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FUEL ETHANOL: THINKING CLEARLY ABOUT THE ISSUES

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Presentation Overview

1. Thinking clearly about energy
   - We need energy services, not energy *per se*
   - Different energy carriers have different strategic importance & different *qualities*
   - Options for dealing with our petroleum problem
2. Biofuels (esp. ethanol): some issues
   - The faulty "net energy" argument
   - Environmental performance of biofuels
   - "Food vs. fuel?" No, that is <u>not</u> the question
   - Economic competitiveness

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Some Basic Energy Facts

1. Services we need from energy (current sources or *carriers* of these services)
   - Heat (natural gas, coal)
   - Light (coal, natural gas, hydro/nuclear)
   - Mobility (petroleum—97%, ethanol)
2. Energy has fundamentally different *qualities*: carriers are not all interchangeable *"All BTU are not created equal"*
3. Our society literally stops without liquid fuels

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All Energy Carriers do Not Have Equal Strategic Importance Either

1. Coal– we have huge domestic reserves
2. Natural gas—imports significant, mostly from Canada and Mexico
3. Petroleum– more than 60% imported and rising
   - "We are addicted to oil"
   - Imported from highly volatile regions in the world
4. Petroleum dependence undermines climate security, economic security & national security
5. Bad for us, **terrible** for poor countries without oil

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Options for Dealing with Petroleum Issue

1. Decrease demand
   - More efficient vehicles (implement available technology)
   - Fewer miles traveled (better planning)
2. Increase supply
   - Athabasca oil sands (Canada)
   - Oil shale (U.S.)
   - Super heavy oil (Venezuela)
   - Coal to liquid fuels (U.S. South Africa, China)
   - Biofuels
     - Biodiesel
     - Ethanol (from corn or cellulosics)

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Ethanol: Going Beyond Perception

- Perception: Ethanol has a negative "net energy"

  Reality: Gasoline's "net energy" metric is worse than ethanol's and anyway this metric is faulty
- Perception: Ethanol will drive up food prices

  Reality: Corn ethanol may cause some consumers to pay slightly more for animal products (meat, milk, etc.); Cellulosic ethanol may reduce food prices
- Perception: Ethanol doesn't help the environment

  Reality: In terms of greenhouse gases, corn ethanol is superior to gasoline now. Cellulosic ethanol will be even better
- Perception: Ethanol will always cost more than gasoline

  Reality: Ethanol from corn costs $1.20/gal; ethanol from cellulosics, when mature, will cost $0.60/gal

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Most Recent Pimentel & Patzek Study*

- Define ethanol's % net energy as:
  - [(Ethanol Heating Value (LHV) – Fossil Energy Inputs) /Ethanol Heating Value (LHV)] x 100
- All BTU are treated as equivalent (1 BTU coal = 1 BTU petroleum = 1 BTU natural gas and so on)
- Confuse "fossil fuels" with "liquid fossil fuels"=petroleum
- They calculate net energy for ethanol from:
  - Corn - 29%
  - Switchgrass - 50%
  - Wood - 57%
- They make no comparisons with other liquid fuels
- I calculate net energy for:
  - Gasoline from petroleum - 45%
  - Electricity from coal - 240%
- **Natural Resources Research, vol. 14, No. 1, March 2005 pgs. 65-76*

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Are All Btu Created Equal: What Does "the Market" Say?

Energy Carrier	**Energy Content* (Btu/X)**	**Typical Market Value ($/X)**	**Market Value ($/MM Btu)**
Coal	20.4 MM Btu/short ton	$40.30/short ton	$2.00
Natural Gas	1,030 Btu/ cubic foot	$7.30 per 1000 cubic foot	$7.10
Petroleum	5.8 MM Btu/barrel	$55 per barrel	$9.50
Electricity	3413 Btu/ Kwhr	$0.082/Kwhr	$24.00
* EIA 2004 pg. 357-386			

