NRCS Natural Resources Conservation Service

NRCS-ENTSC National Soil Quality team

- Ray Archuleta

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Keys to the kingdom of improving soil health

- **Understand your context**
- **Protect the Soil Habitat**
- **Provide Diverse Food (carbon)**

- These are the ‘keys to the kingdom’ of improving soil health and sustainable agriculture because they focus on soil biology and soil ecology; what really runs the soil and all that it does.

Understanding Soil Health: The Brown Revolution!

The greatest roadblock in solving a problem is the human mind!


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TED2005, Filmed Feb 2005; Posted Apr 2007
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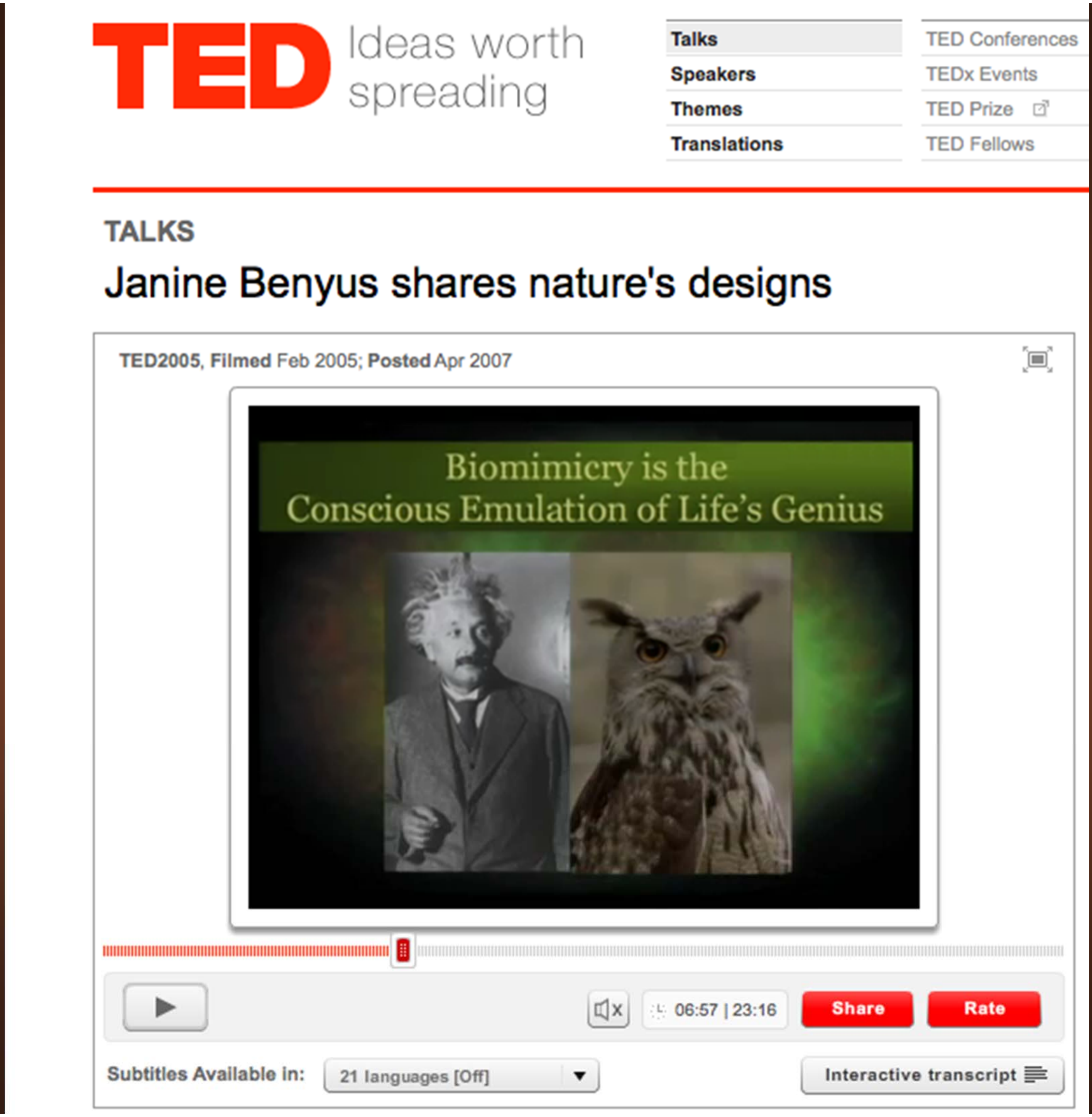
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Conscious Emulation of Life's Genius
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10:13 | 23:16
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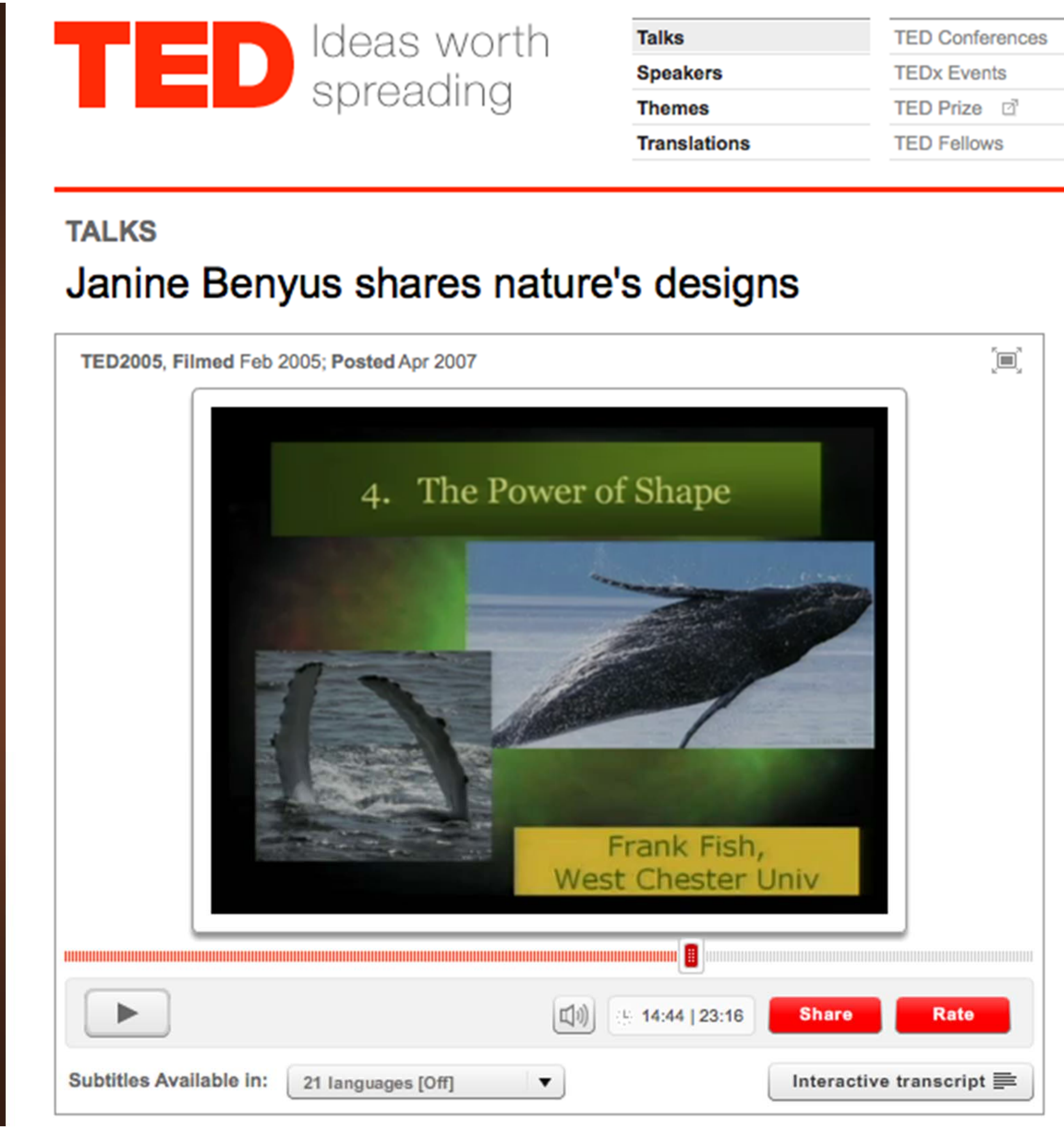
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4. The Power of Shape
Frank Fish,
West Chester Univ
14:44 | 23:16
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TALKS
Janine Benyus shares nature's designs
TED2005, Filmed Feb 2005; Posted Apr 2007
5. Quenching Thirst
QinetiQ/Univ of Bath/
Biomimicry Guild/ Rocky
Mountain Institute
16:00 | 23:16
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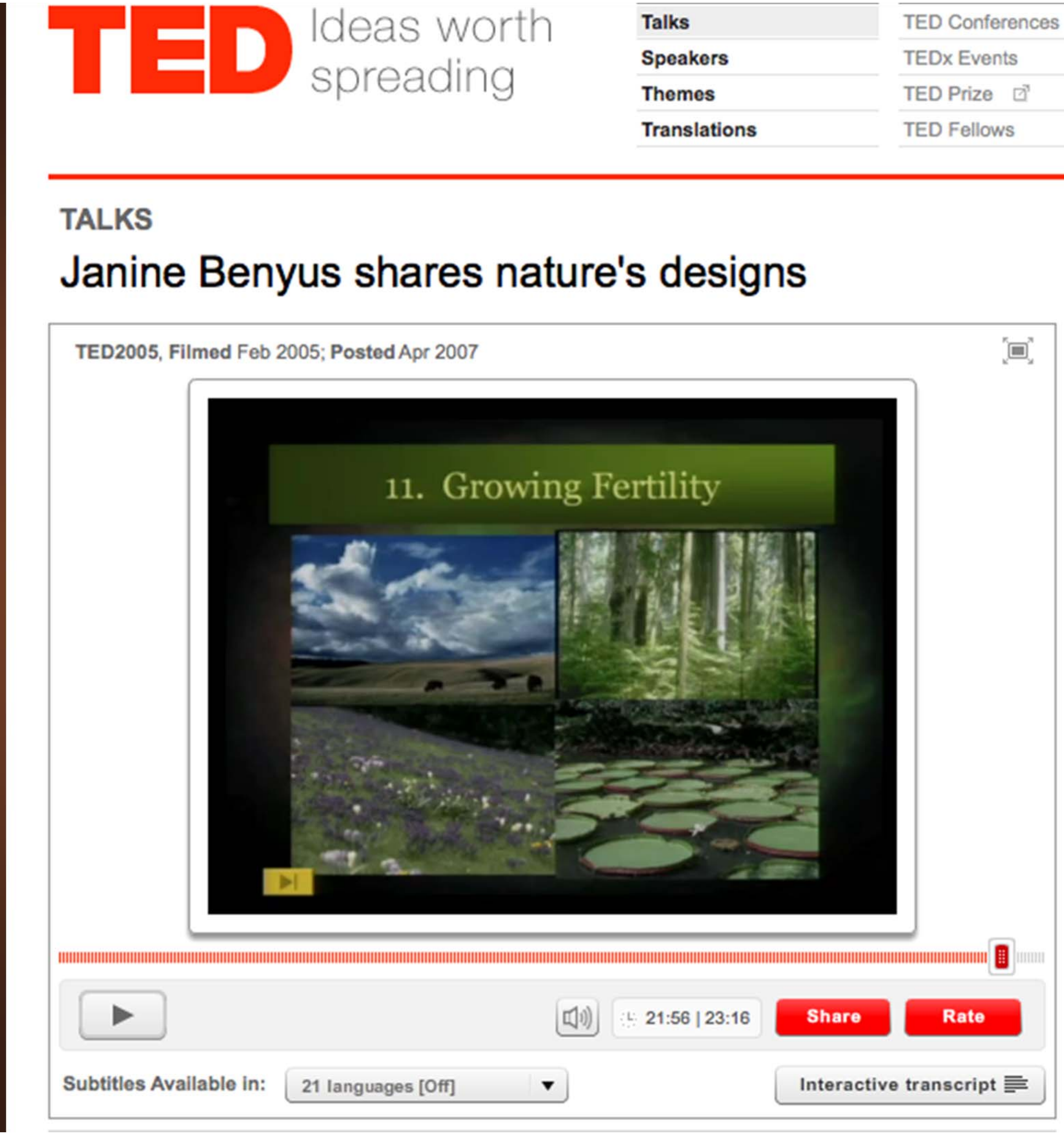
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Janine Benyus shares nature's designs
TED2005, Filmed Feb 2005; Posted Apr 2007
11. Growing Fertility
21:56 | 23:16
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Focus On Nature's Similarities then Dissimilarities

Africa

Virginia

SOIL QUALITY/HEALTH is

The continued capacity of the soil to function as a vital living ecosystem that sustains plants, animals, and humans.

Soil Health

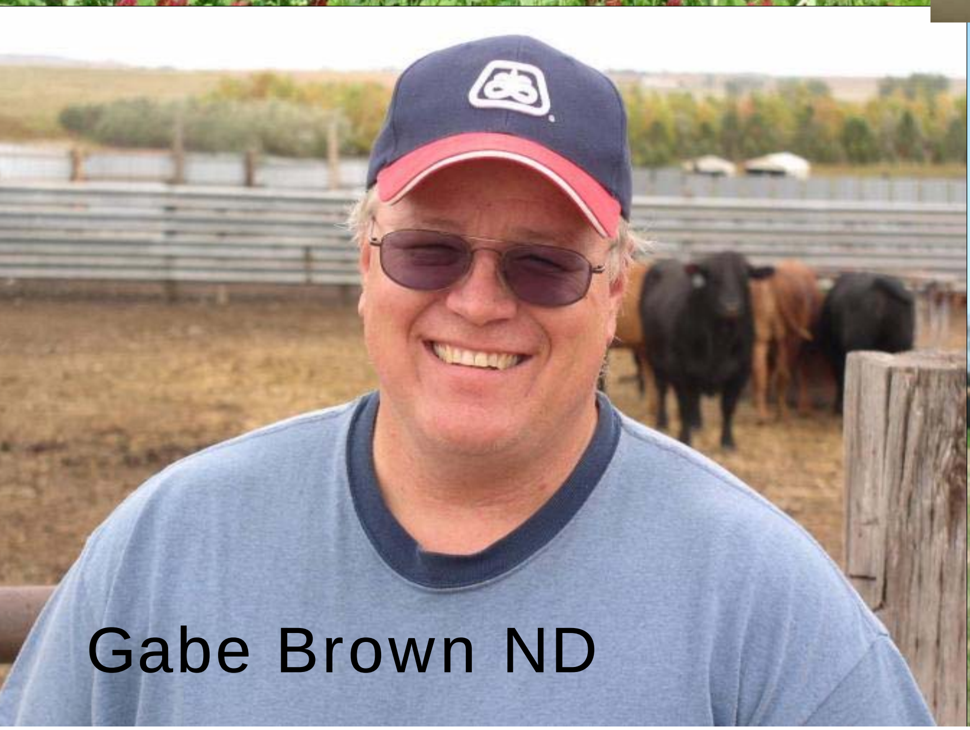
"Every chemical-based pesticide, fumigant, herbicide and fertilizer tested, harms or outright kills some part of the beneficial life that exists in the soil, (or on the leaf surfaces) even when applied at rates recommended by their manufacturers... Less than half of the existing active ingredients used as pesticides have been tested for their effects on soil organisms."

