Project #104
Carbon stabilization during incubation of fermentation byproducts

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Motivation and Objectives

- The co-products from residue-based sustainable aviation fuel (SAF) production can add economic value and improve environmental quality.
- Usage of crop residues risks reducing soil organic carbon; the return of carbon-rich coproducts to the soil can compensate for this removal.
- **We investigate how digestate and high lignin fermentation byproduct (HLFB) alter the turnover of native soil organic carbon and stabilize new carbon in the soil when compared to original crop residue.**

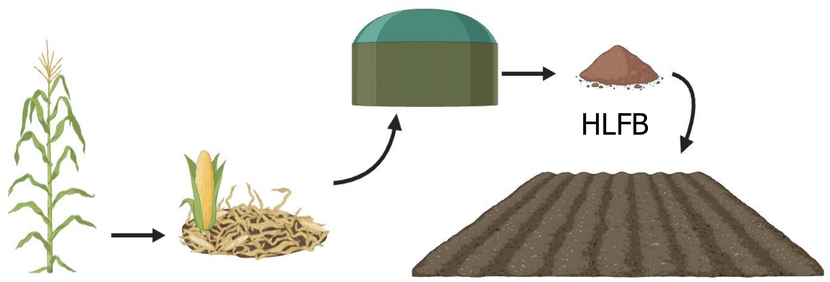

Fig 1. Fermentation co-product soil return

Methods and Materials

- We used a carbon balance model[1] to calculate the rate of change in soil carbon over time after applying raw agricultural residue and HLFB to the soil:

Residue decomposition rate; Carbon stabilization coefficient; Residue pool; Soil organic carbon decomposition rate; Soil organic carbon

$$\frac{\partial C_s}{\partial t} = k_r h_r C_i - k_s C_s$$

- Soil laboratory incubations paired with stable isotope tracing techniques allow tracking the residue carbon fate after these applications (Fig 2.)

Summary

Usage of crop residues for SAF production risks reducing soil organic carbon. We investigate how return of fermentation byproducts stabilize as soil organic carbon using laboratory incubations, isotope tracing, and modeling.

Fig 2. Laboratory incubation setup to trace carbon isotopes. Soil carbon and residue carbon are purposely selected to have different isotopic signature, C_3 and C_4. Carbon dioxide from soil organic carbon and the decomposing residue from each jar is automatically measured every 5 hours with a Picarro G2121-i.

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Results and Discussion

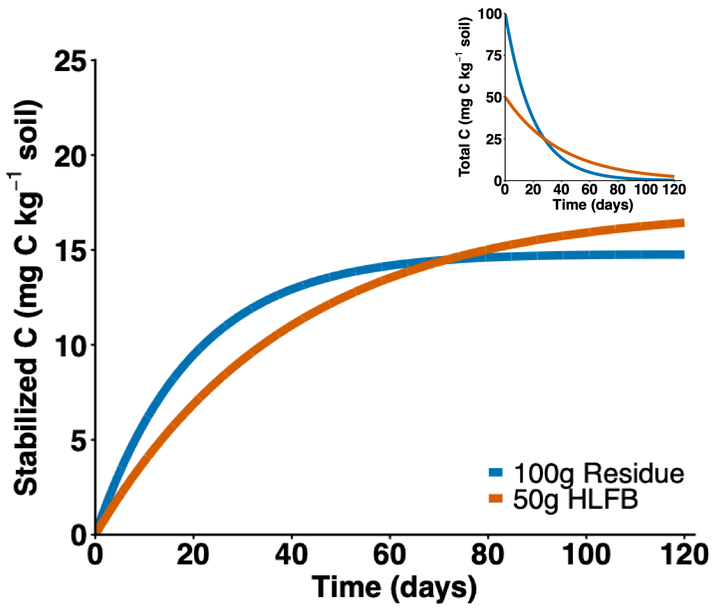

Fig 3. Stabilized soil carbon per kg of soil for HLFB with *hr* > raw residue *hr* and 50% C addition as HLFB compared with residue. Inset: substrate decay.

- **Higher humification of less carbon in HLFB shows slower but steadier carbon stabilization than fresh residue (Fig. 3)**
- **The final result is higher or similar soil carbon despite lower carbon inputs**

Conclusions and Next Steps

- **If experimental results confirm higher stabilization of HLFB, then production of alcohols from residue could be carbon neutral.**
- **The experimental set up will allow a robust testing of this hypothesis.**

References:

[1]Hénin, S., & Dupuis, M. (1945). *Essai de bilan de la matière organique du sol*. Dunod.

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