Soil Health Summit
Wednesday, November 15th, 2017

EAST STANISLAUS RESOURCE CONSERVATION DISTRICT

NRCS Natural Resources Conservation Service

IN COLLABORATION WITH EAST STANISLAUS RCD AND USDA-NRCS:

FEATURING TECHNICAL TRAININGS, RESEARCH UPDATES, CARBON FARM WORKSHOP, AND NETWORKING WITH SOIL HEALTH PROFESSIONALS.

Healthy Soils

Soil, Water, Carbon, Climate, Biodiversity

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Carbon Cycle Institute www.carboncycle.org

...what now remains of the formerly rich land is like the skeleton of a sick man, with all the fat and soft earth having wasted away and only the bare framework remaining. Formerly, many of the mountains were arable. The plains that were full of rich soil are now marshes. Hills that were once covered with forests and produced abundant pasture now produce only food for bees. Once the land was enriched by yearly rains, which were not lost, as they are now, by flowing from the bare land into the sea. The soil was deep, it absorbed and kept the water in the loamy soil, and the water that soaked into the hills fed springs and running streams everywhere. Now the abandoned shrines at spots where formerly there were springs attest that our description of the land is true.

—PLATO, 4TH CENTURY B.C.E.

Soil Health (Soil Quality) is "the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation"

(Karlen et al., 1997). Soil Science Society of America's Ad Hoc Committee on Soil Quality

“**Health** of agricultural soil relates to its ability to build and retain adequate soil organic matter via the activity of plants and soil organisms. Adequate soil organic matter ensures the soil’s continued capacity to function as a vital living ecosystem with multiple benefits that sustains and produces food for plants, animals, and humans.”

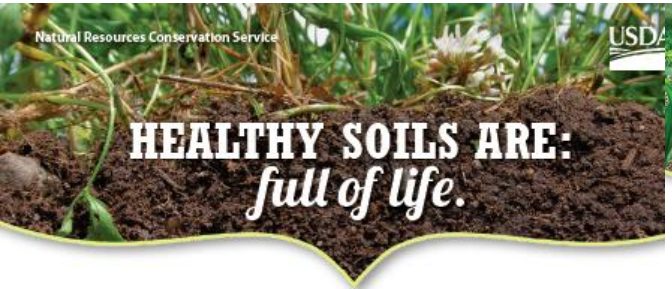
-CDFA

Soil Health: *The capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans. USDA*-NRCS.

Losing Organic Matter

Organic matter is vital to healthy soils, yet most modern agricultural operations are not managed in

ORGANIC MATTER *matters*. IN FACT, THERE MAY BE NO OTHER COMPONENT THAT'S MORE IMPORTANT TO A HEALTHY SOIL THAN ORGANIC MATTER.



Cover Saves Scarce Water

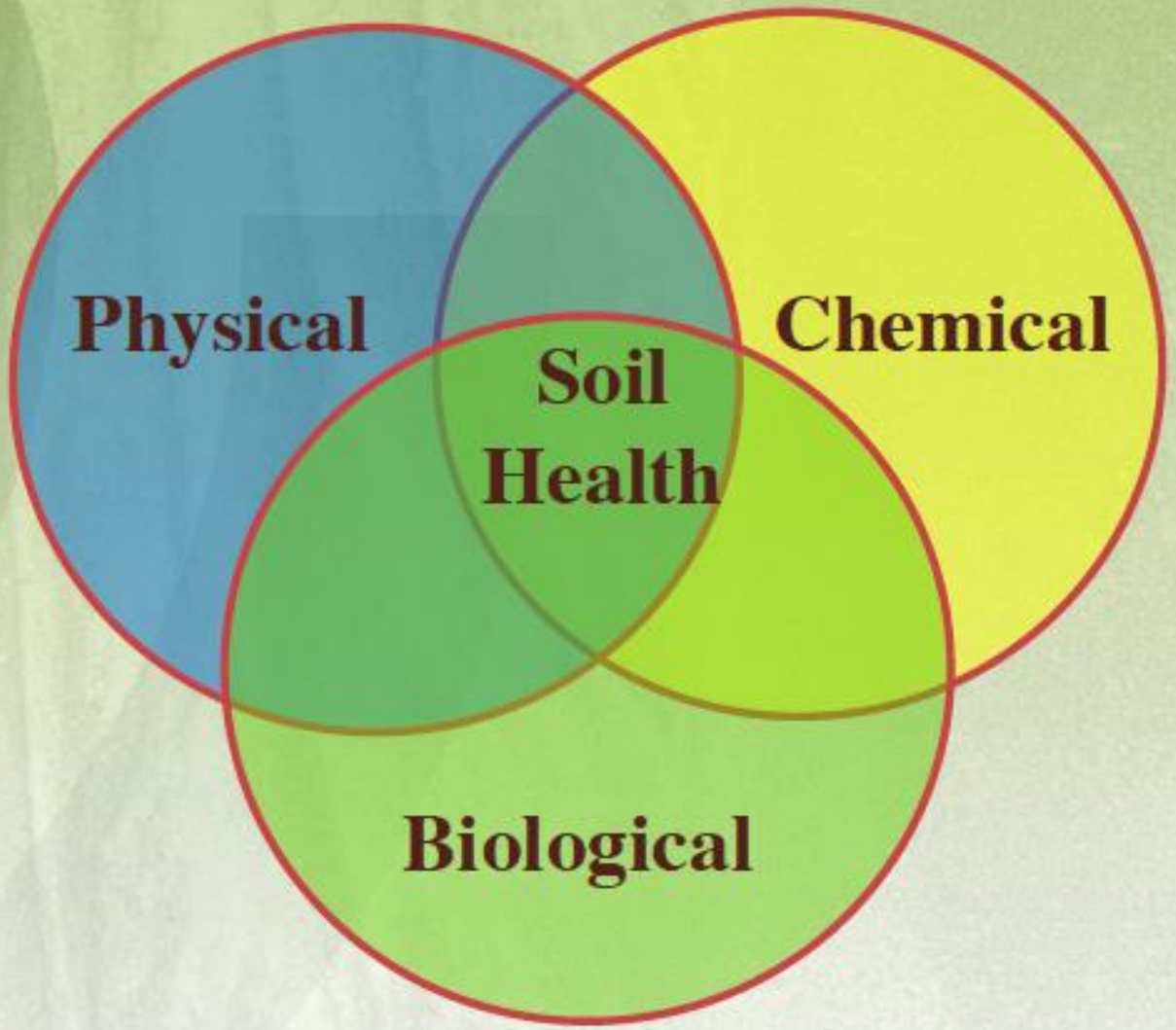
IF YOU'RE TRYING TO MAKE YOUR SOIL HEALTHIER, YOU SHOULDN'T SEE IT VERY OFTEN.

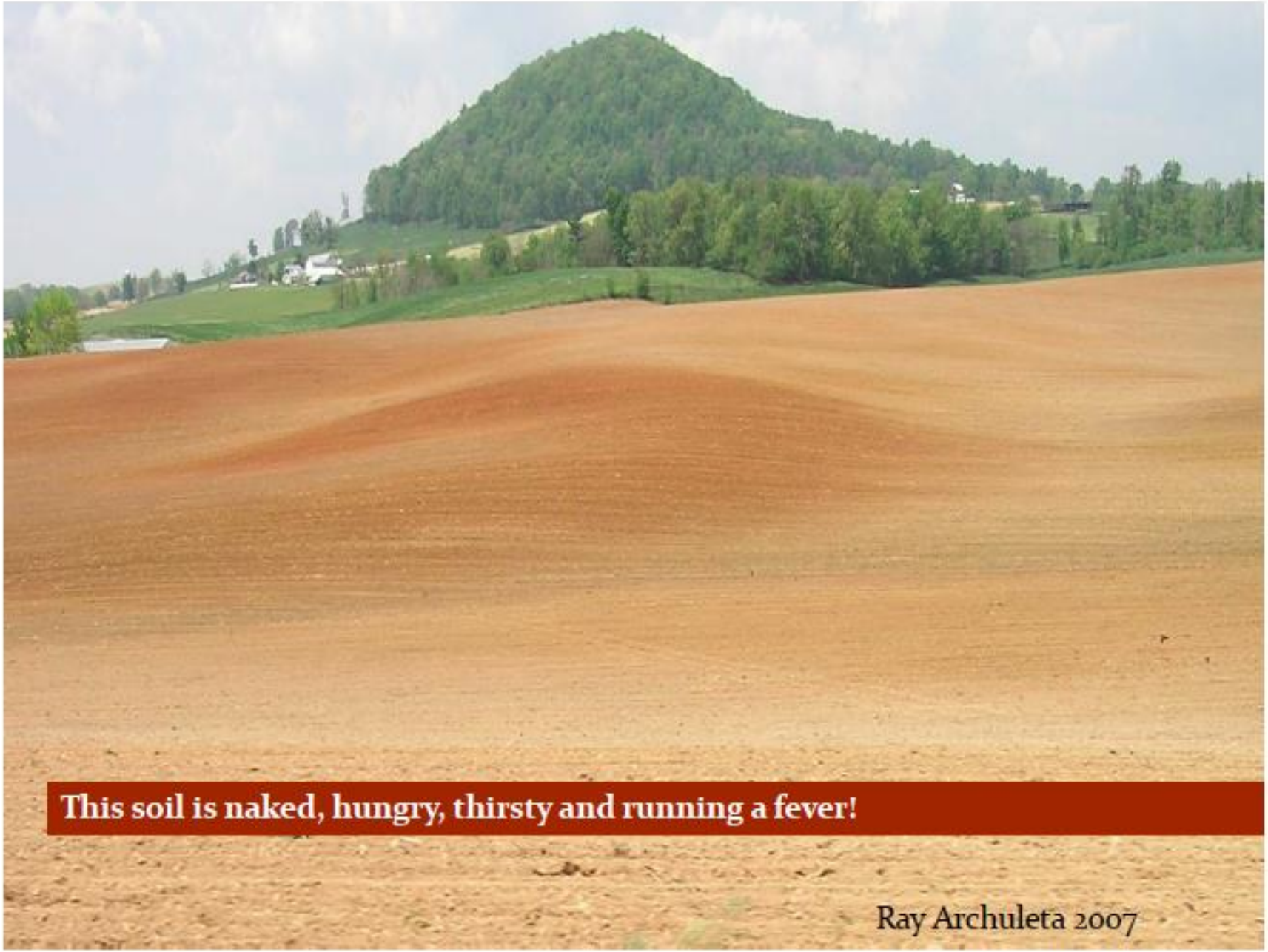
Give it the Stake Test!

