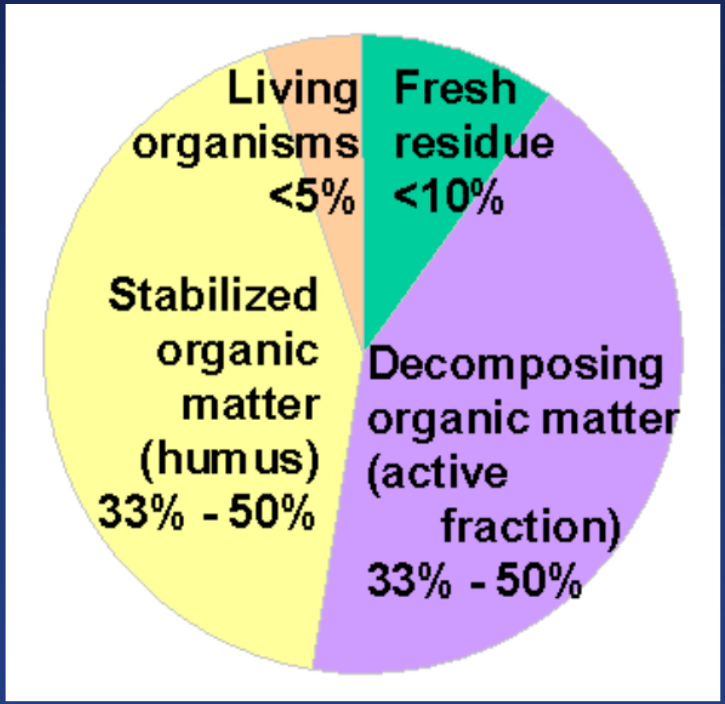
United States Department of Agriculture
Natural Resources Conservation Service

USDA NRCS

# Improving Soil Health

# Functions of Organic Matter in Soil:

- Stores Nutrients
- Feeds soil organisms which in turn decompose organic material and release nutrients
- Holds soil moisture
- Developed by combining Carbon, Oxygen, Nitrogen, and other nutrients.




**Major soil organic matter components (Source: The Soil Food Web, USDA-NRCS).**

# To maximize Soil Health, maximize the soils Organic Matter Content

- **Increased Organic Matter Content =**
  - Increased water holding capacity
  - Increased biological activity
  - Increased Fertility

# Soil Organic Matter and Available Water Capacity

## Inches of Water/One Foot of Soil

| Percent Soil OM | Sand | Silt Loam | Silty Clay Loam |
|---|---|---|---|
| 1 | 1.0 | 1.9 | 1.4 |
| 2 | 1.4 | 2.4 | 1.8 |
| 3 | 1.7 | 2.9 | 2.2 |
| 4 | 2.1 | 3.5 | 2.6 |
| 5 | 2.5 | 4.0 | 3.0 |

Berman Hudson
Journal of Soil and Water Conservation 49(2) 189-194
March – April 1994
Summarized by:
Dr. Mark Liebig, ARS, Mandan, ND
Hal Weiser, Soil Scientist, NRCS, Bismarck, ND

