



# NRCS Soil Health Initiative

*Tony Rolfes*  
*State Soil Scientist*  
*California*







2015

International  
Year of Soils

International  
**Unlock the Secrets**  
2 **IN THE SOIL** 4



World  
Soil Day

So

Role in Addressing Global Resource Problems.

December 5th



# Global Solutions with Soil Health

Loss Of Biodiversity

Food Security


Pollution of air,  
water and Soil

**BUILDING SOILS FOR BETTER CROPS**

SUSTAINABLE SOIL MANAGEMENT

Climate Change

# FOOD SECURITY



healthy soil is key to feeding

**9 billion** 

by **2050**

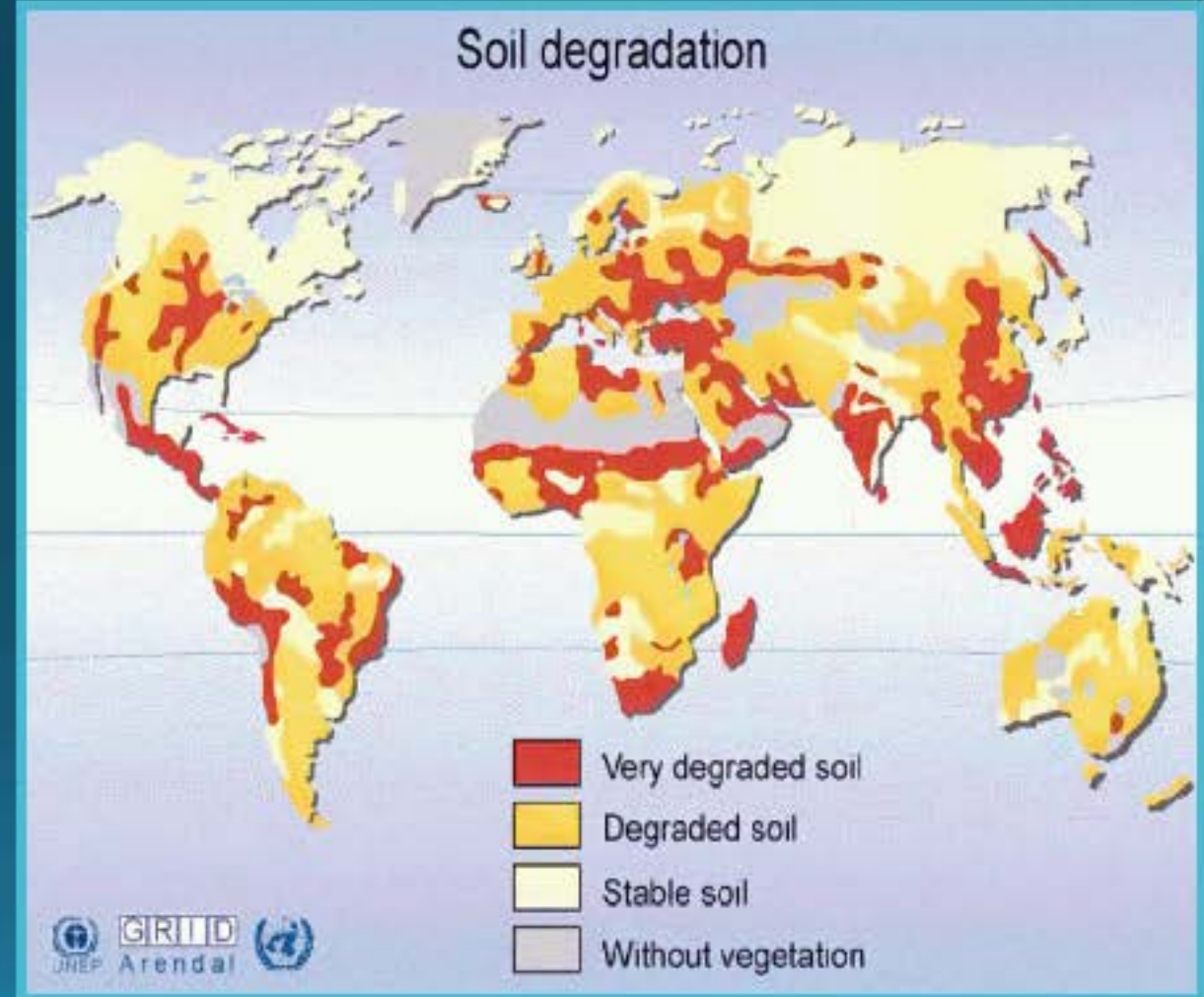
Source: The United Nations

Want more soil secrets?  
Check out [www.nrcs.usda.gov](http://www.nrcs.usda.gov)

**USDA** United States Department of Agriculture

USDA is an equal opportunity provider and employer.

The infographic features a background of soil layers with a green top layer. On the left, a circular icon contains a fork, knife, and spoon. The text is centered and uses a mix of green and white colors.





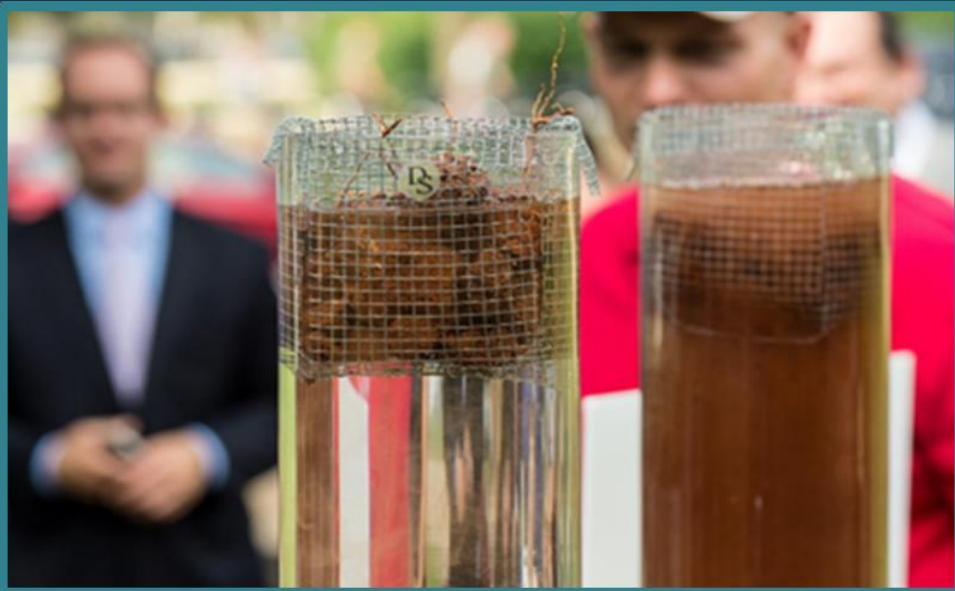
# Soil is an Irreplaceable Resource



is gone, it is gone for good  
at least a **VERY LONG** time







Aggregates

Infiltration

Runoff



Fallow (NCC)