Does your soil have good structure? Give it the slake test! Ray Archuleta, an agronomist with the

"SOFT AND CRUMBLY." "LIKE COTTAGE CHEESE." "LIKE A SPONGE." "LOOSE AND FULL OF HOLES."

Processes in Healthy Soil are working optimally

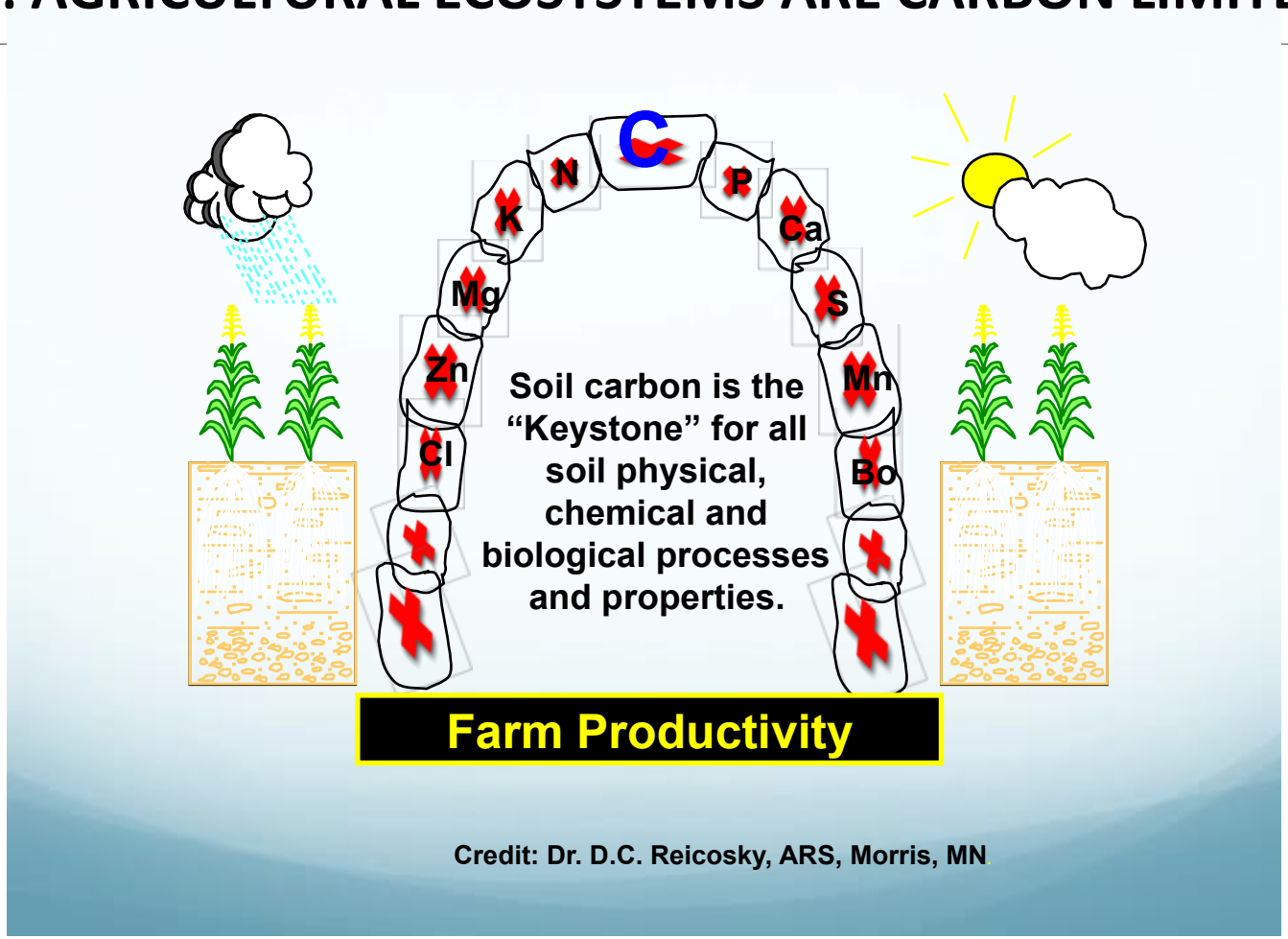



This soil is naked, hungry, thirsty and running a fever!
Ray Archuleta 2007

Carbon:

Key to agricultural productivity and resilience

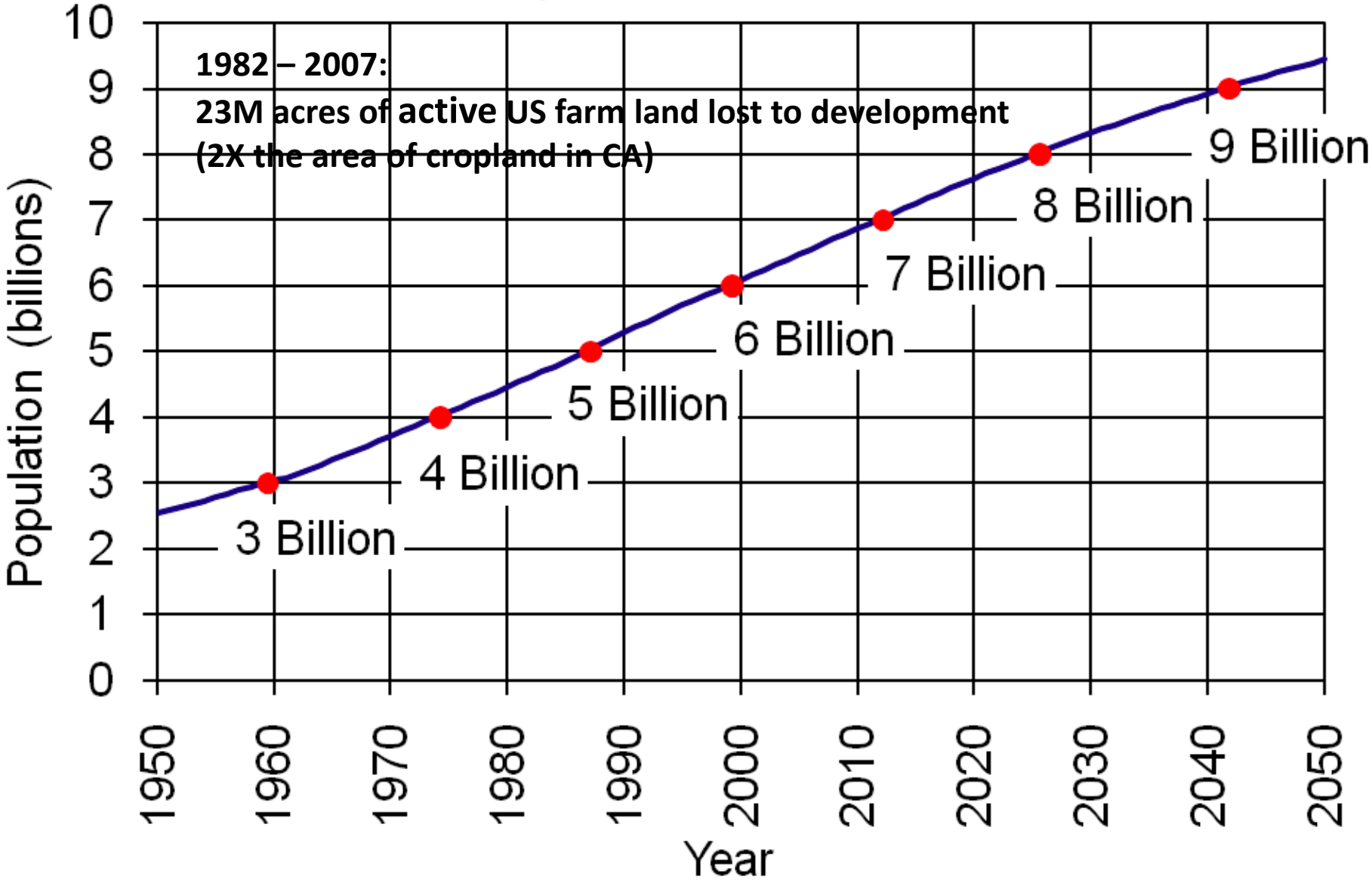
H1: AGRICULTURAL ECOSYSTEMS ARE CARBON LIMITED!



