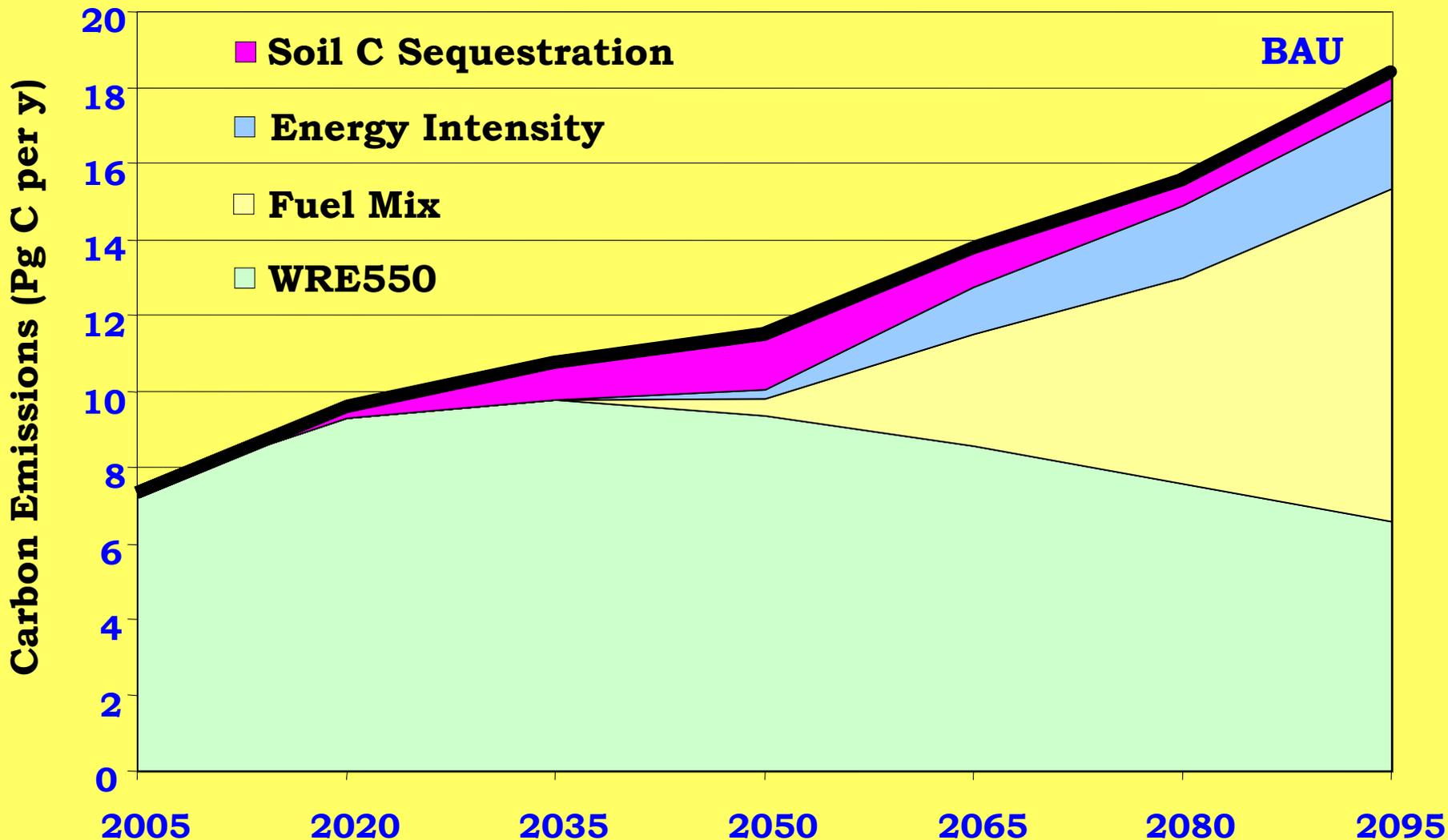


# **Soil Carbon Sequestration to Mitigate increases in Atmospheric CO<sub>2</sub>**

**John Kimble, Ron Follett, and  
Rattan Lal**

**USDA-NRCS, USDA-ARS, OSU**

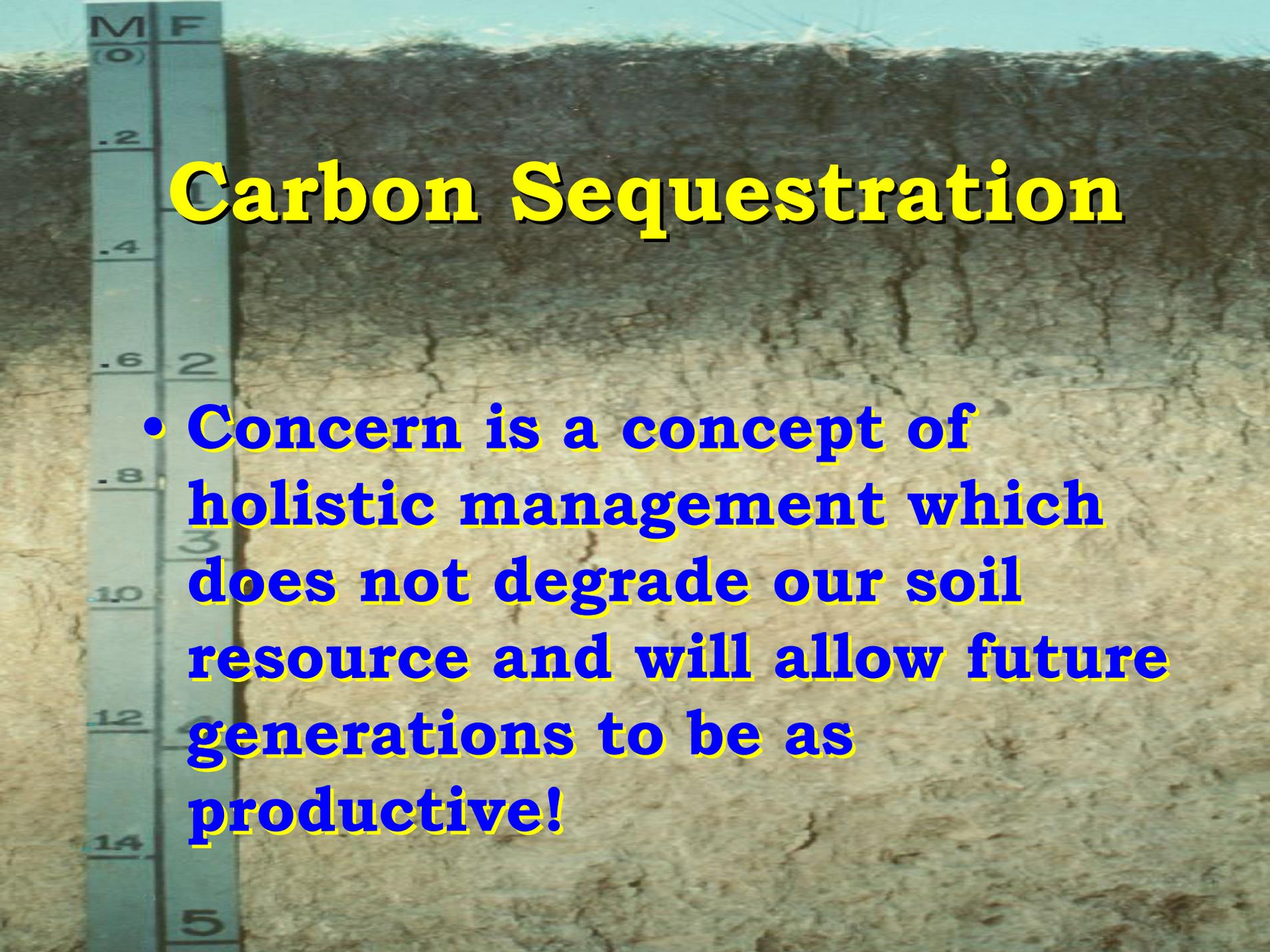
# Carbon Emissions Reductions: WRE 550 with Soil Carbon Sequestration Credits



From: Rosenberg, N.J., R.C. Izaurralde, and E.L. Malone (eds.). 1999. Carbon Sequestration in Soils: Science, Monitoring and Beyond. Battelle Press, Columbus, OH. 201 pp.