Cover Crops

Precipitation Discharged as Runoff

16.3%

0.9%

Average Peak Runoff Velocity

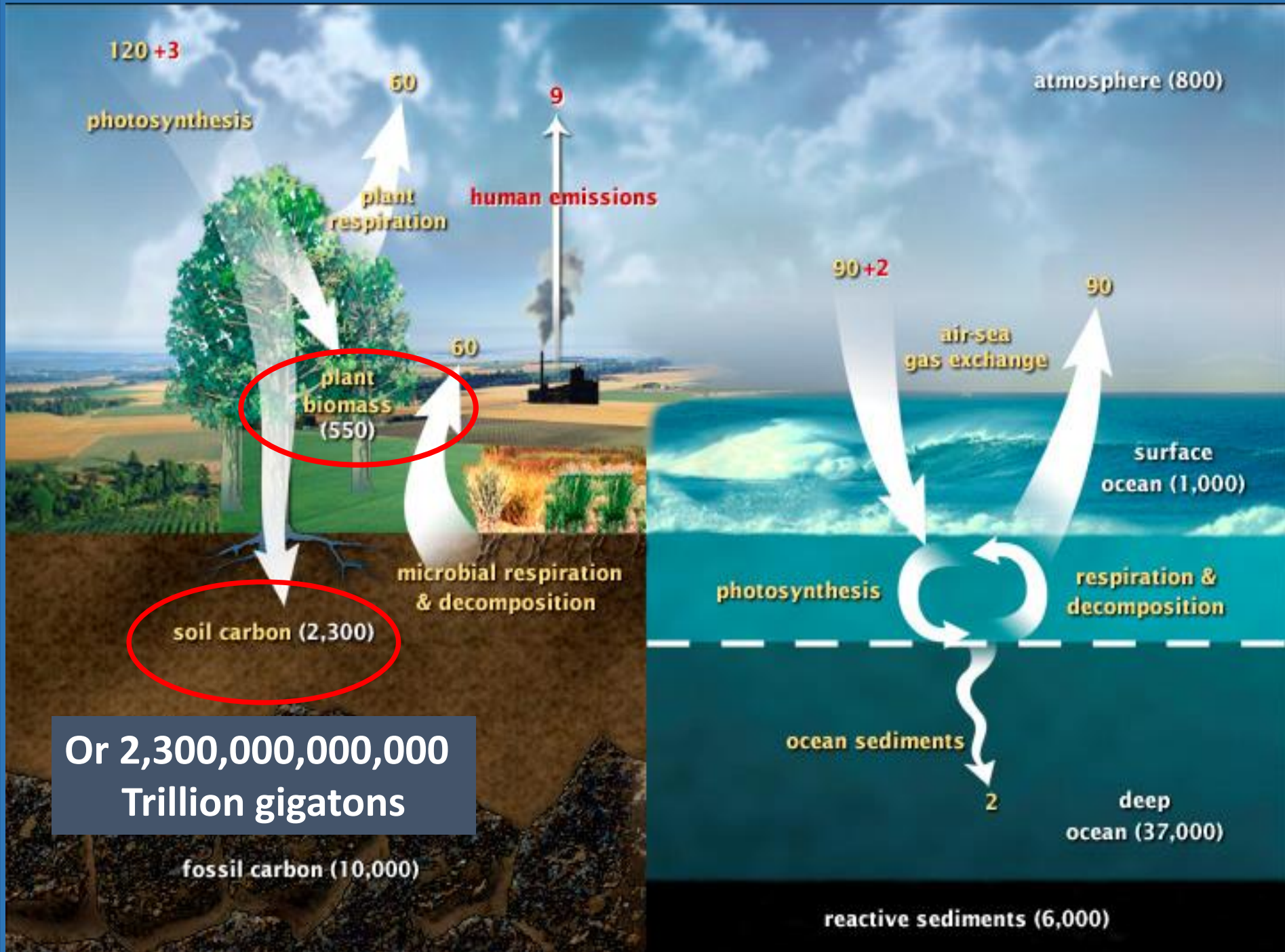
0.52 m/s

0.24 m/s

	Fallow (NCC)	Cover Crops
Precipitation Discharged as Runoff	16.3%	0.9%
Average Peak Runoff Velocity	0.52 m/s	0.24 m/s

# Climate Change

# Soil Carbon Storage



Or 2,300,000,000,000  
Trillion gigatons



# USDA Climate Smart Agriculture



## USDA Building Blocks for Climate Smart Agriculture and Forestry

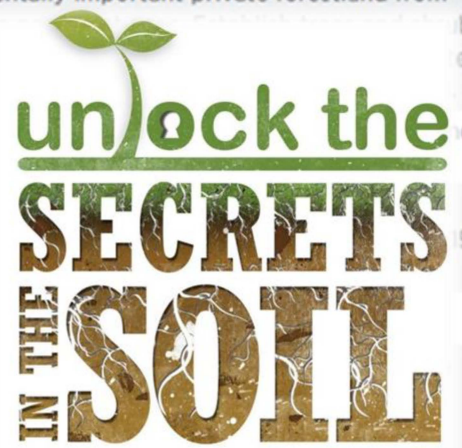


**Implementation Plan and Progress Report**  
May 2016

# NRCS Lead in Soil Health

Goal	GHG Reduction Goal (MMTCO <sub>2</sub> e per year by 2025) <sup>1</sup>
Increase soil carbon sequestration by improving soil health, decreasing erosion of carbon-rich top soil, and increasing soil organic matter.	<b>4 to 18 million Metric tons CO<sub>2</sub> Reduction</b>

Private Forest Growth and Retention	Program and Community Forest and Open Space Conservation Program, protect almost 1 million acres of environmentally important private forestland from conversion to other uses on an additional 1 million acres of forestland to be conserved.	19.5
Stewardship of Federal Forests	Reforest 32 million acres.	2.5
Promotion of Wood Products	Increase the number of forest jobs annually through the National Woodlands Conservation Program to 900 in 2025.	19.5
Urban Forest	Plant 100,000 trees.	0.1
Energy generation And Efficiency	Promote renewable energy efficiency through the National Conservation Program, Rural Energy for America Act, National On-Farm Energy Initiative, and Rural Housing Service programs.	60.2



**Total 121.7 – 135.7**

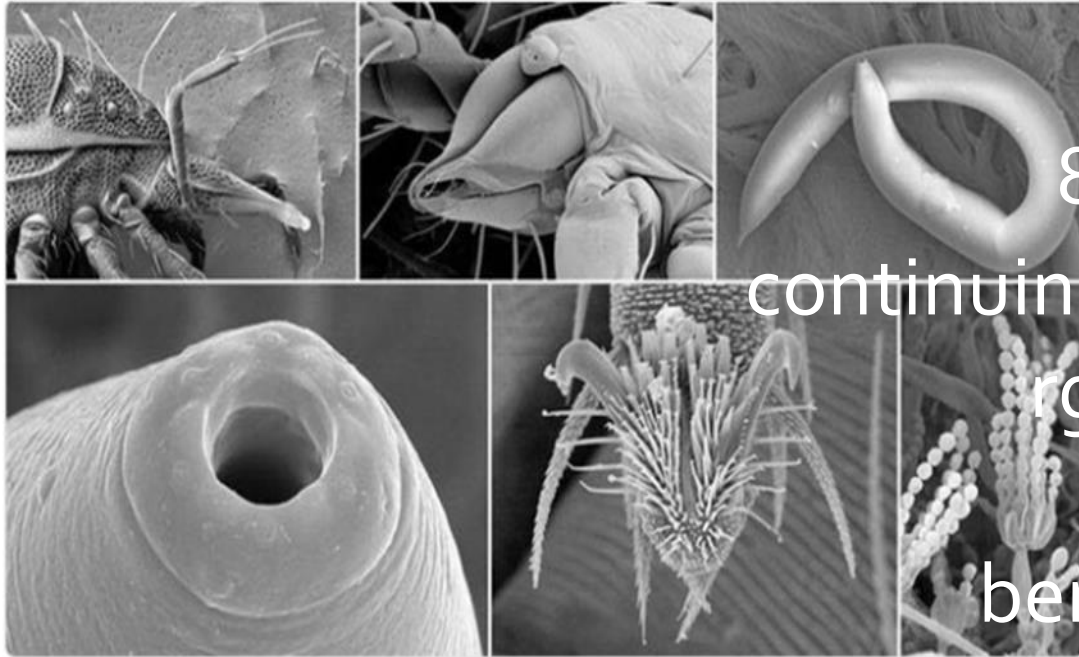


# They Both Contain Capacity to Function as a Living System



USDA NRCS @USDA\_NRCS · 2h

90% of soil function is attributable to soil microbes. [ow.ly/10aQMe](https://ow.ly/10aQMe)



9



859

continuing

organic

holding

benefits.



# The factory of life

## Why soil biodiversity is so important



# If you Machiner Soil Owners Manual



## THE SOIL FOOD WEB

When these diverse soil organisms interact with one another and with the plants and animals in the ecosystem, they form a complex web of ecological activity.



SOIL BIODIVERSITY AND CULTURE



# NRCS Conservation Core Practices for Soil Health



## Conservation Crop Rotation

Growing a diverse number of crops in a planned sequence to increase soil organic matter and biodiversity in the soil.



## Cover Crop

An un-harvested crop grown as part of a planned rotation to provide conservation benefits to the soil.



## No Till

A way of growing crops without disturbing the soil through tillage.



## Mulch Tillage

Using tillage methods where the soil surface is disturbed but maintains a high level of crop residue on the soil level.



## Mulching

Applying plant residues or other suitable materials to the soil surface to compensate for loss of residue due to excessive tillage.



## Nutrient Management

Managing soil nutrients to meet crop needs while minimizing the impact on the environment and the soil.



## Pest Management

Managing pests by following an ecological approach that promotes the growth of healthy plants with strong defenses, while increasing stress on pests and enhancing the habitat for beneficial organisms.



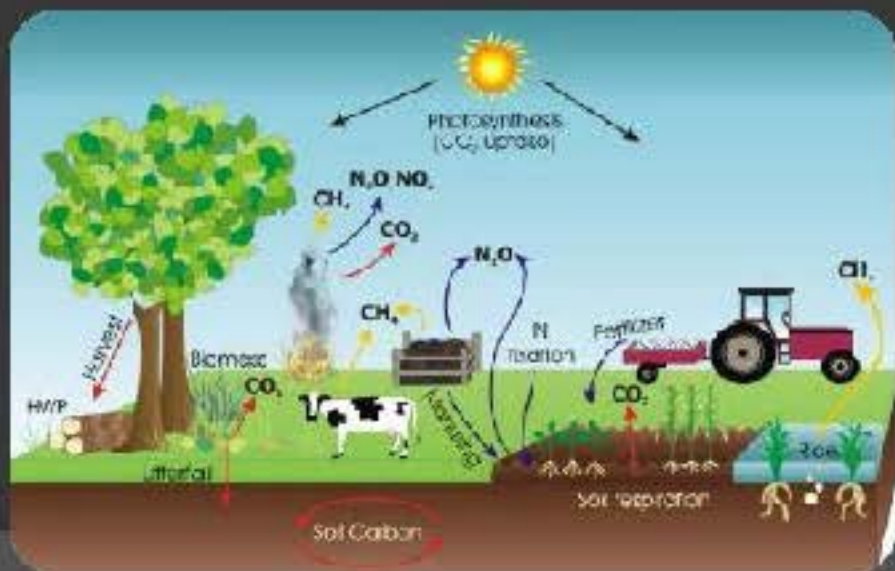
## Core Soil Health Practices



# COMET-Farm

## Scope and key features

- Full farm-level greenhouse gas accounting
  - Soil and biomass C stock changes
  - Soil  $N_2O$  and  $CH_4$  emissions
  - Livestock – enteric  $CH_4$  and manure  $CH_4$  and  $N_2O$
  - Energy – Fossil C emissions; on-farm renewables
  - Other emissions – burning, liming, ...





