

# Carbon Sequestration & Reducing Trace Gases in Colorado Agriculture

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# About the Paustian Research Group

- Led by Dr. Keith Paustian, Professor of Soil & Crop Sciences
- Based at the Natural Resource Ecology Laboratory at Colorado State University in Fort Collins
- More than 100 years combined experience in research into carbon and nitrogen cycling, soil carbon and nitrogen inventories
- Work at all spatial scales, from the field -> county -> state -> national -> global
- Soil carbon inventories completed on five continents and more than a dozen countries
- Develop and manage the COMET tools for modeling GHG emissions for agriculture; used by businesses (like Ben & Jerry's) and for state policy (California's Healthy Soils Program). The COMET Tools ([www.comet-farm.com](http://www.comet-farm.com) and [www.comet-planner.com](http://www.comet-planner.com)) have been developed in collaboration with and with the support of the NRCS, USDA, and other sponsors.

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# Presentation Roadmap

- The Role of Agriculture in Global Warming
- Example based on the Carbon Footprint of Bread
- Opportunities for Improving Agricultural Efficiency
- Carbon Farming
- The Role of Compost

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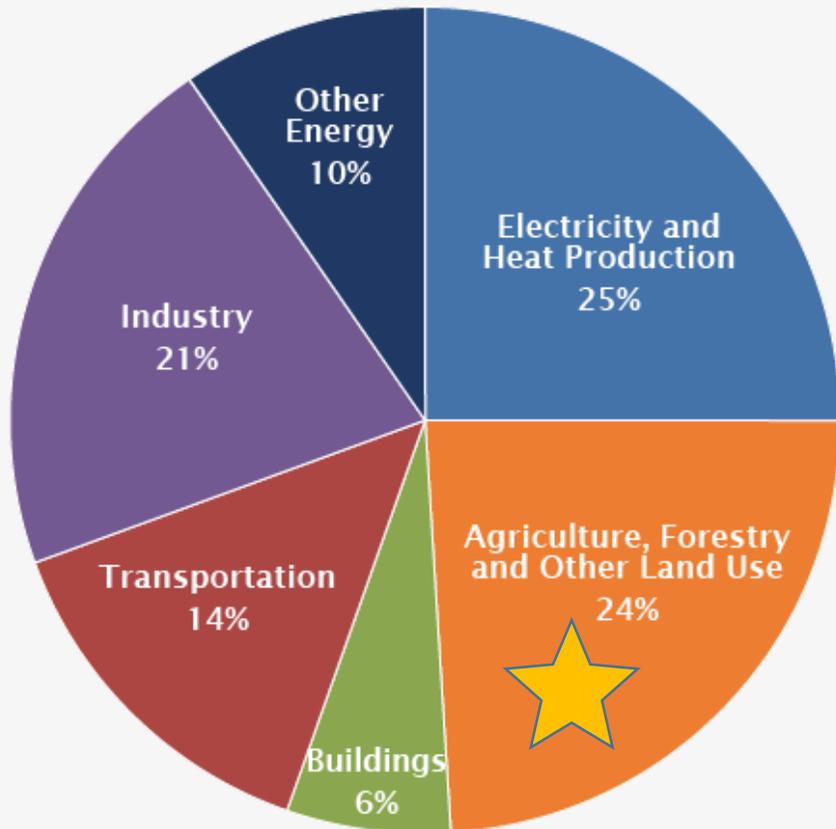


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# Role of Agriculture in Global Warming