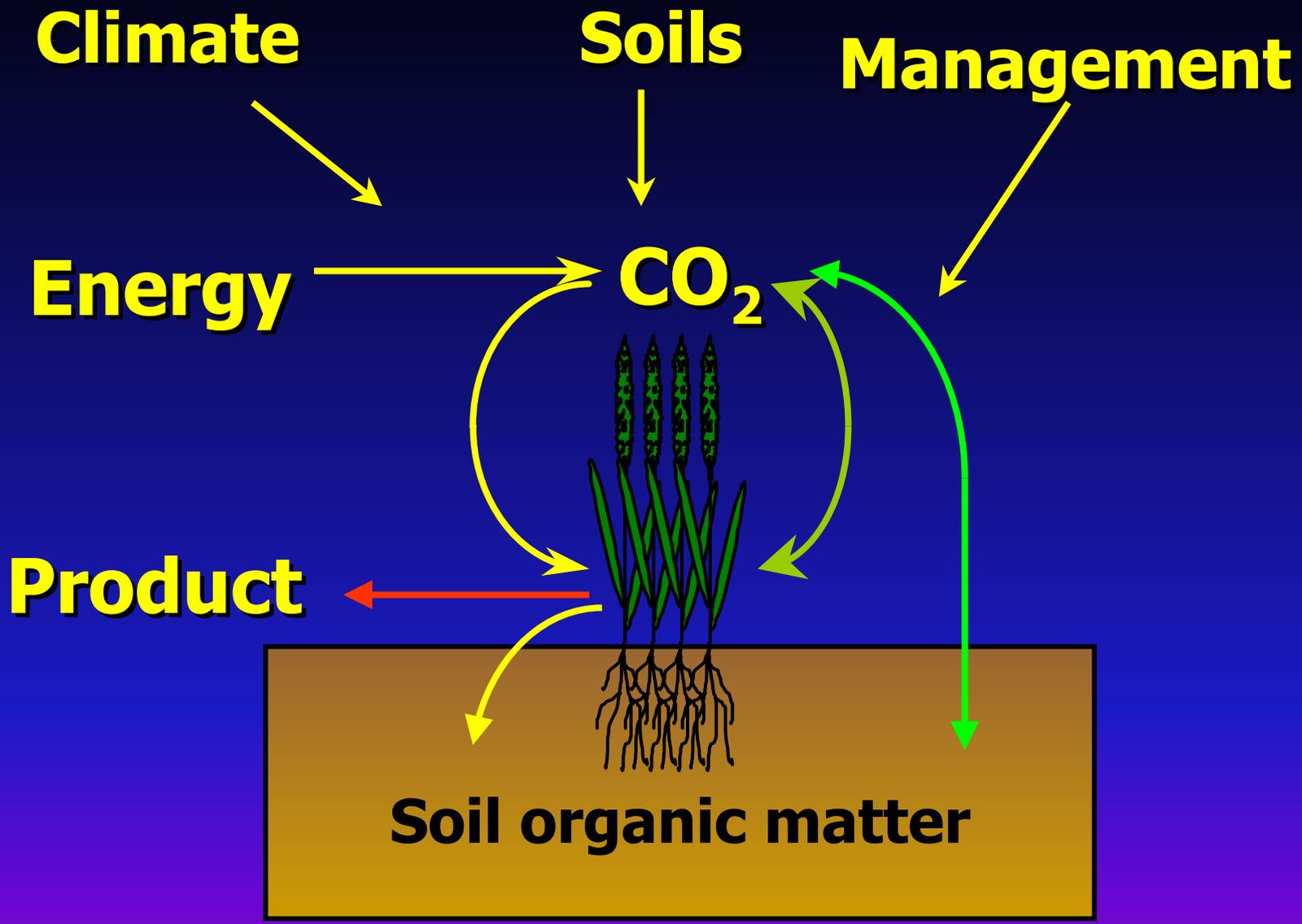
# **Carbon Sequestration**

- **Carbon sequestration refers to the storage of carbon in a stable solid form. It occurs through direct and indirect fixation of atmospheric CO<sub>2</sub>.**
- **The amount of sequestered carbon reflects the long-term balance between carbon uptake and release mechanisms.**
- **Many agronomic, forestry, and conservation practices, including, RMP's lead to a beneficial gain in carbon fixation in soils.**



# Carbon Sequestration

- **Concern is a concept of holistic management which does not degrade our soil resource and will allow future generations to be as productive!**





# Soil Pools

- **Soils are the largest terrestrial pool about 1500 Pg SOC and 700 Pg SIC.**
- **Soils in North America about 22% or 346.7 Pg.**
- **Lost 35-50 percent by clearing of forests, plowing the grasslands, over grazing and poor management of grazing lands.**

# SOIL ORGANIC CARBON

- *Linked to Food Security*
- *Poverty Reduction*
- *Agriculture Sustainability*
- *Improve Nitrogen Use Efficiency*
- *Improving Degraded Lands*



# **Some Soil Carbon Perceptions**

- **Land (soil) is a resilient and inexhaustible!**
- **Soil and dirt are synonymous!**
- **Agricultural Science as it pertains to SOC is a work in progress!**
- **Soil C cannot be measured!**