# Top 3 Hits

## 1. What is the best method to assess soil health?

to ?



United States Department of Agriculture  
Natural Resources Conservation Service  
Soil Quality Institute

### Guidelines for Soil Quality Assessment in Conservation Planning



### IOWA Soil Health Assessment Card

CROP 3089B May 2016

This card is for field assessment and evaluation of soil health indicators as part of the Iowa Soil Health Field Guide.

IOWA STATE UNIVERSITY  
Extension and Outreach

### Comprehensive Assessment of Soil Health

The Cornell Framework Manual



B.N. Moebius-Clune, D. J. Moebius-Clune, B.K. Gugino, O.J. Idowu, R.R. Schindelbeck, A.J. Ristow, H.M. van Es, J.E. Thies, H. A. Shayler, M. B. McBride, D.W. Wolfe, and G.S. Abawi

Third Edition



Cornell University



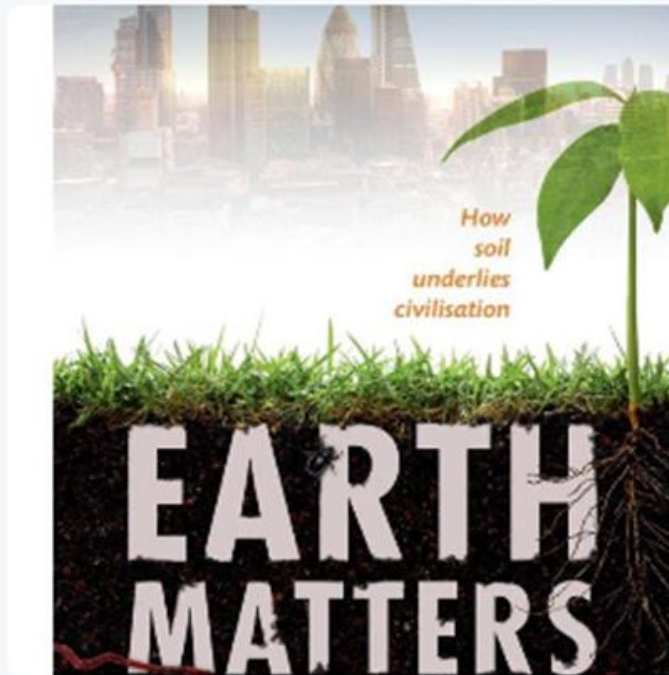
# Earth Matters

“ you don't actually need sophisticated tests to see if a soil is fertile.  
“A Major contributor in soil science is how to measure soil health”



Abbey Wick @NDSUsoilhealth · Aug 21

#soilhealth colleague reading this book came across this paragraph - need to add this to my reading list



health. Soil scientists have come up with many ways to measure soil health, such as measuring plant-available nutrients, the physical structure of soil, or the activity of soil life. But a problem with all of these is that no single measure defines soil health; rather it depends on a rich web of physical, chemical, and biological factors that together operate to give a soil good health. I often joke with students that you don't actually need sophisticated tests to see if a soil is fertile or not. An experienced soil scientist can tell much about a soil from its look, smell, and feel; fertile soil will break away easily from your fingers into well-formed aggregates, it will be rich in colour and smell, indicating well-oxygenated conditions and good drainage, and its organic matter will be intermixed with underlying mineral soil due to high biological activity. This might be a very unscientific view, but simply digging a hole and looking at a soil reveals much about its health. You can see if it has good aggregate structure, whether its drainage is impeded, or whether it is compacted at depth. Of course, simply looking at soil doesn't tell you about the concentration of nutrients or pollutants, or about the activities of microorganisms that are essential for a fertile soil. But it does give some signals about the fertility of the soil.

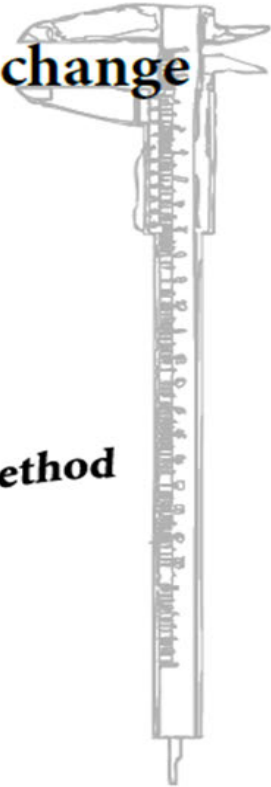
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28



Measuring soil carbon change



A flexible, practical, local method

Peter Donovan

version: October 2013



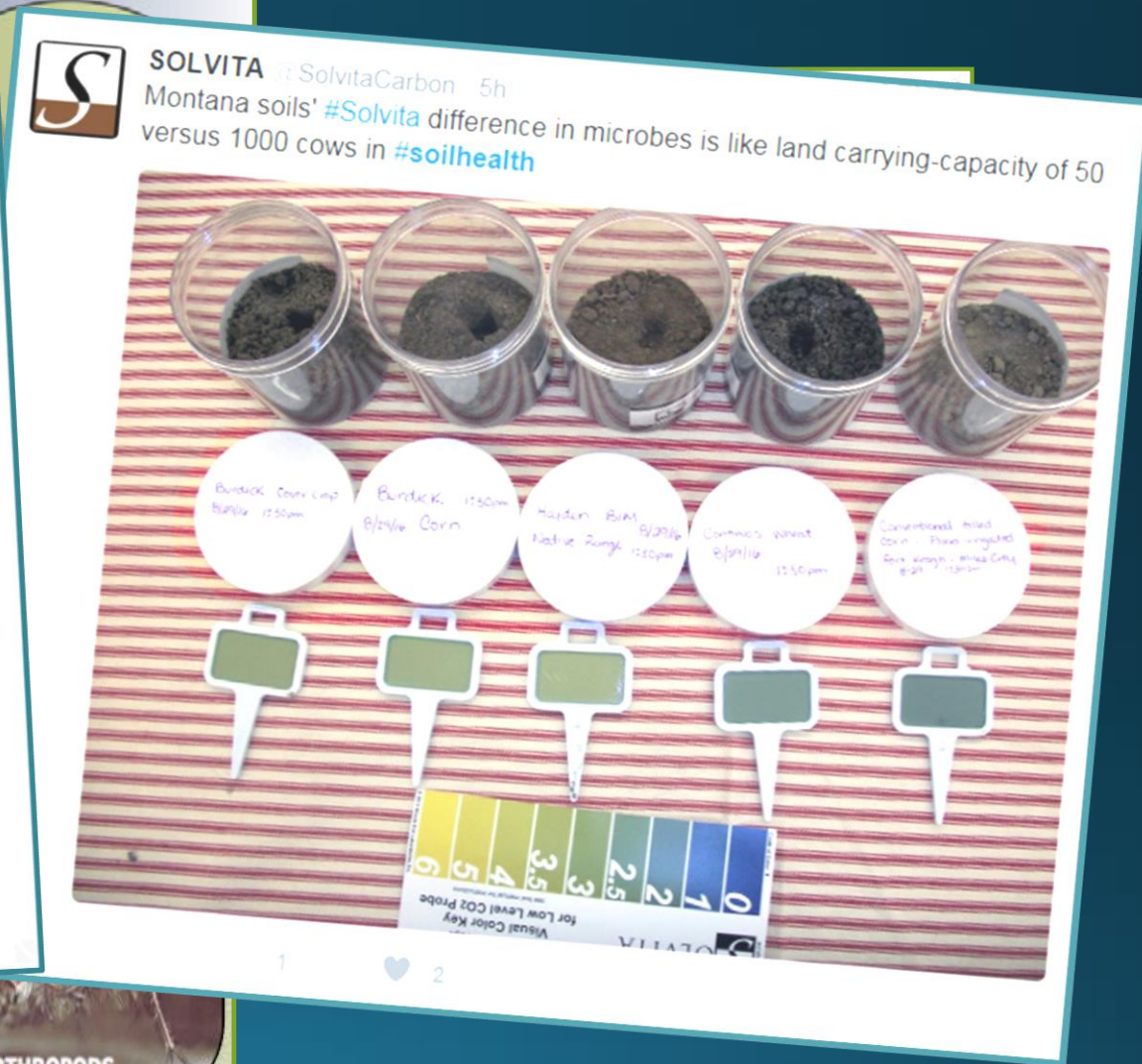
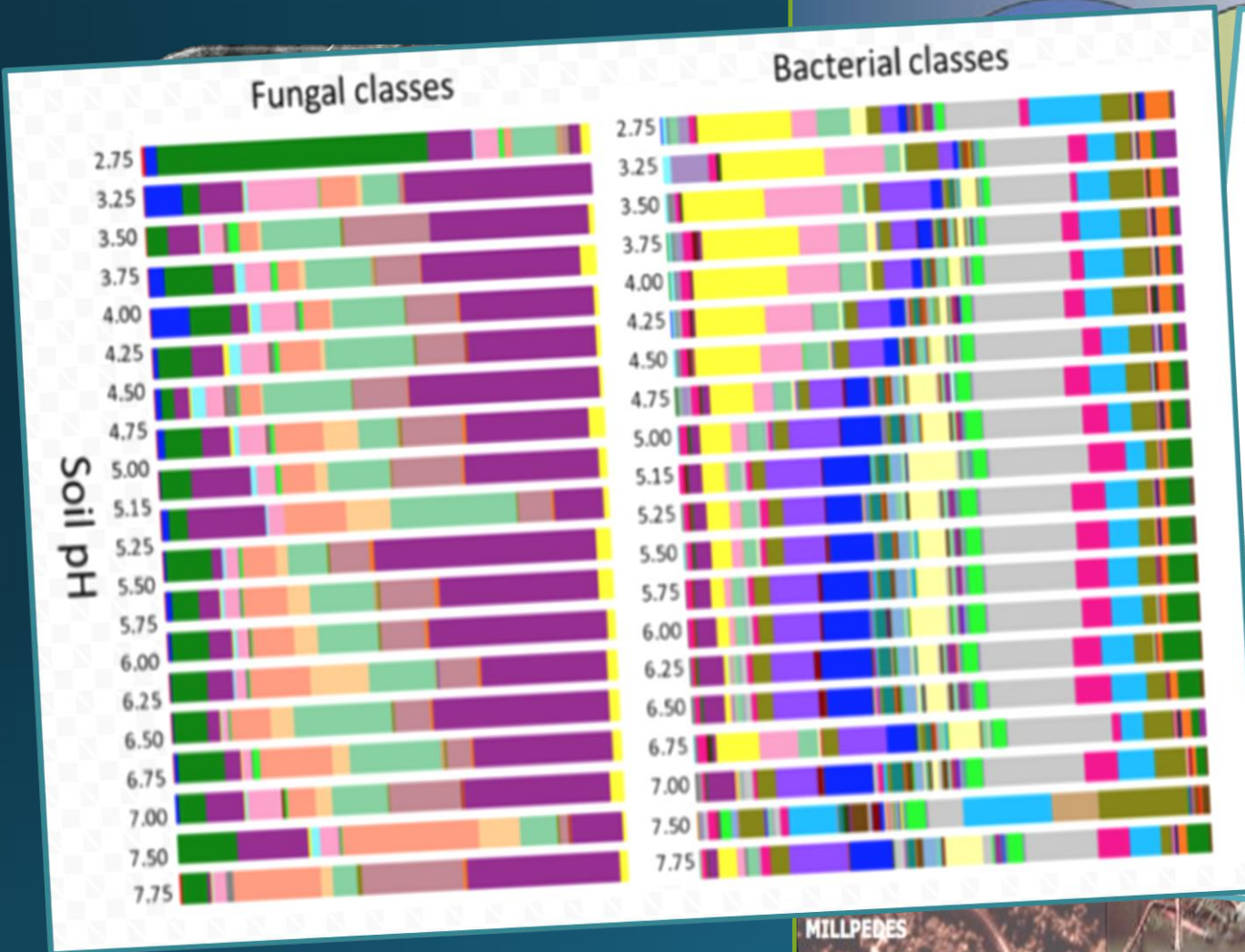
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Range Comparison Field Trials  
"How you measure something  
depends on your purpose"