## Globally

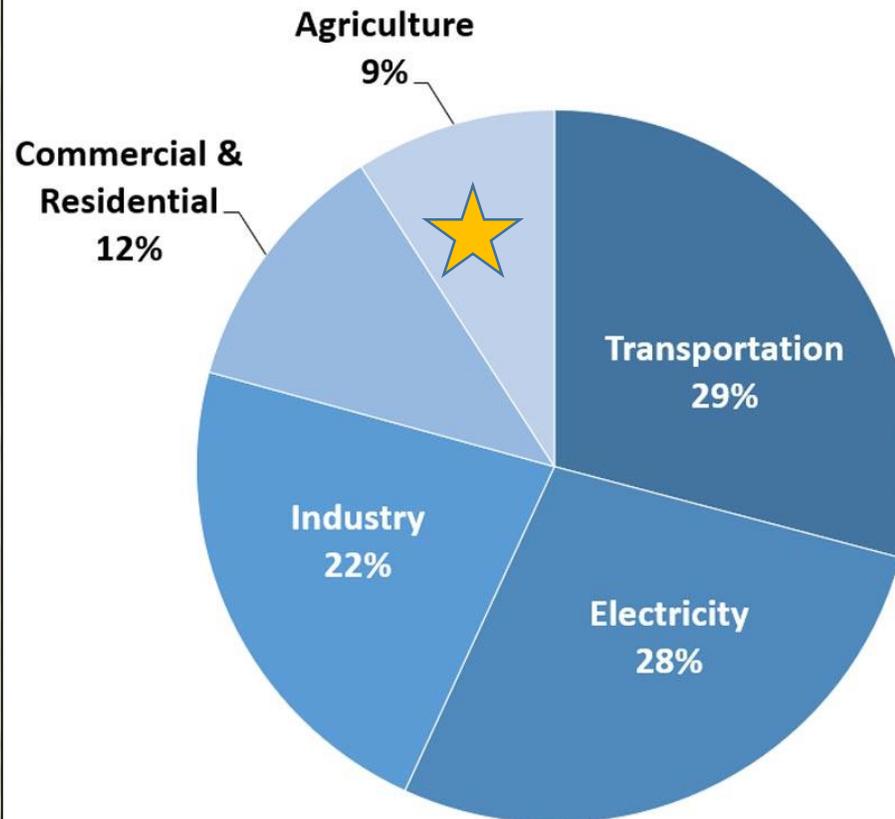
Global Greenhouse Gas Emissions by Economic Sector



Source: U.S. Environmental Protection Agency

## United States

Sources of Greenhouse Gas Emissions in 2017



U.S. Environmental Protection Agency (2019). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2017

*Addressing the Climate Crisis means we must reduce atmospheric carbon dioxide*

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*Agriculture is the most efficient method known to remove carbon from the atmosphere*