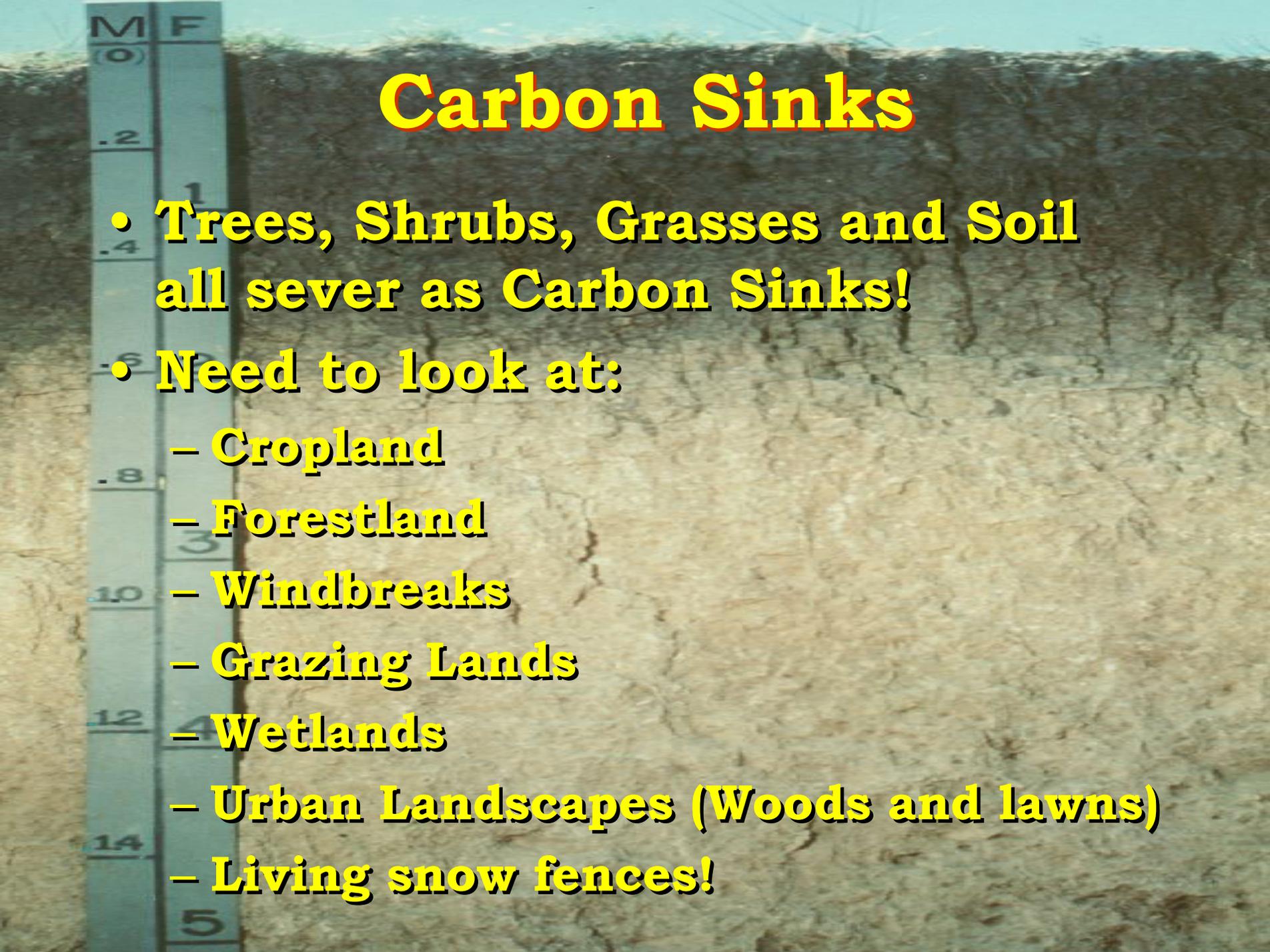
# **This is Carbon Sequestration**



- **Tillage equipment BOOT HILL!**



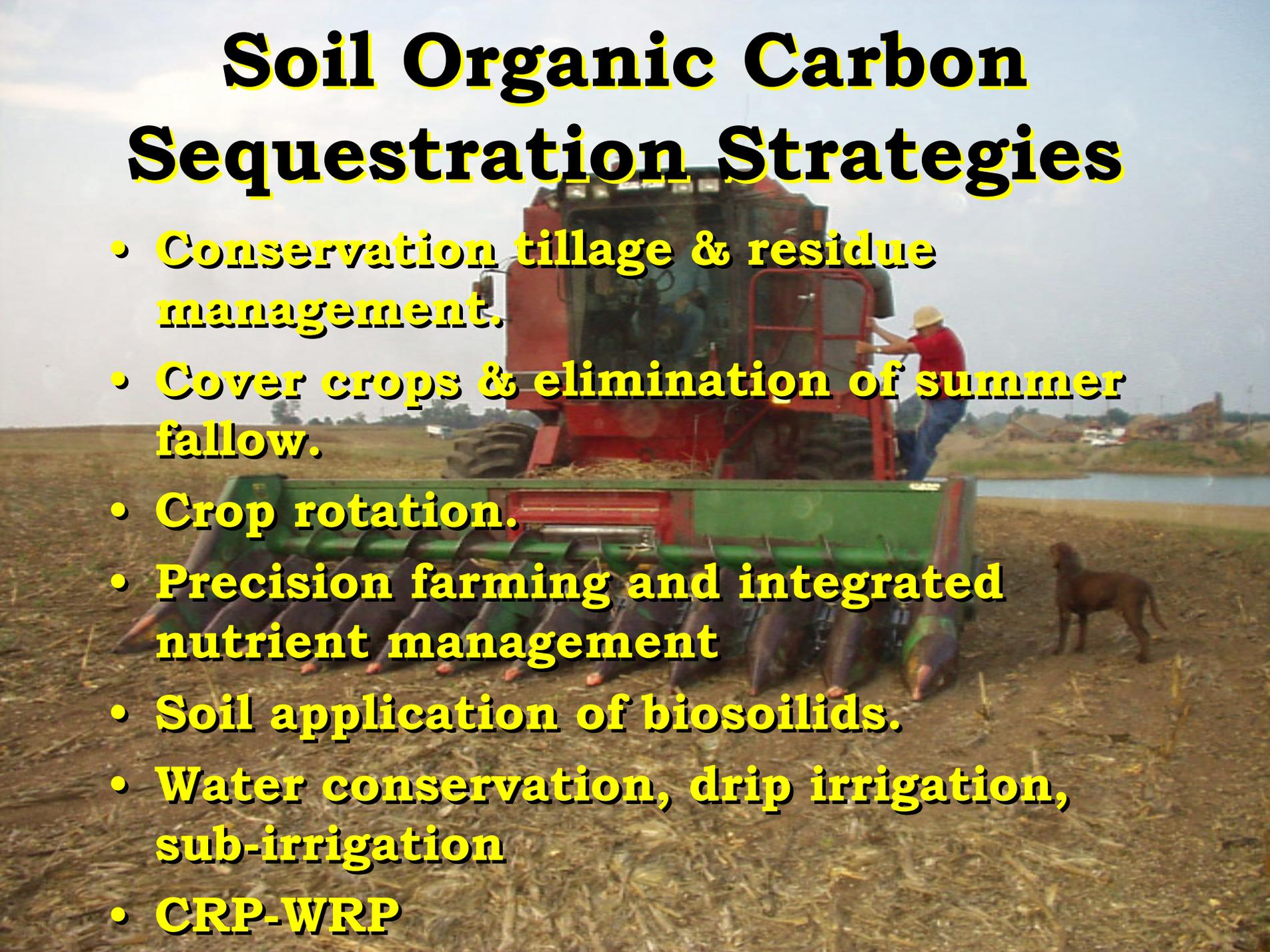
# **Better Fertilizer Management**



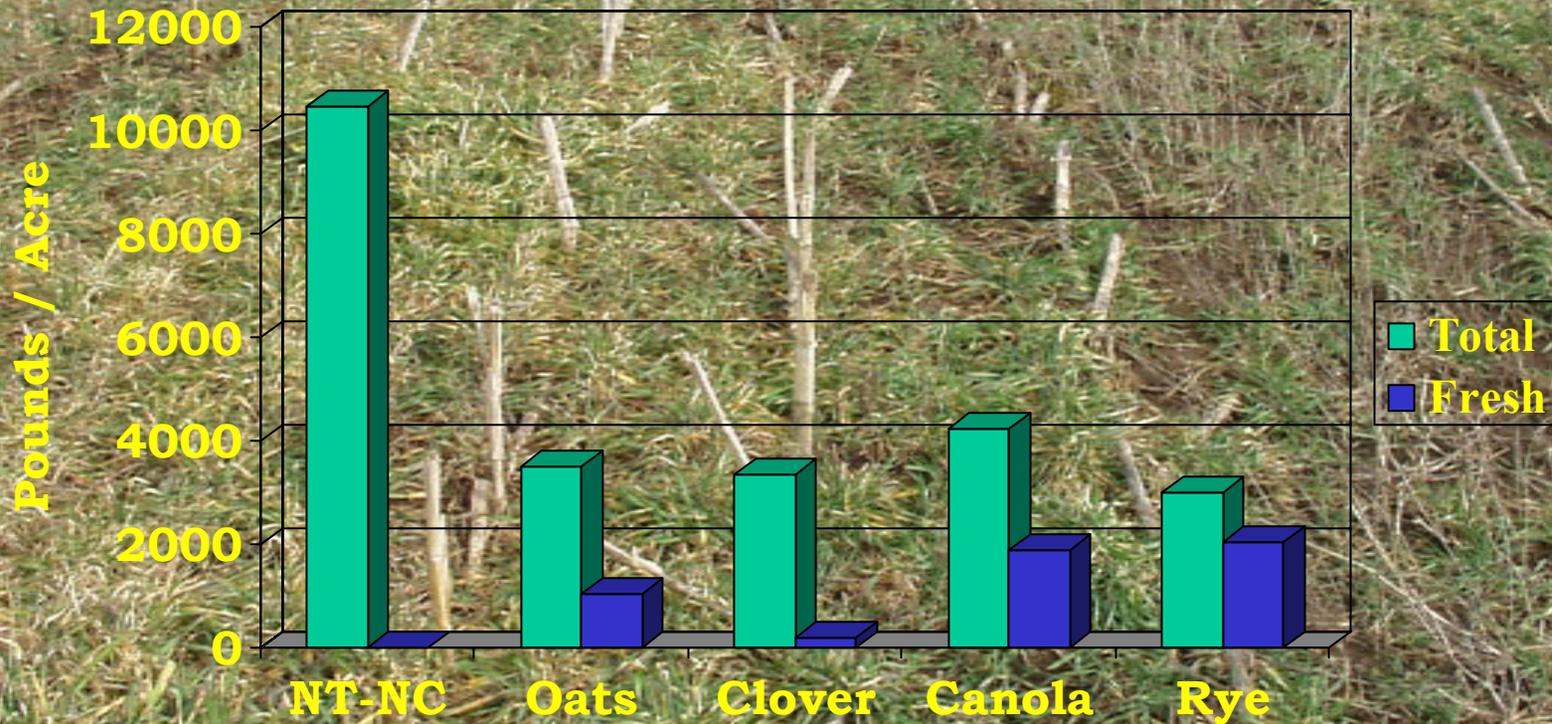
# **Carbon Sinks**

- **Trees, Shrubs, Grasses and Soil all sever as Carbon Sinks!**
- **Need to look at:**
  - **Cropland**
  - **Forestland**
  - **Windbreaks**
  - **Grazing Lands**
  - **Wetlands**
  - **Urban Landscapes (Woods and lawns)**
  - **Living snow fences!**

# **Soil Organic Carbon Sequestration Strategies**

- **Conservation tillage & residue management.**
  - **Cover crops & elimination of summer fallow.**
  - **Crop rotation.**
  - **Precision farming and integrated nutrient management**
  - **Soil application of biosoilids.**
  - **Water conservation, drip irrigation, sub-irrigation**
  - **CRP-WRP**
- 
- A red combine harvester is shown in a field, with a farmer in a red shirt and a hat standing on top of it. The harvester is moving across a field of dry, harvested crops. In the foreground, a brown dog is standing on the ground. The background shows a body of water and some distant buildings under a clear sky.

