Data from: Carbon debt of field-scale Conservation Reserve Program grasslands converted to annual and perennial bioenergy crops

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Keywords	life cycle analysis (LCA), global warming impact (GWI), greenhouse gas (GHG), fossil fuel, corn, switchgrass, restored prairie
Spatial Coverage	North America, US Midwest Corn Belt, Southwest Michigan
Temporal Coverage	Holocene

Abstract

Over 5 million ha of US Conservation Reserve Program (CRP) grasslands have been converted to annual crops since 2000, driven mainly by demand for corn grain ethanol. Much of the soil carbon sequestered under CRP is lost upon conversion, creating a "carbon debt" that is presumed to be repaid by future greenhouse gas (GHG) savings from ethanol's substitution for petroleum. Model simulations, extrapolations, and national statistics rather than direct measurements have been used thus far to estimate the long-term global warming impact (GWI) of such conversions. Here we report measured GWIs for three 22 year-old CRP grassland fields and three conventionally tilled agricultural (AGR) fields (11–17 ha) converted to either annual no-till corn or perennial cellulosic (switchgrass or restored prairie) bioenergy crops. We assessed GWIs for each field over eight years using whole-system life cycle analysis (LCA) by measuring: a) greenhouse gas fluxes via eddy covariance and static chamber methodologies, b) farming operations and agronomic inputs, and c) the fossil fuel offset by ethanol use. Payback times were much longer than those estimated by prior modeling efforts. After 8 years, cumulative GWIs of switchgrass, restored prairie, and corn at the CRP grasslands were, respectively, -2.6±4.0, 6.9±3.6 and 85.2±5.1 Mg CO2-equivalent ha-1. The switchgrass system had repaid its carbon debt by year eight and the restored prairie will have likely repaid by year ten; however, the no-till corn system appears likely to require >300 years. The same bioenergy crops grown on former agricultural lands, with no sequestered carbon lost on conversion, repaid their carbon debts within two years. Results indicate that GWI estimates and carbon debt payback times due to conversion of CRP lands to annual bioenergy crops have been substantially underestimated by current models.

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