Challenges stemming from poor soil health…?

Photos: Bianca Moebius-Clune

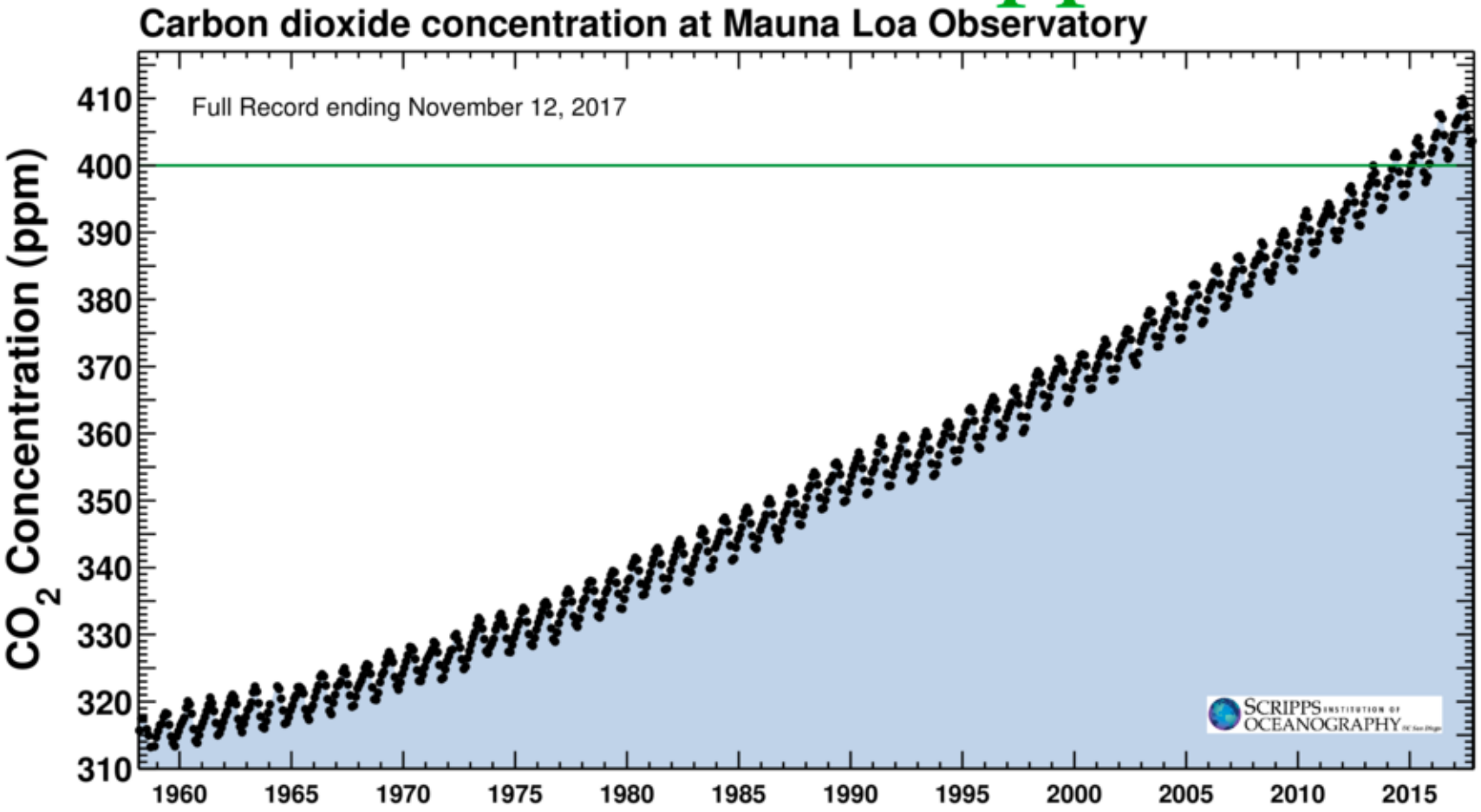
World Population: 1950-2050



Source: U.S. Census Bureau, International Data Base, June 2011 Update.

Latest CO_2 reading
November 12, 2017

404.66 ppm



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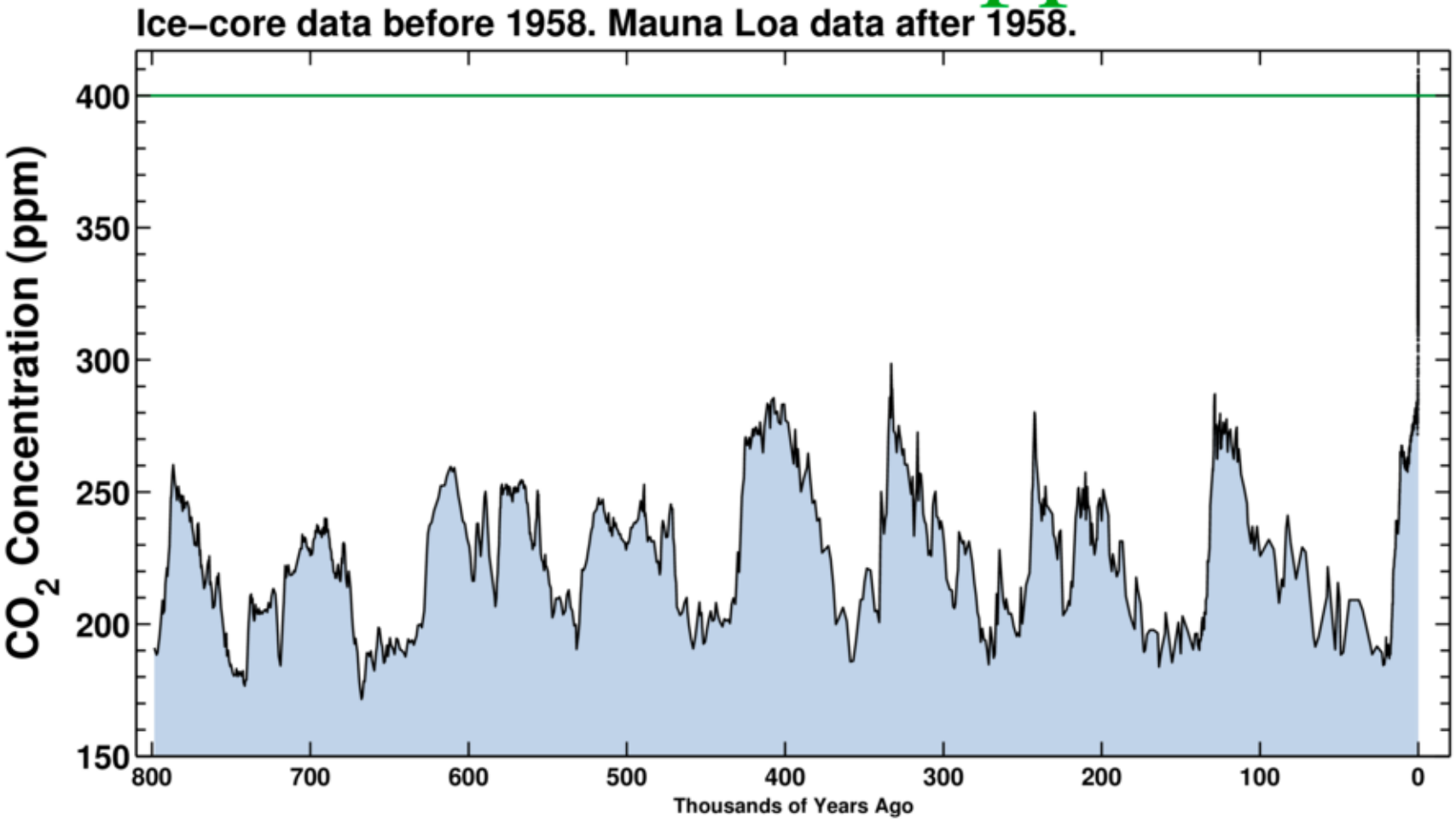
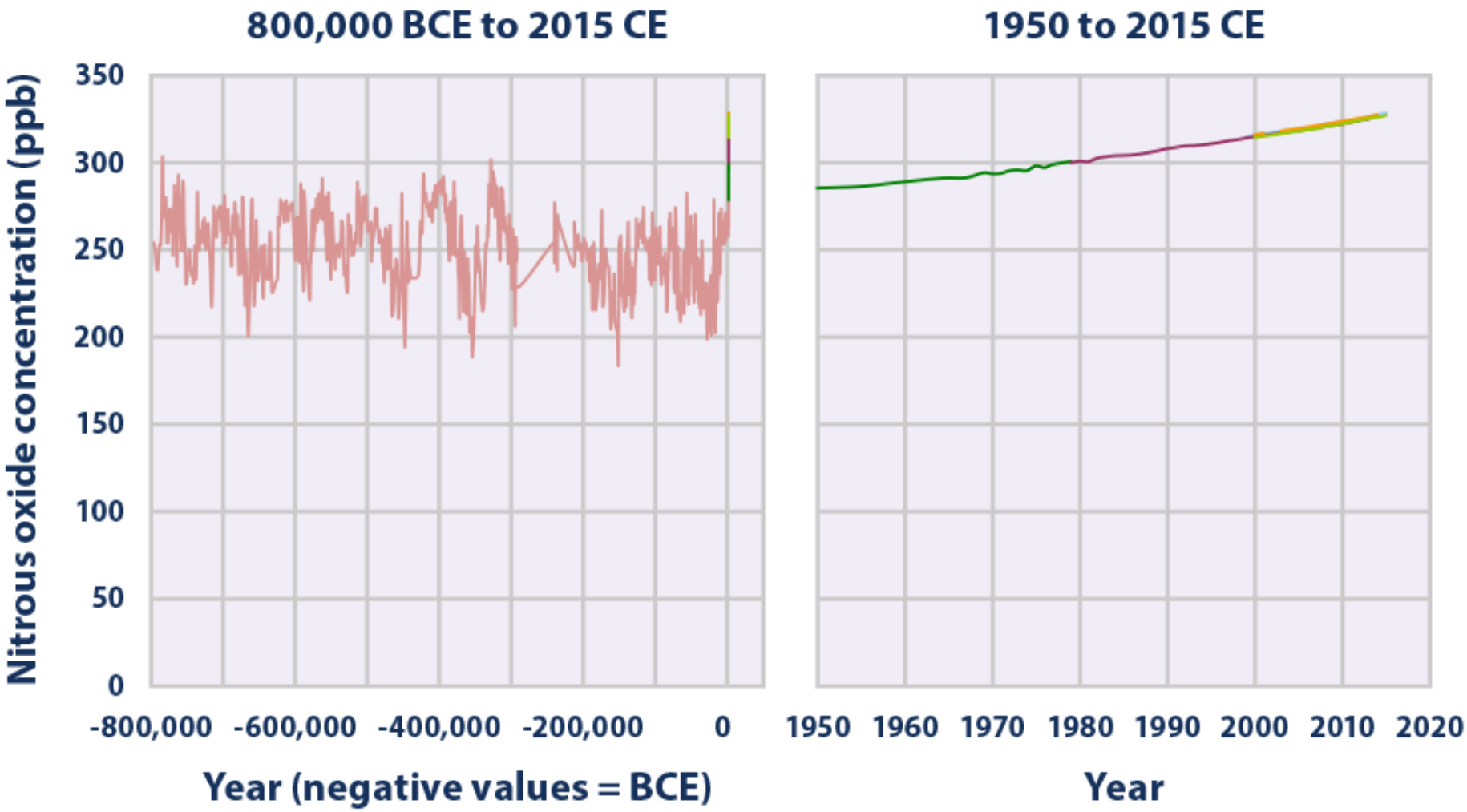