# Greenhouse Gases in Agriculture

Carbon  
Dioxide  
 $\text{CO}_2$

Nitrous  
Oxide  
 $\text{N}_2\text{O}$

Methane  
 $\text{CH}_4$

Heat-Trapping Effect  
= 1X

Heat-Trapping Effect  
= 268X to 298X

Heat-Trapping Effect  
= 34X to 86X

**Sources:**

Burning fossil fuels,  
plowing soil,  
burning forests, pastures, crops

C Sequestration Potential: High  
GHG Reduction Potential: High

**Sources:**

Fertilizers, composting,  
Manure

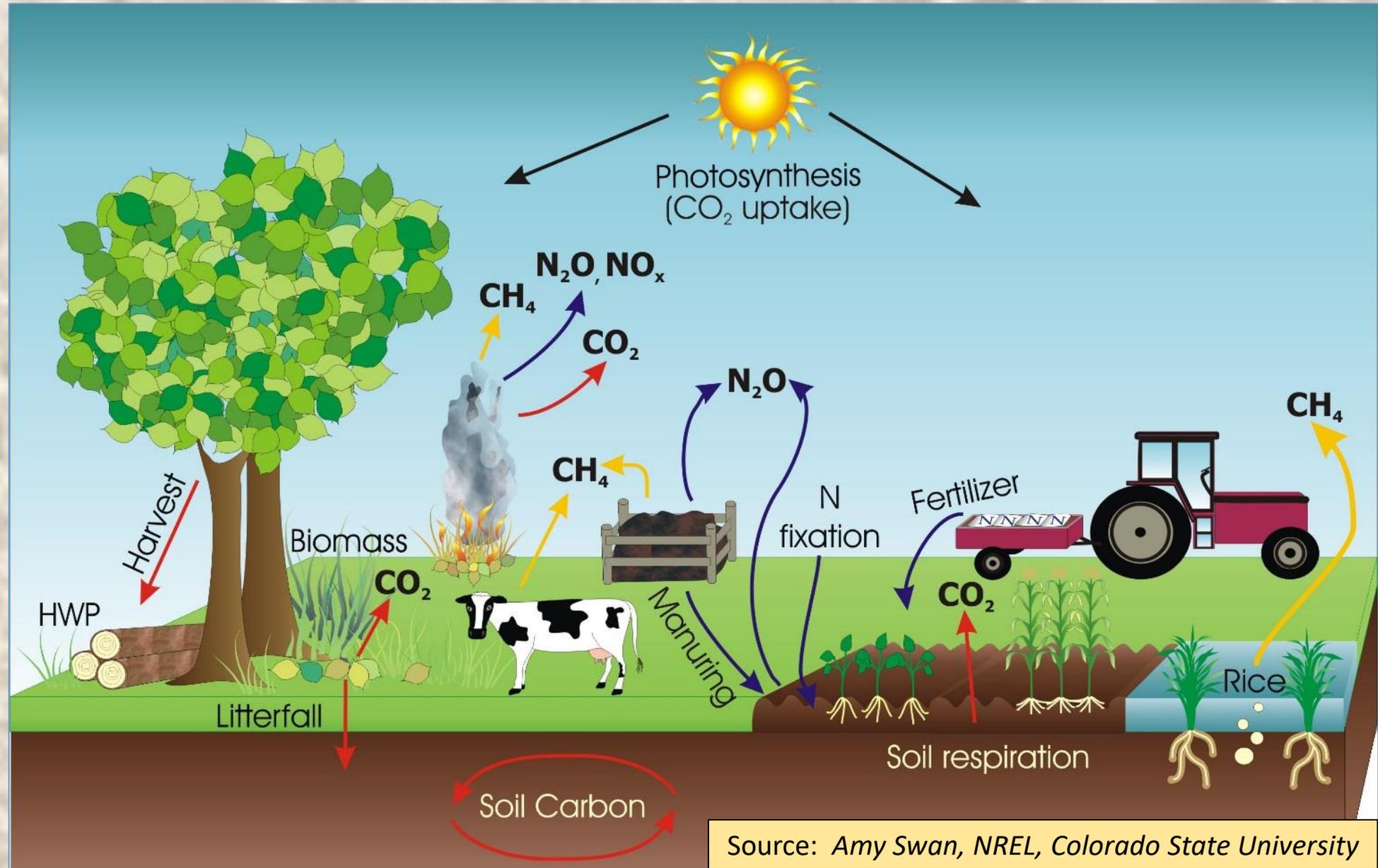
C Sequestration Potential: None  
GHG Reduction Potential: High

**Sources:**

Natural gas leaks, landfills,  
Livestock “burps”, growing rice,  
Livestock manure, composting

