

USDA – NRCS



New Mexico

Re-active Carbon Test Kit By Clarence Chavez

Integrated Cropping Systems and Water Management Handbook (AGRO-76)

<http://www.nm.nrcs.usda.gov/technical/handbooks/iwm/nmiwm.html>

February 2012

4th Year of Testing with the USDA – NRCS Re-active Carbon Test Kit in the New Mexico Soil Health workshops and training sessions.

Integrated Cropping Systems and Water Management Handbook (AGRO-76)

<http://www.nm.nrcs.usda.gov/technical/handbooks/iwm/nmiwm.html>

USDA – NRCS New Mexico

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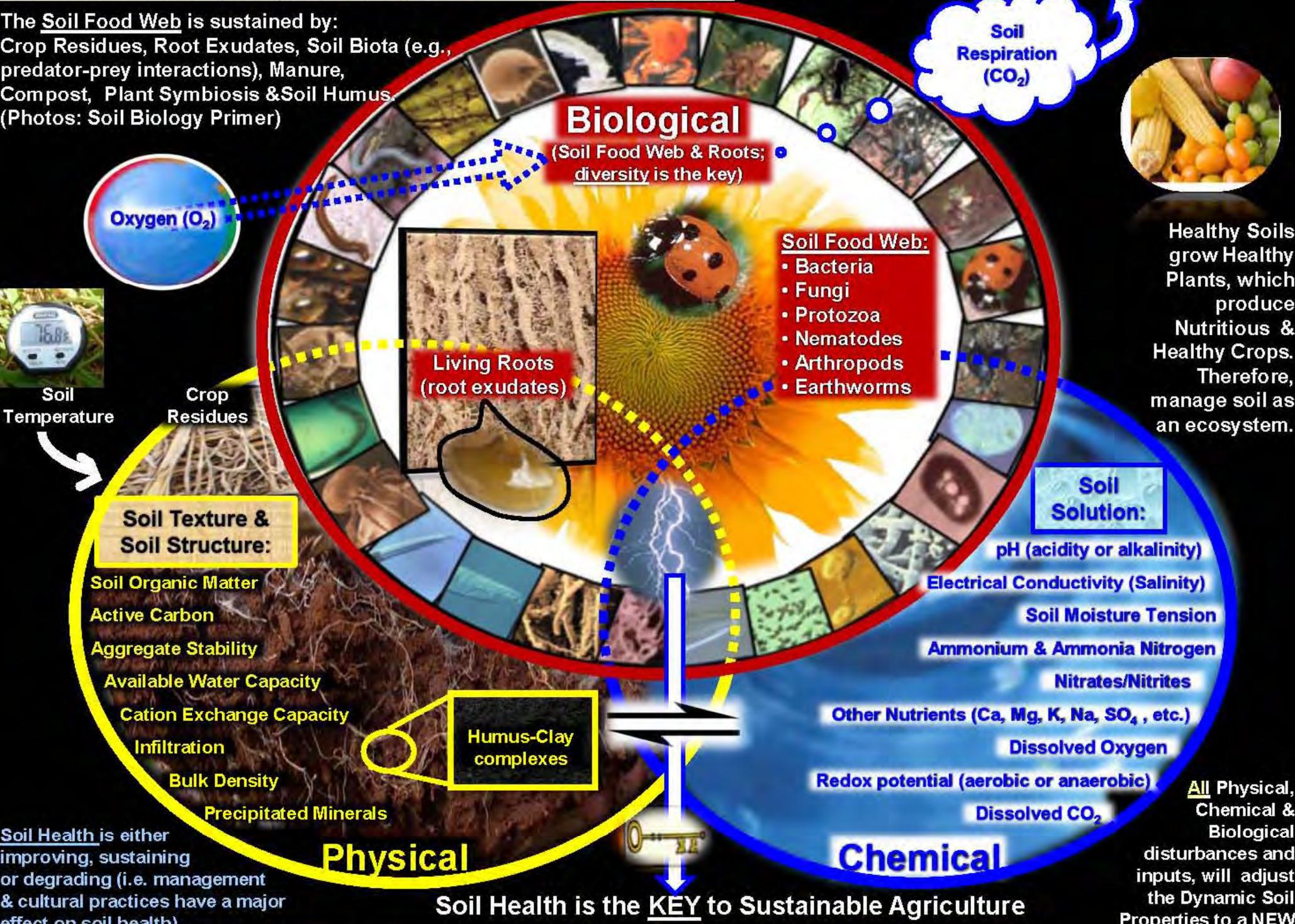
What is Reactive Carbon?

The Reactive carbon component
in soil consists of: Plant and Animal (soil biota)

1. Microbial biomass carbon
2. Particulate organic matter
3. Soil carbohydrates / Sugars
4. Amino acids / Protein
5. Etc...

Just to name a few, there are many more.

The **Soil Food Web** is sustained by:
 Crop Residues, Root Exudates, Soil Biota (e.g., predator-prey interactions), Manure, Compost, Plant Symbiosis & Soil Humus.
 (Photos: Soil Biology Primer)



Biological

(Soil Food Web & Roots; diversity is the key)

Soil Food Web:

- Bacteria
- Fungi
- Protozoa
- Nematodes
- Arthropods
- Earthworms

Living Roots (root exudates)

Soil Respiration (CO₂)



Healthy Soils grow Healthy Plants, which produce Nutritious & Healthy Crops. Therefore, manage soil as an ecosystem.

Soil Solution:

- pH (acidity or alkalinity)
- Electrical Conductivity (Salinity)
- Soil Moisture Tension
- Ammonium & Ammonia Nitrogen
- Nitrates/Nitrites
- Other Nutrients (Ca, Mg, K, Na, SO₄, etc.)
- Dissolved Oxygen
- Redox potential (aerobic or anaerobic)
- Dissolved CO₂

All Physical, Chemical & Biological disturbances and inputs, will adjust the Dynamic Soil Properties to a **NEW EQUILIBRIUM.**

Oxygen (O₂)



Soil Temperature
 Crop Residues

Soil Texture & Soil Structure:

- Soil Organic Matter
- Active Carbon
- Aggregate Stability
- Available Water Capacity
- Cation Exchange Capacity
- Infiltration
- Bulk Density
- Precipitated Minerals

Humus-Clay complexes

Physical

Chemical

Soil Health is the **KEY** to Sustainable Agriculture

Soil Health is either improving, sustaining or degrading (i.e. management & cultural practices have a major effect on soil health)

The Reactive C Field Kit

Many soil properties impact soil quality, but **soil organic matter** deserves special attention.

It affects several critical soil functions and can be manipulated by conservation practices.

(Only through Crop rotations, cover crops, application of manure or compost and moving towards minimum or no till).



The NRCS Reactive C Field Kit is about \$650 per Kit
Does 10 samples at a time (5 gr / sample).



Critical solutions made up for analysis (permanganate solution)



Pocket colorimeter and cuvettes



Taking the color density reading

10 SAMPLES AT A TIME WITH DUPLICATES



How does organic matter
work?

Which soil properties
will change?



How does organic matter work?

- ✓ Once you begin working towards enhancing soil organic matter, a series of soil changes and environmental benefits follow.
- ✓ The rate or degree of these changes and the best practices being used are still dependent on soil, climate, and previous management history.

Better Structure & Infiltration



Tilled Sandy Clay Loam Soil
Notice the Infiltration

Non Tilled Clay Soil

Surface Structure becomes water stable and less prone to crusting and erosion

(Glomalin/Soil Biota/10 - 20% AWHC).

Soil Infiltration and water holding capacity increase.

Beneficial soil organisms become more numerous and active with diverse crop rotations and higher organic matter levels.

Protozoa - Ciliate



Nematode – Bacterial Feeder



Nematode – root feeding nematode captured by fungi!



Soil Biota help create good infiltration



Crop health and vigor increase when soil biological activity and diversity increase.

The primary use of Compost or Manure is to supplement nutrients and add beneficial soil biota with a measure of Organic Matter.



Beneficial Soil Microbes improves when residue management improve.

Transitioning from conventional to organic

The best approach is to feed the soil biota, which will in turn feed the plant.

Top dressing Manure.