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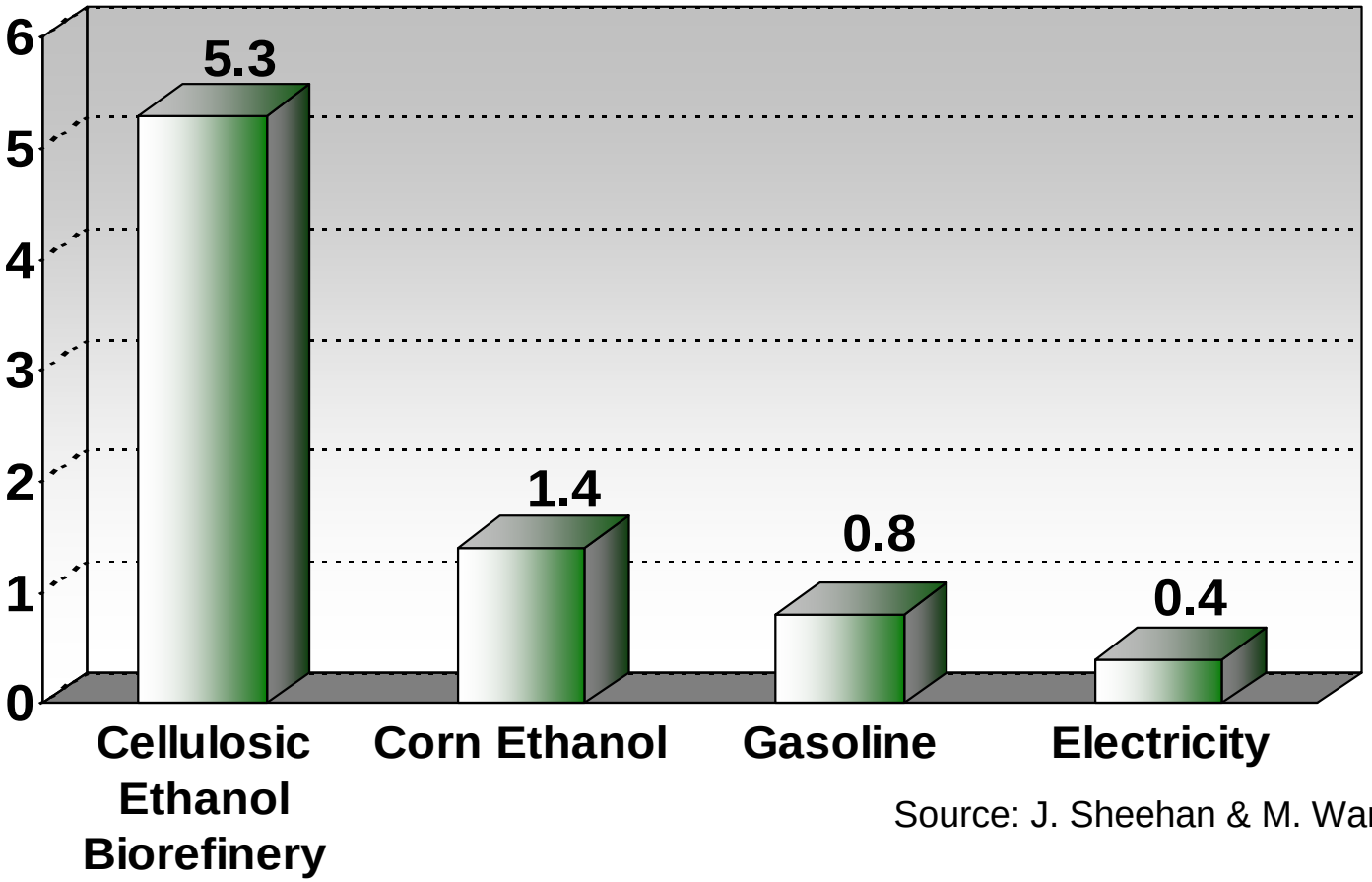
Fossil Energy Replacement Ratio:
the Primary Climate Security Driver

$$\text{Fossil Energy Ratio (FER)} = \frac{\text{Energy Delivered to Customer}}{\text{Fossil Energy Used}}$$