Dr. E. Ingham, 2002, Soil Food Web, Oregon State University


Ray Styer NC


Dave Brandt
OH


Steve Groff
PA


Gabe Brown ND

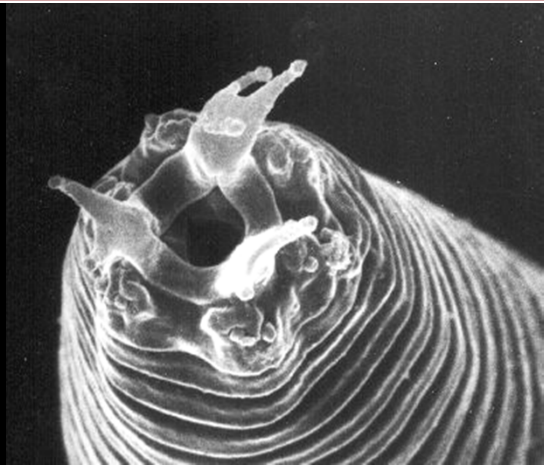

Ray McCormick IN

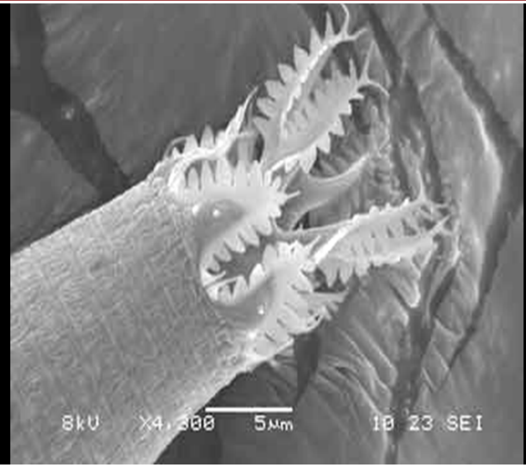
Ecology:

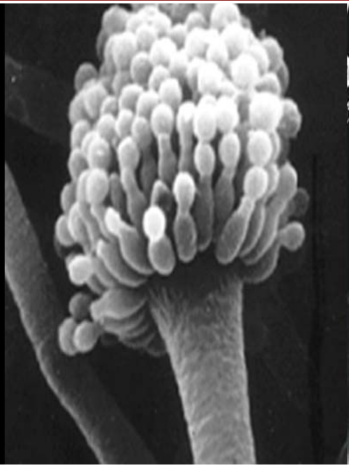
the study of relationships between people, animals, and plants, and their environment.

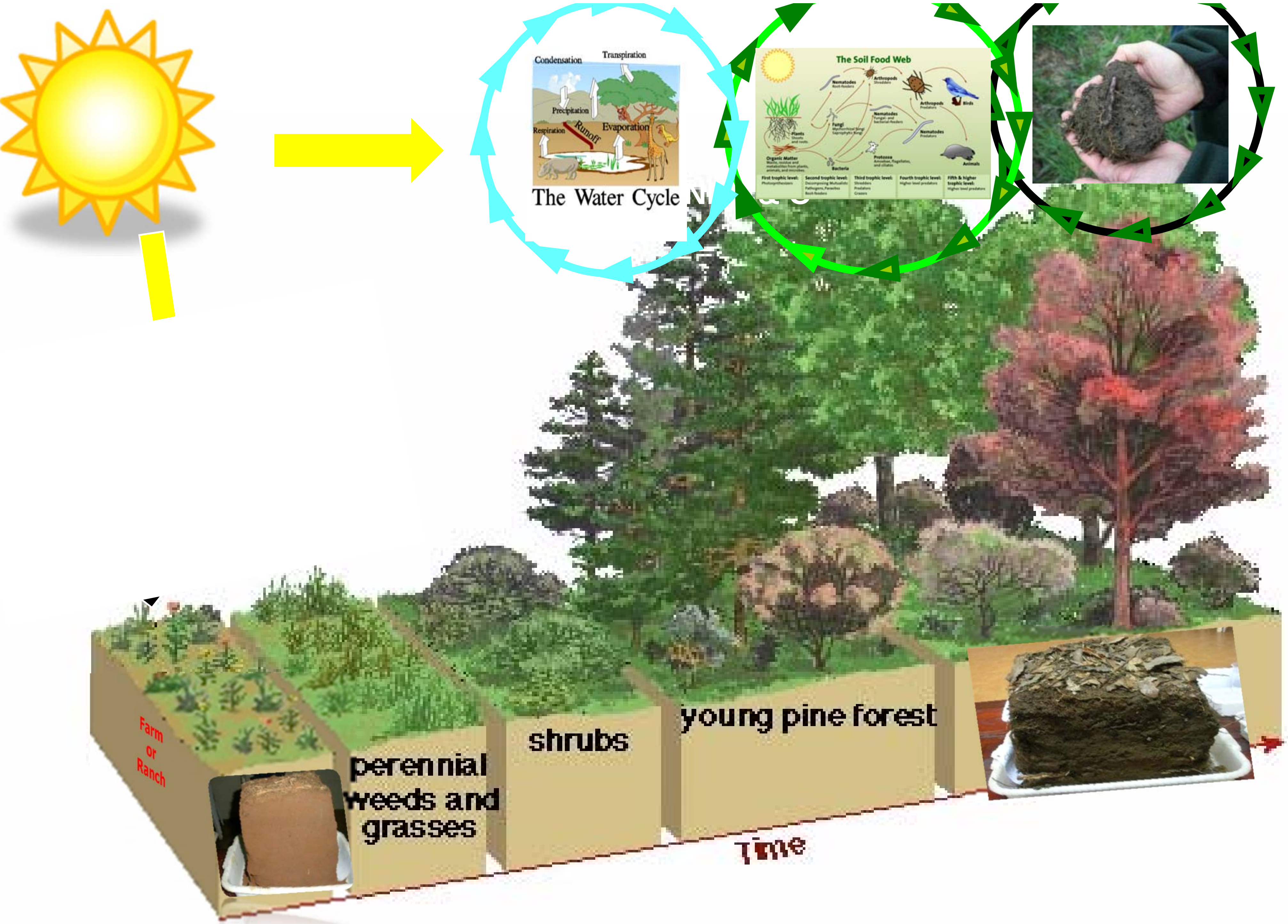
Interconnectedness

Soil Surface



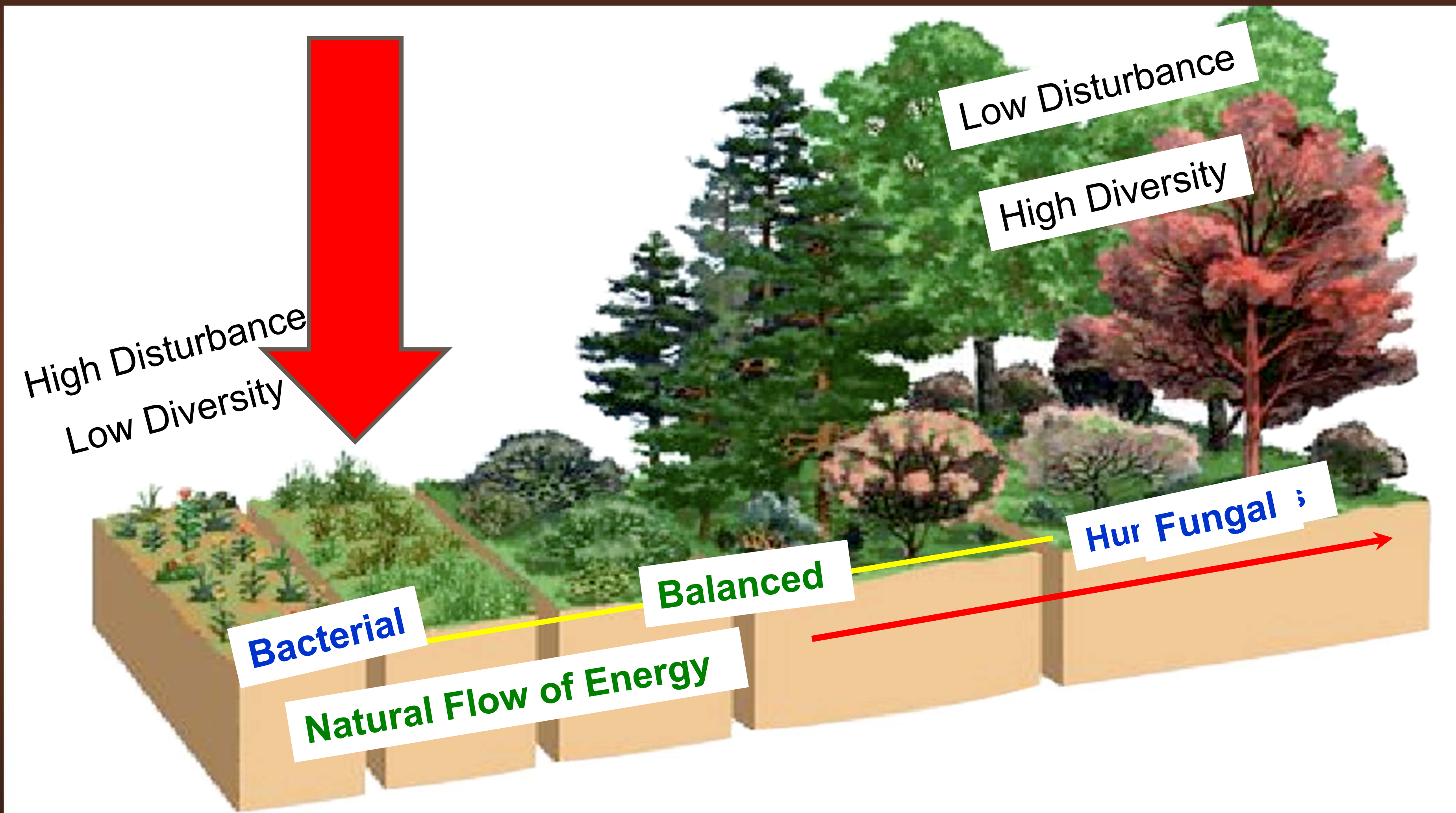






Condensation
Transpiration
Precipitation
Respiration
Runoff
Evaporation
The Water Cycle
The Soil Food Web
Farm or Ranch
perennial weeds and grasses
shrubs
young pine forest
Time

Natural Succession of Plants & Soil




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

North towards New Jersey: 2008

6 year study

Monday, June 12, 2006 8:30am
Rainfall: 1.8 inches

Disk No Cover

Disk Cover

No Tillage No Cover

No Tillage Cover

3.8%-6.2% slopes

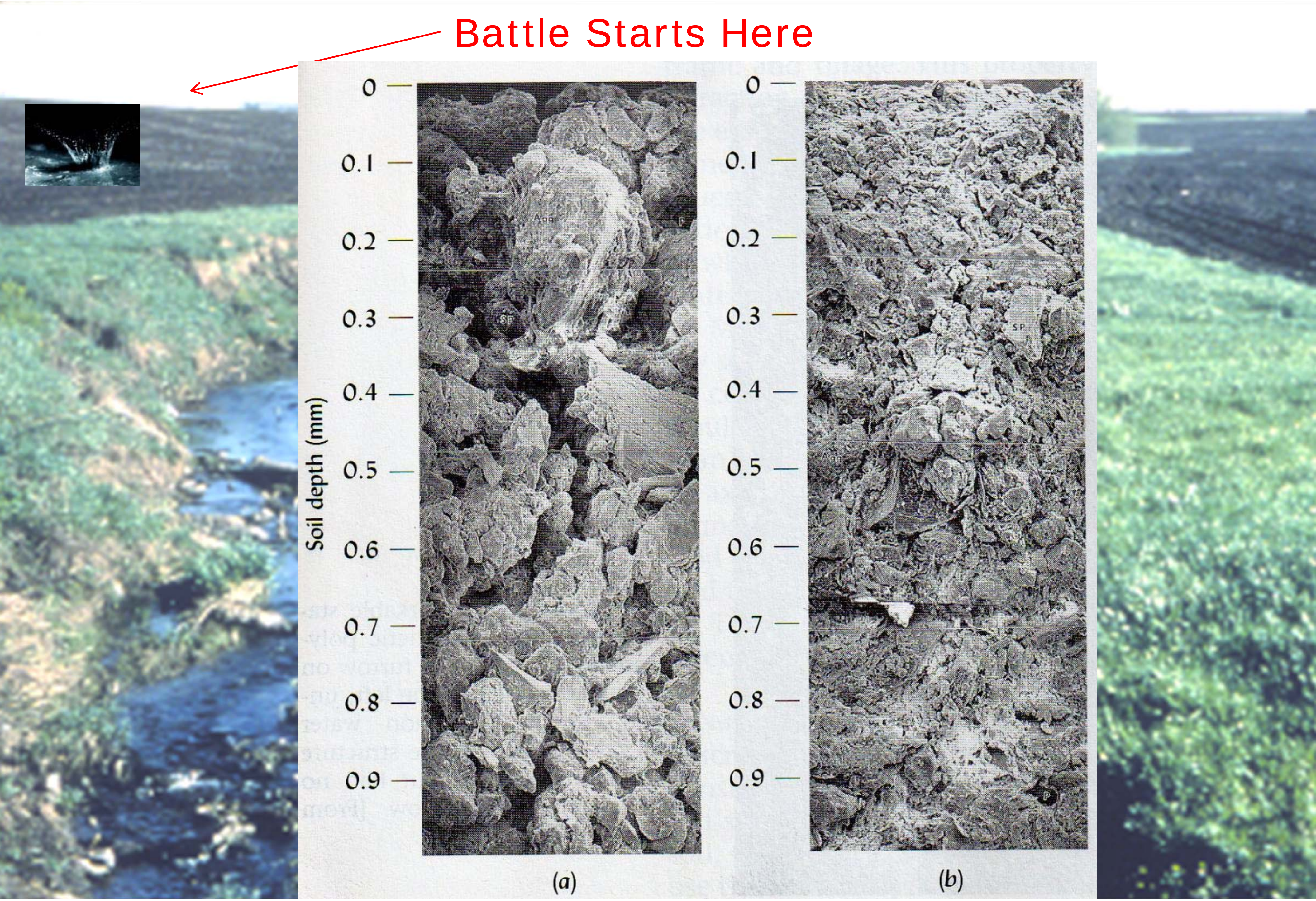
JSWC C.W Raczkowski 2009


Erosion from bare fields
5/2007


Is the Buffer working? 6
/2007


Lubbock Texas Oct.
17,2011


Lubbock Texas Oct.
17,2011


Battle Starts Here
Soil depth (mm)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
(a)
(b)

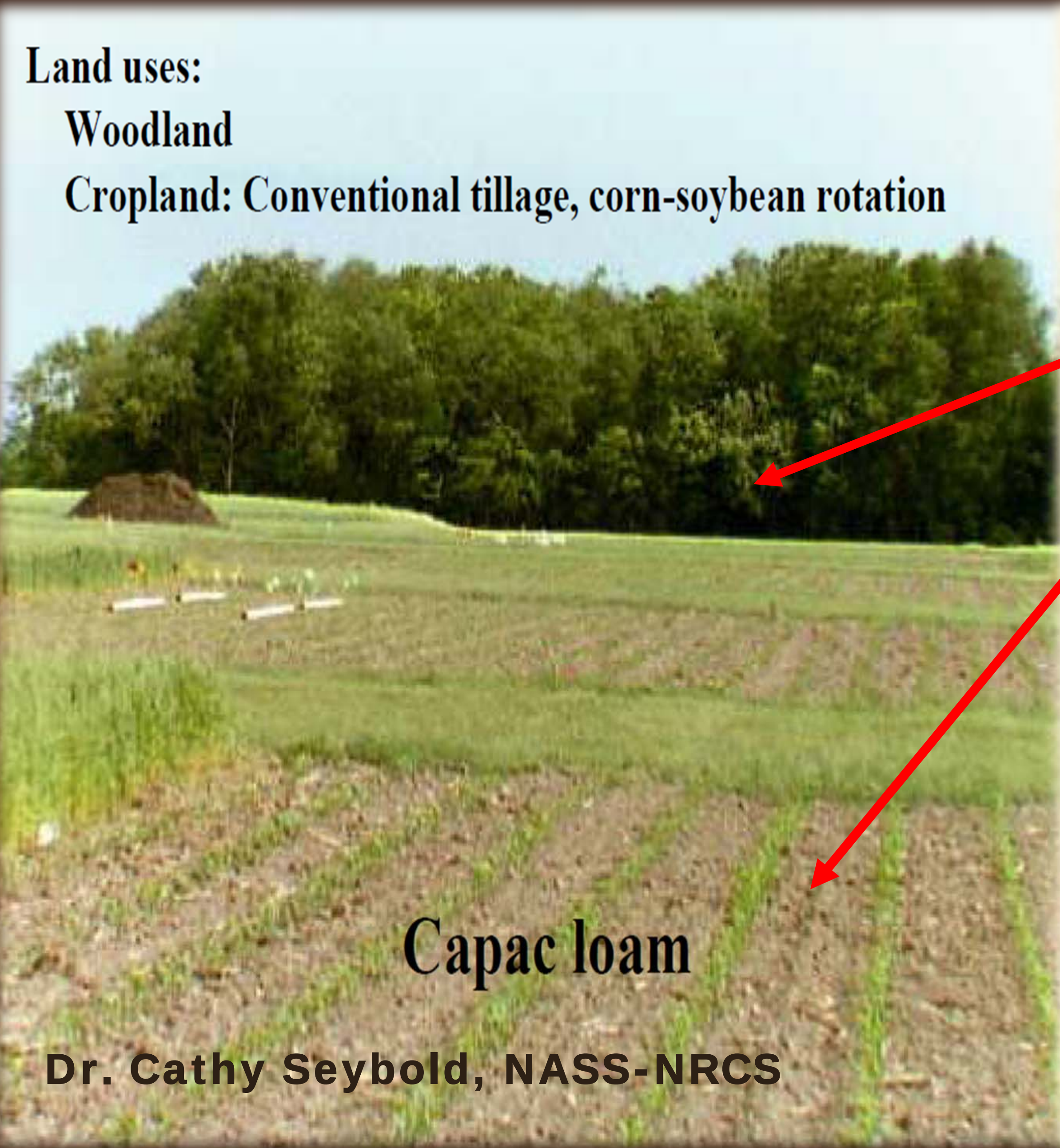
Same Soils: Dynamic Soil Properties Changed!

