Managing for Soil Health and Soil Salinity

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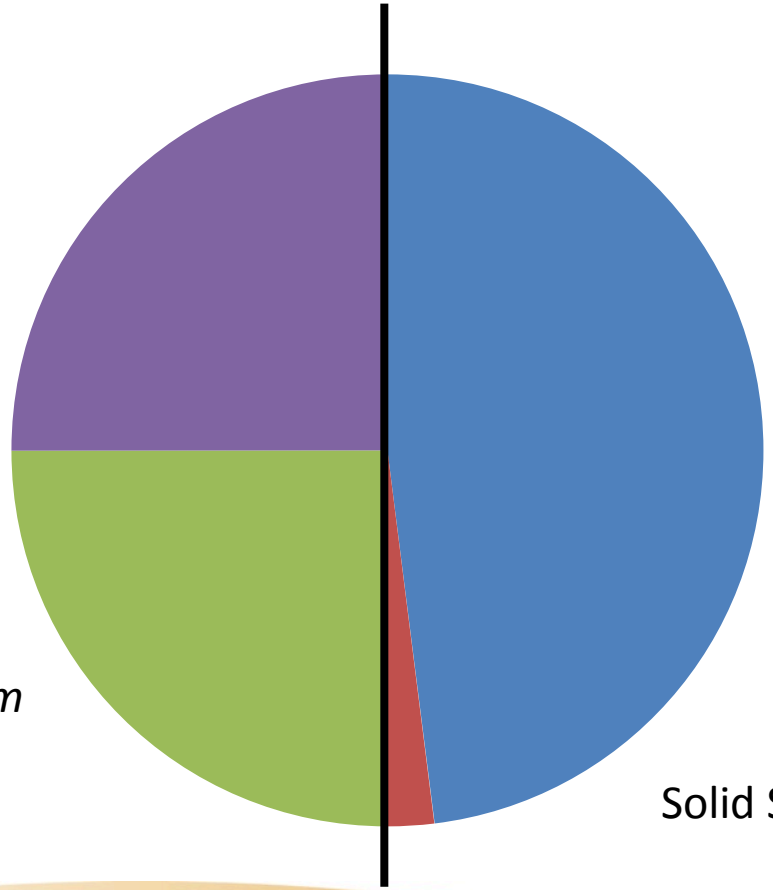
Presentation Outline

- What is soil health?
- What management practices can improve soil health?
- Considerations for both soil health and salinity management

What is soil?



Composition (volume) of Soil

- Mineral
- Organic Matter
- Water
- Air

Pore Space (50%)

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

Solid Space (50%)

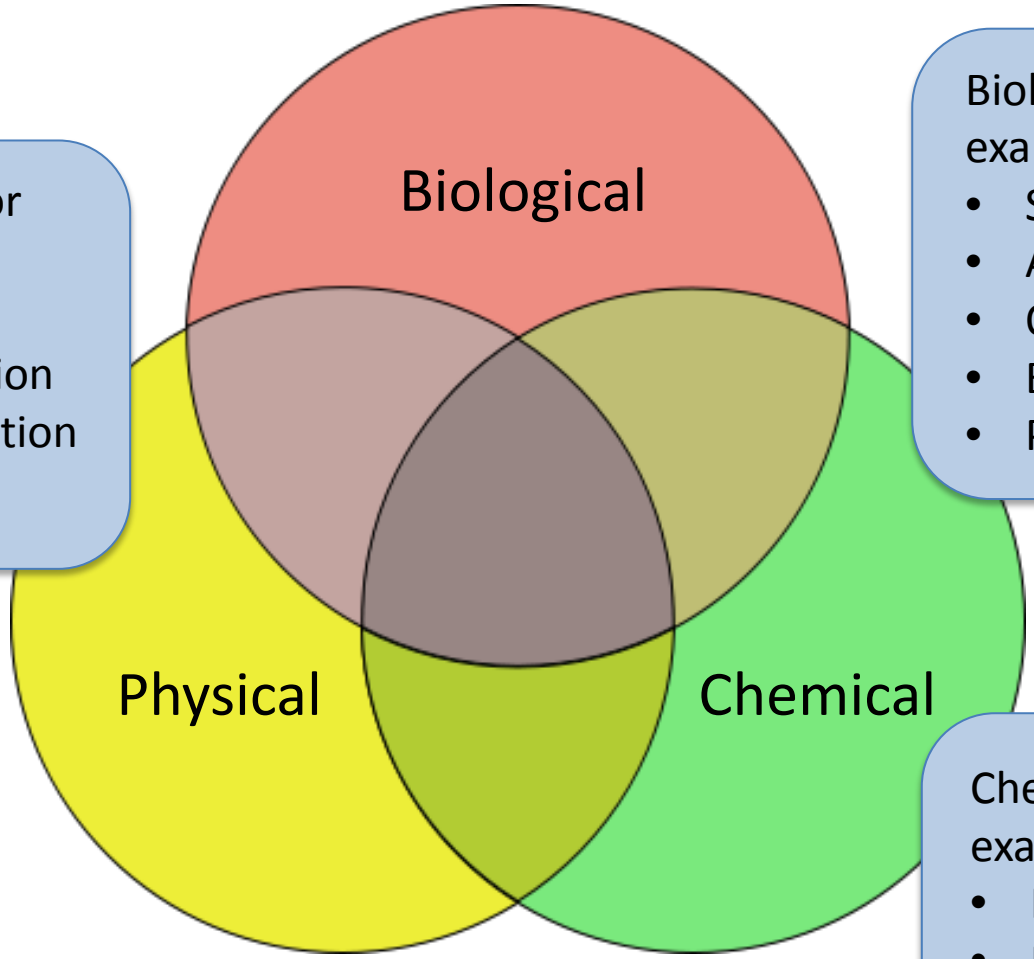
What is soil health?

