Assessment of Sustainable Biomass Removal for Cellulosic Ethanol Production: Soil Sampling, Field- and Regional-Scale Modeling

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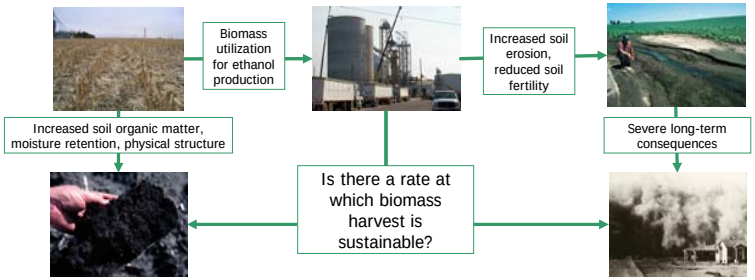
Introduction

Cellulosic ethanol: ethanol produced from non-food biomass such as perennial grasses and crop residues
Crop residues: crop biomass left on field after grain harvest



Objective: Determine optimal rates of residue removal for cellulosic ethanol production, while maintaining soil quality.

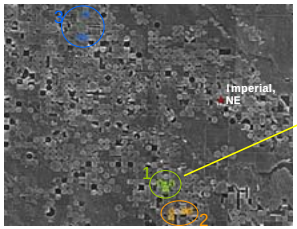
Methods

Imperial, NE: Potential site for cellulosic ethanol plant
- region of concentrated irrigated corn production
- biomass must come from 50 mi radius around Imperial

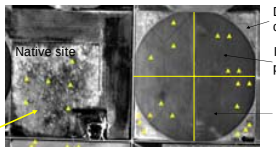
Other project activities:
- evaluation of harvest, including "one-pass" equipment
- wet storage and transport of corn stover

Three part analysis:
1) Residue removal trials and soil sampling
2) Field-scale modeling to test long-term effects of residue removal scenarios and interactions of management practices
3) Regional modeling to estimate total residue yields and soil carbon impact

Soil Sampling



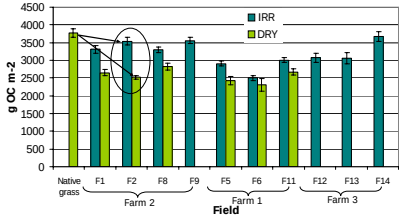
Three farms near Imperial



- **Pivot**
  - 4 quads
  - 3 sites/quad
  - 3 samples/site (composite)
- **Corners**
  - 2 corners/pivot (random)
  - 3 sites/corner
  - 3 samples/site (composite)

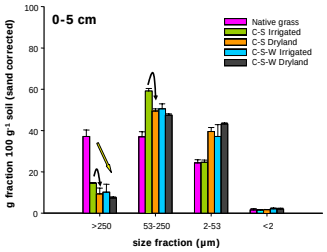
Intact Core Sampling:
- Sampling depth: 1 m
- Depth layers: 0-5, 5-20, 20-50, 50-75, 75-100 cm
- Analyses: Bulk density, soil texture, total soil C and N, inorganic C, soil aggregate size distribution, aggregate-associated C, free particulate organic matter

Total Organic Carbon (0-20 cm) all pivots, Imperial (with stderrors)



- Soil carbon greater in irrigated vs. dryland soils
- Irrigated soil carbon levels similar to native grassland soil, dryland cropping soils are significantly lower than native

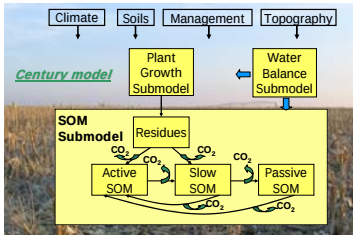
Soil Aggregates



- Fewer large aggregates in cultivated fields than native grassland
- Fewer large aggregates in dryland vs. irrigated cropland

Field-Scale Modeling

Century Model: An agroecosystem model that simulates C, N, P, and S dynamics

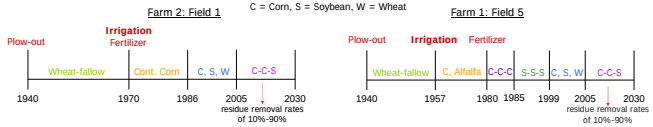


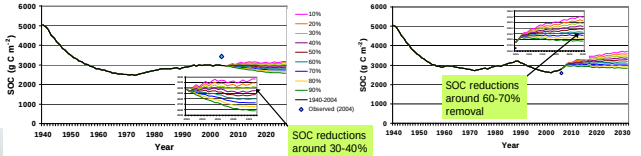
Management for Century Modeling

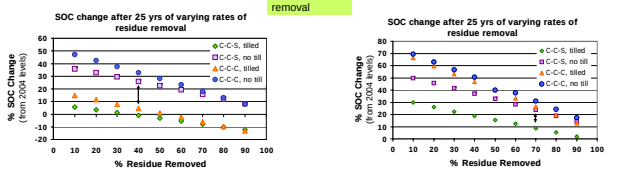
Current Management on Farms:
- Farm 2, field 1: Corn-Corn-Soybean, Reduced Till (chisel, disc), baling of corn residues (~40%)
- Farm 1, field 5: Corn-Corn-Soybean, Strip Till

Rotation and Tillage Management for Residue Removal Scenarios:
1) Current rotation and tillage (C-C-S, tilled)
2) Current rotation and no till (C-C-S, no till)
3) Cont. corn rotation with current tillage (C-C-C, tilled)
4) Cont. corn rotation with no till (C-C-C, no till)

Cropping histories:
C = Corn, S = Soybean, W = Wheat







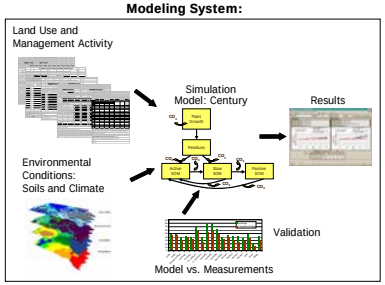
Results:
- **Cropping histories influence how SOC responds to management changes**
- **A switch to no-till may allow increased residue removal without reducing SOC**

Regional Modeling

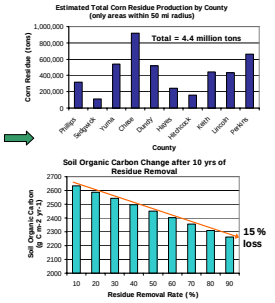
Modeling Region

Irrigated fields within 50 mi. of Imperial, NE

Modeling System:



Residue Yields and Soil Carbon Changes:



Conclusions

- **Residue removals of 40 % or greater will likely result in soil carbon losses under conventional practices**
- **Changes in management, such as adoption of no-till, may allow residue removals without compromising soil quality**
- **Biomass production potentials are high in this region, although dependent on available water resources**

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