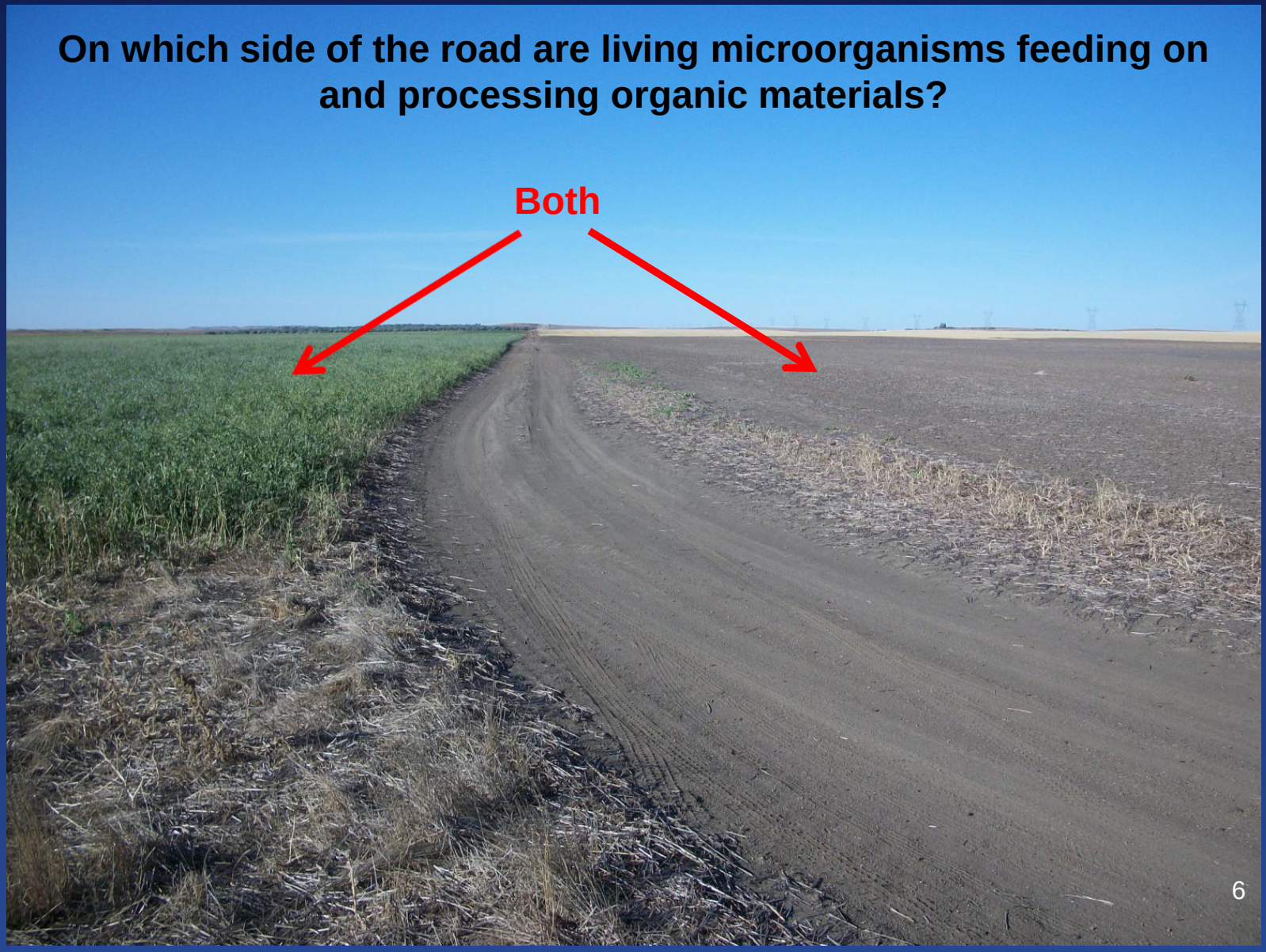
# Management effects on Organic Matter Content

