C sequestration and GHG mitigation in agriculture – can reality live up to potential?

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Knowledge to Go Places

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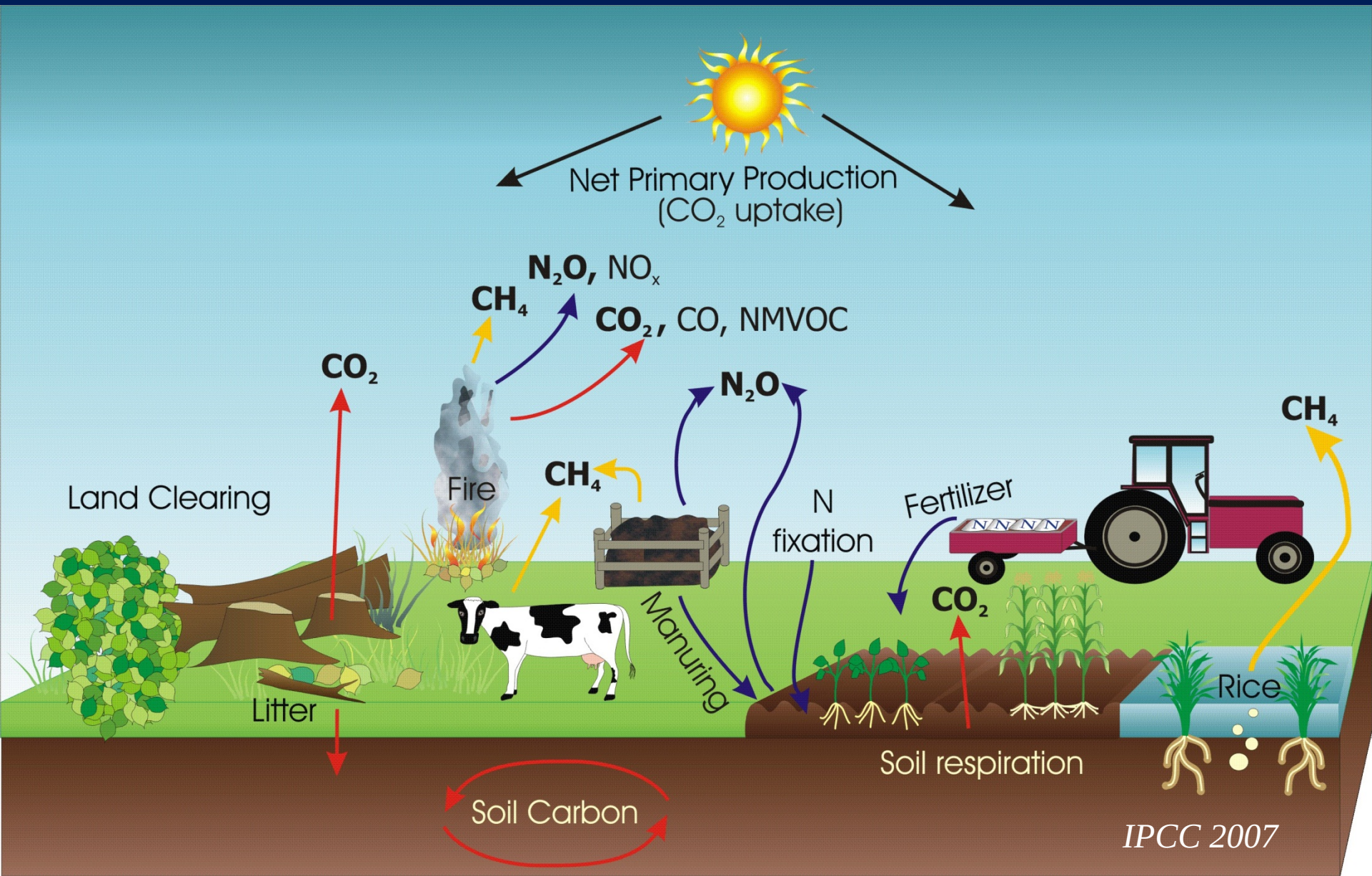
Outline

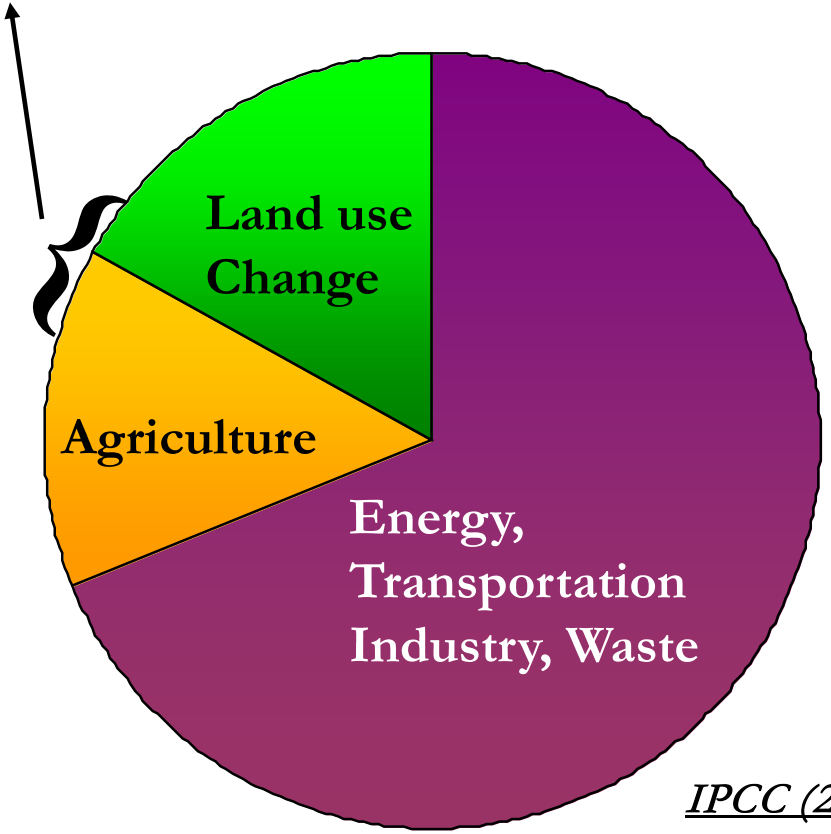
- Background on GHG emission sources and mitigation potential in agriculture
- Examples of management practices to sequester carbon and reduce GHG emissions
- Networking and empowering farmers and ranchers to engage agriculture in GHG mitigation activities

