



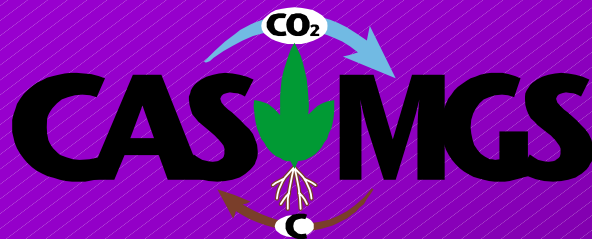
# Agriculture Mitigation of Greenhouse Gases

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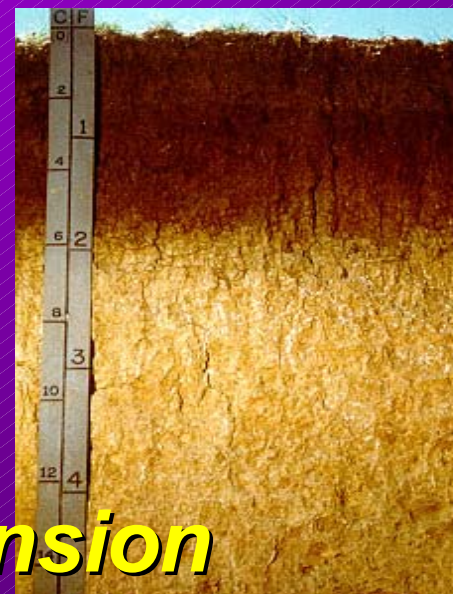
**Kansas State University**



Consortium for Agricultural Soils Mitigation of Greenhouse Gases



***K-State Research and Extension***



# Potential CO<sub>2</sub> Stabilization Options

	Rapidly Deployable	Not Rapidly Deployable
Minor Contributor 0.2 PgC/y	<ul style="list-style-type: none"> <li>• Biomass co-fire electric generation</li> <li>• Cogeneration and Hydropower</li> <li>• Natural Gas Combined cycle</li> <li>• Niche options</li> </ul>	<ul style="list-style-type: none"> <li>• Photovoltaics</li> <li>• Ocean fertilization</li> </ul>
Major Contributor 0.2 PgC/y	<ul style="list-style-type: none"> <li>• C sequestration in ag. soils</li> <li>• Improved efficiency</li> <li>• Industrial Non-CO<sub>2</sub> gas abatement</li> <li>• Ag non-CO<sub>2</sub> gas abatement</li> <li>• Reforestation</li> </ul>	<ul style="list-style-type: none"> <li>• Biomass to hydrogen</li> <li>• Biomass to fuel</li> <li>• Cessation of deforestation</li> <li>• Energy-efficient transport</li> <li>• Geologic storage</li> <li>• High efficiency coal technology</li> <li>• Large-scale solar</li> <li>• Next generation nuclear fission</li> </ul>