**Table 2. Soil C trends in monoculture wheat at the Magruder Plots, Oklahoma State University (Webb et al., 1980).**

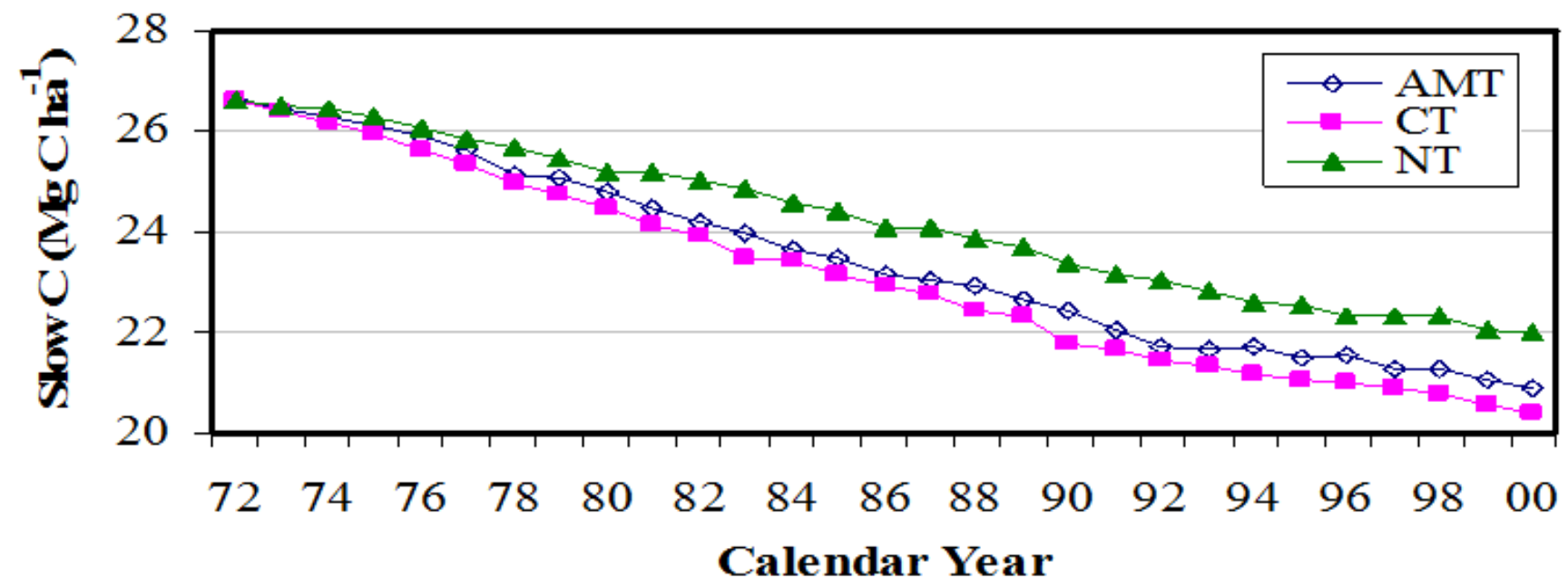
| Treatment | 1892 Original Soil C% | 1927 Soil C% | 1979 Soil C% |
|---|---|---|---|
| Unfertilized wheat | 2.0 | 1.0 | 0.64 |
| Wheat with manure applications | 2.0 | 1.6 | 0.87 |

**Is this Sustainable?**

**On which side of the road are living microorganisms feeding on and processing organic materials?**



# No-Till is beneficial but is it enough?




Temporal trends in soil labile C and slow C pools in association with conventional tillage (CT), no-till (NT), and actual tillage management (ATM) within sample blocks where cropped area was greater than 10% of the block area in the Northwest Great Plains ecoregion.

Tan *et al. Carbon Balance and Management* 2007 **2**:7 doi:10.1186/1750-0680-2-7
Download authors' original image

# Living Roots

- Feed the soil biology-

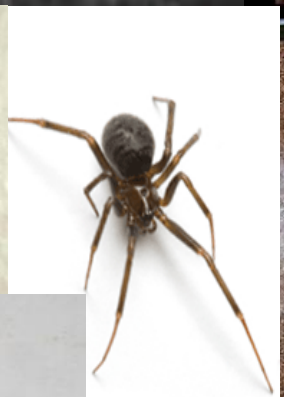
# Root Exudates

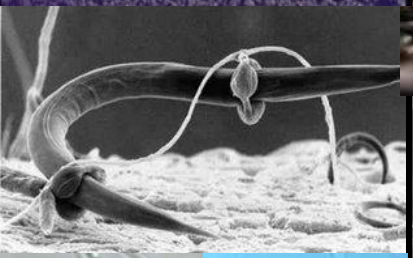
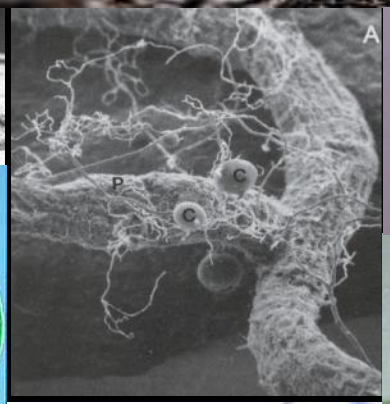
- Amino Acids
- Organic Acids
- Sugars
- Vitamins
- Purines/Nucleosides
- Enzymes
- Inorganic Ions and Gaseous Molecules

