Building Soil Health on Your Farm

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Presentation Outline

- What is soil health?
- How can we measure soil health?
- What management practices can improve soil health?
- How might growing alfalfa improve soil health?

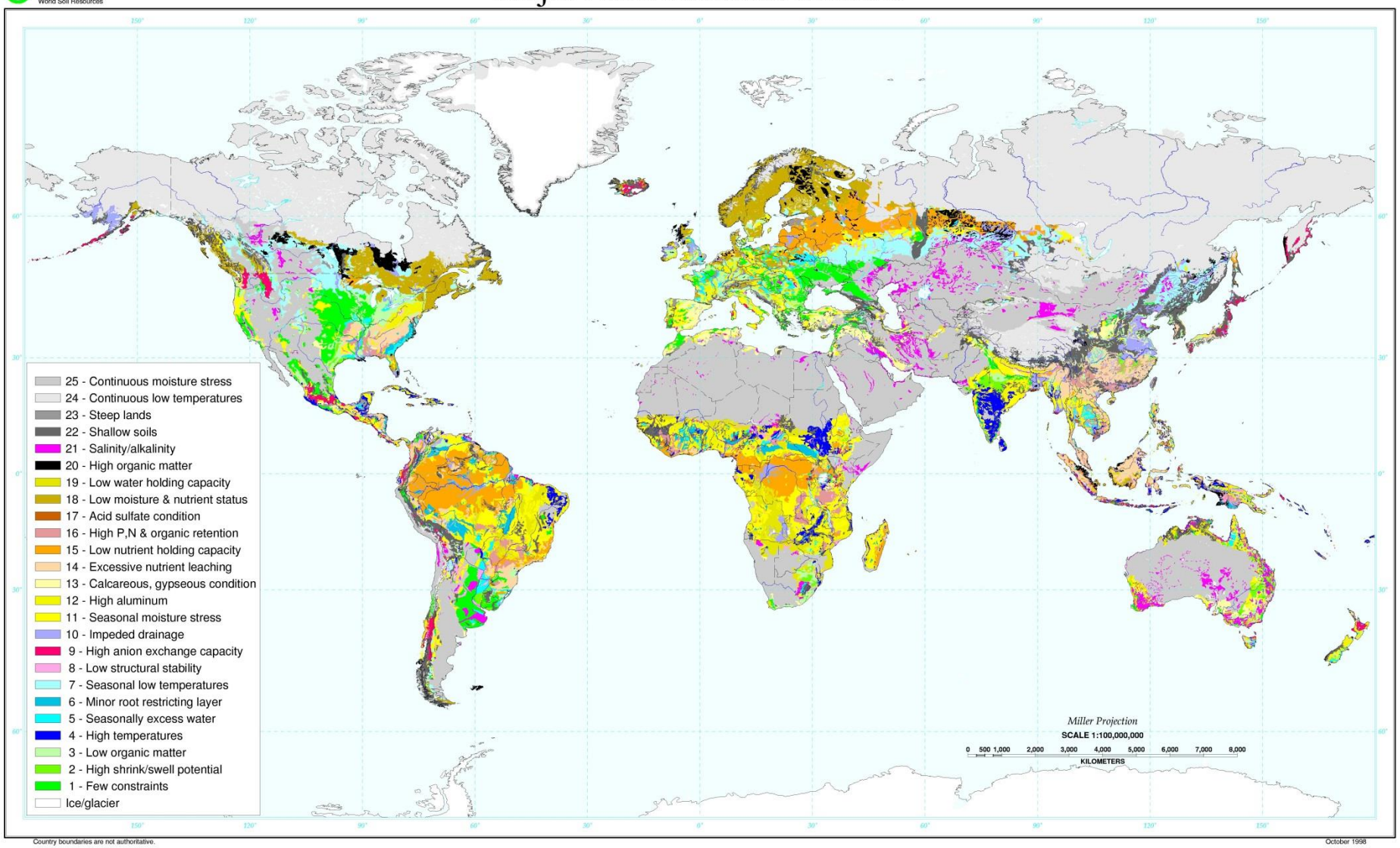
Why all the interest in soil health?