Agricultural sources and sinks of greenhouse gases



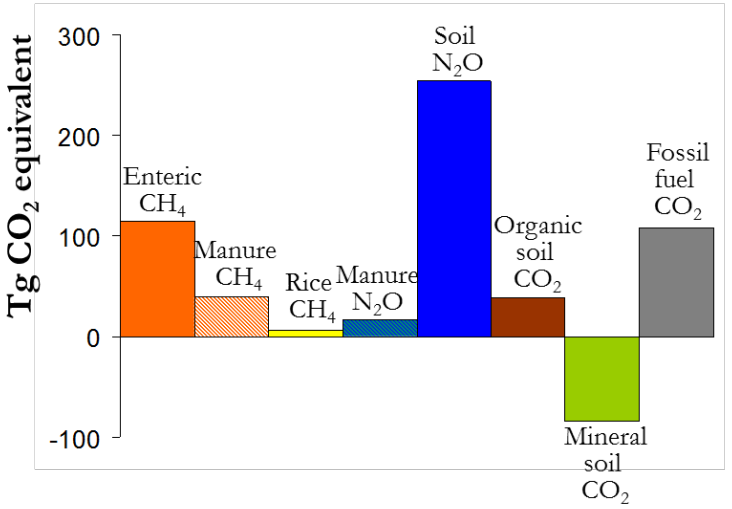
Ag & Land Use are major GHG source categories

31% of Global Warming effect



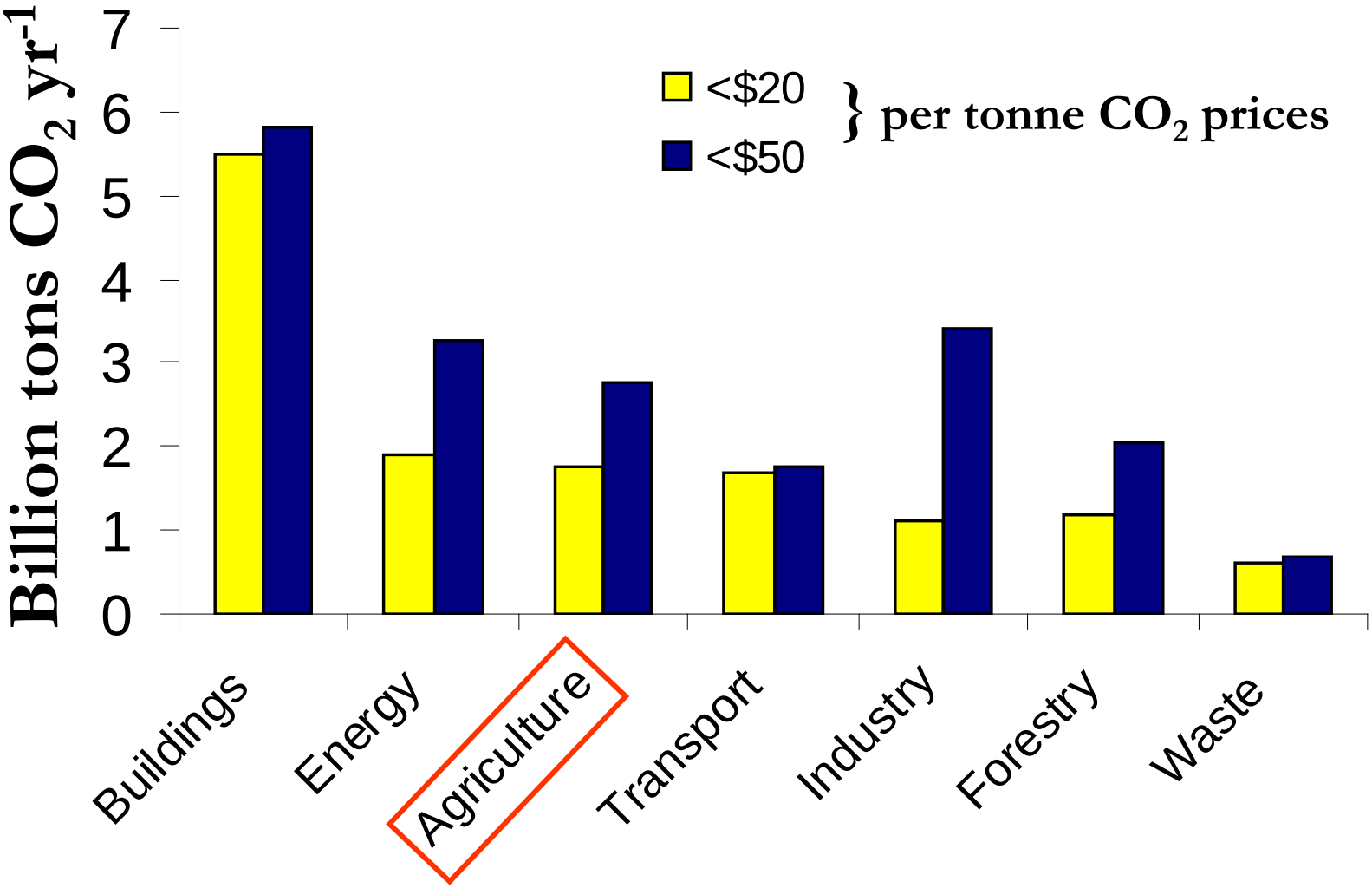
IPCC (2006)

US agricultural emissions
(7% of national total)



EPA, 2006

Agriculture can be a major mitigation sector



IPCC (2007), Smith et al. (2007)

Why are agricultural soils of particular significance?