Conventional Fertilizers (derived from Fossil Fuels in the form of fertilizers).



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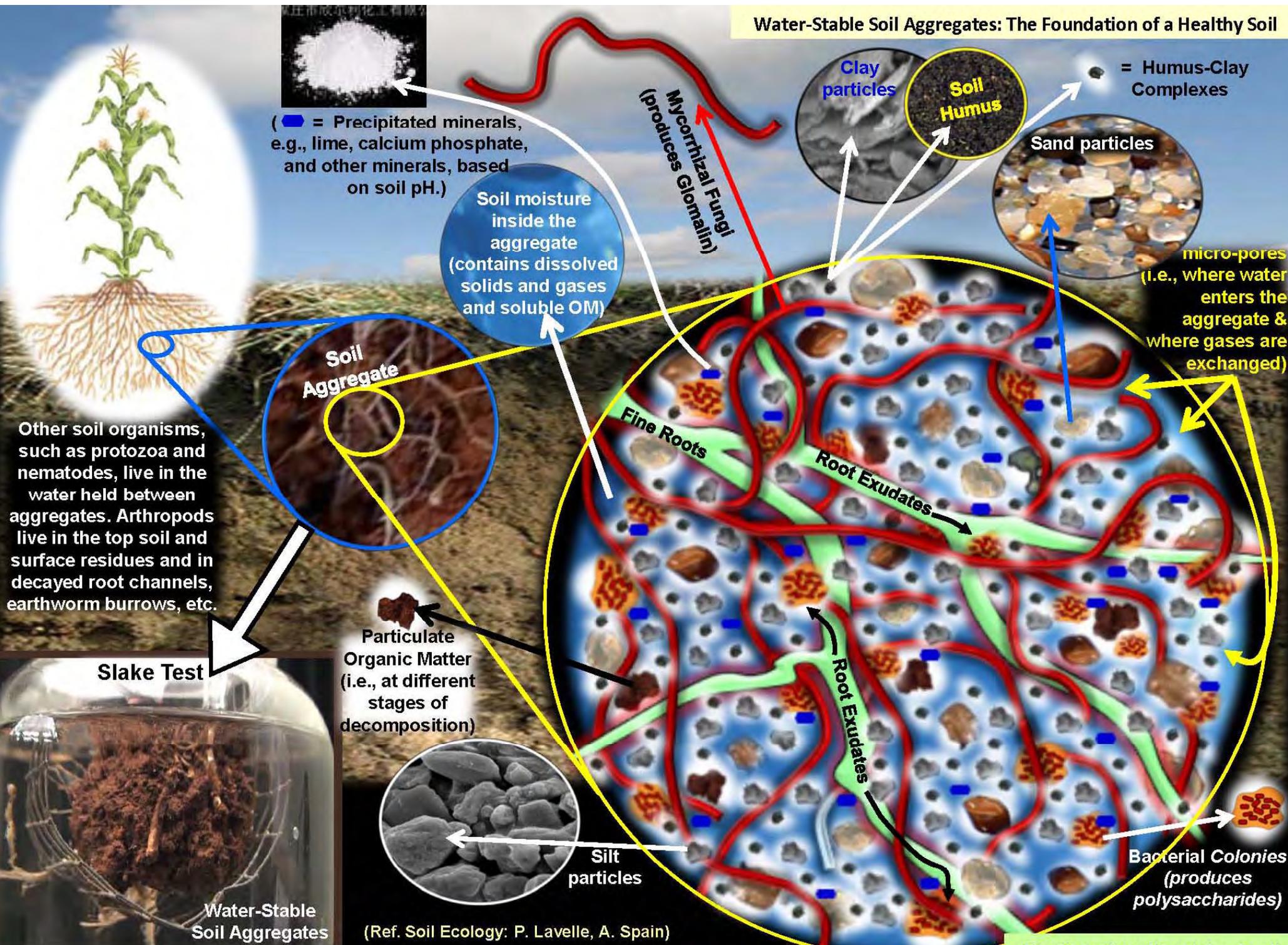
Notice the difference in time

Now lets take a deeper look inside the soil aggregate.

Loamy Sand / Sandy Loam Soil –
That is Highly Structured

Glomalin the Super-Glue of soils

Water-Stable Soil Aggregates: The Foundation of a Healthy Soil



(Ref. Soil Ecology: P. Lavelle, A. Spain)

Biodiversity with minimal soil disturbance drives soil health



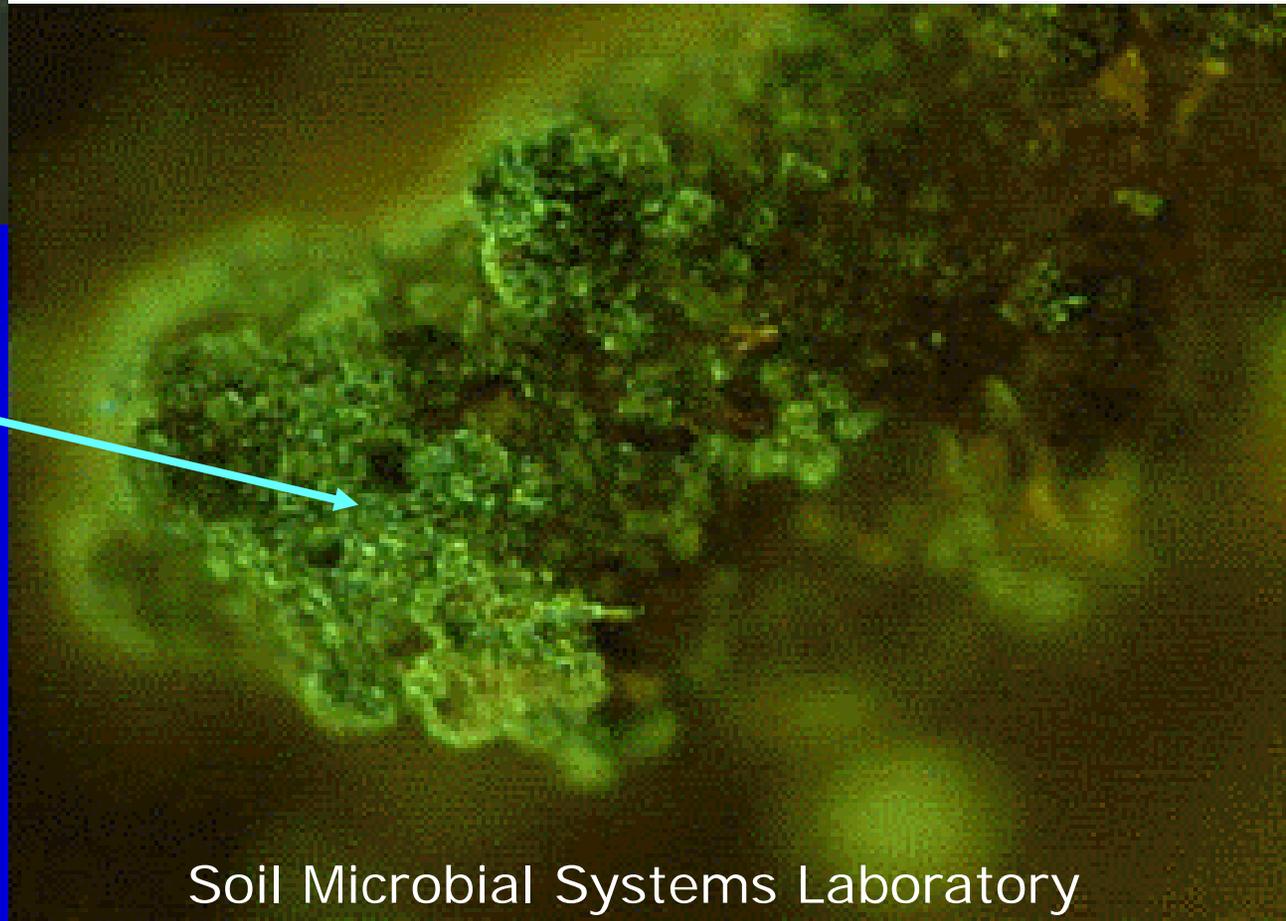
Glomalin in its natural state is brown. A laboratory procedure reveals glomalin on soil aggregates as the green material shown here.



