Net ecosystem GHG and energy balance of bioenergy cropping systems in the U.S. Great Lakes Region

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United States Energy Policy such as the Renewable Fuels Standard has been enacted to reduce dependence on fossil fuels and mitigate global climate change. The Great Lakes BioEnergy Research Center, BioEnergy Cropping Systems Experiment, established in 2008 at sites in Arlington, Wisconsin and Hickory Corners, Michigan, contains annual cropping systems (corn, soybeans, canola) and perennial cropping systems (switchgrass, miscanthus x giganteus, a native grass mix, old field, poplar, and prairie grass mix). Field inputs, empirically measured gas emissions, and yields have been tracked since establishment. This field data was used to perform a net ecosystem greenhouse gas (GHG) and energy balance on these cropping systems with a focus on the global warming potential (GWP). Nitrous oxide emissions had the greatest effect on the GWP of each cropping system of all of the gas emissions considered. The continuous corn cropping systems had the highest nitrous oxide emissions per hectare per year at both study locations as expected. However, the corn systems were among the most favorable in terms of net GWP, due primarily to displacement of gasoline fossil fuel from bioethanol generated from the crop. The perennial systems generally had a negative GWP per hectare per year due to limited inputs and low gas emissions from those systems. Crop yield was a primary driver for net ecosystem GHG, and energy balance. Miscanthus x giganteus was a competitive bioenergy feedstock, particularly in Michigan, however, long term sustainability concerns remain regarding the specie’s lack of genetic biodiversity and subsequent pest resistance potential. On the relatively productive soils of the study, polyculture systems lagged behind the monoculture crops in terms of net ecosystem carbon and energy balance metrics.

Keywords: bioenergy; cropping systems; GHG; GWP