**Climate**

**Soils**

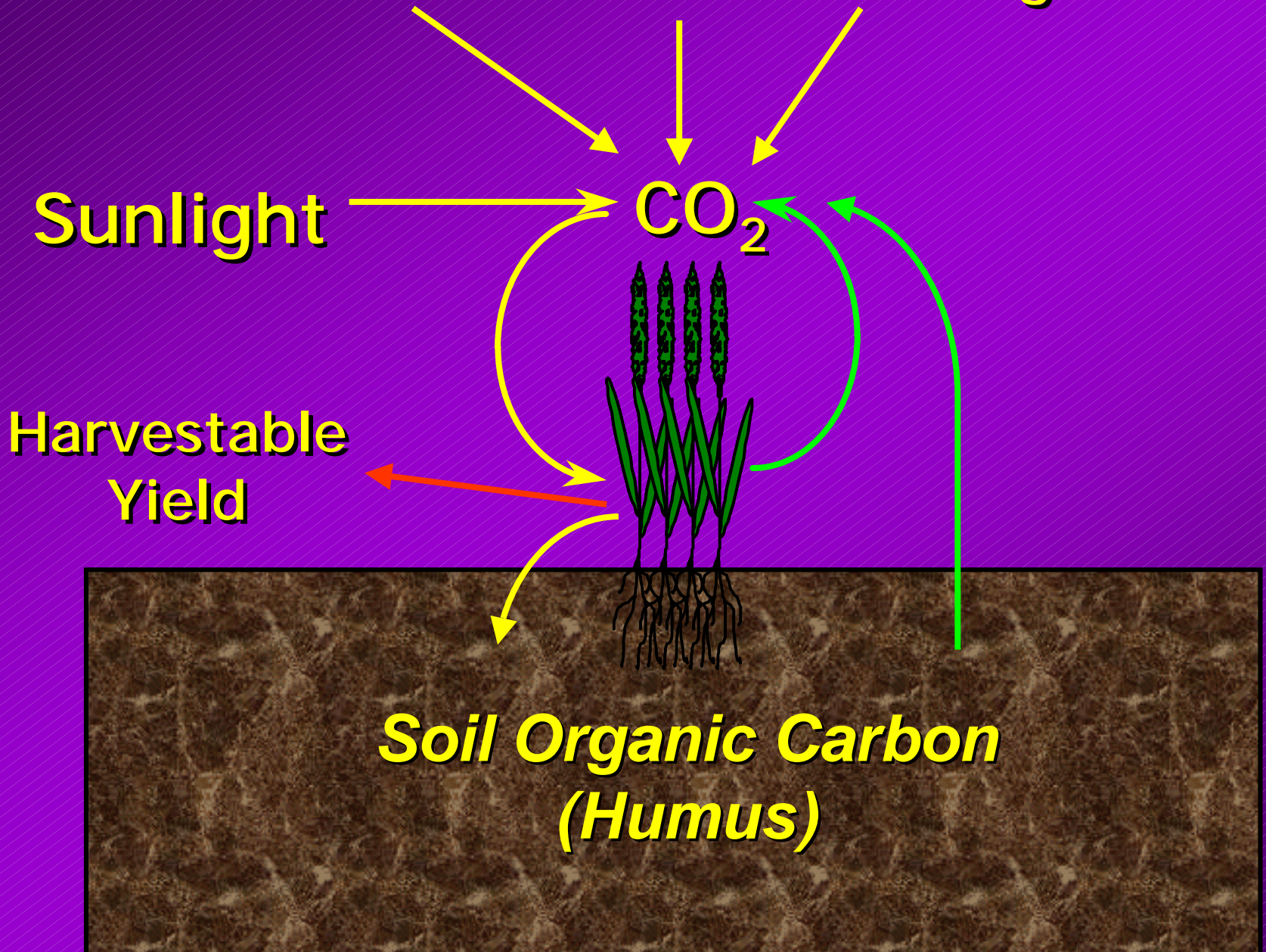
**Management**

**Sunlight**

**CO<sub>2</sub>**

**Harvestable  
Yield**

***Soil Organic Carbon  
(Humus)***



# Agricultural management plays a major role in greenhouse gas emissions and offers many opportunities for mitigation

- **Cropland**

- Reduced tillage
- Rotations
- Cover crops
- Fertility management
- Erosion control
- Irrigation management



No-till seeding in USA

- **Rice paddies**

- Irrigation
- Chemical and organic fertilizer
- Plant residue management



Rice fields in The Philippines

- **Agroforestry**

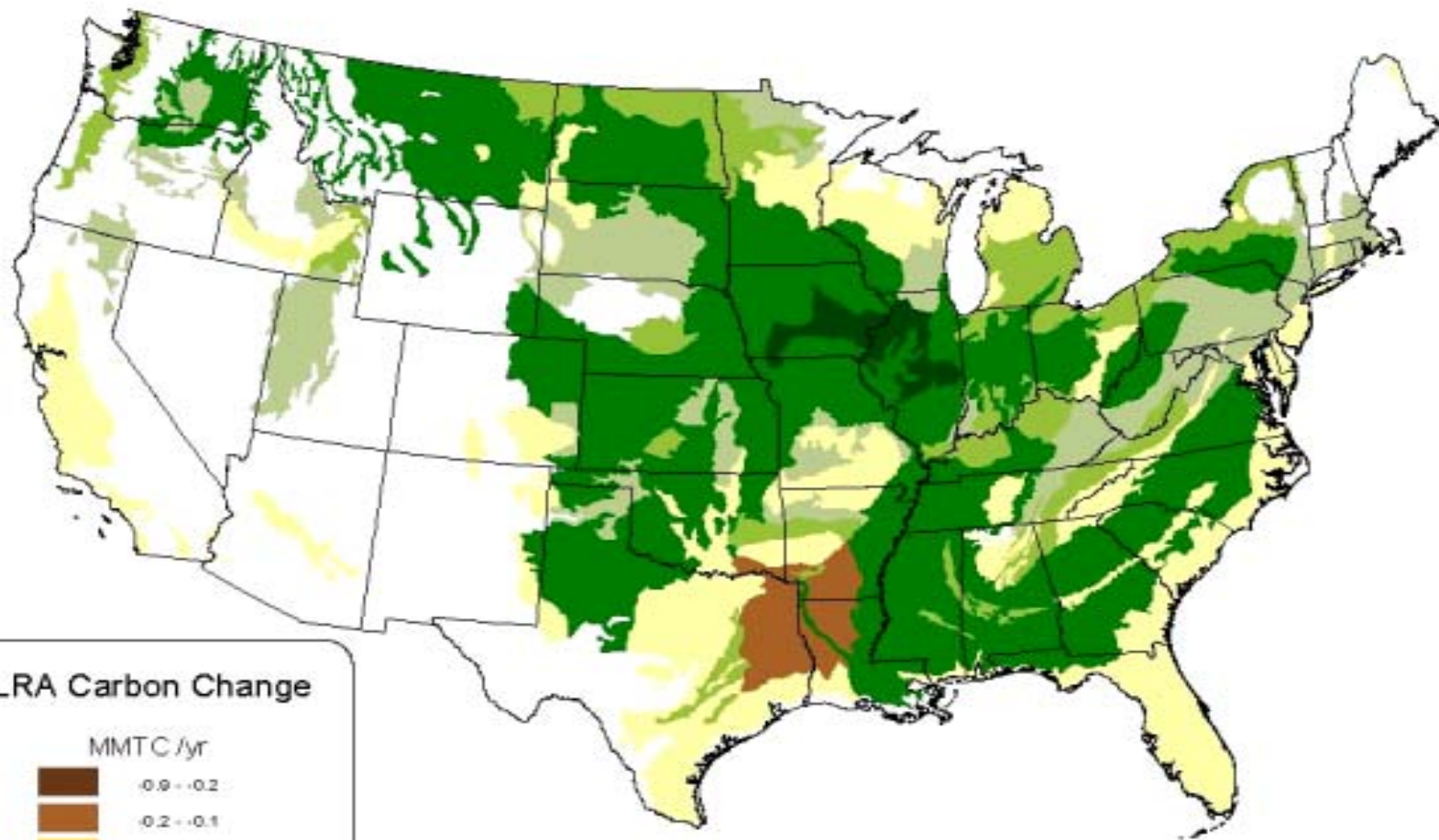
- Better management of trees and cropland



