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Biochar as a carbonaceous material to enhance soil quality in drylands ecosystems: A review

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ABSTRACT

Drylands are fragile environments that should be carefully managed to improve their quality and functions to achieve sustainable development. Their major problems involve low availability of nutrients and soil organic carbon content. Biochar effect on soil is a joint response of micro to nano sized biochar and soil characteristics. In this review, we attempt to carry out a critical analysis of biochar application to enhance dryland soil quality. Correlating the effects identified from its soil application, we explored the subjects that remains open in the literature. The relation of composition-structure-properties of biochar vary among pyrolysis parameters and biomass sources. Limitations in soil physical quality in drylands, such as low water-holding capacity, can be alleviated by applying biochar at a rate of 10 Mg ha⁻¹ also resulting in beneficial effects on soil aggregation, improved soil porosity, and reduced bulk density. Biochar addition can contribute to the rehabilitation of saline soils, by releasing cations able to displace sodium in the exchange complex. However, the recovery process of salt-affected soils might be accelerated by the association of biochar with another soil conditioners. This is a promising strategy especially considering the biochar alkalinity and variability in nutrients bioavailability to improve soil fertilization. Further, while higher biochar application rate (>20 Mg ha⁻¹) might change soil C dynamics, a combination of biochar and nitrogen fertilizer can increase microbial biomass carbon in dryland systems. Other aspect of biochar soil application is the economic viability of scale-up production, which is mainly associated to pyrolysis process being biochar production the costliest stage. Nevertheless, the supplying of feedstock might also represent a great input on biochar final costs. Therefore, biochar-based technology is a big opportunity to improve fragile environments such as drylands, integrating sustainable technologies with regional development. Considering the specificity of application area, it might be a model of sustainable agricultural practices protecting the environment in a bioeconomic perspective.