unlock the SECRETS IN THE SOIL

The road to Soil Health: Farming in the 21st Century

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USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service


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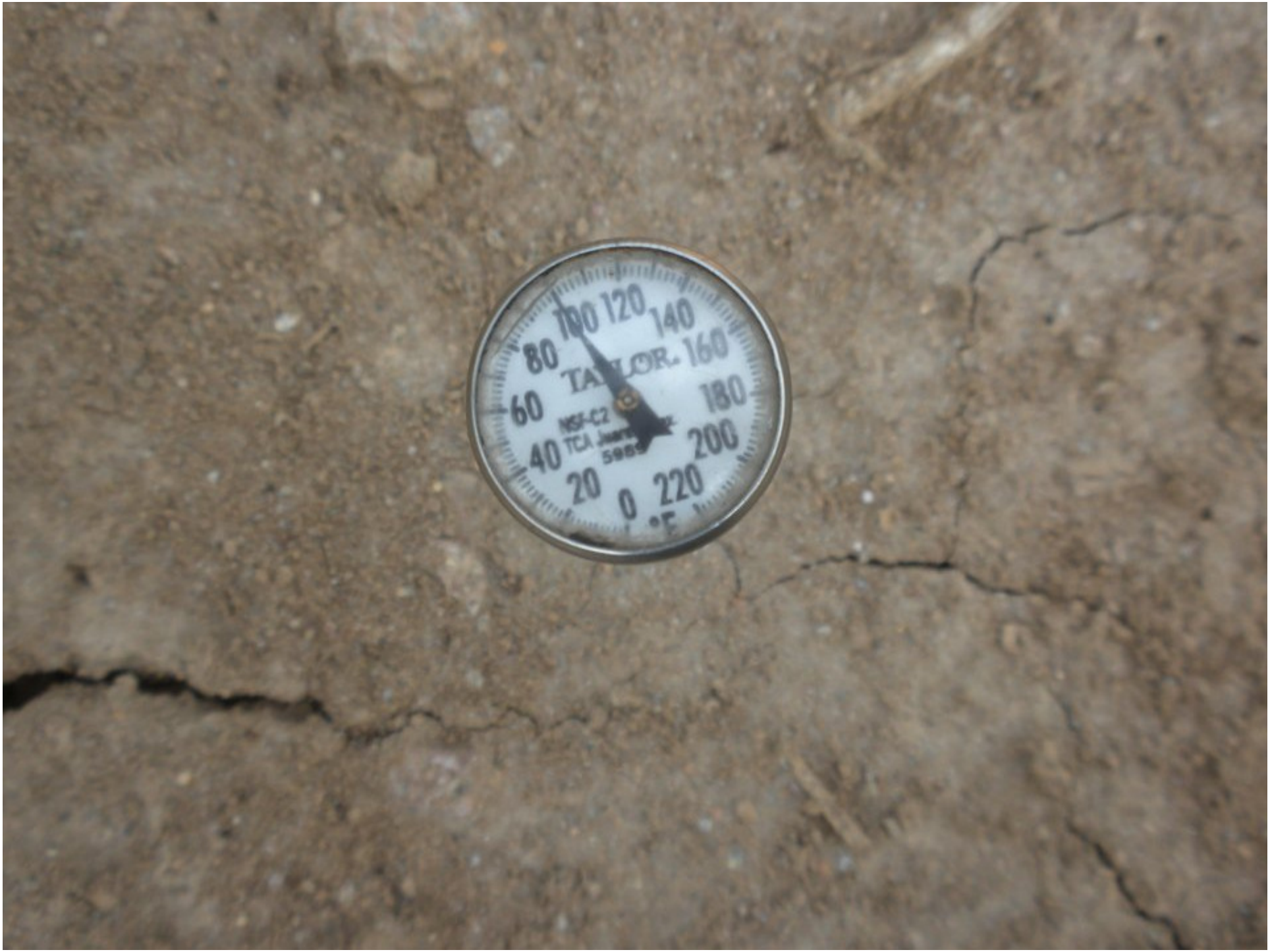
Agricultural soils do not have a water erosion/runoff problem, they have a water infiltration problem.