Maize / coffee fields in Mexico

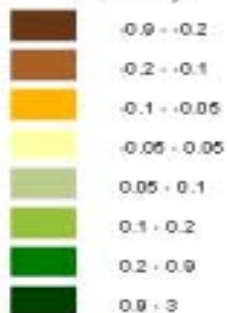


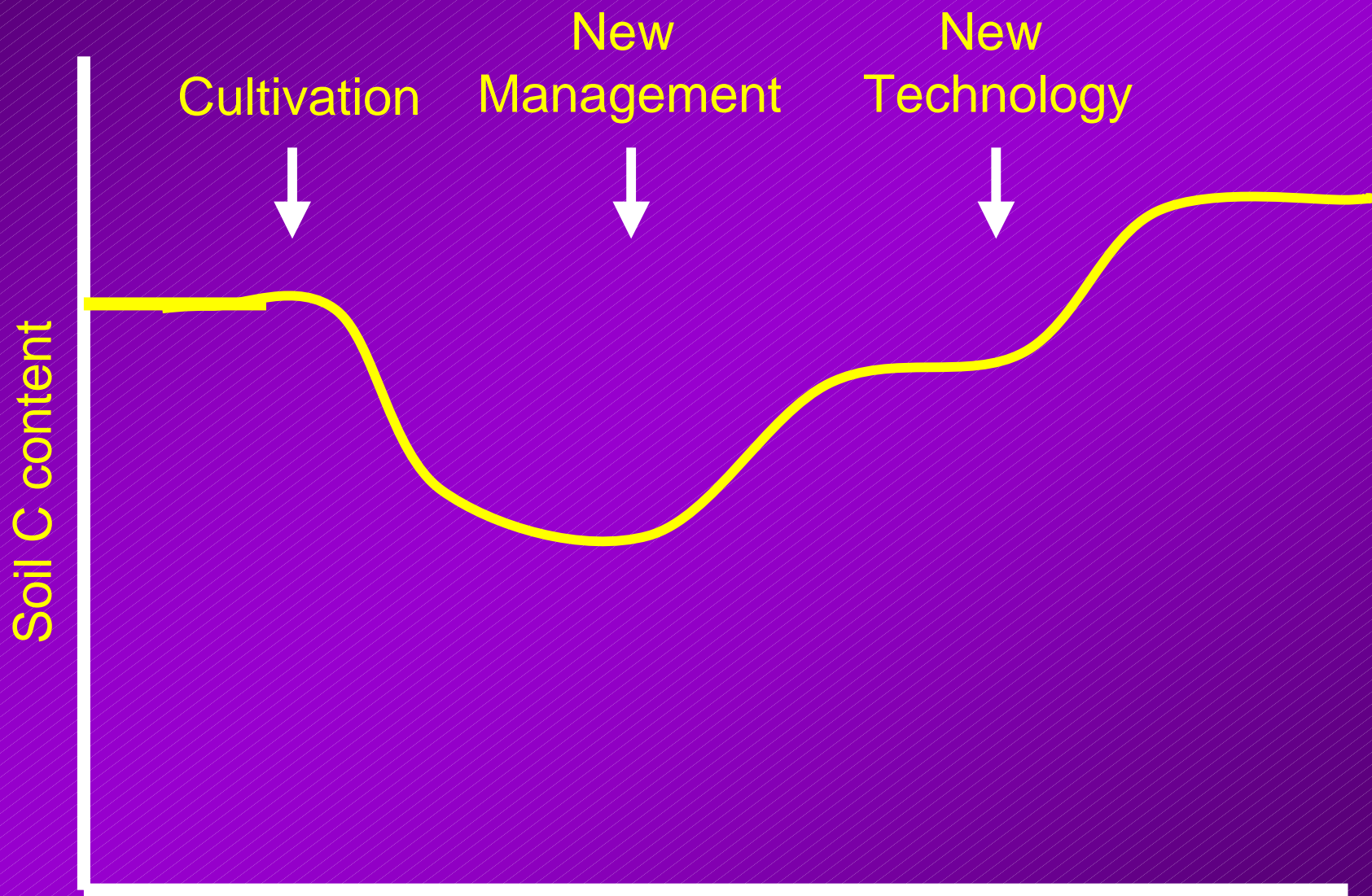
# Agricultural Soil Carbon sequestration