# Biomass in lb/a for selected crops



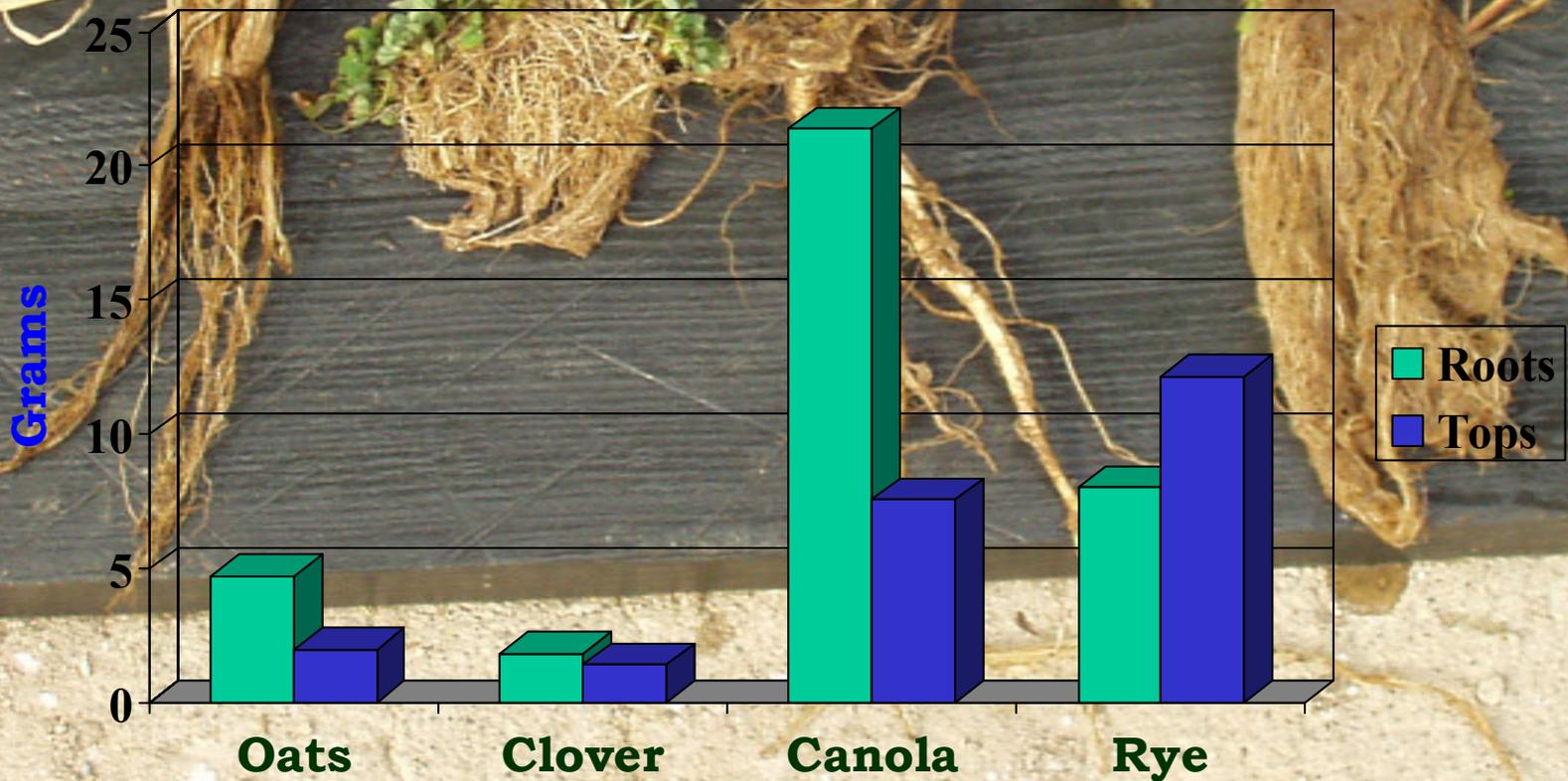
# Cover Crops

- **Improve the soil!**
- **Allows more biomass to be removed as a bio-energy source with out environmental degradation.**

# Corn Stubble Residue



# Single Plant Biomass for Cover Crops



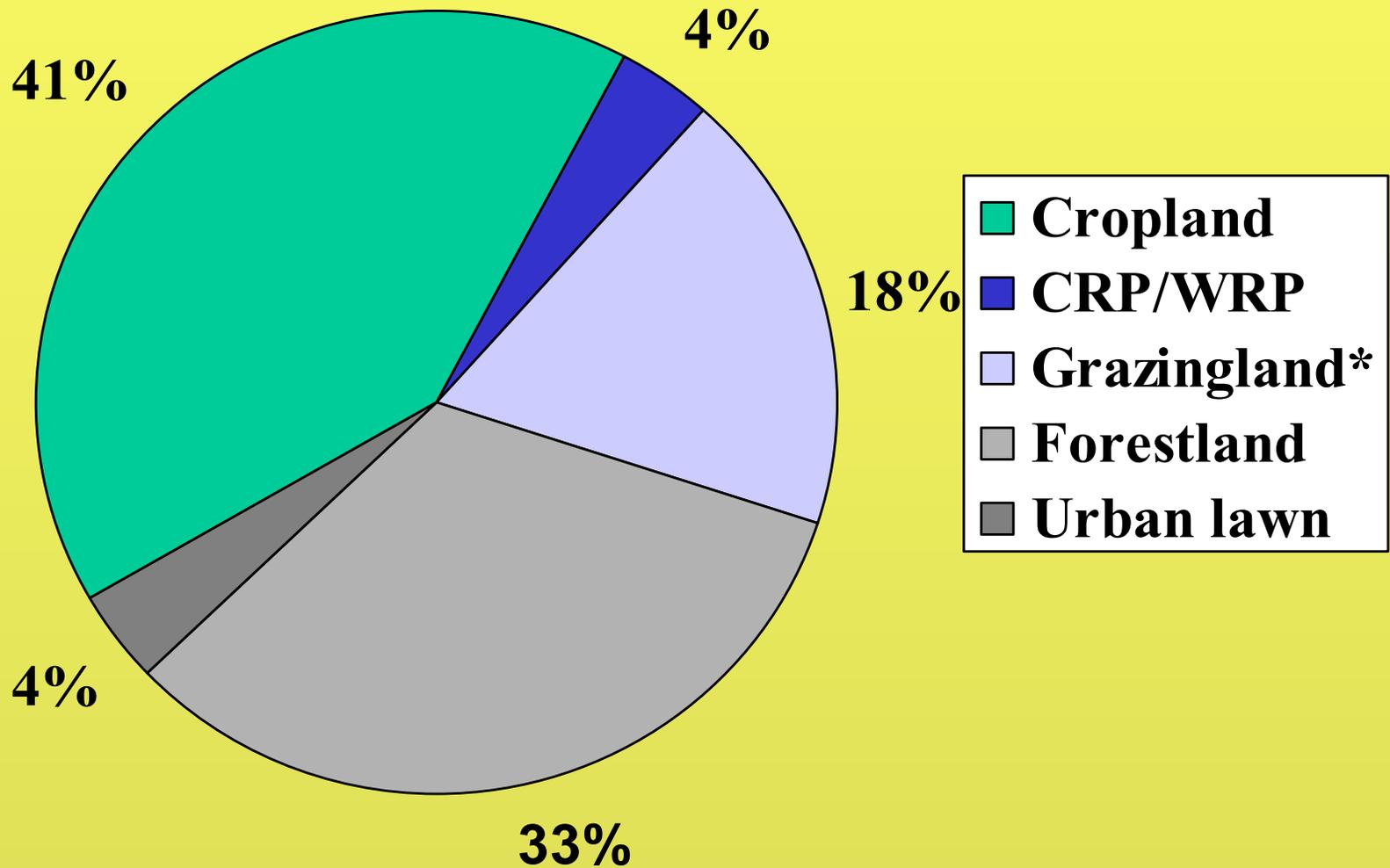
# Degraded Soils

- **40 % of world soils degraded!**
- **We mine the soils for nutrients.**
- **We replace mineral elements with commercial fertilizers but we do not replace **SOIL ORGANIC CARBON**.**
- **BUT WE CAN WITH THE CORRECT MANAGEMENT!**