Air and water quality are impacted by soil conditions, and with little new agricultural land to develop globally, preserving soil quality is critical to sustaining the needs of a growing population (Doran, 2002).

We may think that 'soil health' is a new concept, particularly as it has been recently recognized in state programs, but in fact, preserving soil quality is not new to government policies.

"Some folks don't know how to appreciate good news" (September 16, 1927). Credit: Courtesy of the J.N. "Ding" Darling Foundation.

Soil conservation policy in the United States dates back to the Great Depression, but it was disguised as commodity-control policy. The primary interest was in mitigating soil erosion.



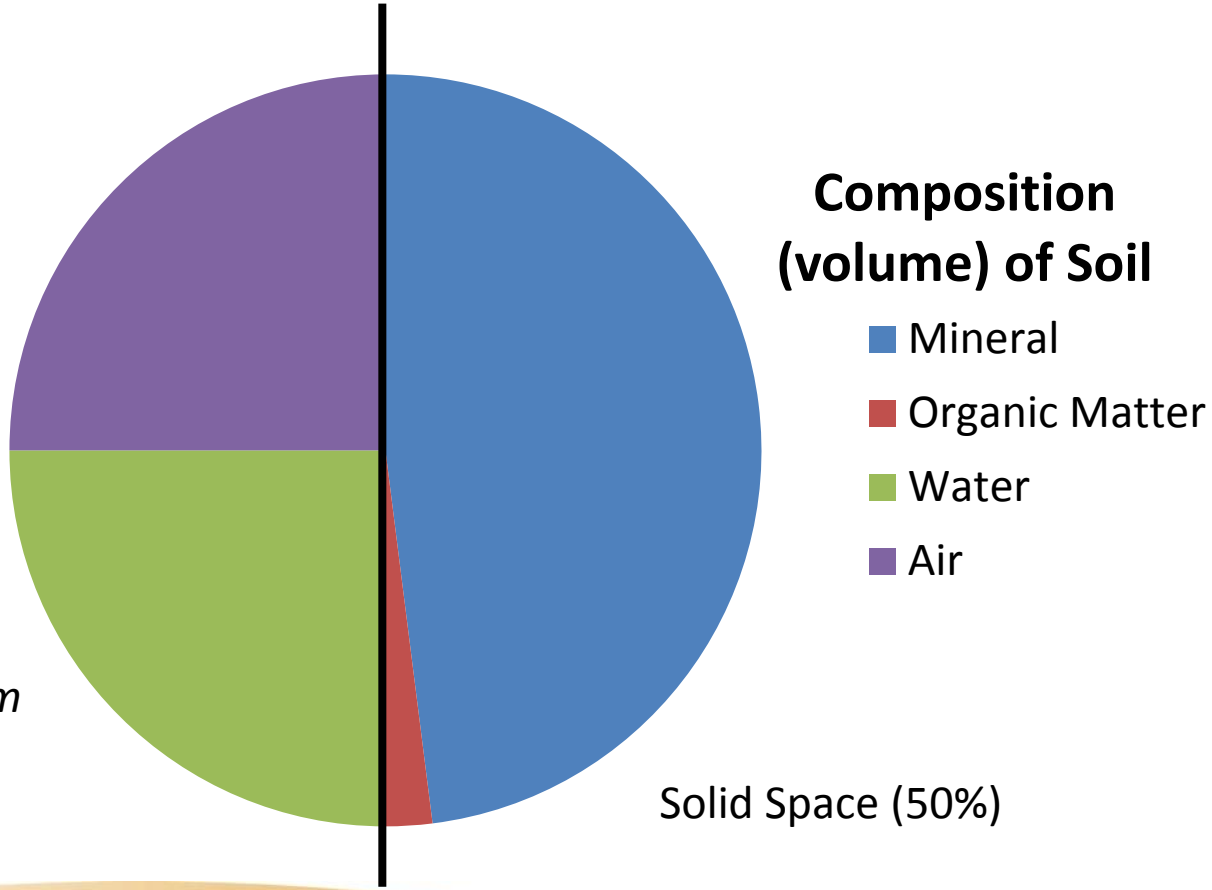
We know, however, that stresses on land go beyond erosion, and include salinity, poor drainage, toxicities, among others, not to mention inhospitable climates for agriculture.