C Sequestration Potential: None  
GHG Reduction Potential: High

# Carbon, Nitrogen, & Farm Management



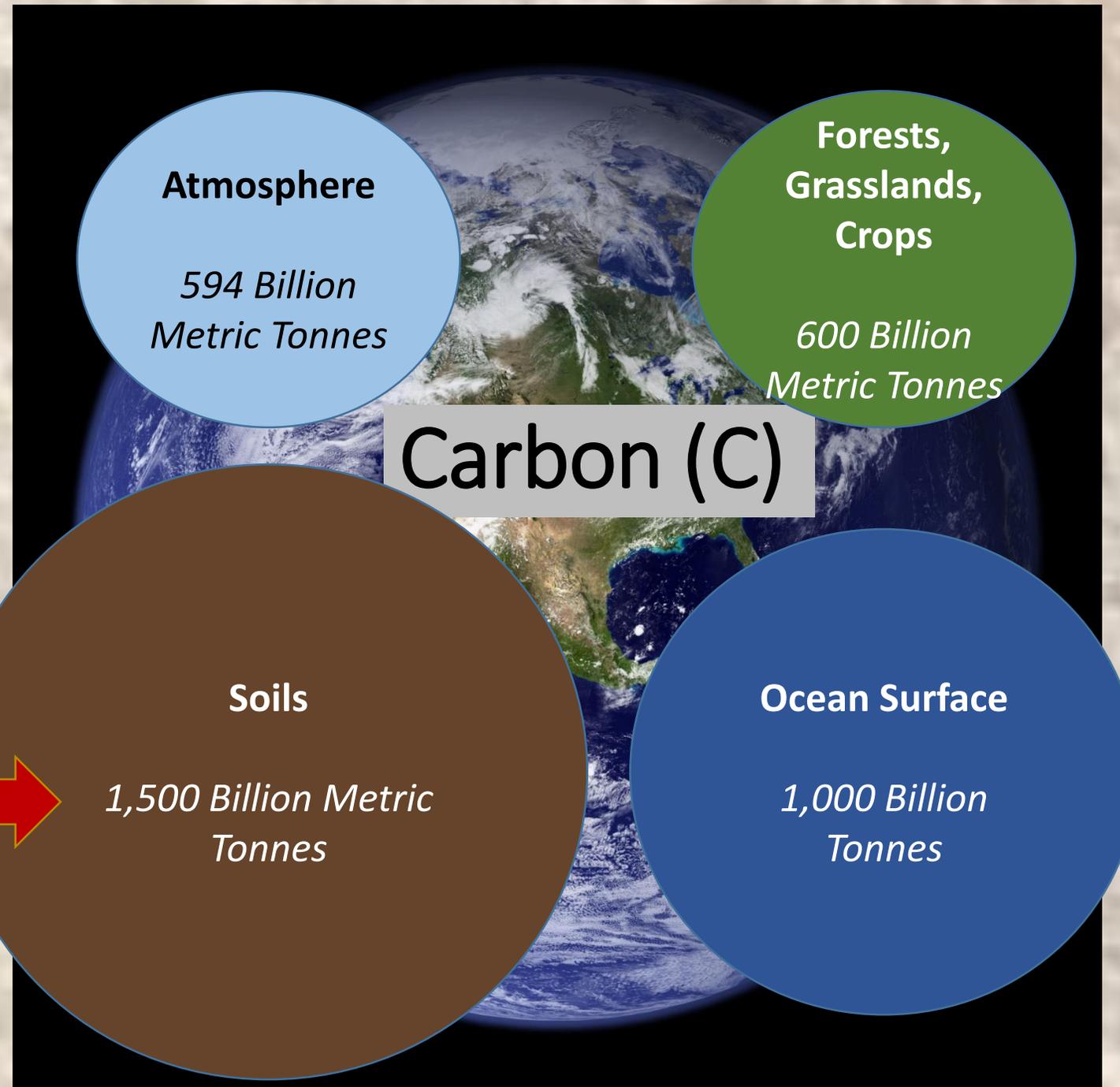
Source: Amy Swan, NREL, Colorado State University

# Managing the global carbon cycle

Some important things to keep in mind about carbon:

1. Carbon is the building block of life and it cycles through four major areas on the planet: the atmosphere, plants and trees, oceans and soils
2. Climate Change is happening because there is too much carbon in the atmosphere
3. By sequestering carbon in plants, trees and soils we can remove carbon from the atmosphere
4. Unlike more carbon in the atmosphere, more carbon in the soil and in vegetation benefits humans and agriculture
5. Carbon & nitrogen must be carefully managed together

The soils store a lot of carbon all ready and, because of historic degradation (through poor practices in modern agriculture) there is a lot of “room” in the soil. **In other words, the soil is a large potential carbon “sink”.**





