

Soils and Ecosystem Functioning



DEPARTMENT OF
**PLANT & SOIL
SCIENCE**

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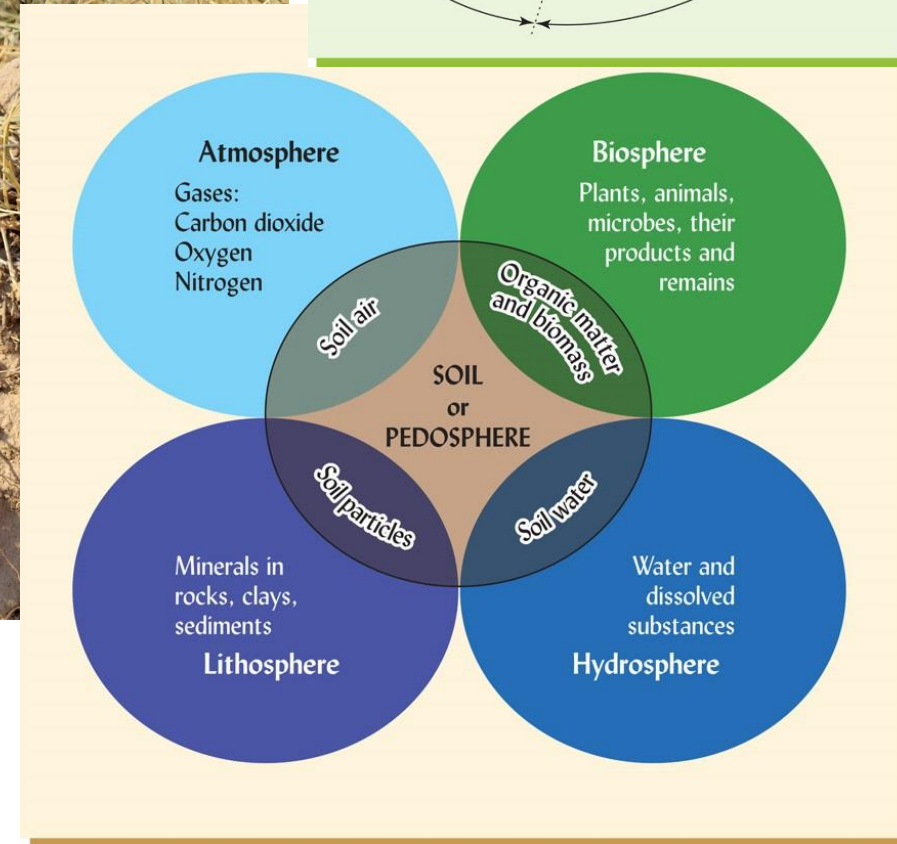
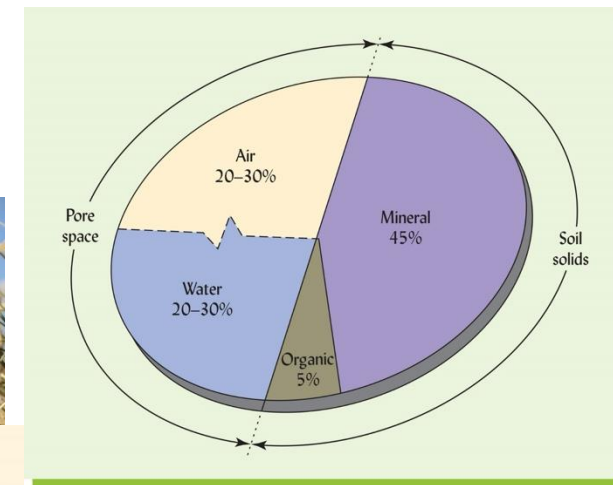


SOIL HEALTH
INSTITUTE

Enriching Soil, Enhancing Life

What is soil?

- SSSA Glossary of Soil Science Terms, definition of soil:
 - (i) The unconsolidated mineral or organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants.
 - **Composed of air, water, minerals, and organic matter.**
 - Intersection of the –spheres.

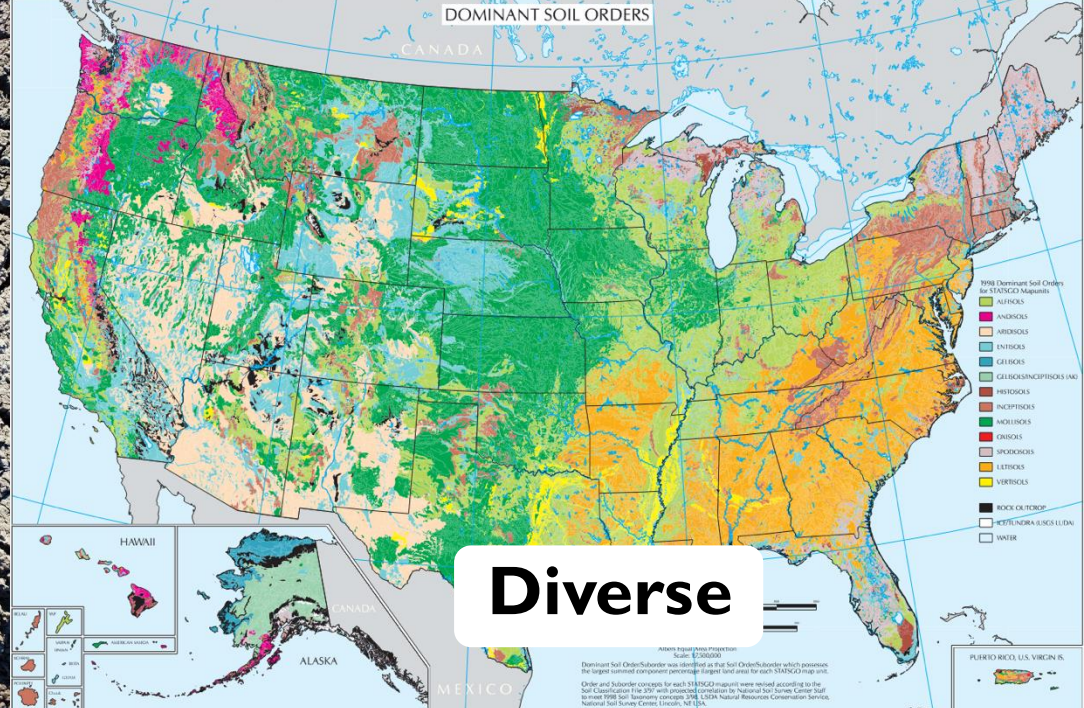




Soils are...