What is soil health?

"the capacity of a soil to function, within ecosystem and land-use boundaries, to sustain biological productivity, maintain environmental quality, and promote plant and animal health."

Doran and Parkin, 1994

What is soil?

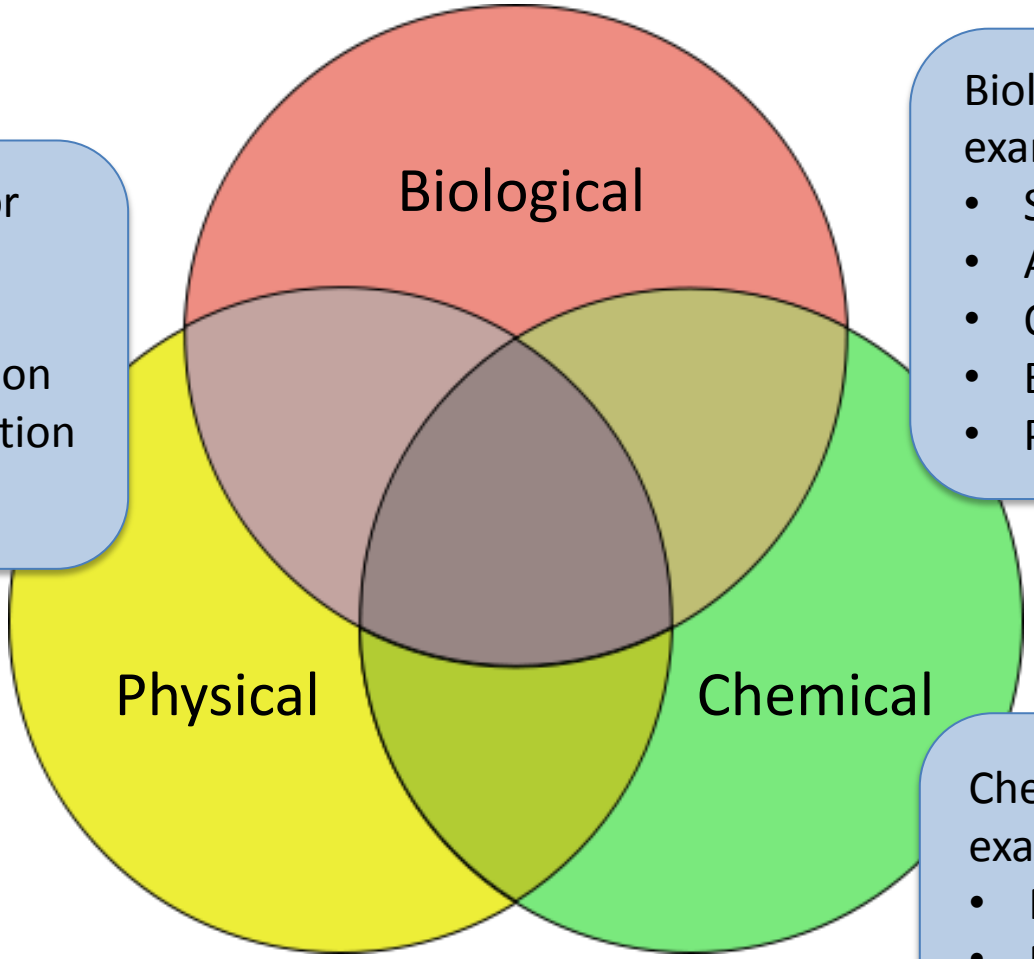


Pore Space (50%)

Pore space may vary from 25-60%, and agricultural management influences pore space.

Solid Space (50%)

What is soil health?

