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Carbon Farming and Biochar Application Using Salinized Water in Oman

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Extended Abstract

The increasing degradation of arable land in arid and semi-arid regions due to salinization, water scarcity, and climate change underscores the urgent need for resilient and sustainable agricultural practices. This study investigates the integration of carbon farming principles with biochar technology using salinized water, aiming to enhance soil health, reduce greenhouse gas (GHG) emissions, and improve crop productivity in salt-affected environments, specifically within Oman. Carbon farming, defined as a land management approach that enhances soil carbon sequestration, offers a low-cost, nature-based climate solution [1]. When combined with biochar—a carbon-rich by product of biomass pyrolysis, this strategy has the potential to regenerate degraded soils, restore productivity, and contribute to climate mitigation [2].

The primary objective of this research is to evaluate the feasibility and effectiveness of producing and applying biochar using salinized water and locally available biomass, such as date palm residues.

Work Package 1 involves collecting and analysing salinized water from various regions in Oman, followed by controlled pyrolysis of pre-treated biomass at 350–600°C. The resulting biochar is characterized using FTIR, BET, XRF, and ICP-OES to assess its physicochemical properties, including pH, surface area, porosity, and elemental composition. The influence of salinity on biochar quality and its suitability for soil amendment is critically examined, building on techniques used in [3].

Work Package 2 focuses on field application and soil–biochar interactions under saline conditions. Biochar-amended soils are tested for improvements in bulk density, porosity, nutrient retention (CEC), and microbial activity over two growing seasons. Preliminary results indicate that biochar application reduced soil electrical conductivity by 34%, increased cation exchange capacity by 80%, and enhanced microbial biomass carbon by 80%. In addition, mung beans crop yield improved by approximately 38%, and water retention capacity increased by over 60%. These findings are consistent with prior meta-analyses demonstrating the soil productivity benefits of biochar across varied environments [5].

Work Package 3 quantifies climate mitigation potential through carbon stock assessments using dry combustion and GHG flux measurements via static chamber techniques. Gas samples are analysed using GC-MS to determine CO_2, CH_4, and N_2O emissions. Initial findings suggest a 30% reduction in CH_4 and a 35% reduction in N_2O emissions in biochar-treated soils [6], [7].

This integrated approach contributes to Oman Vision 2040 by addressing food security, environmental sustainability, and economic diversification. The novelty of this work lies in the adaptive reuse of saline water in biochar production—transforming a limiting factor into a functional input. The research delivers actionable insights into scalable, climate-resilient farming practices suitable for salt-affected and water-scarce regions across the Middle East.

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