Agriculture and GHG emissions

- Carbon dioxide, methane and nitrous oxide are the main GHG emitted by agriculture.
- Atmospheric concentrations of GHG's have increased dramatically since 1800.
  - 30% for CO_2, 100% for CH_4, 10% for N_2O.
- Globally, agriculture currently contributes about **20%** of the total increase in greenhouse warming potential.

Some greenhouse gas mitigation strategies

Mitigating CO_2 emissions

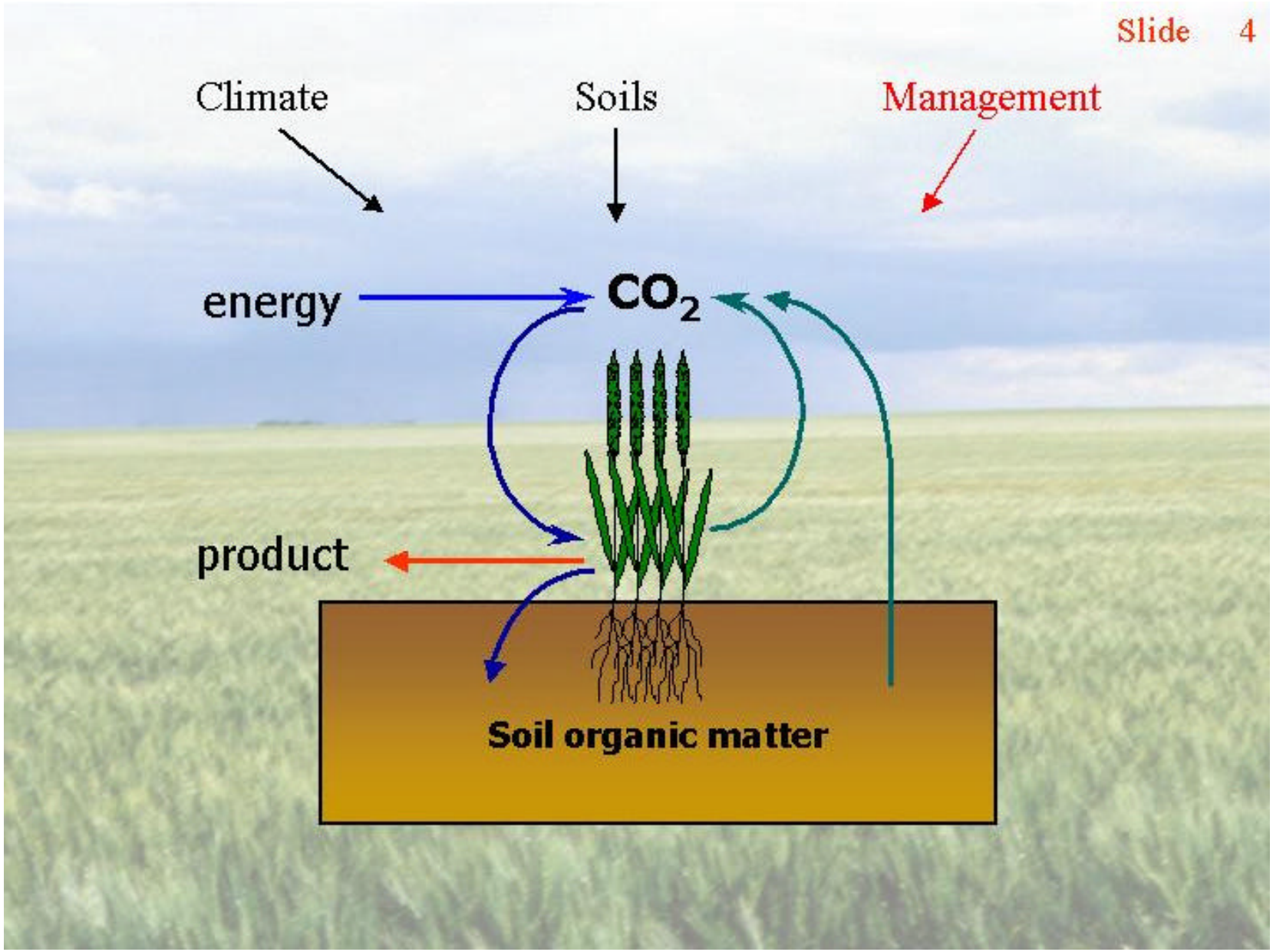
- Reduced deforestation
- Improved energy efficiency
- Biofuel production
- **Carbon sequestration**