100
120
140
80
160
60
180
40
200
20
0
220
°F

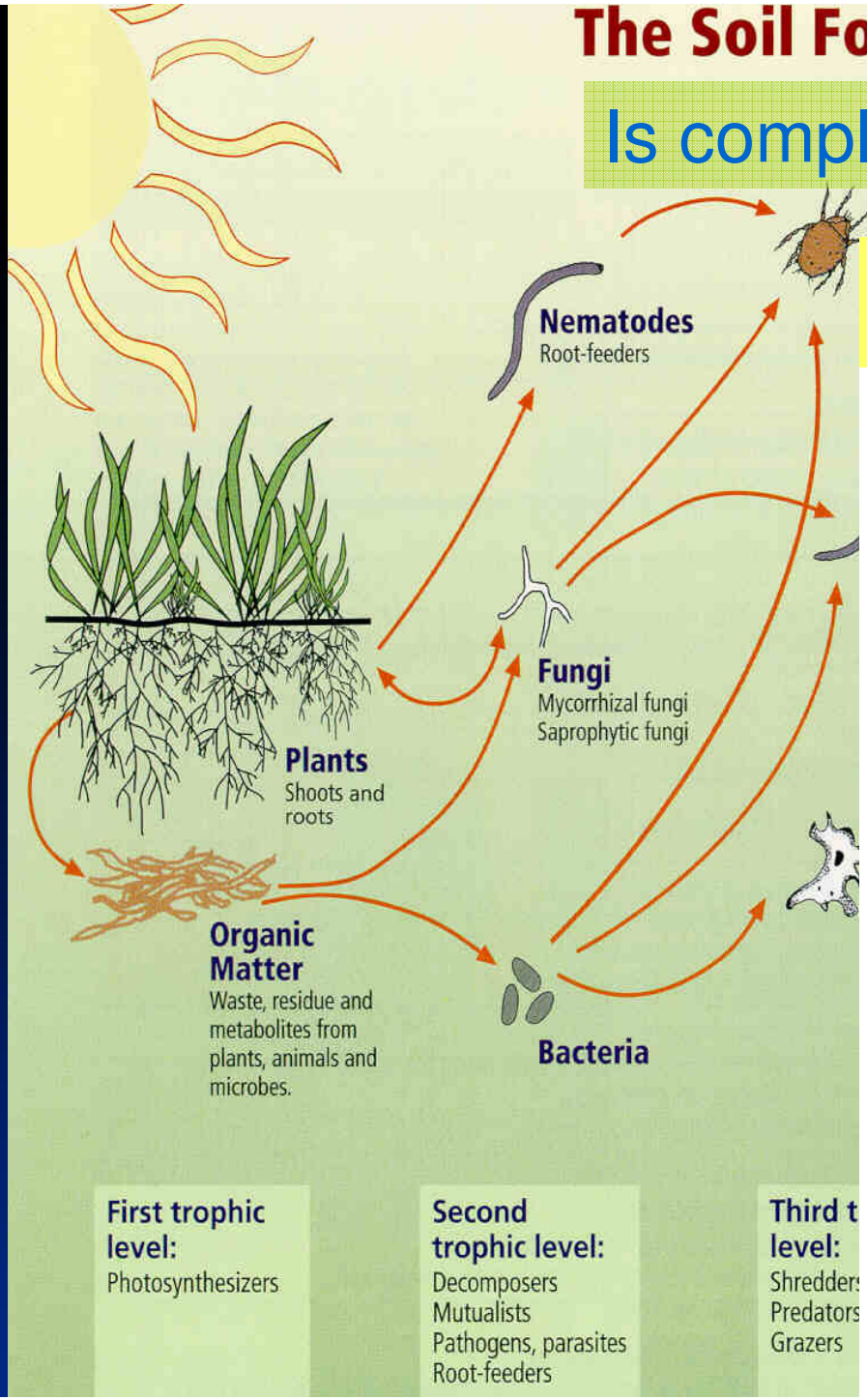
SOIL QUALITY/HEALTH is

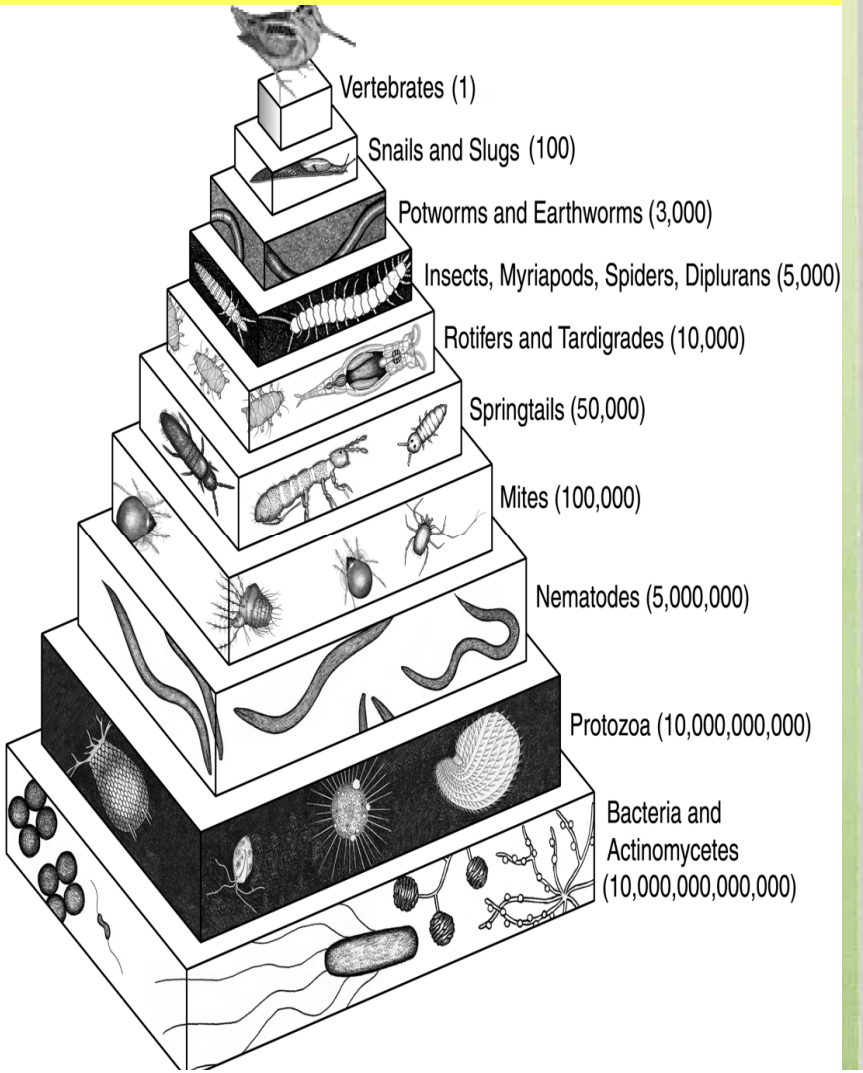
The continued capacity of the soil to function as a vital living ecosystem that sustains plants, animals, and humans.

The Soil Food Web

Is complex

Every trophic level must function for the soil food web to function!



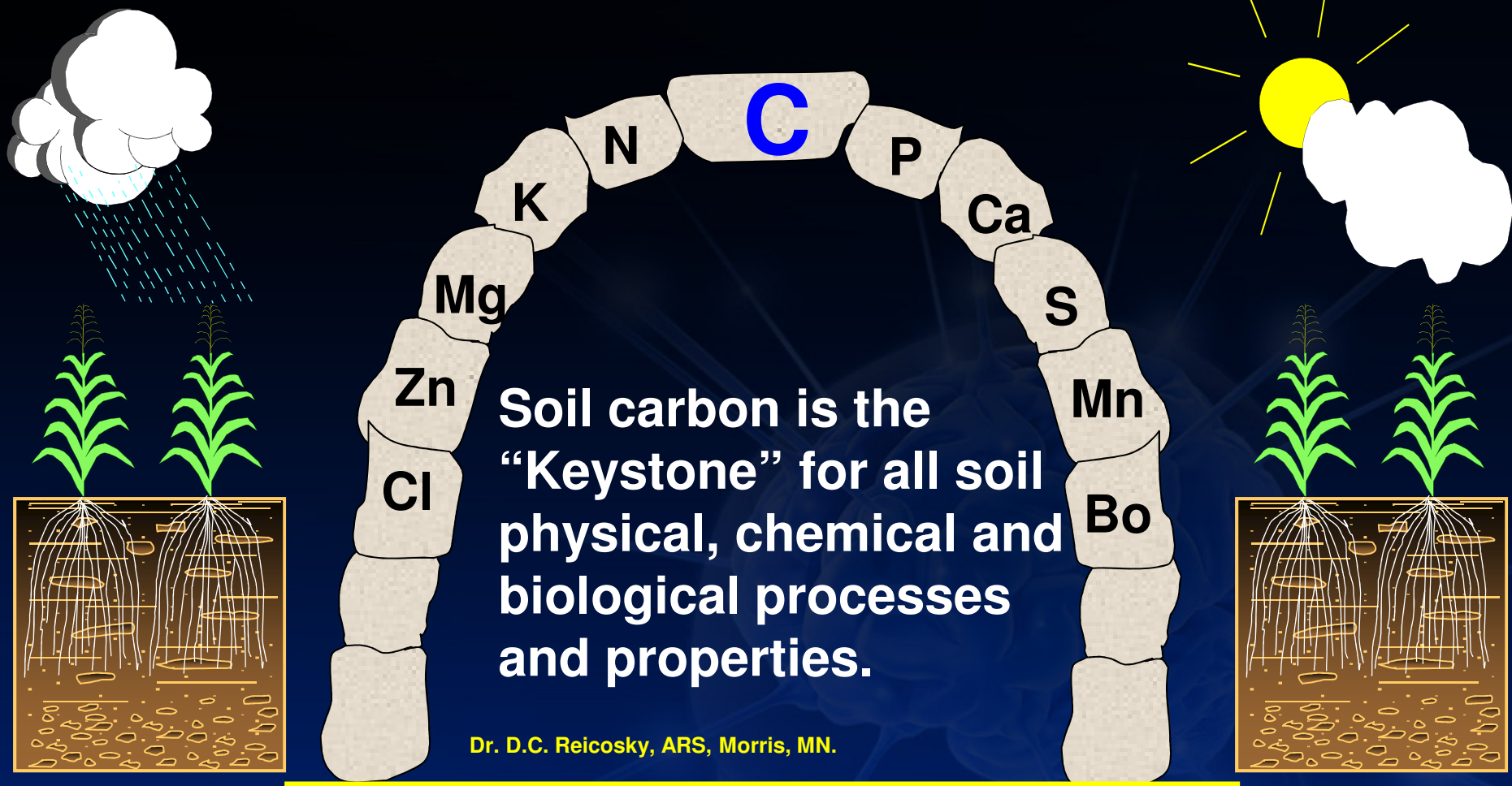


Soil is a Living Factory

- Macroscopic and microscopic organisms
  - Food
  - Water
  - Habitat
  - Powered by sunlight

- Management can improve or degrade soil health
  - Tillage
  - Fertilizer
  - Livestock
  - Pesticides

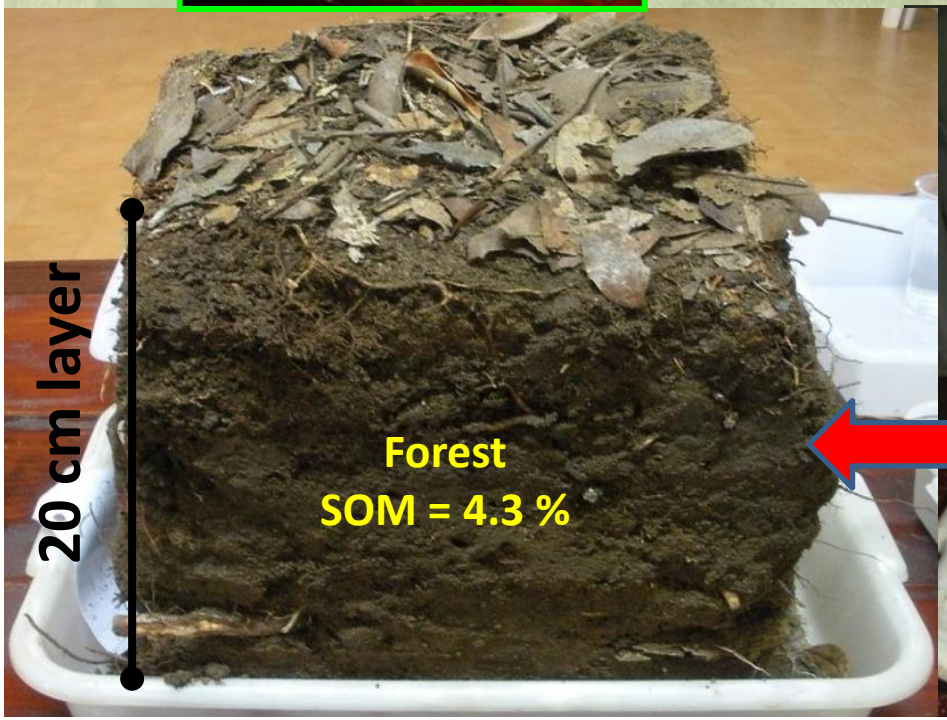
Carbon is a “keystone” in nutrient cycling!