# **Why IS U.S.Agriculture Important**

- **Potential of Carbon Sequestration in U.S. Agricultural Soils:**
  - **Cropland 69-195 MMTC/yr.**
  - **Grazing land 30-110 MMTC/yr.**
  - **Forest Land 48 to 185 MMTC/yr.**
- **Total = 318 MMTC/yr.**
  - **Or 17 % of total US emission (CE 1840) in 1999 MMTC/yr.**

# Soil organic C sequestration potential of different US land Categories (% of 318 MMT C/yr) \*\*



# Environmental value of SOC

## Direct Benefits

- **Sequesters atmospheric carbon**
- **Reduces emissions of particulate matter into the atmosphere,**
- **Improves water quality.**

## Indirect Effects

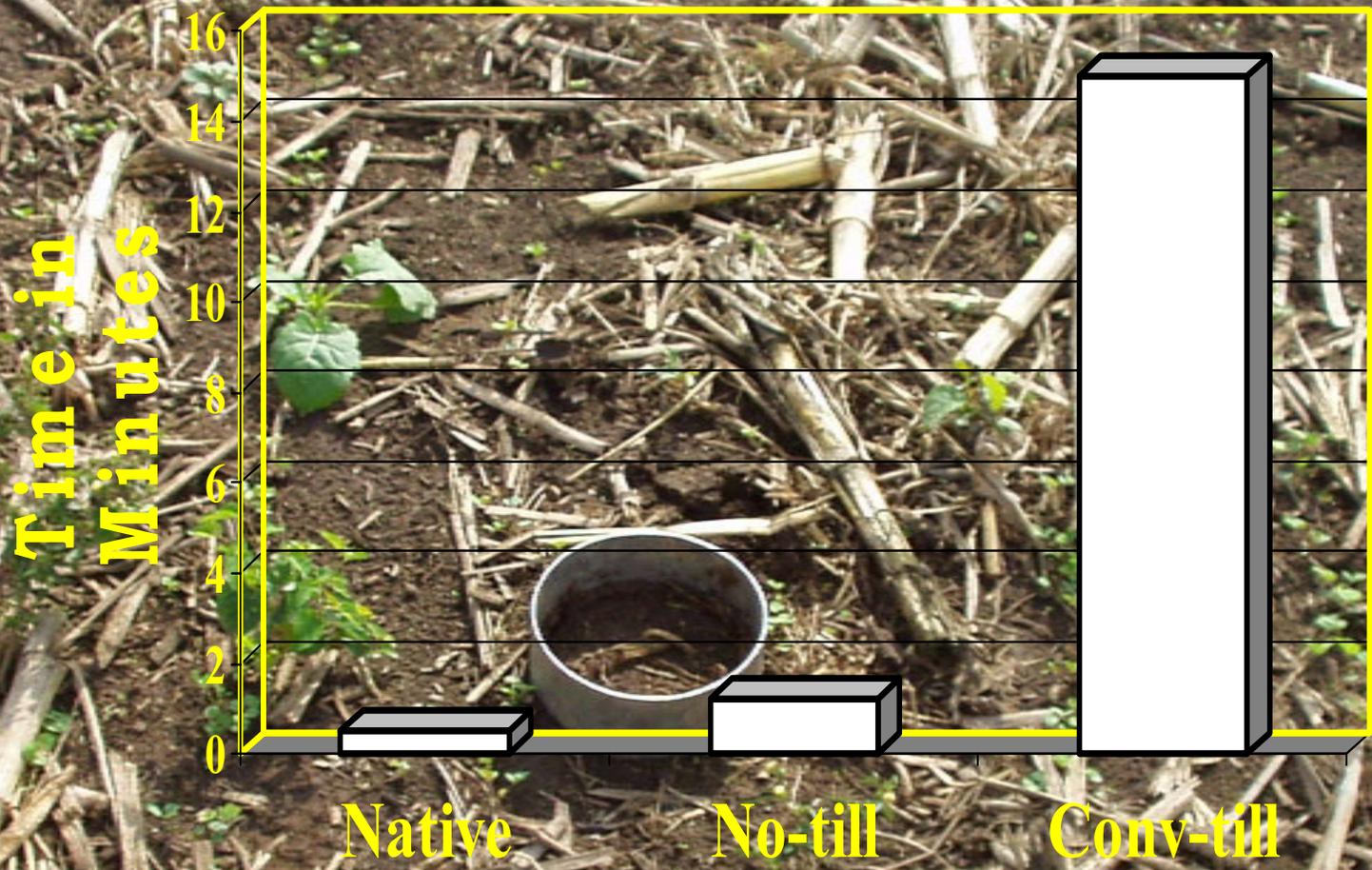
- **Decreases risks of sediment transport.**
- **Reduces dissolved load in water.**
- **Decreases leaching of chemicals in ground water.**
- **Reduces eutrophication and contamination of water.**

**Conventional tillage, South  
Central Ohio, with 2 inches  
of rain over night.**



**No-till, South Central  
Ohio, with 2 inches of rain  
over night.**





**Time for 1 inch of water to infiltrate into the soil, South Central Ohio.**

# **No-till soils Central IL**

- **1980 OM 2.1 % 1995 OM 3.4%**
- **Nitrogen use is now 50-60 % of recommended based on yield goal. Or about 85 lbs.. less per acre than would be applied to conventionally tilled field.**