62.8% loss of SOM after 17 yr intensive tillage

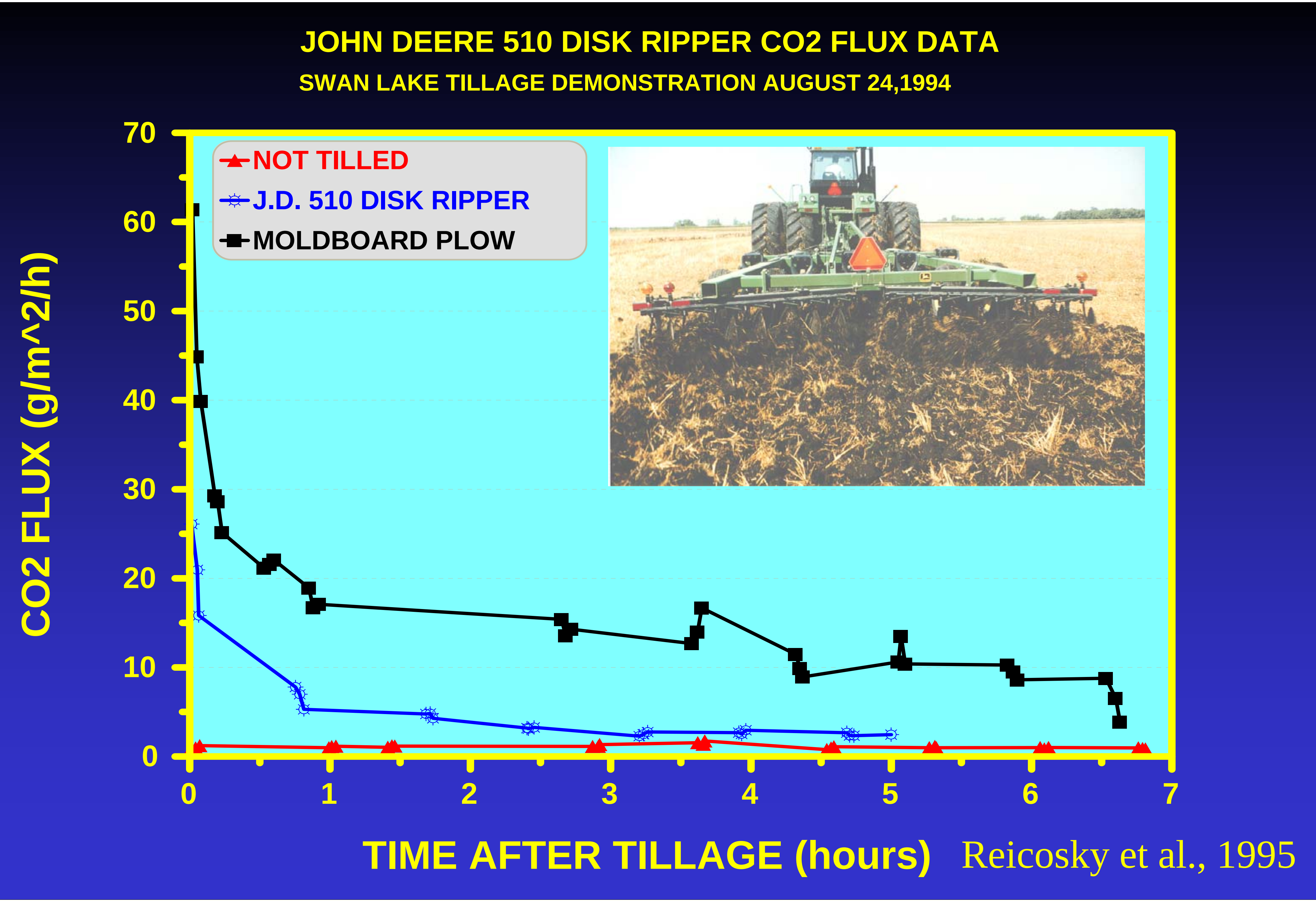

40Yr No-Till Soils - Styer

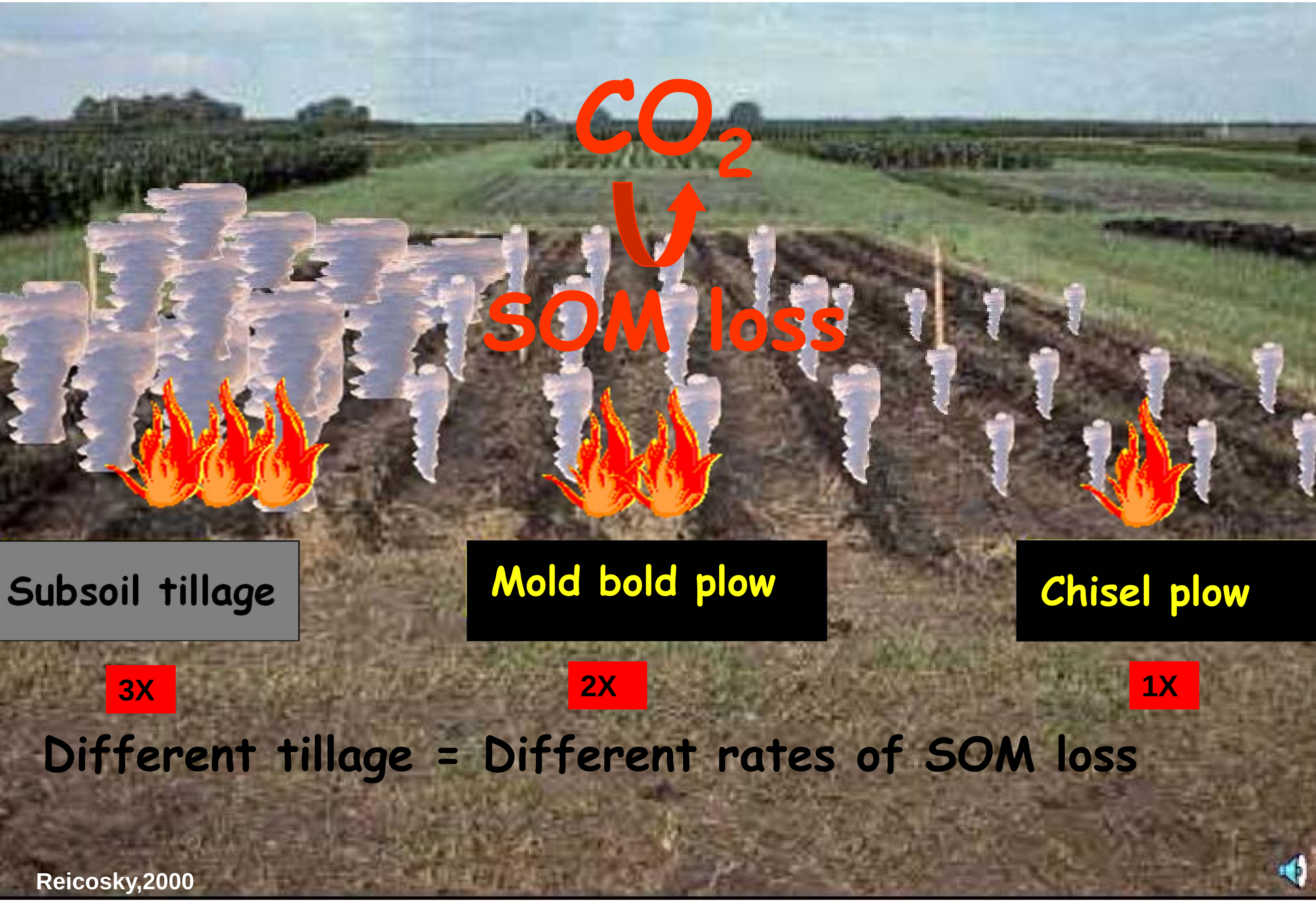

Conventional Till Soil

Study: Use-dependent Soil Properties



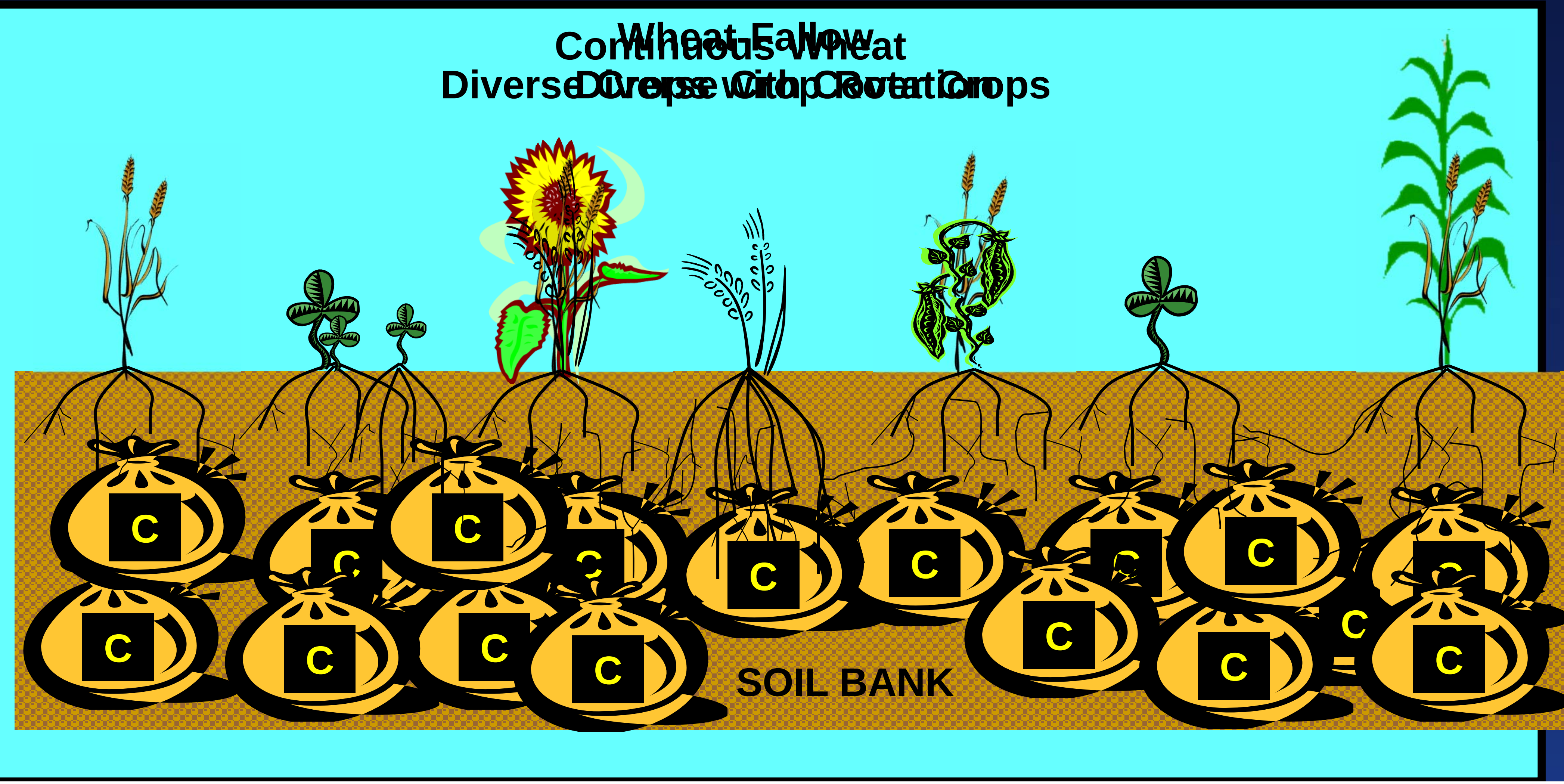
Property	Conv. tillage corn-soybean rotation	Forest site
Bulk density (g cm^3)		
0 - 3 cm depth	1.40	1.01
11 - 13 cm	1.45	
Penetration resistance (kPa)	1300	900
Soil strength (kg dm^{-2})		
0 - 2 cm depth	3.5	4.5
4 - 6 cm	3.2	3.2
Infiltration (in hr^{-1})	0.5	50
K-sat (in hr^{-1})	0.46	2.29
Aggregate stability (% > 0.25 mm)	37	65
Morphological index	2.47	3.55
Soil respiration (g CO_2-C m^{-1} d^{-1})	1.9	7.1
Soil pH	5.7	4.9
Soil nitrate (kg ha^{-1})	17	2.1

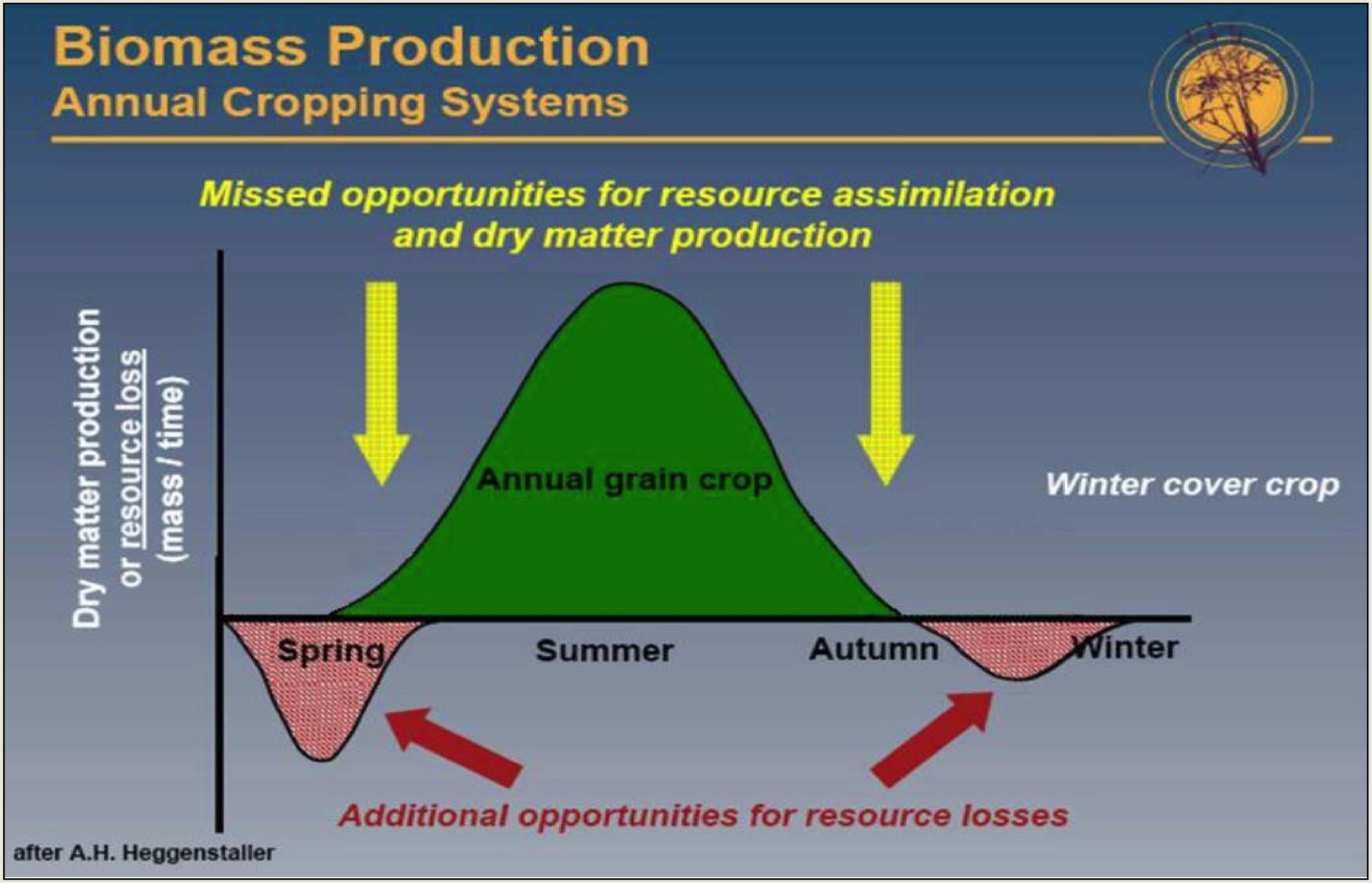

JOHN DEERE 510 DISK RIPPER CO2 FLUX DATA
SWAN LAKE TILLAGE DEMONSTRATION AUGUST 24,1994
NOT TILLED
J.D. 510 DISK RIPPER
MOLDBOARD PLOW
CO2 FLUX (g/m^2/h)
0
10
20
30
40
50
60
70
0
1
2
3
4
5
6
7
TIME AFTER TILLAGE (hours)
Reicosky et al., 1995