Mitigating CH_4 emissions

- Improved ruminant livestock efficiency
- Biogas recovery from manure

Mitigating N_2O emissions

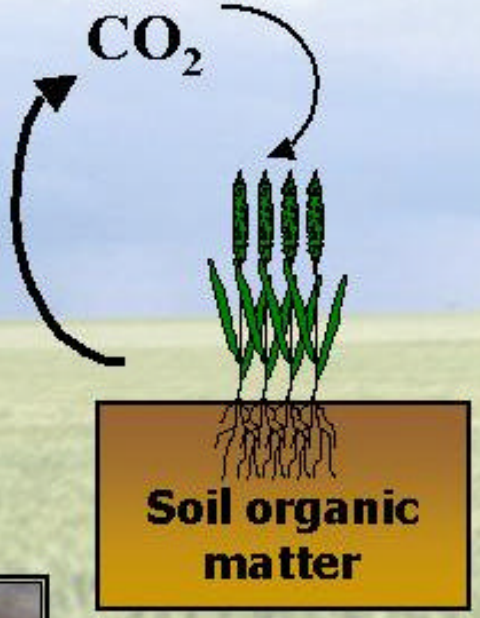
- Improved nitrogen fertilizer use
- Nitrification inhibitors


Climate
Soils
Management
energy
CO_2
product
Soil organic matter

Past Agricultural Practices

Erosion

Intensive tillage



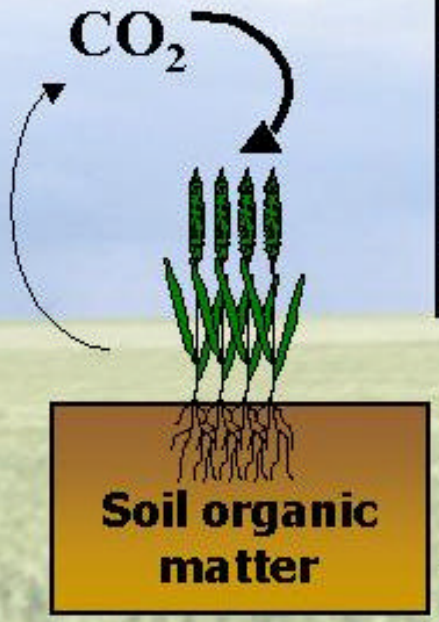
Residue removal

Low Productivity

Improved Agricultural Practices

Conservation buffers

Conservation tillage



Cover crops

Improved rotations

U.S.Potential for carbon sequestration

- Current net C sequestration in agricultural soils is ~ *20* million tonnes per year
- Compared to *28* million tonnes emitted by US agriculture from fuel use, fertilizer and pesticide production
- *75 - 200* million tonnes per year possible with present technology

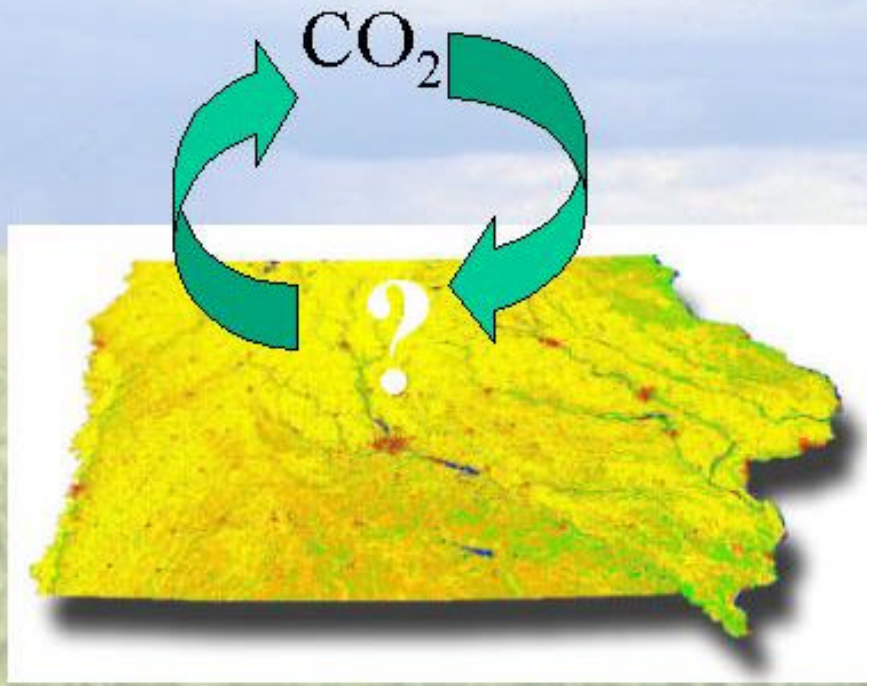
Bruce et al. 1998
Eve et al. 2000
Lal et al. 1998

