The carbon and water impacts of pasture conversion to sugarcane in Southeastern US.

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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. However, the sustainability of cane-based biofuel industry remains highly uncertain particularly as it may displace grazed pastures, a typical landscape of the SE US with high biodiversity value and known to provide multiple ecosystem services. Using biometric, ground-based and eddy covariance methods, we investigated how sugarcane cultivation (i.e. plant cane, PC, 2019; first ratoon cane, FRC, 2020; and second ratoon cane, SRC, 2021) in subtropical Florida impacts C and water fluxes relative to grazed improved (IP) and seminative (SN) pastures, which together make up to 53% of agricultural land. Cane increased on average 1.9-fold and 7.1-fold aboveground productivity relative to IP and SN pastures. However, this reflected in part a shift in belowground C inputs from root-dominated pastures to a litter-dominated system in cane with only 5% C allocation to roots. Consistently, heterotrophic contributions to soil respiration increased from 39.3% and 52.0% in IP and SN respectively to 65.2% in sugarcane. Immediately following conversion from pastures, cane (PC) was a stronger net C source but after first regrowth (FRC and SRC) it became a stronger C sink than pastures. Accounting for C removed by management (i.e. fire, harvest, consumed biomass by grazers), cane was a C source relative to SN (529 gC m-2 y-1), but relative to IP, cane switched from net losses (PC; 770 gC m-2 y-1) to net gains (-61 gC m-2 y-1) three years after conversion (SRC). Although cane produced higher yield per water consumed, evapotranspiration was higher in cane and IP than in SN pasture, suggesting that the regional water balance implications of land use conversion will depend on the proportion of IMP versus SN pastures converted to cane. Overall, our results suggest that cane cultivation could impact the hydrological cycle, and that the implementation of management strategies targeting C storage – such as green harvest and amending soils with biochar or cane co-products – could be critical to the development of a sustainable bioenergy landscape in SE US.

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