What is the role of bioenergy in soil carbon storage?

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Carbon fluxes in the soil

- Soil carbon pool includes organic carbon and inorganic carbon.
- Carbon storage depends on many things, including climate, soil type/soil zone, type of crop or vegetation cover, and management practices.
- Agriculture and forestry currently sequester about 12% of U.S. GHG emissions.\(^1\)
- Soil response to climate change is expected to be multifaceted with effects that are not yet well understood.\(^2\) However, warming soils increase soil respiration which releases more CO\(_2\) into the atmosphere.\(^3\)

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\(^1\) EPA 2021 Inventory of Greenhouse Gas Emissions and Sinks: 1990-2019
\(^3\) Hicks Pries et al. 2017 DOI: 10.1126/science.aal1319

Managing carbon is key to soil health.

Bioenergy relationship with agriculture

• Majority of identified biomass and waste feedstocks still rely on land use.
  • Agricultural residues (e.g., corn stover)
  • Dedicated energy crops
  • Forestry residues
  • Waste streams and re-usable carbon sources (e.g., waste food and manure slurries, anaerobic digester sludge, biosolids)

The agricultural and food system accounts for 26-31% of our total GHG emissions. 100% GHG emissions reduction in biofuels cannot be attained without the whole supply chain.

• Changes in soil organic carbon (SOC) influence net GHG emissions from bioproducts.4,5
  ▪ Land use change and biomass removal are two examples of how SOC can be affected by biofuel/bioproduct production.

• Nitrous oxide emissions also affect the GHG balance of biofuels/bioproducts.6,7
  ▪ ~ 80% of US N₂O emission is from soil management.1
  ▪ Bioenergy crops, specifically, can require a significant amount of fertilizer and weed killer.8

https://www.energy.gov/eere/bioenergy/feedstock-technologies

5 Locker et al. 2019 https://doi.org/10.1016/j.jclepro.2019.03.154
6 Yang et al. 2021 DOI: 10.1016/j.scitotenv.2020.141795
8 Li et al. 2021 https://doi.org/10.1021/acs.est.1c02238

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Technical gaps and opportunities

Opportunities with renewable fuels incentives and carbon offsetting schemes

- Mitigating lifecycle emissions from biofuels through agricultural practices
- Identifying efficacious carbon drawdown practices
- Developing reliable measures for carbon credits from agriculture including bioenergy crops
- Identifying potential feedstocks that can optimize soil carbon storage and biofuel and bioproduct yield
- Quantifying impacts on biomass processing/conversion
- Helping farmers’ economic bottom line for sustained application and implementation through market adoption

Farming practices can mitigate GHG emissions of corn for ethanol - Tillage management and variable rate application of N are relatively low cost with large abatement potential

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