Regenerative Agriculture and Greenhouse Gas Mitigation

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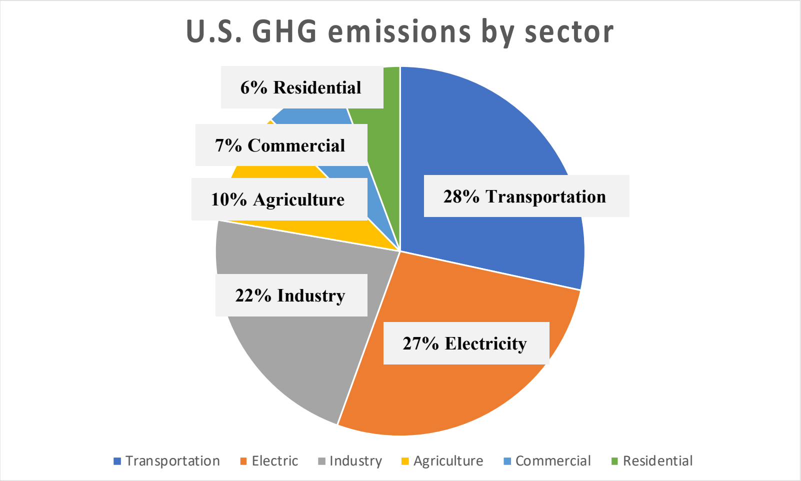
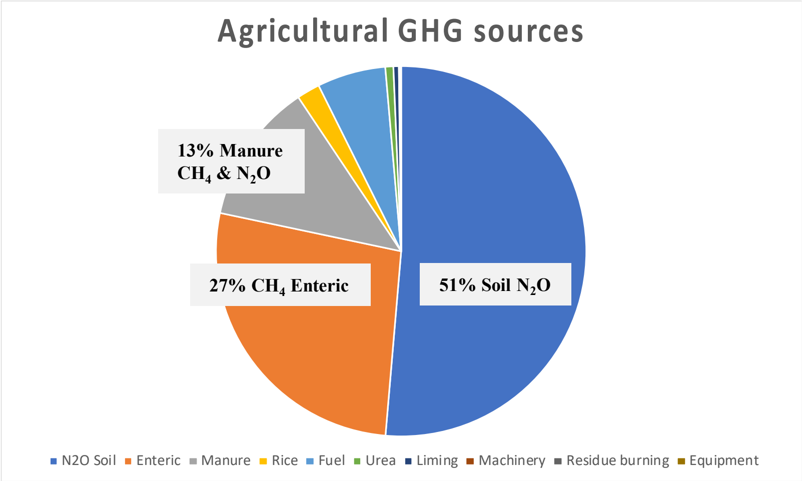
Overview

- Greenhouse Gas (GHG) Emissions from Agriculture
- Conventional vs. Regenerative Agriculture
- Agriculture and GHG Mitigation
- Policy Considerations
- Questions?

Greenhouse Gas Emissions from Agriculture





- **Agriculture** causes 10% of total U.S. GHG emissions.
- **Nitrous oxide** (N_2O) is largest component of agricultural GHG emissions. Agriculture contributes most of U.S. N_2O emissions.
- **Reducing Nitrous oxide** is a key potential benefit of improved agricultural management.
- **Methane** (CH_4) is second largest agricultural GHG. Animal agriculture is a dominant source of CH_4 emissions in the U.S.