## MLRA Carbon Change

MMTC /yr

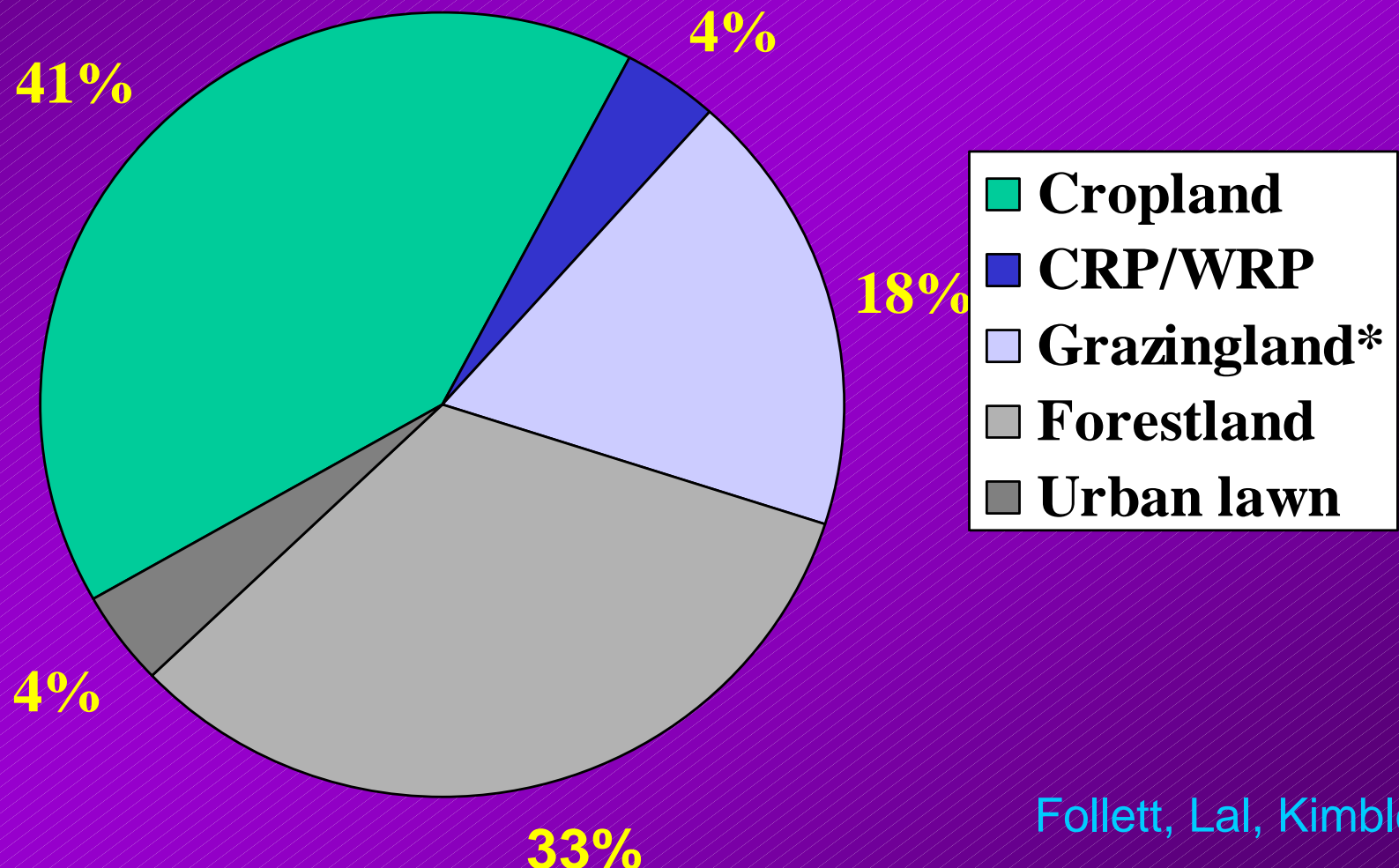




# Soil C Sequestration with conversion to No-tillage (MT C ha<sup>-1</sup> y<sup>-1</sup>)

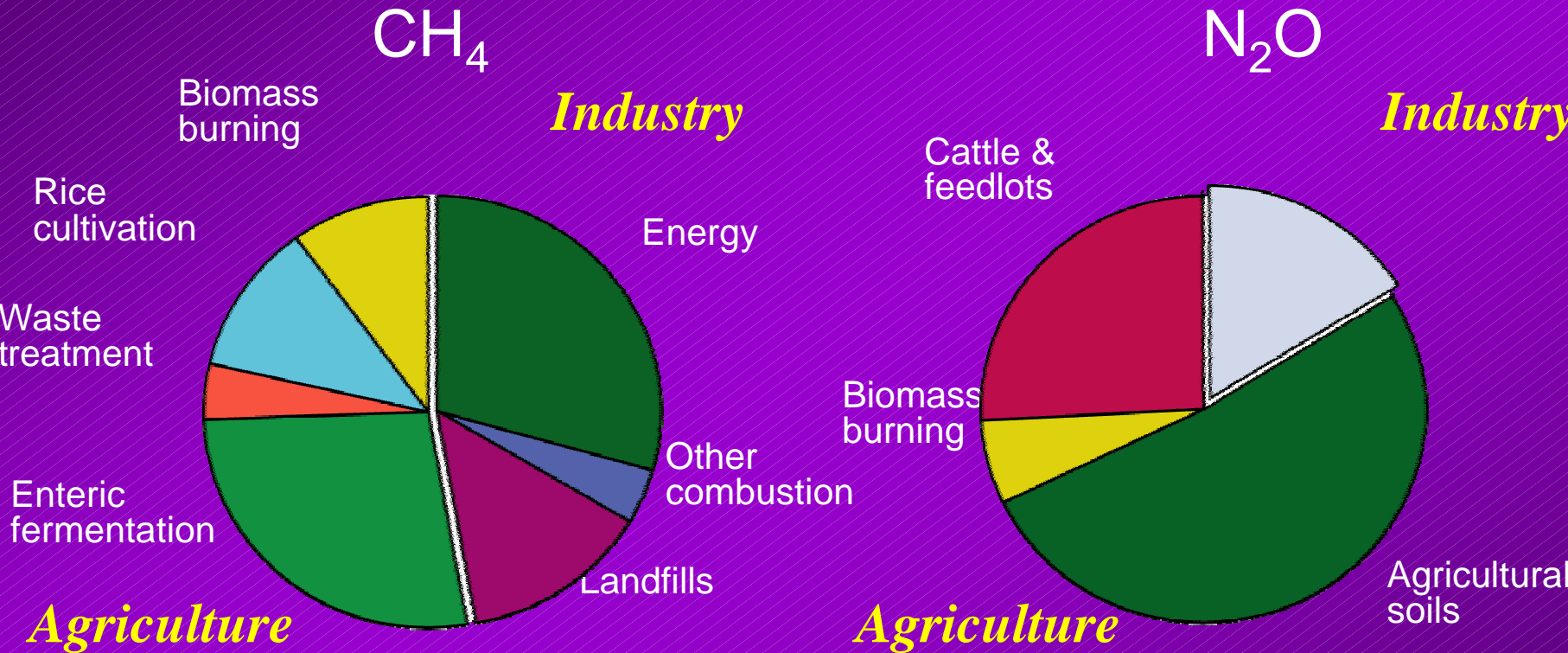
Site	Crop	MT C ha <sup>-1</sup> y <sup>-1</sup>
Colorado & Kansas	Wheat	0.100 – 0.706
Kansas	Sorghum	0.088 – 0.605
Kansas, Michigan, Ohio	Maize	0.300 - 1.05
Kansas	Soybean	0.128
Brazil		0.51-1.84
Global		0.57
Kansas	Set Aside	0.800

