LEOPOLD CENTER
FOR SUSTAINABLE AGRICULTURE

Conversion to perennial vegetation: Quantifying soil water regime, aeration, and implications for enhancing soil resilience to climate change

Abstract: Iowa was once awash with native prairie vegetation, and now it is covered with annual crops. This project looked at the different effects these two systems have on Iowa's landscape and natural resource base.

Results indicate that relative to corn systems, prairie systems reduced soil compaction, decreased soil water drainage and nitrate leaching, decreased soil nitrous oxide emissions, and increased soil carbon dioxide emissions. Overall, the prairie systems had favorable environmental impacts relative to corn systems.

ECOLOGY

Investigators:

Robert Horton
Agronomy
Iowa State University

Co-investigators:
Thomas Sauer
USDA-ARS
National Laboratory for Agriculture and the Environment
Ames

Aaron Daigh
Agronomy
Iowa State University

What was done and why?

The project was designed to provide a quantitative, side-by-side comparison of corn- and perennial-based cropping systems by analyzing soil ecosystem processes.

The overall objectives were to:

- provide comprehensive, long-term comparisons of a range of contrasting biomass feedstock production systems to continuously measure the volumes and nitrate concentrations of soil water drainage and the soil atmosphere concentrations of carbon dioxide, CO2, and oxygen, O2, in reconstructed prairie and cropping systems managed for biofuel production;
- complement these measurements with periodic measurements of the two most significant greenhouse gas (CO2 and nitrous oxide N2O) fluxes, management zone bulk densities, air permeability, soil aggregate stability, and plant rooting characteristics; and
- utilize the data to construct a user-friendly, modular computer simulation model of soil ecosystem responses to changing land use and potential climate change scenarios suitable for federal, state, and local agency personnel.

What did we learn?

Quantifying the impact of biofuel crops on soil, water and air qualities is critical information for use by policy makers and agency personnel to complete a comprehensive environmental assessment of biofuel cropping systems. Soil physical properties, N2O effluxes, soil root densities, and tile drainage loads all appear to be beneficially enhanced under prairie systems relative to corn in traditional corn-soybean rotations and continuous corn systems with and without cover crop. Work on a model/decision support tool was slower than anticipated. Nonetheless, good progress was made and a proof-in-concept of the approach has been demonstrated. To finish the model and make it an effective statewide tool ideally would include CT-scans of major Iowa soils under both row-crop and prairie vegetation. Further research on the benefits of perennial biofuel cropping systems on ecosystem assets such as water use and water balance components is needed to articulate the full impact of land use changes from annual row crops to perennial cropping systems on soil, water and air resources.