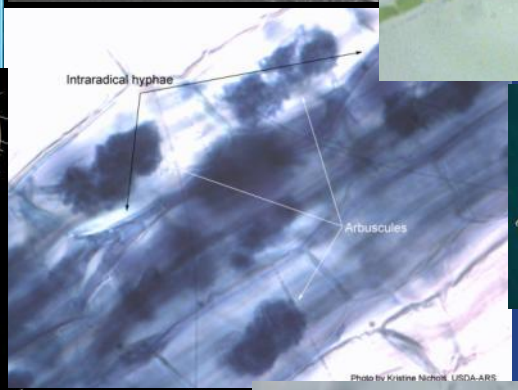
**TABLE 1.2**
**Root Products: A Classification**

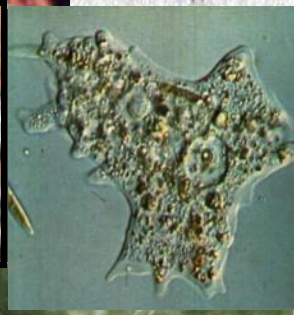
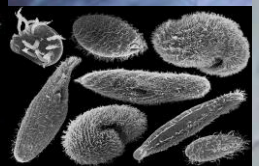
| Product | Compound |
|---|---|
| Root exudates | |
| Diffusates | Sugars, organic acids/anions, amino acids, water, inorganic ions, oxygen, riboflavin etc. |
| Excretions | Carbon dioxide, bicarbonate ions, protons, electrons, ethylene, etc. |
| Secretions | Mucilage, protons, electrons, enzymes, siderophores, allelochemicals, etc. |
| Border cells | Root cap cells separated from the root apex |
| Root debris | Cell contents, lysates, etc. |

*Source:* From Uren, N.C. and Reisenauer, H.M., *Adv. Plant Nutr.*, 3, 79, 1988. With permission.