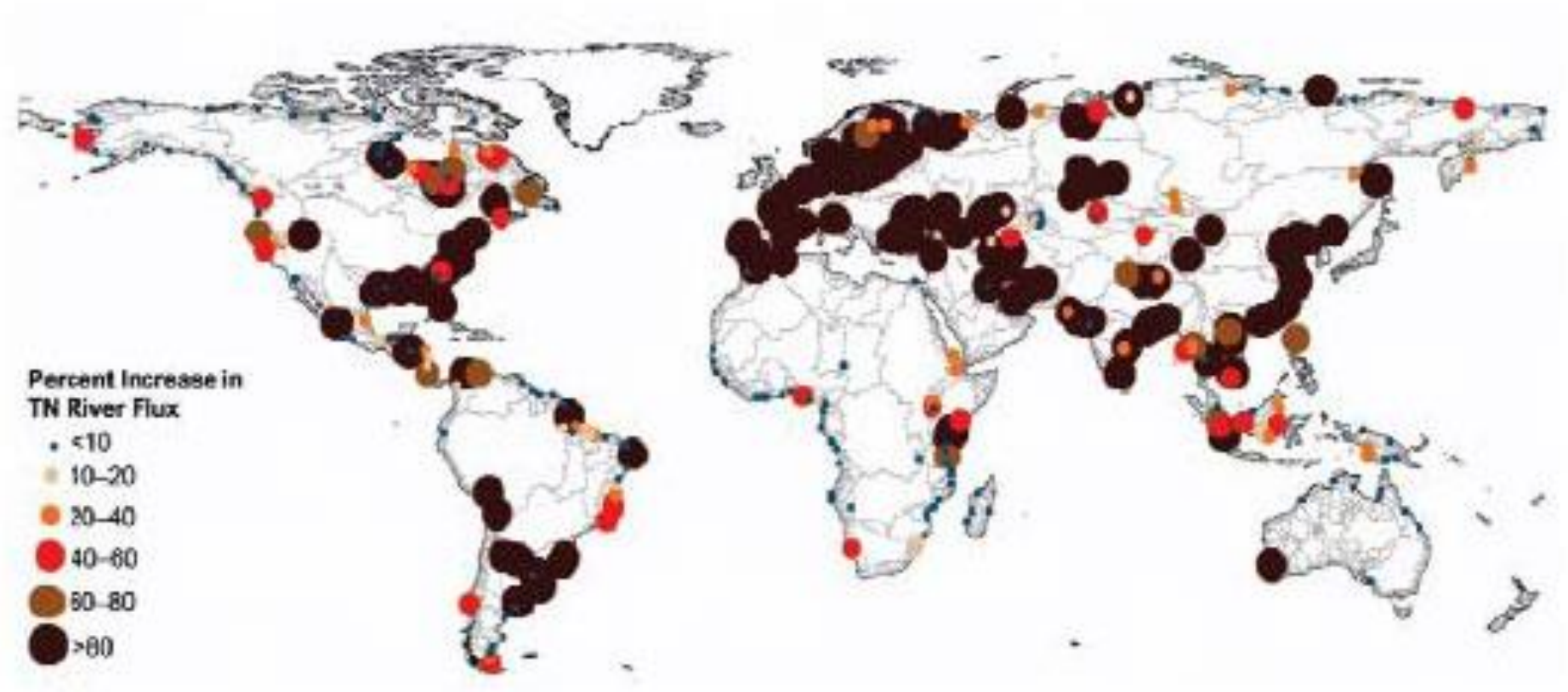
Global Atmospheric Concentrations of Nitrous Oxide Over Time



Data source: Compilation of six underlying datasets. See www.epa.gov/climate-indicators for specific information.

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climate-indicators.

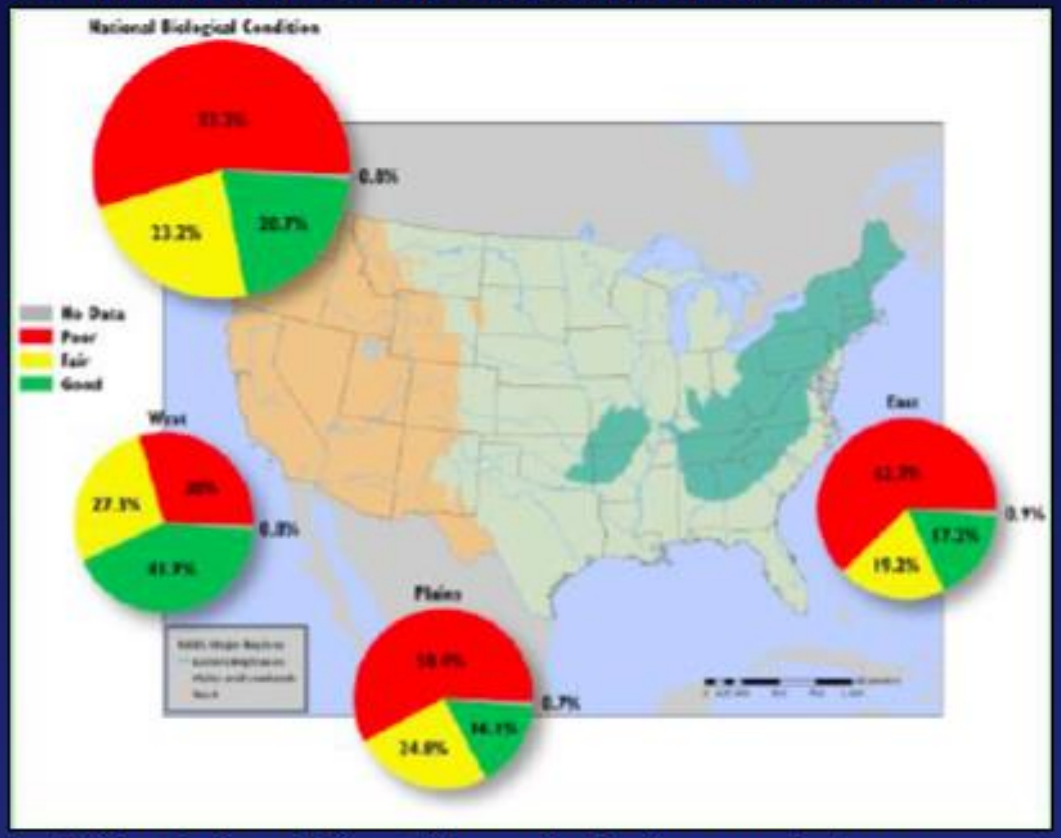
The World's Most Serious Dead Zones



Nitrogen and Phosphorus runoff from agriculture are the primary causes of coastal dead zones.