"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 health?

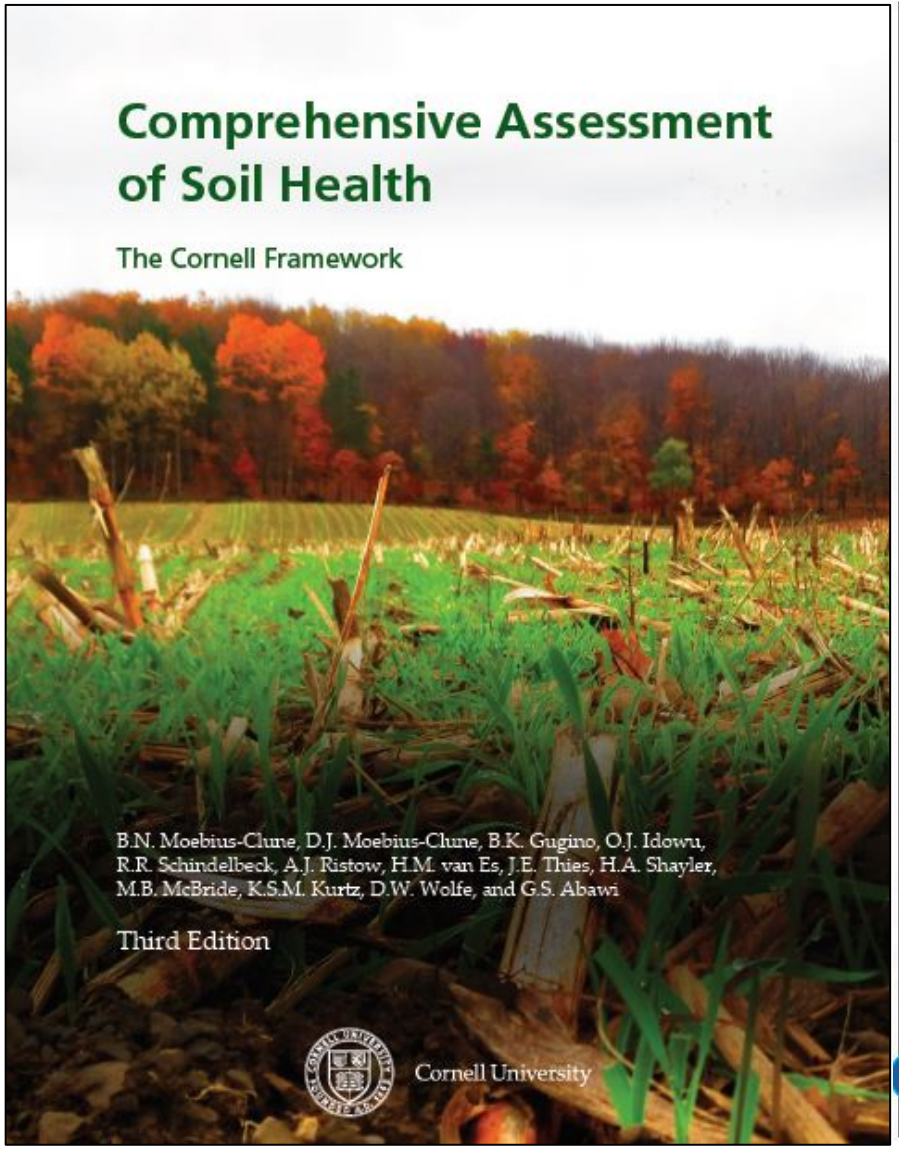
Physical Indicator examples:
- Compaction
- Soil aggregation
- Water infiltration
- Bulk density



