New Tools and Incentives for Carbon, Nitrogen, and Greenhouse Gas Accounting and Management in Corn Cropping Systems

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The Issue

Many farmers remain reluctant to explore mitigation options because they lack useful tools to quantify how management decisions will affect yield, net profits and greenhouse gas (GHG) emissions in a changing climate. Assessing soil carbon (C) stocks and verifying C sequestration can be costly. Market and policy solutions to incentivize mitigation must consider the costs of monitoring and verification, valuation of environmental benefits, and factors determining farmer behavior.

Project Goal

Our overarching goal is to provide small- to large-scale corn growers with low-cost soil C assessment and GHG management tools, and provide policymakers with an evaluation of policy and market incentive options across a range of future climate scenarios. Collectively, these new tools will promote climate change mitigation, optimize farm productivity in the face of adapting to a changing climate, and have applications beyond corn production systems.

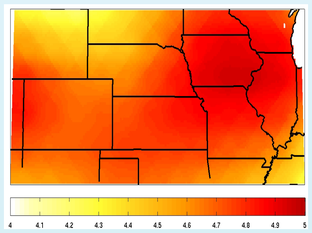
Specific Objectives

1. Develop and test low-cost approaches to soil C assessment
2. Regionally validate and enhance two biogeochemical models, DayCent and Precision Nitrogen Management (PNM)
3. Test and implement web-based tools (COMET-Farm; Adapt-N) for farm-level C, N and GHG accounting and management
4. Use regionally downscaled climate scenarios and DayCent and PNM models to analyze regional impacts of historical and future climate change scenarios, land use, and management practices on GHG emissions, soil C sequestration and corn yields
5. Use an economic equilibrium model, in conjunction with climate and crop-soil models (Obj 4), to evaluate current and long-term costs and benefits of various policy incentives for mitigation

Early Phase Accomplishments

Climate Modeling

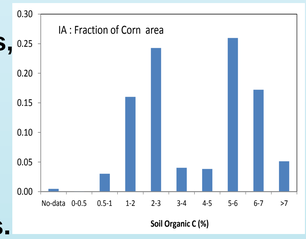
Four climate model projection products have been acquired for the focus regions (primarily NY, IA, CO), which will allow tailoring projections to the needs of the biogeochemical modeling teams, and allow comparisons between raw global climate models, statistically downscaled projections, and regional climate models.



Mean annual temperature change (°F) for portions of the study area for the 2050s minus the 1980s. Based on 16 GCMs from the BCS dataset for the A2 scenario.

Geospatial Analyses

Data and maps of soil characteristics, land cover, land use, cropping systems, and corn production statistics have been made available for regional biogeochemical model parameterization and for developing stratified field sampling plans that will allow up-scaling of soil C assessments.



Bimodal distribution of soil C (based on SURGO data) in corn area of IA, due to native soil properties and tile drainage

Soil C Assessment

- The soil C teams will have collected over 3000 samples by end of Year 2.
- Preliminary analyses from long-term sites are elucidating dynamic relationships between C fractions, N, BD, and soil texture with depth and crop management.
- High-density grid sampling at selected sites is being used for power analyses and geostatistical modeling for estimating required sample number and for predicting soil C at unsampled locations and depths.

Soil Measurements (to 75 cm depth, stratified across cropping systems, soil types, climate in NY, IA, CO, NE)
-Soil Texture
-Bulk Density (BD)
-% Organic Matter (OM)
-Total %C, %N
-Soil Inorganic C
-Active C (permanganate oxidation)
-VNIR spectroscopy
-MIR spectroscopy

Improved Biogeochemical Models

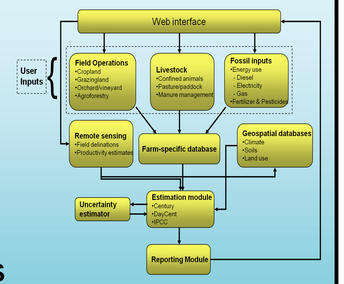
DayCent and Precision Nitrogen Management (PNM) models, which form the backbone of the COMET-Farm and Adapt-N web tools (see next panel) are being regionally calibrated and improved for better estimates of GHG emissions (particularly N_2O emissions) and soil C dynamics as affected by management and climate.

Economic-Policy Model

An initial economic equilibrium model framework for evaluation of farm management choices affecting yields, GHG emissions and soil C sequestration in response to policy and climate change is complete. The next phase– gathering historical data and developing the simulation protocol to link the economic model with the biogeochemical and climate models– is underway.

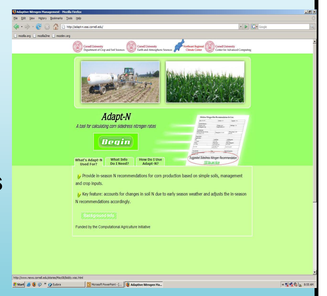
COMET-Farm Web Tool

- DayCent biogeochemical model
- Full farm-level energy and GHG accounting for animal as well as corn and other crop production systems
- Estimates soil and biomass C stock changes
- A spatial user interface for specific field and soil locations
- A system that utilizes existing NRCS products and databases such as SSURGO
- Beta-testing beginning in 2012 and 2013



Adapt-N Web Tool

- Precision Nitrogen Management (PNM) biogeochemical model
- Simulates soil C and N dynamics and corn N uptake based on real-time weather to optimize fertilizer N inputs
- Currently being used by corn growers in the NE US and parts of Midwest
- Being modified for this project to evaluate climate, management, and policy effects on current and future N inputs and GHG emissions



Concluding Remarks

All Year 1 and 2 Milestones have been met, which primarily address Objectives 1 – 3 of our proposal. This lays the groundwork for subsequent project phases that ultimately will:

- Provide corn growers with model-based decision support tools available on the web for C, N and GHG accounting and management that will facilitate adaptation to climate change and farm-level mitigation
- Provide guidelines for low-cost soil C assessment utilizing existing soil databases, geospatial stratification, and geostatistical modeling techniques for estimating soil C at unsampled locations and depths
- Provide policy makers with tools for determining the costs and benefits of various policy incentives for adaptation and mitigation in the agriculture sector

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