Source: J. Sheehan & M. Wang (2003)

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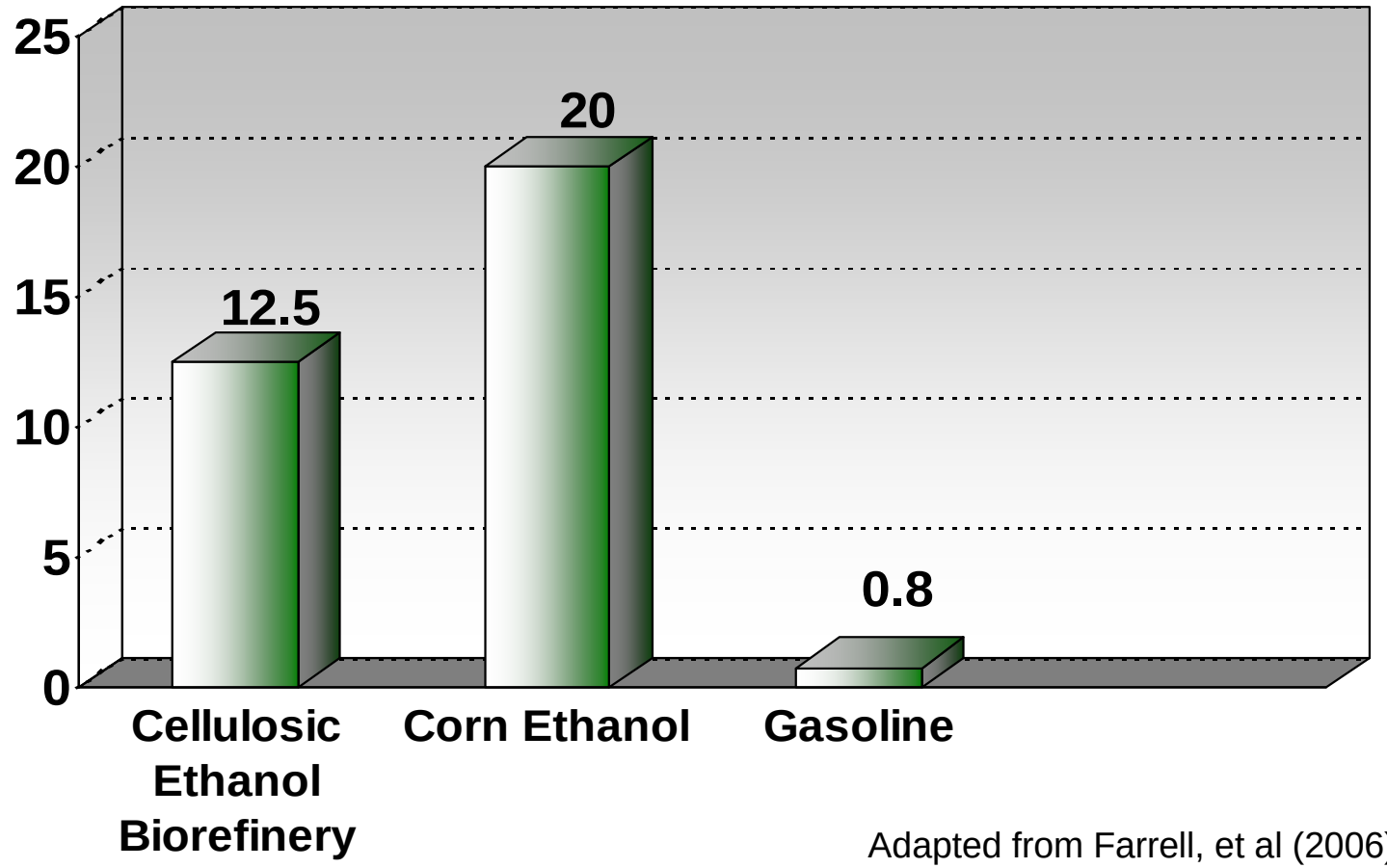
Petroleum Replacement Ratio:
the Primary Energy Security Driver

$$\text{Petroleum Replacement Ratio (PRR)} = \frac{\text{Liquid Fuels Delivered to User}}{\text{Petroleum Energy Used}}$$