Fungal Hyphae & Spore

Glomalin is very stable, glycoprotein, that stores carbon in the soil as a glue and protects the soil biota.

It makes up a large amount of soil organic matter and a portion is reactive carbon.

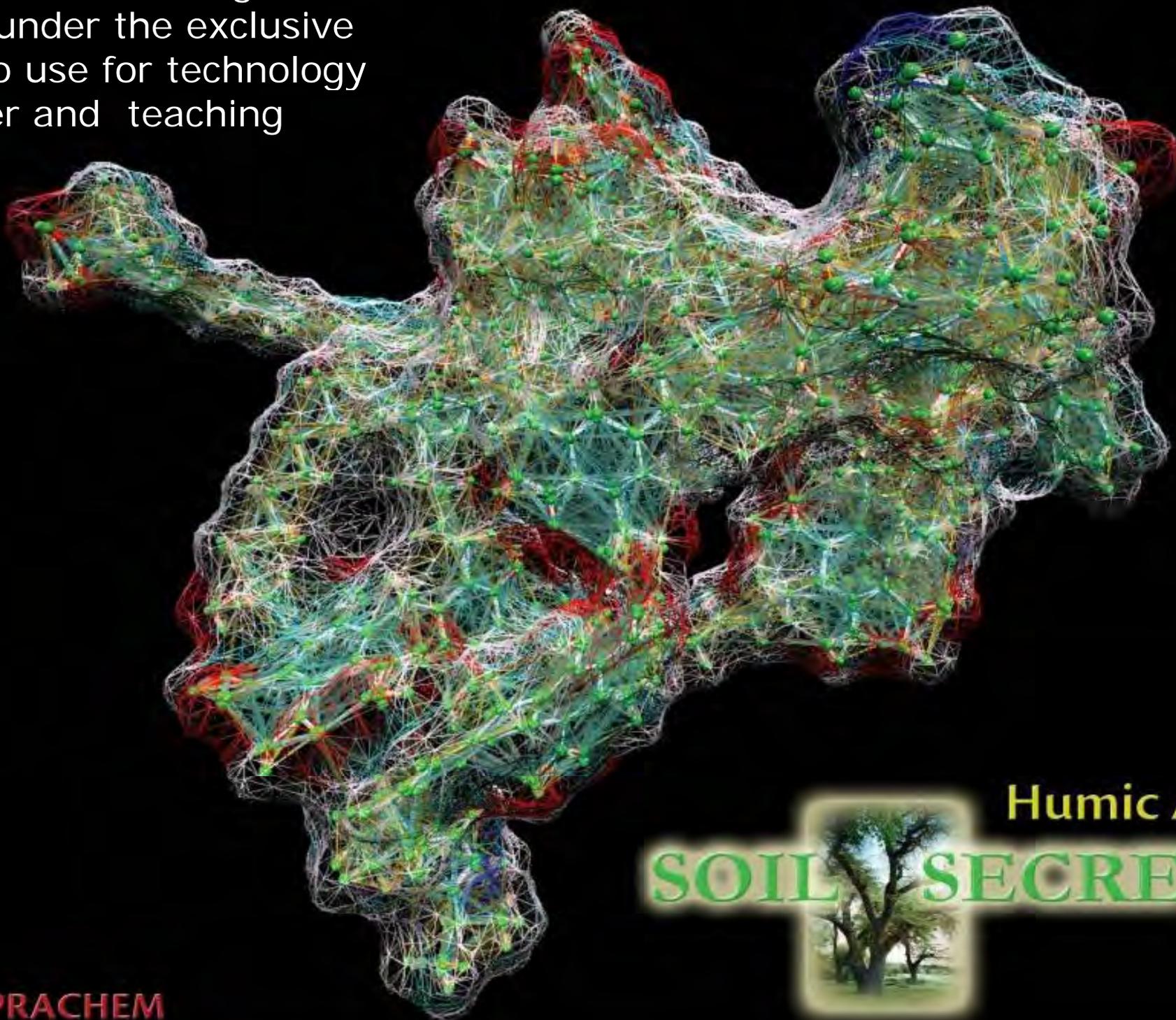


Mycorrhizal fungi and other members of the fungi family are
-- soil structure builders.



In this photo, sand grains are bound to a root by hyphae from endophytes (fungi similar to mycorrhizae), and by polysaccharides secreted by the plant and the fungi.

USDA-NRCS is using this photo under the exclusive right to use for technology transfer and teaching