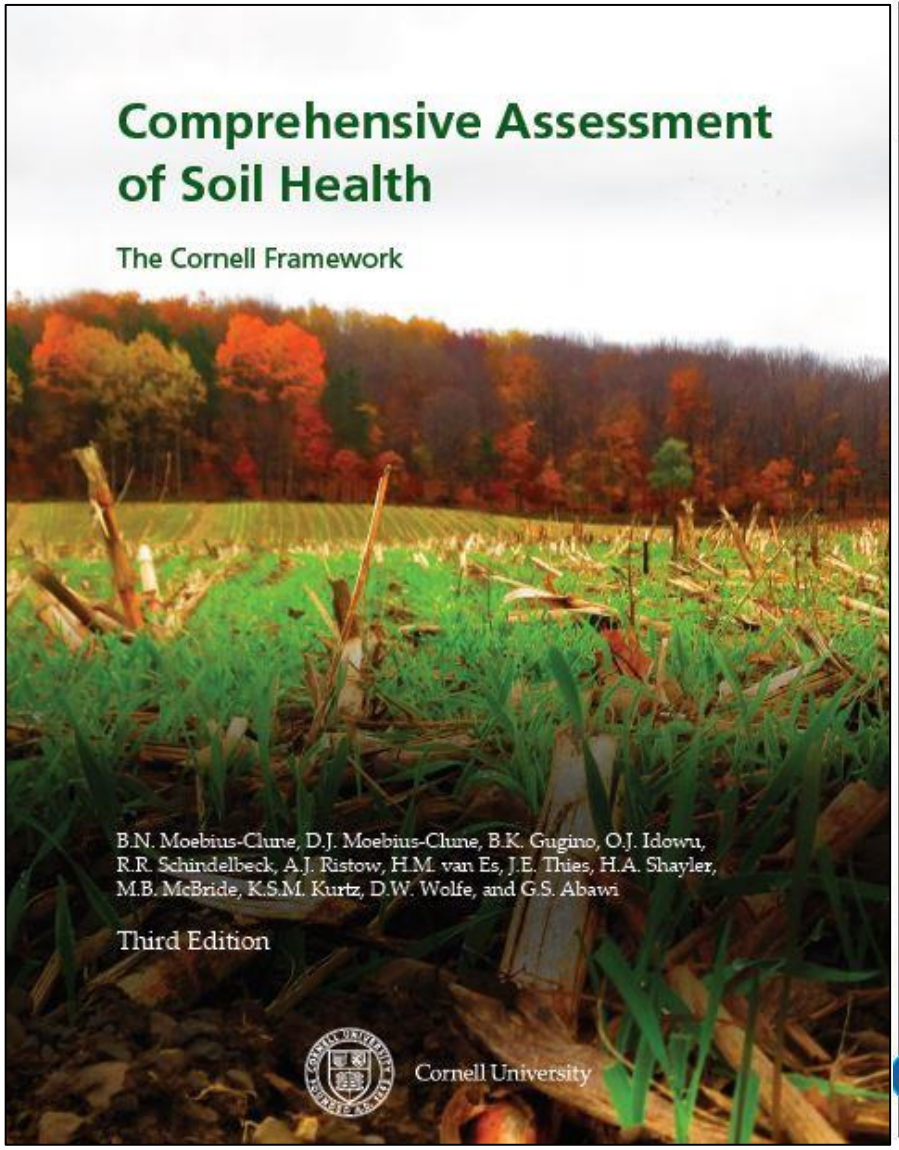


Physical Indicator examples:
- Compaction
- Soil aggregation
- Water infiltration
- Bulk density

Biological Indicator examples:
- Soil respiration
- Active carbon
- Organic matter
- Earthworms
- Pest pressure

Chemical Indicator examples:
- Macronutrients
- Micronutrients
- pH
- Salinity

Soil Health Framework – An Example



Comprehensive Assessment of Soil Health

From the Cornell Soil Health Laboratory, Department of Soil and Crop Sciences, School of Integrative Plant Science, Cornell University, Ithaca, NY 14853. http://soilhealth.cals.cornell.edu