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

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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: 3 4

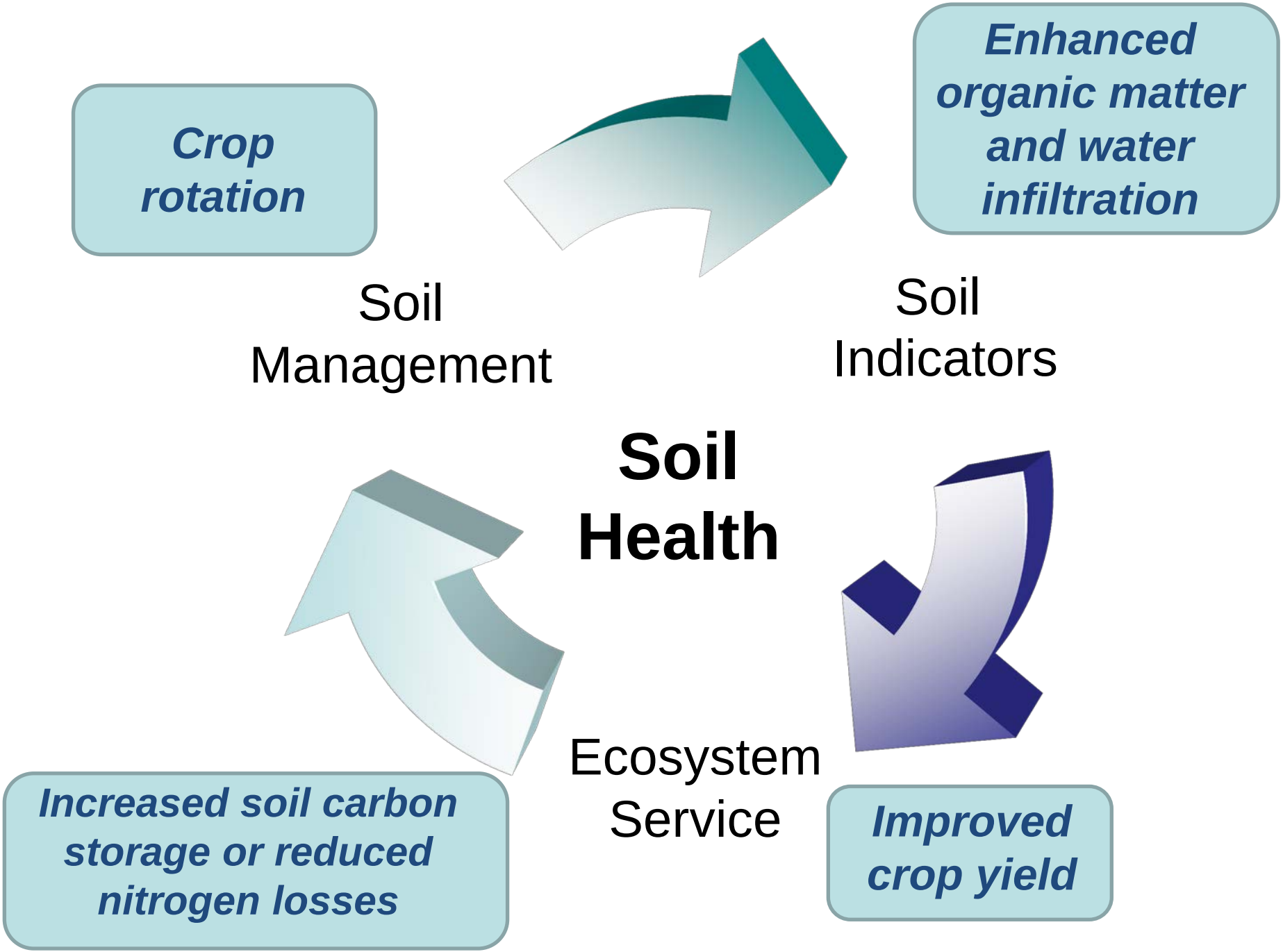
Group	Indicator 2	Value 3	Rating 4	Constraints 5
physical	Available Water Capacity	0.14	37	
physical	Surface Hardness	260	12	Rooting, Water Transmission
physical	Subsurface Hardness	340	35	
physical	Aggregate Stability	15.7	19	Aeration, Infiltration, Rooting, Crusting, Sealing, Erosion, Runoff
biological	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.