- Soils are the largest (non-geologic) terrestrial C pool **(> 1500 Pg C** in surface 1m).
- Land conversion to agriculture has historically been a major source of CO_2 (**140-260 Pg CO_2** from soils).
- Continued climate change may create a positive feedback with increased emissions of GHGs from soils.
- These are the soils we can **proactively manage** to rebuild C stocks, remove CO_2 and improve agricultural sustainability.

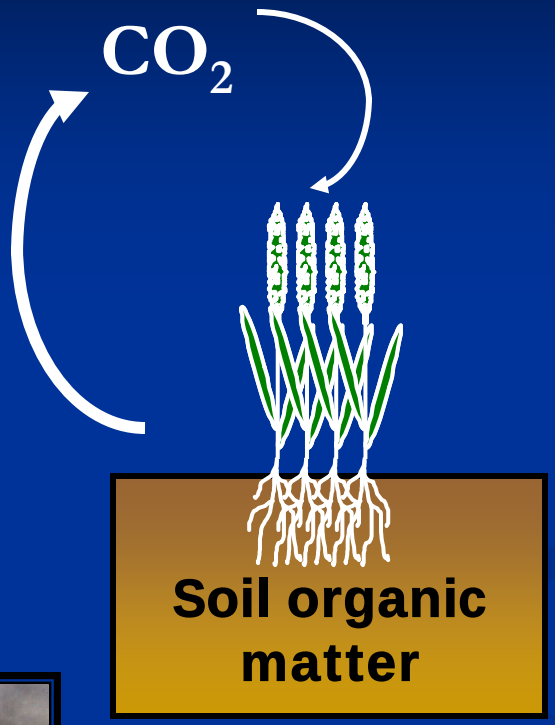
Mitigating agricultural GHGs

- **Increasing uptake and storage of CO_2 in biomass and soils**
- **Reducing N_2O emissions from soils and manure management**
- Reducing CH_4 emissions from soils, livestock and manure
- Reducing fossil fuel use for operations and production inputs