Grower: 1
Bob Schindelbeck
306 Tower Rd.
Ithaca, NY 14853

Agricultural Service Provider:
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rrs3@cornell.edu

Sample ID:	LL8
Field ID:	Caldwell Field- intensive management
Date Sampled:	03/11/2015
Given Soil Type:	Collamer silt loam
Crops Grown:	WHT/WHT/WHT
Tillage:	7-9 inches

Measured Soil Textural Class: **silt loam**

Sand: **2%** - Silt: **83%** - Clay: [illegible]%

Group	Indicator (2)	Value (3)	Rating (4)	Constraints (5)
physical	Available Water Capacity	0.14	37	
physical	Surface Hardness	260	12	Rooting, Water Transmission
physical	Subsurface Hardness	340	35	
physical	Aggregate Stability	15.7	19	Aeration, Infiltration, Rooting, Crusting, Sealing, Erosion, Runoff
biological	Organic Matter	2.5	28	
biological	ACE Soil Protein Index	5.1	25	
biological	Soil Respiration	0.5	40	
biological	Active Carbon	288	12	Energy Source for Soil Biota
chemical	Soil pH	6.5	100	
chemical	Extractable Phosphorus	20.0	100	
chemical	Extractable Potassium	150.6	100	
chemical	Minor Elements Mg: 131.0 / Fe: 1.2 / Mn: 12.9 / Zn: 0.3		100	

