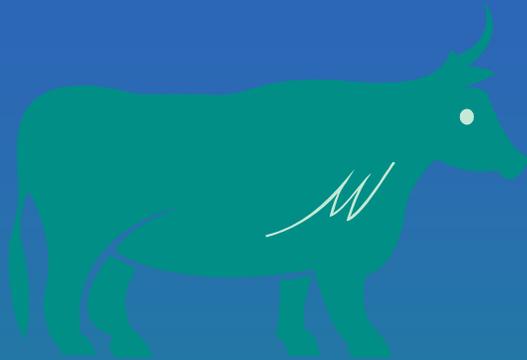




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# Managing Soils in Rangelands

*Jenny Daigle*

State Soil Scientist  
NRCS  
Alexandria, LA



# What is Rangeland?

Land on which the native vegetation is predominantly:

- grasses
- grass-like plants
- forbs
- shrubs

Photo by Gary Kramer

# What is Rangeland?

## This land includes:

- natural grasslands
- savannas
- shrub lands
- most deserts
- tundras
- areas of alpine communities
- coastal marshes
- wet meadows

Photo by Tim McCabe



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# What is Rangeland Health?

The degree to which the integrity of the soil, the vegetation, the water, and the air; as well as the ecological processes of the rangeland ecosystem are balanced and sustained.

Photo by Diane Shields



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# What is Soil?

A dynamic resource that supports plants:

- Mineral particles (sand, silt, clay)
- Organic Matter
- Living organisms
- Air
- Water

# What does soil quality affect on rangeland?

- Plant production, reproduction, and mortality
- Erosion
- Water yields and water quality
- Wildlife habitat
- Carbon sequestration
- Vegetation changes
- Establishment and growth of invasive plants
- Rangeland health

Photo by Gary Kramer



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# How are soil quality and rangeland health related?

- They are interdependent
- The capacity of the soil to function affects ecological processes:
  - Capture of water
  - Storage of water
  - Redistribution of water
  - The growth of plants
  - Cycling of nutrients

Photo by Gary Kramer



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# Why is soil quality important?

Certain conditions change with changes in soil quality:

- the amount of water from rainfall and snowmelt that is available for plant growth;
- runoff, water infiltration, and the potential for erosion;
- availability of nutrients for plant growth;
- the conditions needed for germination, seedling establishment, vegetative reproduction, and root growth;
- ability of the soil to act as a filter and protect water and air quality.

Photo by Lynn Betts



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# Soil Quality Indicators on Rangeland

- Ecological processes on rangeland are evaluated with soil and vegetative indicators.
- Indicators are key soil and plant community characteristics that are sensitive to change in the environment.
- They reflect complex ecosystem processes that are too difficult or expensive to be measured directly
- They provide information about the current status of rangeland ecosystems.

Photo by Gary Kramer



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# Soil Quality Indicators on Rangeland

- Sensitive to change as a result of management & climate
- Easily measured and reproducible
- Reliable
- Accessible to users
- Applicable to field conditions

(Doran and Parkin, 1994; Gregorich et al., 1994)

Photo by Gary Kramer



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# Types of Assessments

- Quality is compared to some reference:
  - site-to-site comparison on same soil type
  - compare management systems
  - compare problem spots to non-problem areas
  - compare to standard or reference condition
- Monitoring over time at the same site:
  - compare to baseline condition
  - trend in soil quality over time