Adapted from Farrell, et al (2006)

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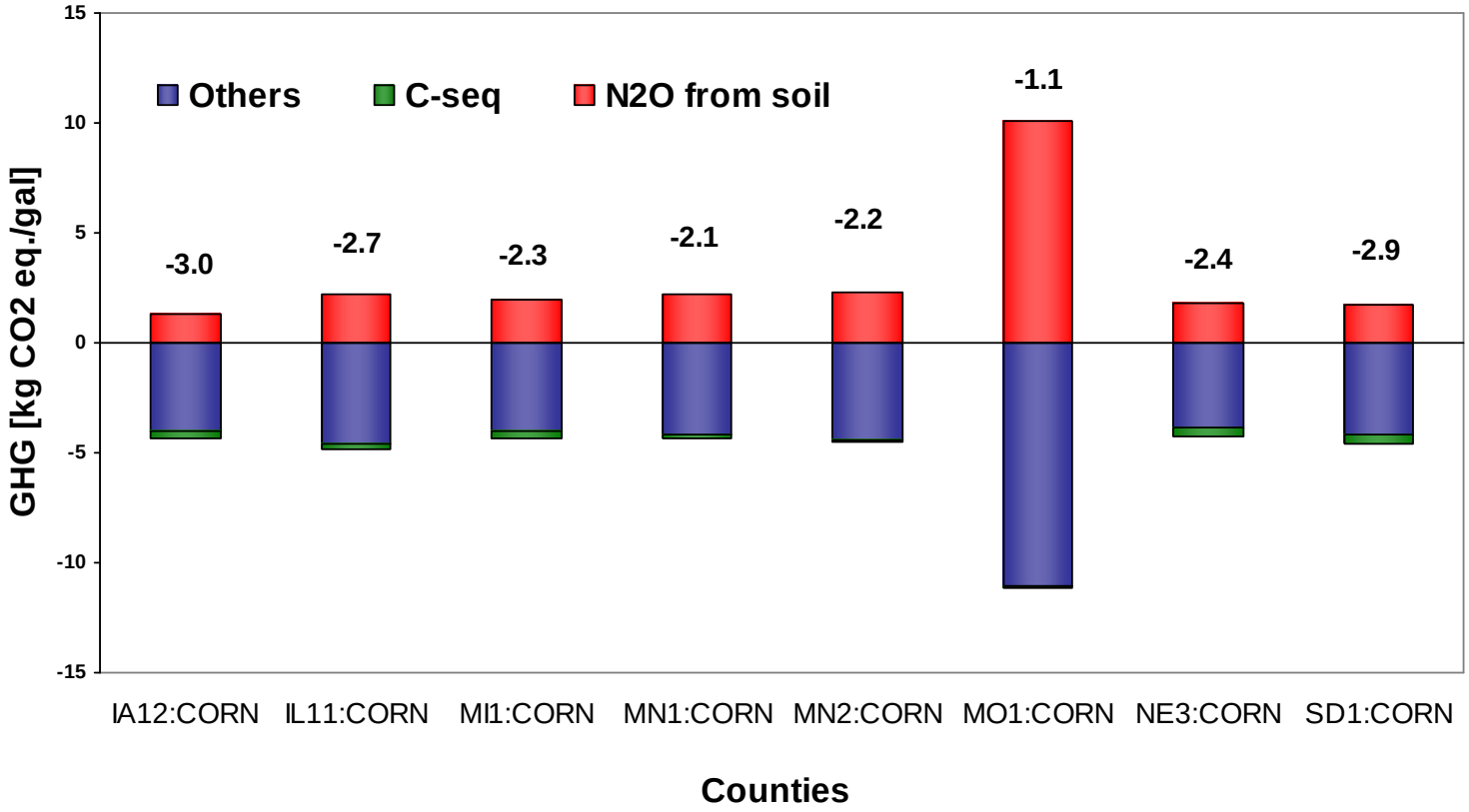
GHG Emissions in Ethanol Fuel System