# Soil C sequestration potential of different US land Categories (% of 322 MMT C/yr) \*\*





# Anthropic Sources of Methane and Nitrous Oxide Globally

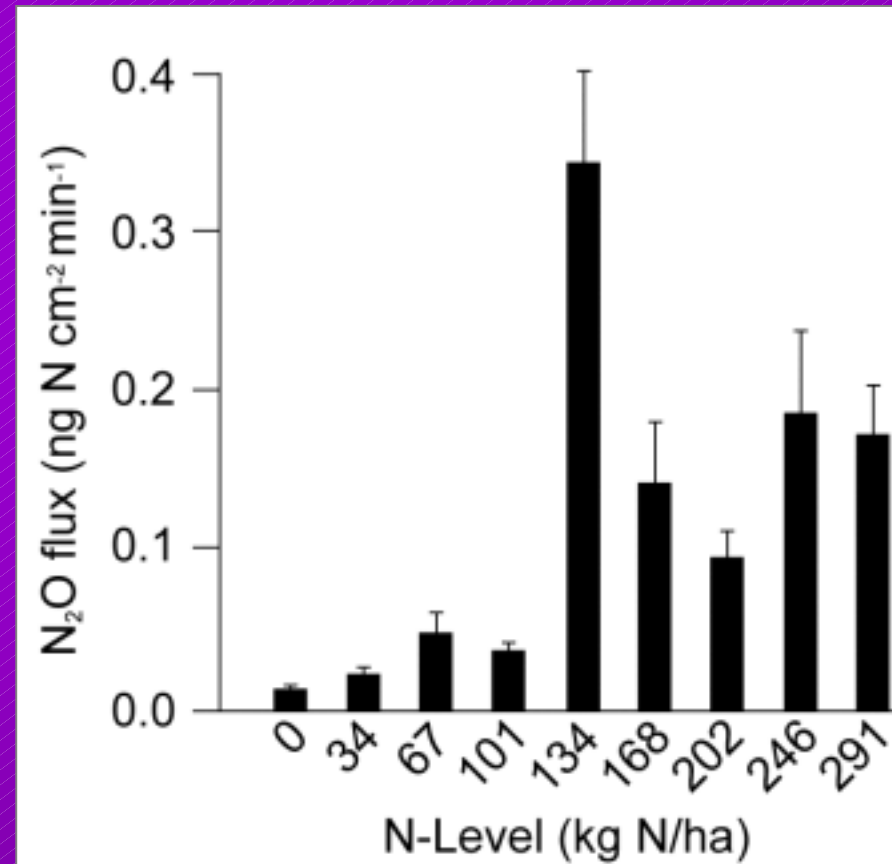


Total Impact 2.0 Pg C<sub>equiv</sub>

1.2 Pg C<sub>equiv</sub>

# N Management to reduce N<sub>2</sub>O flux

- Timing
  - Split applications
  - Delayed applications
  - Use nitrification inhibitors
- Placement
  - Banded
  - Injected
- Rate
  - Utilized N from organic matter efficiently
    - Soil, crop residue, cover crops



Source McSwiney et al.