Photo by Jerry Daigle

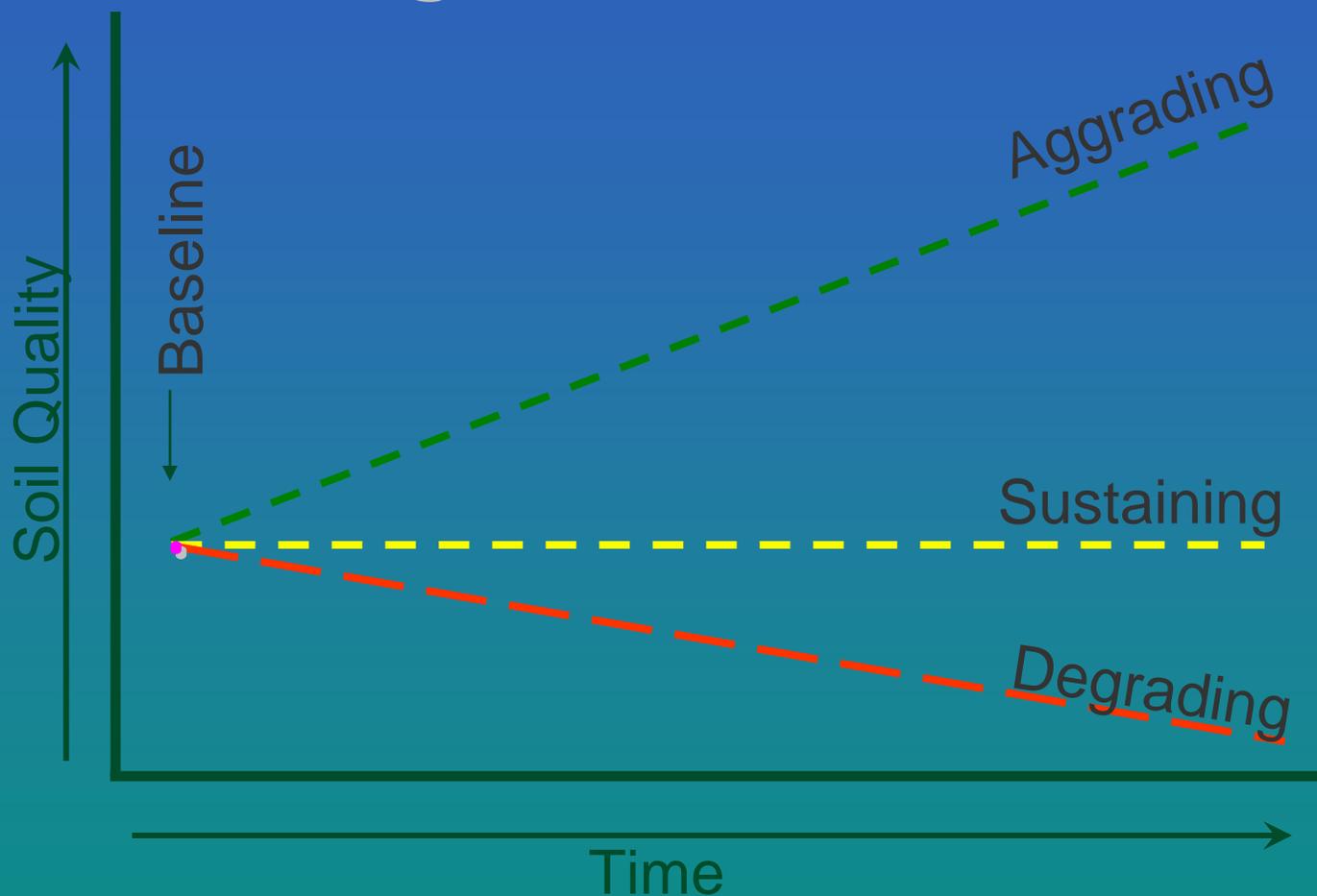


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# Monitoring of Trends



(Seybold et al., 1998)