Past Agricultural Practices

Erosion

Intensive tillage

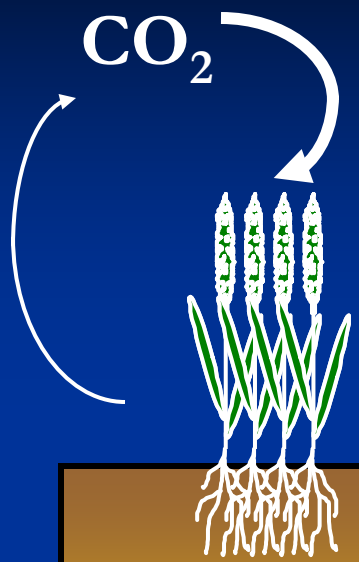


Residue removal

Low Productivity

Improved Agricultural Practices

Conservation buffers



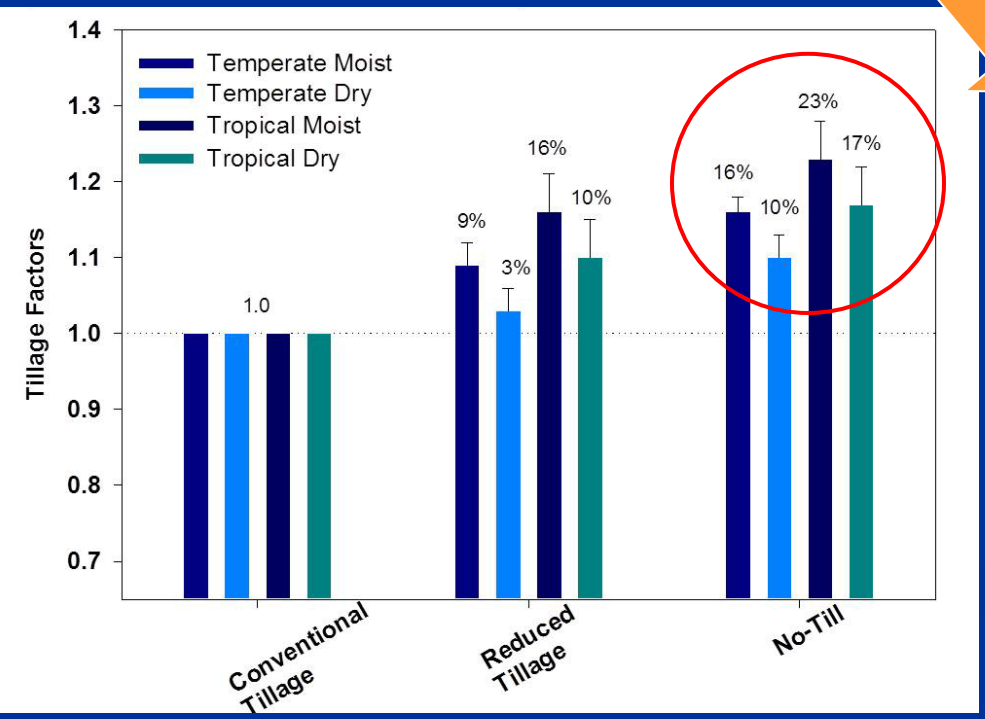
Conservation tillage

Cover crops

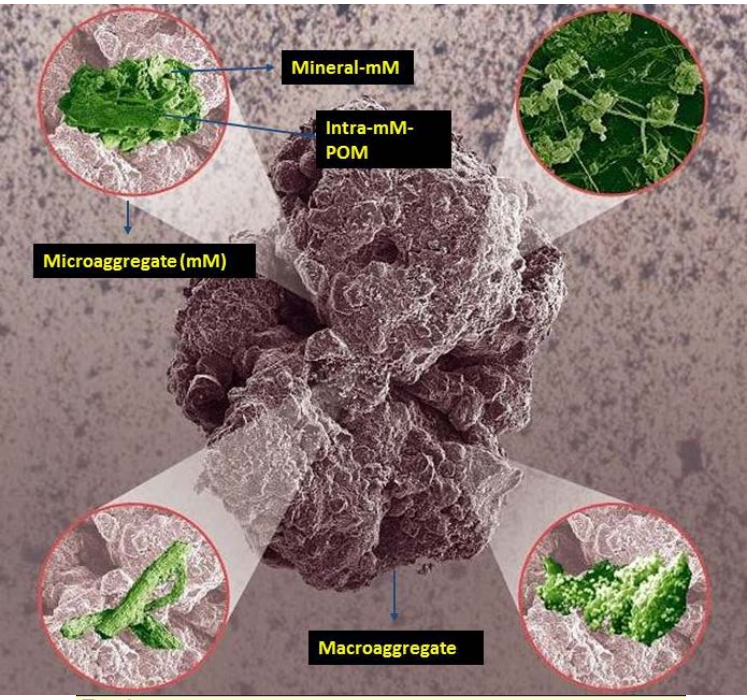
CRP

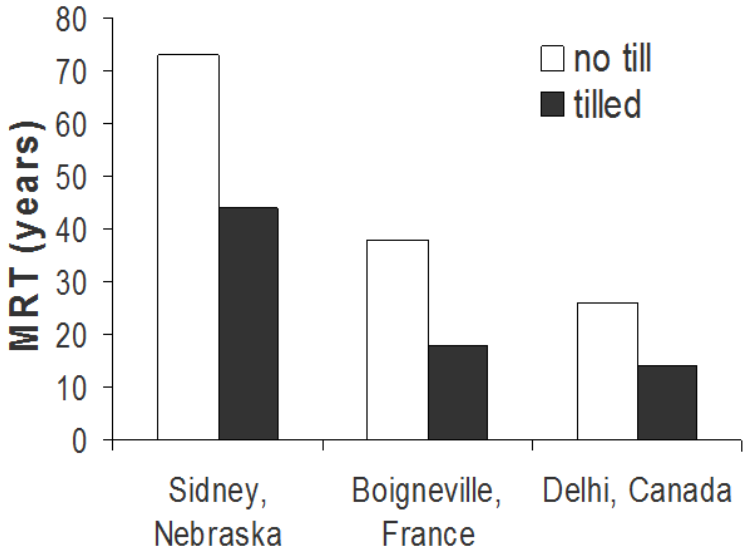
Improved rotations

Less tillage and more residues increase soil C storage in **most** arable soils!