$\text{CH}_4$  capture

$\text{CH}_4$  emissions reduction  
from livestock



# Measurement, Monitoring and Verification

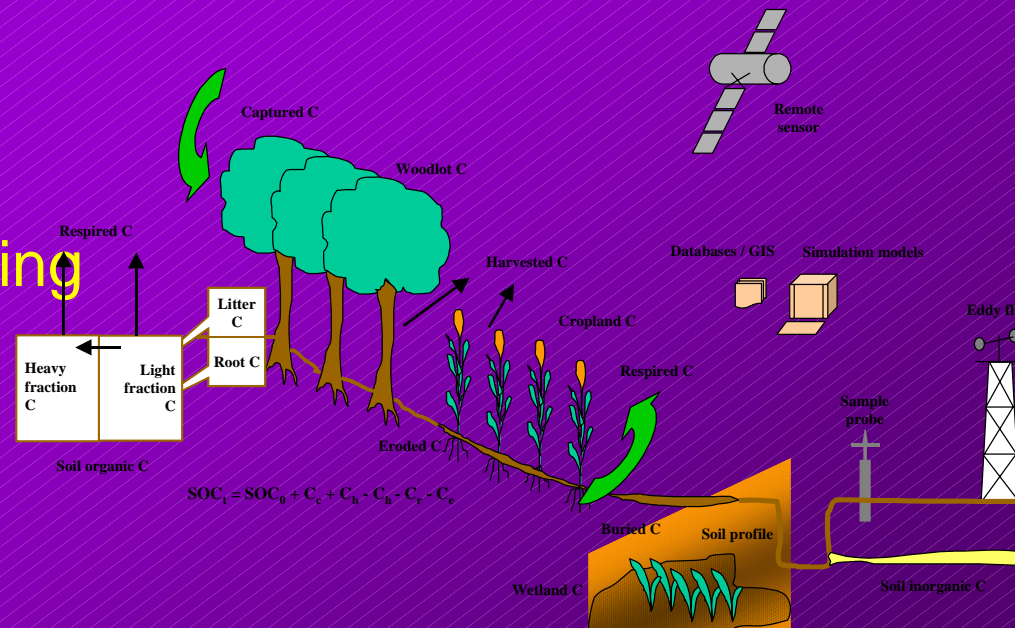
## Detecting soil C changes

- Difficult on short time scales
- Amount changing small compared to total C

## Methods for detecting and projecting soil C changes (Post et al. 2001)

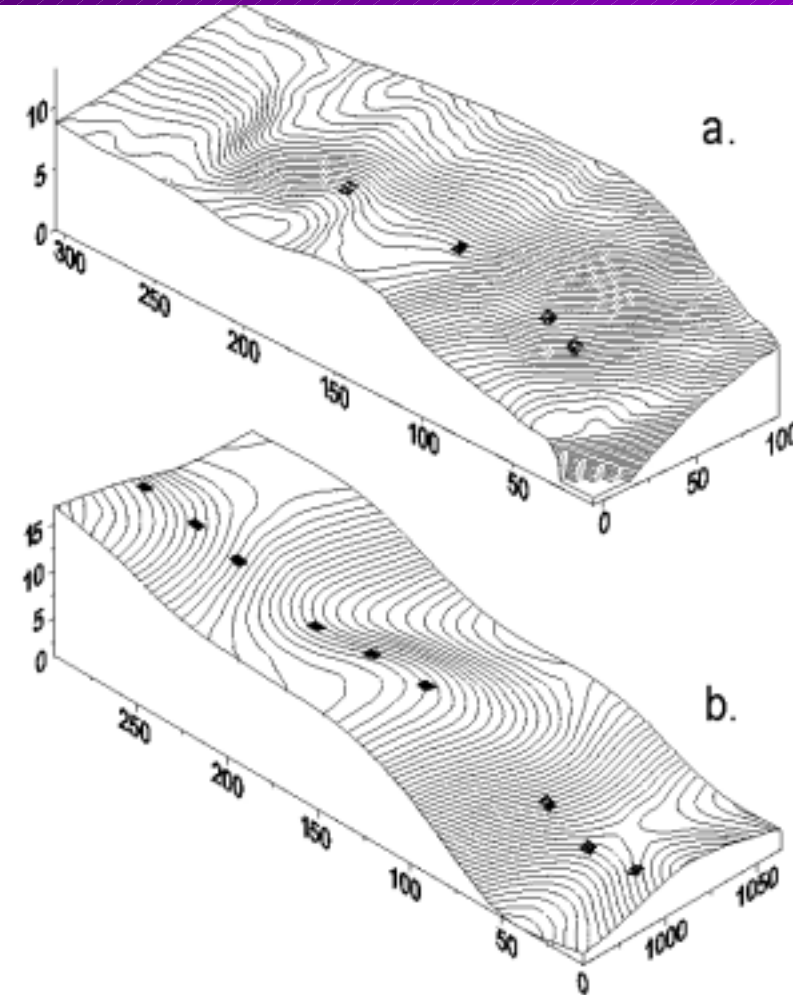
- Direct methods
  - Field measurements
- Indirect methods
  - Accounting