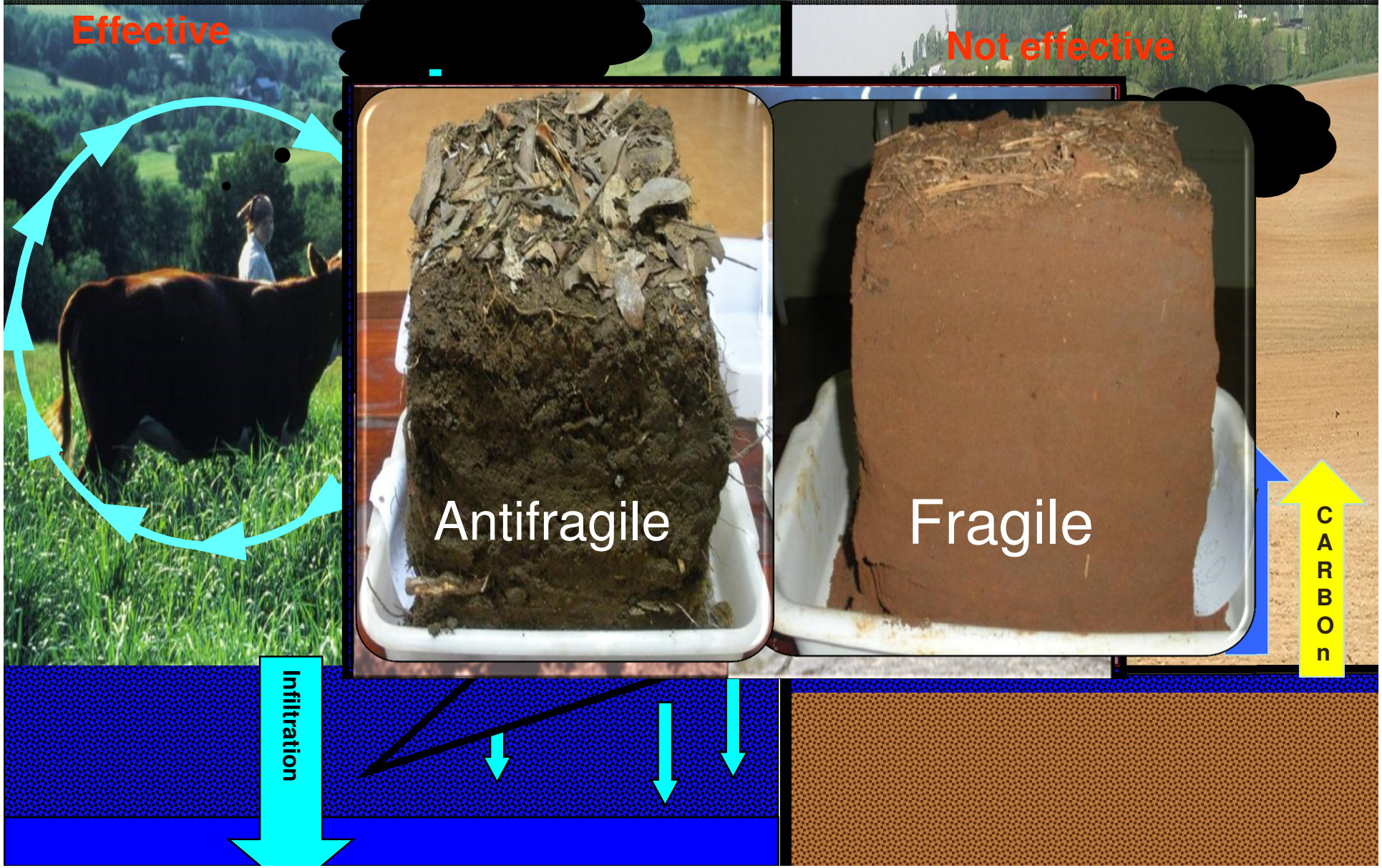
Management platform

Management Changes Soil Properties & Capacity of Soil to Function

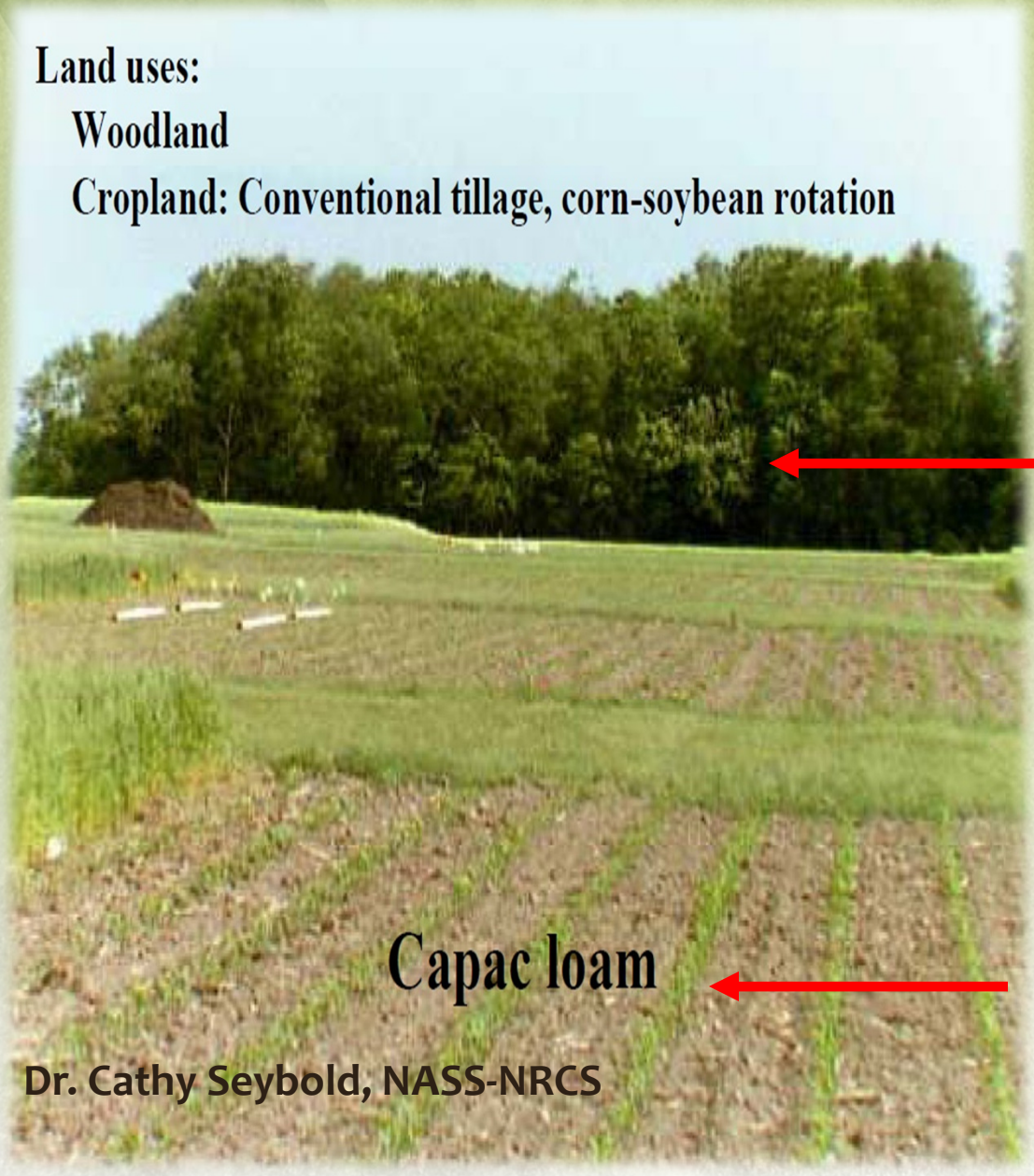
62.8% loss of SOM after 17 yr intensive tillage



Chronic Physical,Chemical,and Biological Stress:
diminishes ecosystem processes



Study: Use-dependent Soil Properties



Wooded Soil: Bulk Density- 1.01 g/cm^3

Infiltration rate	Soil Nitrate loss
5o in./hr	1.8 lbs. N/ac.

Conventional Tillage- Corn-Soybean: Bulk Density- 1.40 g/cm^3

Infiltration rate	Soil Nitrate loss
.5o in./hr	15 lbs. N/ac.