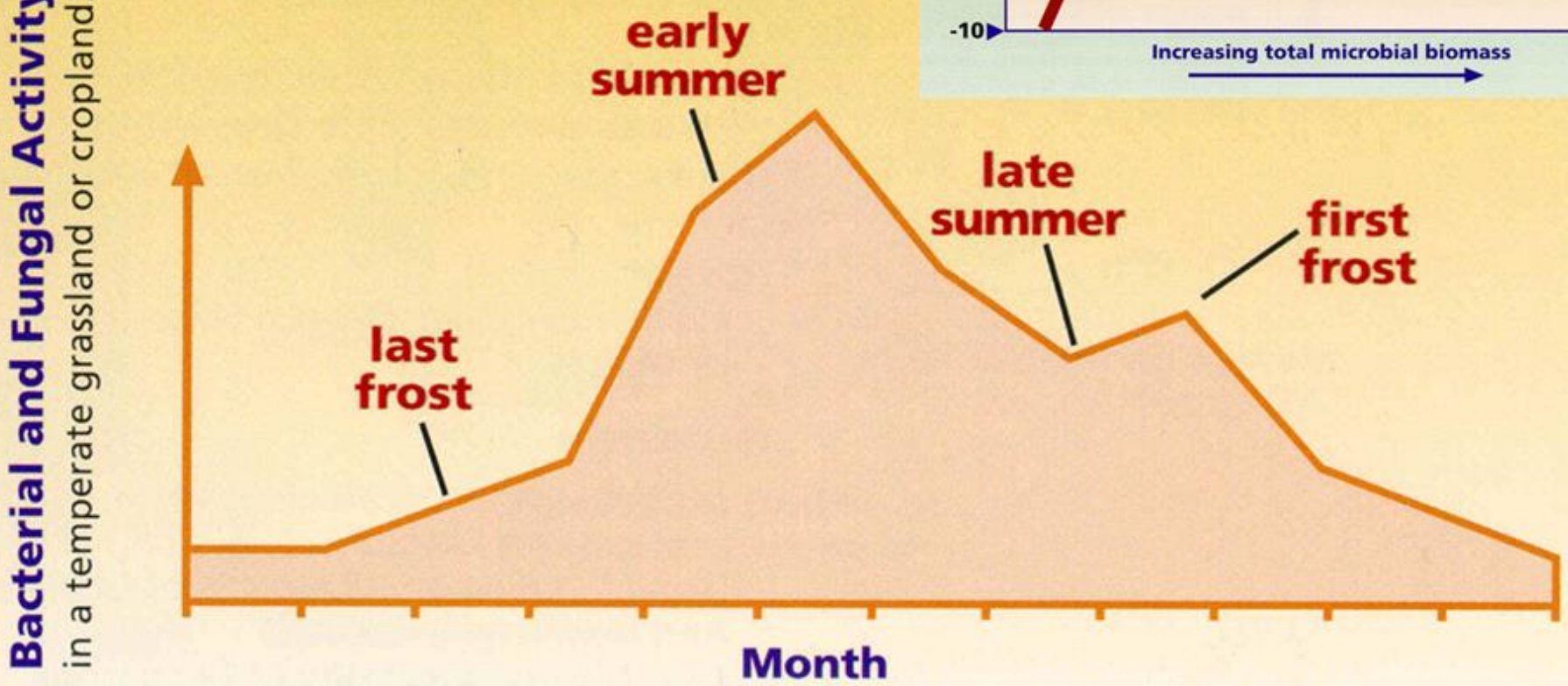

Intraradical hyphae
Arbuscules

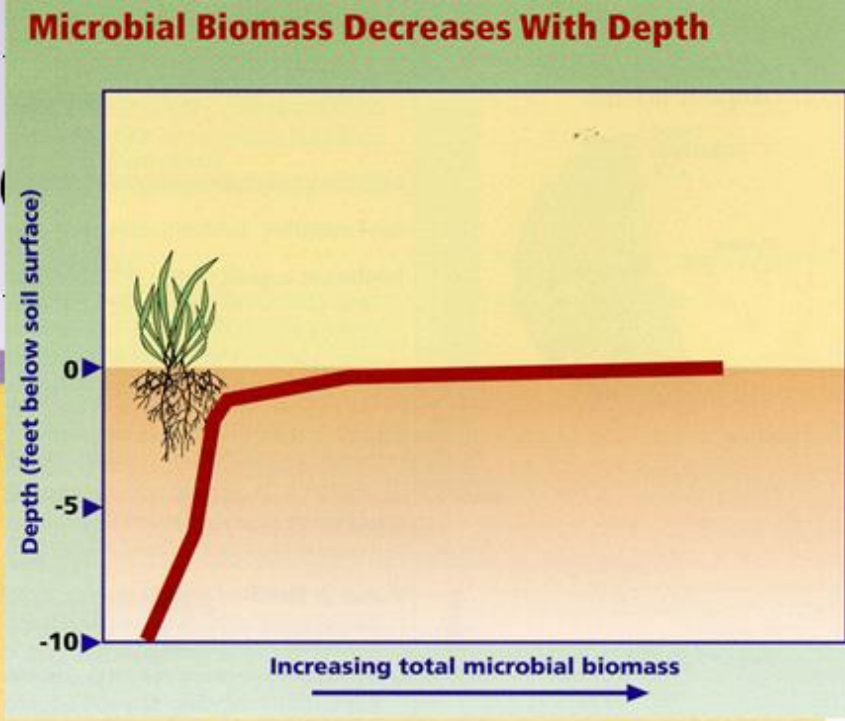
Knowledge for Life

Click to ad

## Seasonal Microbial Activity




USDA Natural Resources Conservation Service



# Keep the Soil Covered

- Armor- residue to protect the soil
  - Reduces erosion
  - Cools soil temperatures
  - Manages moisture
  - Weed Suppression