National Water Quality Challenges

- Biological conditions of nation's rivers and streams
  - Poor - 55.3%
  - Fair – 23.3%
  - Good – 20.7%
  - Unknown – 0.8%
- Greatest stressors:
  - Phosphorous
  - Nitrogen
  - Riparian cover and disturbance
  - Streambed sediment
  - Enterococci



Biological condition of the nation's rivers and streams, based on the Macroinvertebrate Multimetric Index. From National Rivers and Streams Assessment (2008–2009) (EPA, 2013.)

Downward Spiral of Soil Degradation

1. Intensive tillage, insufficient added residues, low diversity, no surface cover

2. Soil organic matter decreases, erosion, subsoil compacted

3. Aggregates break down

4. Surface becomes compacted, crust forms

5. Infiltration decreases
Erosion by wind and water increases

6. More soil organic matter, nutrients, and top soil lost

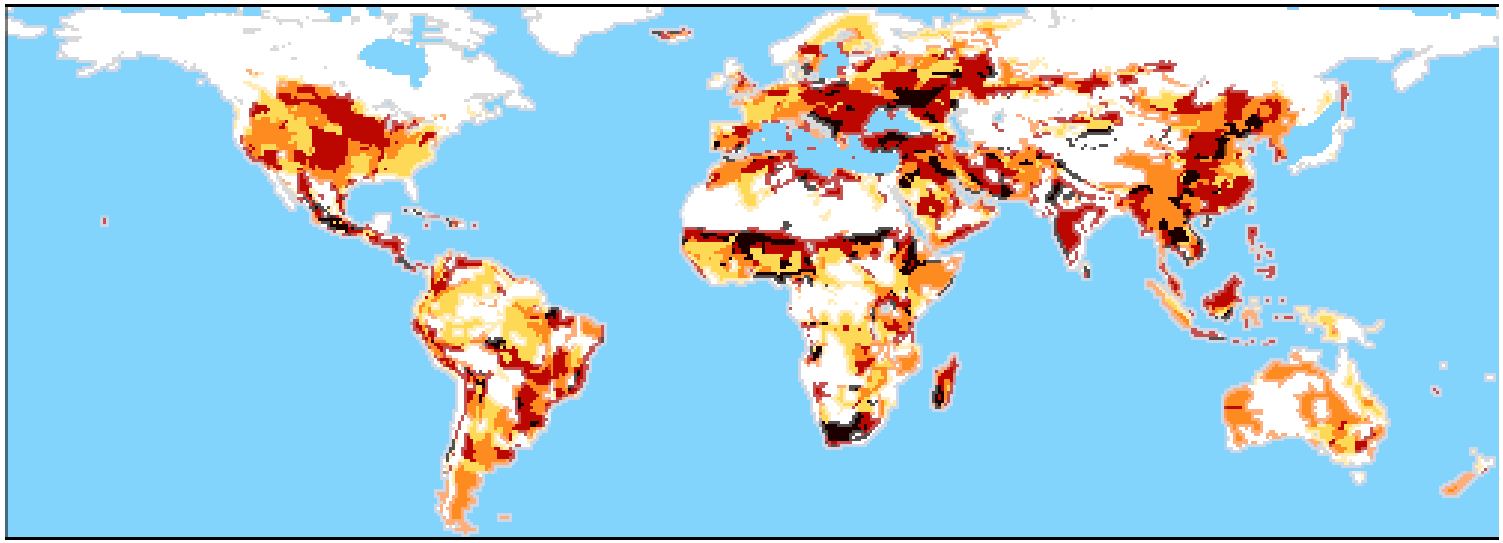
7. MORE ponding & persistent wetness, but LESS soil water storage; less rooting; lower nutrient access by plants; less diversity of soil organisms, more disease

8. Crop yields decline

9. Hunger and malnutrition, especially if little access to inputs

Modified from *Building Soils for Better Crops*

Soil Degradation Severity



Low Medium High Very High Non-degraded

PROJECTION: Geographic

SOURCES: UNEP/ISRIC

UNEP

EAD/GRID-Geneva

How do we improve soil health?


No Cover


With Cover Crop

Soil Health: the continued capacity of the soil to function

as a vital living ecosystem that sustains plants, animals, and humans

Soil Organic Matter

SOM influences the physical, chemical, and biological properties of soils, and therefore, plant growth.

It improves soil aggregation, structure, and porosity, and lowers bulk density. Because the soil structure is improved, water infiltration rates increase.

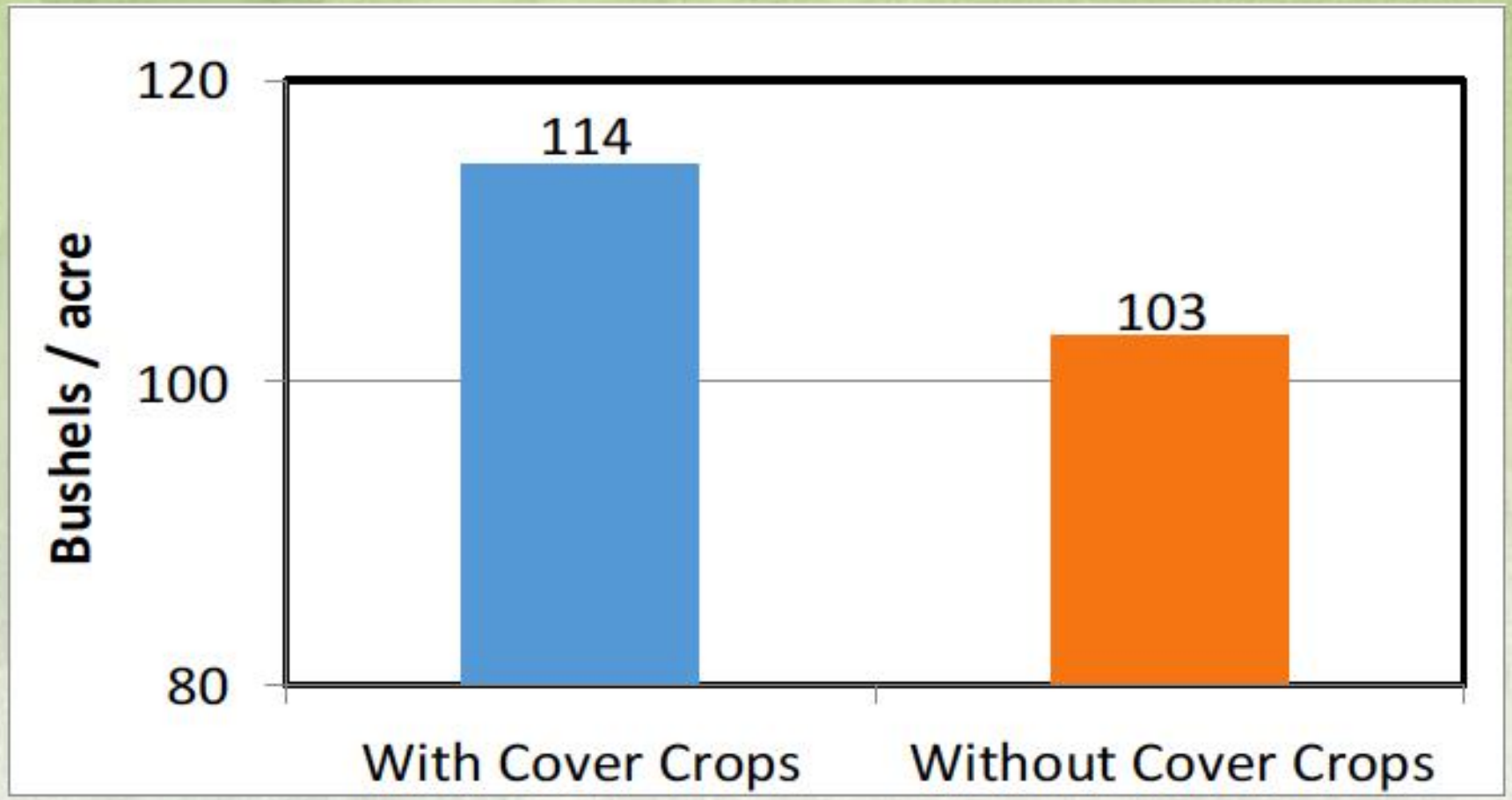
SOM has a high capacity to adsorb and exchange both water and cations;