State-level C analyses: Iowa

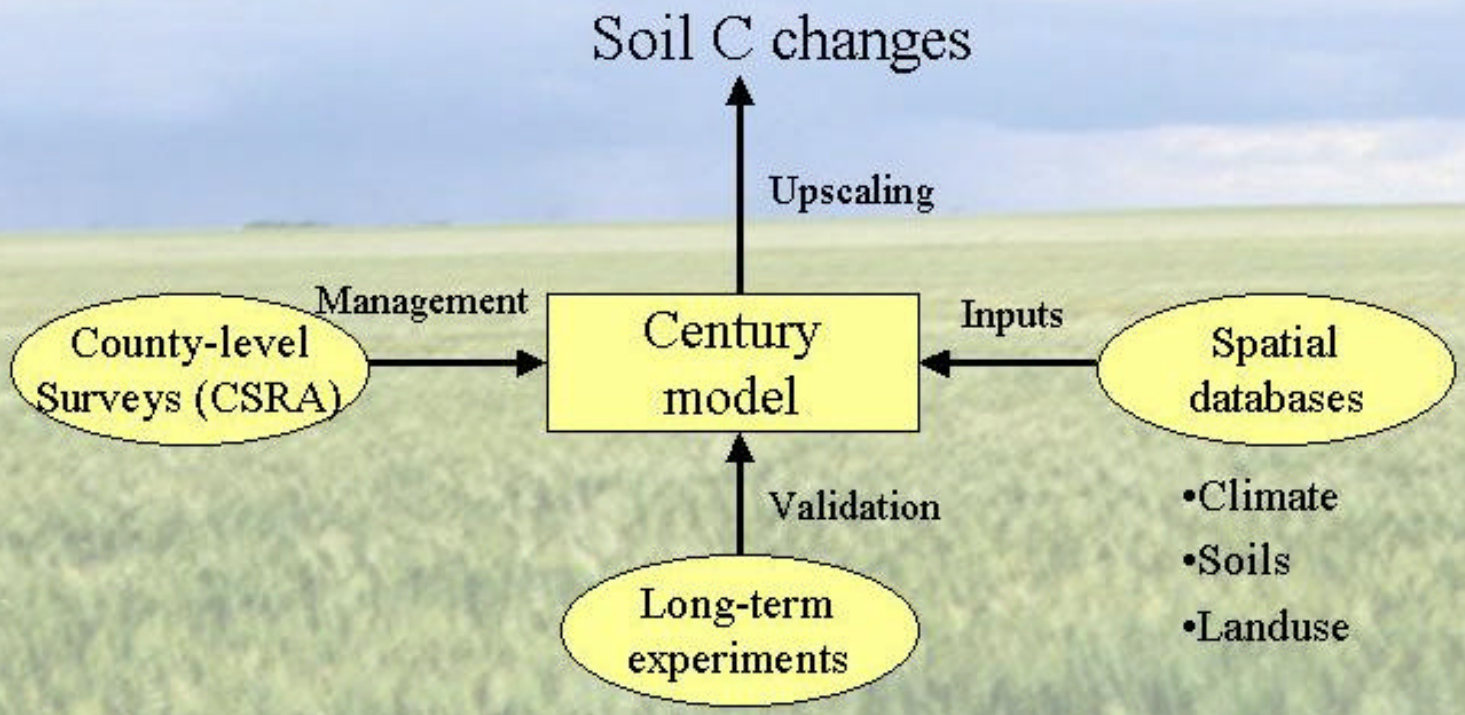
Objectives

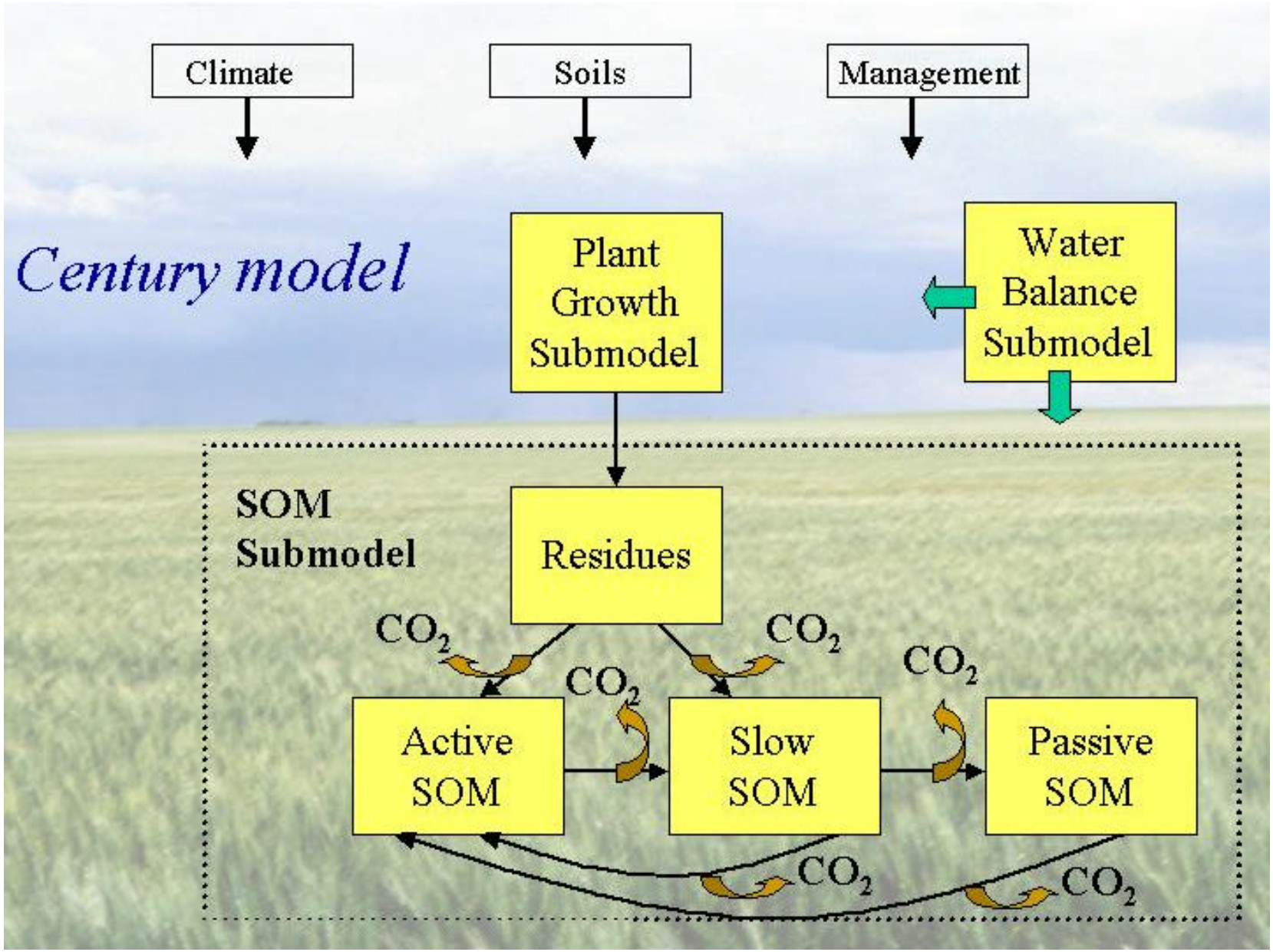
Are ag. soils in Iowa presently sequestering carbon?

What is the potential to sequester carbon in Iowa soils with adoption of agricultural conservation practices ?