**Tilling the Soil**



**Planting**



**Applying Fertilizer**



**Applying Pesticides**



**Harvest**



**Shipping to Millers**



**Landfill Waste  
30-40% of food**



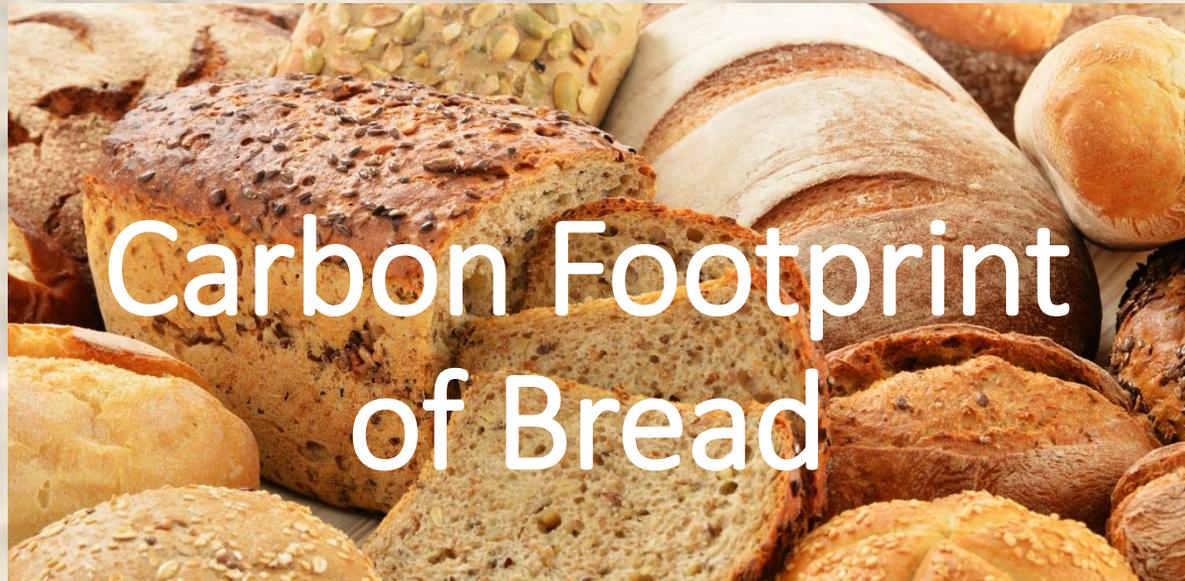
**Energy Use for Baking**



**Shipping to Bakers**



**Milling Flour**



# Carbon Footprint of Bread

Carbon Dioxide (CO<sub>2</sub>)

Tilling the  
Soil



*Releases carbon  
stored in soil  
organic matter, by  
increasing organic  
matter  
decomposition*

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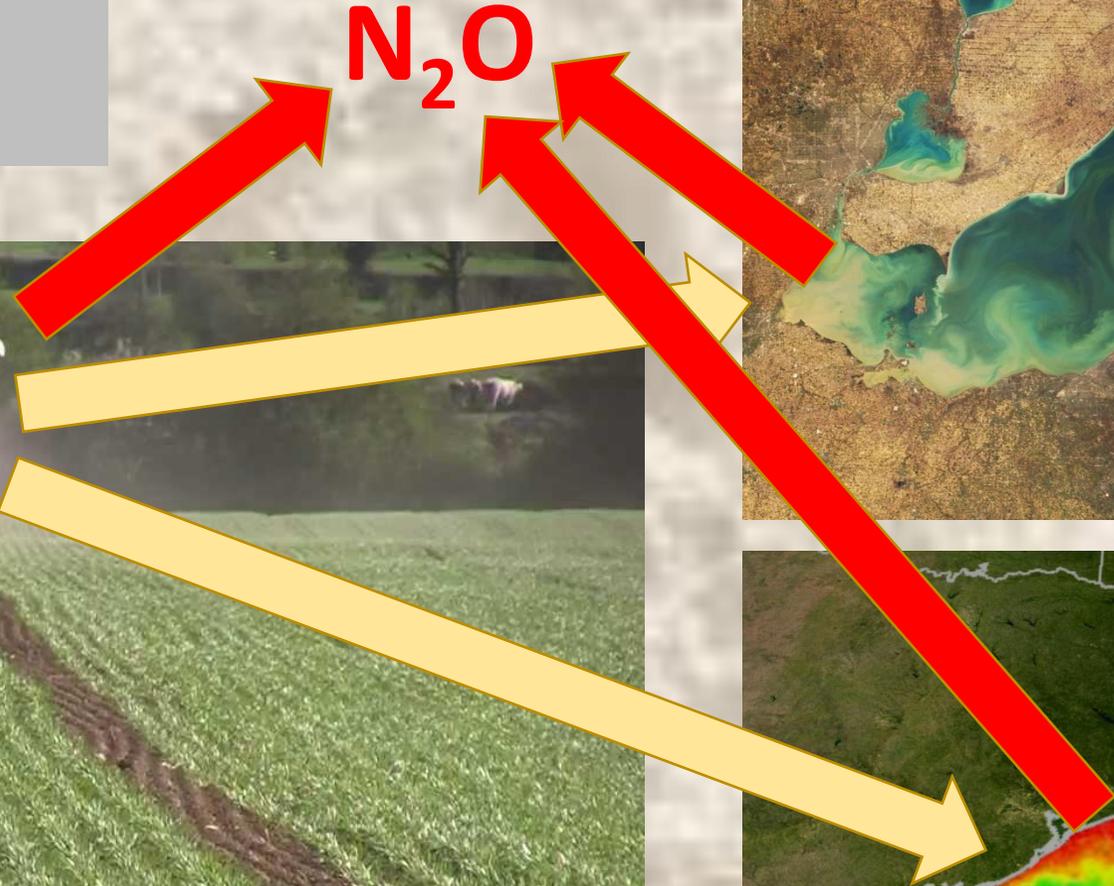
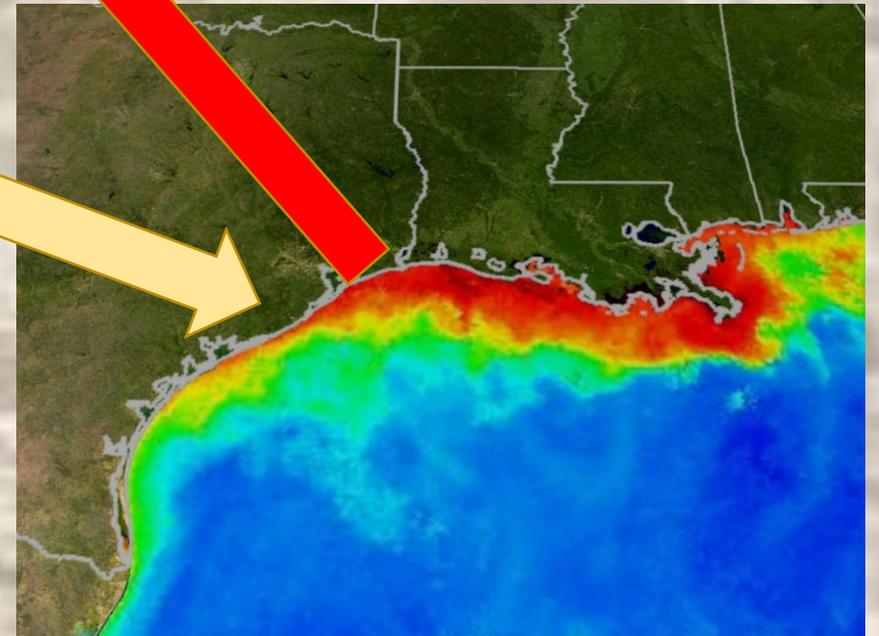
*Impacts soil  
health*