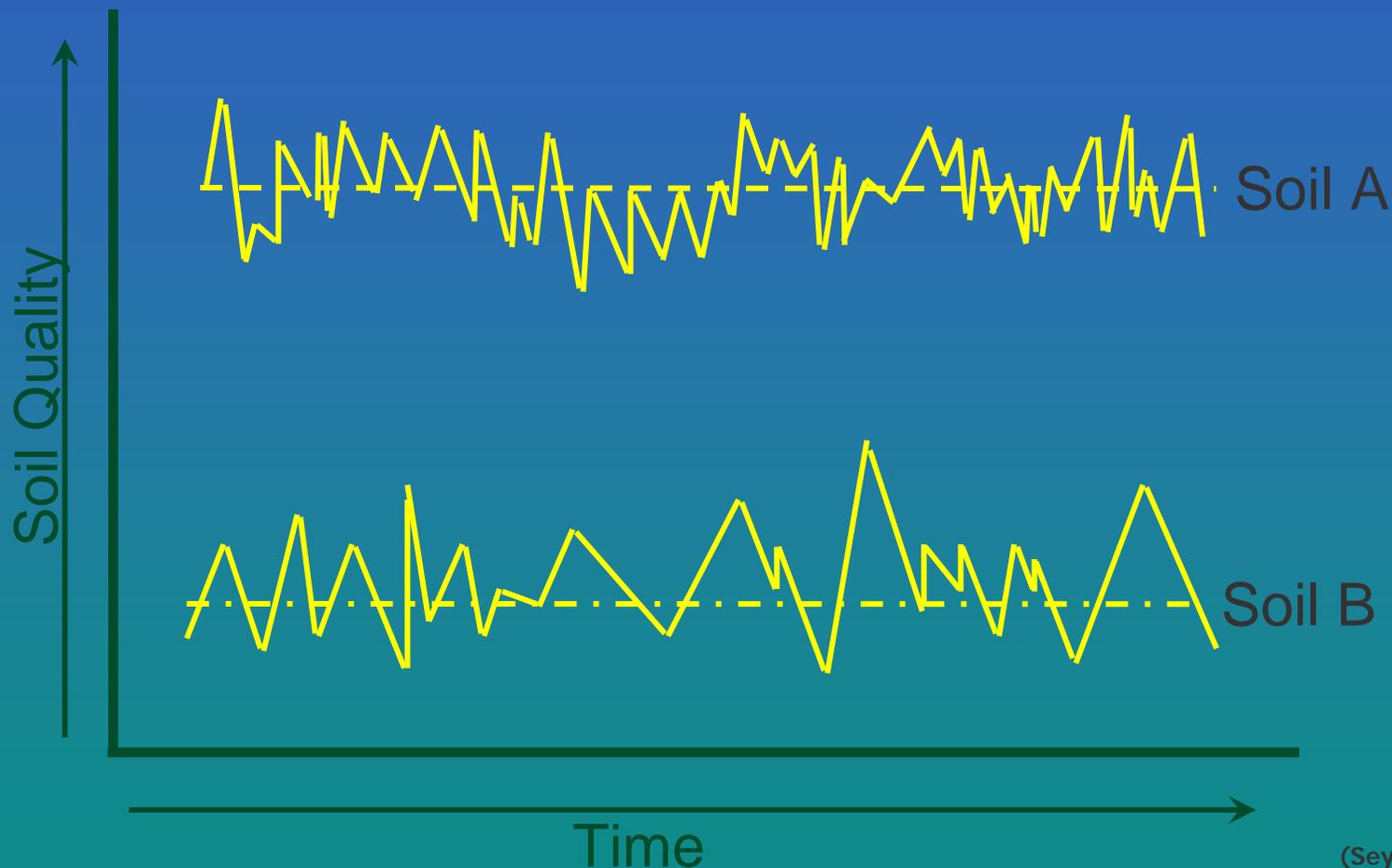


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# No Change Trends (Sustaining)



(Seybold et al., 1998)

# What soil quality indicators are used on rangeland?

- Soil Properties
- Soil surface features
- Spatial patterns and variability



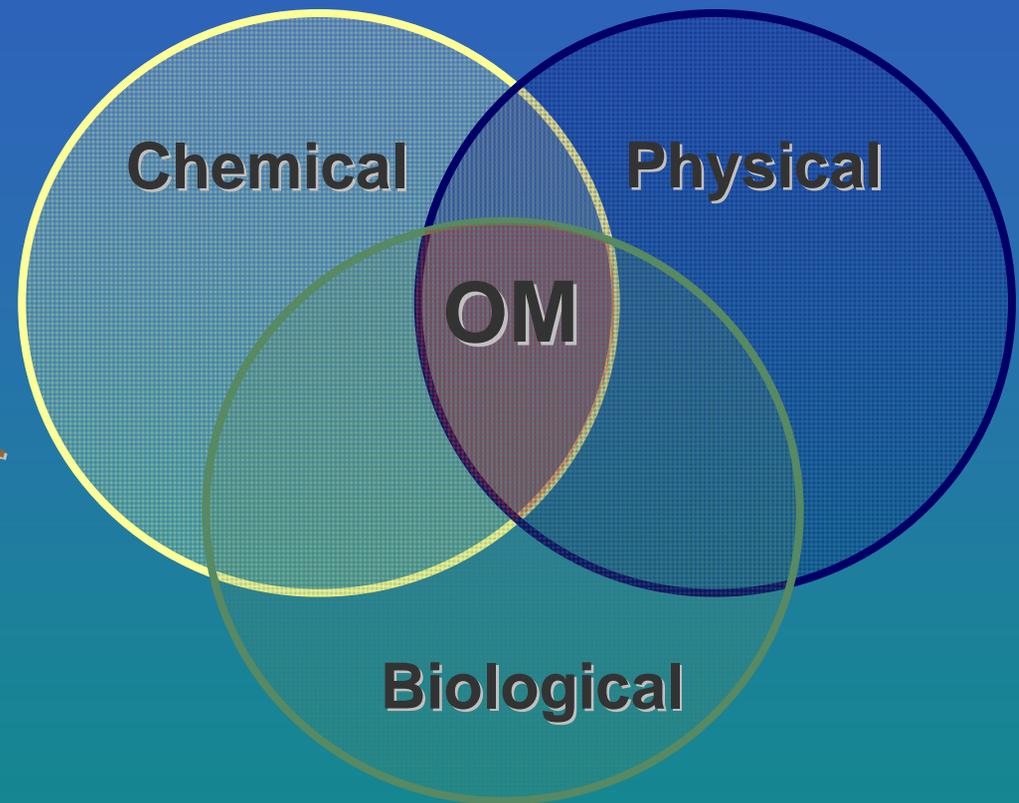
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# Soil Properties