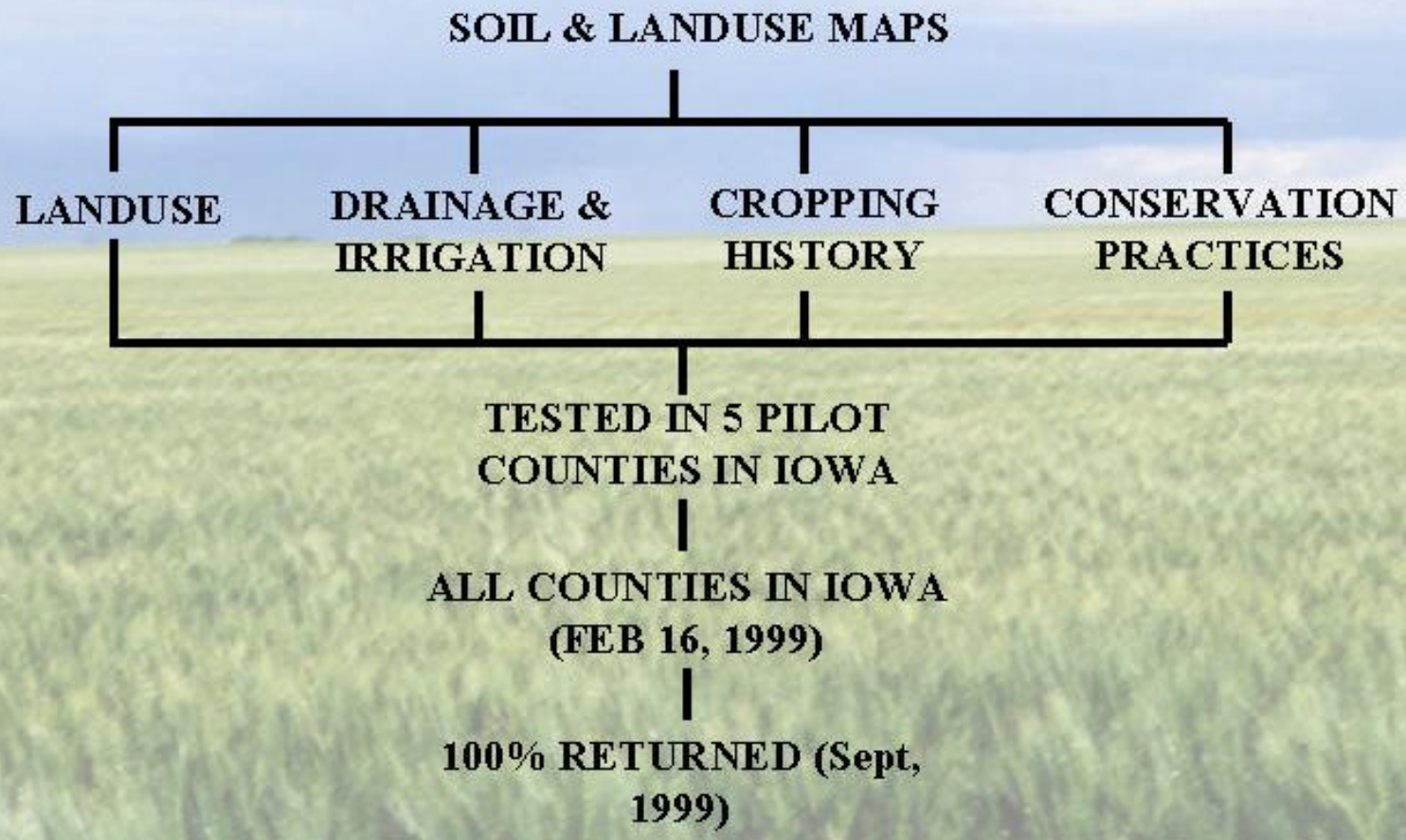


Approach

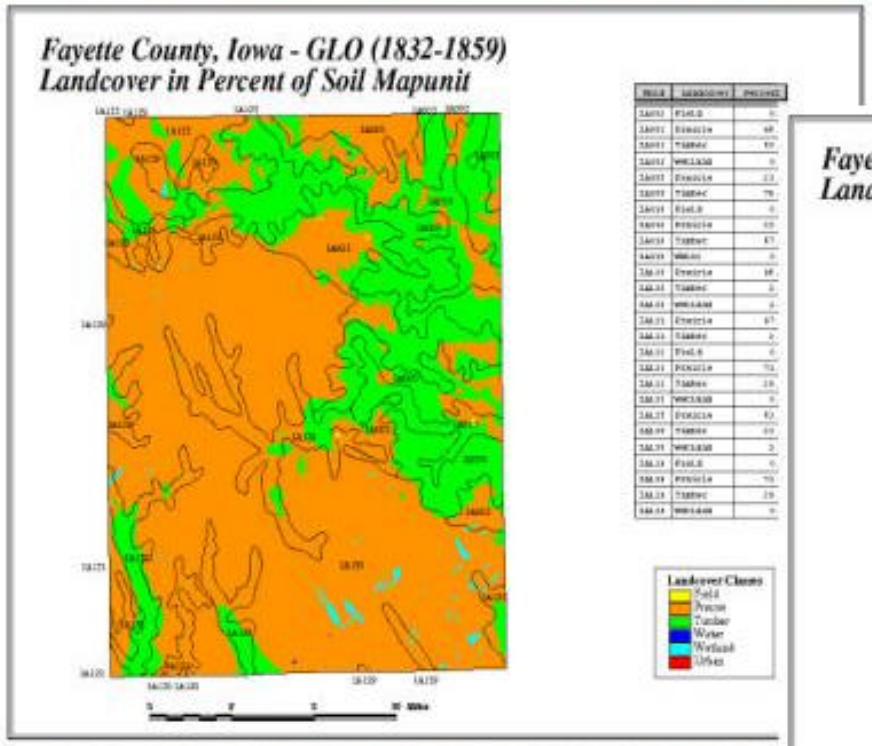

Soil C changes
Upscaling
Management
County-level Surveys (CSRA)
Century model
Inputs
Spatial databases
Validation
Long-term experiments
•Climate
•Soils
•Landuse

