Title: Can Perennial Bioenergy Cropping Systems Promote Negative N_2O Fluxes?

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Project Goals:

(i) Determine the occurrence and frequency of negative N_2O fluxes from bioenergy cropping systems using automated flux chamber technology
(ii) Identify environmental and soil characteristics that might favor N_2O consumption and determine their predictive capacity

Abstract Text: Atmospheric nitrous oxide (N_2O) concentrations reached a new high of 331 ppb in 2019 primarily due to agricultural intensification and soil disturbance. Efforts to mitigate N_2O from agricultural soils have thus far focused on reducing fluxes from high-emitting systems such as fertilized row crops. The potential for promoting negative fluxes (denitrification of atmospheric N_2O) in low-emitting systems such as perennial bioenergy feedstocks has been unexplored, largely because of the technical difficulty of identifying small negative fluxes within a background of more frequent and easier-to-detect high or net-zero fluxes. Automated flux chambers deployed in situ offer the opportunity to better resolve the potential for negative fluxes with near-continuous measurements and low analytical error. We examined sub-daily N_2O fluxes from 2012 to 2017 (six years) under nine different bioenergy cropping systems in the GLBRC Biofuel Cropping System Experiment at the W. K. Kellogg Biological Station in southwest Michigan USA. Daily, weekly, monthly, and annual flux measurements were calculated individually for positive and negative sub-daily data after first determining a minimum flux detection limit of ±1.029 g N_2O-N ha^{-1} d^{-1}. Of 37,000 sub-daily fluxes, 34% were statistically less than zero, ranging from -1.029 to -926 g N_2O-N ha^{-1} d^{-1}. Weather transitions lowered the magnitude of negative N_2O fluxes. Minimum daily temperature and volumetric soil moisture content (0-10 cm depth) together explained 45% of negative N_2O fluxes. The variability of N_2O fluxes and the preceding seven days' average precipitation were strongly associated. Higher plant diversity and lower inputs also promoted the frequency and magnitude of negative fluxes. Results suggest a potential for designing bioenergy cropping systems with a capacity to consume atmospheric N_2O.

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