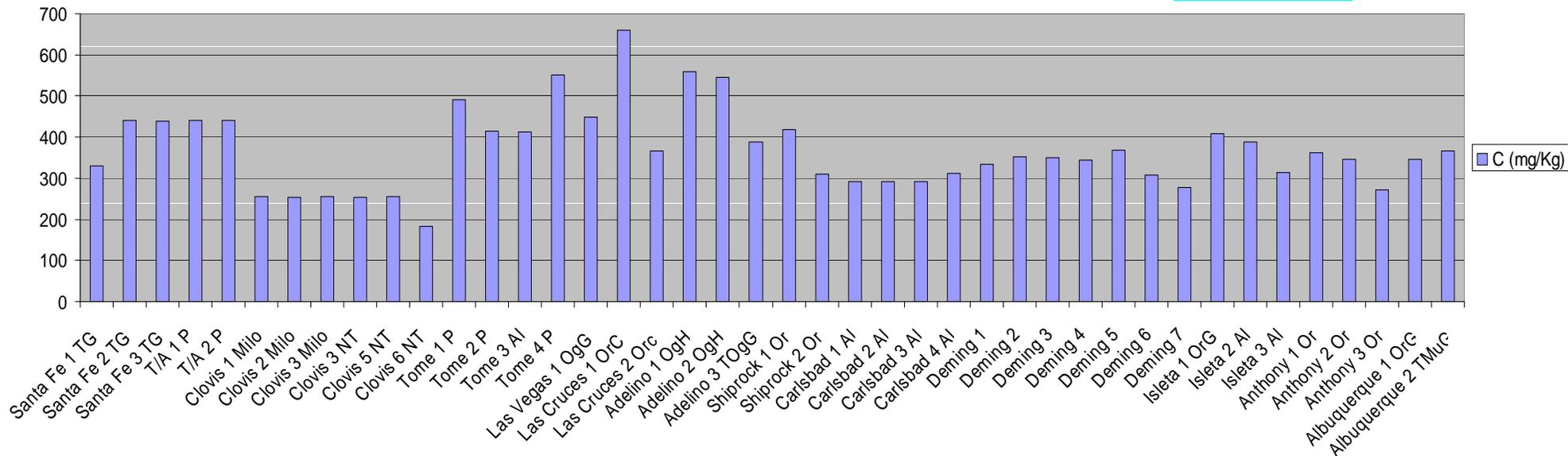
Humic Acid
SOIL SECRETS

© SUPRACHEM

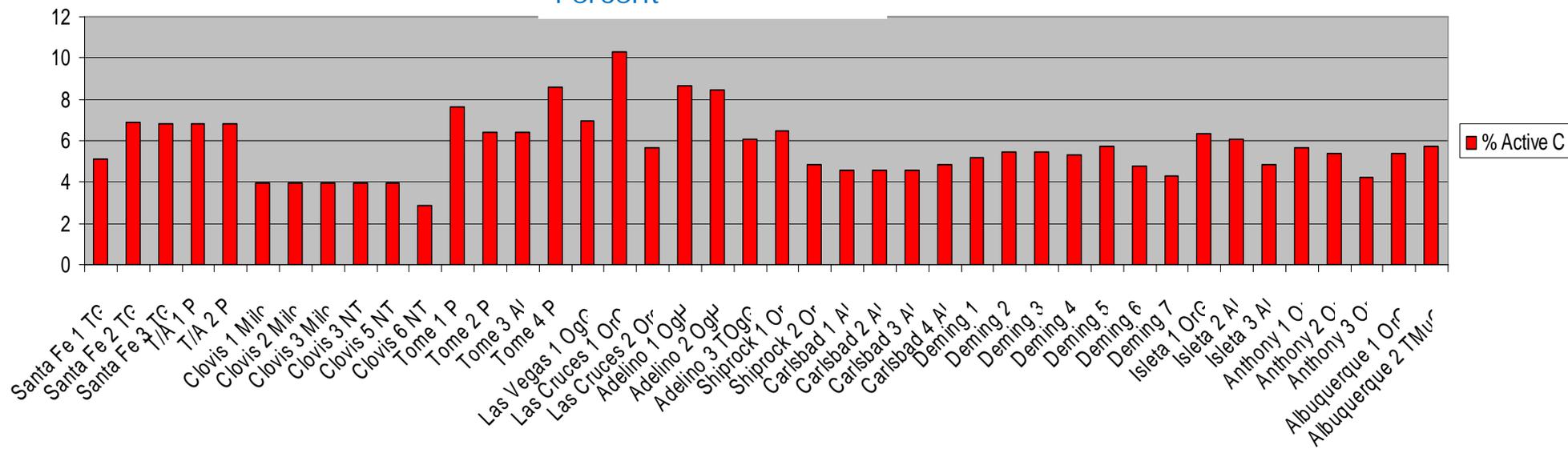
USDA-NRCS does not support, promote or endorse soil secrets

Reactive Carbon mg/Kg

Year 2009

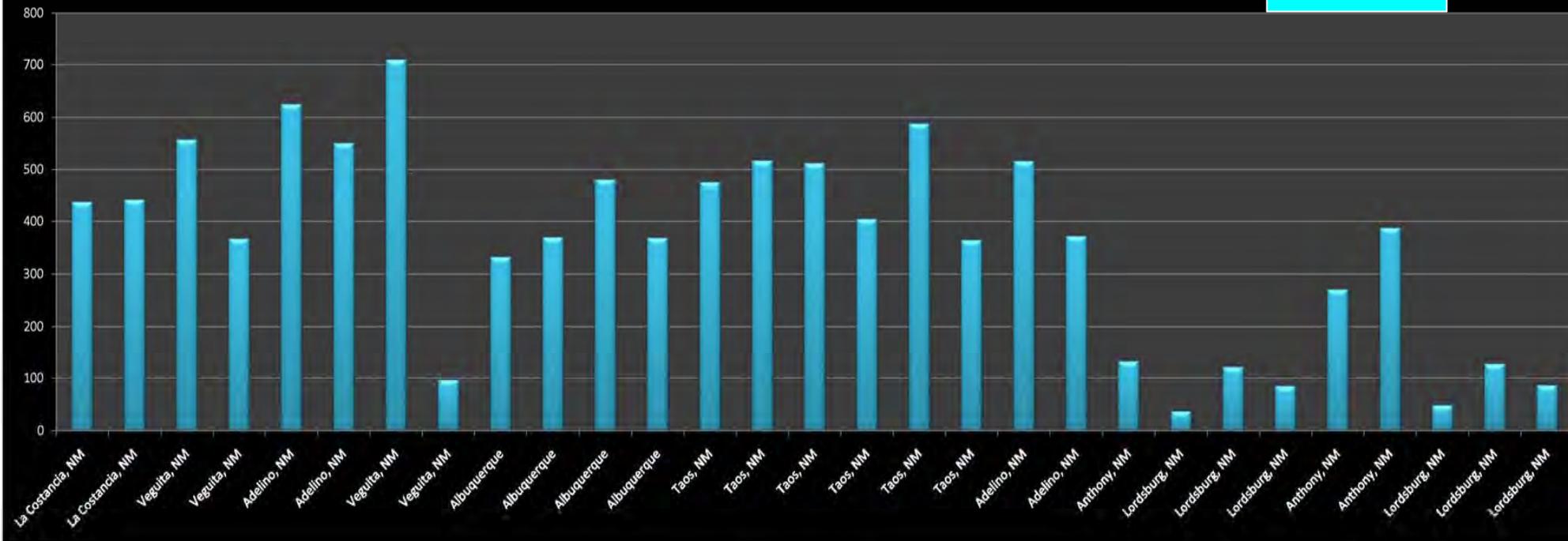


Reactive Carbon Percent

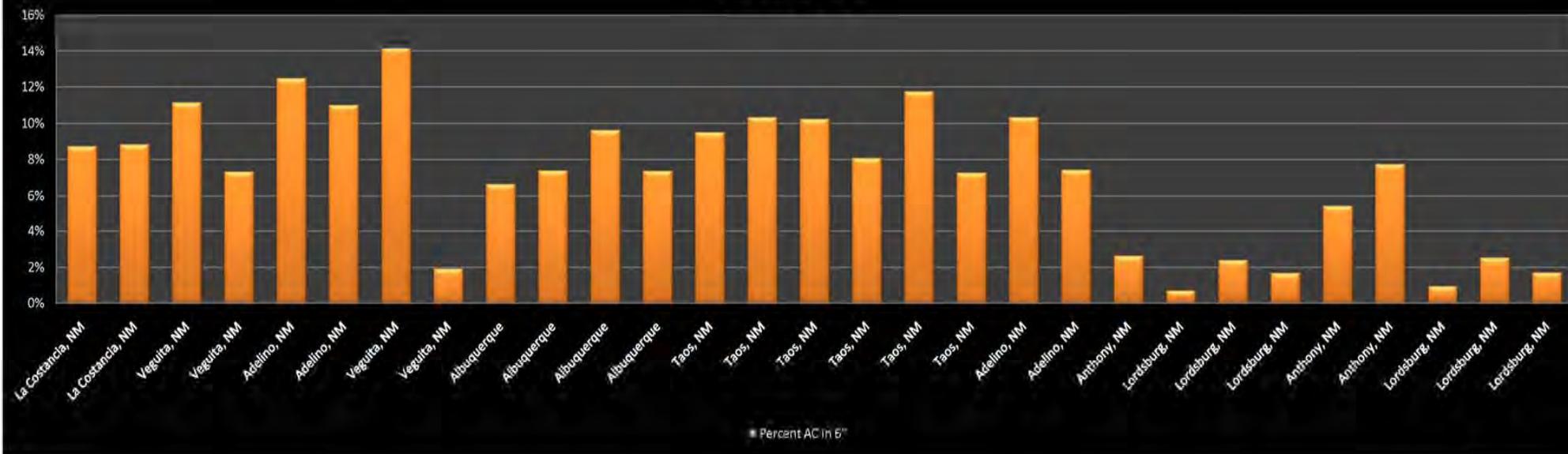


Lab Active C mg/kg -1

Year 2010



Percent AC in 6"