Active



Diverse



Complex



Alive



Beautiful

Soil as the foundation of ecosystems

Ecosystem services (or, Nature's Contributions to People): The tangible and intangible benefits that humans obtain from ecosystems.

- 1. Provisioning services:** Goods such as food, water, medicine
- 2. Regulating services:** Processes that improve water quality, decompose wastes, regulate atmospheric gases
- 3. Supporting services:** Assist with or provide a medium for nutrient cycling, seed dispersal, biomass production
- 4. Cultural services:** Aesthetic value, recreation, spiritual/religious relationships



What does soil do?

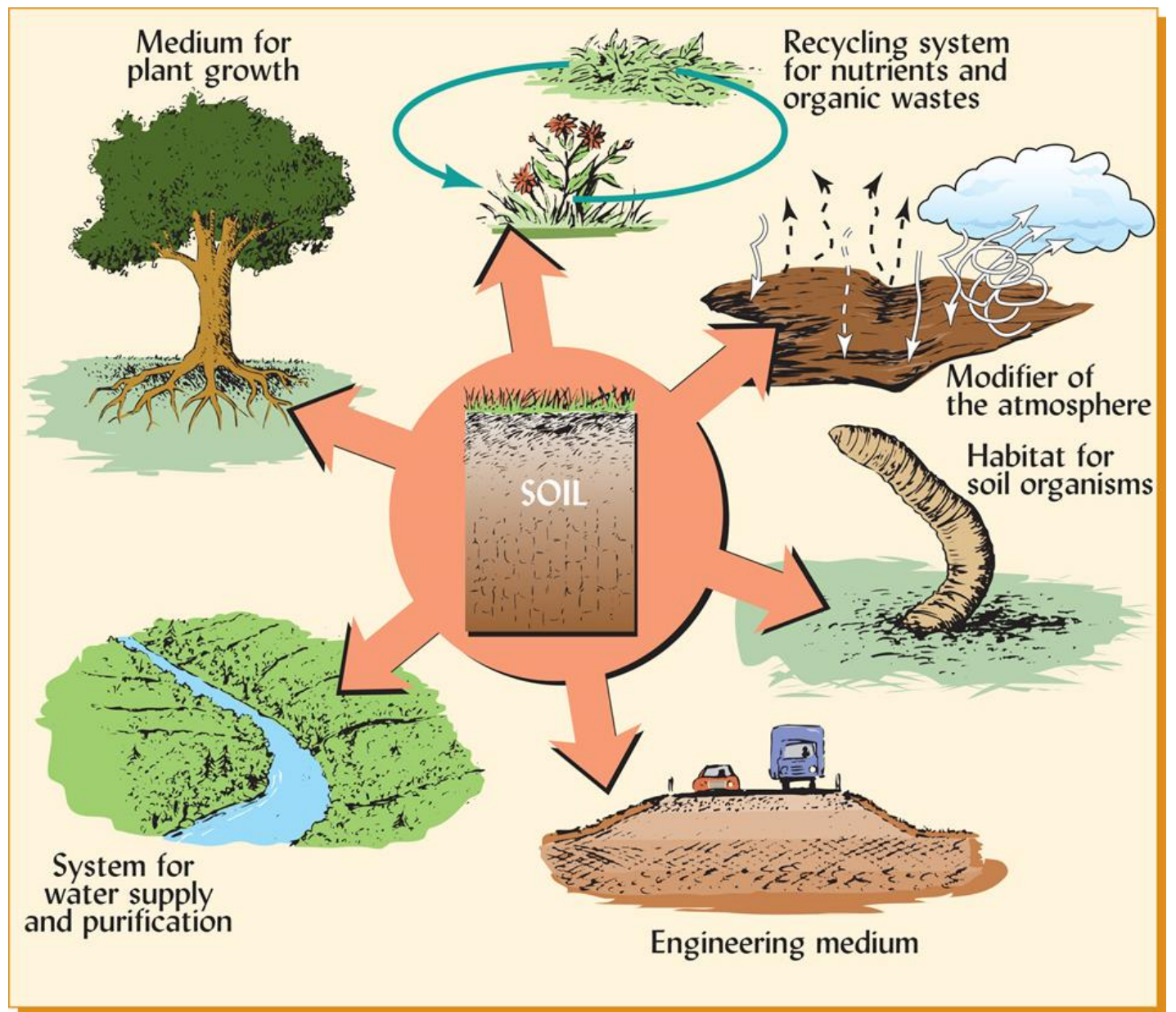
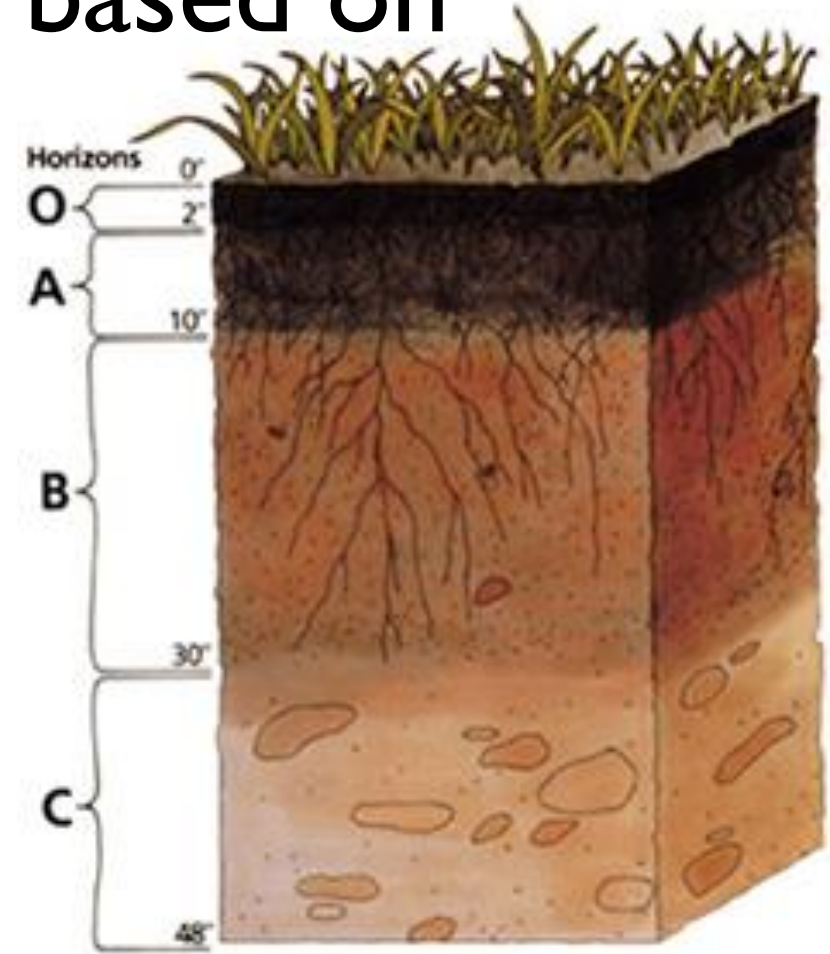