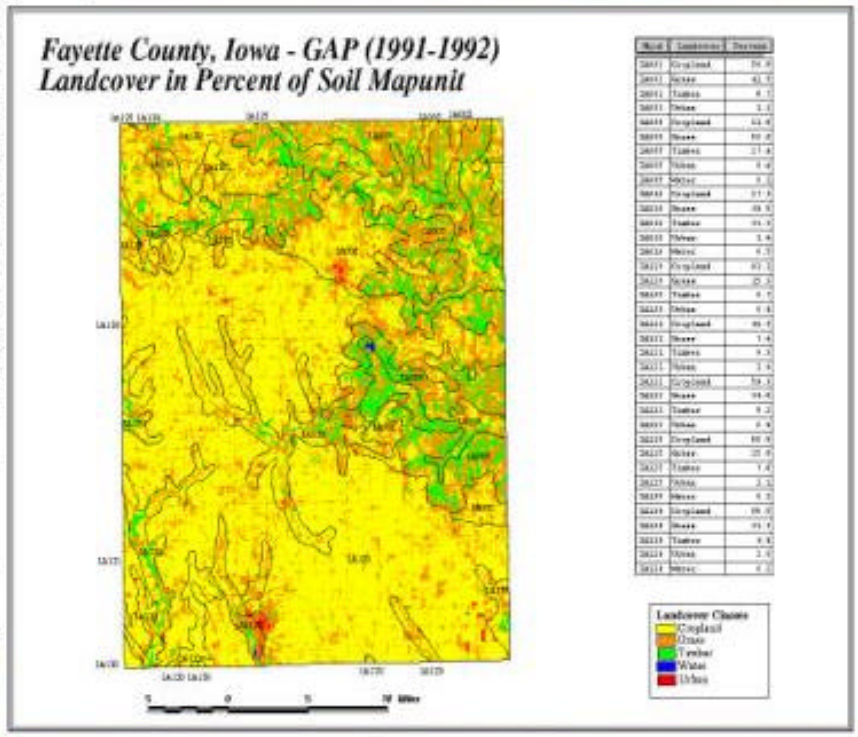

Climate
Soils
Management
Century model
Plant Growth Submodel
Water Balance Submodel
SOM Submodel
Residues
CO_2
CO_2
CO_2
CO_2
Active SOM
Slow SOM
Passive SOM
CO_2
CO_2