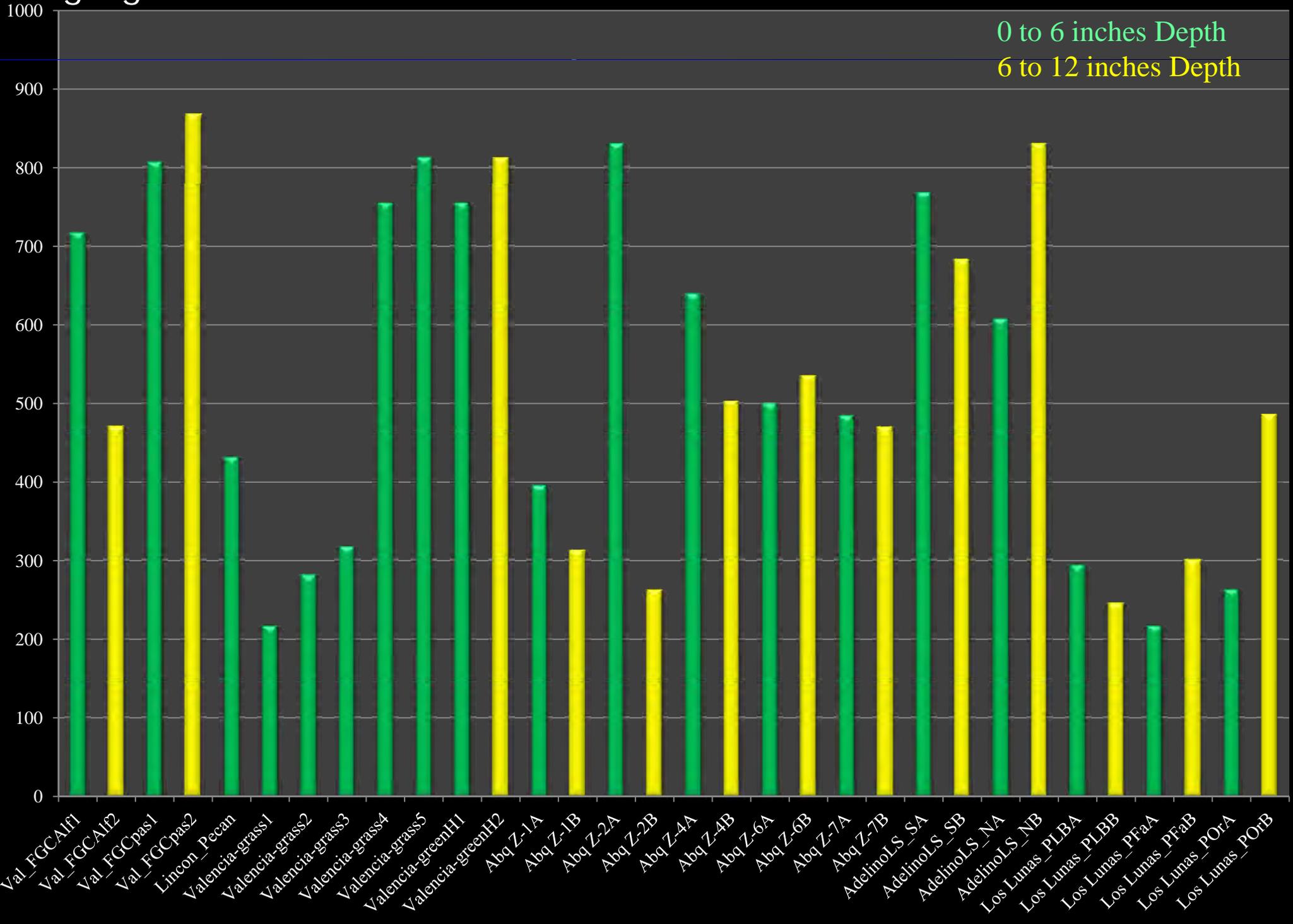


• Percent AC in 6"