# What are Soil Health Measurement Complex to Simple



Micro and Macro Organisms



# Traditional Soil Testing Methods

Soil N, P, K

Soil pH, CEC

% Organic matter



Where's the soil biology?

## Fertilizer Recommendation





# New Soil Testing Methods

soil testing in nature's image

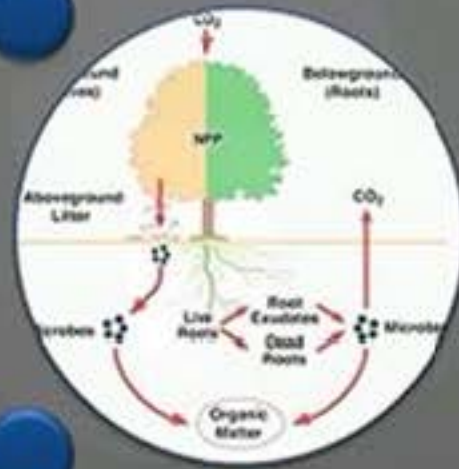
Soil N, P, K

Soil Organic N and P

Microbial Activity

Water Extractable C

C:N balance



Grow Cover Crops or Practices to Increase Organic matter

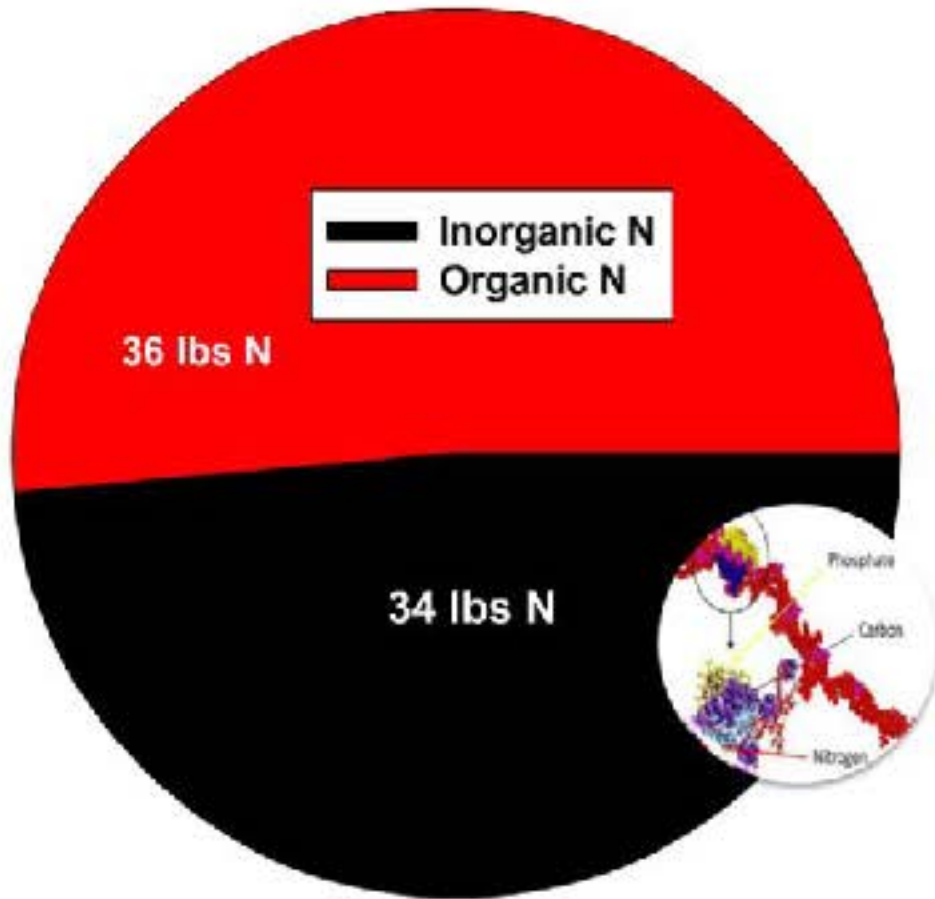




Since 1965\* we have been missing half of the N

\*2M KCl 1965 Bremer

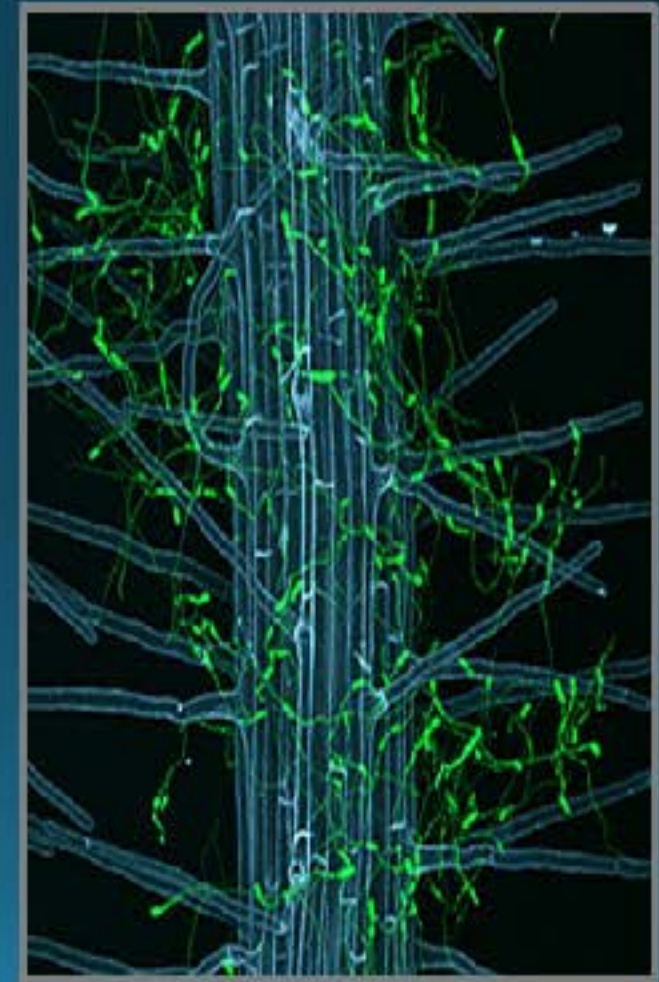
Water Extractable Total Nitrogen  
Average of 6227 soil samples