CO_2
SOM loss
Subsoil tillage
Mold bold plow
Chisel plow
3X
2X
1X
Different tillage = Different rates of SOM loss
Reicosky,2000


The Soil Livestock is a complex and diverse mix of species and represents the greatest concentration of biomass of anywhere on the planet.
Arbuscules
Photo by Kristine Nichols, USDA-ARS

Managing for Soil Health

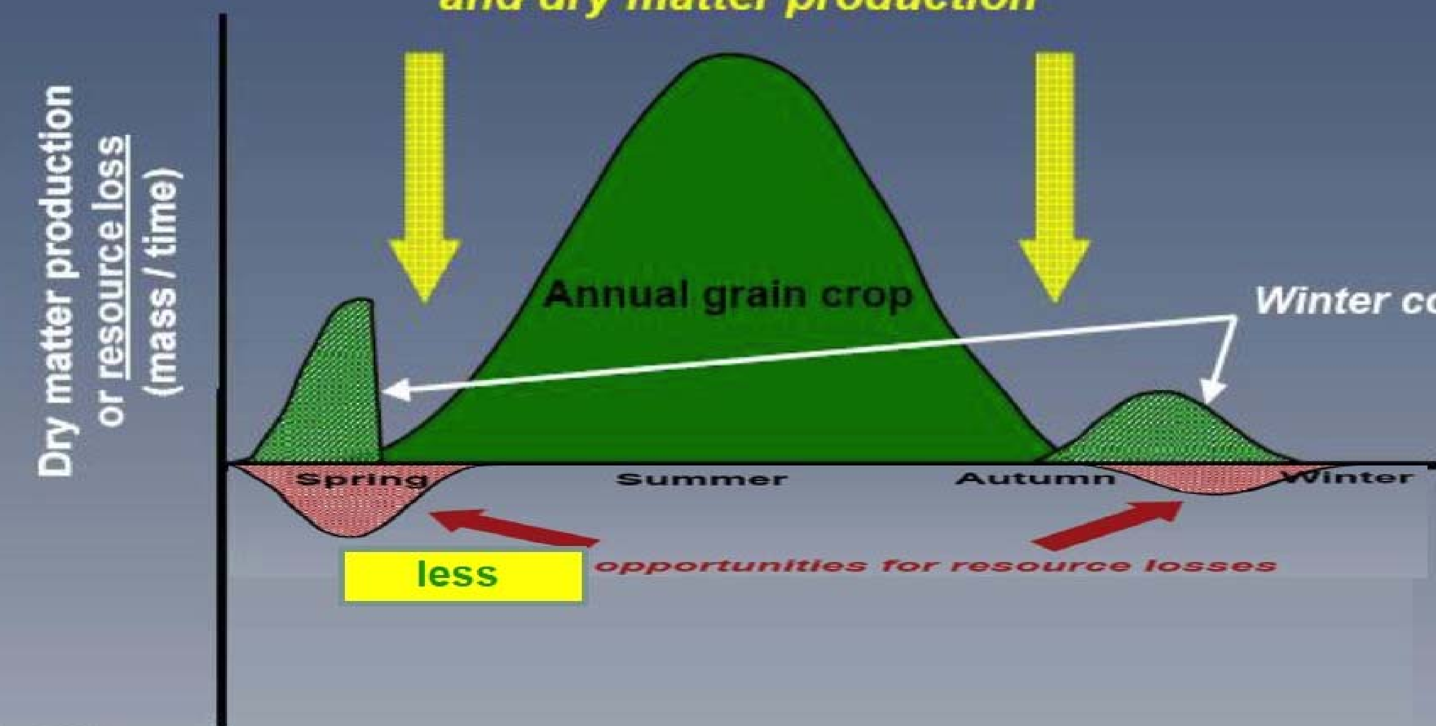




A. H. Heggenstaller, University of Alberta

Biomass Production

Annual Cropping Systems

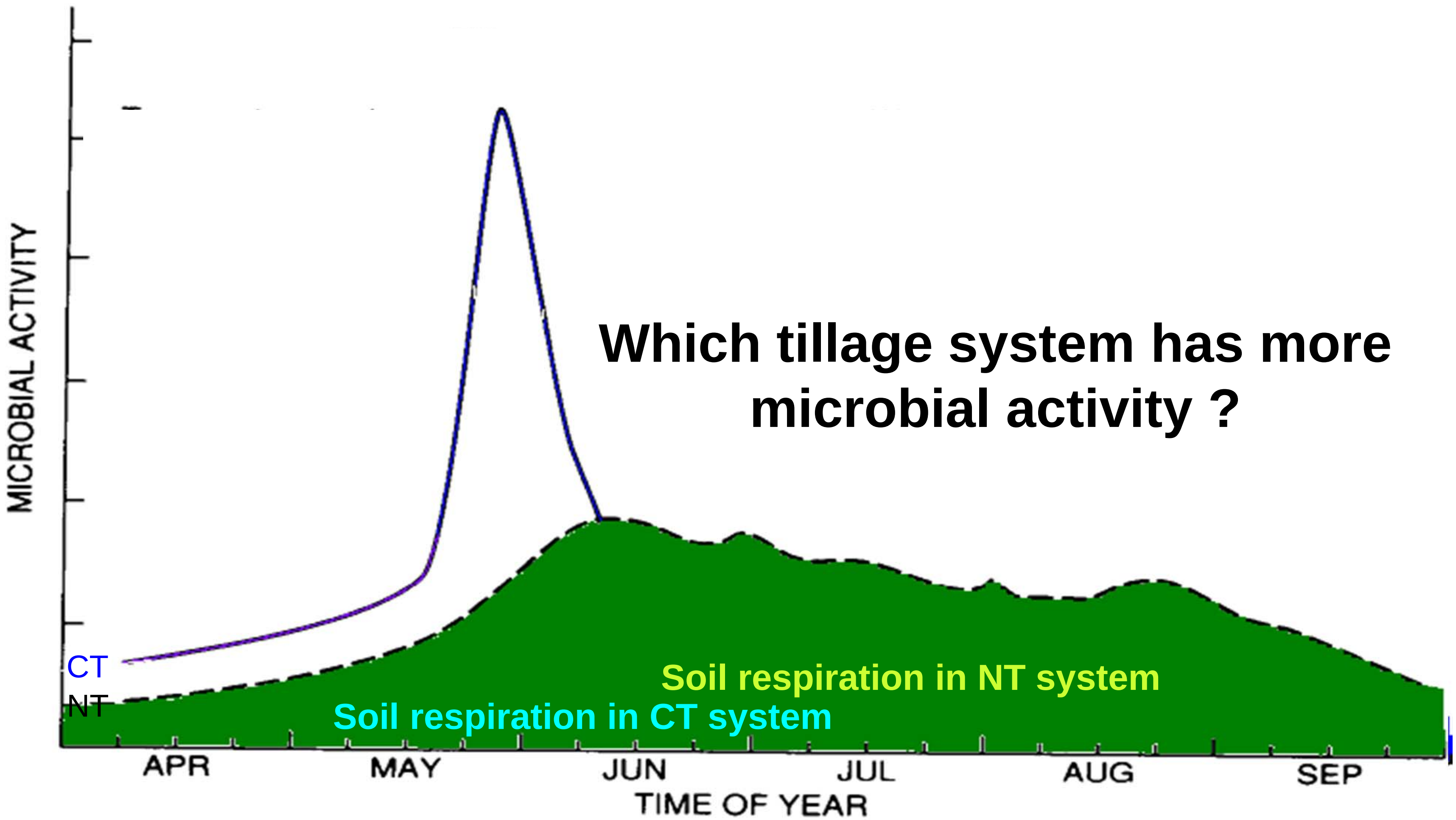


The Science of Conservation, We Deliver!

NRCS East NTSC

A. H. Heggenstaller, University of Alberta

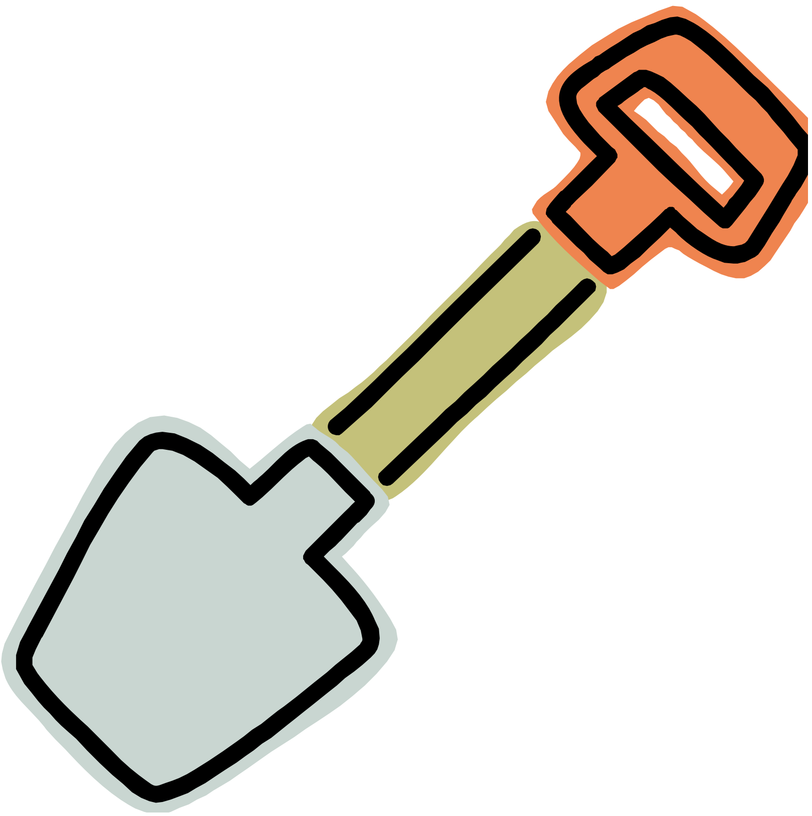
Effect of tillage on microbial activity



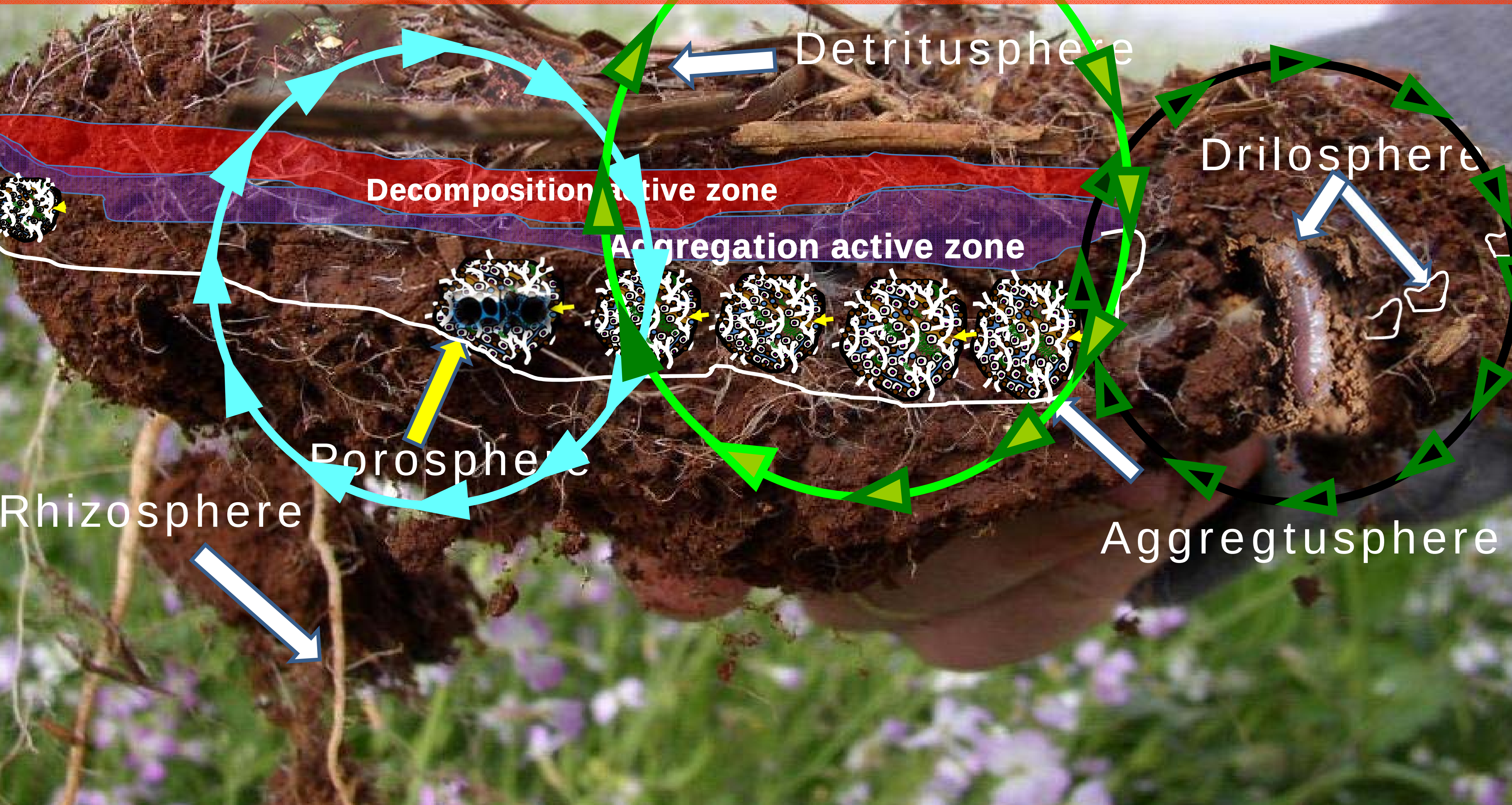
Which tillage system has more microbial activity ?

Havlin et al. (1999)

Shovel: A Tool to determine soil health



A hierarchical approach to evaluating the significance of soil biodiversity to biogeochemical cycling



M.H. Beare, D.C. Coleman, D.A. Crossley Jr., P.F. Hendrix and E.P. Odum (1995)

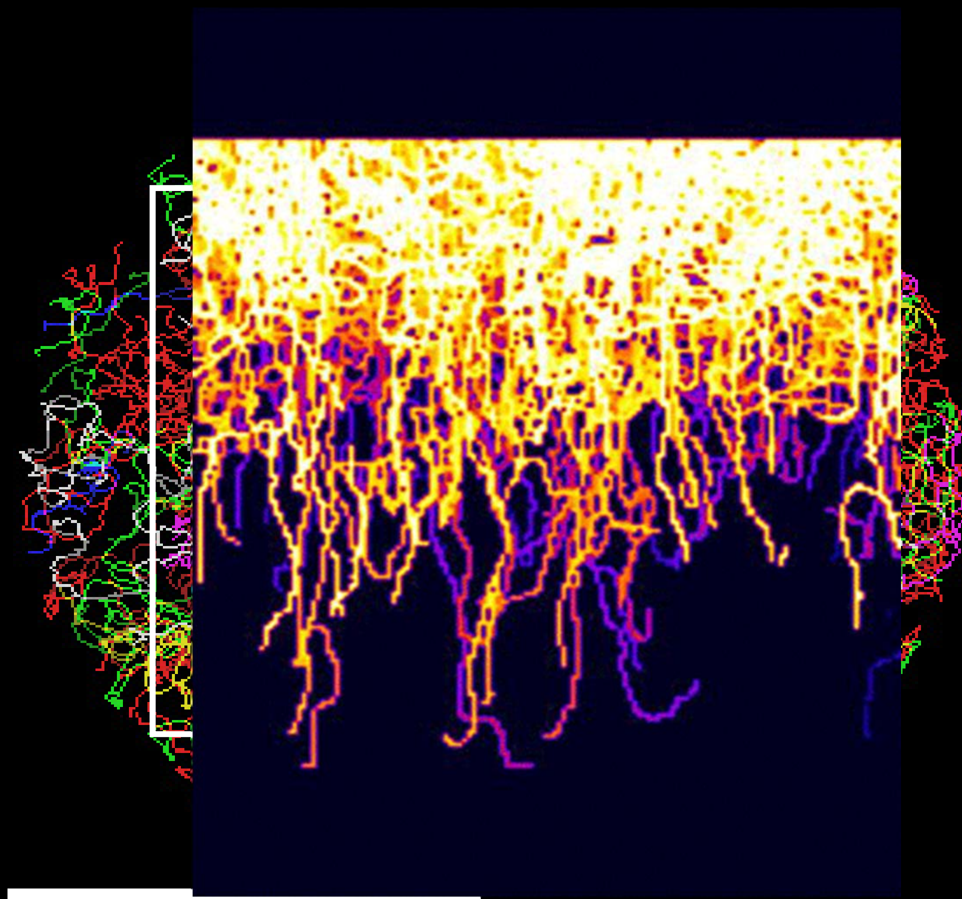
Nature's residue managers

Giant Australian earthworm

Megascolides australis can get up to 11 feet !!