# **No-Till Spring Wheat and Barley Idaho**

- **Farm Sampling Data**
  - **Start of no-till, 1985**
    - **Organic Matter 1.25 %**
  
  - **After 15 years no till**
    - **Organic Matter is 2.6 to 3.25 %**

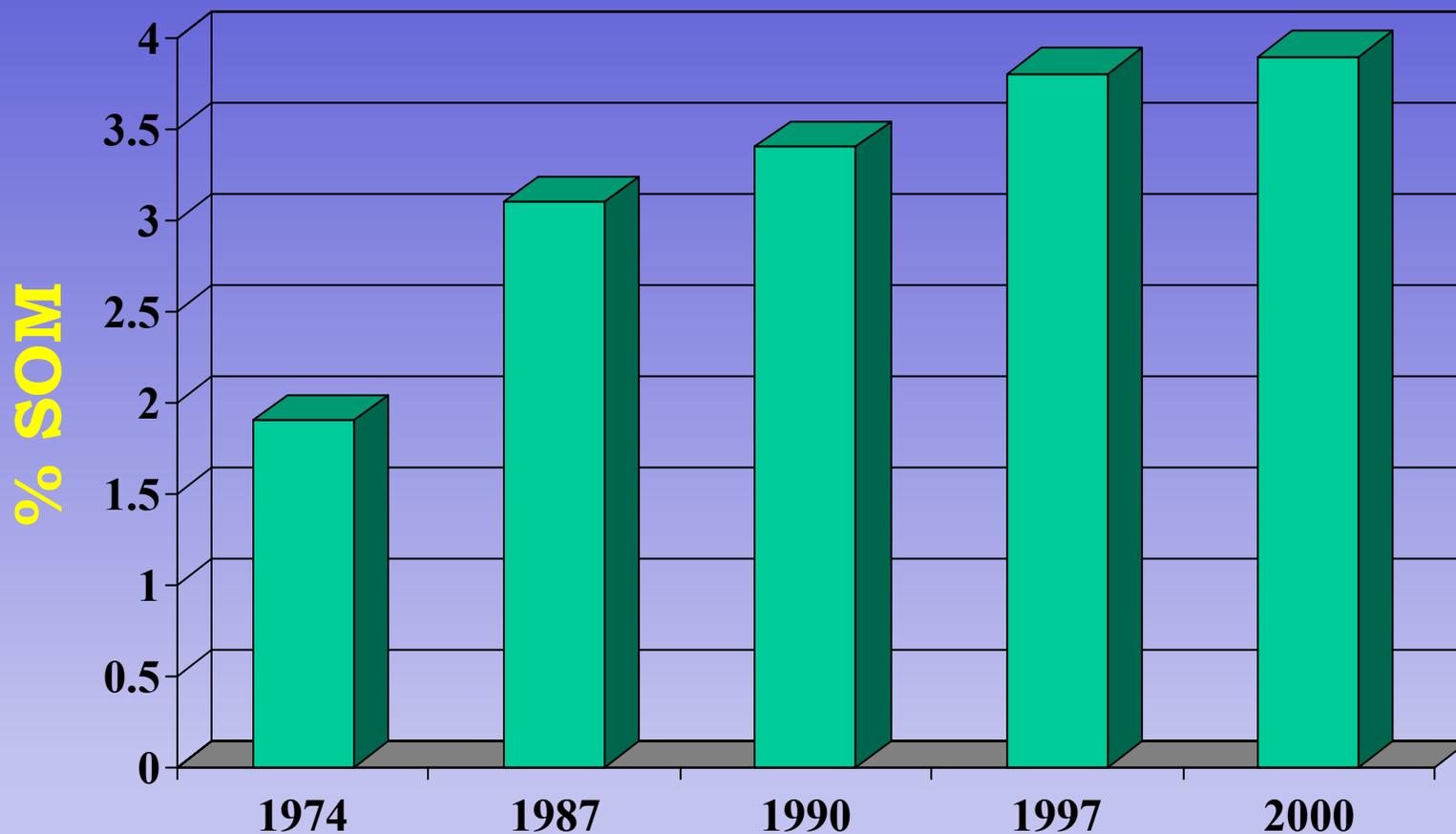
# Renwood Farm Data by done by Innovative Cropping Systems Group in VA.

## 7.5 % slope and 5 year storm event

Treatment	Runoff Cu.Ft/Ac	Sediment lb/ac	Nitrogen lb/ac	Phosphorus lb/ac
Plowed +fert	6506	3176.3	9.17	3.65
No-till + Litter	1547	30.5	0.54	0.38
No-till	2014	18.5	0.49	0.27
No-till+ Fert subsoil	1537	5.4	0.47	0.26
No-till +fert	1373	16.0	0.46	0.25

	-----%			
Average Reduction By no-till	74.9	98.2	94.7	92.0

# Changes in SOM over time under a complete no-till system in Central Illinois from Kinsella, 2002



# **A Role for Agriculture**

**Agriculture Can be a Solution to Environmental Issues in General**

**Agriculture Can Help Mitigate the Greenhouse Effect**

**Enhanced Soil, Water & Air Quality and Agricultural Sustainability Result from Increased C Sequestration**

# **Win-Win or No-Regrets Strategy**

- **The soil and the producer benefit by increasing soil organic carbon through..**
  - **Improved soil tilth**
  - **Improved water holding capacity**
  - **Improved drainage**
  - **Reduced soil erosion**
  - **Improved water and air quality**
  - **Long-term sustainability of production.**
- **Society benefits through...**
  - **Reduced levels of atmospheric carbon**
  - **Reduced soil erosion**
  - **Improved water and air quality**
  - **Increased food security**