“If plants could not take up organic compounds herbicides would not work”

Plants eat: Inorganic N  
And Organic N from soil organic matter

## Managing the Nitrogen Cycle

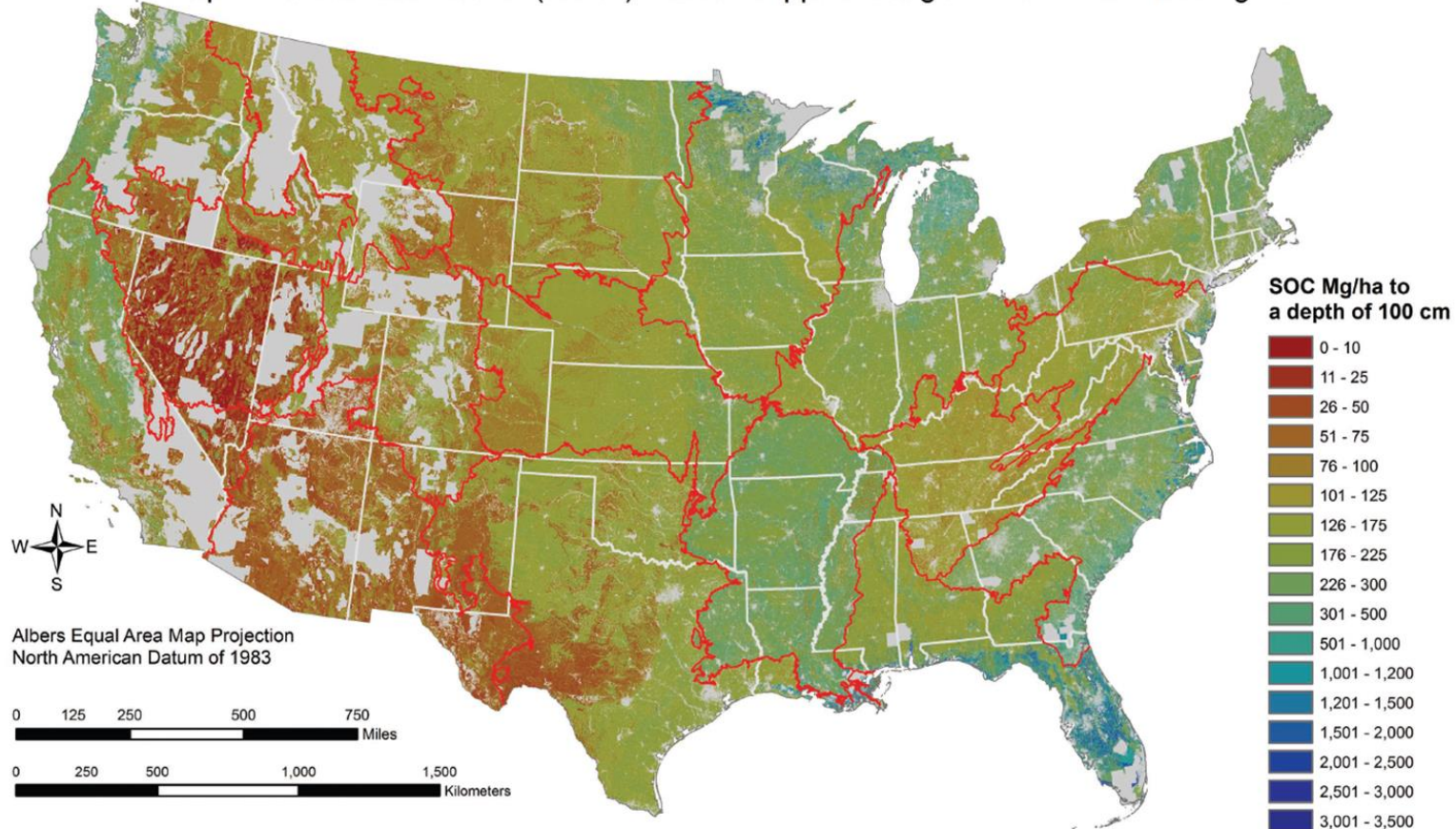




# 2. What is baseline soil carbon for California?

## Soil Organic Carbon Stocks

Rapid Carbon Assessment (RaCA) Values Mapped Using SSURGO and NLCD grids

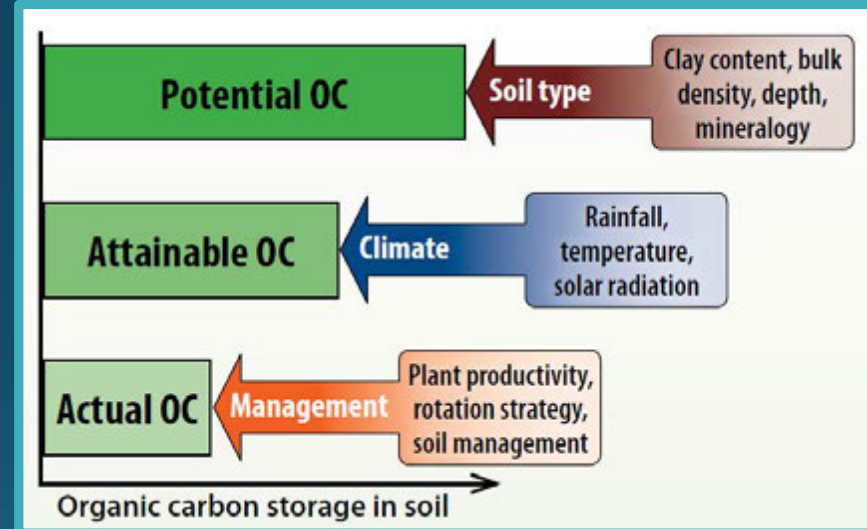


Albers Equal Area Map Projection  
North American Datum of 1983

0 125 250 500 750 Miles

0 250 500 1,000 1,500 Kilometers

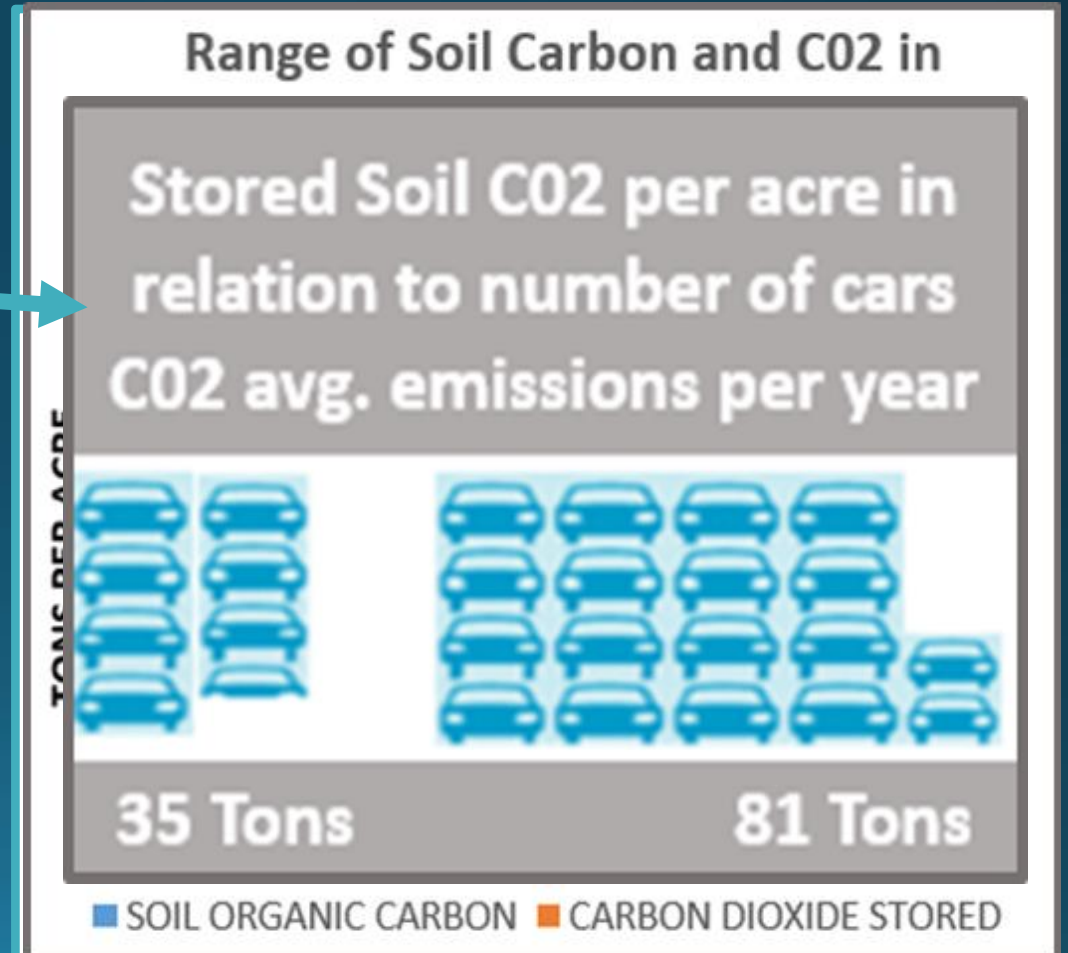