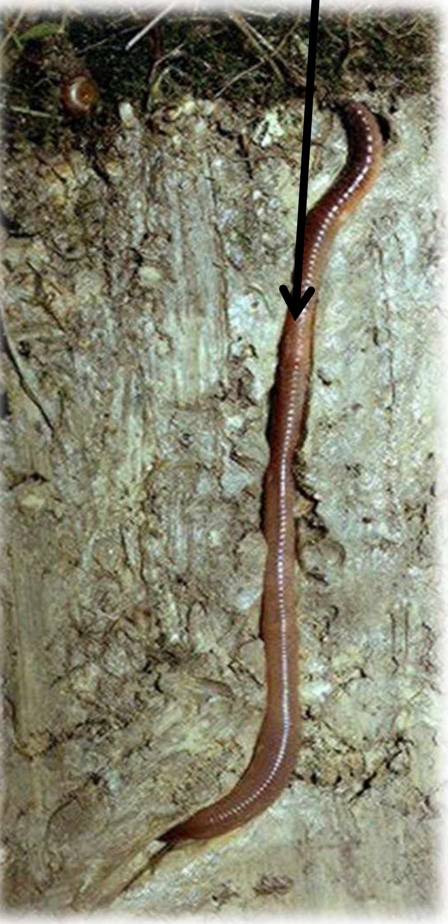
Soil Engineers: Earthworms
Subsoil macropores - Model of earthworm burrow systems

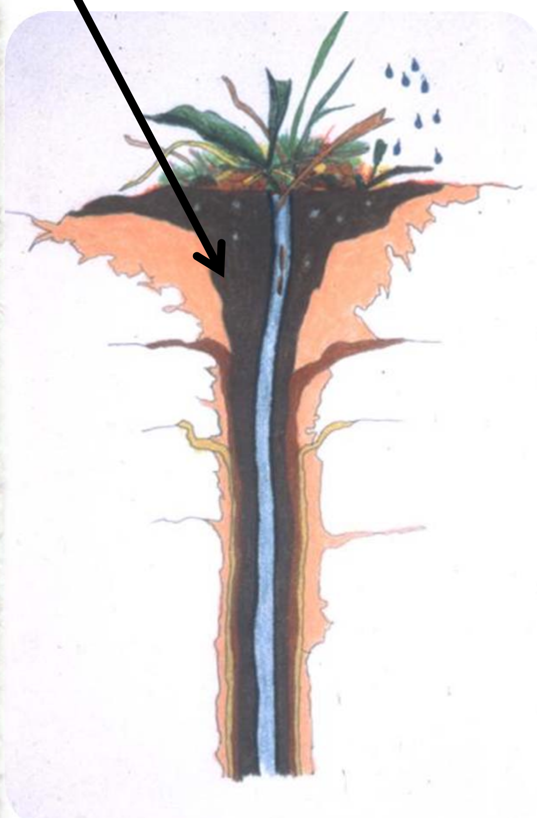
75 ind/m²
- 30% endogeic (∅ 2-3 mm)
- 70% anecic (∅ 6 mm)
- ∅ core 212 cm



Bastardie, Capowiez *et al.* Biol Fertil Soils (2002) 36:161–169

Drilosphere: Zone of earthworm influence

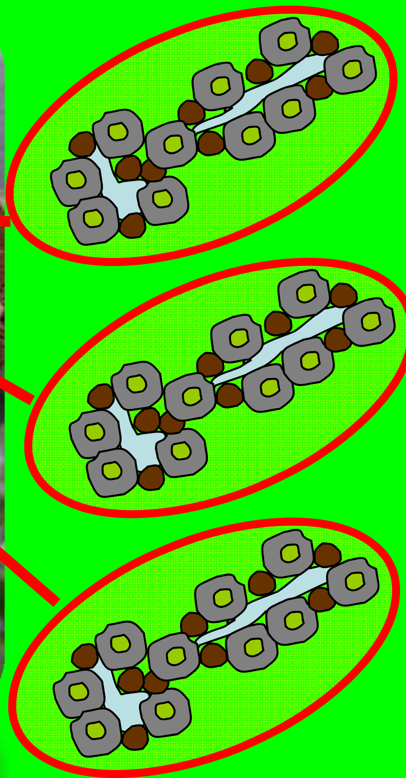




- •Redistributes plant litter "Carbon" throughout the soil the profile
- • Soils are enriched with N,P, and humified organic matter
- •Increase water infiltration
- •Provide a bio pore for plant roots
- •Homogenize soil surface
- •Increase bio-diversity in soils

M.H. Beare, D.C. Coleman, D.A. Crossley Jr., P.F. Hendrix and E.P. Odum (1995)

Aggregatusphere : Occluded Habitat of Micropores



.Protects organic matter from decay
•Storage site for organic matter
• Habitat of Oligotrophic and Copiotrophic bacteria
•Protects and maintains the integrity of the porosphere

They are linked mainly by fungi hyphae, roots fibers, polysaccharides, Glomalin,rhizodeposition, and aromatic humic materials

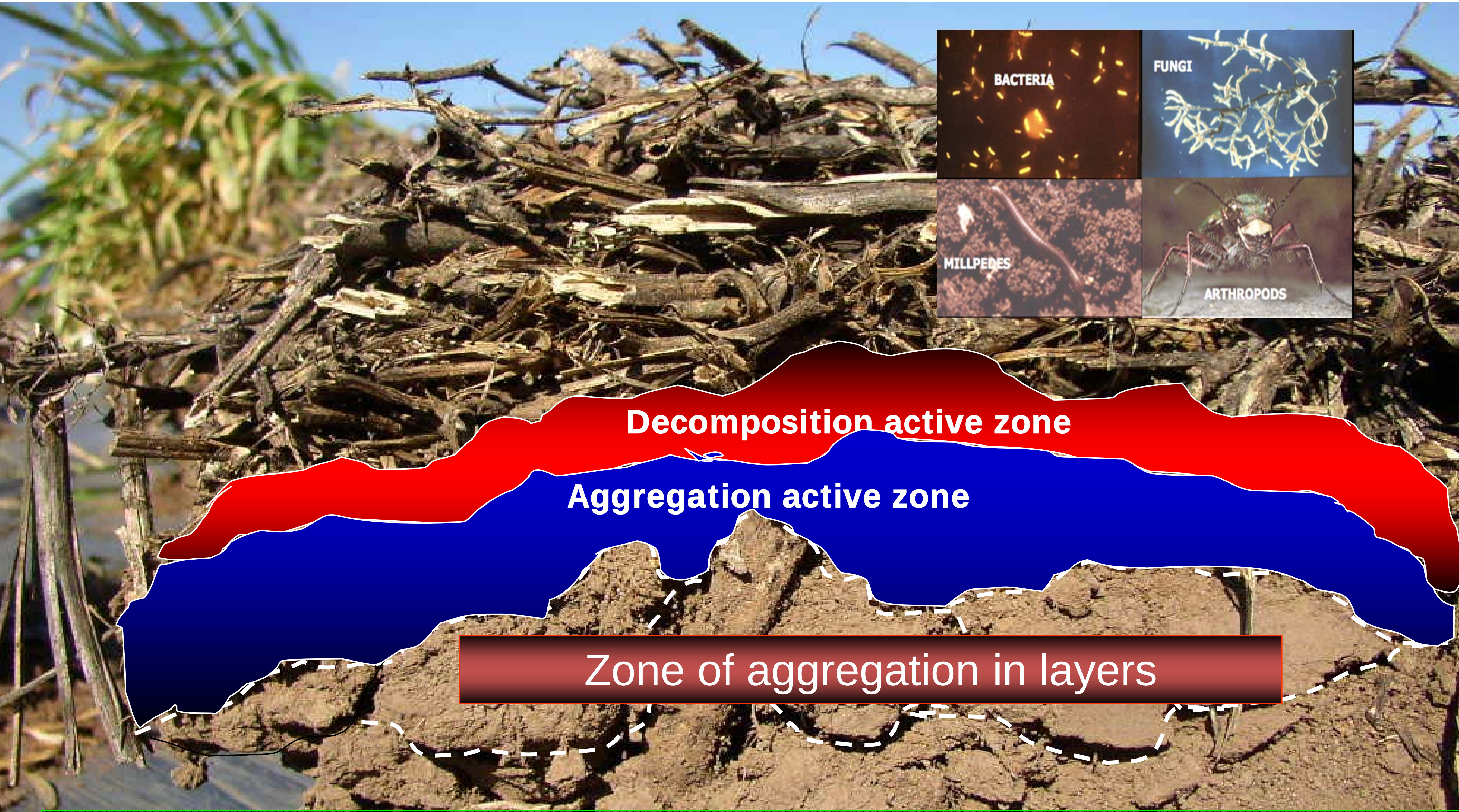
Beare, D.C. Coleman, D.A. Crossley Jr., P.F. Hendrix and E.P. Odum (1995)

Cottage Cheese

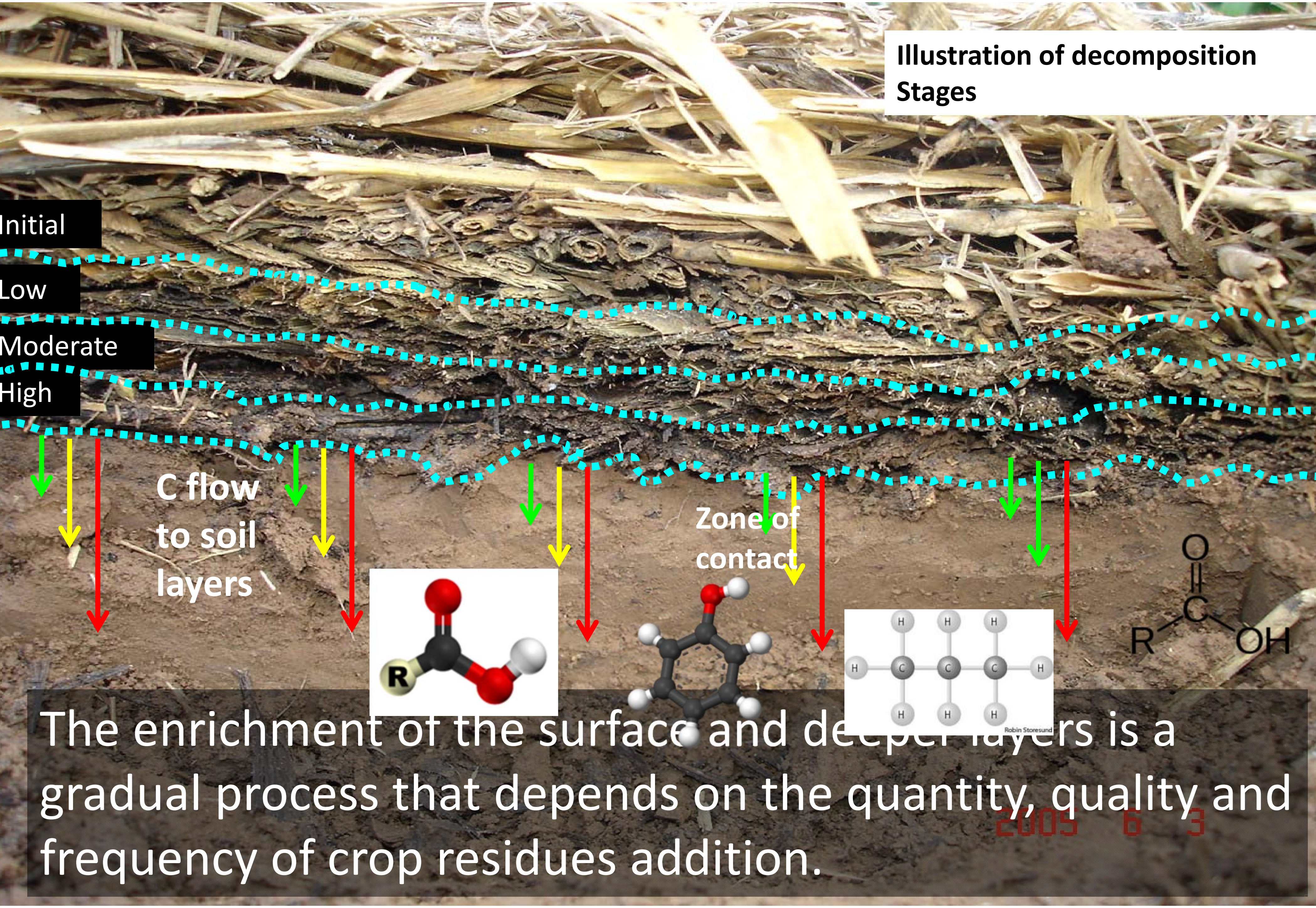
The Detritusphere:

. Protects the aggratusphere and the poroshpere from the sun, wind and rain

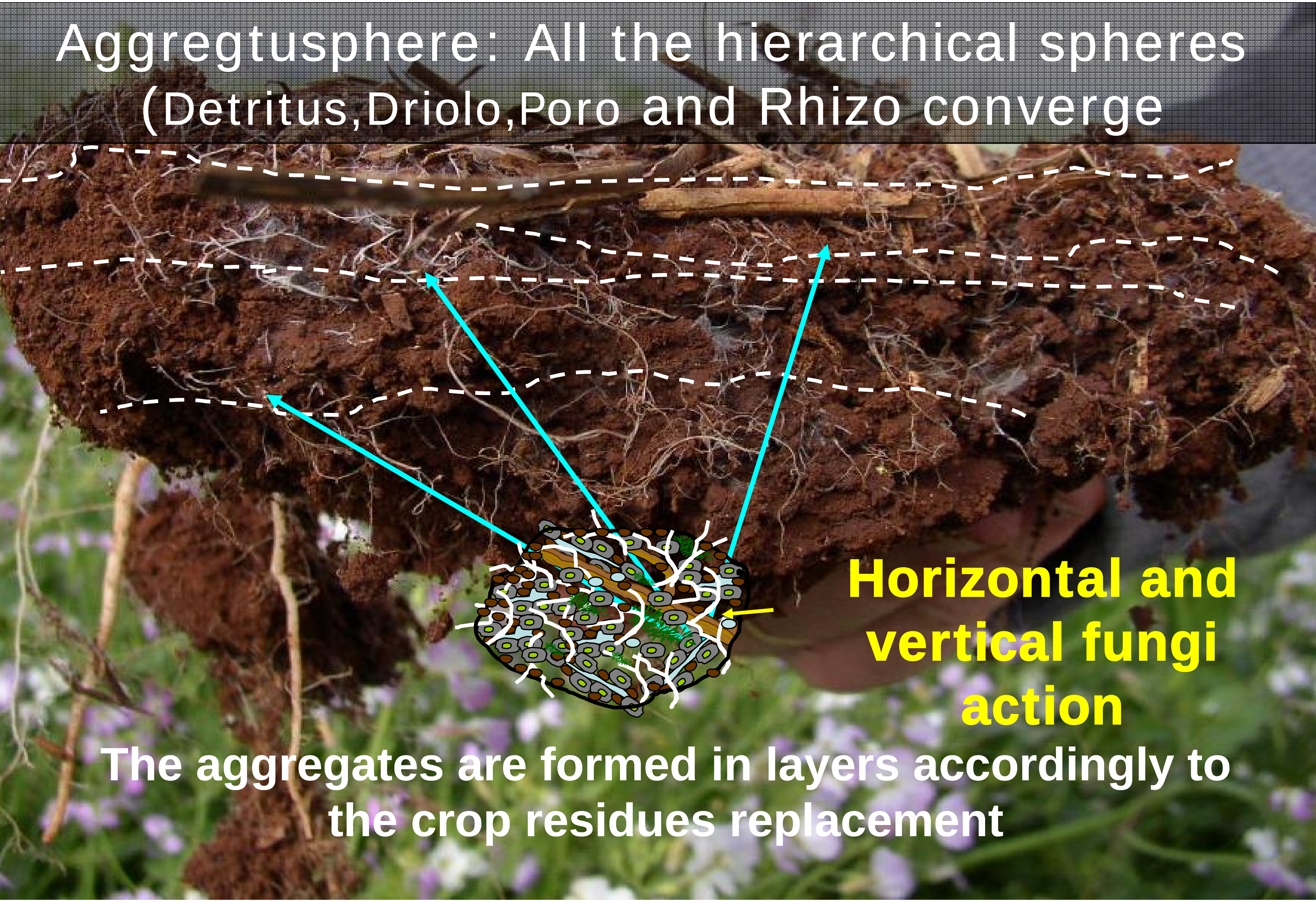
- Lowers temperture and evaporation
- Provides habitat and food for soil organisms
- Enhances biogeochemical nutrient cycling
- Builds soil structure and nutrient reserves