New Mexico Reactive Carbon

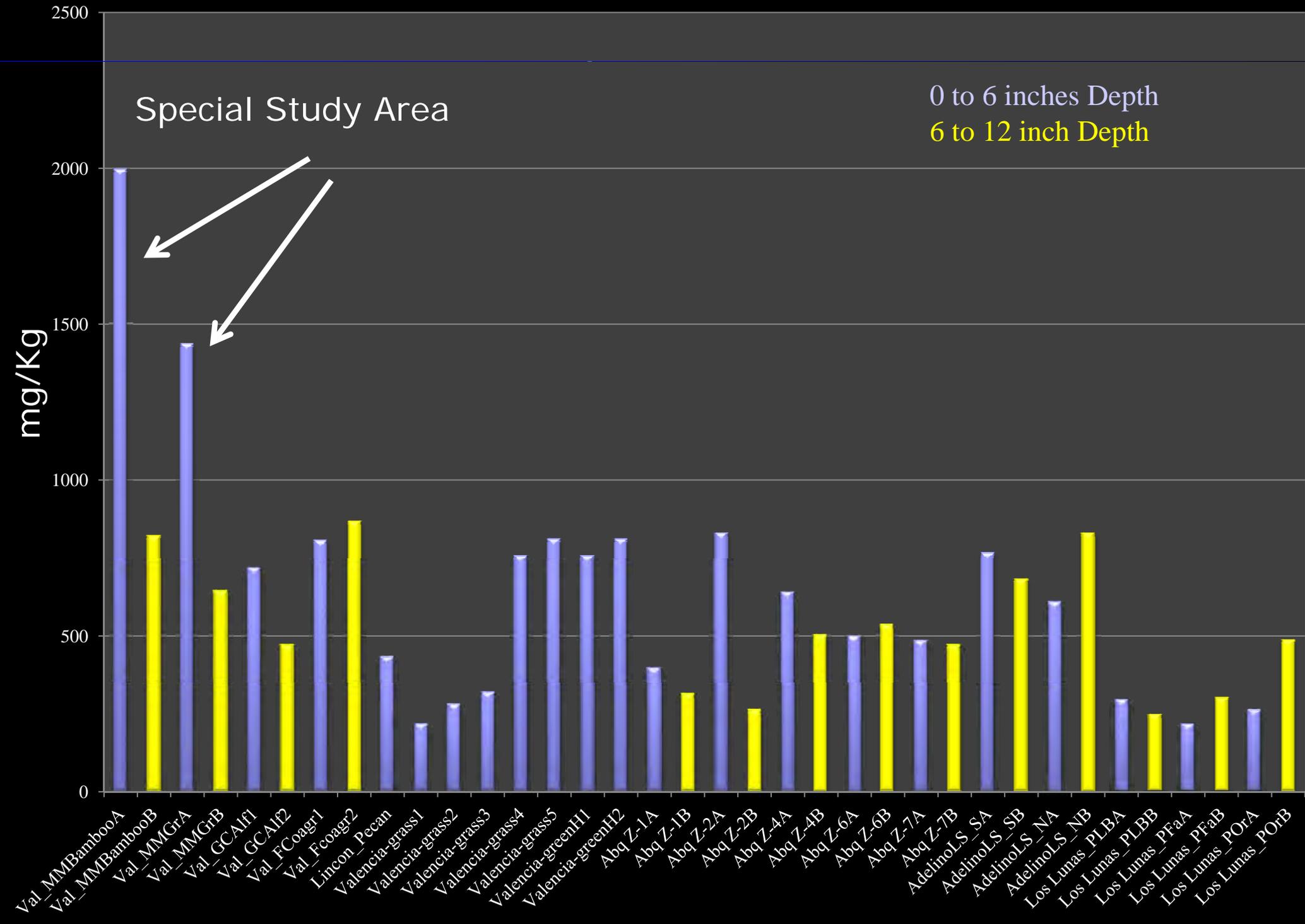
FY 2011 C. Chavez

mg/Kg



New Mexico Reactive Carbon

FY 2011 c. Chavez

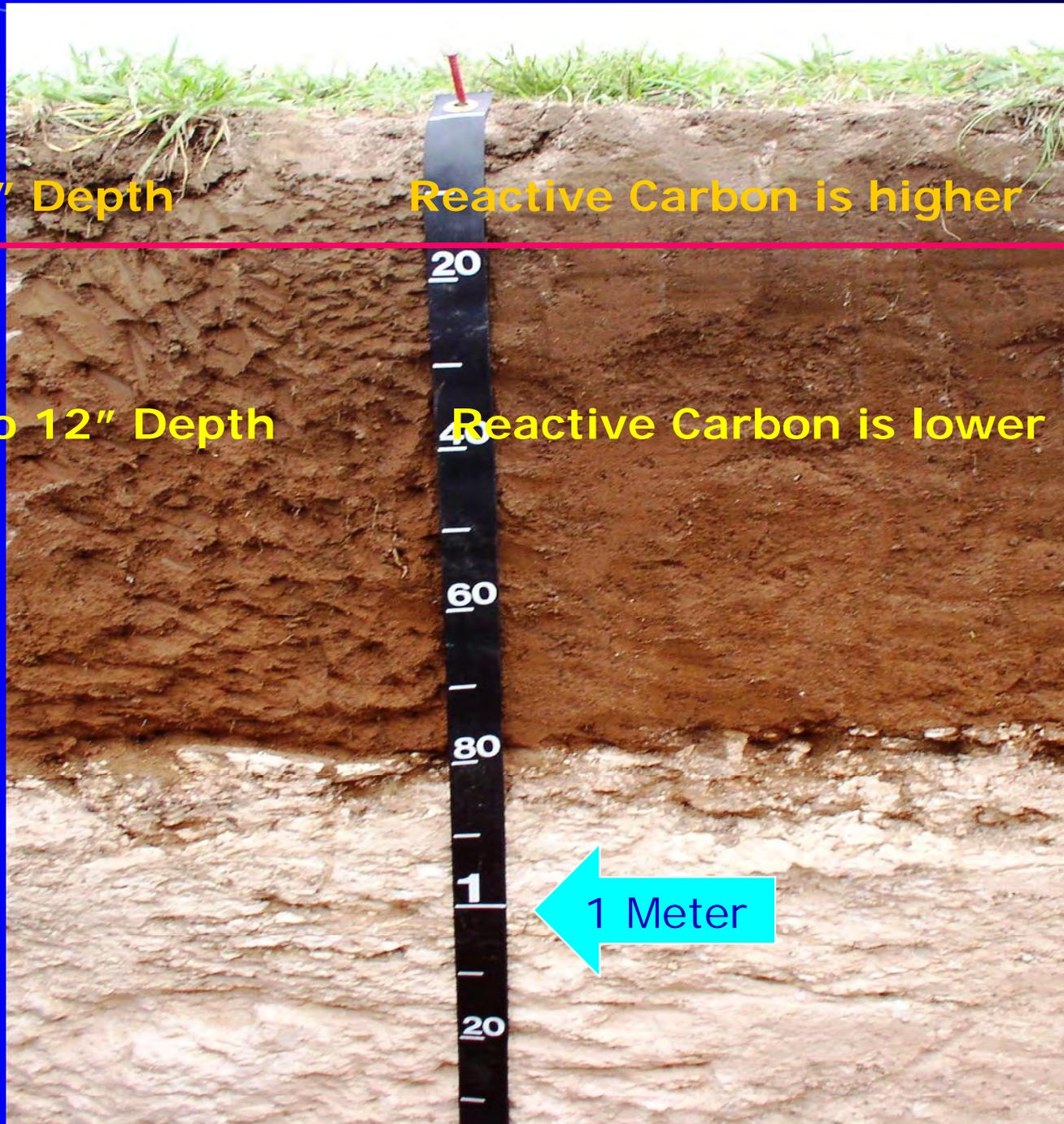


0 to 6" Depth

Reactive Carbon is higher

6 to 12" Depth

Reactive Carbon is lower



New Mexico Reactive Carbon Testing Is Showing: Clovis, NM.

New Mexico Reactive Carbon Testing Is Showing: Las Cruces, NM



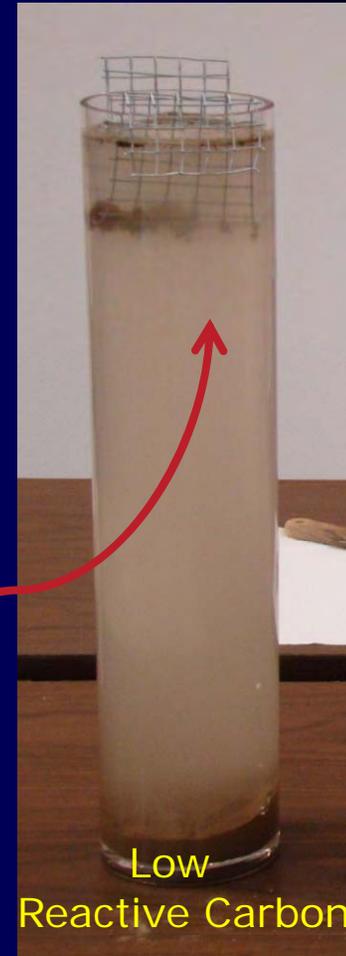
0 to 6" Depth

Reactive Carbon is higher

6 to 12" Depth

Reactive Carbon is lower

Reactive Carbon Field Test



Higher Reactive Carbon

Good Aggregate Stability

+875 mg/kg

200mg/kg

Increasing Reactive Carbon



Low Reactive Carbon

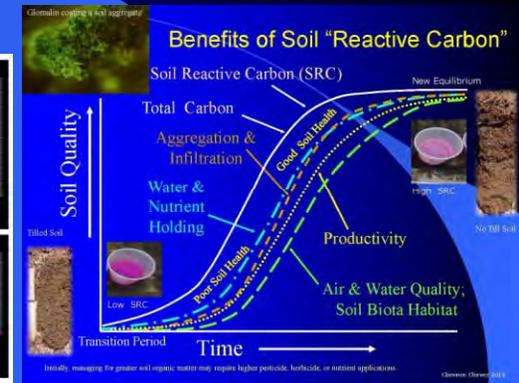
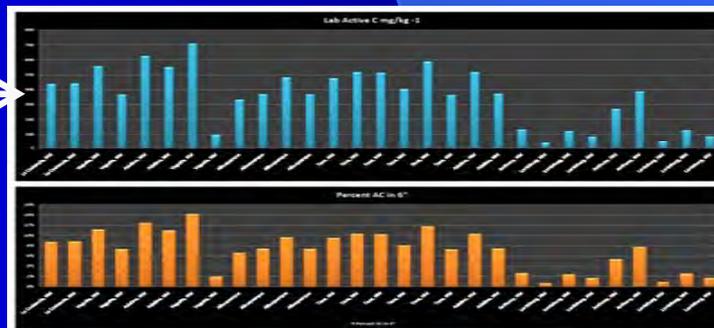
Poor Aggregate Stability

In New Mexico Soils - Reactive Carbon range from 2.5% to 15.3% of the Total Carbon in the Soil



Soil Organisms
Glomalin
Root Exudates
Organic Matter
etc.

400 mg-Kg

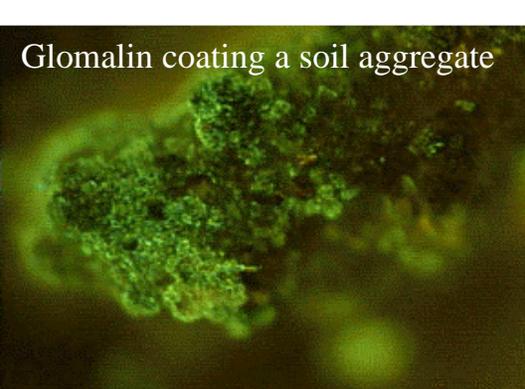


Reactive Carbon and Soil Health Categories By lbs/ac/ft ^{-6"}

Poor	Fair	Good	Excellent
<350	550	750	1500 mg/kg
x1.7	x1.7	x1.7	x1.7
<hr/>	<hr/>	<hr/>	<hr/>
595 lbs/ac/ft ^{-6"}	935 lbs/ac/ft ^{-6"}	1,275 lbs/ac/ft ^{-6"}	2,550 lbs/ac/ft ^{-6"}

Conversion Factor of 1.7 is based on Bulk density of the Texture and conversion of ppm to lbs/Ac/Ft at a 6 inch depth.