6 Overall Quality Score: **51** / Medium

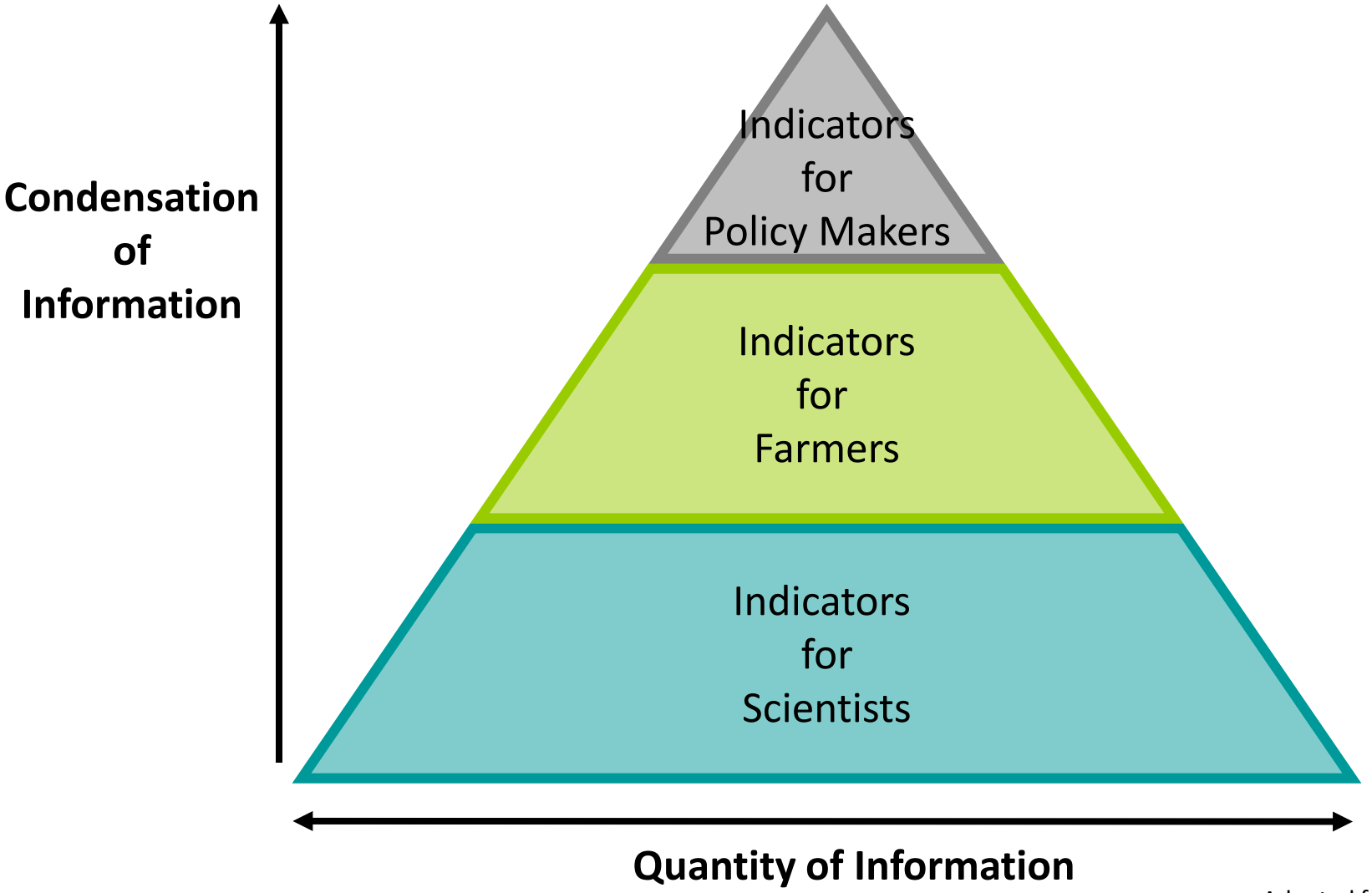
Soil health indicators should…

- Measure properties that are sensitive to management and have an impact on soil functionality.
- Not be too costly.
- Be selected with consideration of the landscape and climate.

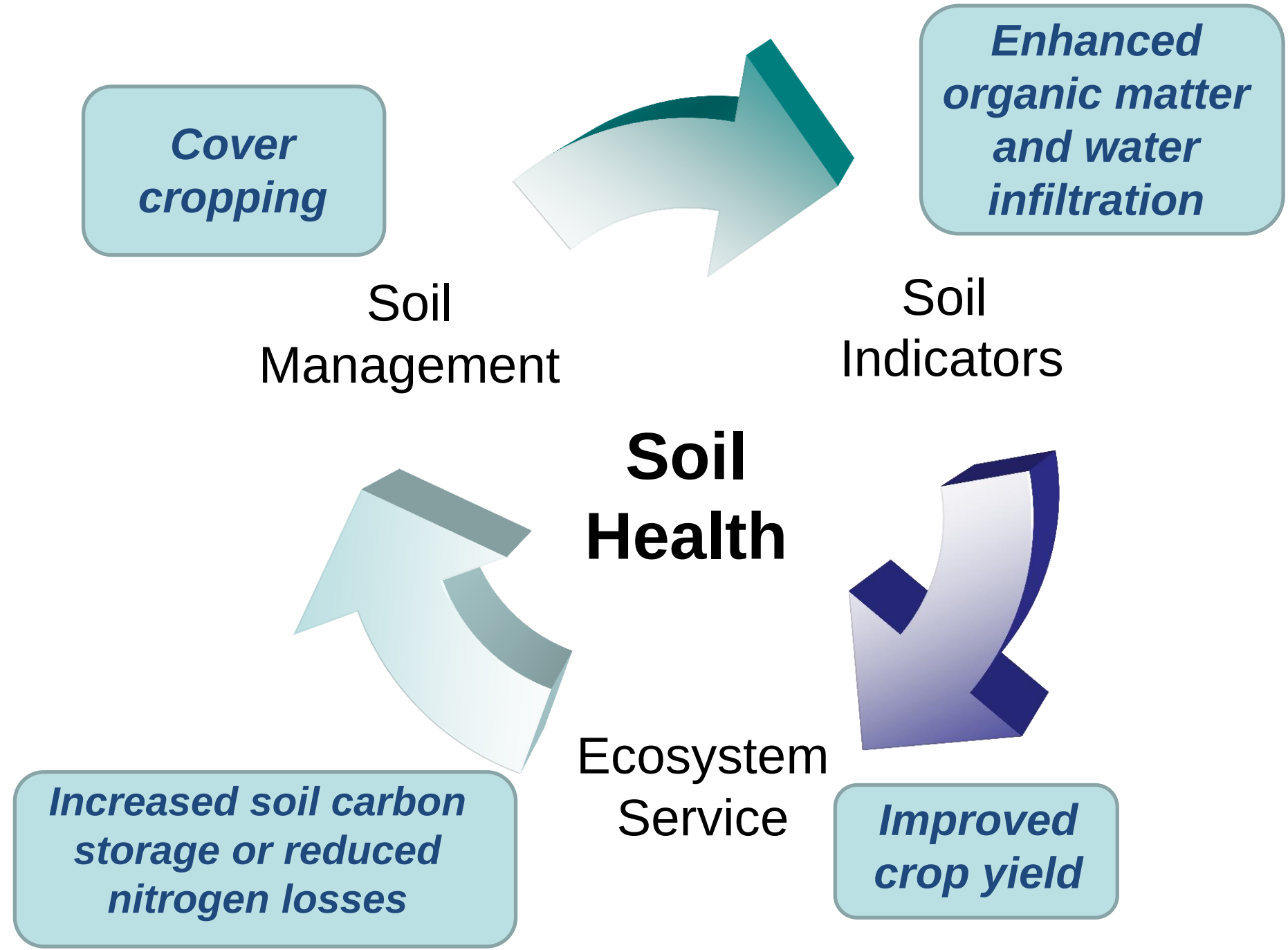
Changes in soil health happen over the long-term.