Carbon Sequestration Rural Appraisal

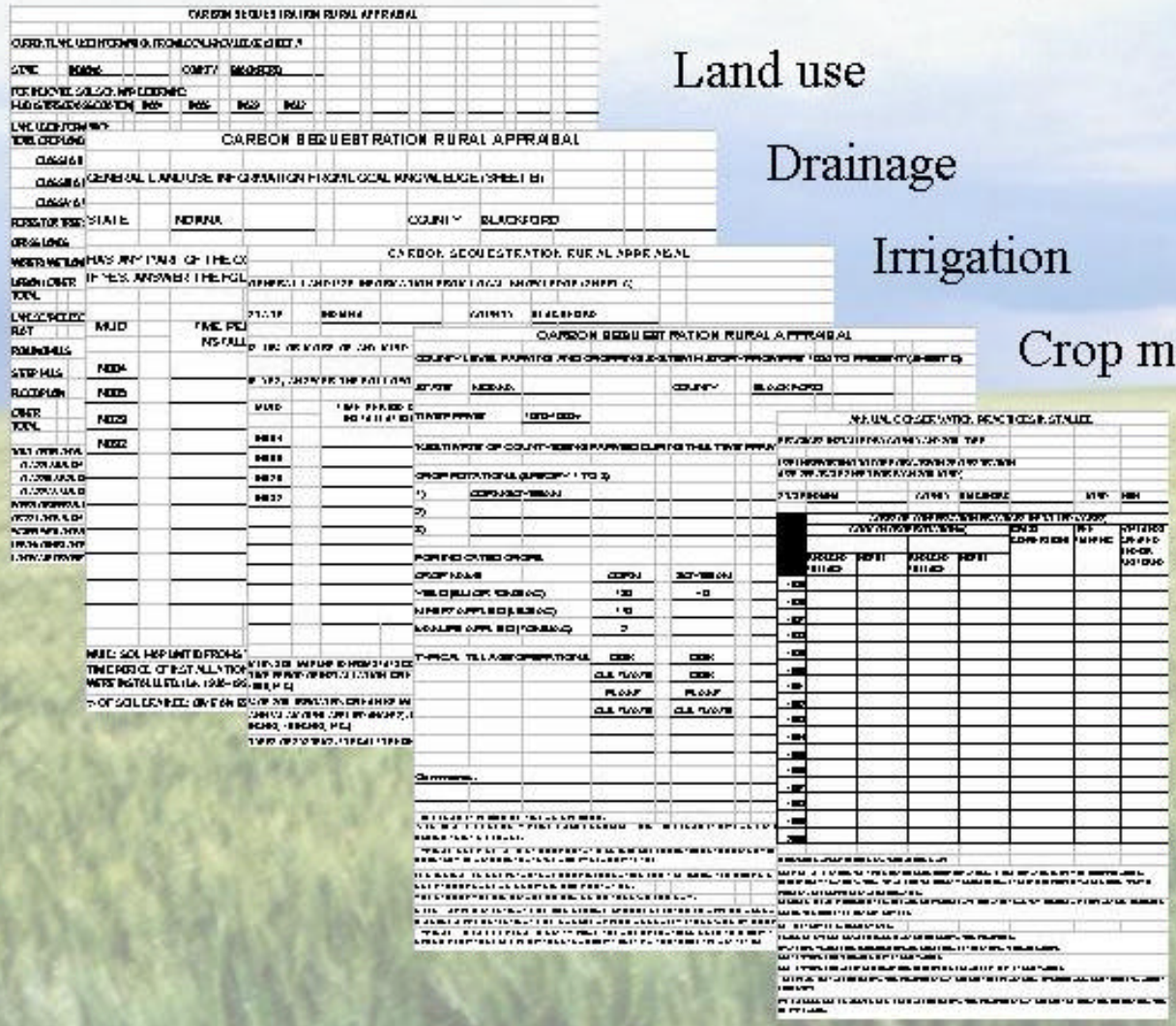


Native vegetation, current landcover and soil associations by county





Carbon Sequestration Rural Appraisal



Land use

Drainage

Irrigation

Crop management

Conservation practices

Century Scenario 2 Simulations

Base

Scenario 1

Scenario 2

Equilibrium

One 7,000 year simulation for each soil texture in each county.

Average 2.97 simulation runs for each equilibrium simulation

CRP1
CRP2
Intensive Tillage C-C