- Physical
- Chemical
- Biological
- Organic Matter



# Physical Soil Properties

- Aggregate stability
- Depth of soil, topsoil, & rooting
- Infiltration & bulk density
- Water holding capacity

Structureless

Good Structure

(after Doran & Parkin, 1994)

Photo from Soil Quality Course CD-ROM



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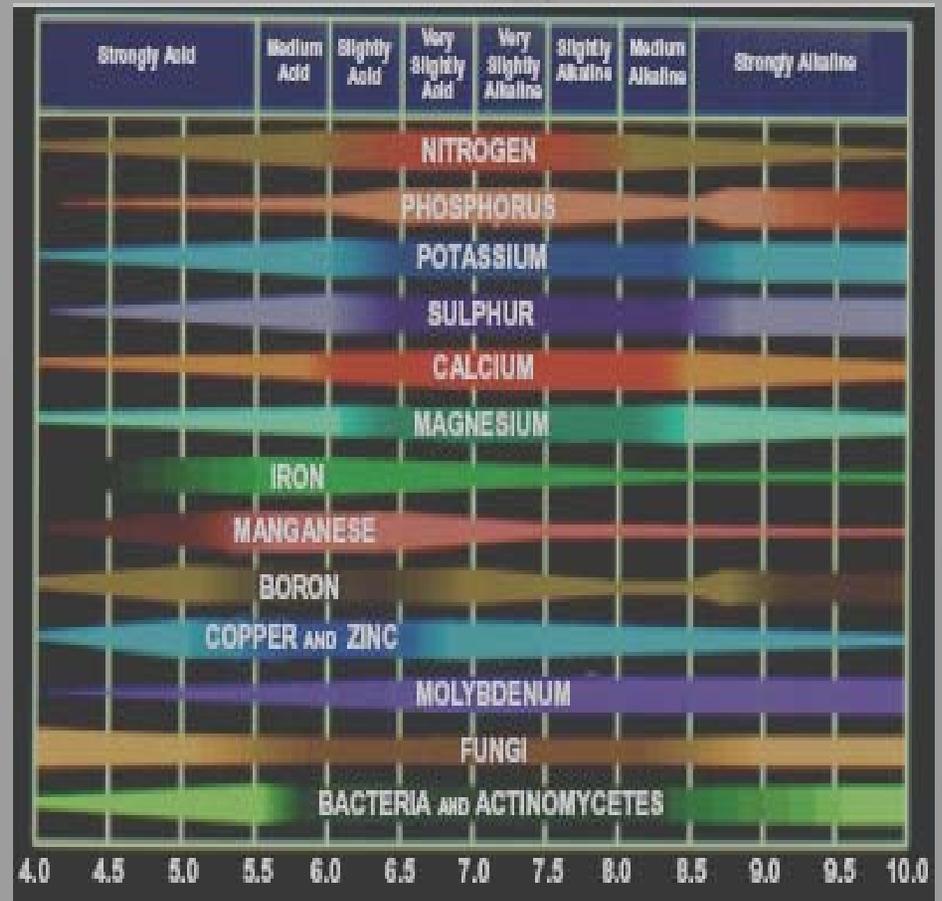
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# Chemical Soil Properties

- Soil organic matter
- Soil Reaction (pH)
- Soil Electrical Conductivity (EC)
- Extractable N, P, & K

(after Doran & Parkin, 1994)