Data: 2018 U.S. EPA inventory

Conventional vs. Regenerative Agriculture

Historic Midwest U.S. Ecosystems

Restored Wetland
Dixon Waterfowl Refuge, Illinois

Restored Prairie
Dixon Refuge, Illinois

Images: The Wetlands Institute

Conventional Agricultural Practices

Bare fallow and tillage

Tile drainage

Images: Mark David

Conventional Agriculture and Nutrient Pollution

Eutrophication and toxic algal blooms

Hypoxia: Gulf Coast Dead Zone
Average size: 5,408 square miles

Images: NASA

Conventional Agriculture and Soil Erosion

Natural Soil Erosion

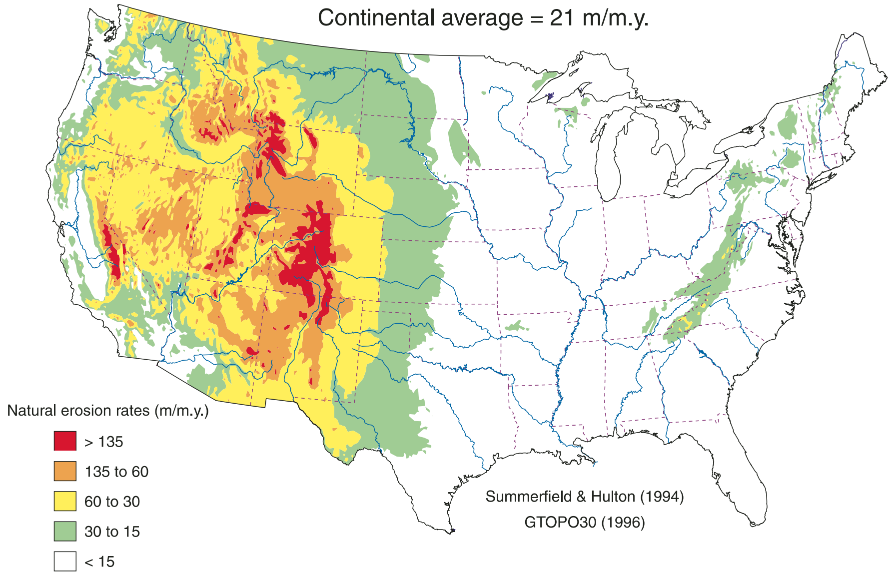


Figure 6. Estimates of average natural erosion (denudation) rates inferred from GTOPO30 area-elevation data and global fluvial erosion-elevations relations from Summerfield and Hulton (1994). Mean rate of denudation for the entire area of the contiguous United States is ~21 m/m.y.

Cropland soil erosion

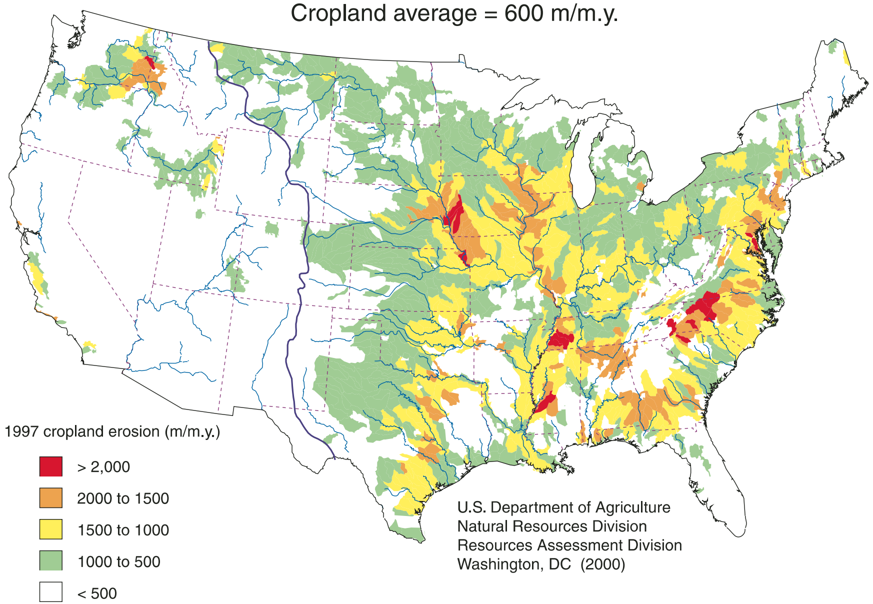


Figure 8. Rates of cropland erosion derived from estimates by the Natural Resources Conservation Service using the Universal Soil Loss Equation, and scaled to a farmland average of 600 m/m.y. The solid blue line is the western edge of the North American craton, here defined as the margin of the Great Plains physiographic province. Areas of arable land are largely confined to cratonic regions under 1 km in elevation.

Wilkinson and McElroy. 2007.
Geol. Soc. Am. Bull.. 119(1/2):140-156

Implementing Regenerative Practices

Cover bare soils with plants

- Increase system productivity
- Increase soil organic matter (SOM) from increased plant residues
- Active root zone retains nutrients, increases infiltration, reduces erosion and improves soil physical structure

Diversified rotations to cover bare soils

- Cover crops (retain nutrients)
- Legume crops (nitrogen fixation)
- Perennial rotations (deeper, denser roots)

No-till to reduce runoff and erosion

Images: Laurie Drinkwater

Regenerative Agriculture: No-Till and Soil Health

Reduce soil erosion; improve soil structure, water infiltration and water retention