Soil health indicators will…

vary depending on who is the interested party.



Adapted from (Braat, 1991)


Cover cropping
Enhanced organic matter and water infiltration
Soil Management
Soil Indicators
Soil Health
Ecosystem Service
Increased soil carbon storage or reduced nitrogen losses
Improved crop yield

What we know…

Practices that improve soil health: adding organic matter amendments (e.g. compost)

Improves:

- Soil aggregation
- Water infiltration
- Nutrient availability for plants
- Food source for soil biology

What we know…

Practices that improve soil health: reduced soil disturbance (i.e. tillage)

Improves:

- Soil aggregation
- Organic matter
- Soil carbon storage

What we know…

Practices that improve soil health: cover cropping

Improves:

- Weed suppression
- Nitrogen availability (adding to soil pool)
- Nutrient scavenging (subtracting from soil pool)
- (Reduces) Compaction
- Food sources for soil biology

Managing for soil health

Background: CDFA developed the Healthy Soils Program and awards grants for projects that improve soil health and sequester carbon.

- Compost, reduced tillage, and cover cropping are approved practices

Objective: Determine how practices impact soil quality, greenhouse gas emissions, and/or crop yield.

Funding is provided through California Climate Investments (i.e. cap and trade); thus, greenhouse gas monitoring is integrated into HSP projects.

Managing for soil health

Demonstration project (2018-2020) was funded to trial:

- Summer cover crop in San Joaquin
- Winter cover crop in Sutter
- Compost amendment in Merced

Soil tests: bulk density, pH, salinity, total C and N, aggregate stability, infiltration, and active C

GHG measurements: (N_2O, CH_4) around rain events and management practices

Cover crop performance and crop yields

UC ANR and CDFA partner on Climate Smart Agriculture

Goal: encourage adoption of science-based climate smart farming and ranching practices.

Provide: technical assistance for growers in applying for:

- Statewide Water Efficiency and Enhancement Program (SWEEP)
- Healthy Soils Program (HSP)
- Alternative Manure Management Program (AMMP)

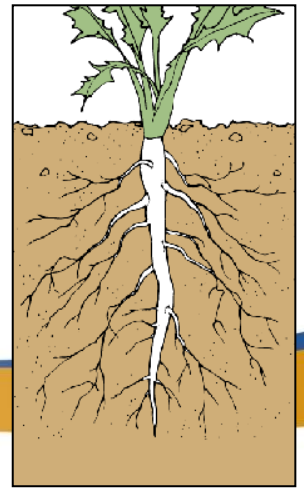
Hiring: 10 Community Education Specialists working with UCCE Advisors (See https://ucanr.edu/Jobs/Jobs_990/)

More information: Doug Parker (UC ANR) and Amrith Gunasekara (CDFA)

What we want to know more about…

How might growing alfalfa improve soil health?