Figure 1.2 The many **functions** and ecosystem services performed by soil can be grouped into six crucial **ecological roles**. (Brady/Weil)

Soils are defined and described based on their properties

- **Physical**
 - Color, structure, texture, density
- **Chemical**
 - pH, salts, nutrients, organic matter
- **Biological**
 - Micro/meso/macro-organisms, vegetation

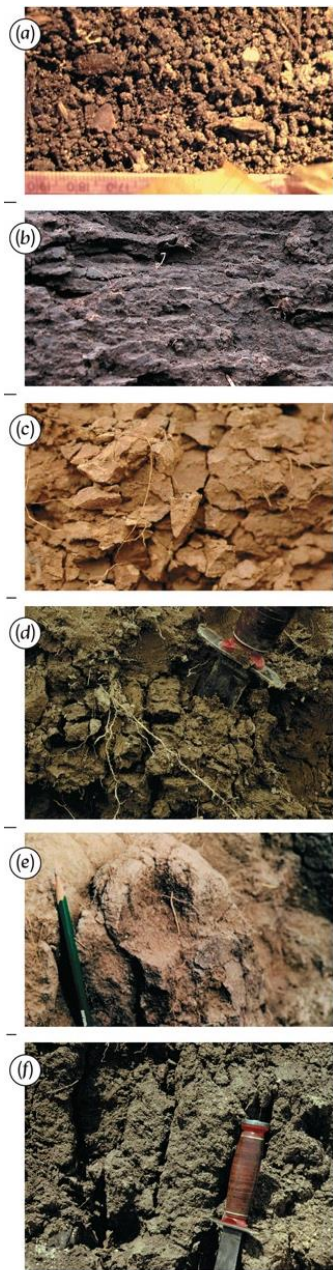
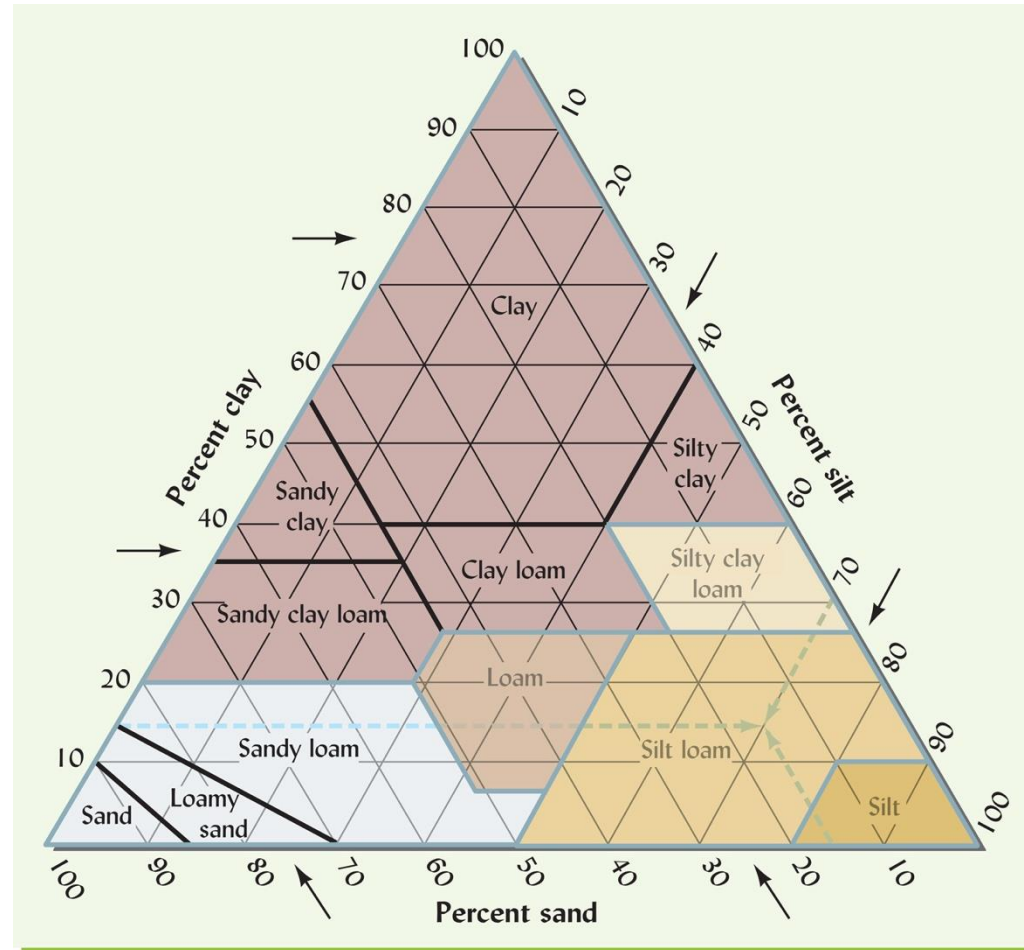


Horizons = horizontal soil layers
Profile = vertical description

“Soil type” can mean a lot of things

Often refers to relative differences in **soil properties** such as...