Others: GHG emissions associated with agronomic inputs and fuel consumption in agriculture process, biorefineries, vehicle operation, and alternative product systems

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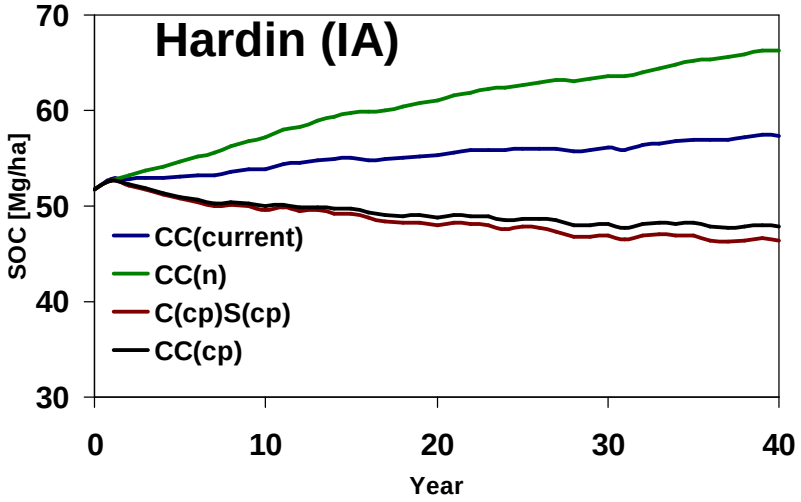
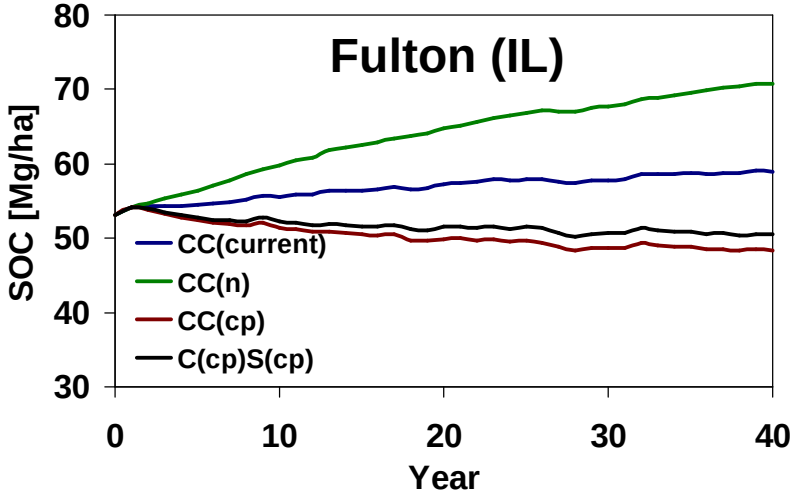
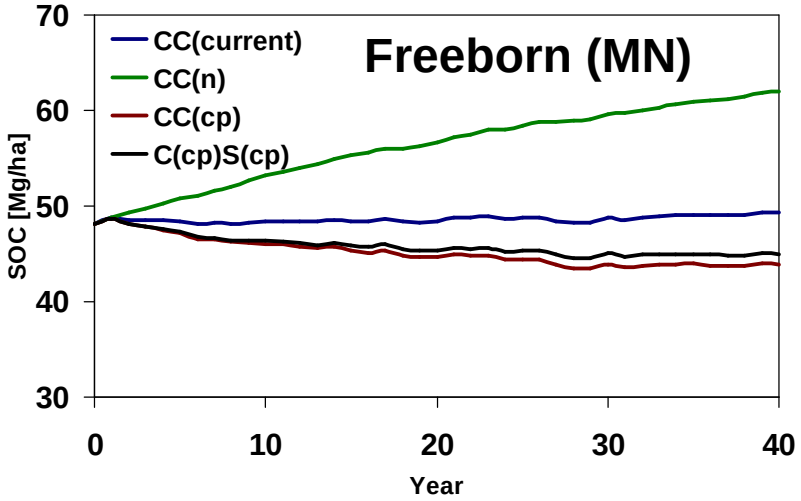
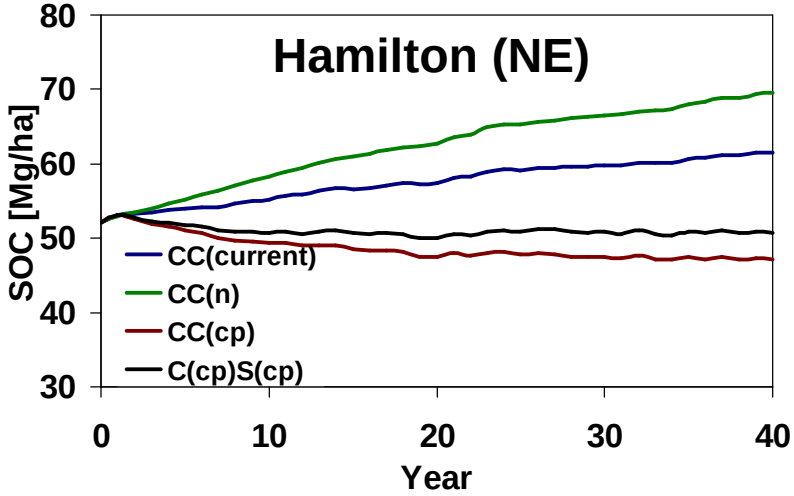
Soil Organic Carbon Trends: Different Practices