# Cools soil temperature

Soil temp on soil with residue cover. 88F

August 10, 2011
Air temp this afternoon was about 85F

Soil temp on bare soil. 98F

Soil temp on soil with residue cover and under sunflower canopy. 78F

**140° F** — **Soil bacteria die**

**130° F** — **100% moisture lost through evaporation & transpiration**

**100° F** — **15% moisture is used for growth**
**85% moisture lost through evaporation & transpiration**

**70° F** — **100% moisture is used for growth**

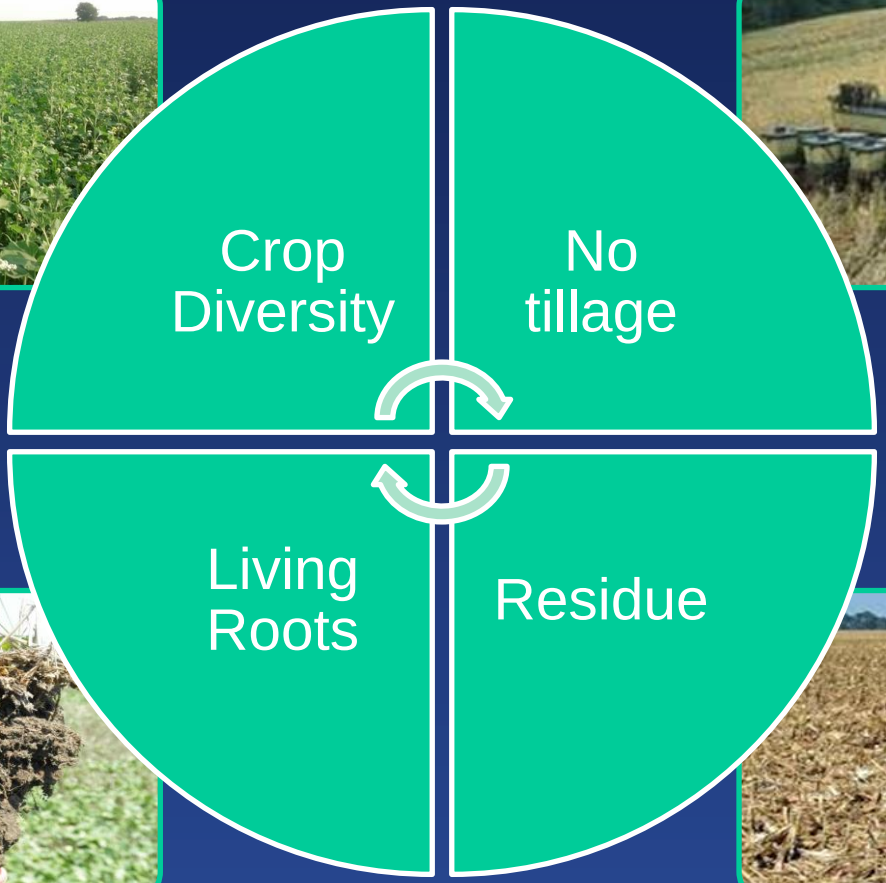
J.J. McEntre, USDA SCS, Kerrville, TX, 1956