- Nitrogen-fixing crop with little-to-no nitrogen fertilizer added over the life of the crop.
  - *Provides a nitrogen benefit of 50-125 lbs N/acre to subsequent crop (Lin and Putnam)*
  - *Candidate crop for groundwater banking (Dahlke, Putnam, and Orloff)*
- Deep-rooted
  - *Nutrient scavenging*
  - *Channels for water infiltration*



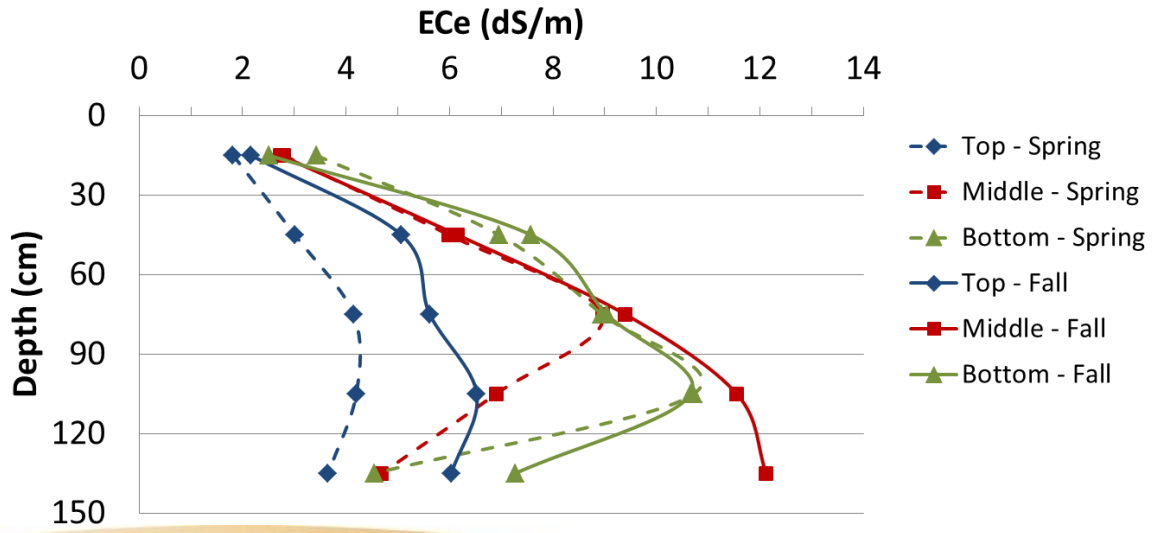
What we want to know more about…

How might growing alfalfa improve soil health?

- No tillage over the productive life of the stand.
  - *Improve soil aggregation*
  - *Enhance soil carbon storage*
- Alfalfa covers the soil as a cover crop would do but over several years.
  - *Reduces wind and water erosion*
  - *Reduces sediment and pesticide (e.g. pyrethroid) movement off-site*

What we want to know more about…

How might deficit irrigation compromise the potential benefits of growing alfalfa for improving soil health? *(e.g. salinity, soil biology)*



What we want to know more about…

How might compaction from equipment operations be mitigated?

Summary

- Soil health is defined as soil functioning and can be described by biological, chemical, and physical characteristics.
- Soil health is influenced by inherent site characteristics and management practices.
- We know that practices like cover cropping, organic matter amendments, reduced disturbance, and plant diversity/rotations improve soil health.
- Growing alfalfa has the potential to improve soil health as a deep-rooted, nitrogen-fixing ‘cover crop’, but we need to study how irrigation and equipment operations can be managed to prevent any compromises to soil health.

Thank you!

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http://ucanr.edu/sites/deltacrops/

http://ucanr.edu/blogs/sjcfieldcrops/