Crop rotation
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. manure, 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

Why all the interest in soil health?

With little new agricultural land to develop globally, preserving soil quality is critical to sustaining the needs of a growing population (Doran, 2002).

Air and water quality are impacted by soil.

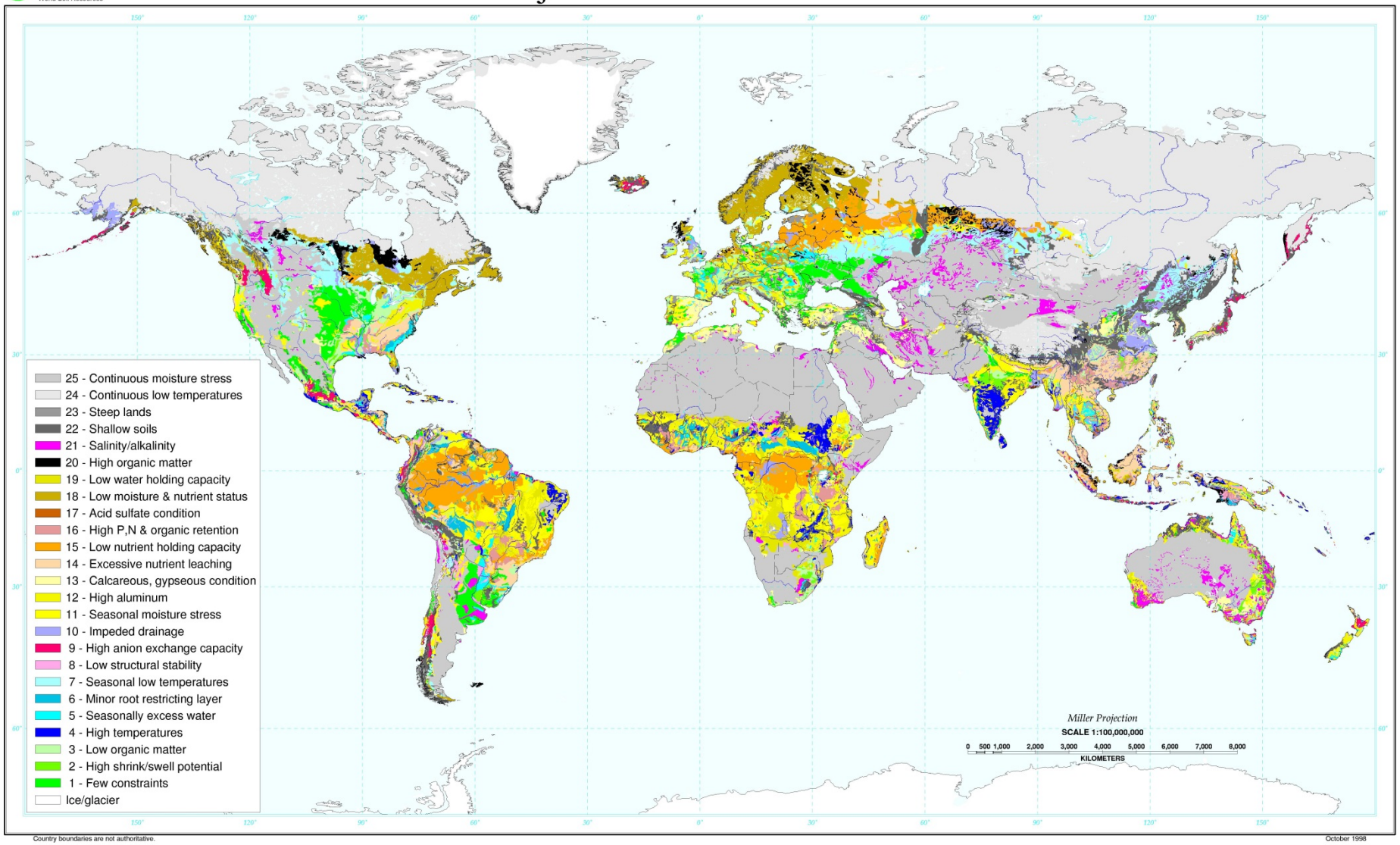
We may think that 'soil health' is a new concept, particularly as it has been recently recognized in state programs, but in fact, preserving soil quality is not new to government policies.