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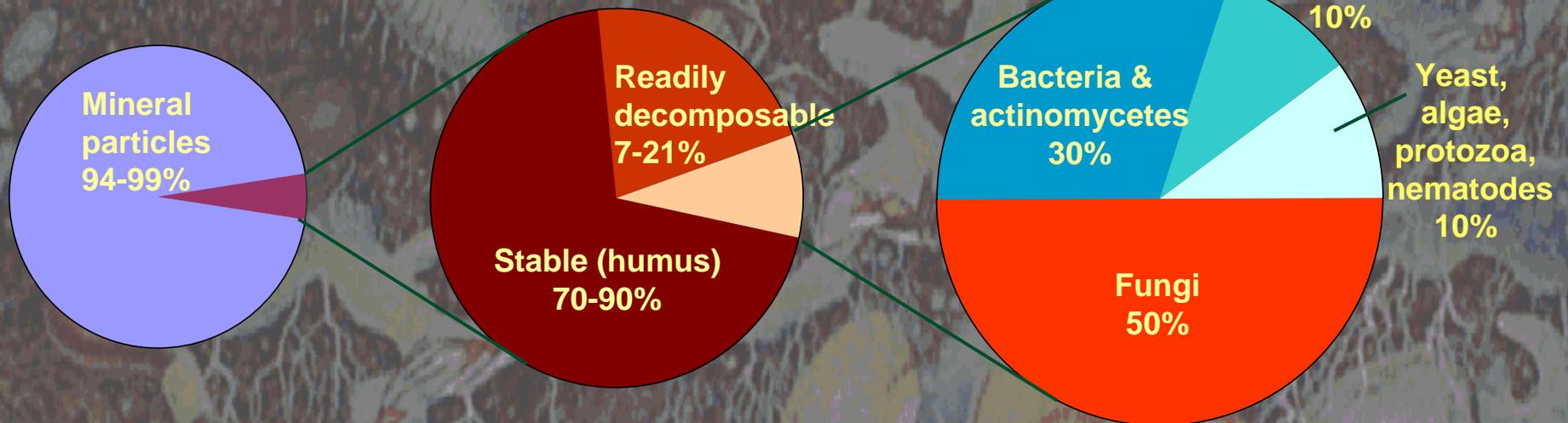


# Soil Composition & Organisms

Soil microbial biomass  
3-9% of total SOM mass

Soil organic matter  
1-6% of total soil mass

Soil



# Organic Matter & Rangeland Quality

- Increases soil porosity
- Increases water and nutrient holding capacity of soil minerals (CEC)
- Provides nutrients following decomposition (N,P,S)
- Helps soils withstand trampling
- Protects against erosion

# Soil Microbial Properties

- Microbial biomass C & N
- Potentially mineralizable N
- Soil respiration (water content & temperature)



(after Doran & Parkin, 1994)



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# Soil Food Web Structure

- Definition
  - The interaction of producers, consumers, and decomposers in the soil.
- Why is it important?
  - Sustains life in the soil
  - Aggregate and humus formation
  - Essential for nutrient cycling
  - Plant disease control