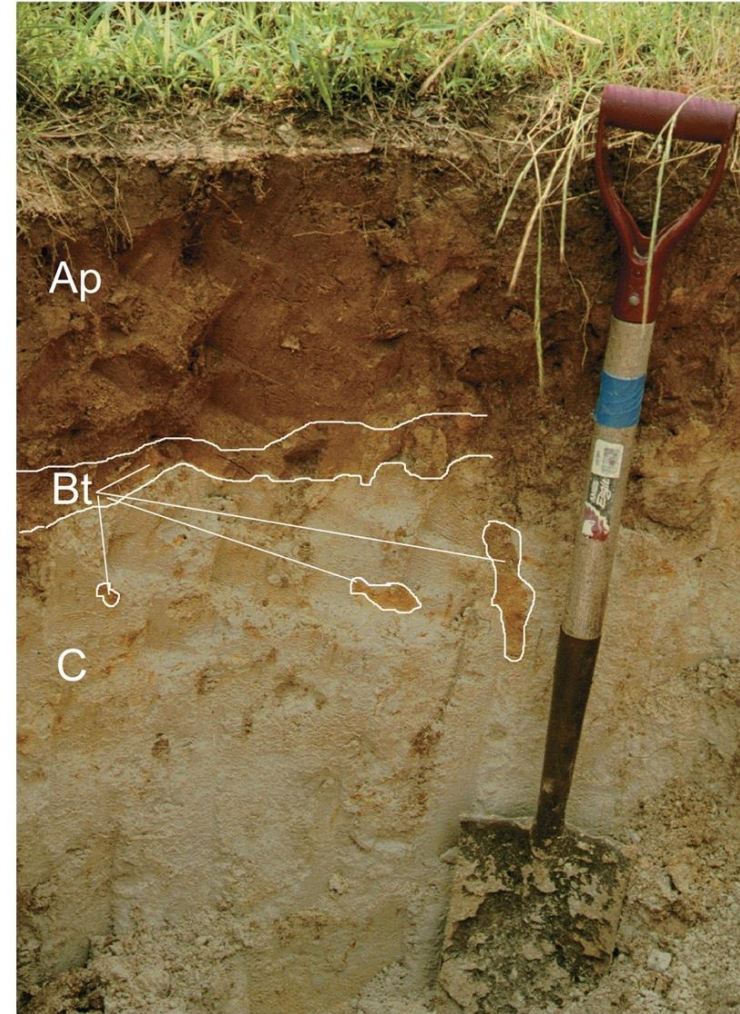
- Texture
- Structure
- Mineralogy
- ...and more!



“Soil type” can also indicate taxonomic classification

Soil taxonomy is a system of identifying and classifying soils based on chemical, physical, and biological properties

- Moisture/temperature, color, texture, structure, chemical/mineral properties, pH, depth, unique features, etc.



Soils taxonomic classification

Table 3.2

COMPARISON OF THE CLASSIFICATION OF A COMMON CULTIVATED PLANT, WHITE CLOVER (*TRIFOLIUM REPENS*), AND A SOIL, MIAMI SERIES

Plant Classification			Soil Classification	
Phylum	Pterophyta	Increase specificity 	Order	Alfisols
Class	Angiospermae		Suborder	Udalfs
Subclass	Dicotyledoneae		Great Group	Hapludalfs
Order	Rosales		Subgroup	Oxyaquic Hapludalfs
Family	Leguminosae		Family	Fine loamy, mixed, mesic, active
Genus	<i>Trifolium</i>		Series	Miami
Species	<i>repens</i>		Phase ^a	Miami silt loam

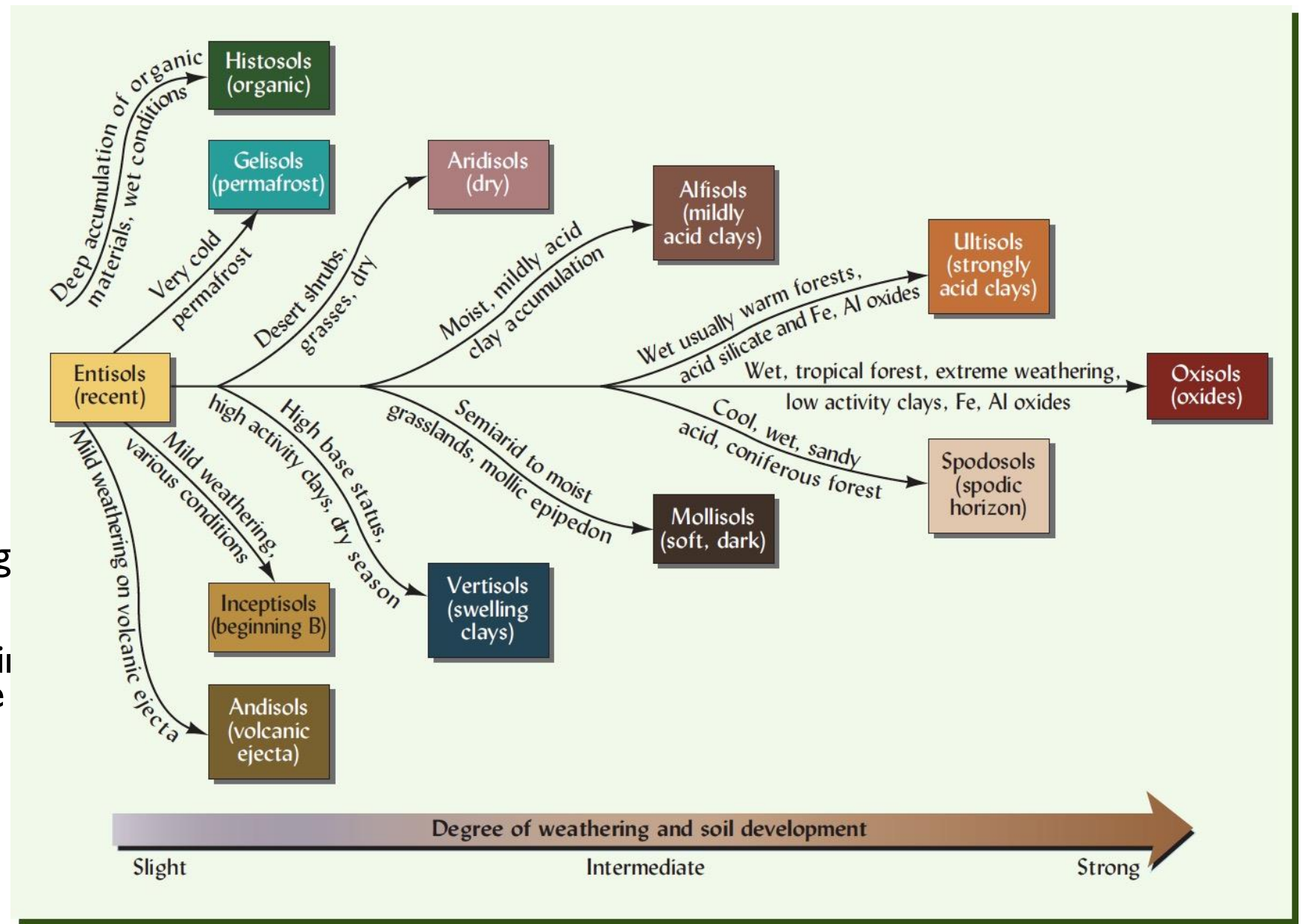
Think of a “**Soil Order**” as equal to a “**Phylum**” for living organisms

