern agriculture practices (Ahmad et al., 2022). Organic agriculture is the need of the hour as it improves the quality of soil, decrease air and water pollution. Biochar can be a promoting factor for organic agriculture. The problems of salinity, heat stress and degraded soil can be tackled by biochar with improving the soil health. The major challenge in soil- water- plant system is soil fertility management which can be improved by the application of biochar. Biochar can be used in rice field to reduce the Nitrogen retention, Green house gases emission from soil and enhance carbon stocks accompanied by enhanced crop production. Biochar can also be used as rooting or potting media in tissue culture as it plant shows

greater response to biochar in comparison of other media. Due to the characteristics like high water holding capacity, large surface area, high pH and cation exchange capacity, biochar proves to be the useful soil amendment as it improves the soil health with increasing the crop production.

CONCLUSION

The management of Agricultural residues by thermally degrading them to biochar is gaining attention though out the world. Biochar has made substantial breakthrough in mitigating GHGs emission, tackling the problems of salinity, draught and heat stress. It also gains attention as soil amendment it is known to improve the crop production and soil health and fertility. Biochar is a marketable product which can also contribute to the farmer's income. This article urges to explore the ways to produce and use this abundant resource to contribute in the economically sustainable growth.

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