Impacts of Increased Corn Production for Ethanol on Net Greenhouse Gas Fluxes

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INTRODUCTION

- The growing market for corn ethanol has the potential to reduce greenhouse gas (GHG) emissions associated with fossil fuel combustion.
- However, projected increases in cropland for biofuel production will also impact emissions of GHGs from soils.
- Agricultural soils have become a net sink for CO_2, largely due to enrollment of land in the Conservation Reserve Program (CRP).
- Conversion of former CRP lands and grasslands into biofuel production will impact soil C. Fertilization of former CRP lands will increase soil N_2O emissions.
- Furthermore, corn production is likely to increase on lands currently used for other crops or crops grown in rotation with corn.

OBJECTIVES

Quantify the net GHG flux from increased corn ethanol production.

Use DAYCENT to estimate soil GHG fluxes and crop yields for increased corn production.

Combine soil GHG fluxes with emissions from farm inputs, farm operations, feedstock conversion, and fossil fuel offsets in a complete life cycle analysis.

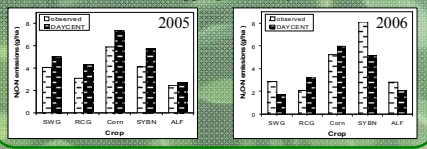
The Four Cropping Scenarios Simulated:

- **Grassland converted to corn cropping**
  Grazed land until 2006, converted to corn 2007
- **CRP lands converted to corn cropping**
  Corn until 1987, CRP 1988-2006, then corn 2007
- **Other crop rotations converted to corn cropping**
  Other crop rotations to corn in 2007
- **Grassland remaining grassland**
  Continuous grazed land remaining grassland

The DAYCENT Model

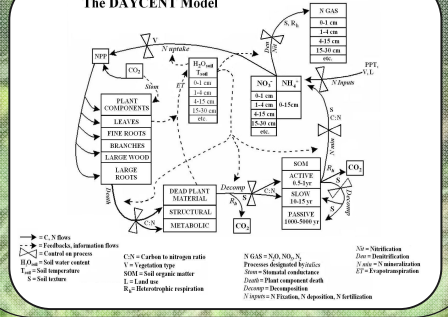
DAYCENT is the daily time-step version of the CENTURY (Parton et al. 1994) biogeochemical model.
DAYCENT simulates fluxes of carbon (C) and nitrogen (N) between the atmosphere, vegetation, and soil.

Model Validation: Average Daily N_2O Emissions from biofuel cropping in Pennsylvania



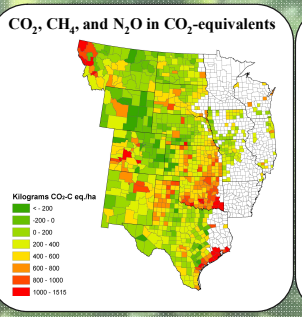
Using weather data (daily max and min air temperature, precipitation), soil-texture class, and land-use inputs, DAYCENT can dynamically evaluate the impact of cropping systems on crop production, soil organic carbon, and trace-gas fluxes.

The DAYCENT Model

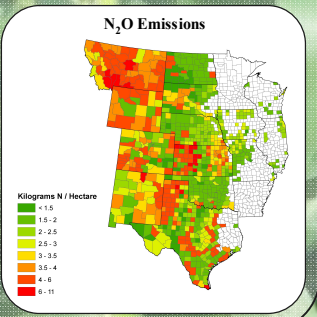


County Soil Emissions: Grassland Converted to Corn Cropping

CO_2, CH_4, and N_2O in CO_2-equivalents

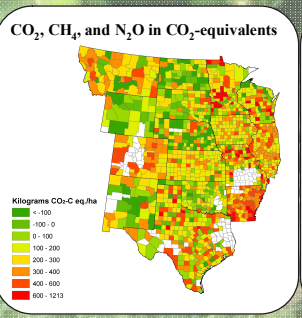


N_2O Emissions

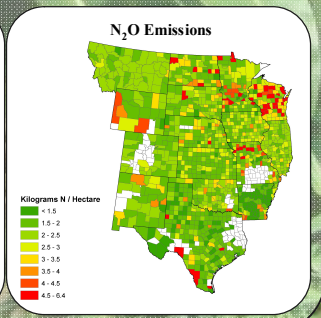


County Soil Emissions: CRP land Converted to Corn Cropping

CO_2, CH_4, and N_2O in CO_2-equivalents

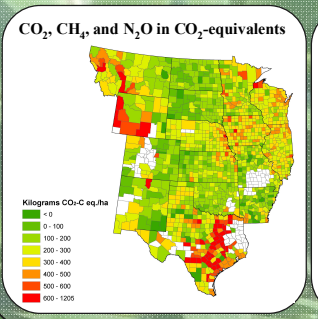


N_2O Emissions

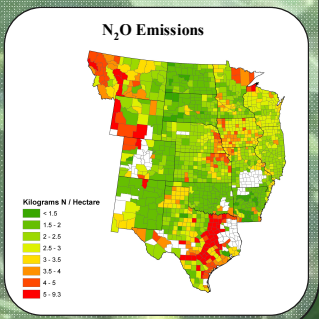


County Soil Emissions: Other Crop Rotations to Corn Cropping

CO_2, CH_4, and N_2O in CO_2-equivalents

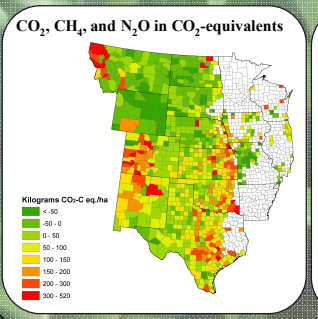


N_2O Emissions

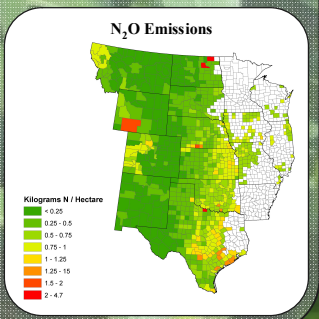


County Soil Emissions: Grassland Remaining Grassland

CO_2, CH_4, and N_2O in CO_2-equivalents



N_2O Emissions



CONCLUSIONS

With the increased demand for corn ethanol, farmers are expected to plant the largest corn acreage in the United States since 1944.

- DAYCENT simulations suggest yields from grassland and CRP converted to corn will be lower than current corn cropping systems by 10-15%.
- Emissions of N_2O (300 x more potent than CO_2 as a GHG) on average were simulated to increase five fold when compared to grassland and CRP.
- Soil carbon storage can either increase or decrease according to simulations, depending on variables like environmental conditions and tillage practices.
- According to DAYCENT, soil N2O emissions are the primary source and also the most sensitive to land use change and management decisions.