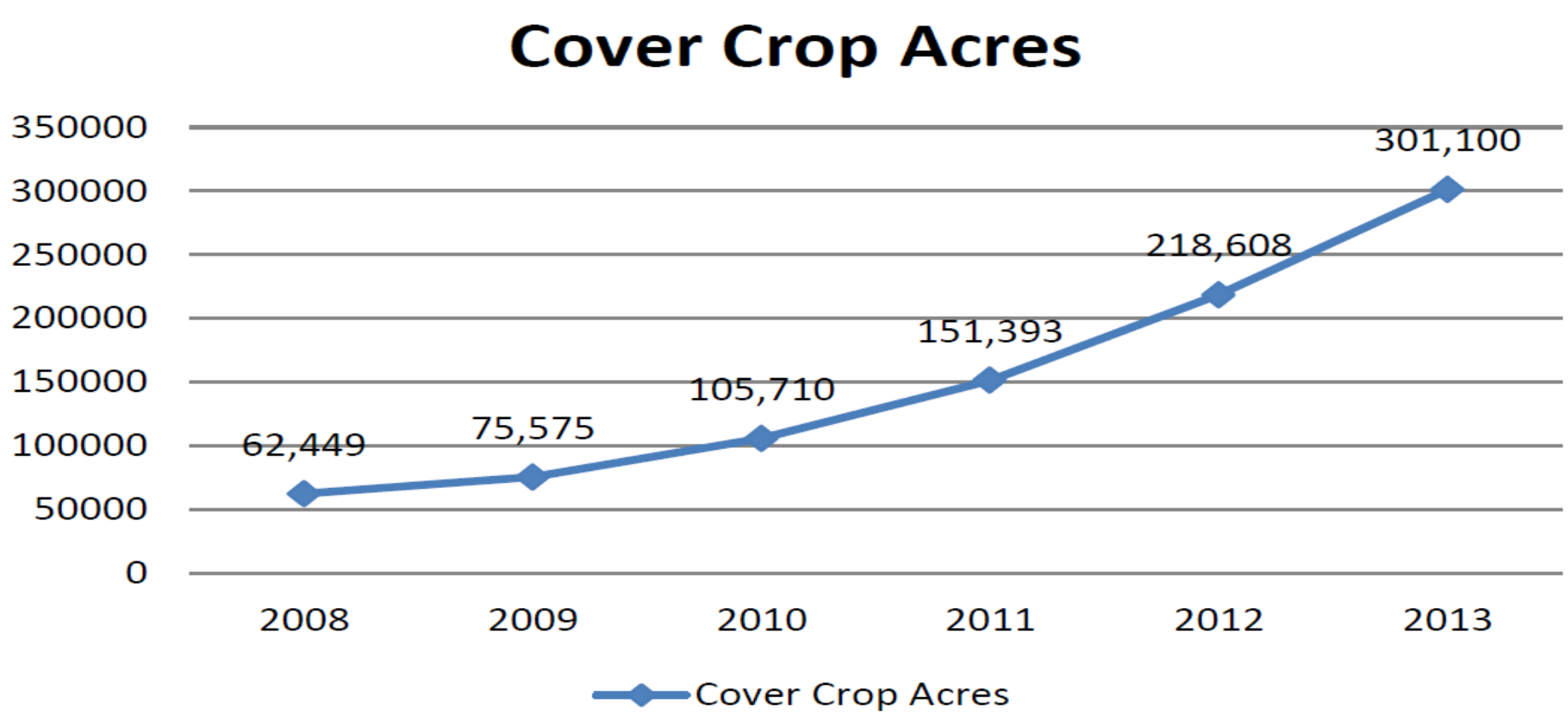
# Typical Numbers of Soil Organisms in Healthy Ecosystems

| | Ag Land | Prairie | Forest |
|---|---|---|---|
| | Organisms per gram (teaspoon) of soil | | |
| Bacteria | 100 mil. -1 bil. | 100 mil. -1 bil. | 100 mil. -1 bil. |
| Fungi | Several yards | 10s – 100's of yds | 1-40 miles (in conifers) |
| Protozoa | 1000's | 1000's | 100,000's |
| Nematodes | 10-20 | 10's – 100's | 100's |
| | Organisms per square foot | | |
| Arthropods | < 100 | 500-2000 | 10,000-25,000 |
| Earthworms | 5-30 | 10-50 | 10-50 (0 in conifers) |

USDA Natural Resources Conservation Service

# All 4 principles play a key role in the process






| Year | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|
| Total Acres | *62,449* | *75,575* | *105,710* | *151,393* | *218,608* | *301,100* |
| Average Acreage per Respondent | *116* | *133* | *169* | *228* | *303* | *421* |
| Number of Responses | *537* | *567* | *623* | *664* | *720* | *714* |

SARE-CTIC Cover Crop Survey Results - 2013

# QUESTIONS

**The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).**

**To file a complaint of discrimination write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.**