- Stratified accounting
- Remote sensing
- Models





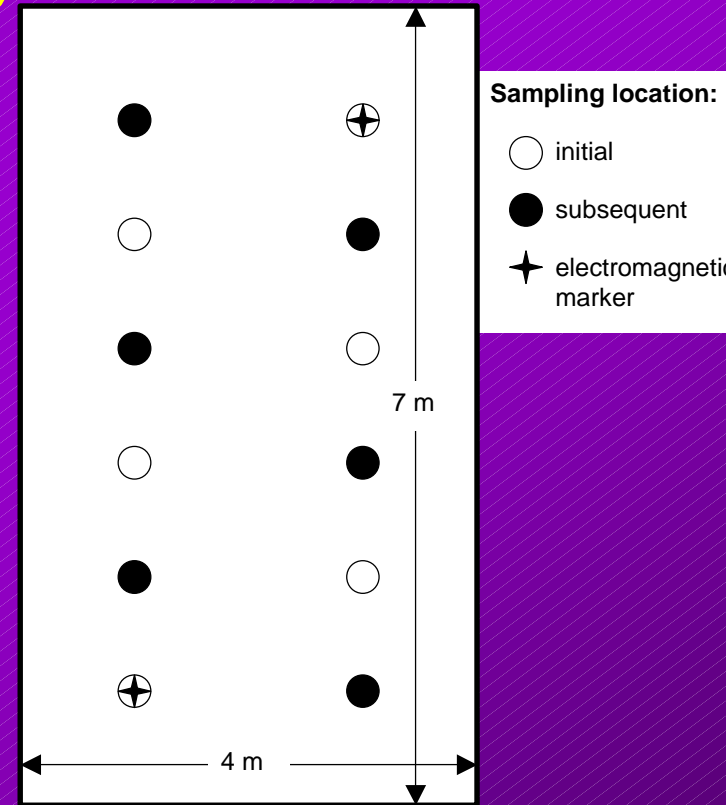
# Sampling strategies: account for variable landscapes





# Geo-reference microsites

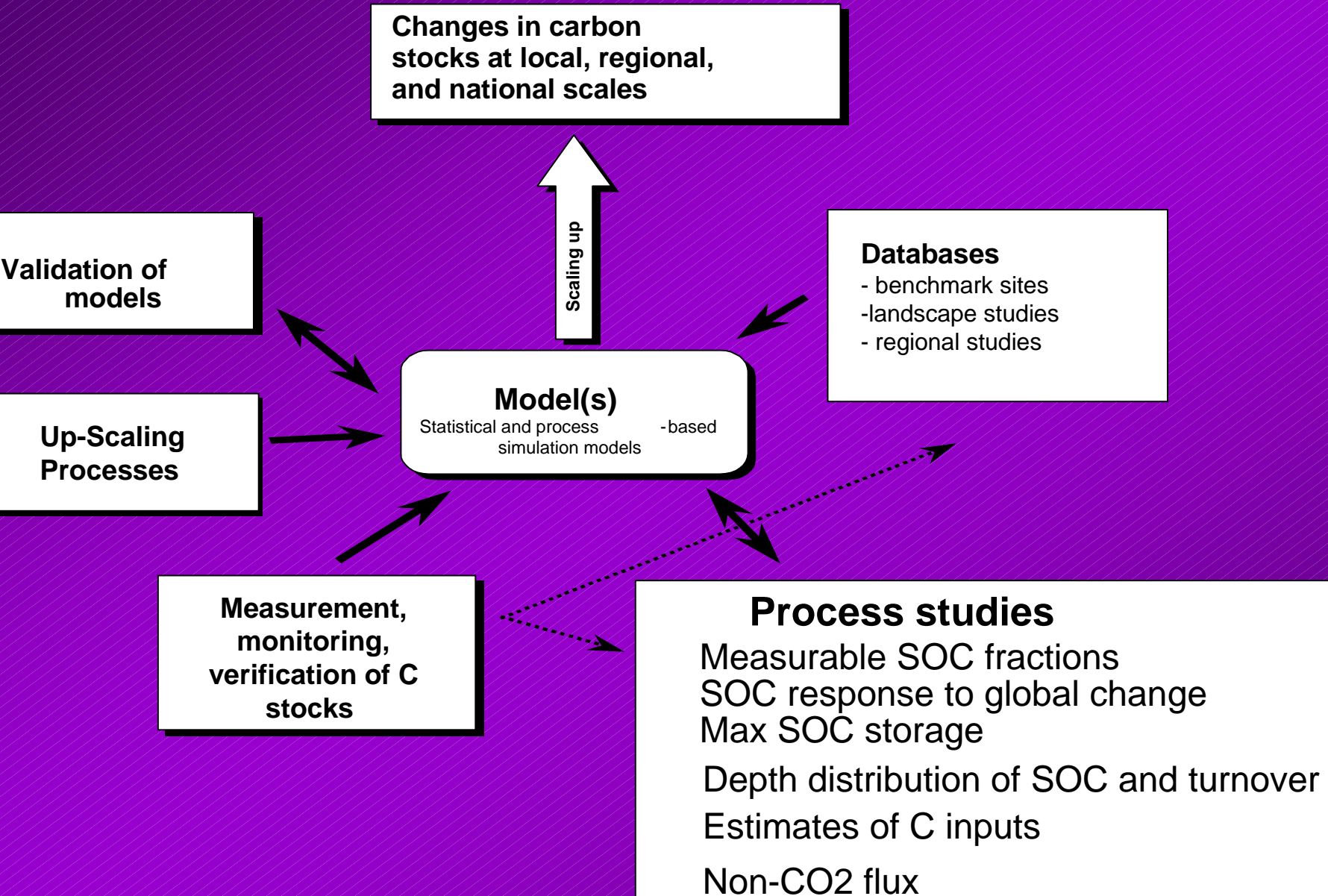
- Microsites reduces spatial variability
- Simple and inexpensive
- Used to improve models
- Used to adopt new technology
- Soil C changes detected in 3 yr
  - 0.71 Mg C ha<sup>-1</sup> – semiarid
  - 1.25 Mg C ha<sup>-1</sup> – subhumid