Think of a “**Soil Series**” as equal to the scientific name (**Genus + species**) for living organisms

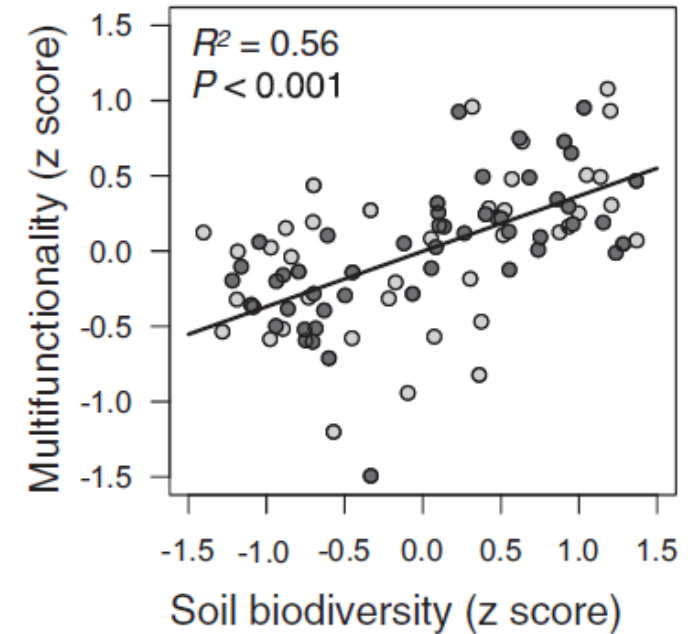
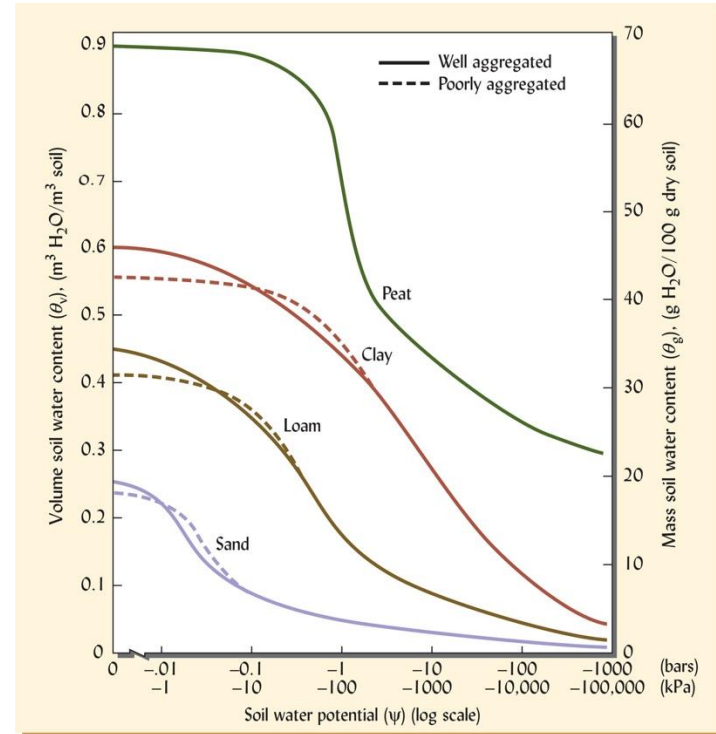
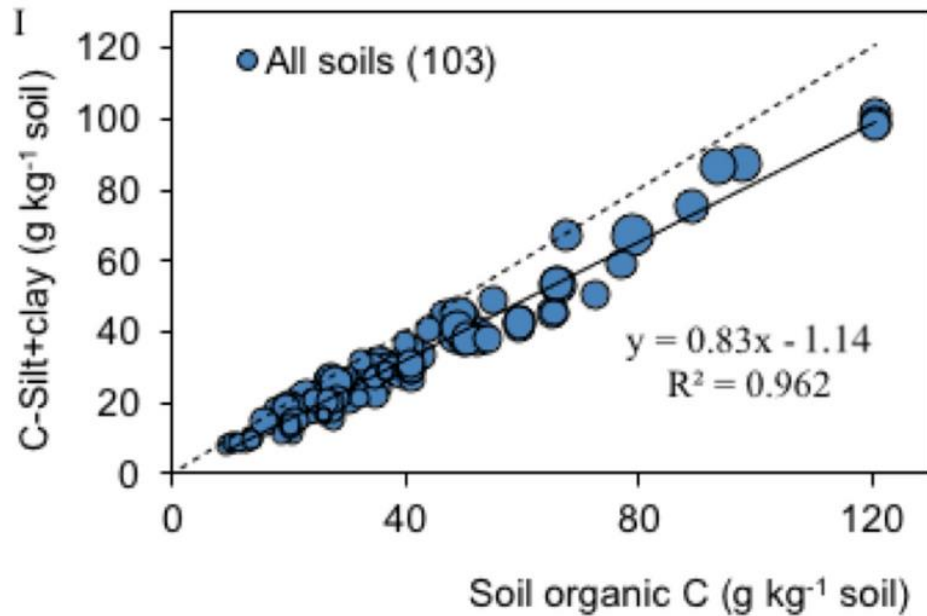
^aTechnically not a category in *Soil Taxonomy* but used in field surveying. *Silt loam* refers to the texture of the A horizon.

Twelve (12) Soil Orders

Figure 3.9 Diagram showing general degree of weathering and soil development in the different soil orders classified in Soil Taxonomy. Also shown are the general climatic and vegetative conditions under which soils in each order are formed.