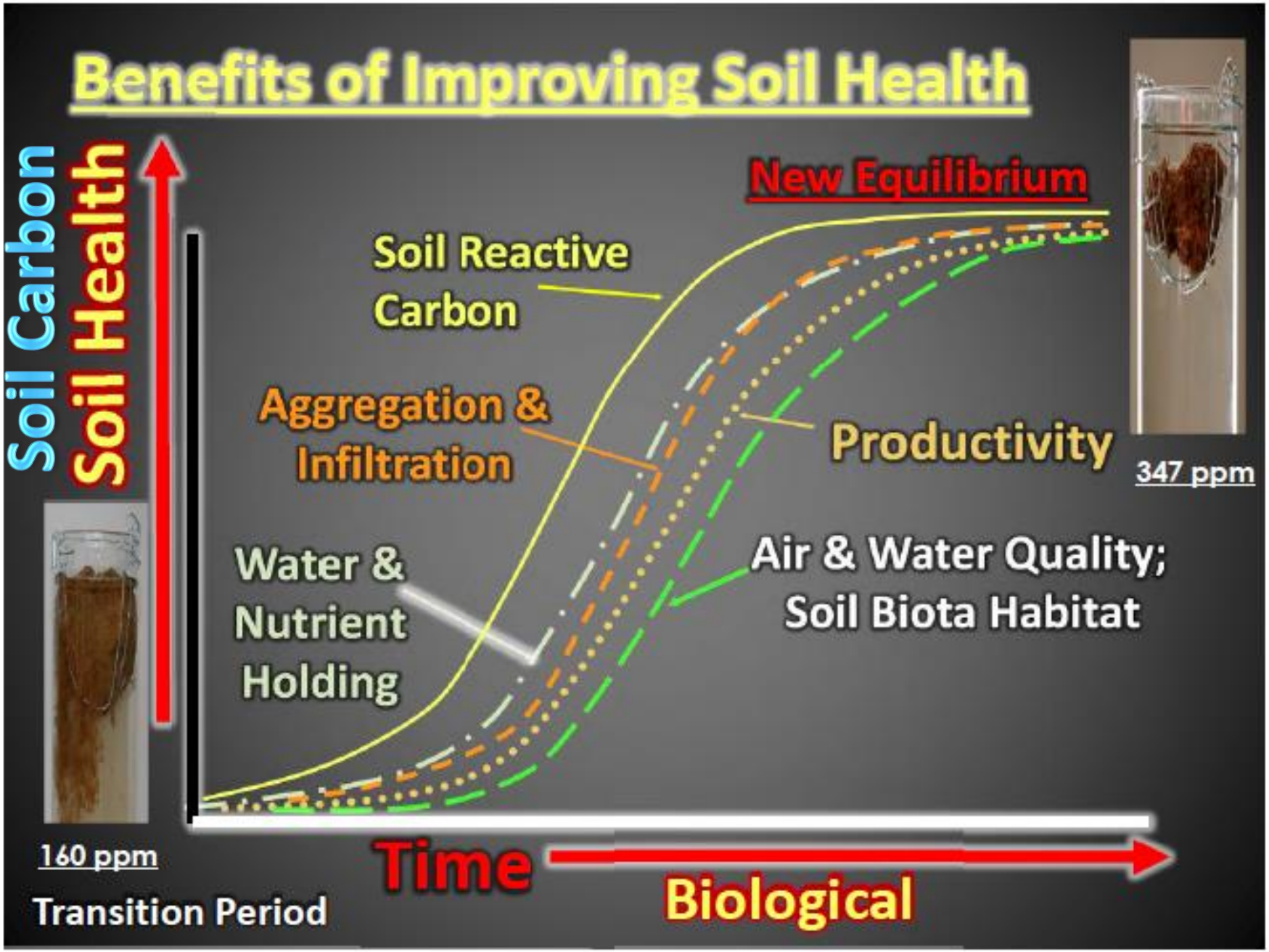
As SOM is decomposed by soil microbes, nitrogen, phosphorous, sulfur, and many micronutrients are released and become available for plant growth.

SOM is the source of energy for the soil ecosystem

USDA-SARE, CTIC Survey 2013

2012 Corn Yield, Drought States




Benefits of Improving Soil Health
Soil Carbon
Soil Health
New Equilibrium
Soil Reactive Carbon
Aggregation & Infiltration
Productivity
347 ppm
Water & Nutrient Holding
Air & Water Quality; Soil Biota Habitat
160 ppm
Transition Period
Time
Biological

do not DISTURB

Minimize soil disturbance.

mix it UP

Maximize diversity (plants, animals, amendments, inoculants…).

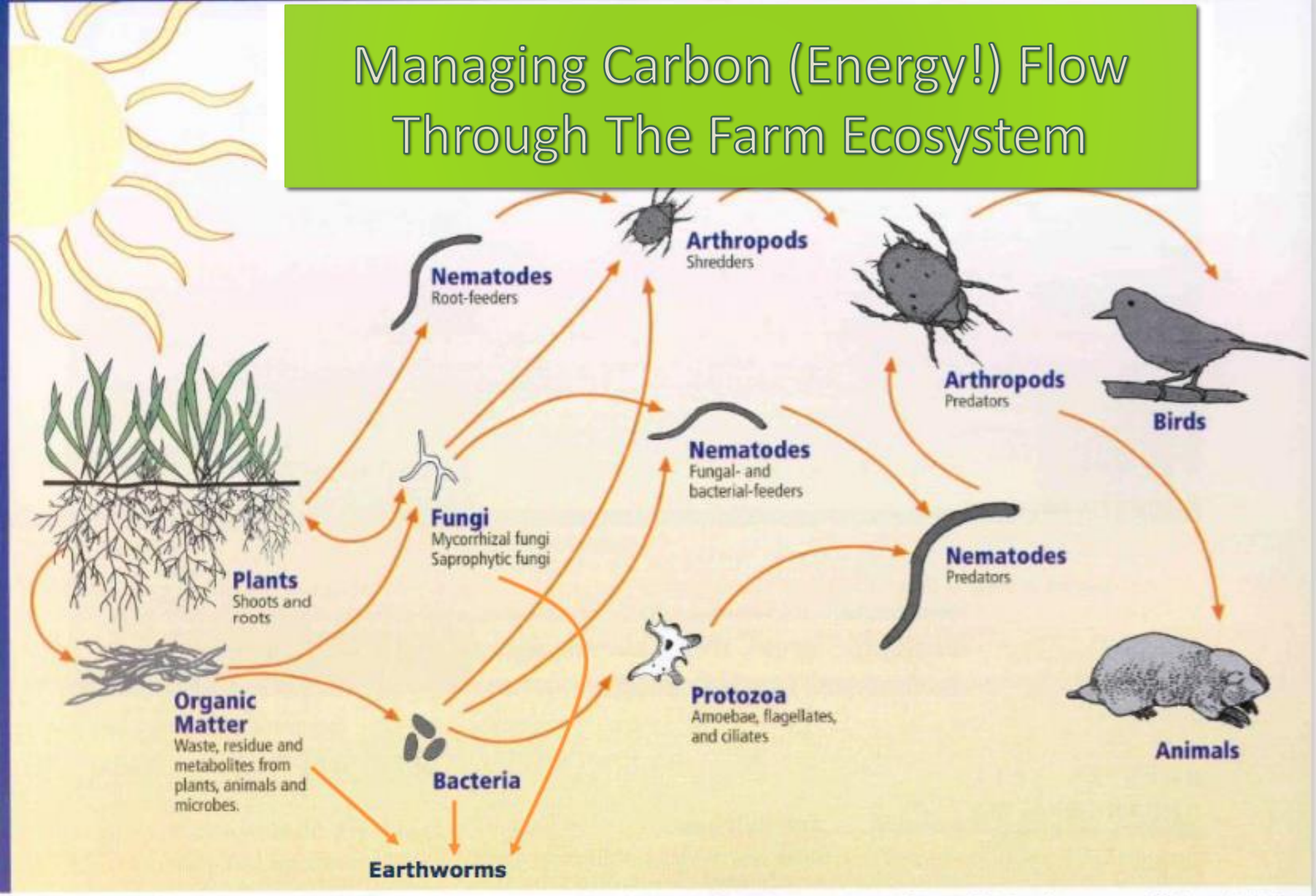
discover THE COVER

Keep the soil covered.

tap into ROOTS

Maximize living roots.