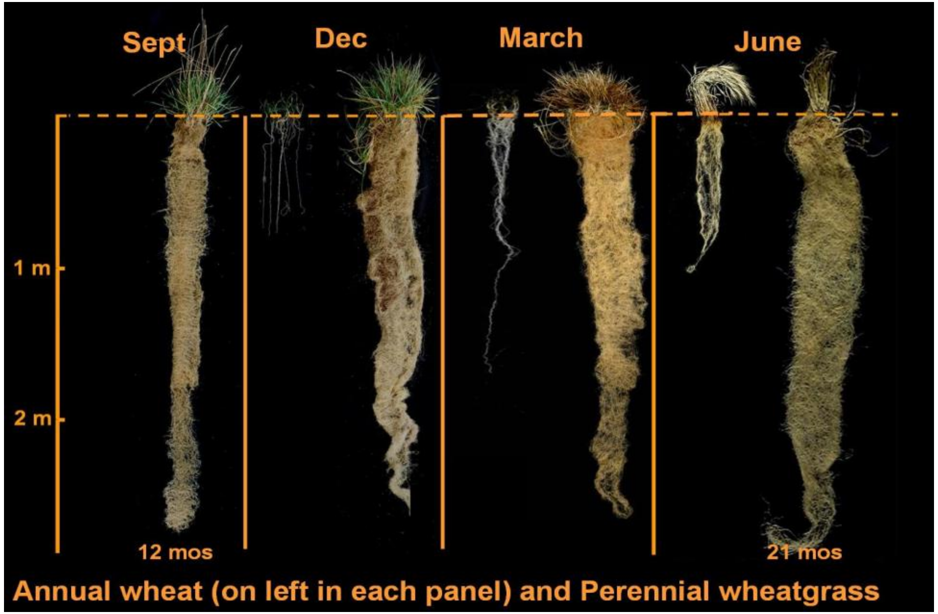
No-till planting

Image: Mastrorilli. CREA: Southern Italy

Regenerative Agriculture: Perennial Systems

Continuous plant cover; reduce soil erosion; improve soil structure, water infiltration, soil moisture, and nutrient use efficiency

Perennial grasses
Image: Jennifer Blesh



Perennial grains
Image: Jerry Glover

Agriculture and GHG Mitigation: Scale of Offsets

FAST-GHG: Greenhouse Gas Accounting Tool

U.S. commodity crops:

- corn, soybean, wheat

Management practices:

- Cover crops
- No-till, reduced tillage
- Nitrogen management

Time scale:

- 100-year accounting framework

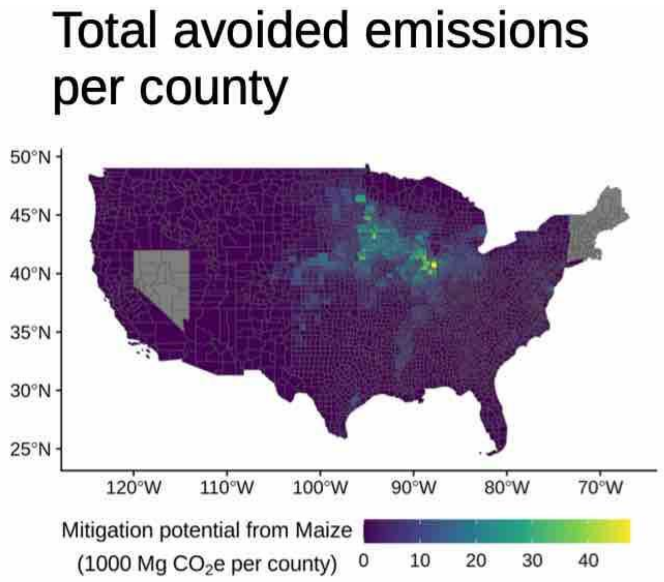
Accounts for:

- Change in nitrous oxide (N_2O) emissions, carbon dioxide (CO_2) emissions, and soil organic carbon (SOC) sequestration
- Leakage
- Permanence

GHG Mitigation Potential for Corn

Corn soil health BMPs

Total avoided net GHG per county



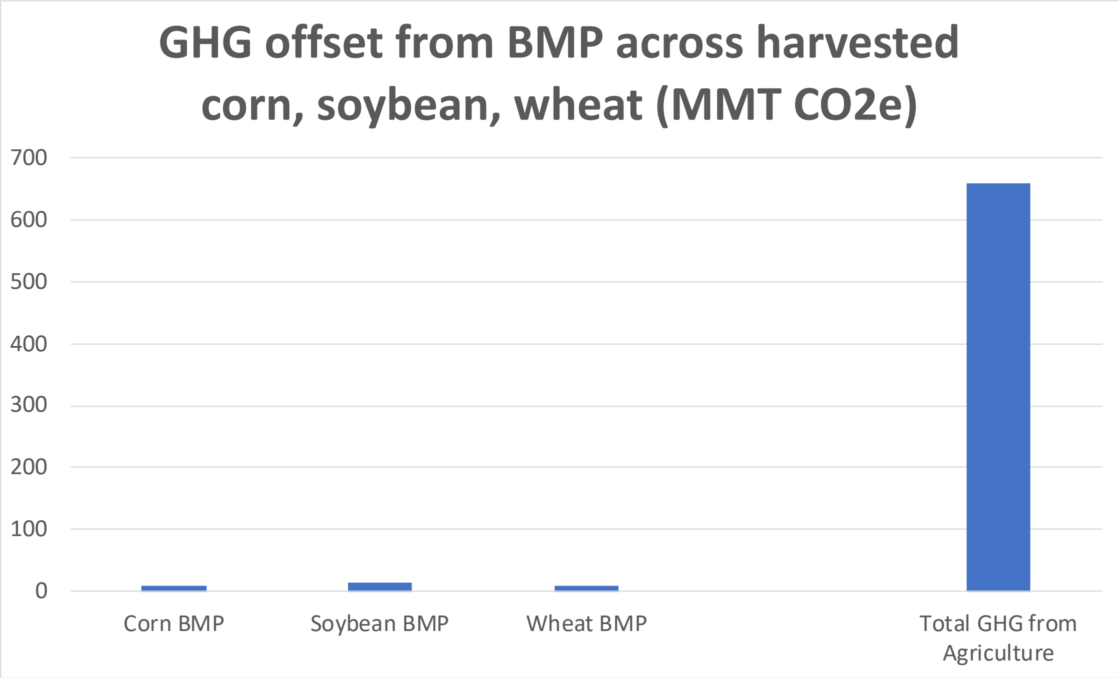
FAST-GHG tool estimates corn best management practices (BMPs) avoid a total of 8.3 Million Metric Tons (MMT) CO_2e