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*Makes soils more  
vulnerable to  
erosion*

Nitrous Oxide ( $N_2O$ )  
298X  $CO_2$

$N_2O$



Methane ( $\text{CH}_4$ )  
25 X  $\text{CO}_2$

Food and  
Yard Waste



**Opportunities for improving  
agricultural efficiency, carbon  
sequestration, and reducing GHGs**



Tilling the Soil



Landfill Waste  
30-40% of food



Baking



Shipping to Bakers



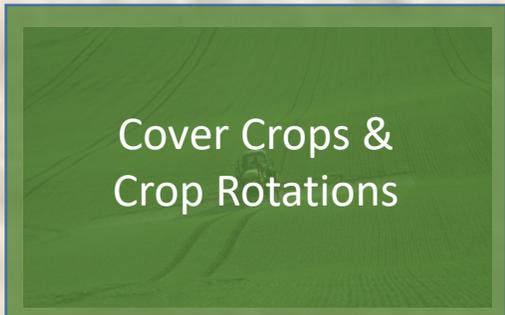
Plant Windbreaks & Shelterbelts

Planting



Apply Compost, Use Cover Crops, Crop Rotations, Slow-Release Fertilizers

Applying Fertilizer



Cover Crops & Crop Rotations

Applying Pesticides



Harvest



Shipping to Millers



Milling Flour

*Agriculture and Forestry are the most efficient methods known to remove carbon from the atmosphere and store it in the Earth*

COMPOST

Combined, these practices are known as “Carbon Farming”

# Carbon Farming practices include, (but are not limited to):

- Create compost and apply it to soils
- No tillage/minimum tillage
- Adding cover crops
- Windbreaks, shelterbelts, riparian restoration
- Managed grazing, integrated crop + livestock systems
- Reducing and carefully managing synthetic fertilizers

All of these practices reduce GHG's and improve soil health. They also...

