Title: Impact of Sugarcane Cultivation on C and H_2O Fluxes in Southeastern United States following Conversion from Grazed Pastures

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Project Goals:

The overarching objective of this research is to improve our understanding of the environmental costs and benefits of pasture conversion to sugarcane, and inform sustainable land use decisions for bioenergy crop cultivation.

Abstract Text:

The Southeastern US (SE US) has the capacity to produce almost a third of the 36 billion gallons target established by the Energy Independence and Security Act. The expansion of cane, a subtropical high yielding feedstock, will likely reshape the US bioenergy landscape, although the consequences of this land use change on the environment are highly uncertain particularly as it may displace grazed pastures, a typical landscape of the SE US. Here, we investigated how the conversion of pastures to sugarcane in subtropical Florida impacts carbon (C) and H_2O fluxes using eddy covariance, chamber and biometric methods. Pastures included grazed improved and semi-native pastures, which make up for 53% of agricultural land. Sugarcane exhibited 3-fold and 11-fold higher aboveground productivity relative to improved and semi-native pastures. The land conversion drastically reduced root C allocation from 45% and >95% in improved and semi-native pastures to barely 5% in sugarcane. The conversion shifted belowground C inputs from a root-dominated to a litter-dominated system, and decreased the contribution of root respiration to soil C losses by 5-10%. Given differences in the chemical recalcitrance, aggregation and mineral associated organic matter formation of root- and litter- derived C inputs, establishing sugarcane in grazed pastureland could profoundly alter the formation and persistence of soil organic matter, and long-term soil C storage. Immediately following conversion from pasture, sugarcane was a stronger net source of CO_2 than grazed pastures but after first regrowth it became a stronger net CO_2 sink (i.e. Net Ecosystem CO_2 Exchange). After accounting for C removal (i.e. due to fire, harvest, consumed biomass by grazers), sugarcane was a net C source to the atmosphere (i.e. Net Ecosystem C Balance; +662 and +196 gC m^{-2} yr^{-1} following sugarcane conversion and after first regrowth), the semi-native pasture was a net sink, and the improved pasture was C neutral (-223 and +5 gC m^{-2} yr^{-1} for semi-native and improved pastures for the studied period). These results emphasize the importance of conversion disturbances (i.e. tillage, cultivation, planting) and management practices (i.e. fire) in shaping the C balance of ecosystems. Although sugarcane produced higher yield per water consumed, evapotranspiration was higher in cane and improved pasture than in semi-native pasture, suggesting that the regional water balance implications of land use conversion will depend on the proportion of improved versus semi-native pastures converted to sugarcane. Overall, our results suggest that feedstock optimization and the implementation of management strategies targeting carbon storage are critical to the development of a sustainable bioenergy landscape in SE US,

and highlight the role of bioenergy crops in potentially altering the water cycle to support bioenergy demand.

Funding Statement: Funding for this work was provided by the DOE Center for Advanced Bioenergy and Bioproducts Innovation (U.S. Department of Energy, Office of Science, Office of Biological and Environmental Research under Award Number DE-SC0018420).