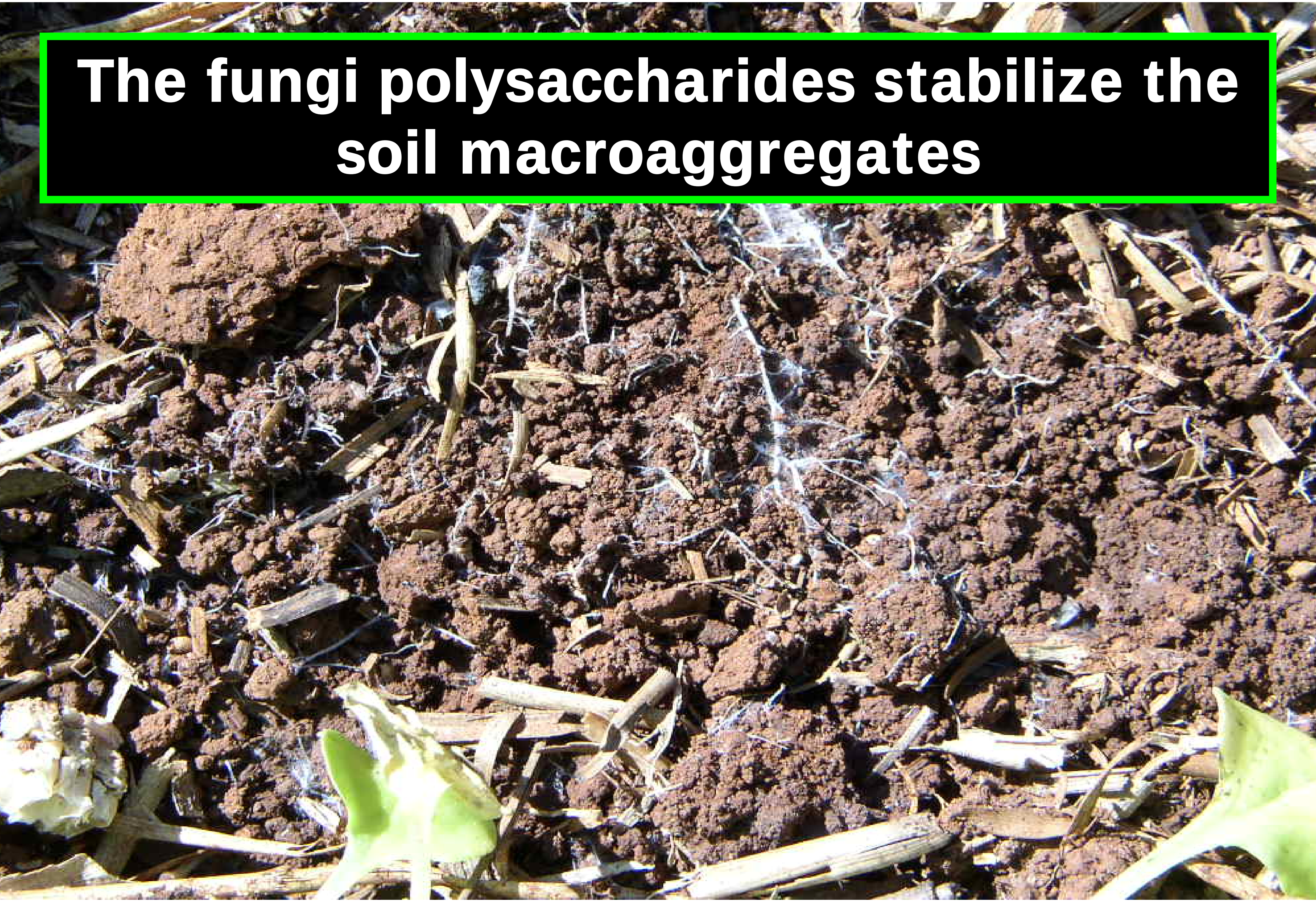
This enrichment of the surface layer with SOM maintains soil quality by enhancing aggregation and facilitating aeration (Doran and Parking, 1994; Franzluebbers, 2007).



The enrichment of the surface and deeper layers is a gradual process that depends on the quantity, quality and frequency of crop residues addition.


Aggregtusphere: All the hierarchical spheres
(Detritus,Driolo,Poro and Rhizo converge
Horizontal and
vertical fungi
action
The aggregates are formed in layers accordingly to
the crop residues replacement

The fungi polysaccharides stabilize the soil macroaggregates



Roots and fungi hyphae

That *“root-hyphae-net”* holds intact the aggregates

The clay in the surface protects the roots and hyphae from microbe attack

The stability in many soils is associated with the organic matter (From Dr. Joao Sa)

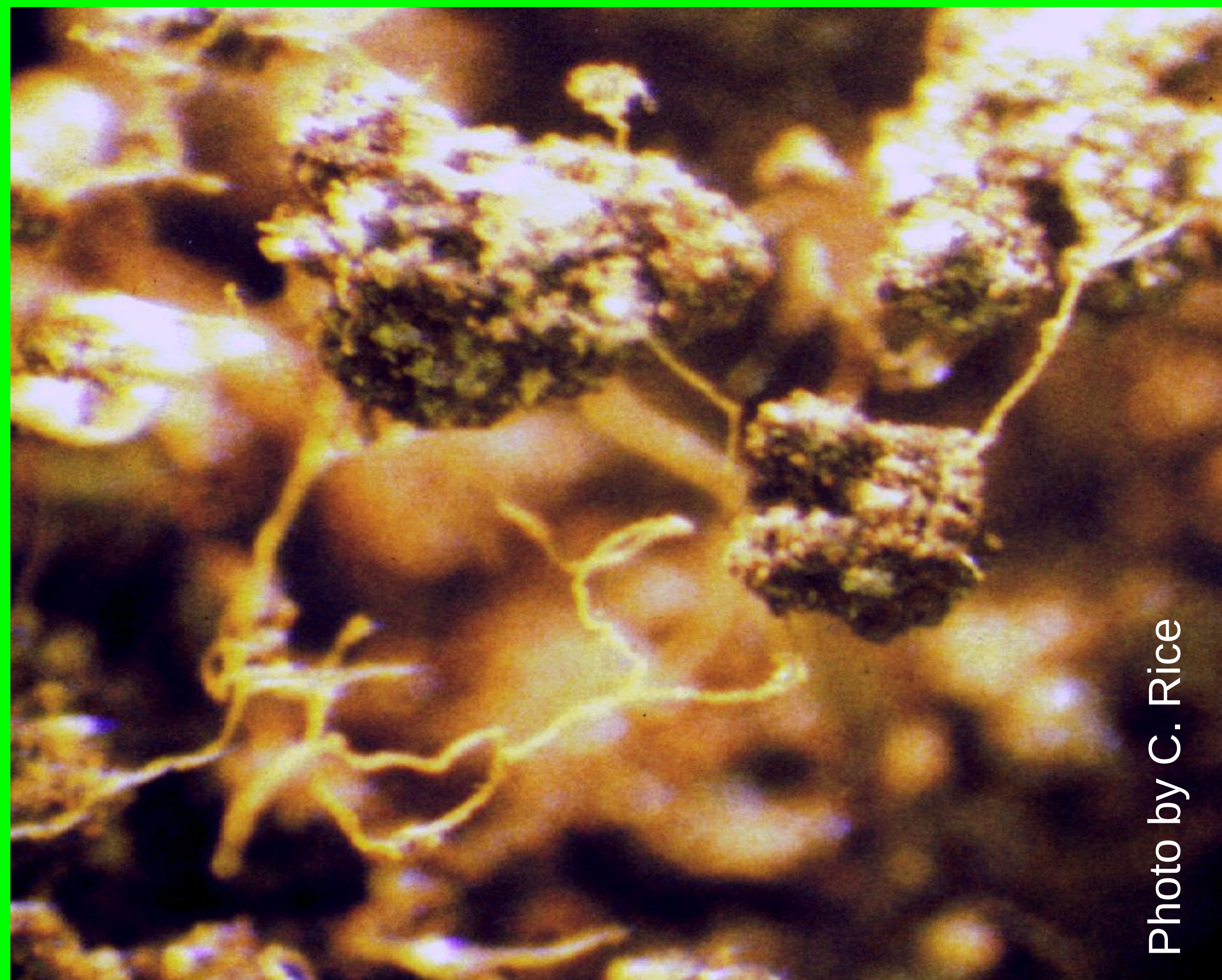
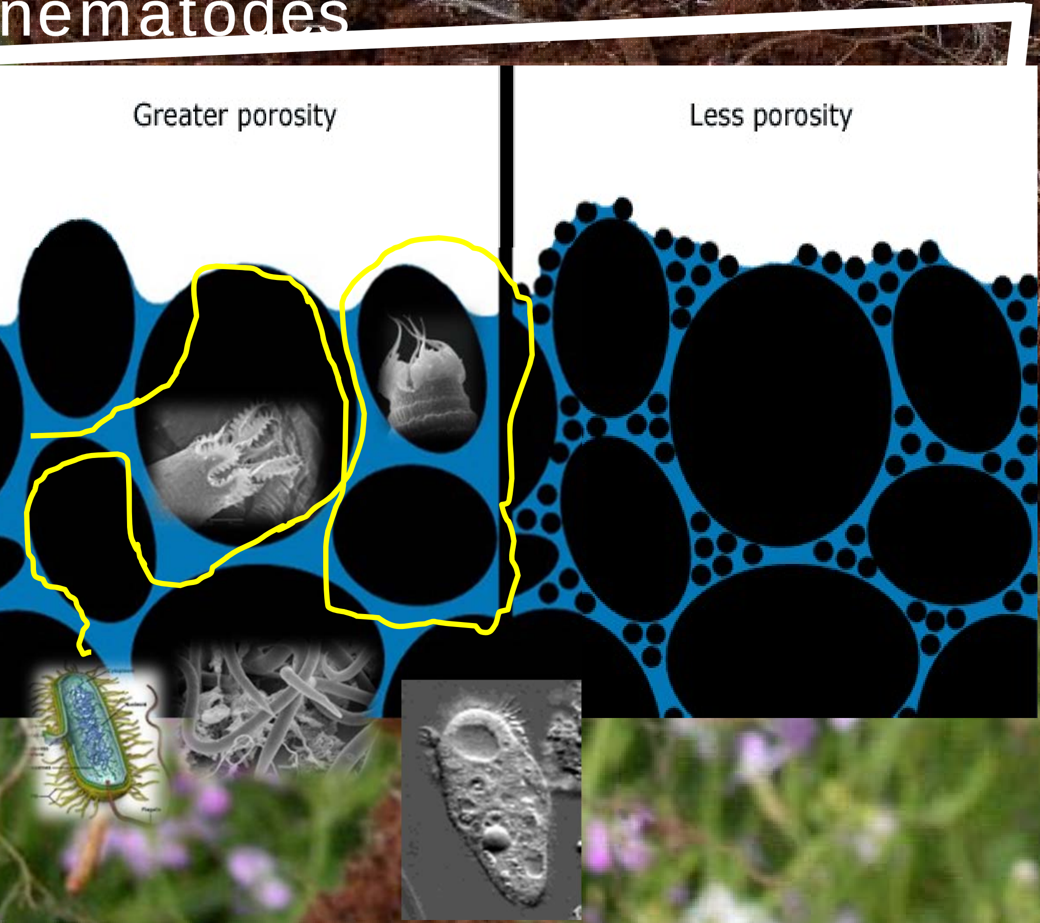


Photo by C. Rice

Porosphere: Arrangement of Solids and Voids

Primary an Aquatic Habitat (water films): for protozoa, bacteria, Mycorrhizae, and nematodes

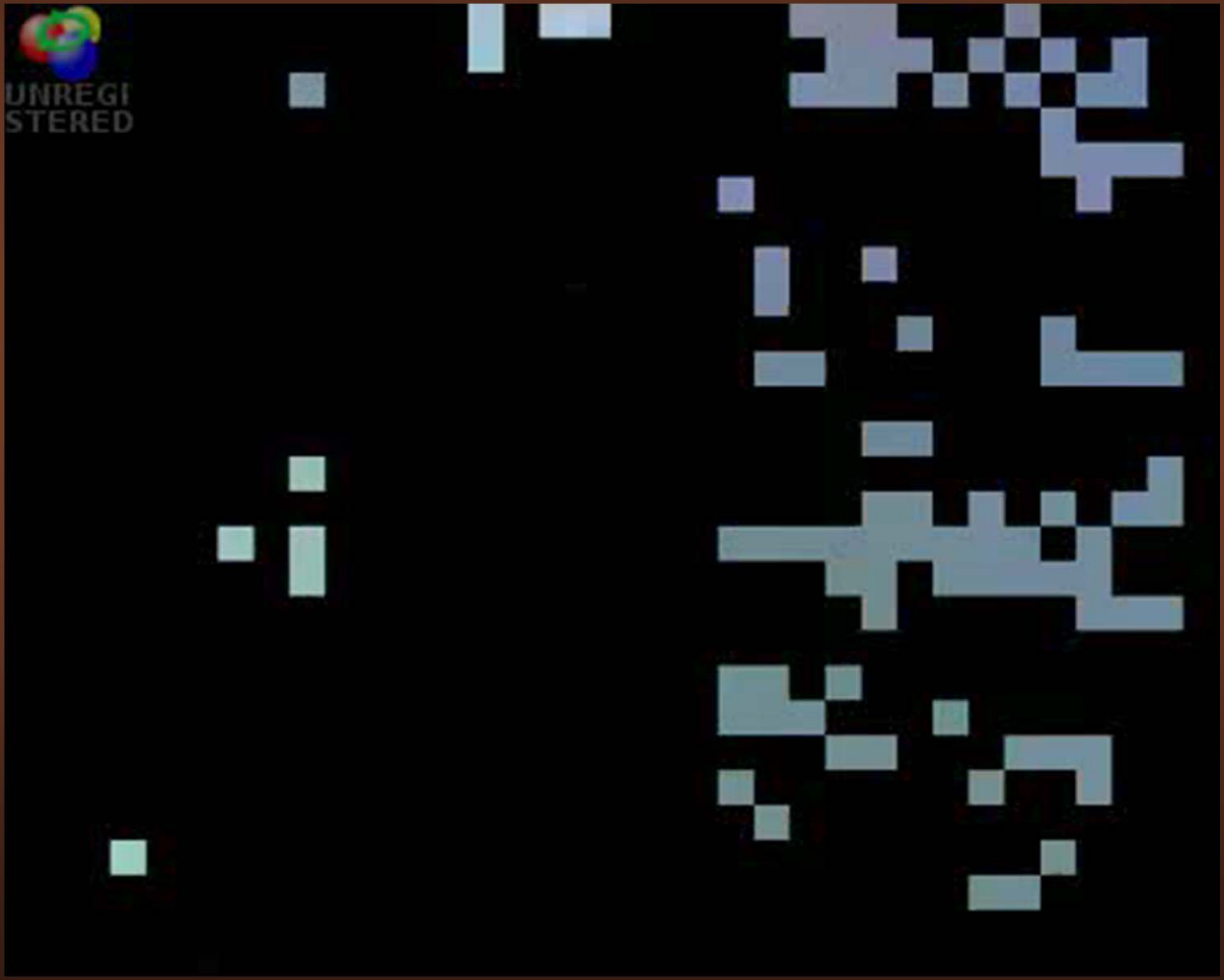


The lungs and circulatory system of the soil:

- Regulates water and air flow
- Impacts N, P Mineralization
- Impacts soil organism bio-mass and diversity
- Site of nutrient exchange
- Site of mycorrhizal entanglement and sequestration of water and nutrients
- Root interface
- Part of the water cycle

M.H. Beare, D.C. Coleman, D.A. Crossley Jr., P.F. Hendrix and E.P. Odum (1995)

The root is a Leverage Point: Engineering



Root Exudates:

Amino Acids

Organic Acids

Sugars

Vitamins

Purines/Nucleosides

Enzymes

Inorganic ions and Gaseous Molecules

West 1939, Fries and Forseman (1951), Gagnon and Ibrhaim (1998)

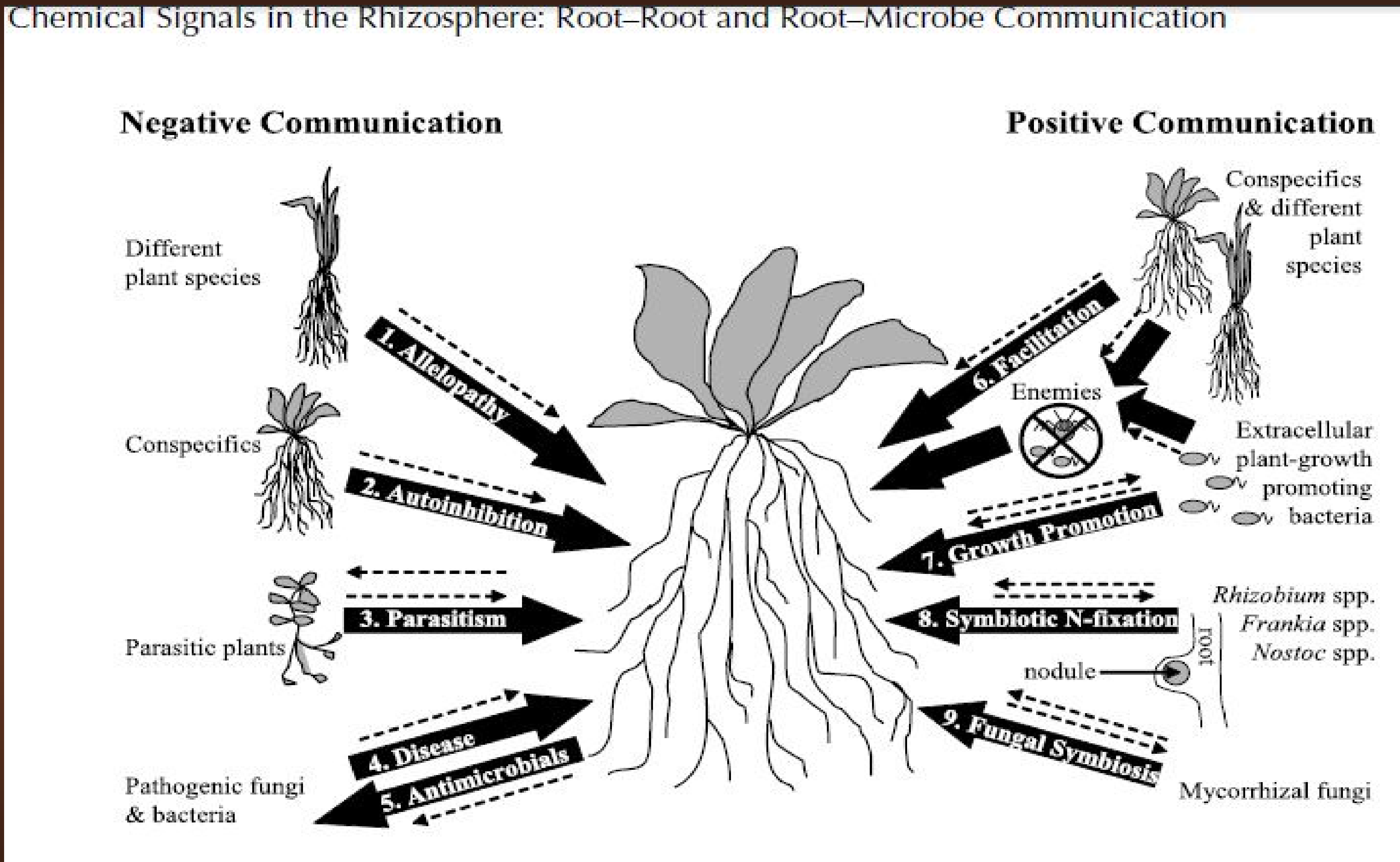
Plants and Microbes Communicate

TABLE 1.2
Root Products: A Classification

Product	Compound
Root exudates	
Diffusates	Sugars, organic acids/anions, amino acids, water, inorganic ions, oxygen, riboflavin etc.
Excretions	Carbon dioxide, bicarbonate ions, protons, electrons, ethylene, etc.
Secretions	Mucilage, protons, electrons, enzymes, siderophores, allelochemicals, etc.
Border cells	Root cap cells separated from the root apex
Root debris	Cell contents, lysates, etc.

Source: From Uren, N.C. and Reisenauer, H.M., *Adv. Plant Nutr.*, 3, 79, 1988. With permission.

Robert Pinto, 2007 The Rhizosphere



Robert Pinto, 2007 The Rhizosphere

Scum Test

Switchgrass

Switchgrass – Immediately After Placing in Water

Switchgrass – After Submerging and Disruption

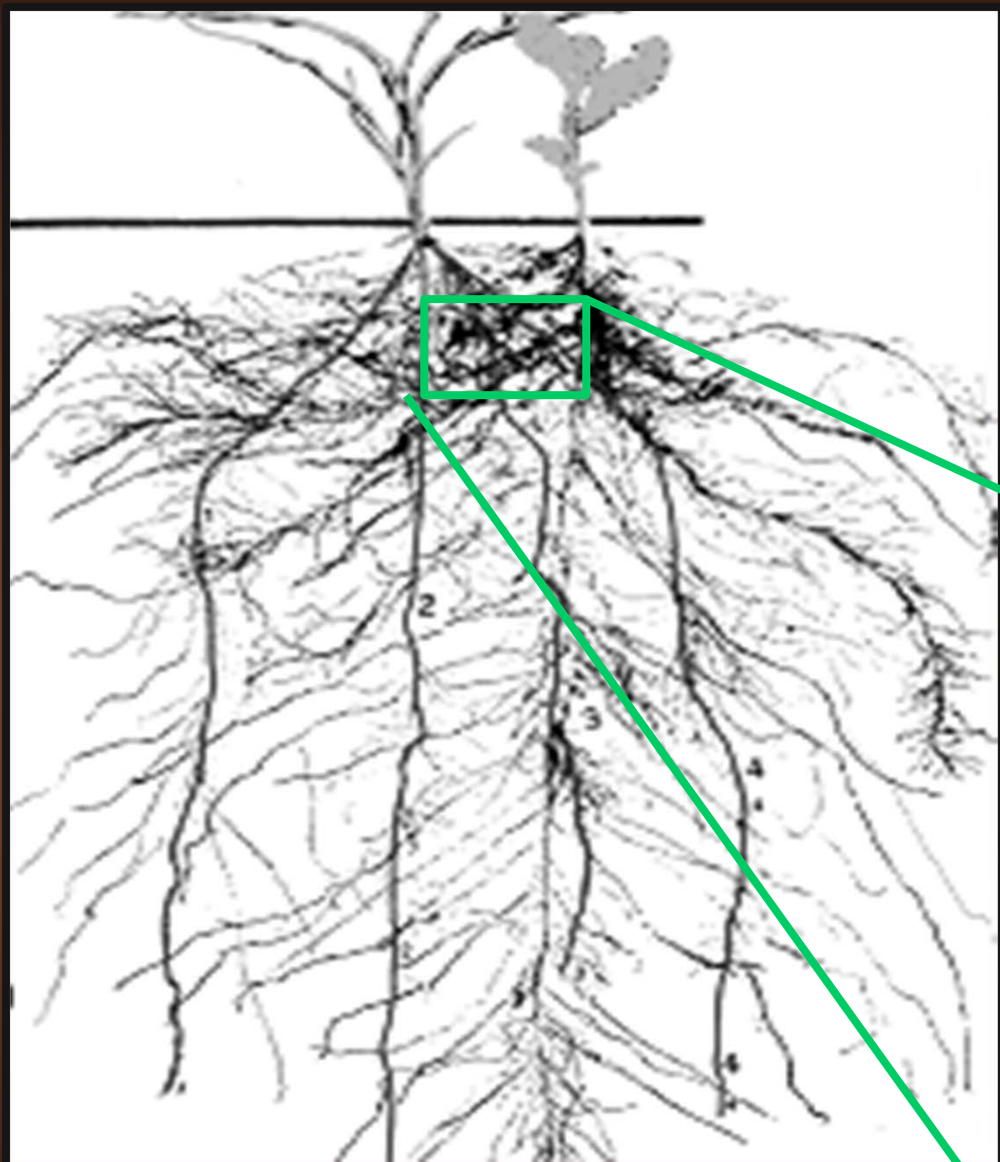
Switchgrass

Big Bluestem

Alfalfa

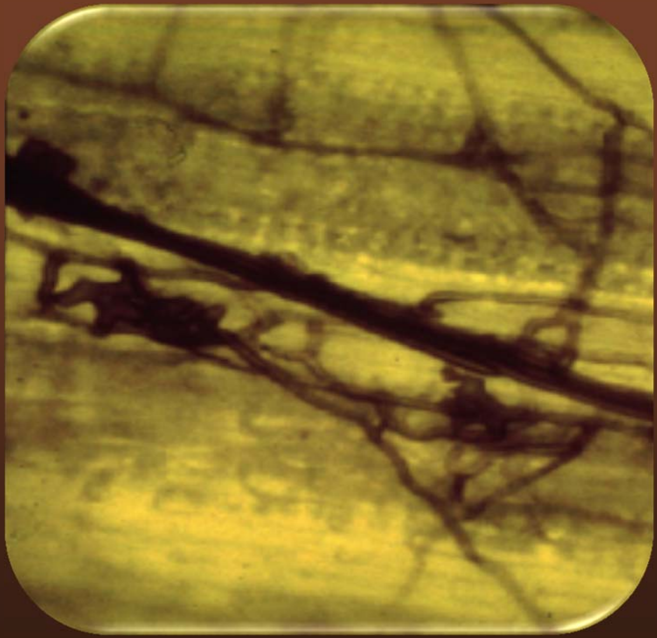
Spring 2008 Weed Suppression (ND)

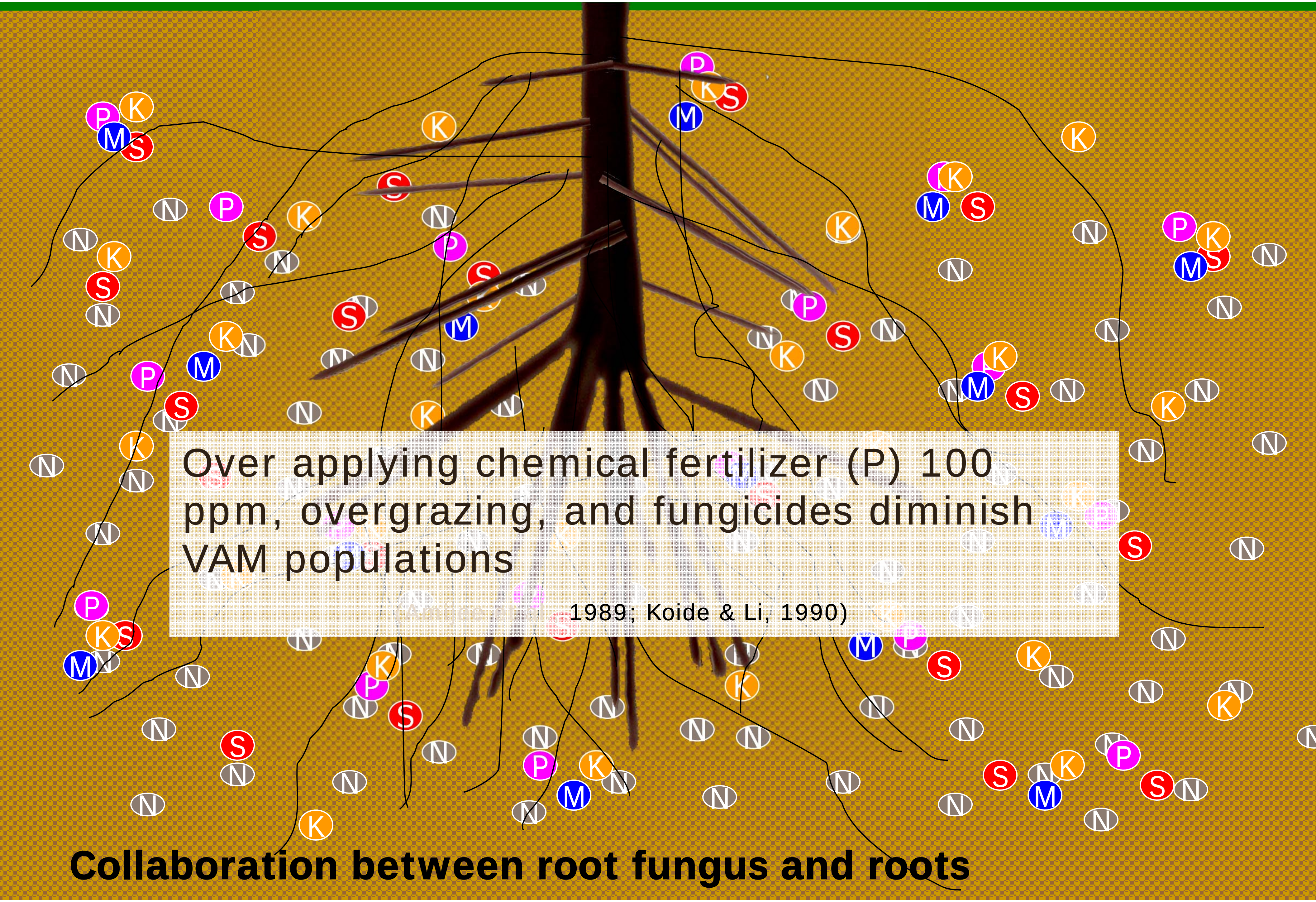
Plant-Plant Nutrient Transfer



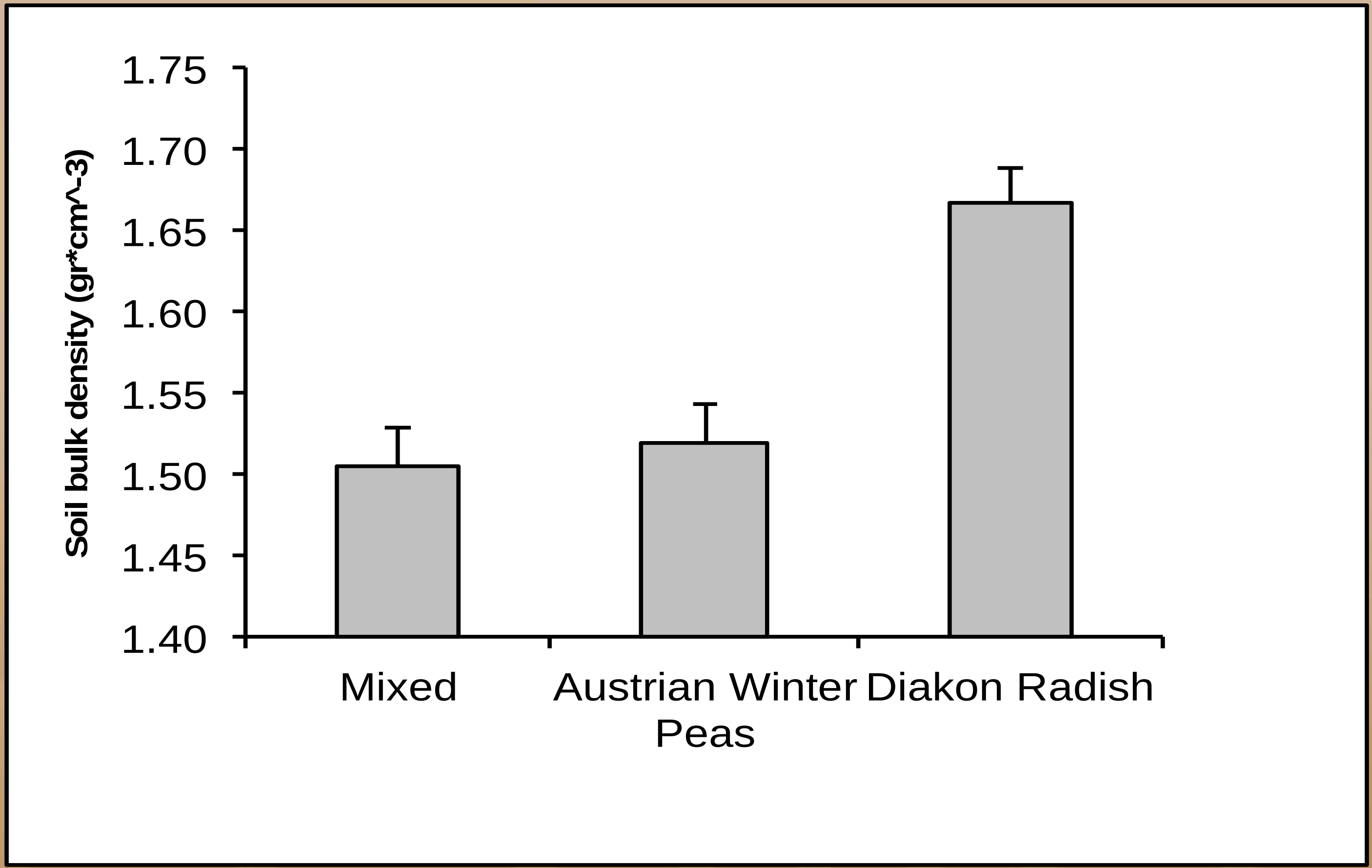
Fungi- Service they provide

- Decompose Organic Matter
- Glomalin secretion develops soil structure
- Extract nutrients
- Hold nutrients



