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A 13-Year Record Indicates Differences in the Duration and Depth of Soil Carbon Accrual Among Potential Bioenergy Crops

Background/Objective

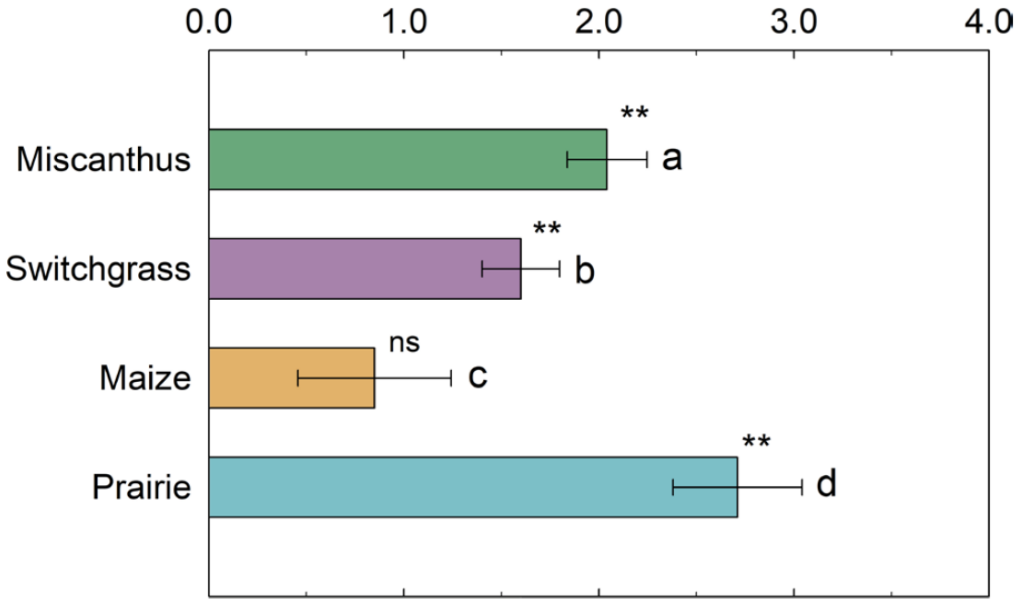
While annual cropping systems such as maize/soy rotation perpetuate soil organic carbon (SOC) loss, perennial crops have been found to contribute to SOC increases. However, most perennial crop studies have been short-term, resulting in incomplete understanding of their long-term impacts on SOC. This study addresses this knowledge gap by examining SOC dynamics over time for three perennial systems compared to maize/soy over a 7- to 13-year period.

Approach

Miscanthus, switchgrass, and mixed prairie plots were planted at the Illinois Energy Farm in 2008 on land that had been previously in maize/soy rotation. Soil, biomass, and eddy covariance data were collected throughout the study with final sampling for prairie in 2016, switchgrass in 2019, maize in 2020, and miscanthus in 2021.

Results

While samples taken at 6 years post-planting did not statistically resolve SOC changes, samples taken 8 to 13 years post-planting showed that SOC increased under the perennial crops while declining or remaining unchanged under annual maize/soy. Consistent with this observation, net ecosystem C balance (NECB) was negative for perennial crops (indicating gain of C) and positive for maize/soy (indicating C loss).



SOC accrual rate (Mg C ha^{-1} y^{-1}) in the top 1m of soil between 2008 and 2016 for maize, miscanthus, switchgrass, and restored prairie. Bars = mean (n=5). Error bars = standard error of the mean. **p ≤ 0.05, ns=not significant.

Significance/Impacts

Planting perennial crops on land formerly used for annual maize/soy can slow or reverse soil C losses, with greatest SOC increases from species-rich prairie. Long-term datasets are needed to further understand the dynamic nature of SOC accrual and retention.

Kantola et al. 2025. "A 13-Year Record Indicates Differences in the Duration and Depth of Soil Carbon Accrual Among Potential Bioenergy Crops." *GCB Bioenergy*. DOI: 10.1111/gcbb.70080.