FAST-GHG (Woolf, Woodbury, Tonitto 2020)

Regenerative Agriculture and GHG Mitigation

Annual reduction of net GHG from improved management of commodity crops in 2018:

- 5-10% reduction of national agricultural emissions.
- <1% of total national emissions.
- Reduction results from regenerative agricultural practices and improved nitrogen management.



Policy Considerations

Regenerative Agriculture and GHG Mitigation

The main benefit is to maintain the soil resource and improve water quality:

- Add soil organic carbon.
- Retain nutrients.
- Reduce soil erosion.
- Improve soil structure and water management.

A smaller co-benefit is to mitigate GHG emissions:

Non-reversible GHG benefits from reducing excess nitrogen inputs.

- Reduced nitrous oxide (N_2O) emissions.
- Reduced carbon dioxide (CO_2) and N_2O emissions from nitrogen fertilizer production.

Reversible GHG benefit from **increased soil organic carbon** accumulation.

Regenerative Agriculture and GHG Mitigation Accounting

Permanence: We must account for the reversibility of soil organic carbon.

- Soil organic carbon accumulation saturates after 20-30 years of regenerative management.
- Regenerative agricultural practices must be continued indefinitely to retain this accumulated soil carbon, otherwise it can be lost.
- Cost of long-term commitment to improved practice.

Regenerative Agriculture and GHG Mitigation Accounting

Risk of reversal in practice to quantify soil organic carbon benefits

- Policy should factor in reversibility.
- Reversible benefits (increased soil organic carbon) are riskier than non-reversible benefits (reduced nitrous oxide or carbon dioxide emissions).
- Long time scales, such as 100-years, are important because climate change is a long term process.

Regenerative Agriculture and GHG Mitigation Accounting

Leakage: Net GHG emissions resulting from a change in yield must be accounted for.

- Yield change has large impact on net GHG emissions.
- Leakage quantification:
    - Yield change due to management
    - Extensification vs. Intensification
    - Carbon cost of converting natural lands to agricultural production
    - Carbon benefit if land removed from production
- Policy assessment must account for leakage.

Managing Landscapes to Increase Carbon Storage

Reduced demand for current commodity crops

Perennial systems

- Improved perennial forage and managed grazing
- In the future, possibly perennial grains
- 2nd generation biofuels and bioenergy

Dietary changes

- Reduced animal product consumption
- ‘Manufactured proteins’

Increased demand for non-crop ecosystem services from landscapes

- Water quality
- Flood mitigation
- Wildlife habitat and recreation

Motivating Improved Agricultural Management

Payments for Ecosystem Services (PES):

Payment for practice – *Challenging to quantify benefits*

- Estimate benefits based on long-term research studies
- Estimate benefit averaged over many farms
- Proven feasible for implementation

Payment for outcomes – *Challenging to verify benefits*

- On-farm monitoring can cost more than the payment amount.
- Modeling requires trained experts and sufficient on-farm data.

Reversibility and leakage affect both practice or outcomes based PES.

Summary

Net GHG emissions reduction

- Focus on reducing fossil fuel use across all sectors.

Regenerative agricultural practices

- Maintaining the soil resource and improving water quality are the main benefits.
- GHG mitigation is a co-benefit.

Agricultural GHG emissions assessment

- Include leakage and permanence.
- Nitrous oxide and methane are the main GHGs.
- Focus on permanent rather than reversible reductions in GHG emissions.

Carbon-rich landscapes

- Farmer access to improved practice
- Shift in crop demand
- Accounting for ecosystem benefits (regulatory & market approaches)

Thank You

Questions?