Moderate Tillage C-C
No Till C-C
Intensive Tillage B-C
Moderate Tillage B-C
No Till B-C
Intensive Till B-W-A-A-C
Moderate Till B-W-A-A-C
No Till B-W-A-A-C
Intensive Tillage C-B-B
Moderate Tillage C-B-B
No Till C-B-B
Intensive Tillage C-B-W
Moderate Tillage C-B-W
No Till C-B-W

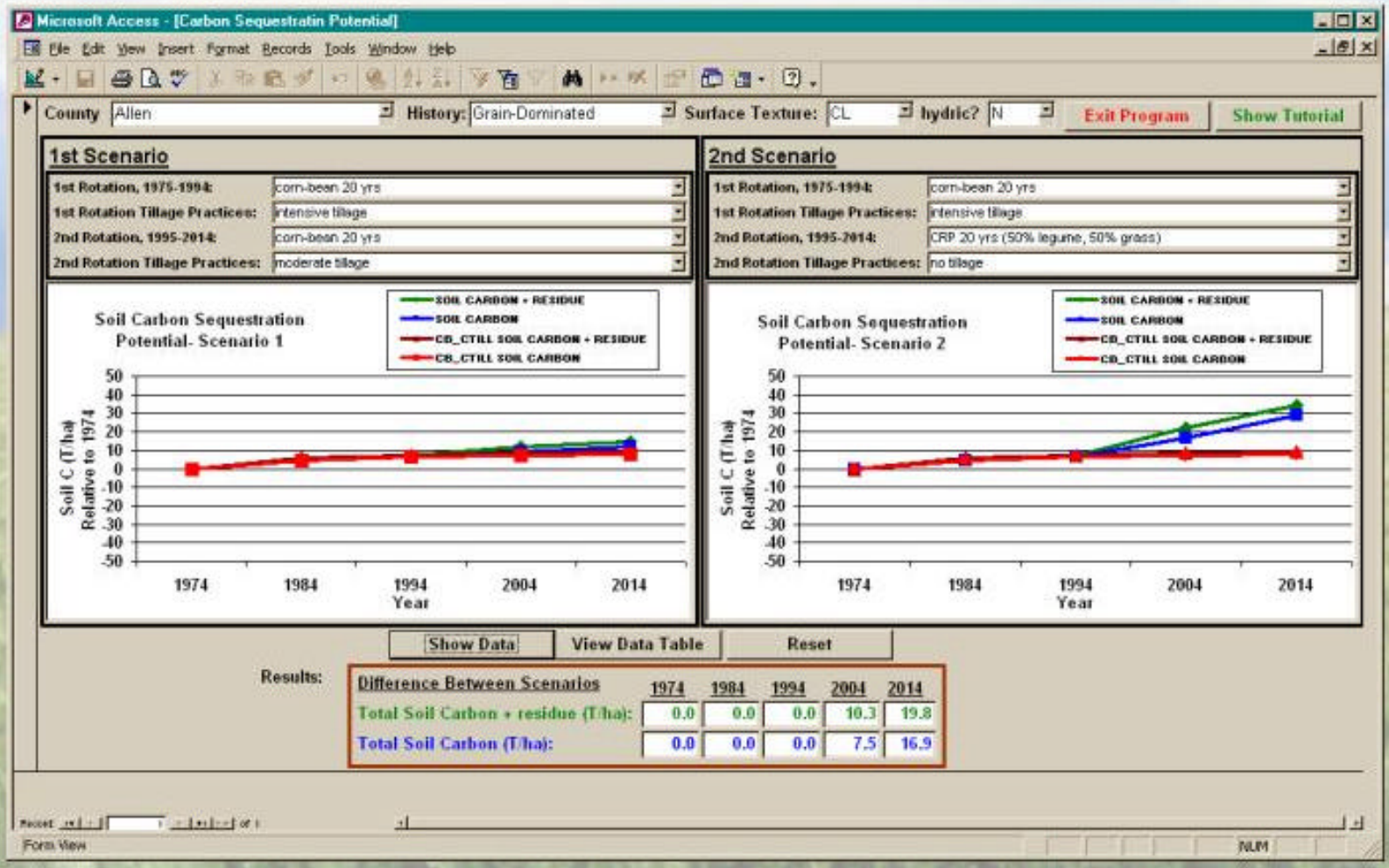
Between 1995 and 2014 three different tillage options for each of the four rotations plus two CRP options resulting in 15 Scenario 2 Simulations for each Scenario 1 Simulation.