Soil properties affect soil function

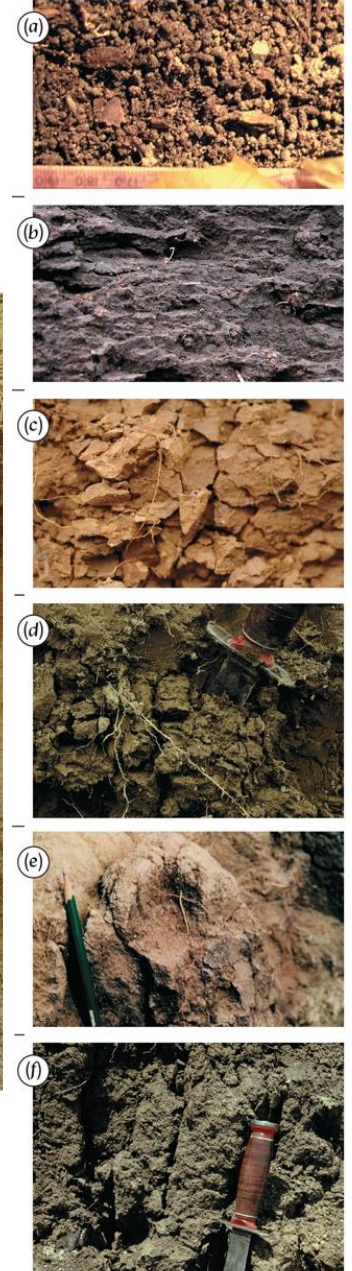
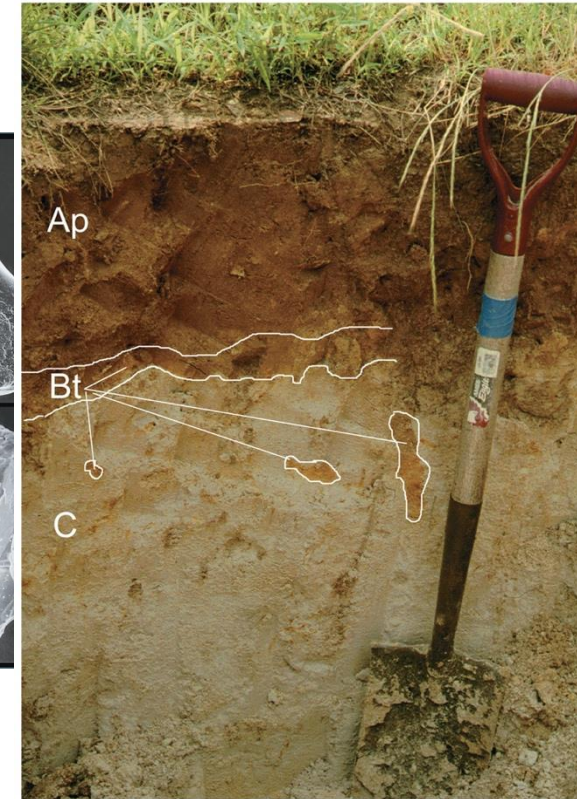
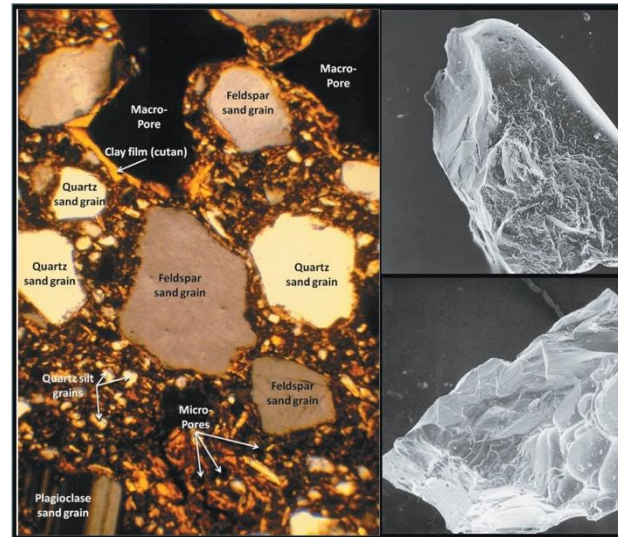


Matus, F.J. 2021. <https://doi.org/10.1038/s41598-021-84821-6>

Wagg et al., 2014.
www.pnas.org/cgi/doi/10.1073/pnas.1320054111

Diverse properties of soils affect how they are best managed

- Colors
 - Red/yellow, light/dark, intensity/brightness
- Textures
 - Sand, Silt, Clay proportion
 - Clay mineralogy
- Structures
 - Sphere, Plate, Block, Prism
- Profiles
 - Layering (horizons), depth
- Soil forming factors
 - Climate, temperature/moisture regimes, vegetation



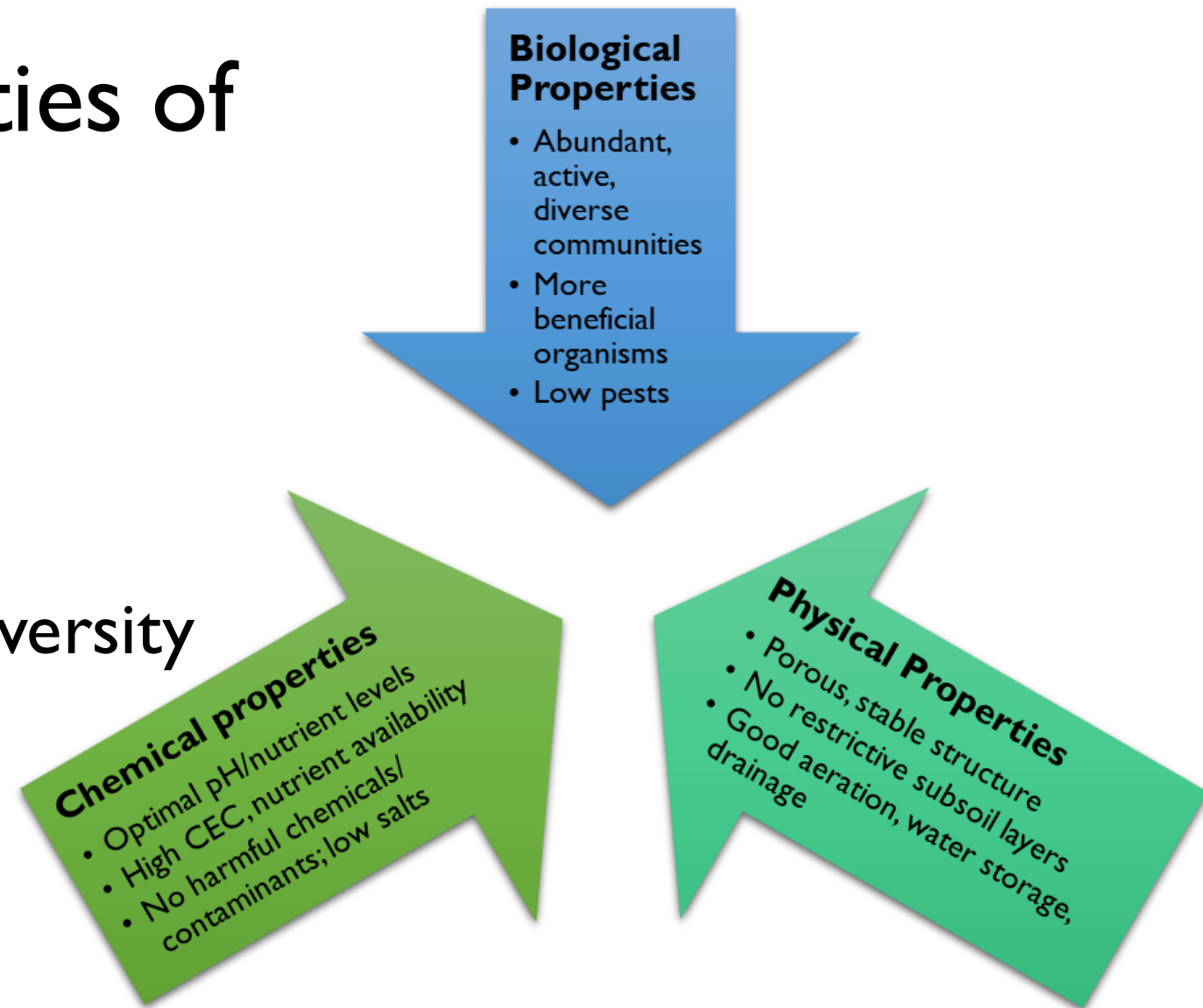
A close-up photograph of two hands holding a large clump of dark brown soil. The soil is rich and moist, with several earthworms visible. One worm is prominently shown in the center, and another is at the bottom left. The hands are positioned at the top and bottom of the frame, with fingers spread to hold the soil. The background consists of green grass and some dry, yellowish plant matter.