CC (current): continuous corn under current tillage practices; **CC (n):** continuous corn under No-tillage practice; **C (cp) S (cp):** corn soybean rotation under conventional plowed tillage; **CC (cp):** continuous corn under conventional plowed tillage. Soil organic carbon is the fraction of total soil carbon that is organic—it is a surrogate for soil fertility

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Winter Cover Crops in Corn Rotation

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Bare Corn Field- Holt, Michigan
May 5, 2005

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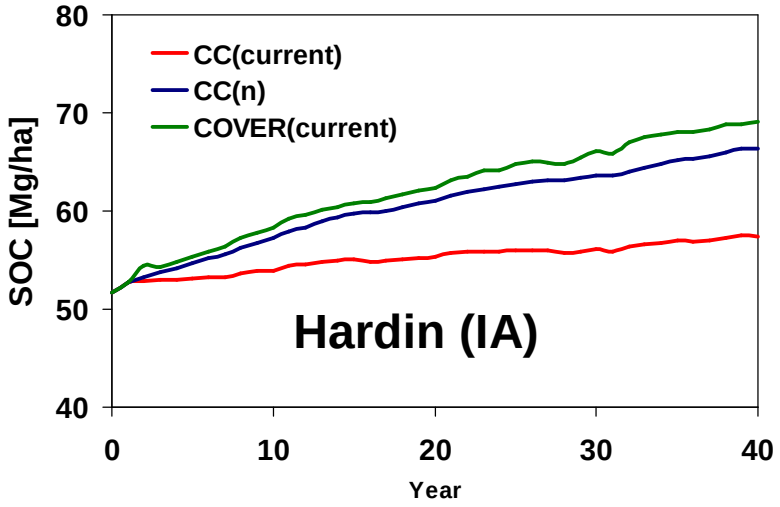
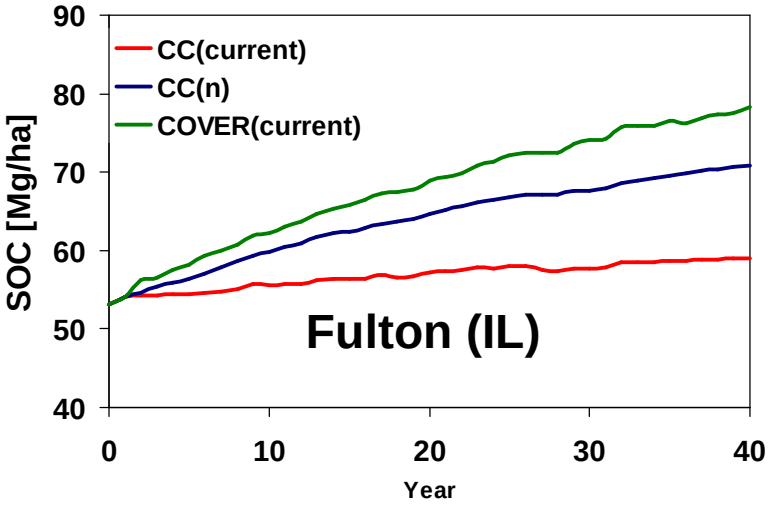
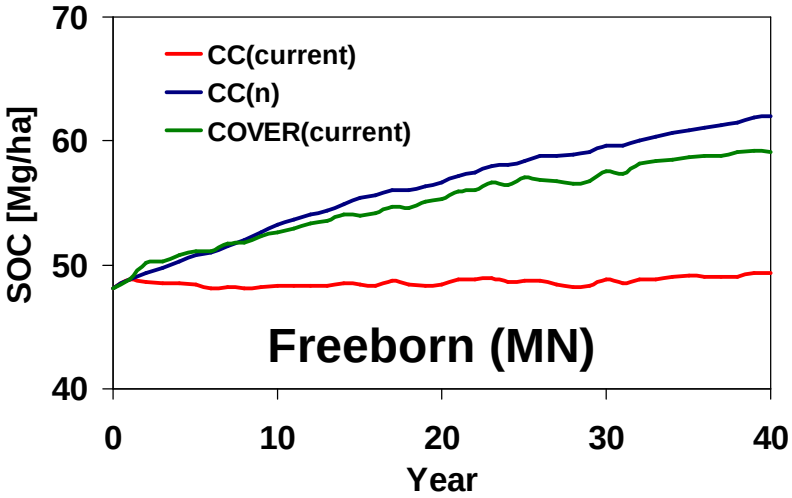