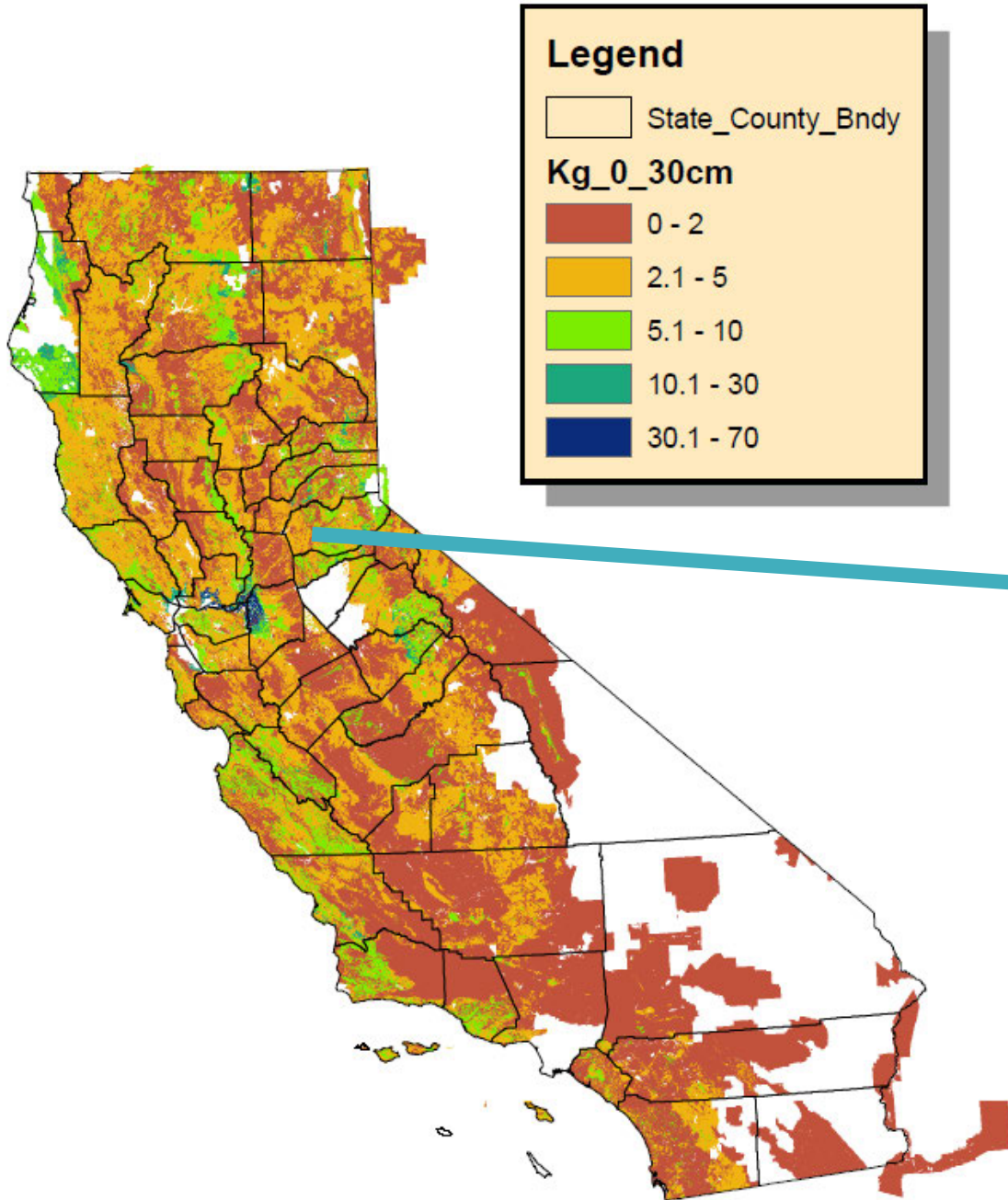
## It Depends?





# Soil Carbon

Typical CV Soil 5 to 12 Pounds  
Tons of Soil Carbon and CO<sub>2</sub> per acre  
SOC in Surface Foot, 1.0 to 2.5 % OM





# National Cooperative Soil Survey Soil Characterization Data

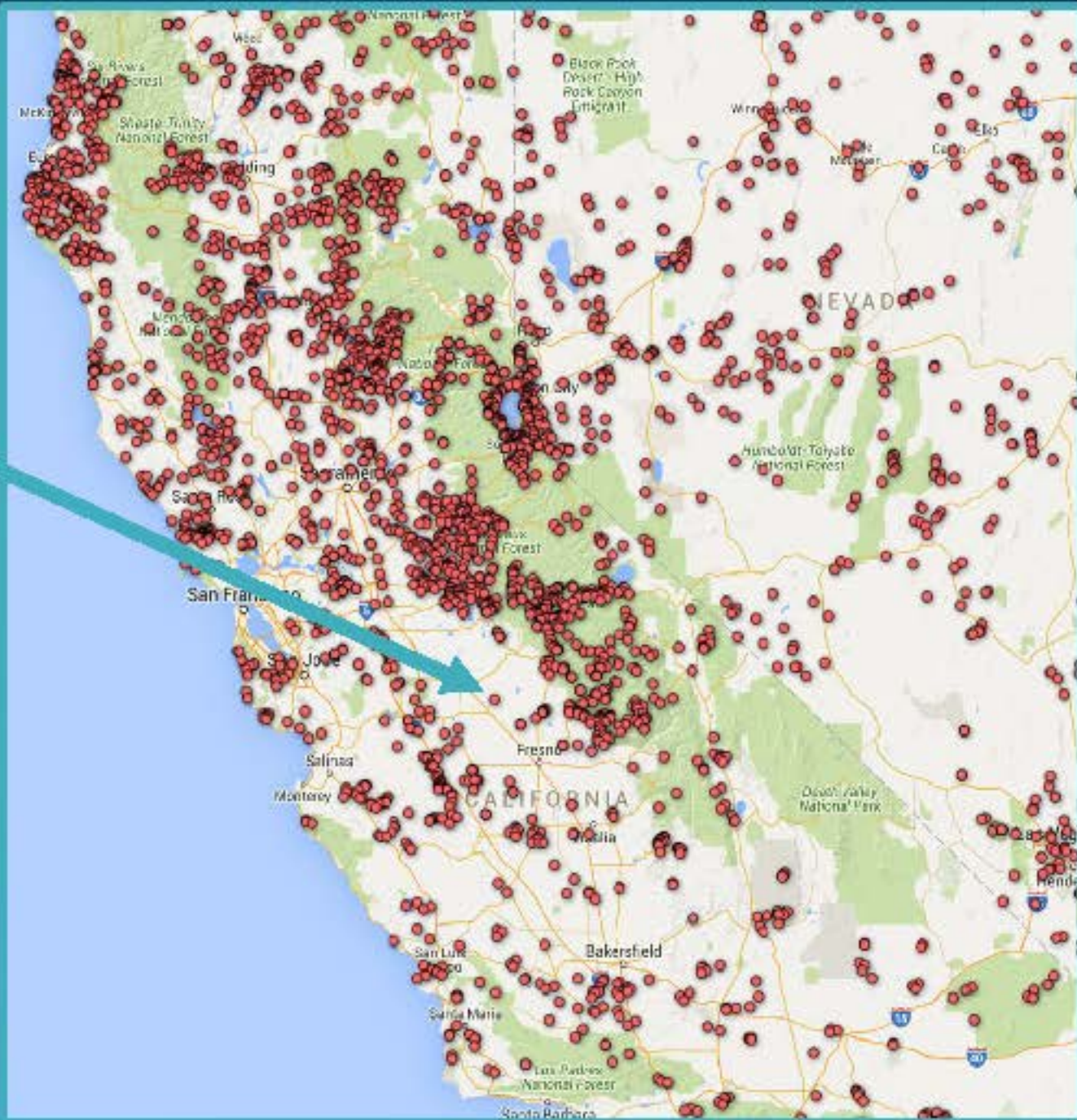
## Carbon & Extractions

Layer	Depth (cm)	Horz	Prep	-1- -2- -3- -4- -5- -6-		
				(----- Total -----) C N S OC	Est OC	OC C/N (WB) Ratio
						6A1c
79P00900	0-0	Ap	S			0.54
79P00901	0-0	C1	S			0.13
79P00902	0-0	C2	S			0.06
79P00903	0-0	C3	S			0.05