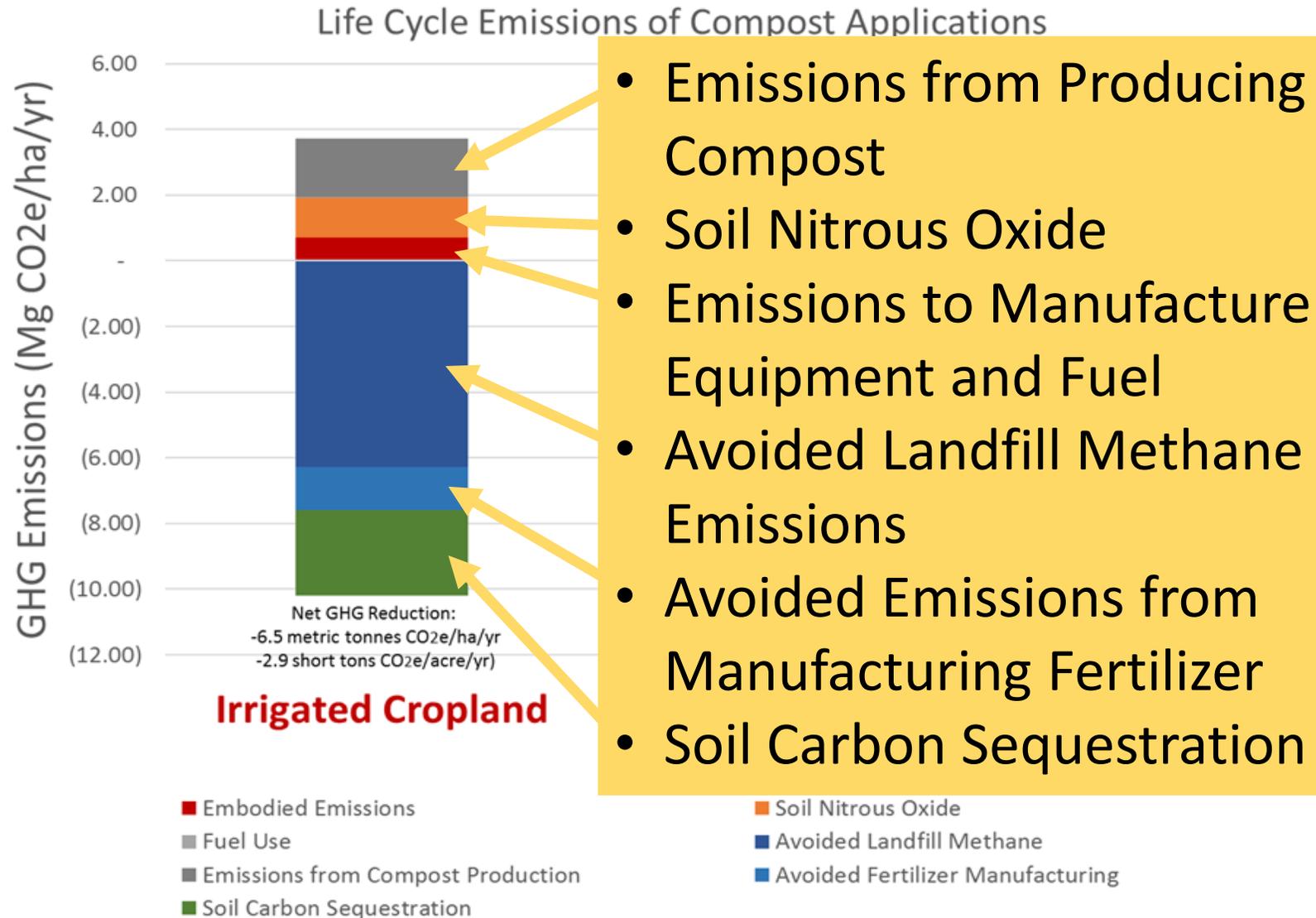
- Increase soil water holding capacity (helps farmers use less water)
- Increase water infiltration (prevents flooding)
- Improve nutrient cycling (increase nitrogen, phosphorus, potassium uptake by plants)

# The Role of Compost

Diverting food waste from landfills -> composting -> applying compost to agricultural soils has many climate benefits

- Avoids methane emissions from landfills (reduced trace gas emissions)
- Increases soil organic matter (carbon sequestration)
- Improves nutrient cycling (reduced trace gas emissions)
- Replaces manufactured fertilizers (fossil fuel emissions upstream)

# The Role of Compost



*There are multiple pieces when it comes to making agriculture a climate change solution, and making compost and applying it to soils has some of the greatest combined benefits of any practice.*

***Thank You***

*Mark Easter*

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