Soil Organic Matter & Available Water Capacity

Percent SOM	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

Inches of Water/One Foot of Soil

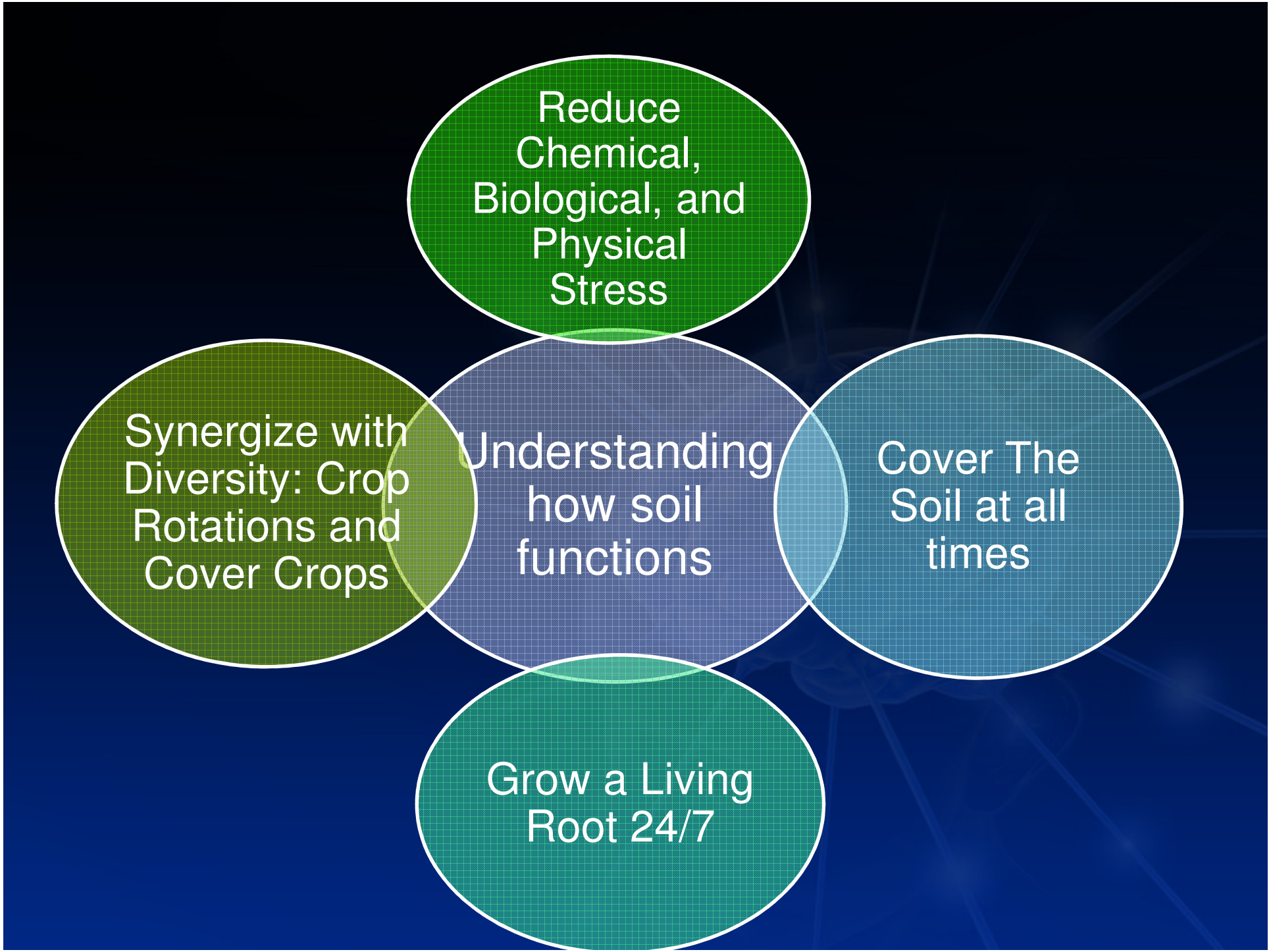
1 acre inch = 27,150 gallons of water

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

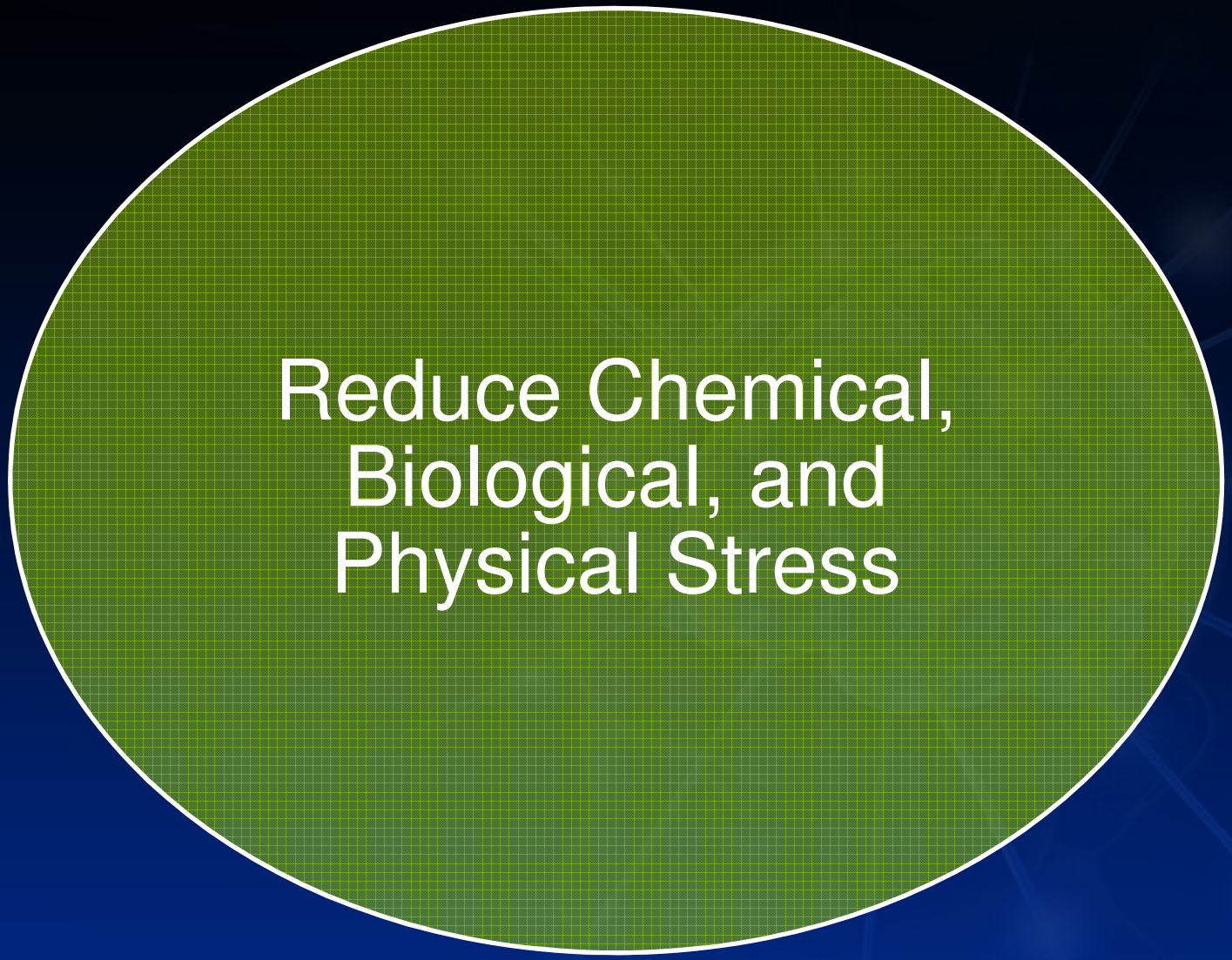
Soil OM Changes

Table 1.—Soil measurements from Lamar Black's farm (Millen, GA), 11/15/01.