What is Soil “Health”

The continued capacity of a soil to function within ecosystem boundaries to sustain biological productivity, maintain environmental quality, and promote plant and animal health.

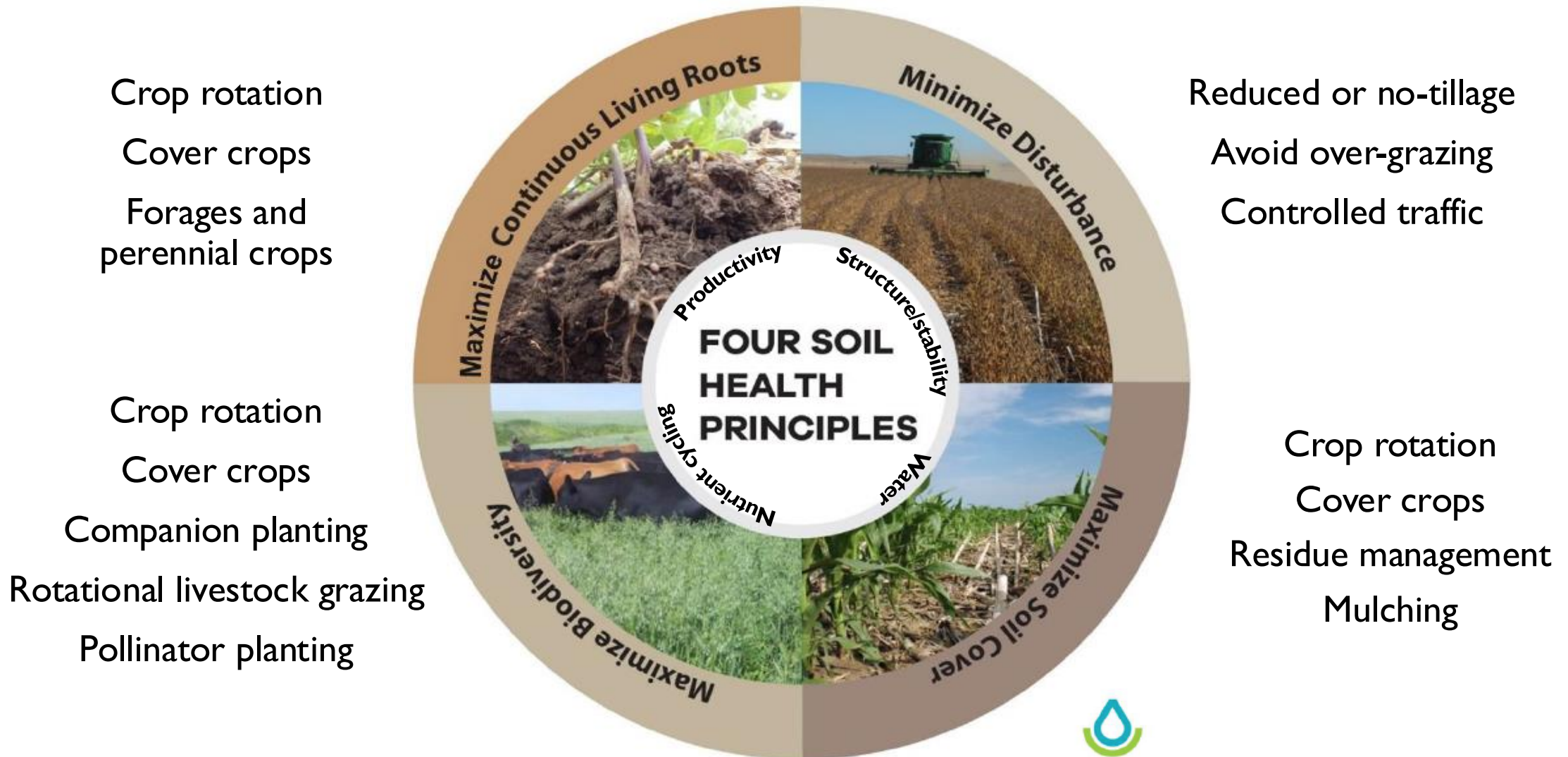
Functions & properties of healthy soil

1. Produce food, fiber, fuel
2. Purifies water
3. Sequesters carbon
4. Provides habitat for biodiversity
5. Cycles/recycles nutrients

