How can biochar affect greenhouse gas fluxes in agricultural soils?

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BIOCHAR AS SOIL AMENDMENT

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BIOMASS
e.g.: manure, compost, organic waste, crop residues

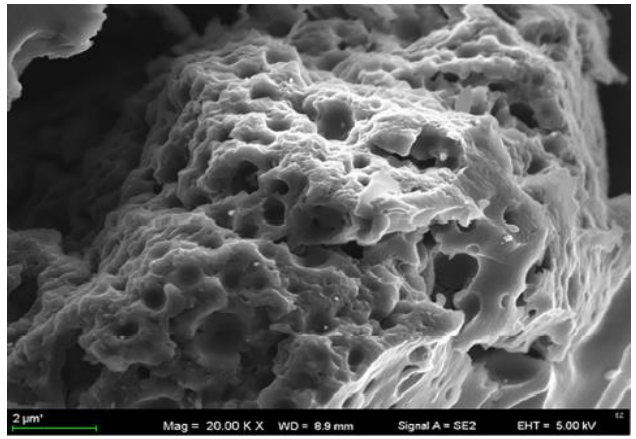
PYROLYSIS
high temperature, oxygen-limited atmosphere

BIOCHAR - solid, carbon-rich product

Type of biomass and parameters of pyrolysis determine biochar properties

Biochar characteristics and its effects on the soil properties:

- **High porosity** → improved soil porosity and sturcture; increased water storage (water holding capacity)
- **Low density** → reduced soil bulk density due to incorporation of the low bulk density material into the soil
- **High surface area** → promoted formation and enhanced stabilization of macro-aggregates
- **Alkaline** → increased soil pH; an alternative to lime amendment
- **High C content** → increased soil organic carbon concentration
- **High cation exchange capacity** → improved plant nutrient availability, beneficial for plant growth
- **Presence of various minerals and functional groups** → increased inorganic nutrient content and bioavailability



Biochar image from SEM (magnification x20.000)
(Walkiewicz et al.,2020)

BIOCHAR EFFECT ON SOIL GREENHOUSE GAS FLUXES

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BIOCHAR APPLICATION TO SOIL

CO_2 EMISSION

- Contribution to the labile organic carbon pool in soil = **increased CO_2 emission**
- Adsorbtion of soil CO_2 molecules due to large adsorption capacity = **decreased CO_2 emission**
- Indirect impact on CO_2 flux by affecting physical and chemical soil parameters (e.g.: porosity, water content, pH)
- Influence on the activity and diversity of microbes involved in CO_2 production

CH_4 UPTAKE / EMISSION

- Creation of more favorable conditions for methanotrophs by increasing soil pH = **increased CH_4 oxidation**
- Increased soil porosity and aeration, and decreased bulk density promotes the formation of aerobic conditions = **increased CH_4 oxidation (especially in saturated soils) and decreased CH_4 emission**
- Increased abundance of the methanotrophs = **increased CH_4 oxidation**

N_2O EMISSION

- Inhibition of soil denitrification by microbes due to enhanced soil aeration and oxygen concentration = **decreased N_2O emission**
- Immobilization of nitrogen compunds due to adsorption of NH_4^+ and NO_3^- resulting in decreased inorganic N pool for nitrifiers and denitrifies = **decreased N_2O emission**

References:
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