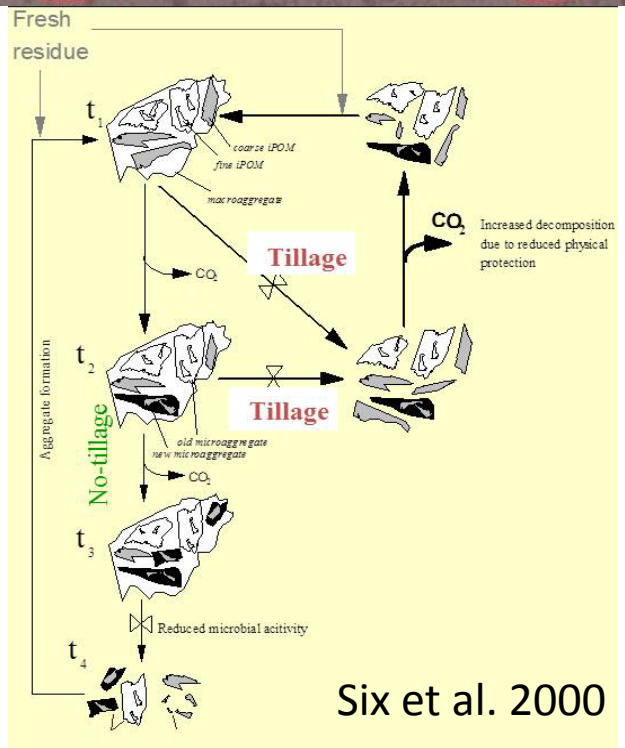


Ogle et al. 2005

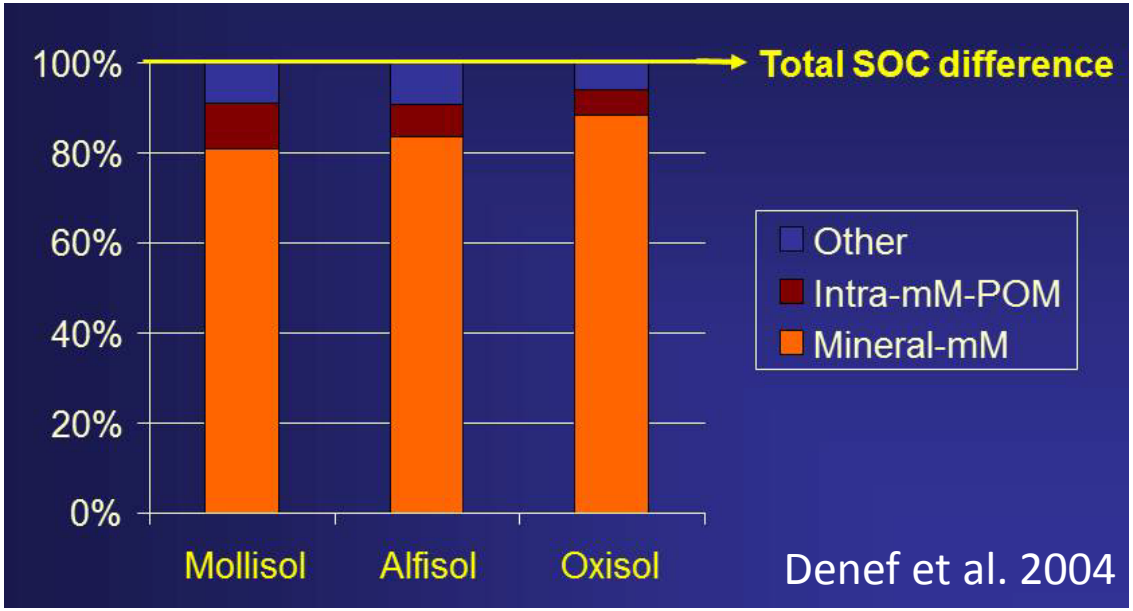




Paustian et al. 2000

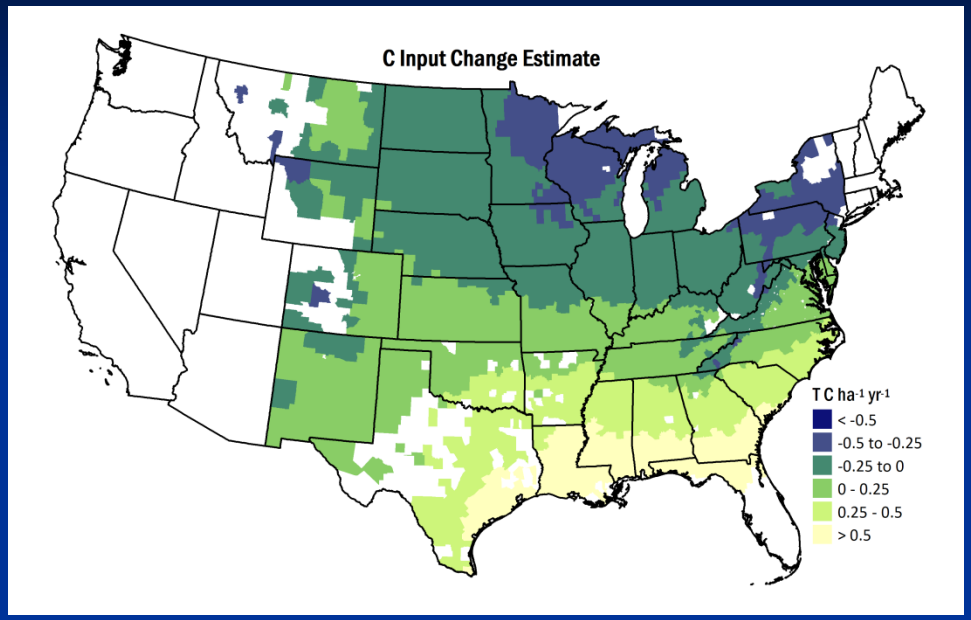


Six et al. 2000



Denef et al. 2004

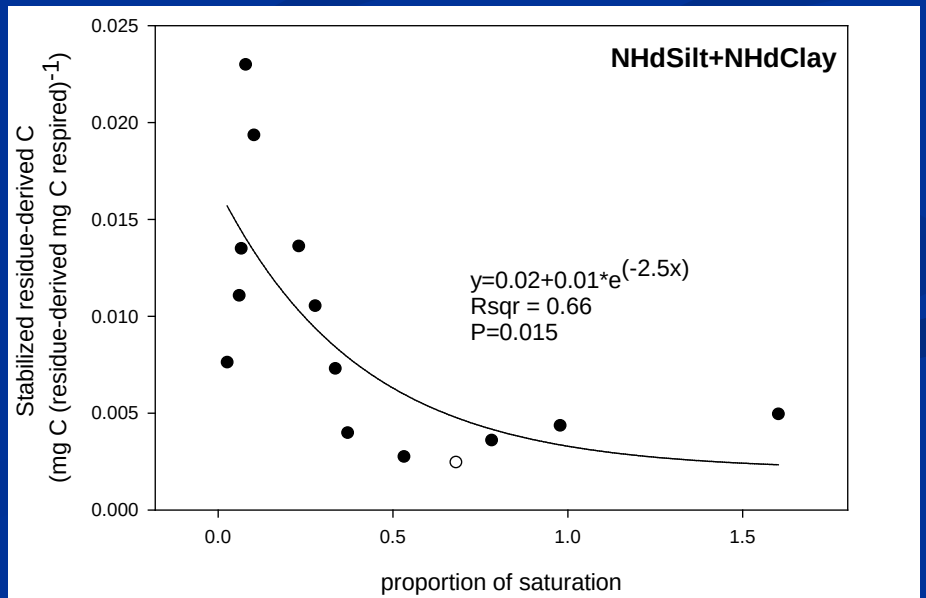
Reduced residue inputs



Ogle et al. 2012

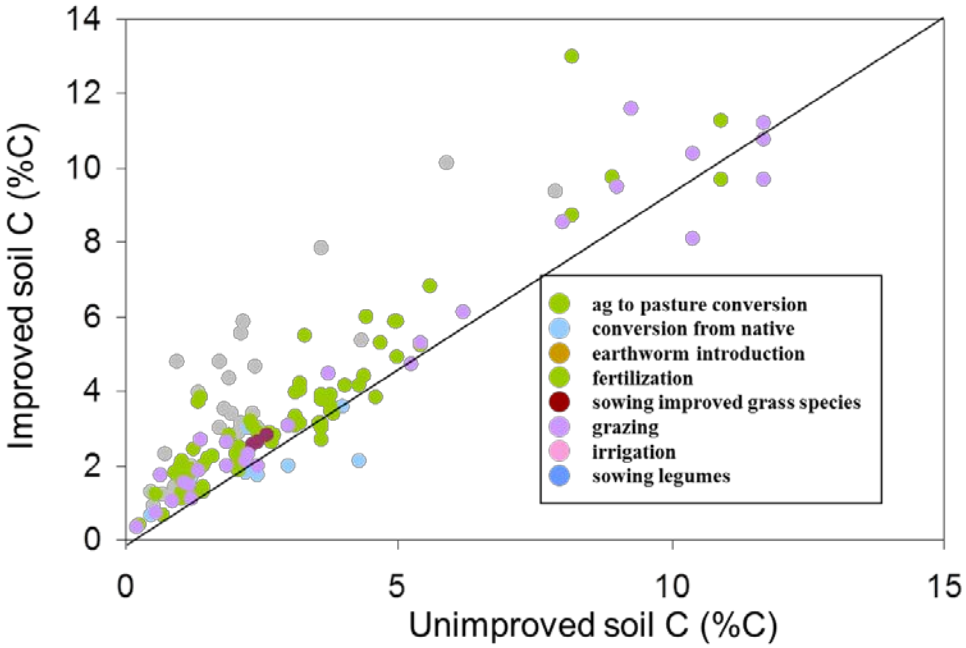
No-tillage does **not** increase C in soils with high organic matter in cool, moist climates

Saturation of organic matter in surface soil layers



Stewart et al. 2009

Soil C stocks can be increased with improved pasture management



Conant et al. 2000

Biochar addition to soils as a strategy to mitigate GHG emissions and sequester C in soils