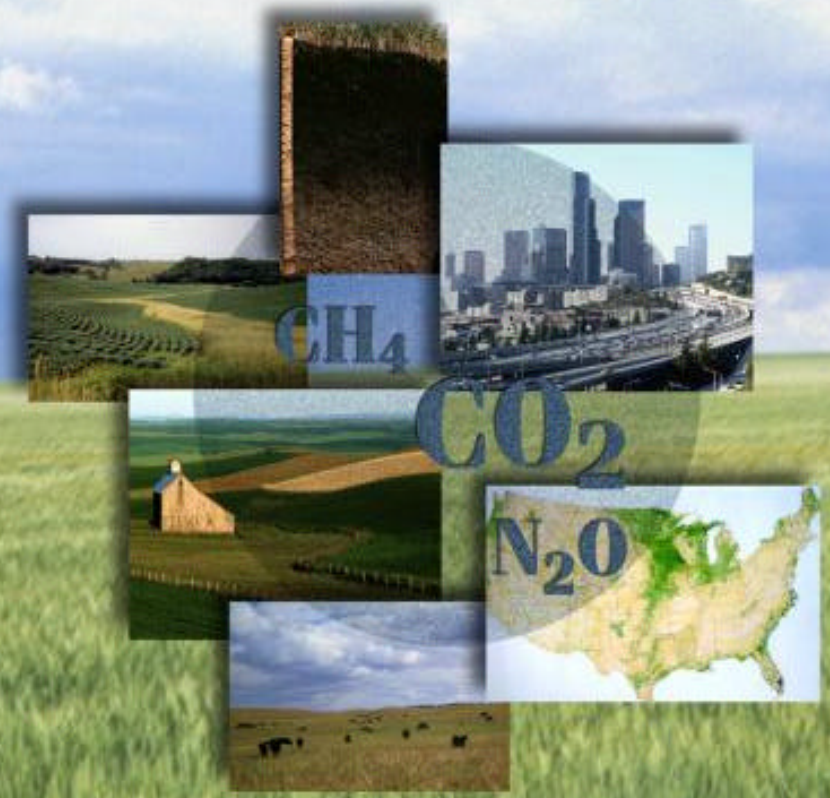
~ 203,000 Scenario 2 Simulations

Current C storage in cropland soils

System	Area (Mha)	C store increase (MMT)
Conventional tilled cropland	5.2	0.43
Mulch tilled cropland	3.0	0.82
No till cropland	1.1	0.66
CRP and grass buffers	1.1	1.3
Wetland restoration	0.04	0.02
Organic soils	0.02	-0.17
Total	**10.5**	**3.1**

C Sequestration Database



Consortium for Agricultural Soils Mitigation Of Greenhouse Gases (CASMGS)

- Colorado State University
- Iowa State University
- Kansas State University
- Michigan State University
- Montana State University
- The Ohio State University
- Purdue University
- Texas A&M University
- University of Nebraska
- Battelle-Pacific Northwest National Laboratory