



Comparison of Cropland Emissions, Carbon Sequestration, and Soil Health Outcomes in Alfalfa (*Medicago Sativa*) and Corn (*Zea Mays* L.) Production Fields in an Integrated Crop-Livestock Dairy System

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RATIONALE & OBJECTIVES

- Dairy producers are interested in opportunities to achieve net zero greenhouse gas emissions through strategic farm management practices.
- Crop type may affect both field carbon flux and soil health outcomes.
- How does inclusion of alfalfa in the dairy rotation affect a farm's carbon footprint – the net balance of greenhouse gas emissions and accumulation of carbon in soil and vegetation?
- How do soil health outcomes compare in alfalfa and corn silage fields in a dairy forage system?

Objectives:

To compare soil health outcomes and carbon uptake in alfalfa and corn silage fields in a dairy production system.

RESEARCH DESCRIPTION

Locations:

In 2021, the study included 3 corn silage and 3 alfalfa fields in southern Wisconsin. The alfalfa fields were selected to include stand ages of 1, 2, and 3 years. All fields had a similar management history, and a rotation which included both alfalfa and corn silage.

Design:

- Fields were divided into zones based on soil type and topography. A total of 48 sites were sampled, with 8 sampling sites applied to each field (Figure 1). All soil type x topography combinations were represented in the dataset.

Data collection:

Soil carbon dioxide emissions were measured monthly at each location during the growing season. Continuous carbon flux (the exchange of carbon between the soil and the atmosphere) data were also collected year-round from a 100-foot tower on the farm. Soil measurements included pH, P and K, bulk density, aggregate stability, soil organic carbon, active carbon (available as food for soil microorganisms), and soil biological diversity (fungal and bacterial microorganisms).

Figure 1. Map of the sampling locations.



RESULTS

- Young alfalfa fields (1-2 years) at the research farm were a net carbon sink
- Older alfalfa fields (>2 years) tended to lose carbon on an annual basis
- Field topography was a greater predictor of soil health outcomes than crop type, due to within-field patterns of erosion and topsoil accumulation
- Alfalfa fields accumulated soil bacterial and fungal diversity with increasing stand age

CONCLUSIONS

- For fields with a similar crop rotation and management history, crop type within the sampling year was not as important as landscape position in predicting soil health outcomes. However, inclusion of alfalfa within the crop rotation is likely an important factor in reducing soil organic carbon losses over time and may contribute to improvements in soil conditions for the subsequent corn silage crop. Perennial cover in the study site contributed to a longer growing season, and greater carbon accumulation during the early and late parts of the growing season. Additional research is needed to identify management practices that will increase carbon accumulation, or reduce carbon losses, from older alfalfa stands. It is possible that alfalfa-grass mixes may increase biomass production in both above- and below-ground vegetation as stands age, but studies are needed to evaluate the potential impacts on forage quality and productivity over time. Alfalfa varieties which allow for fewer cuttings with high productivity and forage quality may present an opportunity to increase net field carbon balance.