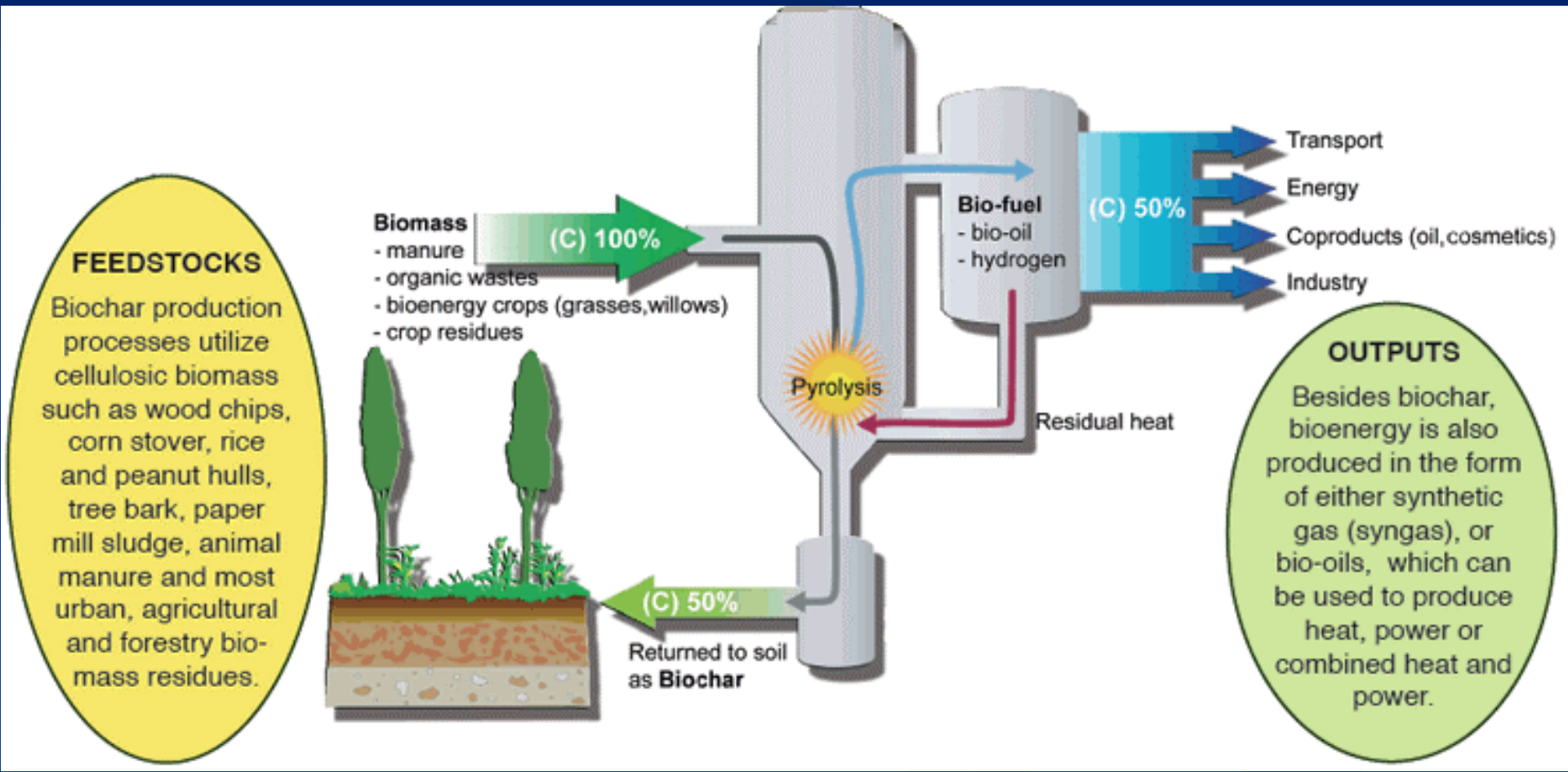
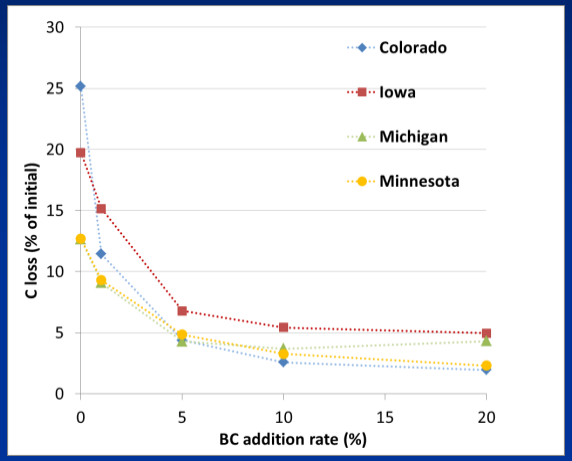
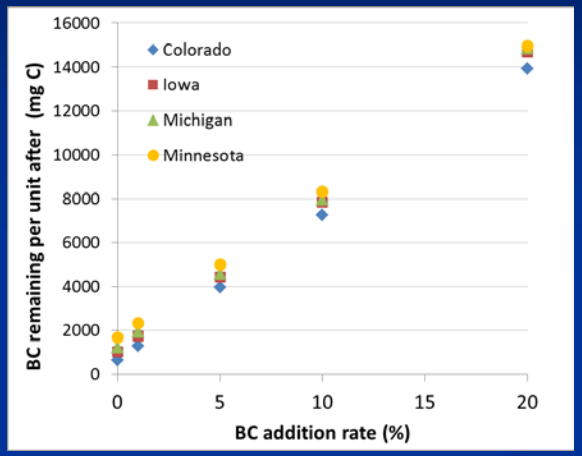