Managing Carbon (Energy!) Flow Through The Farm Ecosystem



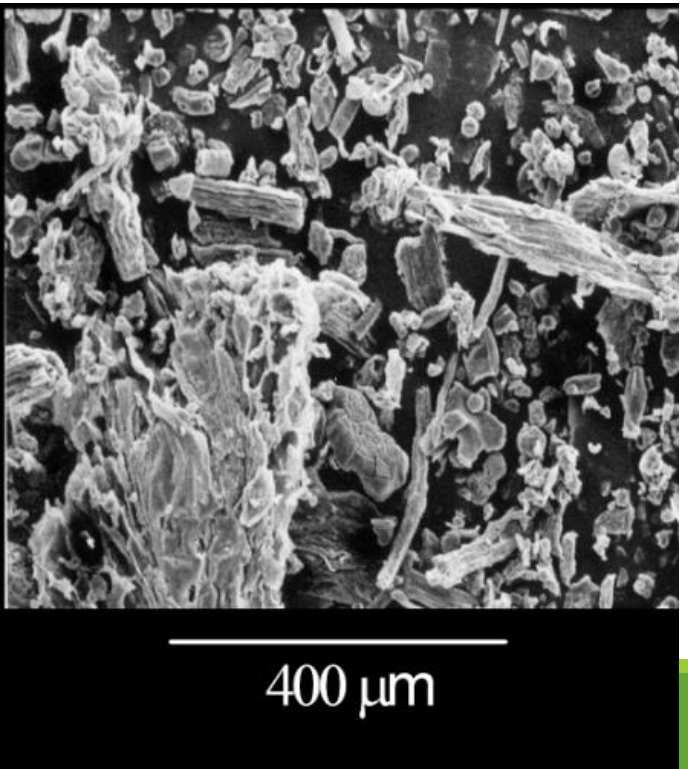
First trophic level:	Second trophic level:	Third trophic level:	Fourth trophic level:	Fifth and higher trophic levels:
Photosynthesizers	Decomposers Mutualists Pathogens, Parasites Root-feeders	Shredders Predators Grazers	Higher level predators	Higher level predators

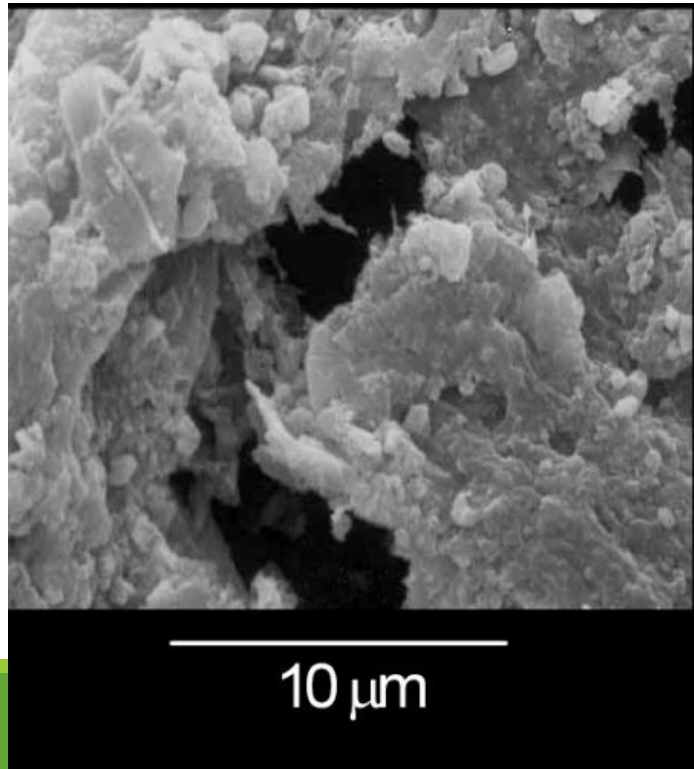
Managing working lands for carbon increases means managing for increases in

Fertility

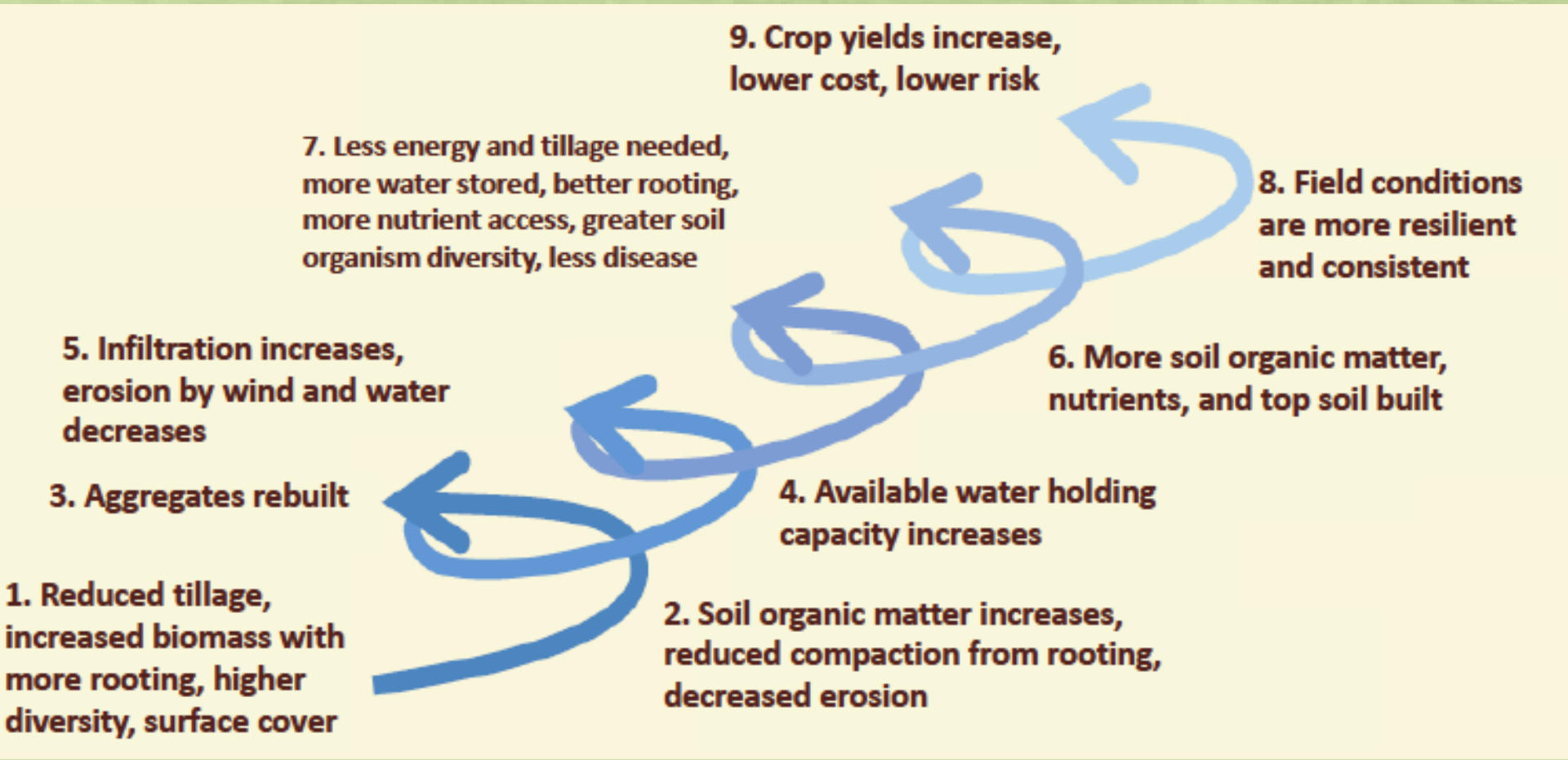
- **Water holding capacity**
- **Resilience**
- **Biodiversity**
- **Productivity**