Photo by Lynn Betts

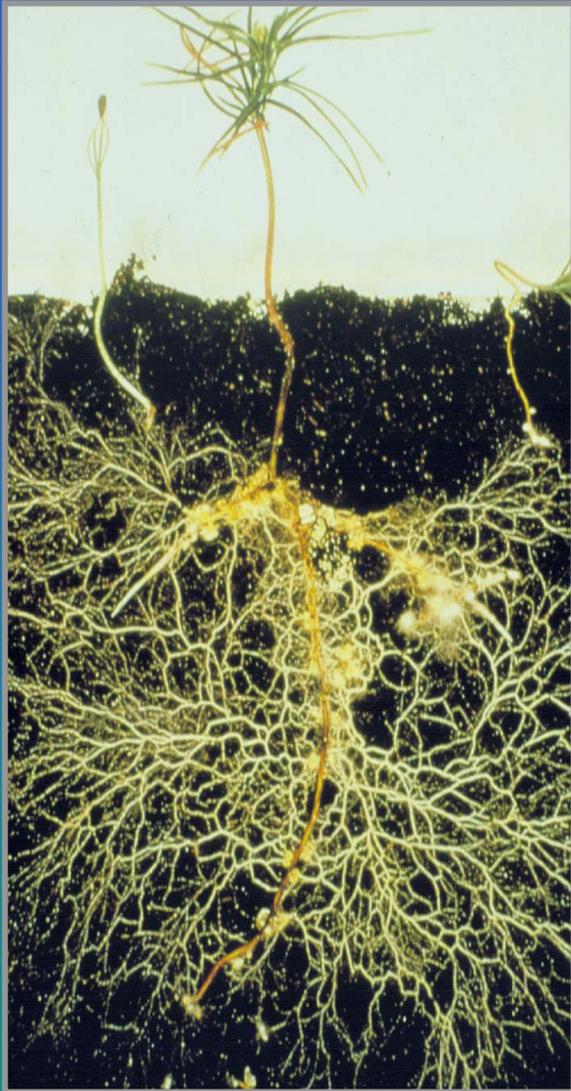


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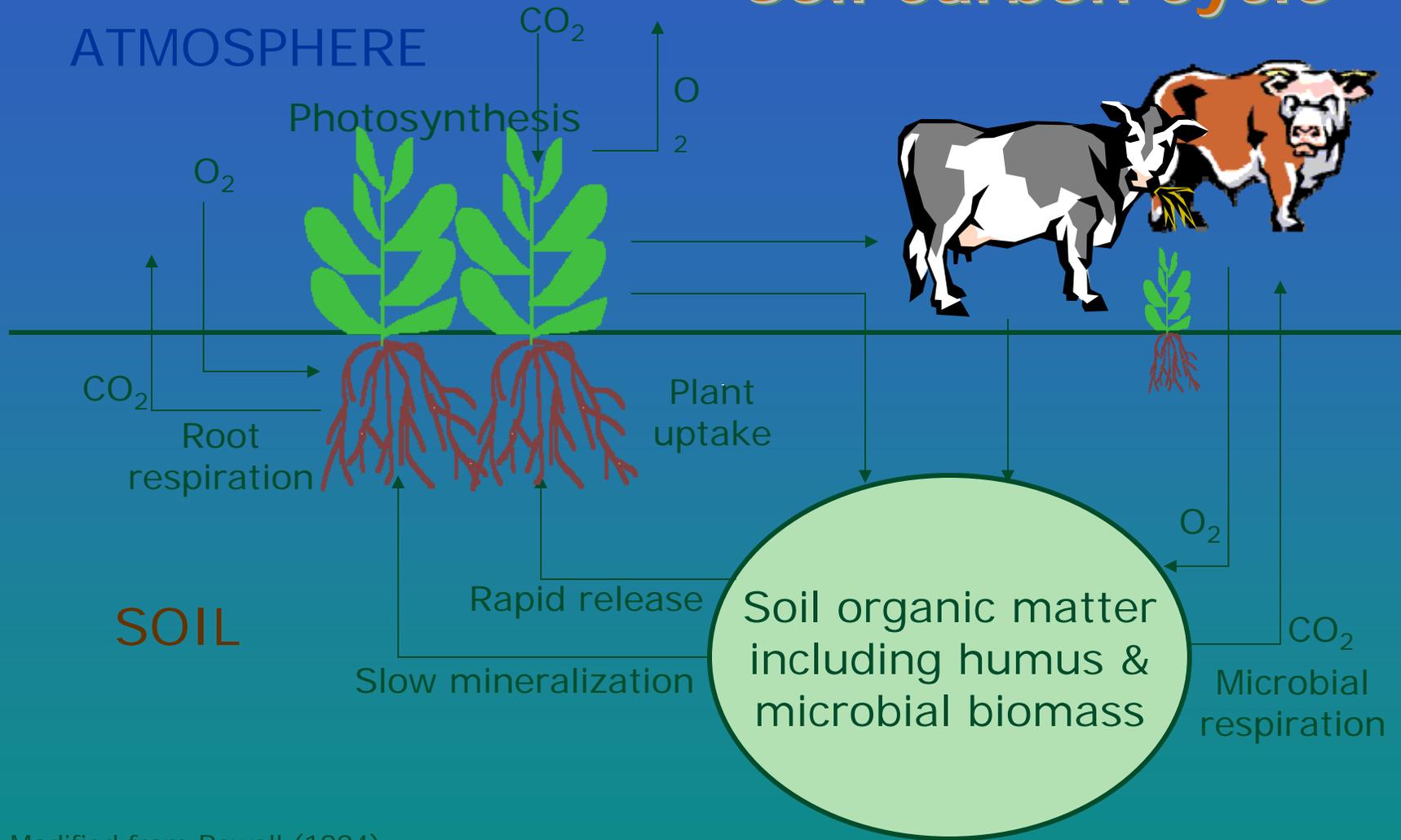
# Soil Food Web of Rangeland Soil



# Plant Roots

- **Why are they important?**
  - **Plant vitality and production**
  - **Indicate soil physical condition – compaction**
  - **Create soil pores**
  - **Form soil aggregates**
  - **Facilitate soil microbial activity**
- **Management for healthy root growth**
  - **Minimal compaction / good soil porosity**
  - **Effective nutrient cycling and nutrient availability**

# Soil Carbon Cycle



Modified from Rowell (1994)

# Soil Surface Features

- Bare soil
- Pedestaled plants or rocks
- Exposed plant roots
- Rills
- Gullies
- Wind scours
- Soil deposition

Reflect processes such as surface runoff and soil erosion.