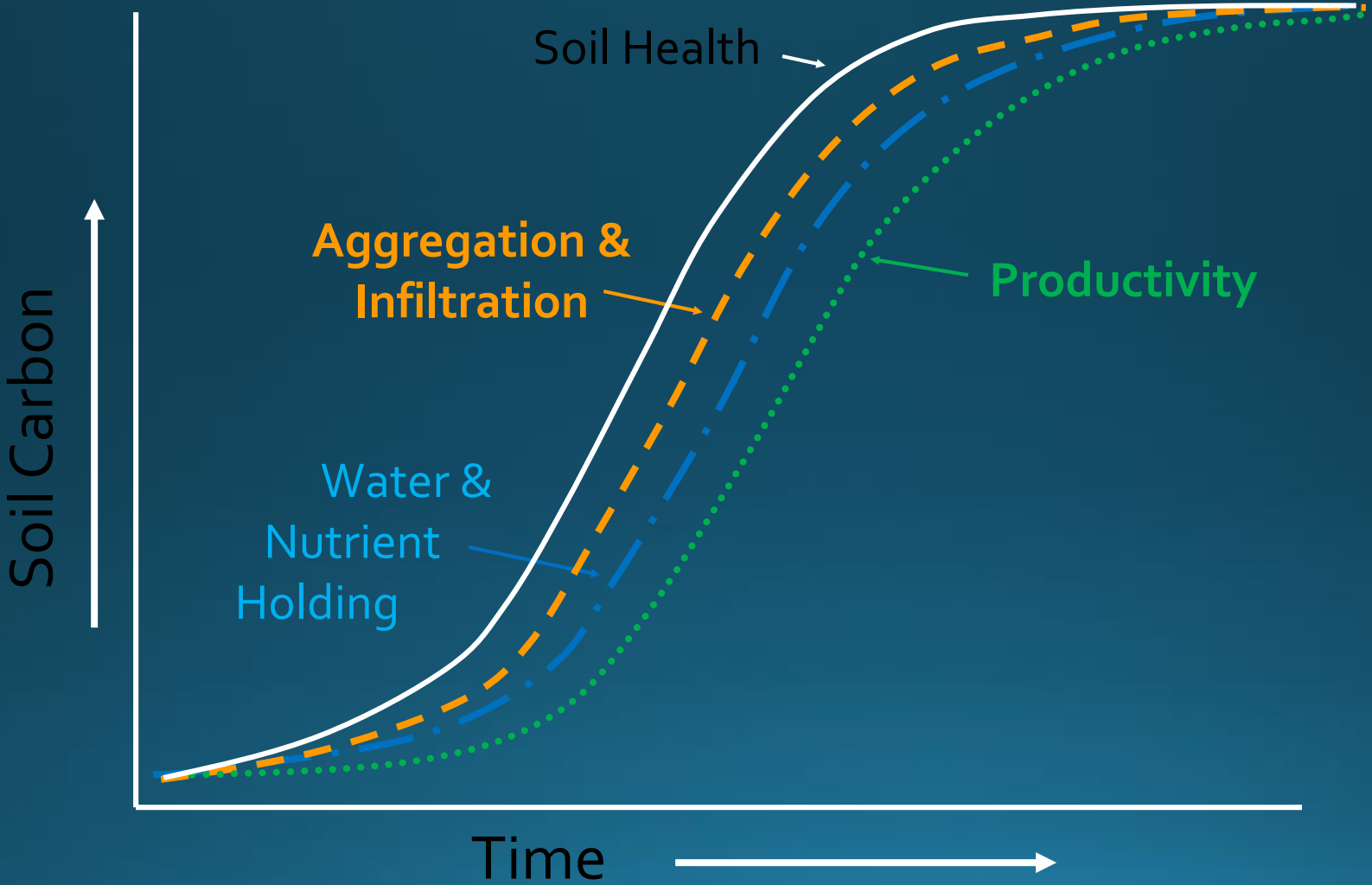
## -9- -10-

CEC8	CEC7
Sum	NH <sub>4</sub>
Cats	OAC
(--- cmol(+) kg <sup>-1</sup> )	
5A3a	5A8 a
3.4	3.3
1.7	1.1
1.6	1.3
2.1	1.0





# Benefits of Soil Carbon



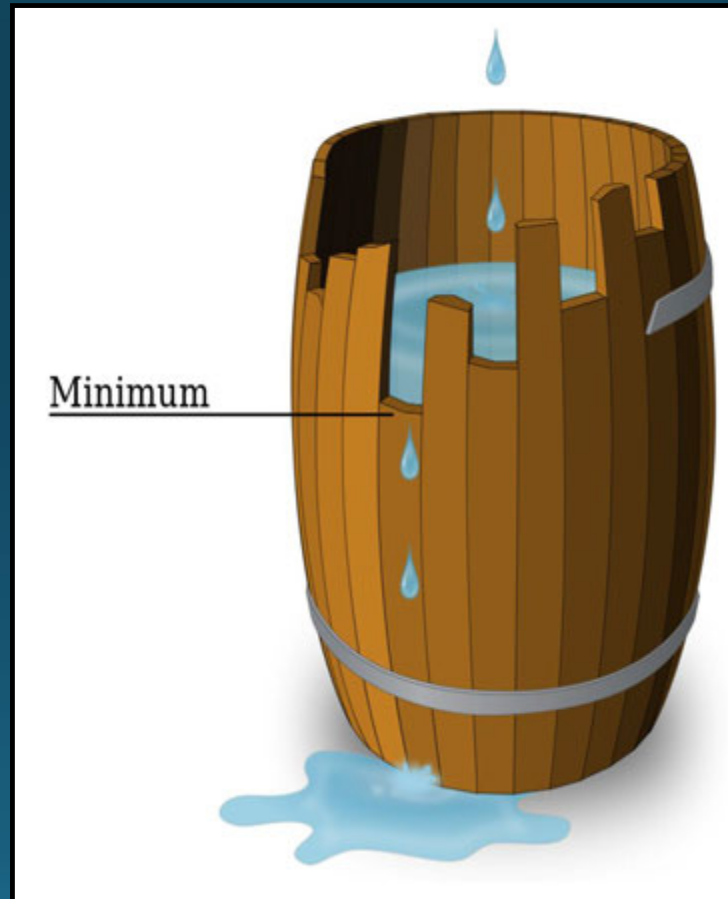


# What is the most limiting to crop production?

Nitrogen ?



Water ?




Other?





# Carbon


Feed the soil it's Alive



**Growers who...**

- **disturb the soil as little as possible**
- **use diverse crop rotations**
- **plant cover crops**
- **leave crop residue on the soil**

**... have the key to sustainability!**

**USDA**  **NRCS**  
United States Department of Agriculture  
Natural Resources Conservation Service

[www.nrcs.usda.gov](http://www.nrcs.usda.gov)