Glomalin coating a soil aggregate

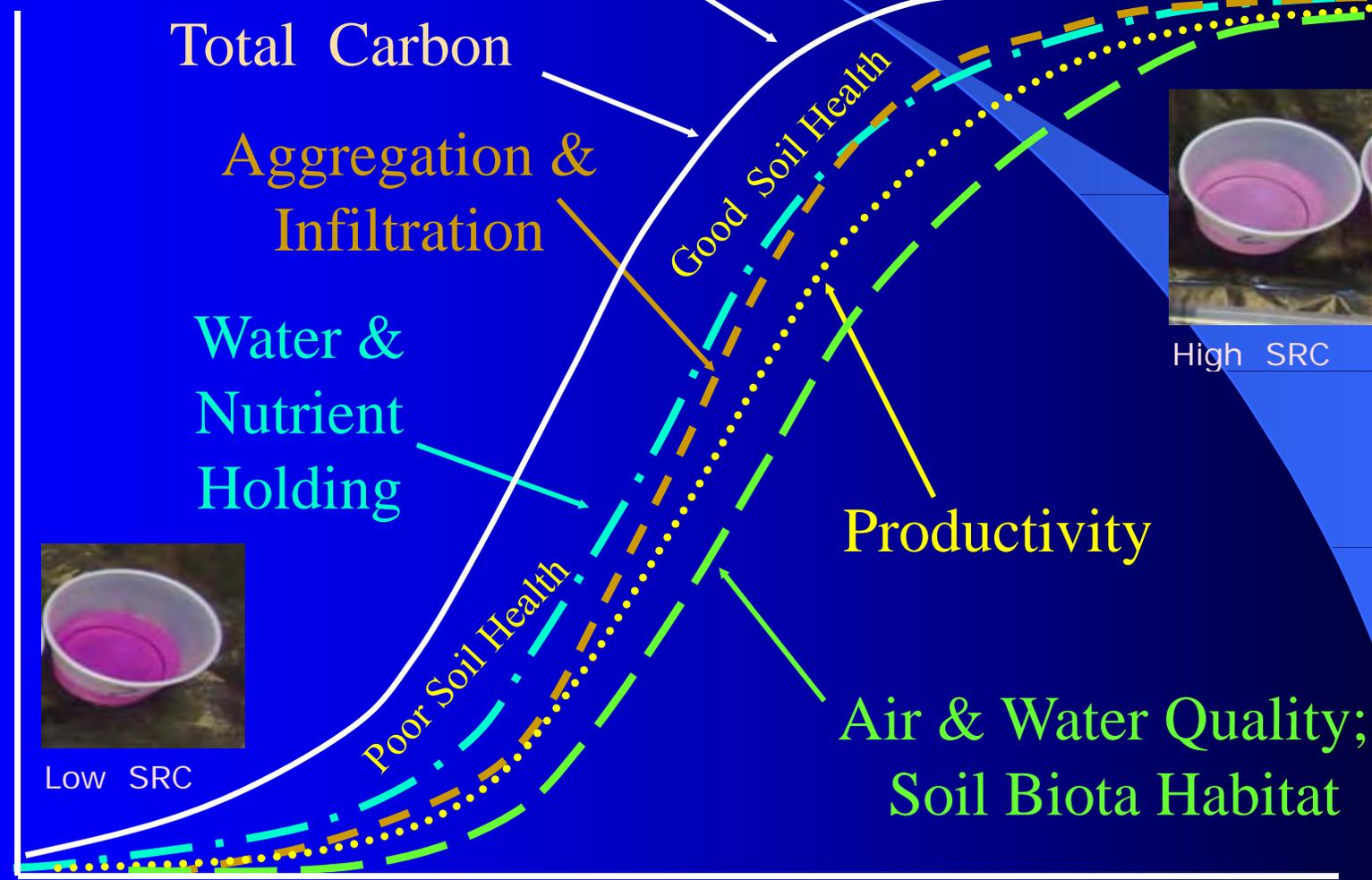


Benefits of Soil "Reactive Carbon"

Soil Reactive Carbon (SRC)

New Equilibrium

Soil Quality ↑



High SRC



No Till Soil



Low SRC

Transition Period

Time →



Tilled Soil

Initially, managing for greater soil organic matter may require higher pesticide, herbicide, or nutrient applications.



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C. Chavez 2012

What does it mean?

- ✓ Soil Biota increase. (Microbes)
- ✓ Aggregate Stability (Soil Structure).
- ✓ Bulk Density of a soil will increase (Not Compaction)
- ✓ Improves Traffic-ability (Becomes more resilient)
- ✓ Increased infiltration. (Microbes/OM)
- ✓ Reduced soil crusting. (Glomalin/Soil Glues)
- ✓ Higher water holding capacity. (Range:10 to 20%)
- ✓ Improved nutrient cycling.



Organic Matter makes the soil darker and richer looking.

Taking the soil from this ...

To this in 3 to 5 years with an Integrated Cropping System



Reactive Carbon Readings

Sample 25 - 37 -mg/kg

Sample 26 -127 mg/kg

7 year old Grapevine with new cover crop



**Reactive Carbon
Readings**

Sample 27 - 48 mg/kg

Sample 28 - 86 mg/kg

3 Yr. Grapevine with out cover crop

Managing for soil quality - Farming

- ❖ Add organic matter- Cover crops, manure, green manure, compost. (Integrated Cropping System)
- ❖ Avoid excess tillage – it causes soil compaction & destroys Structure.
- ❖ Carefully manage fertilizer and pesticide use. Chemicals will harm microorganisms.
- ❖ Increase ground cover – reduces both wind and water erosion. (Cover Crops/mulching)
- ❖ Diversity across the landscape.
- ❖ Integrated Pest Management

Managing for soil quality - Rangeland

- Manage grazing, fire, and vehicle use.
- Increase/maintain plant species production.
- Improve plant cover and minimize bare spots.
- Promote species diversity and root diversity.
- Protect soil from water and wind erosion by plant cover.
- Use designated trails or roads; to reduce the number of trips.



"Human kind has not woven the web of life.

We are but one thread within it.

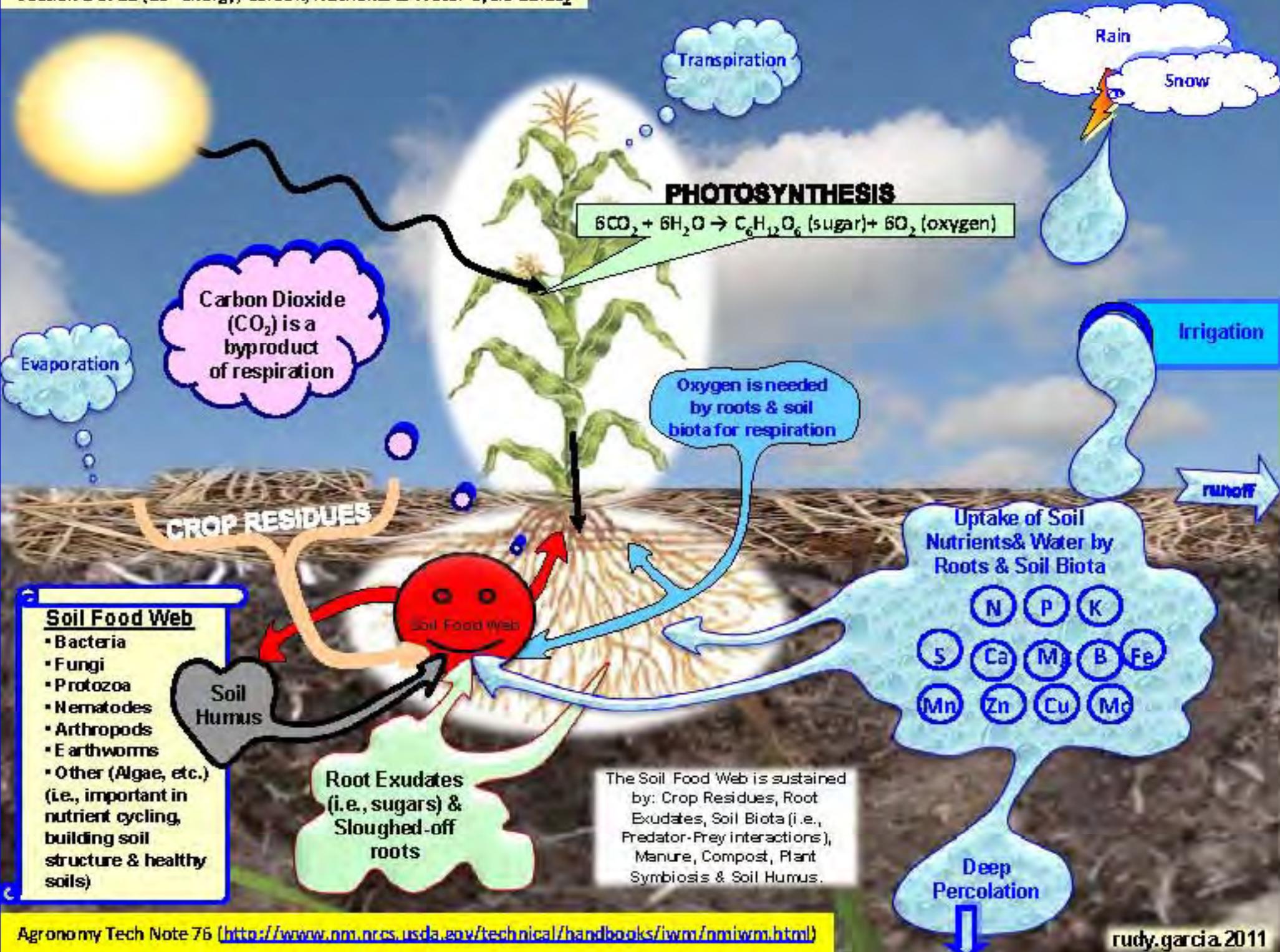
Whatever we do to the web,

we do to ourselves.