Photo from Soil Quality Course CD-ROM



Photo from Soil Quality Course CD-ROM



## Soil Surface Features

- Accumulation of soil in valleys, foot slopes
- Appearance of rocks and subsoil on knobs
- Muddy runoff water
- Soil crusts
- Decreased plant health

Reflect processes such as surface runoff and soil erosion.



# Spatial Patterns & Variability

The distribution and cycling of water and nutrients in rangeland soils are affected over both short and long distances by such processes as erosion and deposition.

The kinds, amounts, and spatial distribution of living plants and decaying residue also affect nutrients and water.

Accordingly, as the distribution of soil organic matter becomes less uniform, resource availability declines in some patches and increases in others.

Photo by Gary Kramer

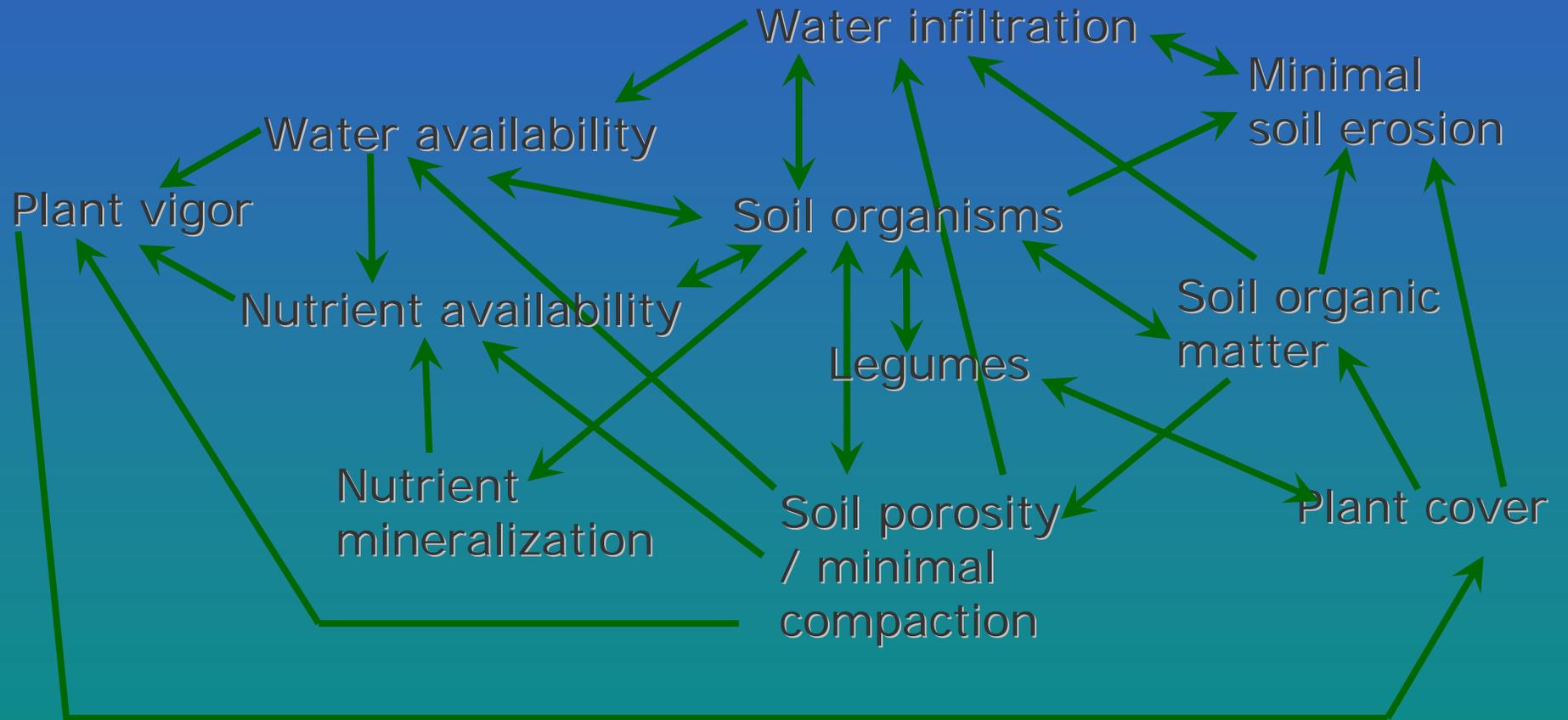


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# Rangeland and Soil Quality



## To Protect Soil Function and Rangeland Health

- Maintain or increase litter cover on the field.
- Increase or maintain plant production.
- Promote diverse species with high root biomass.
- Decrease the number and size of bare areas.