Figure courtesy International Biochar Initiative

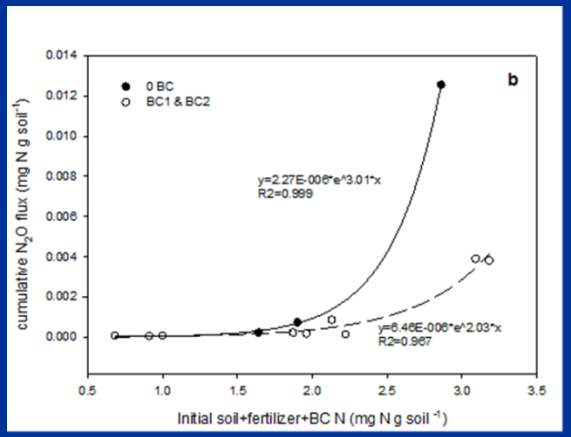
Biochar addition to soils as a strategy to mitigate GHG emissions and sequester C in soils

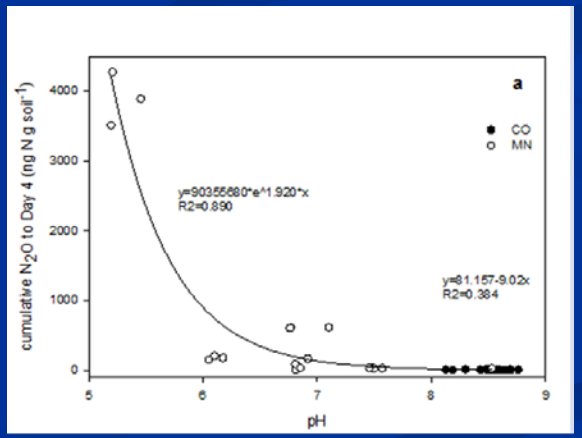
1. Biochar can increase soil C stocks – only a minor fraction of BC decomposes in the short term. Overall, it accumulates in soil at a rate proportional to addition rate, in the absence of leaching or erosion





2. Biochar may reduces N_2O emissions – in fertilized soils, likely via > pH and NO_3^- adsorption



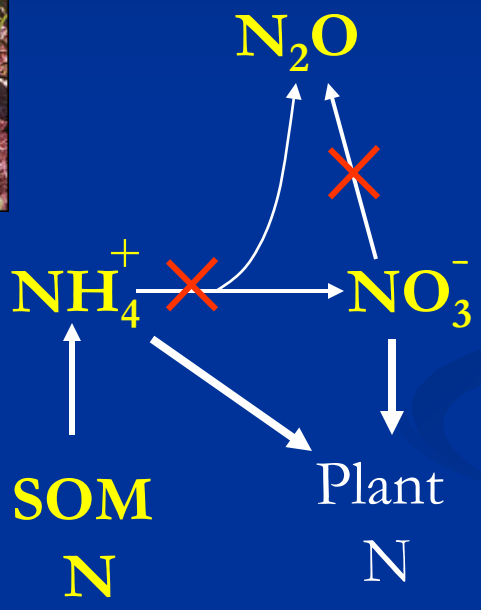


M. Francesca Cotrufo – unpub. data

Reducing N_2O

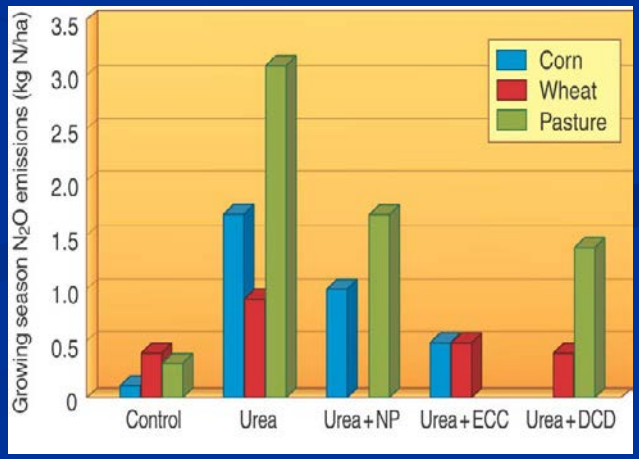
Improved timing and application rates

Improved placement



Water and fertilizer mgmt

Nitrification inhibitors/ slow release fertilizer



Where are we now?

- Agriculture has one of the largest near-term mitigation potentials.
- Many proven technologies and many farmers who can, and are willing to, make management changes for modest **incentives**.

…. But inclusion of agriculture has lagged significantly within current international GHG mitigation policies and in voluntary offset markets

Why?

Confidence in capabilities to quantify, verify and administer agricultural GHG mitigation activities is a key issue

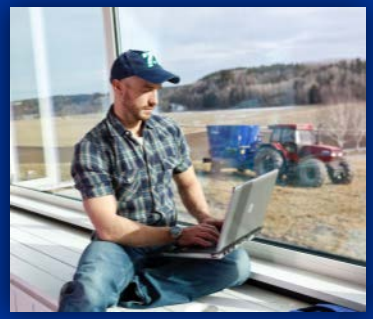
- Emissions/sinks are dispersed, non-point source.
- Direct measurement requires specialized equipment and training and is too expensive for deployment in most mitigation projects.
- Local-scale variability – climate and soil conditions and **farm-level management – matters!**

To address these challenges, we need a new partnership – a new network – that puts farmers and ranchers at the center!