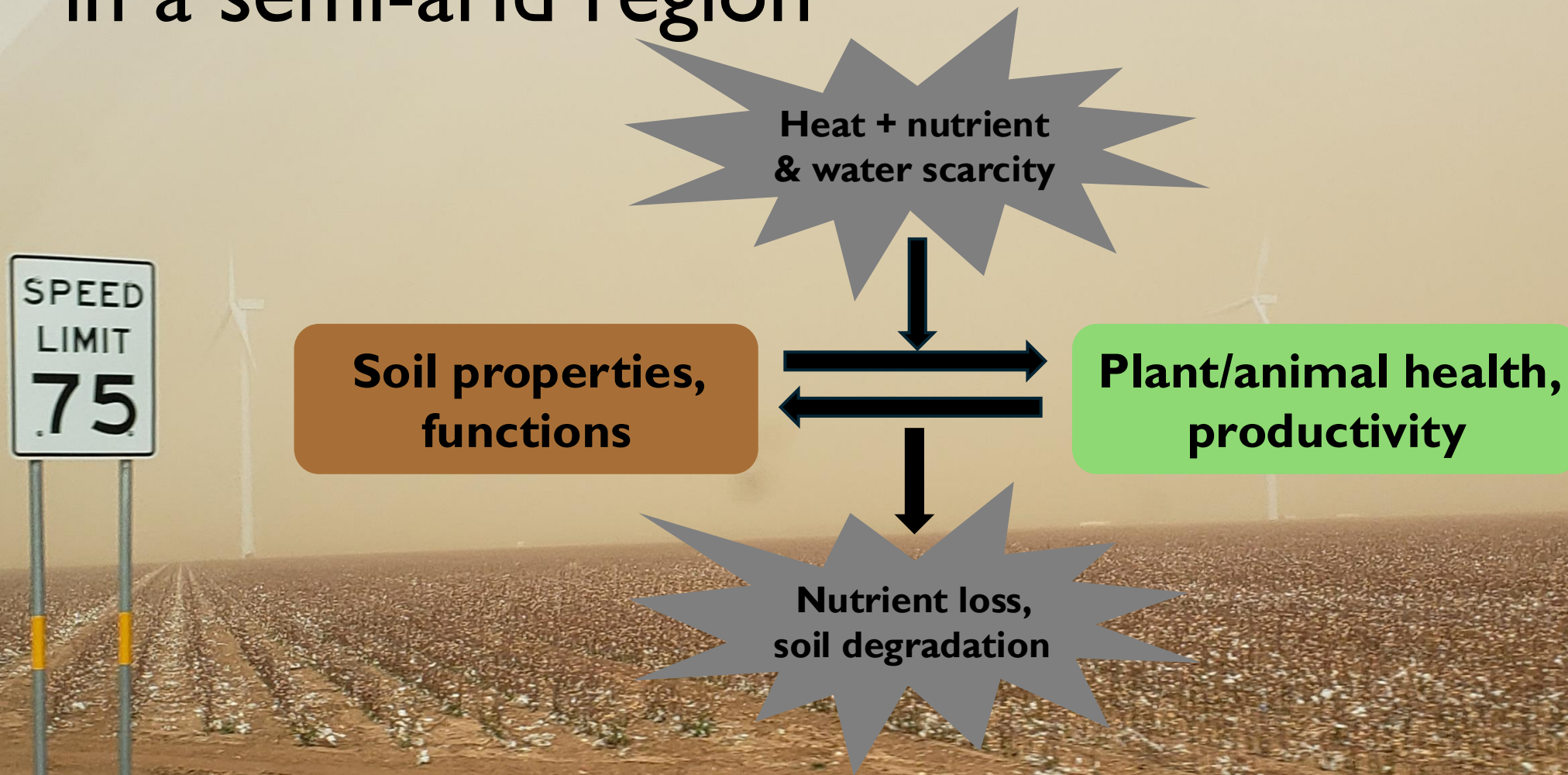


Adapted from Fig. 8.1 in *Building Soils for Better Crops: Ecological Management for Healthy Soils*. 2021. USDA-SARE Handbook 10.

How do we manage soil health?



Challenges for sustainable soil management in a semi-arid region



Soil health challenges



Soil degradation



Resource scarcity

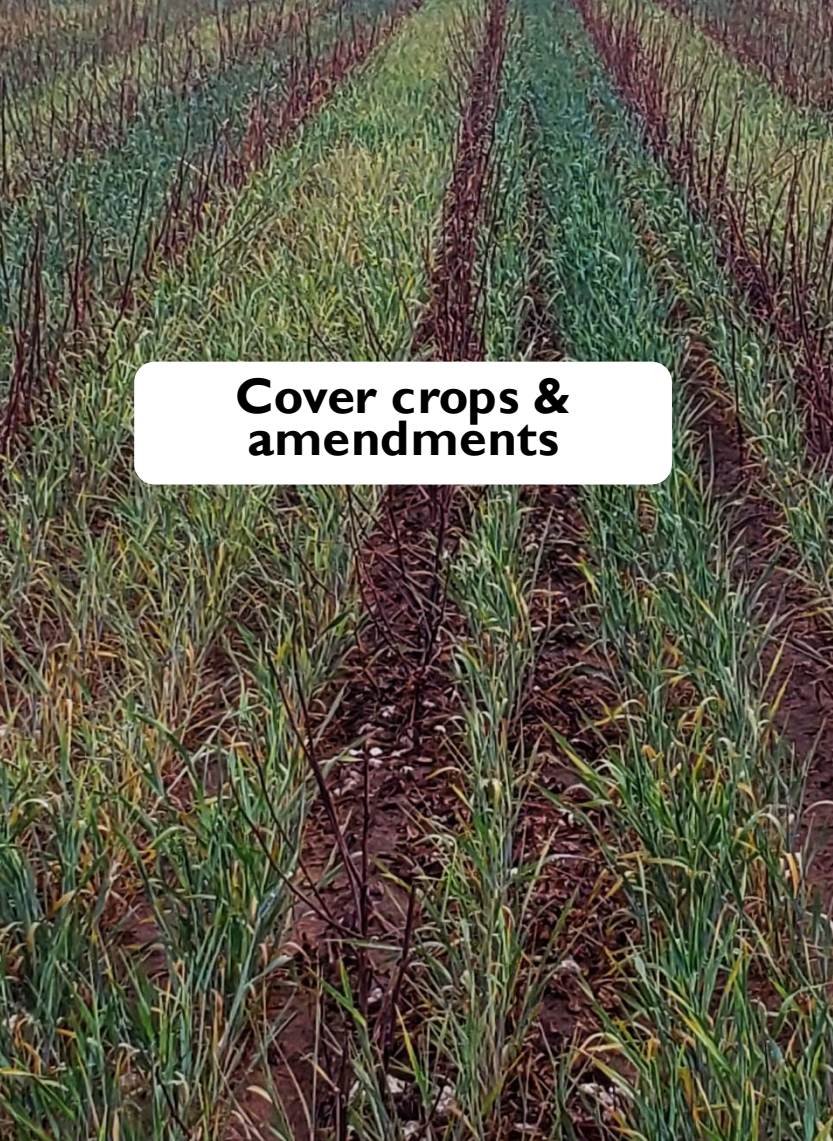


Environmental Stress

Soil health successes!



Rotations



Cover crops & amendments



Perennial pastures & legumes