Photo by Gary Kramer



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## To Protect Soil Function and Rangeland Health

- Reduce soil surface disturbance, especially in arid areas.
- Minimize grazing and traffic when the soil is wet.
- Use prescribed burning to prevent fuel build-up.
- Assess and monitor soil quality and vegetation for early indication of changes in soil function and rangeland health.



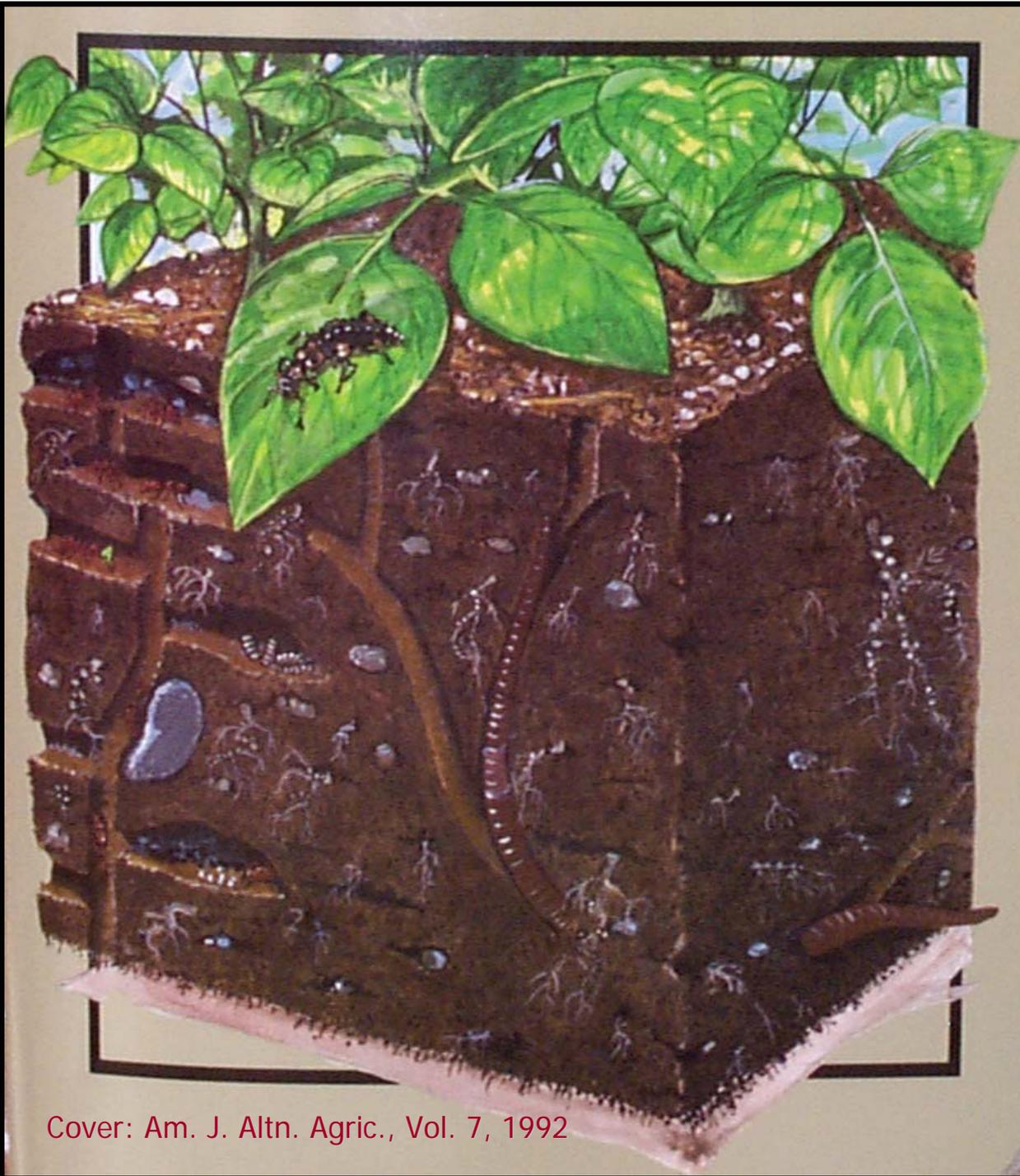
Photo by Irv Cole



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**Our  
Soil  
Is**

**Our  
Strength**



Natural Resources  
Conservation Service

Cover: Am. J. Altn. Agric., Vol. 7, 1992