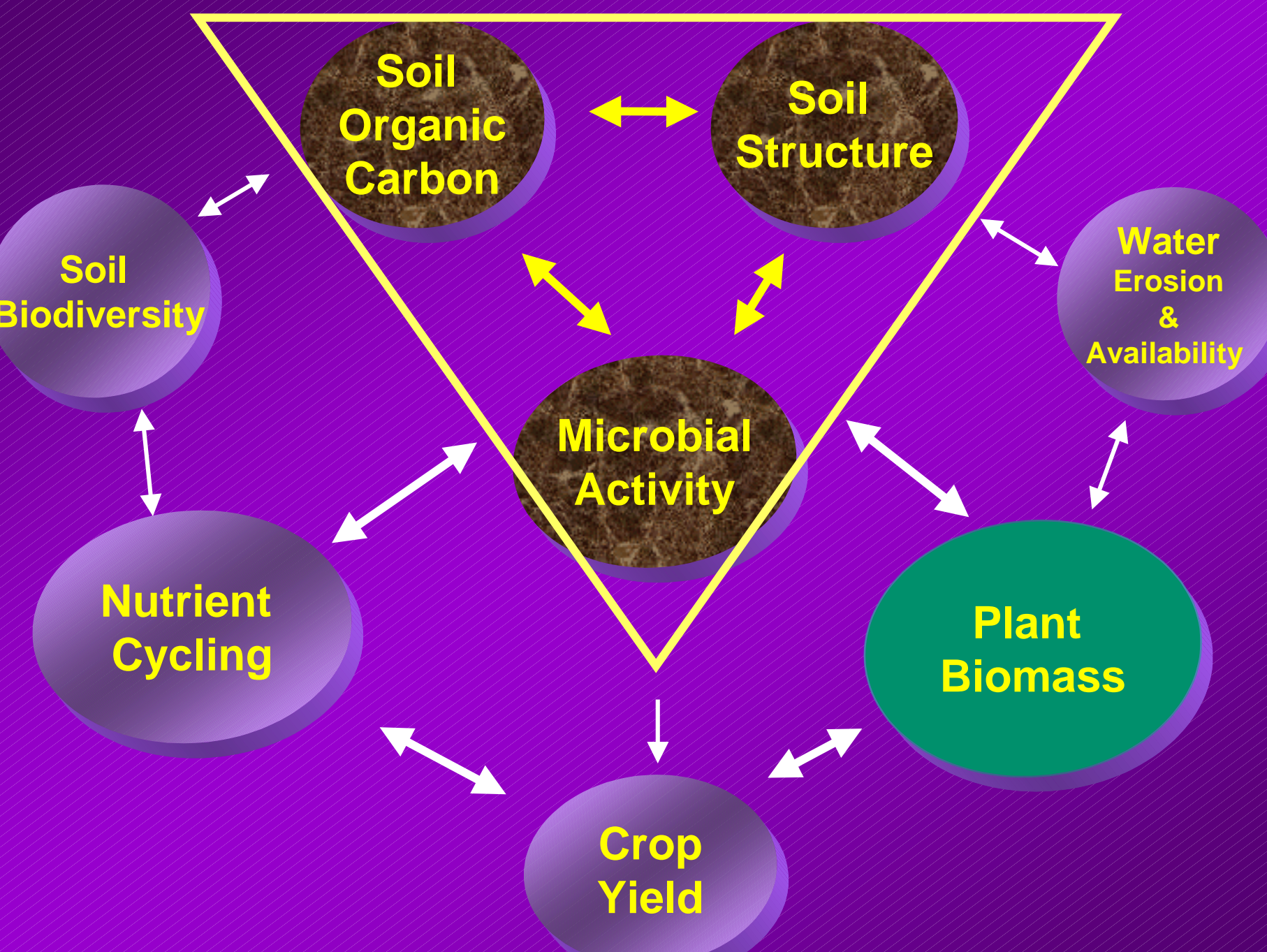


# Examples of feasibility and pilot projects on soil carbon sequestration

Region	Land Use	Land management change
Saskatchewan, Canada	Cropland	Direct seeding / cropping intensification
Pacific Northwest, USA	Cropland	Direct seeding / cropping intensification
<b>Midwest Iowa, Kansas, Nebraska</b>	<b>Cropland Grass planting</b>	<b>No-till New grass plantings</b>
Oaxaca, Mexico	Crop / natural fallow secondary forest	Fruit tree intercrops with annual crops / Conservation tillage
Pampas, Argentina	Cropland	Direct seeding
Kazakhstan	Cropland	Agriculture to grassland

# Areas of potential cooperation between countries







# ***K-State Research and Extension***



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