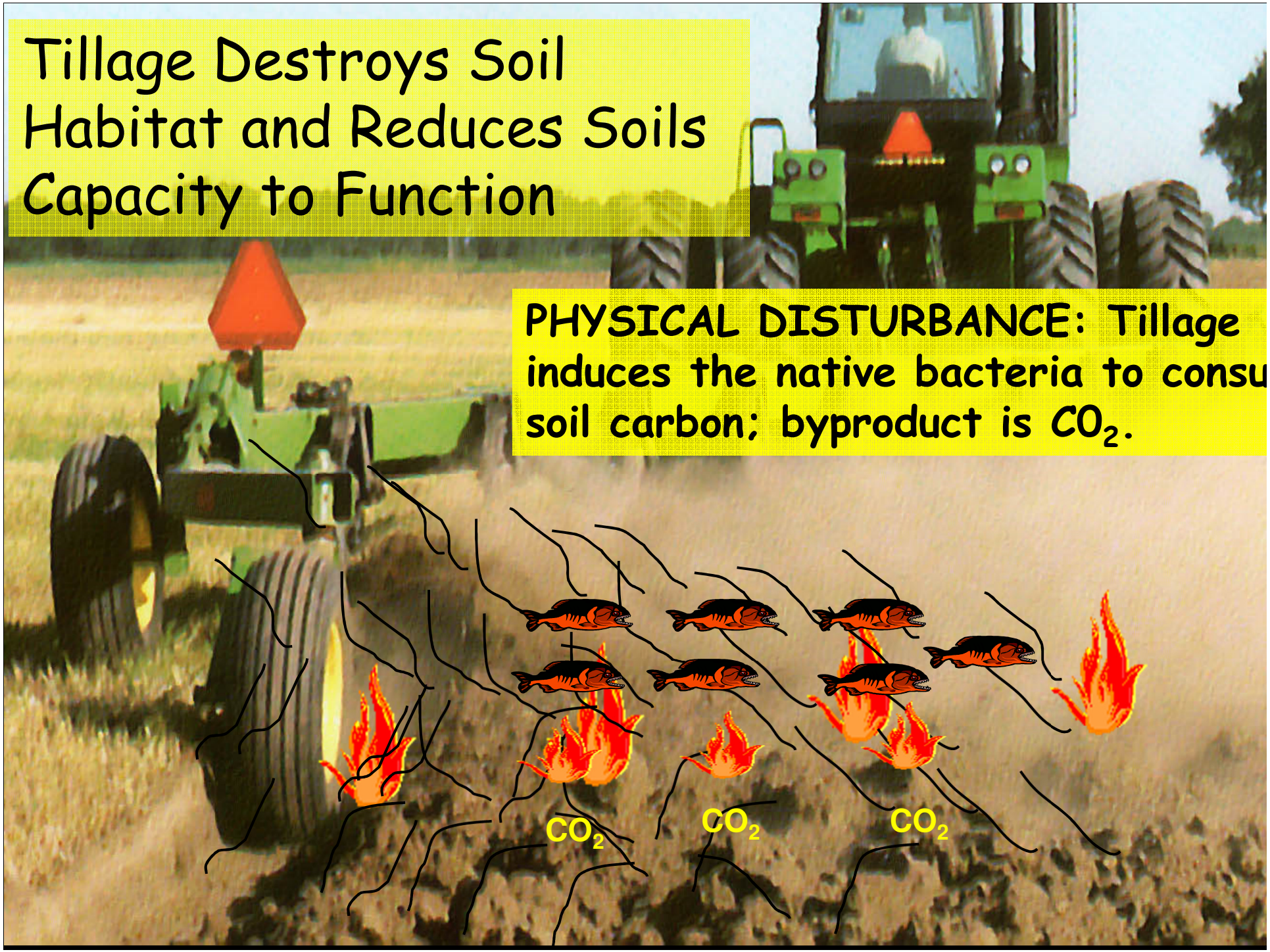
Treatment	Bulk density (g/cm^3)	Aggregate stability (%)	Slaking (class)	Soil carbon (%)	Approx. soil org. matter* (%)	Moisture content (g/g)
Long-term cover crop/strip till	1.40	39	5.8	1.4	2.4	0.13
Short-term cover crop/strip till	NA	36	6.0	1.3	2.2	NA
2-year conventional tillage	1.46	12	5.0	0.5	0.9	0.02
Monocrop cotton conventional	1.58	21	3.8	0.7	1.2	0.03


Reduce Chemical, Biological, and Physical Stress
Synergize with Diversity: Crop Rotations and Cover Crops
Understanding how soil functions
Cover The Soil at all times
Grow a Living Root 24/7