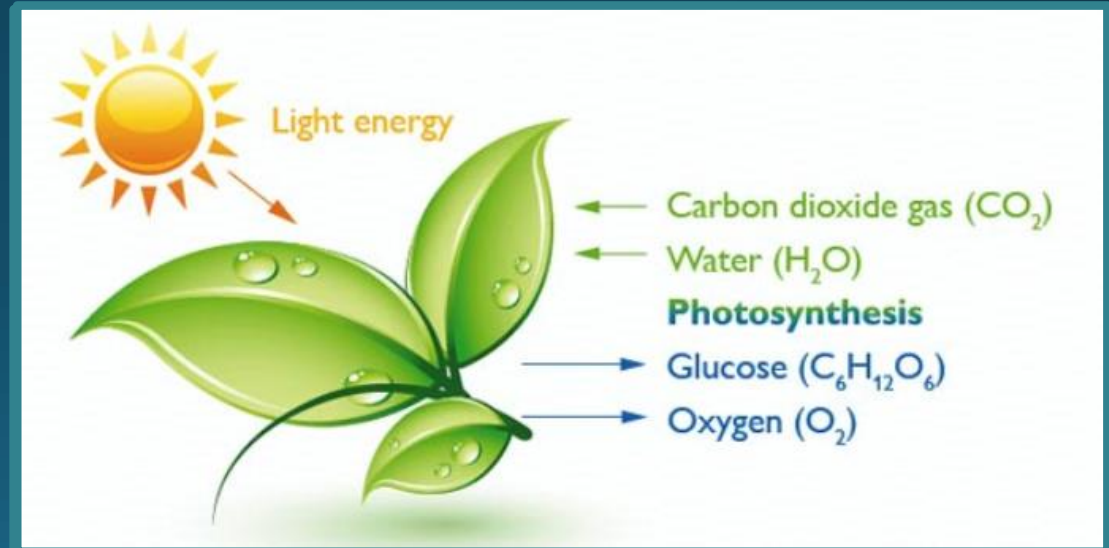




Ancient Solar energy + fossil fuels  
Harvest current solar energy

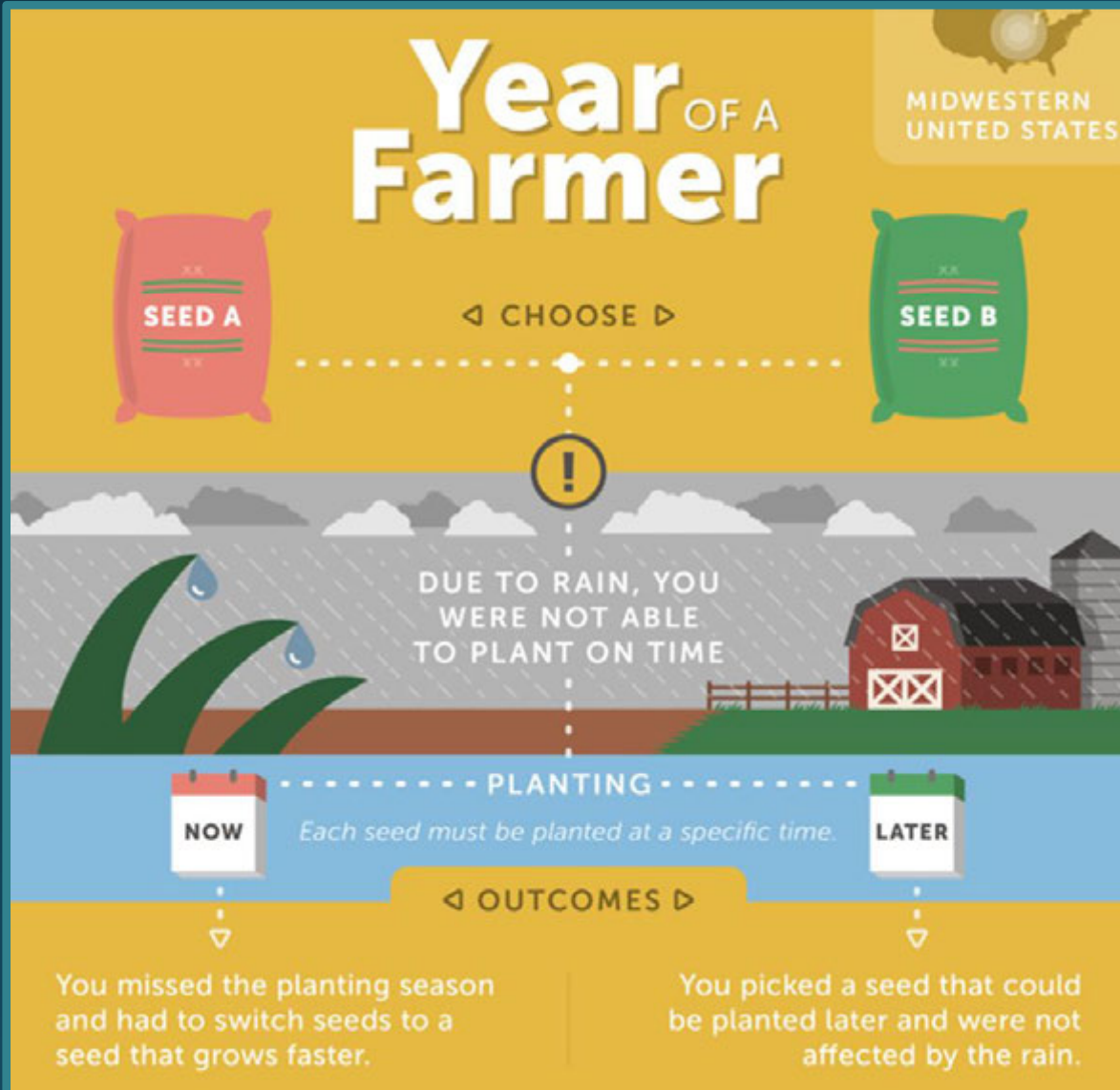
With Plants Solar Panels  
\* Fuel for Equipment \$\$

\* Free nutrient supply  
\* Fertilizers \$\$





# 3. Adaption of soil health Practices (BMP's) in CA?



## It's Difficult!

Farming is a business!  
At least 40 decisions made each crop year...  
Economics is one of several factors influencing decisions.

Crop

Also conservation to protect the soil while producing food, feed, and fiber.

Variety  
Timing/Schedule

Equipment

Regulation

Requirements

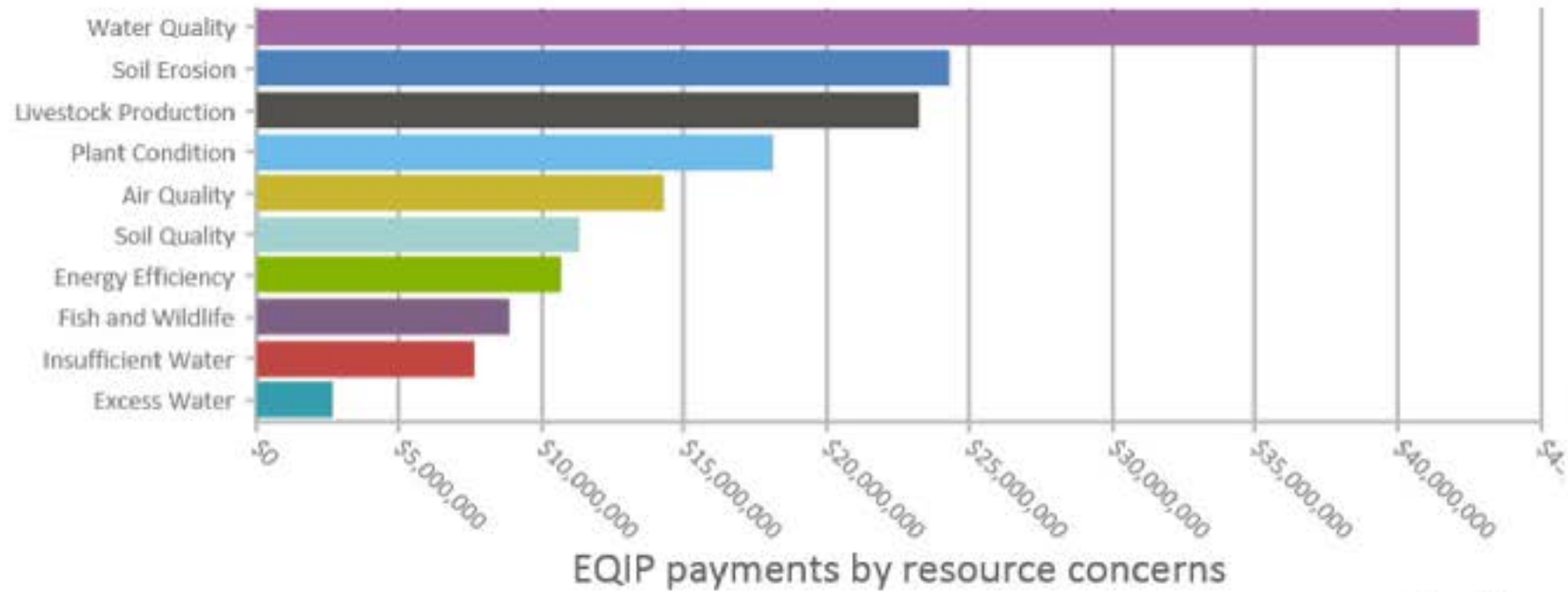
Irrigation  
Fertility

IPM



# NRCS Conservation to Address Soil health North Dakota vs California

## EQIP impacts on resource concerns in North Dakota, 1998-2015



[CanvasJS.com](#)

[See resource concern data](#)



# A Shift in Management Shift in Thinking about Farming



Conventional Tillage

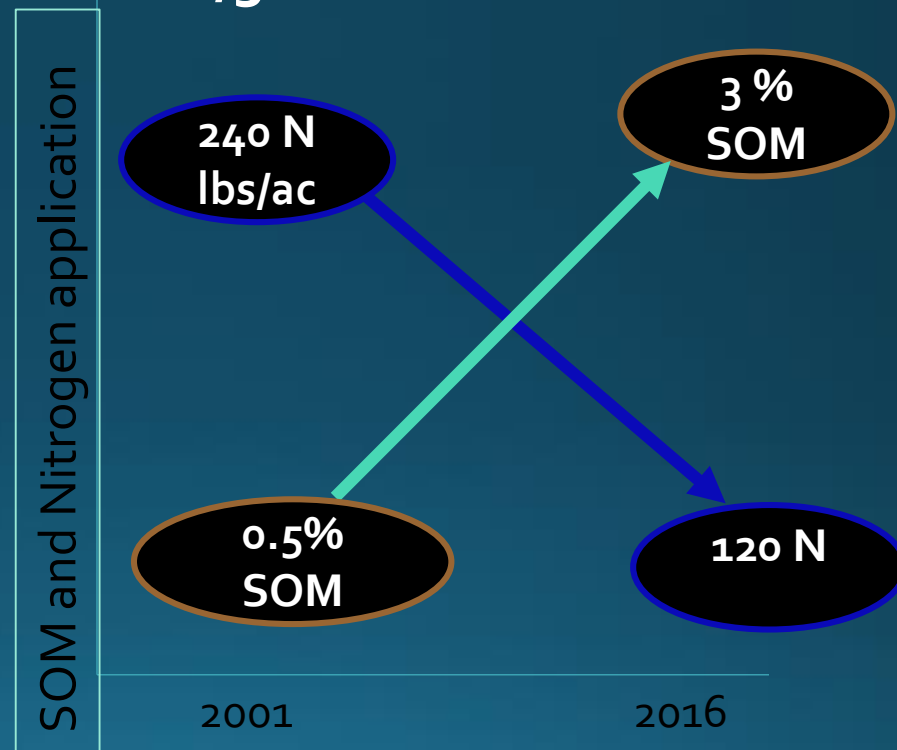


No Till

# Example: Soil Health Management



1/3 Reduction in Water Use



Sano Farm in Fresno, CA





# *Long* LIVE the **SOIL**

There's an amazing amount of life in *healthy soil*.  
More importantly, that *living resource* is also *life-giving*.

That's why USDA's Natural Resources Conservation  
Service is working with America's farmers and  
ranchers to keep it *healthy* and *functioning—for life*.



Visit [www.nrcs.usda.gov](http://www.nrcs.usda.gov) to learn more.

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