Policy Assessments

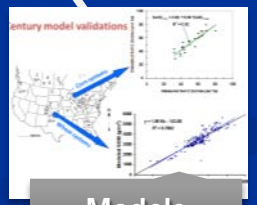
Inventories

Ecosystem Service Markets



Geographic Databases

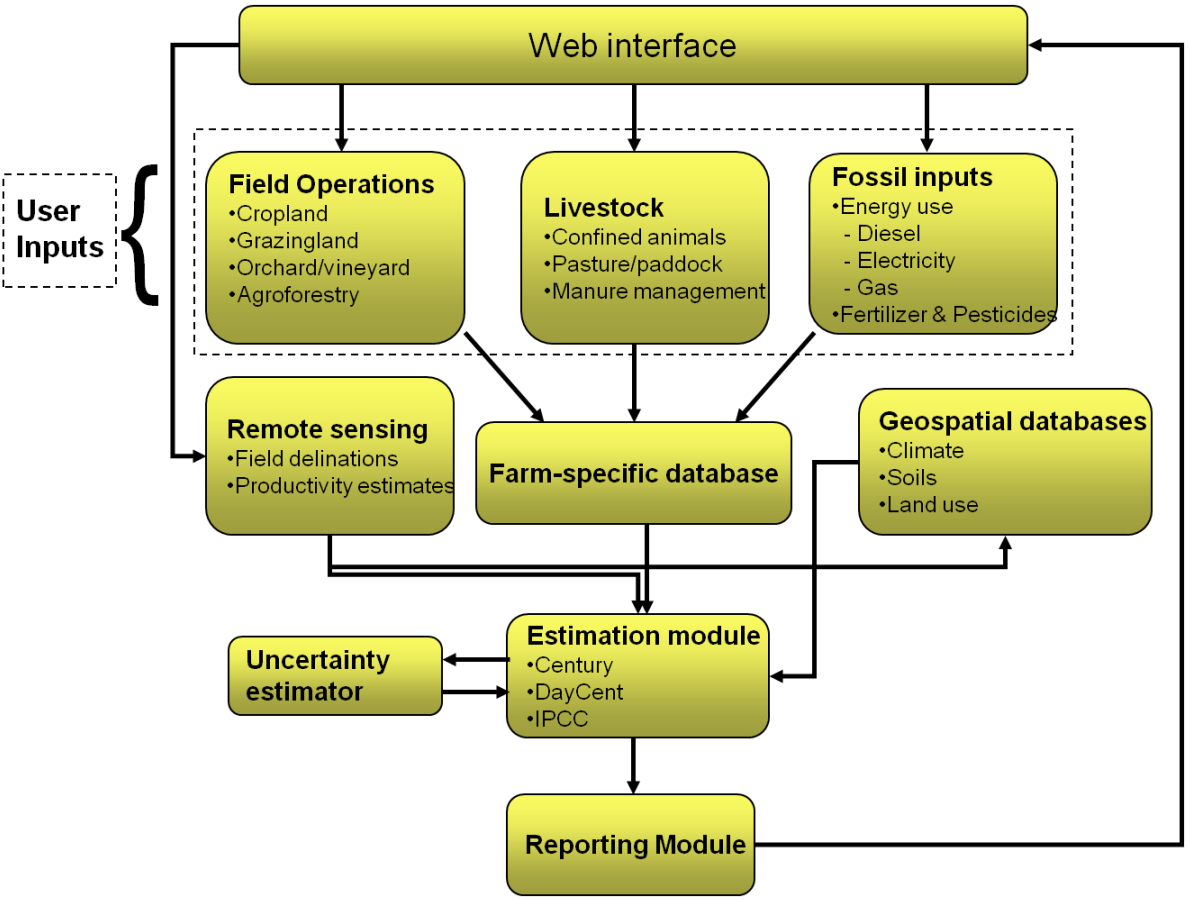
Remote Sensing Data

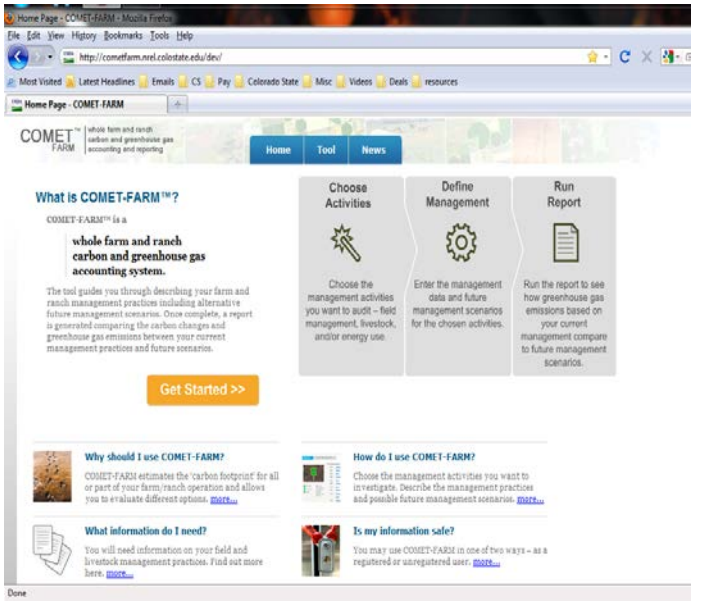


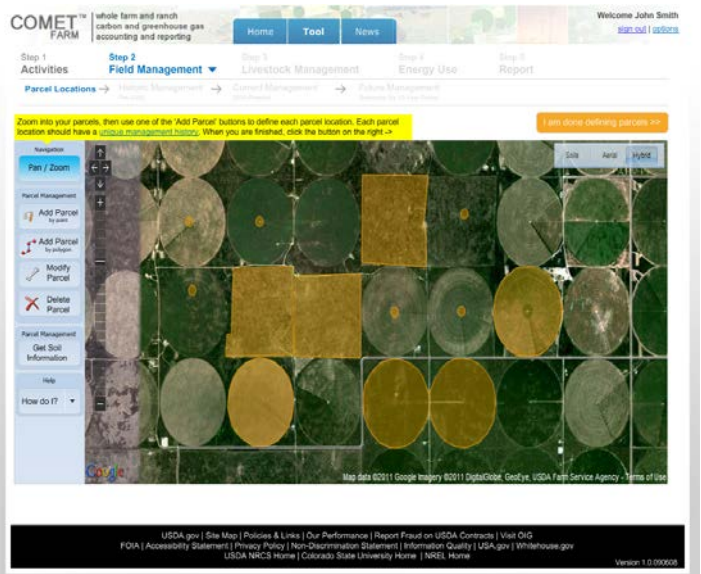
Models

Measurement Network

COMET-Farm system for farm-level GHG accounting







Concluding remarks

- Agriculture has a significant (especially near-term) technical capacity to mitigate GHG emissions
- Many technologies are feasible and can be implemented at relatively low cost – but **do** require incentives to farmers
- Barriers exist – a key issue is better capabilities to quantify and verify GHG mitigation results at the farm scale.
- Emerging systems can empower farmers – who have both the knowledge and the decision-making needs – for a positive engagement by agriculture.