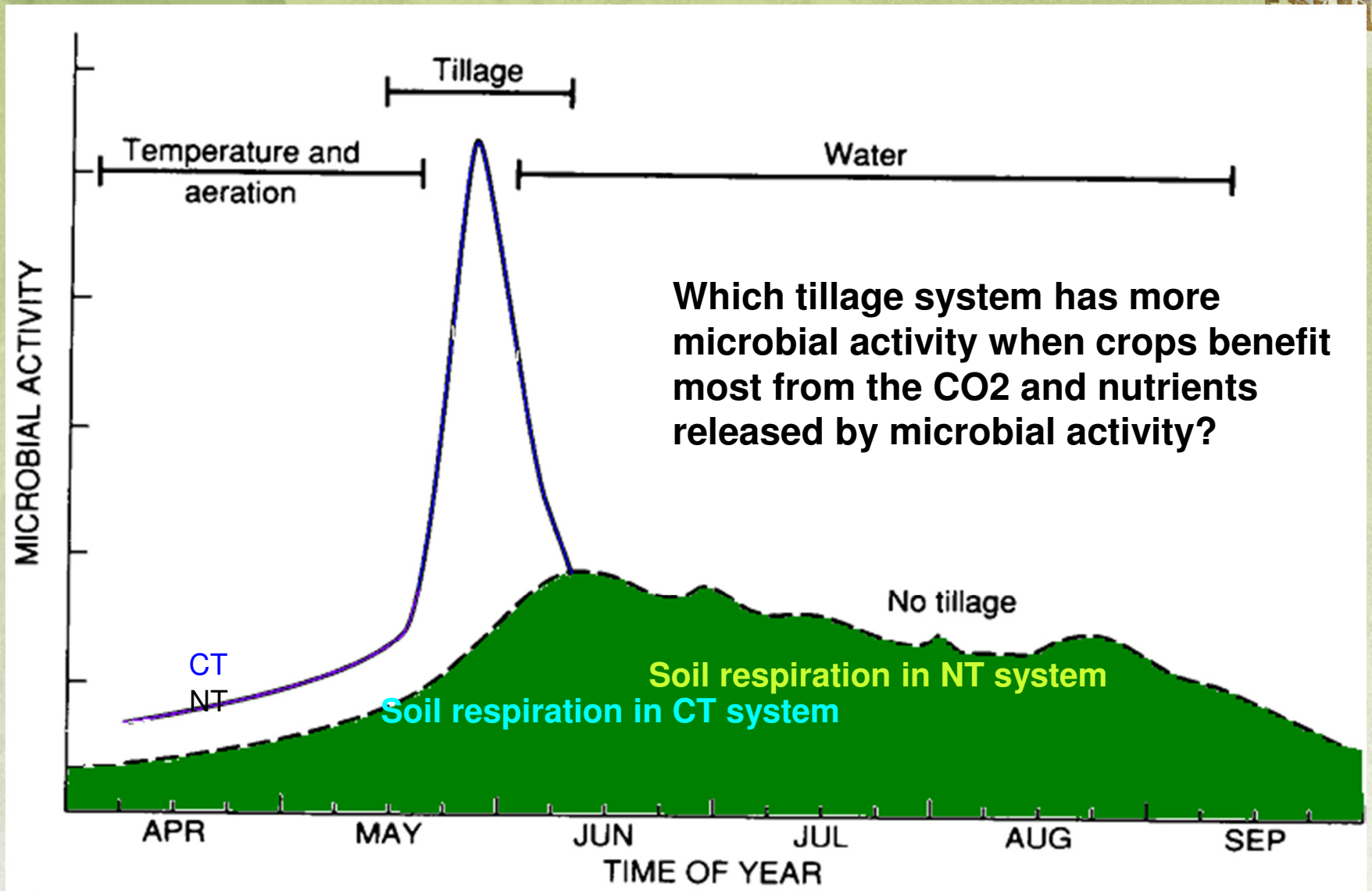
Protect the Habitat



Tillage Destroys Soil Habitat and Reduces Soils Capacity to Function

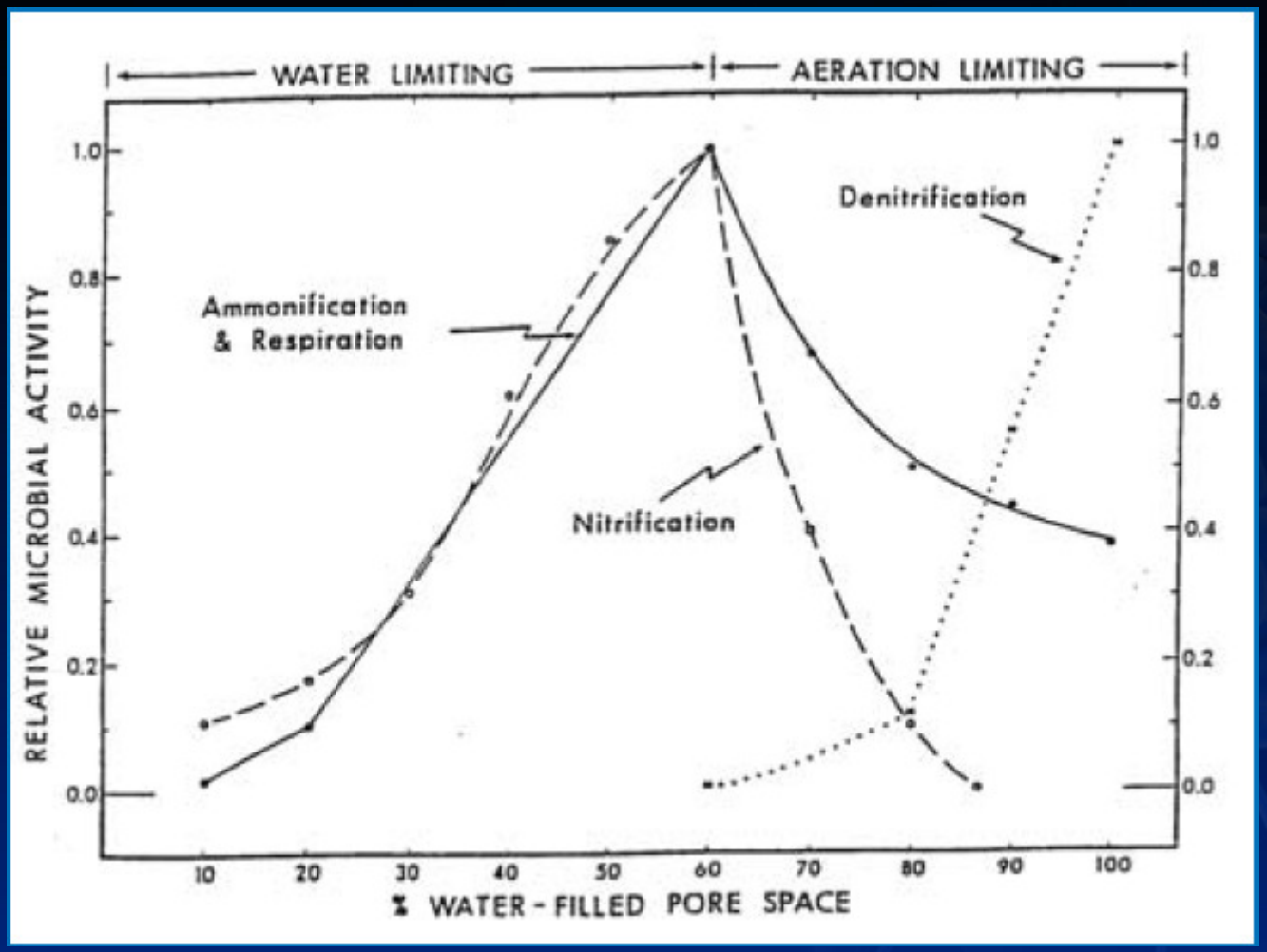


Effect of tillage on microbial activity



Havlin et al. (1999)

Factor Affecting Respiration



- Respiration peaks at field capacity
- 60% of pore spaces field
- >80% pore space water filled
- Anaerobic organisms use Nitrate instead of Oxygen

Chemical disturbances: <u>over-application</u> of pesticides, fertilizers and manures

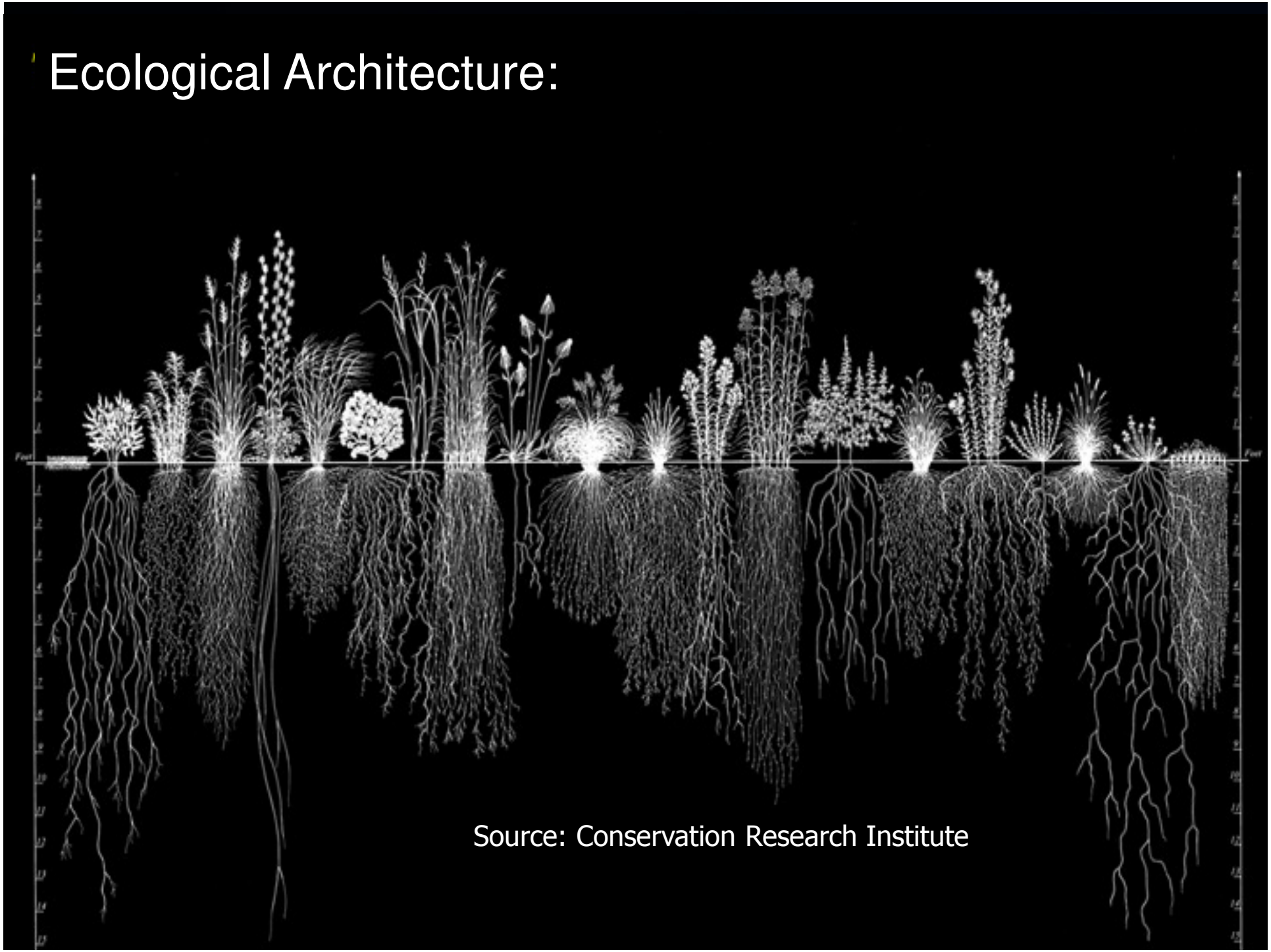
Feed the soil diverse food (carbon)

Synergize with Diversity: Crop Rotations and Cover Crops

Diversify with Crop Diversity

- Plants interact with particular microbes
  - Trade sugar from roots for nutrients
- Microbes convert plant material to OM
- Requires a diversity of plant carbohydrates to support the variety of microbes
- Lack of plant diversity will drive system to favor some microbes more than others

Ecological Architecture:

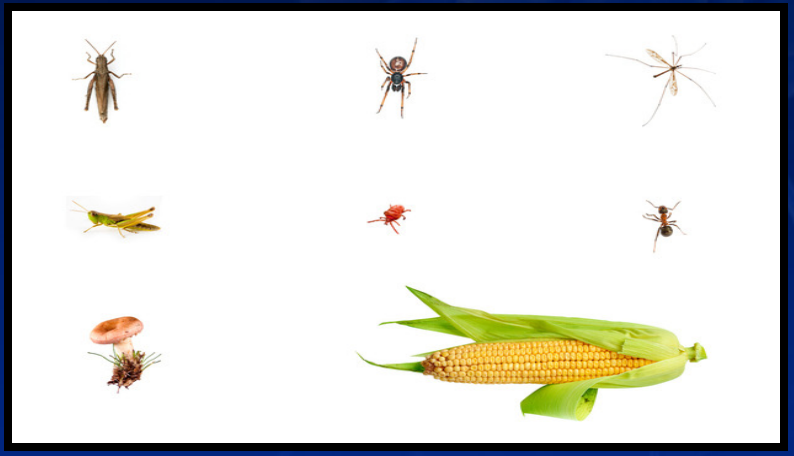


Source: Conservation Research Institute

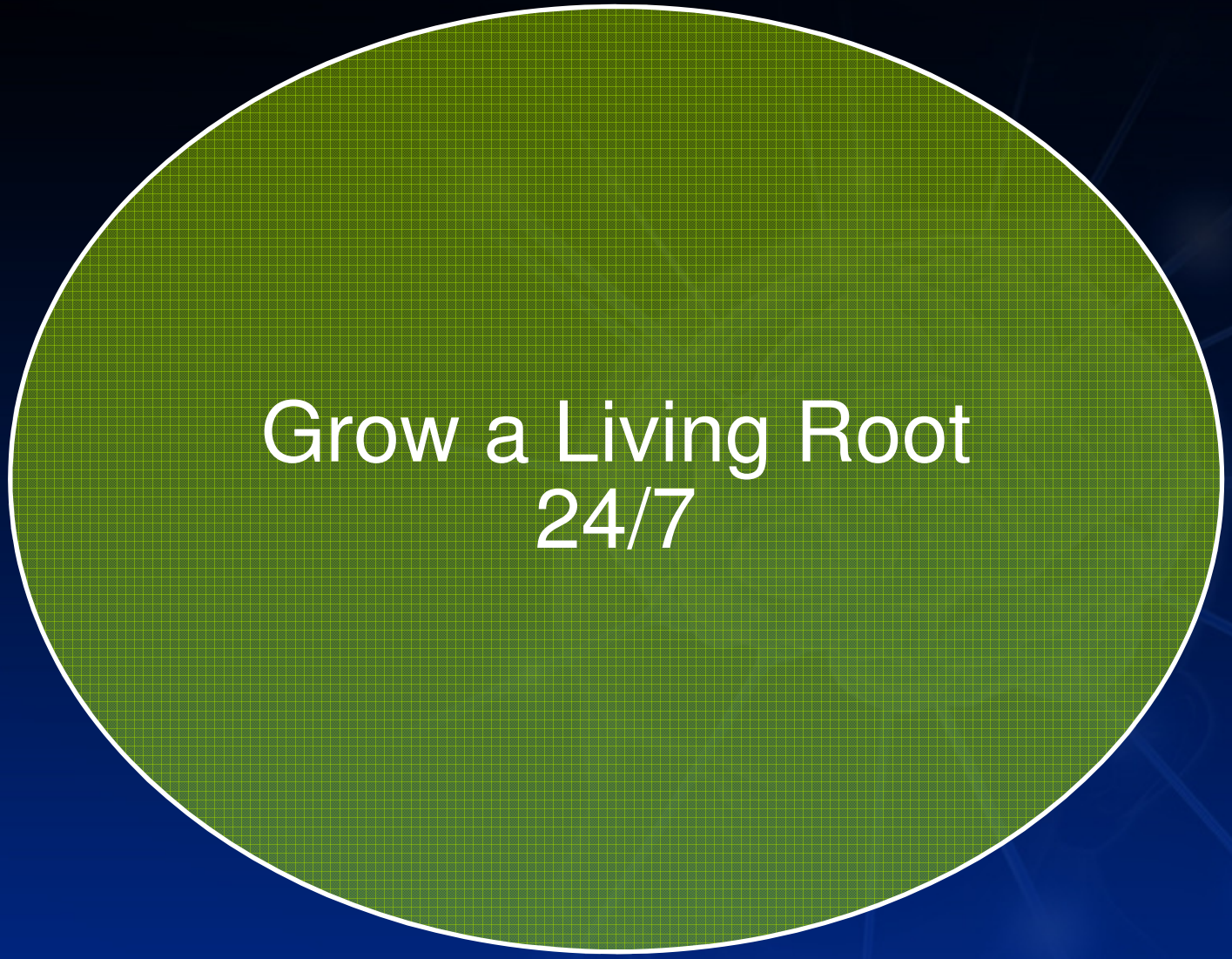
Costa Rica
150 Plants & Animals
24 Hours - Forest

Cape Town, South Africa
100 Plants & Animals
24 Hours - Grassland

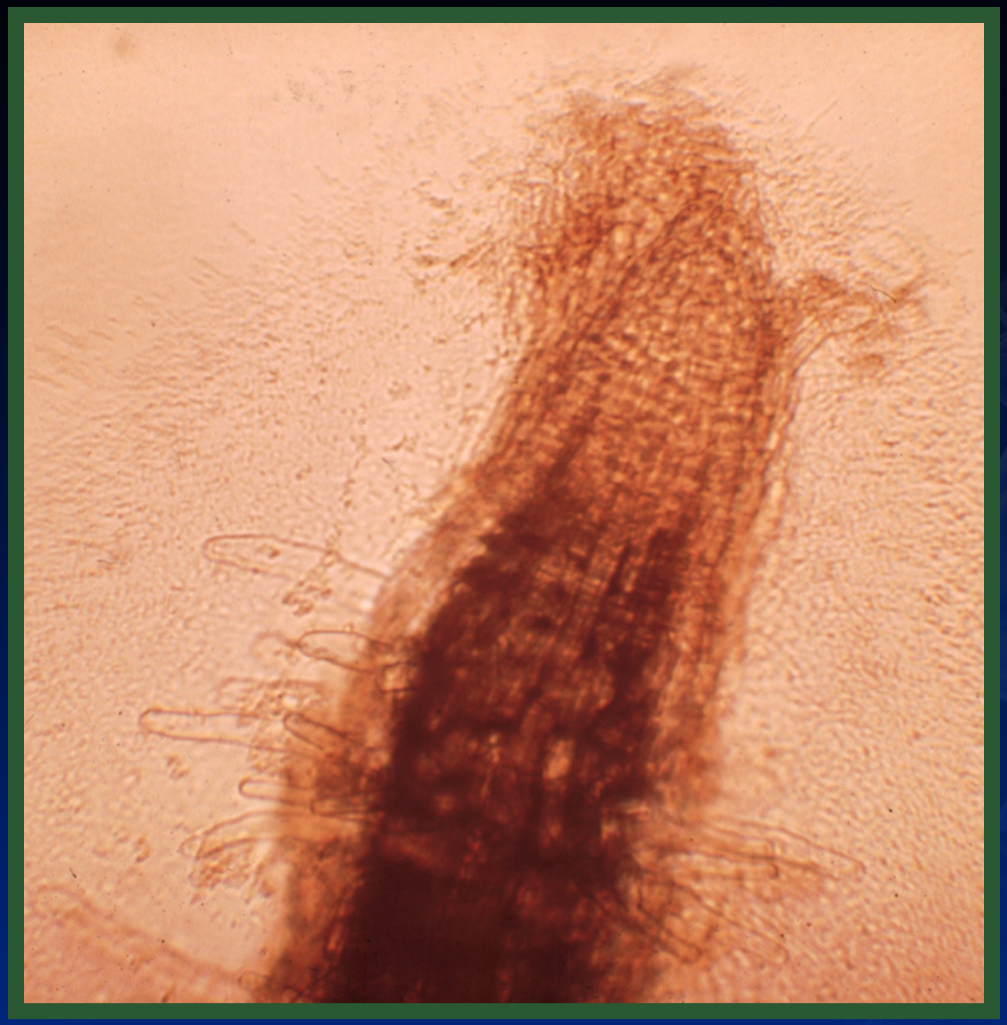
Iowa Corn Field
8 Plants & Animals
24 Hours



Build the Habitat

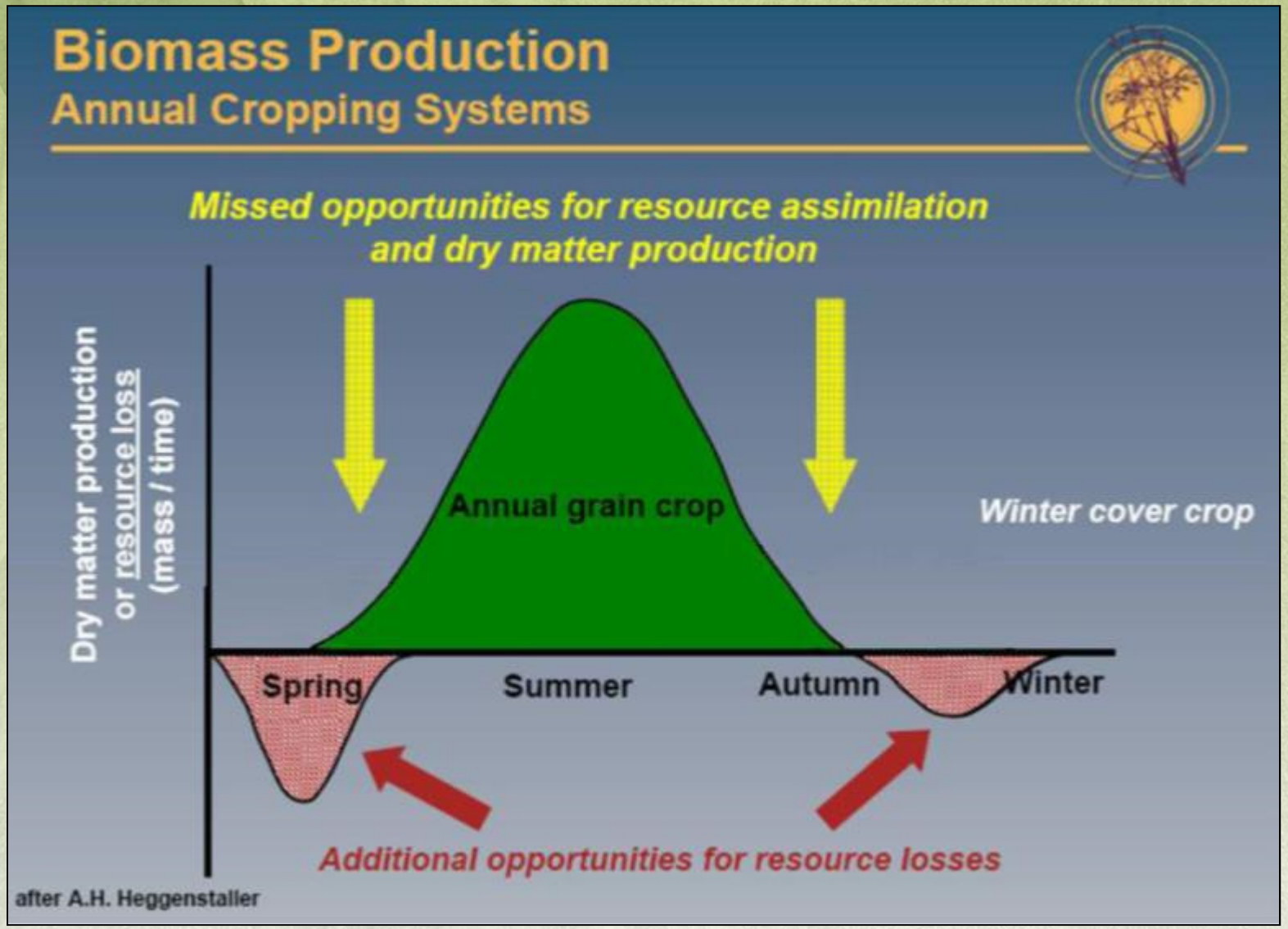


Rhizosphere
Where Roots Meet Soil



Zone of Concentrated Biological Activity

- Bacteria
- Fungi
- Protozoa
- Nematodes



A. H. Heggenstaller, University of Alberta

Broadcast while defoliating cotton

Broadcast while defoliating cotton

Seeded a multi-species cover crop mix

- Cereal rye
- Crimson clover
- Hairy Vetch


Mid October

Protect the Habitat

When soil temperature reaches...