All things are bound together.

All things connect."

Chief Seattle, 1854



CROP ROTATIONS



RESIDUE MGT.



COVER CROPS



NO-TILL & MIN.-TILL



POLLINATORS



Many of the same flowering plants that support pollinators also support beneficial predatory and parasitic insects.

Soldier beetle



Parasitoid wasp



Ladybird beetle



The Xerces Society

IRRIGATION SYSTEM & LASER LEVELING



IRRIGATION WATER MGT.



IPM, Weed Mgt., other.



COMPOST

MANURE MGT.



SOIL FOOD WEB

SOIL HEALTH

GRAZING



NUTRIENT MGT.	Irrigation Water Analysis (ppm x 0.227 x 48" = lb. /ac.)		Soil Analysis 0-6" depth Bulk Density = 1.4 g/cm ³ ppm x 1.90 = lb/ac (6" depth)		Nutrient Inputs (recommendations)	Plant Tissue Analysis	
	ppm or mg/l	Pounds per Acre	ppm or mg/Kg	Low Adequate High		Lbs./ac. (based on 1000 lb./ac. yield)	Note: N is kjeldahl nitrogen & Sulfur is total Sulfur % or ppm & Rating (Low - High) Q = Optimum
ON = Organic Nitrogen mineralized							
Organic Matter			0.6%	11,400 Low			
N mineralized			ON	12.0 Low	Manure?		
Nitrate-Nitrogen	1.12	12.2	4.5	8.55 lbs./ac	55.0 N	2.66% Q	2.49 - 2.8%
Phosphorus			5.0	Low	22.5 P ₂ O ₅	0.12% Q	0.11 - 0.3%
Potassium	8.23	89.5	122.0	Low	18.3 K ₂ O	0.95% Q	0.74 - 1.25%

Biodiversity with minimal soil disturbance drives soil health. Therefore, growing diverse crops will develop a diversity of organisms in the soil. This will result in restoring soil health and crop productivity.

The NRCS Reactive C Field Kit

- Provides a fairly accurate assessment of a critical soil quality factor (Lab proxy)
- Test samples should be sent to:
NRCS - State Office - soil section for analysis.



“The nation that destroys it’s soil, destroys itself.”

- Franklin D. Roosevelt

Hatch, NM



Villanueva, NM



Where can we go from here: Farmer Soil Health Workshops

Crownpoint, NM



Santa Fe / Nambe, NM



In 4 years we have given 58 workshops

For more information Please
Contact Your Local Office
of the

Natural Resource Conservation Service
or
Soil and Water Conservation District.



REFERENCES:

Islam, K.R., and R.R. Weil. 2000. Soil quality indicator properties in mid-Atlantic soils as influenced by conservation management. *J. Soil Water Conserv.* 55:69–78.

Weil, R.R., K.R. Islam, M.A. Stine, J.B. Gruver, and S.E. Samson-Liebig. 2003. Estimating active carbon for soil quality assessment: A simplified method for laboratory and field use. *Am. J. Altern. Agric.* 18:3–17.

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National Soil Survey Center (Active Carbon Test Kit)

100 Centennial Mall N.

Lincoln, NE 68508-3866

currently at

NRCS, Pacific c Islands Area

300 Ala Moana Blvd., Rm. 4-118

Honolulu, HI 96850-0050

Soil Survey Staff . 2008-2012. Soil survey field and laboratory methods manual. Soil Survey. Invest. Rep. 51, Version 1.0. U.S. Gov. Print. Office, Washington, DC.

Sara Wright, USDA-ARS-Soil Microbial Systems Lab., Bldg. 001, Rm 140, BARC-W, Beltsville, MD. 20705. email: swright@asrr.arsusda.gov. Glomalin-A Manageable Soil Glue.

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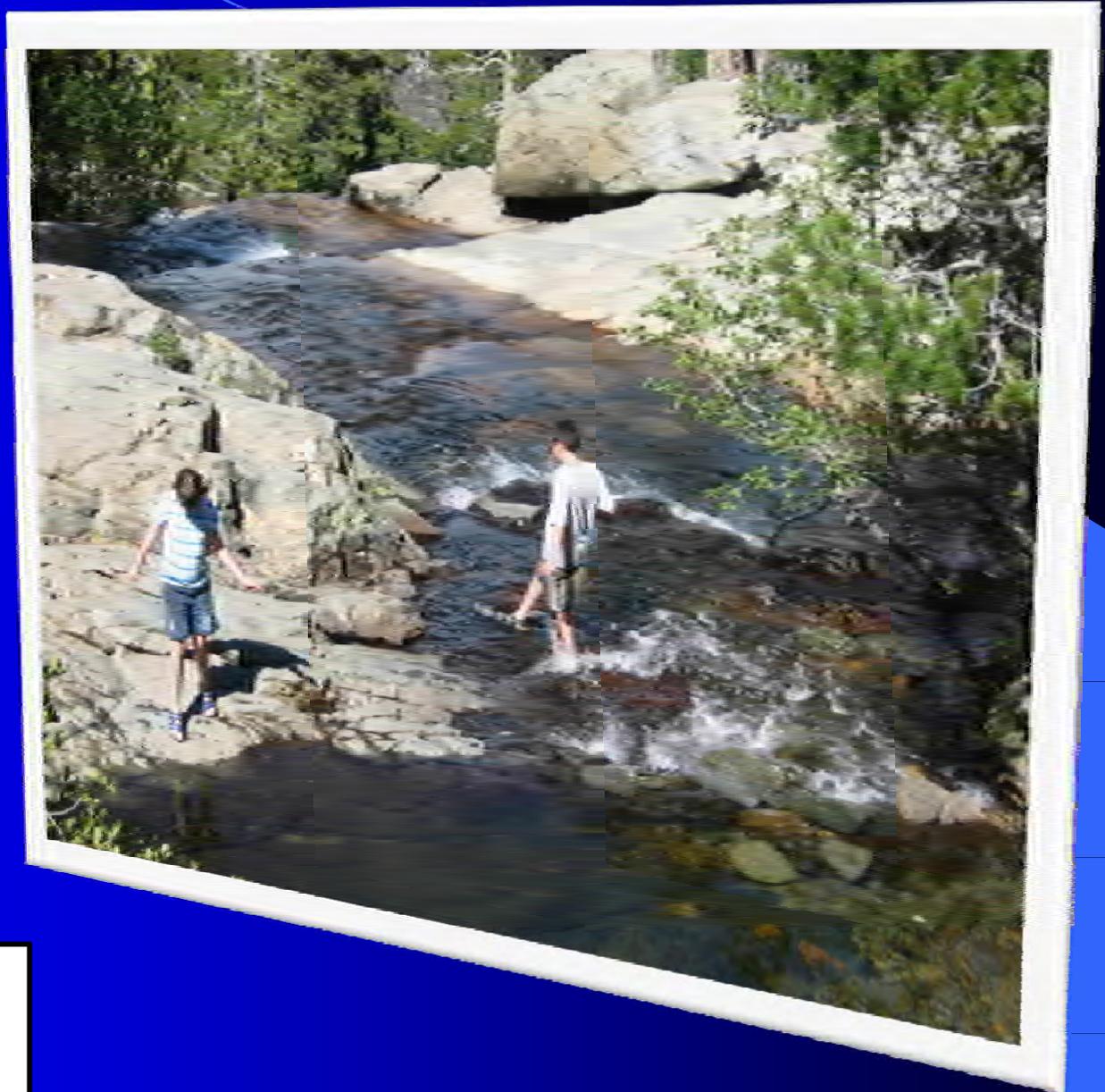
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Sustainability is our future!!!!



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Any QUESTIONS ?

**For more information Please
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or

Soil and Water Conservation District



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