- ***Soil Health!***

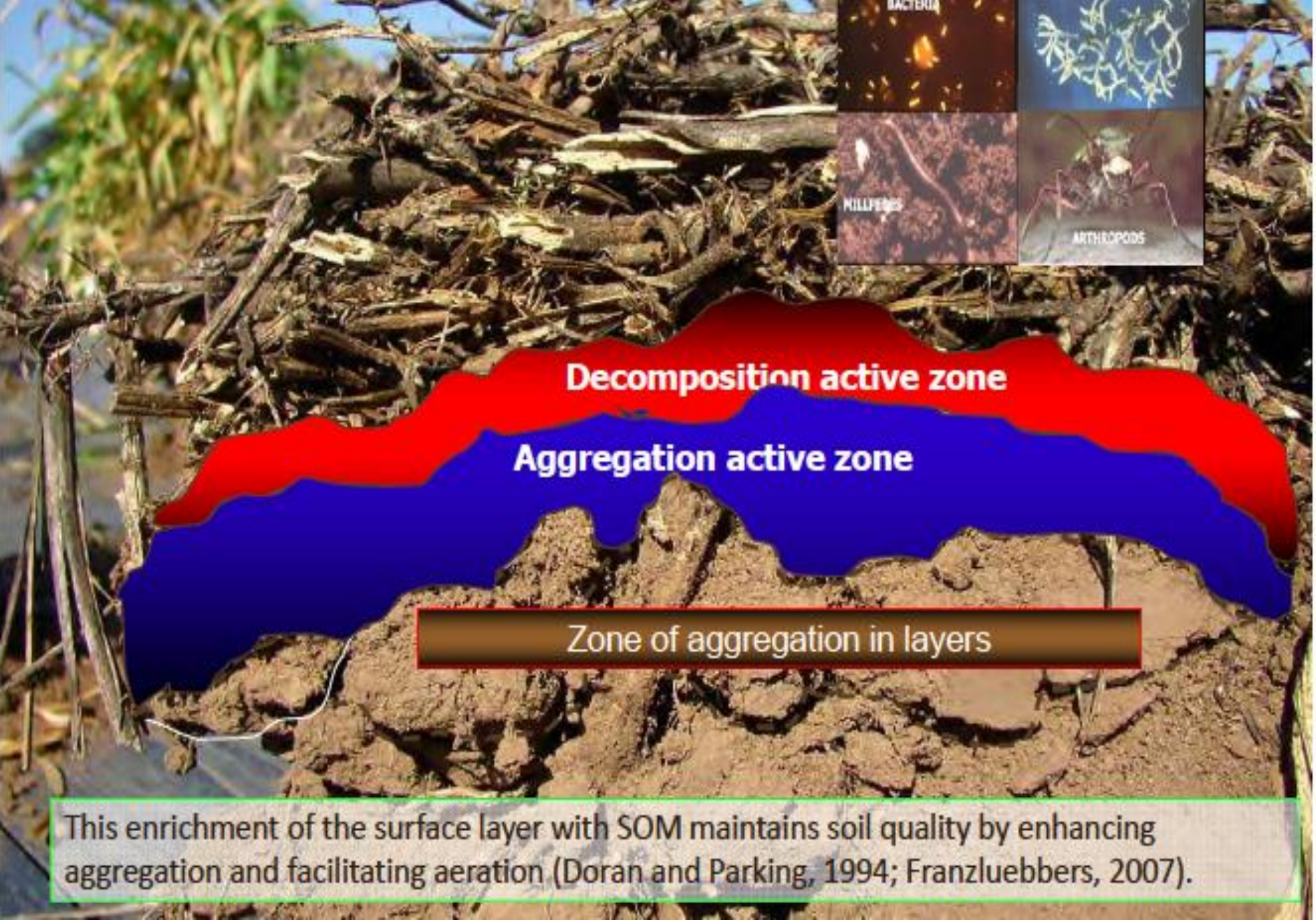




Upward Spiral of Improving Soil Health



Modified by Dr. Dorn Cox from *Building Soils for Better Crops*



This enrichment of the surface layer with SOM maintains soil quality by enhancing aggregation and facilitating aeration (Doran and Parking, 1994; Franzluebbers, 2007).

USDA-NRCS SOIL HEALTH INFOGRAPHIC SERIES #002

unlock the SECRETS IN THE SOIL

what's underneath

healthy soil has amazing water-retention capacity.

Every **1%** increase in organic matter results in as much as **25,000** gal of available soil water per acre.

Source: Kansas State Extension Agronomy e-Updates, Number 357, July 6, 2012

USDA United States Department of Agriculture

Want more soil secrets?
Check out **www.nrcs.usda.gov**

USDA is an equal opportunity provider and employer.

Estimated Additional Soil Water Holding Capacity With Carbon Farm Plan Implementation, 8,000 acre Ranch, Santa Barbara County, CA

Table 15. Estimated Additional Soil Water Holding Capacity (WHC) With Plan Implementation

PRACTICE	DESCRIPTION	20 YEAR SOM INCREASE (Mg)	ANNUAL WHC INCREASE BY YEAR 20 (AF)
Compost application on Rangeland (NRCS practice standard in development)	Application of 1/4" of compost to 4300 acres of permanent pasture.	53867 Mg	493.78
Compost application on Cropland (590)	Application of 1" of compost to 617 acres of cropland.	23637.05 Mg	216.67
Shelterbelt (380)	13.6 miles (90 acres) of 50' wide shelterbelts	1068.12 Mg	9.79
Prescribed Grazing (528)	Grazing management to favor perennials and improve production on 7300 acres.	15912.80 Mg	145.86
Riparian Restoration	Restoration of 94 acres of riparian system along 7.75 miles of stream corridor Planting of native trees and shrubs.	3043.23 Mg (derived from Lewis et al 2015)[1]	27.89
No-till system-Tillage Management (512).	Convert tilled forage fields to permanent pasture; minimize tillage on croplands	425.06 Mg	3.89
Minimum-Tillage (345)	Conversion of tilled crop fields to minimum tillage on	1089.91 Mg	9.99
Silvopasture (381)	Establish trees on approximately 1,000 acres) of treeless pasture.	4027.24 Mg (derived from Gaman 2008)	36.91
TOTAL		**103,070**	**917.52**

[1] Lewis et al 2015 model coefficients indicate annual increases of soil carbon = 0.2 kg/m^2. 1 acre = 4046.85642 m^2.

The Carbon-Soil-Water-Climate Connection

If California's approximately 9 million acres of irrigated croplands achieved even a 1% increase in SOC (from 1% to 2%) in the plow layer alone, the associated water holding capacity increase would be roughly 1.5 M acre feet and the CO2e sequestered would be about 300 M metric tons.

Assumptions:
based on the plow layer (top 6.7" of soil) only; including deeper soil strata will increase potentials accordingly;
1% increase in SOM results in 1 acre-inch increase in soil water holding capacity per acre;
1% increase in SOC represents 2% increase in SOM;
1 metric ton (2,200 lbs) of soil C represents 3.67 metric tons of CO2e;
1% increase in (plow layer only) SOC is about 10 short tons or 9 metric tons SOC/acre.

Improved Infiltration - Brookings County, SD

Carbon-rich topsoil from beneath perennial grass (left hand) compared to adjacent carbon-poor soil (right hand). By holding more air, sustaining moisture and having higher bioavailability of soil nutrients, carbon-rich soils benefit plants and soil biota.

Photo: Lucy House, 'Anabank', Baralaba

Same Soils: Dynamic Soil Properties Changed!

62.8% loss of SOM after 17 yr intensive tillage

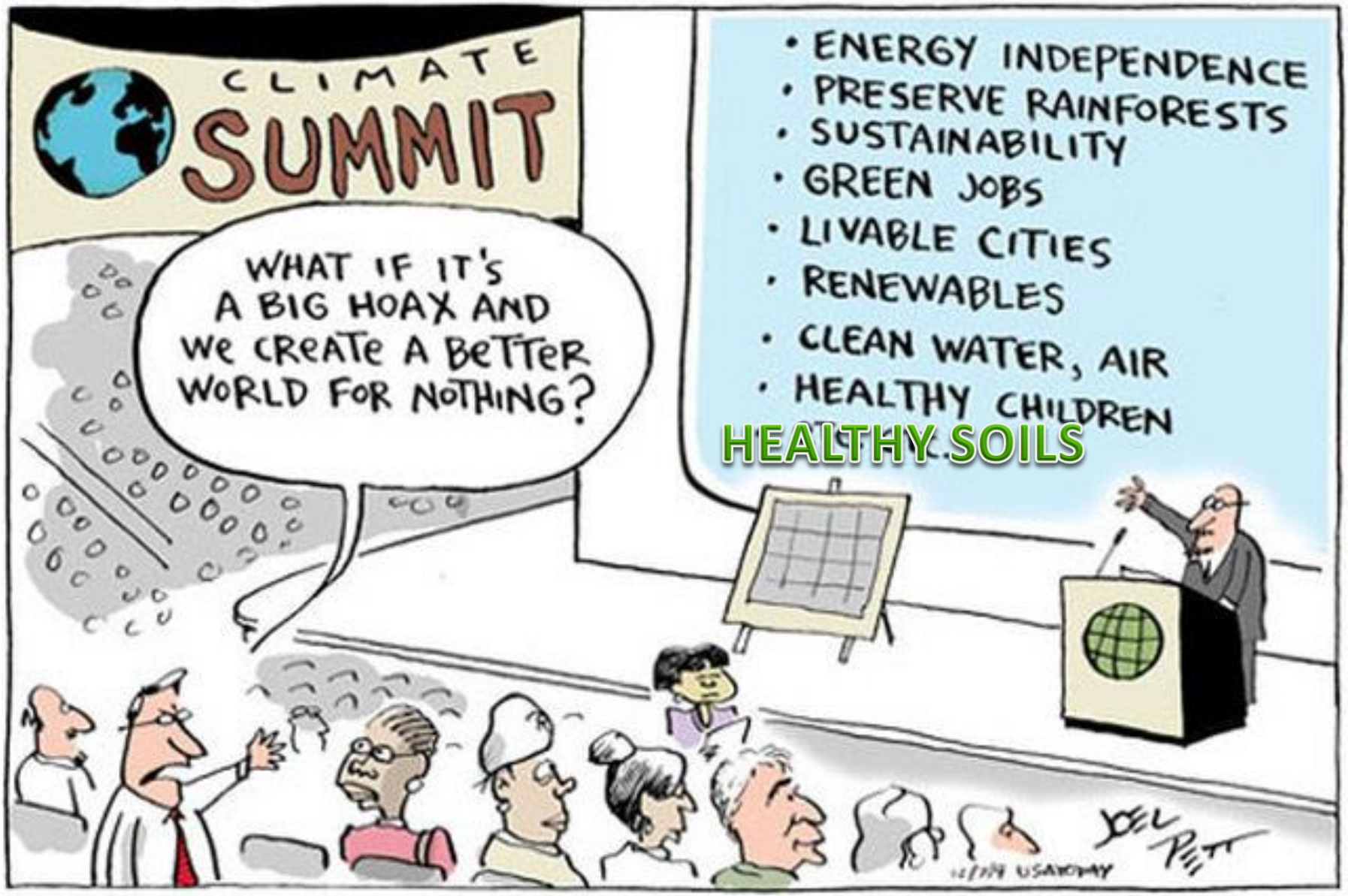


Image: © Joel Pett/USA Today