"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.

U.S. Dept. of Agriculture
Natural Resources Conservation Service
Soil Survey Division
World Soil Resources

Major Land Resource Stresses



Country boundaries are not authoritative.

October 1998

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.

Summary of Previous Research:
Salinity and Leaching

- Objective of previous research was to understand soil salinity profiles in Delta tomato and alfalfa fields to help inform salinity management and water policies.
- Project results illustrated a build-up of salts in the soil to levels that have the potential to affect crop yields, and low leaching fraction.

Summary of Previous Research:
Salinity and Leaching

- The Delta's unique growing conditions put constraints on growers' ability to manage salts.
- ***Winter rain appears to provide our best leaching in normal rainfall years.***
- ***Enhance leaching during the off-season by leveraging rainfall with irrigation water to wet profile before a rain event.***

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

Summer Cover Crop Site

In SJC, we grew a summer cover crop between winter cereal crops.

- 4 acres, 3 blocks, 2 treatments (cover crop vs. none)
- 'Red Ripper' cowpea planted at 50 lbs/acre on 7" row spacing
- Anticipated benefits: Cowpea needs warm soil conditions for germination, fixes nitrogen, and is moderately tolerant of salinity
- Anticipated challenges: moisture and pests

Preliminary Research Results:
Summer Cover Cropping

- Cover cropping had no observed effect on bulk density, Total N, and Total C.
- Cover cropping may have slightly raised the pH in the top 30 cm, compared to dry fallow.
- ***The application of irrigation water to the cover crop treatment increased soil moisture and contributed to a reduction in the concentration of salts in the upper layers of soil compared to dry fallow.***

Preliminary Research Results:
Summer Cover Cropping

Baseline soil properties (July 2018).

Depth (cm)	Bulk Density (g/cm^3)	Soil Moisture (% by vol.)	Salinity (EC_e)	pH	Total N (%)	Total C (%)
0-15	1.01	0.13	0.47	5.39	0.27	3.47
15-30	0.97	0.17	0.62	5.32	0.25	3.06
30-60	1.06	0.22	1.29	5.7	0.17	2.01
60-90	1.02	0.26	2.44	5.9	0.10	1.06

Preliminary Research Results:
Summer Cover Cropping

Soil properties after one season of cover cropping (October 2018). Data represent the average of three replicates.

Trt	Depth (cm)	Bulk Density (g/cm^3)	Soil Moisture (% by vol.)	Salinity (EC_e)	pH	Total N (%)	Total C (%)
No CC	0-15	0.96	0.08	1.05	5.32	0.27	3.39
No CC	15-30	0.92	0.13	1.39	5.29	0.23	2.97
CC	0-15	0.90	0.23	0.60	5.49	0.27	3.42
CC	15-30	1.06	0.26	0.67	5.47	0.23	2.89

Summary

- Soil health is defined as soil functioning and is influenced by inherent site characteristics and management practices.
- We know that practices like plant diversity/crop rotations, cover cropping, organic matter amendments, and reduced disturbance, improve soil health by sequestering carbon, and enhancing soil biology and nutrient cycling.
- Previous salinity work indicated the best time for salinity management was during the winter, but there may be other solutions that manage for soil health and salinity.

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Thank you!

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

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