140 F Soil bacteria die

130 F 100% moisture is lost through evaporation and transpiration

113 F

Some bacteria species start dying

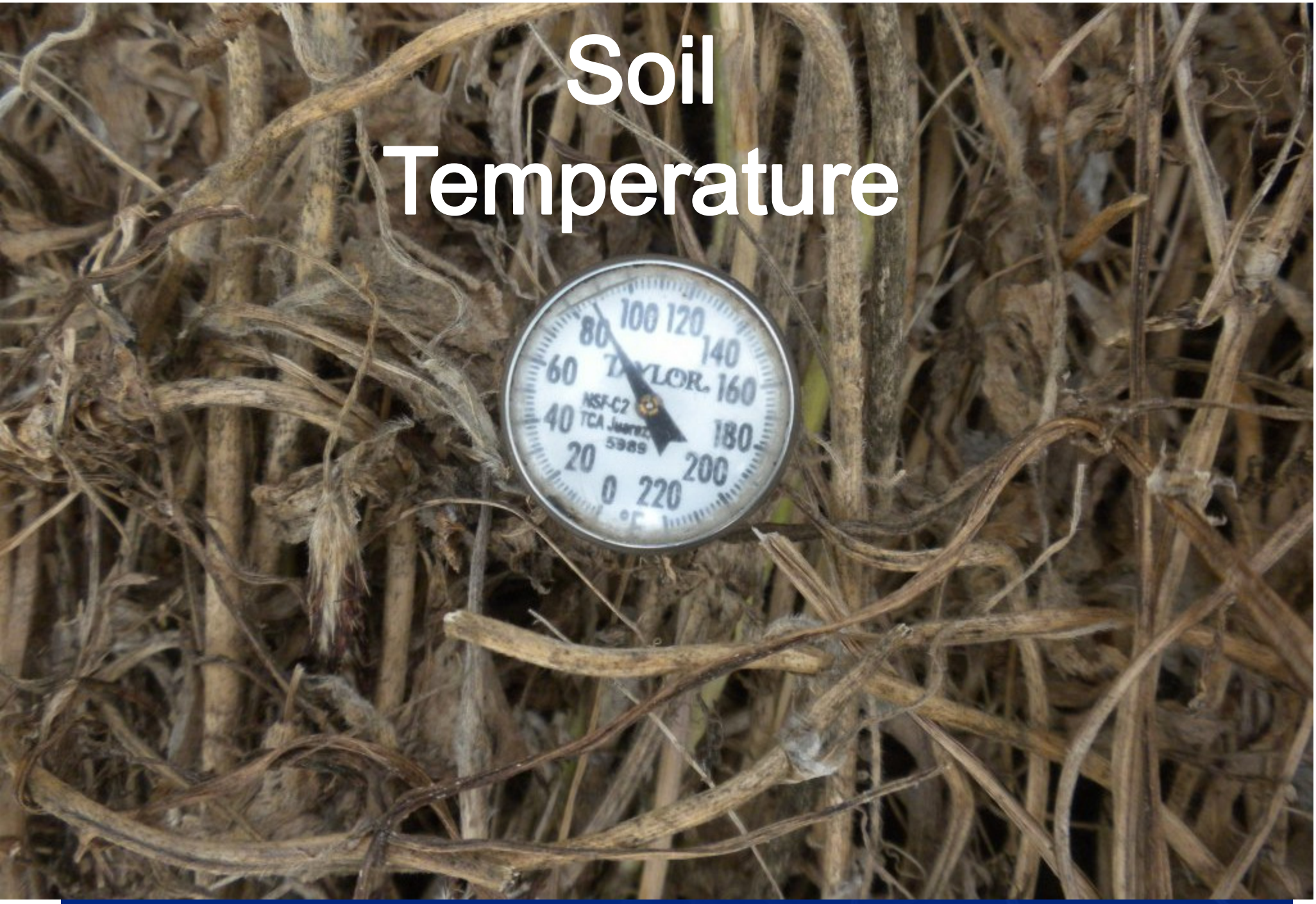
100 F 15% of moisture is used for growth
85% moisture lost through evaporation and transpiration

95 F

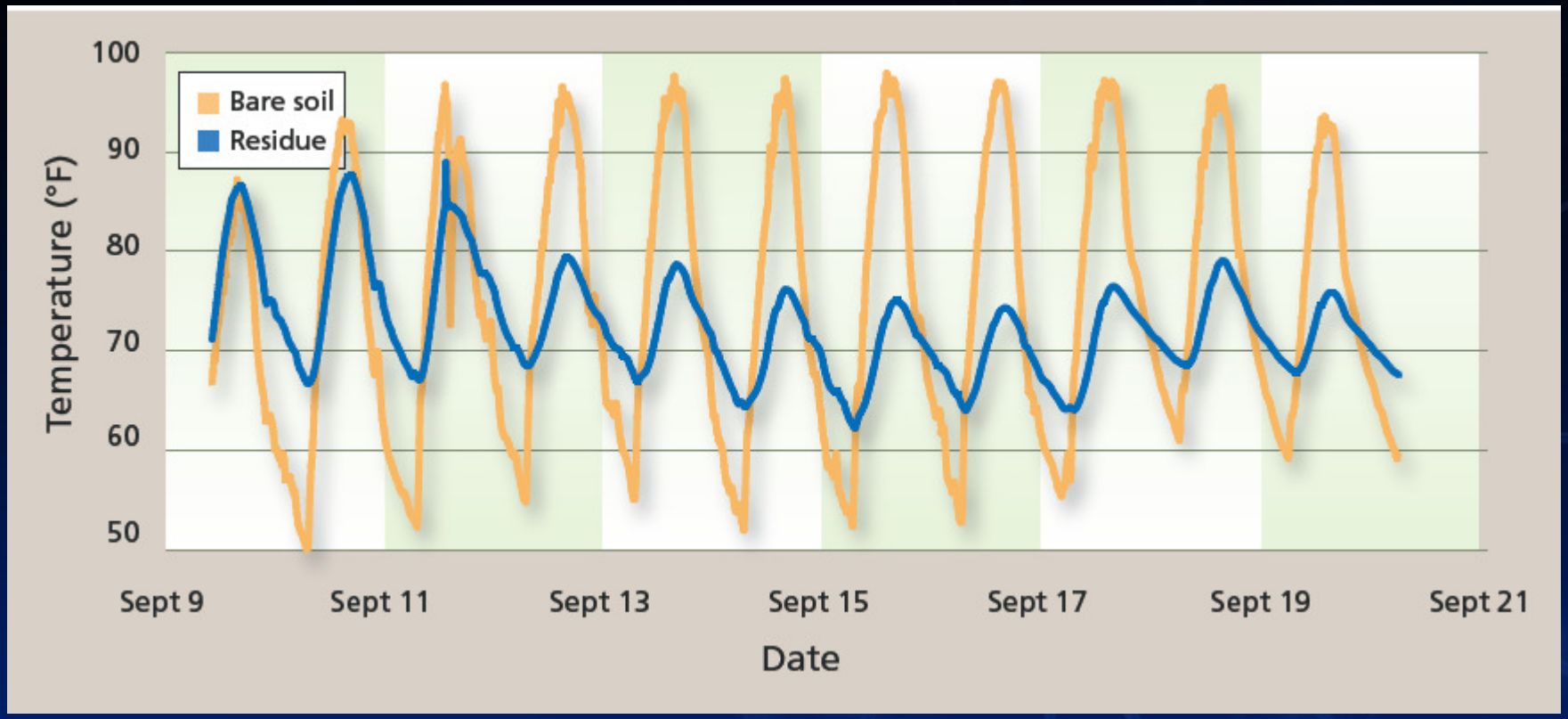
70 F 100% moisture is used for growth

J.J. McEntire, WUC, USDA SCS, Kernville TX, 3-58 4-R-12198. 1956

Soil Temperature



Soil temps at 1 cm




3 Bales Per
Acre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