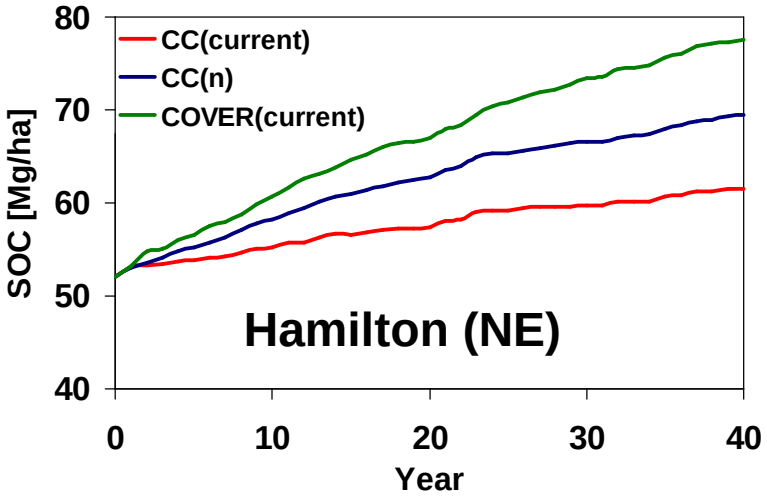
Cover Crops & Soil Organic Carbon









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Brief Summary of Key Results

- Ethanol fuel system provides greenhouse gas emission benefits over gasoline fuel system regardless of farming sites
- Farming site & practices are key to improving the environmental performance of the ethanol fuel system— highly variable
- N2O emissions from soil largely determine greenhouse gas emissions profile of the ethanol fuel system
- Proper management (eg, no till, cover crops) can increase greenhouse gas emission benefits of the ethanol fuel system

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Questions ??