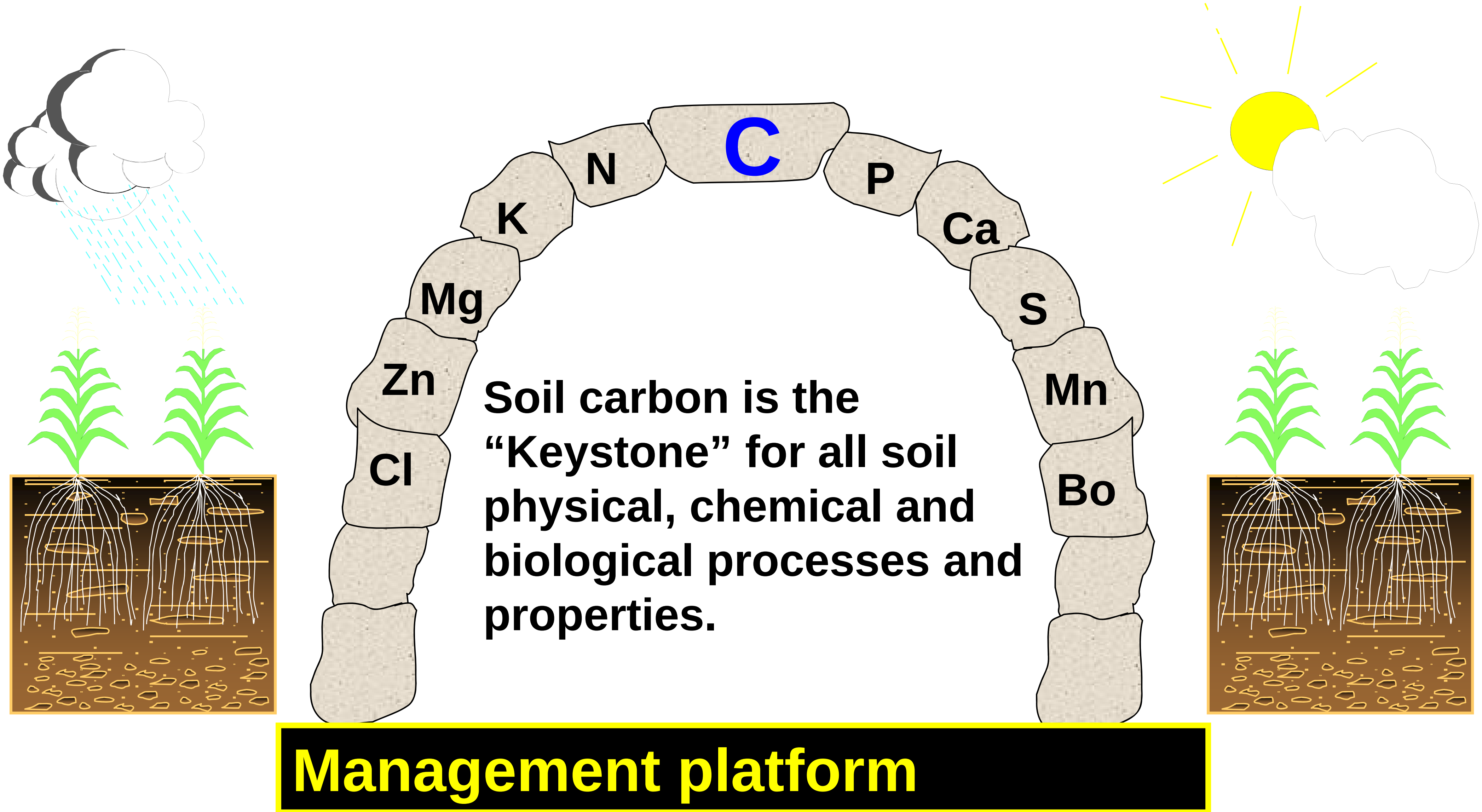

Over applying chemical fertilizer (P) 100 ppm, overgrazing, and fungicides diminish VAM populations
(Amijee et al., 1989; Koide & Li, 1990)
Collaboration between root fungus and roots

Soil Densities



growth

Ohio State



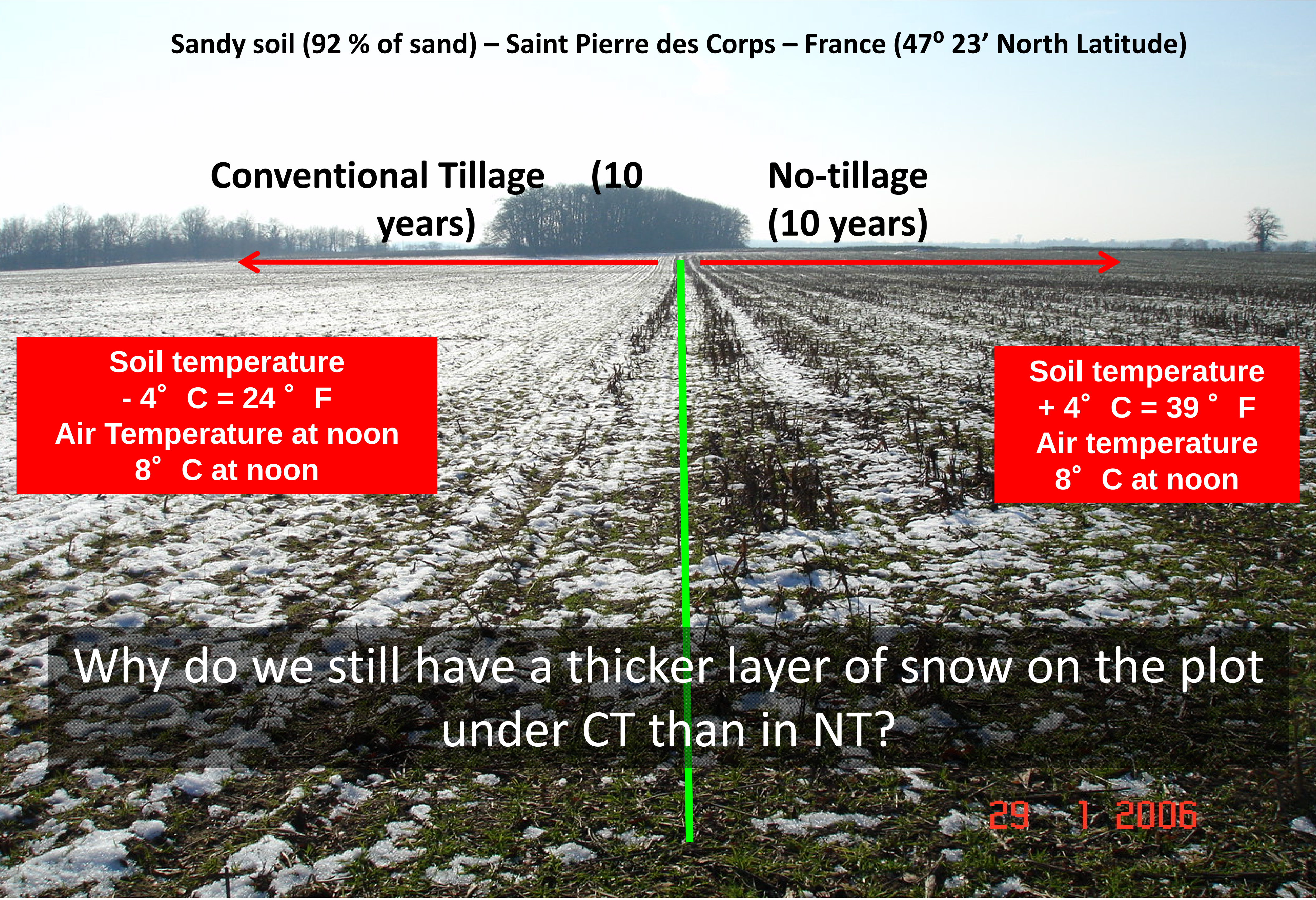
Dr. D.C. Reicosky, ARS, Morris, MN.

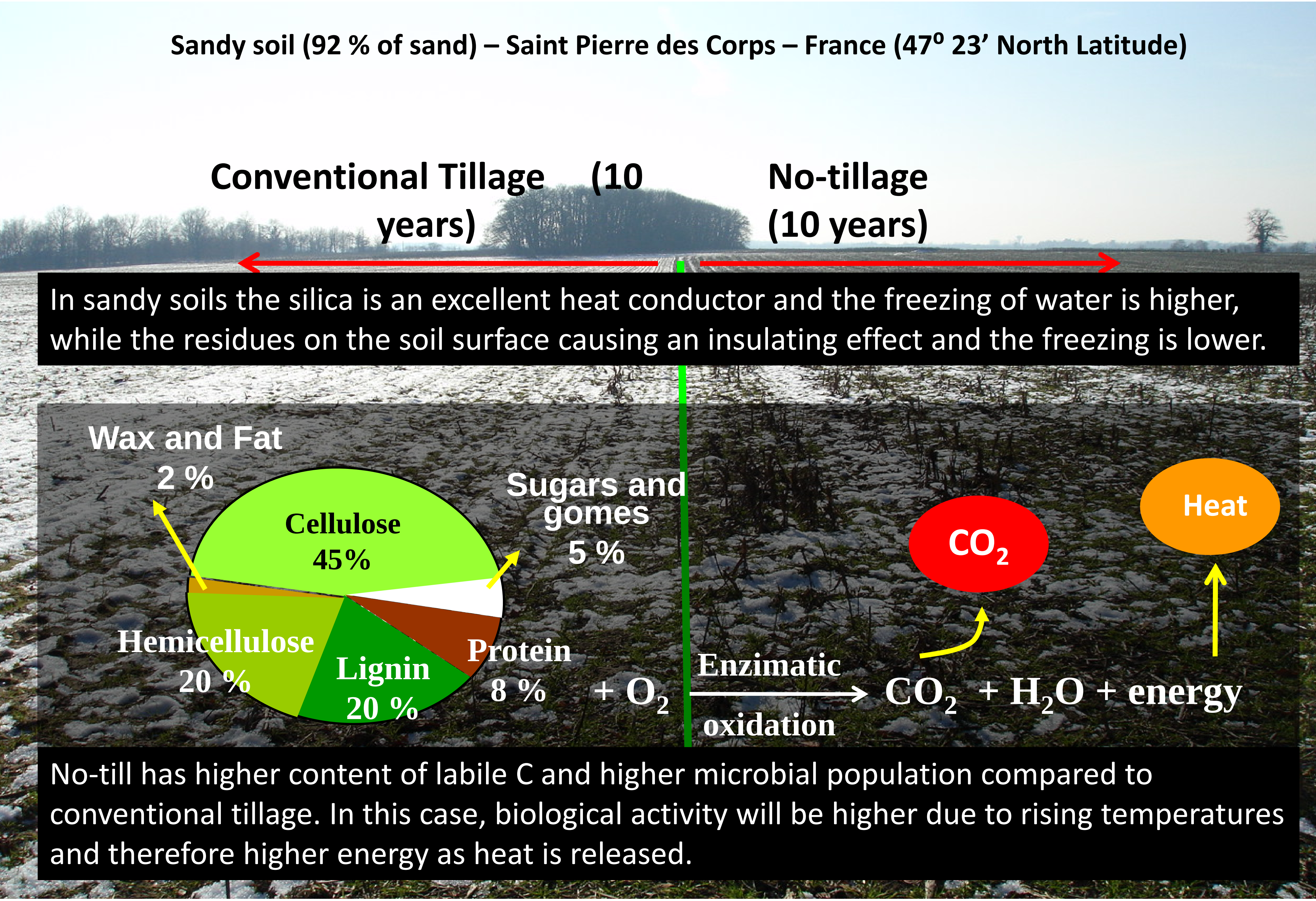

Crop residues
Crop residues
Cover Crops
Animal manure
20 years of similar tillage intensity and C inputs
but contrasting types of organic inputs

Priming effect: soil releases nutrients to plant

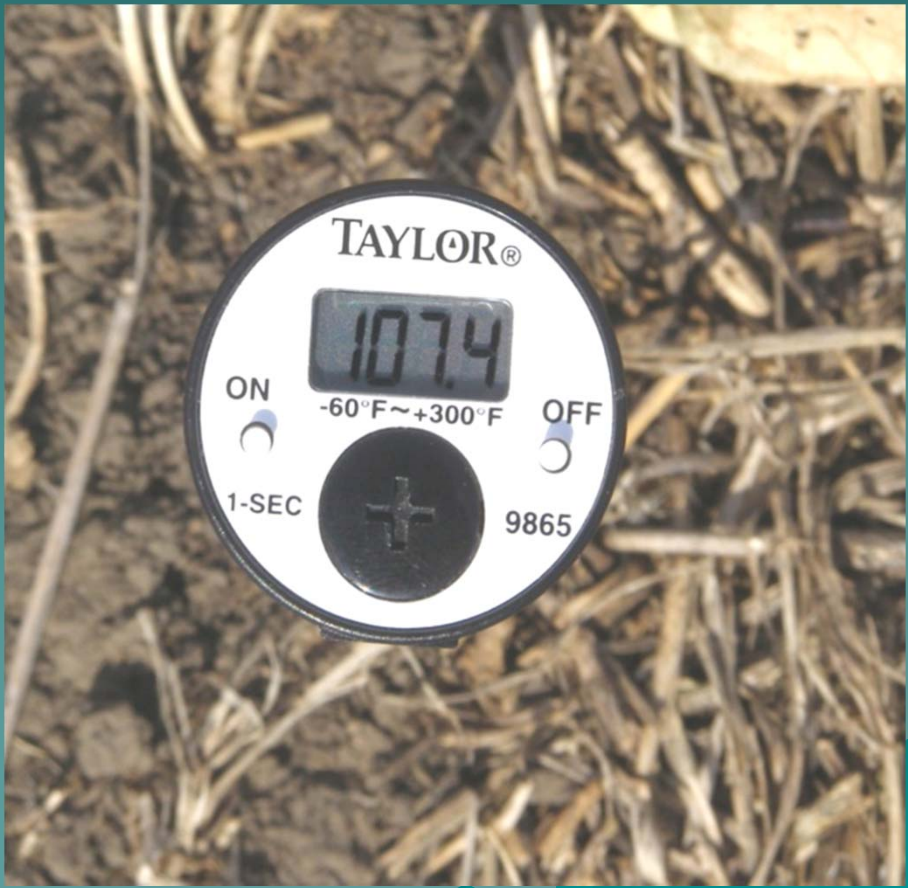
Destructive release of nutrients:	Constructive release of nutrients:
Tillage: Disking, Plowing and other high soil disturbance Activities. 	Plant Roots: Exudates  
Commercial l Fertilizer : Over use in low carbon soils (tilled) or buffered soils. 	Soil Organism Predation:  
Fallow Fields: (Leaky system) 	Manure or Compost: 
Fire 	Crop Residue or plant litter:  

Various Sources

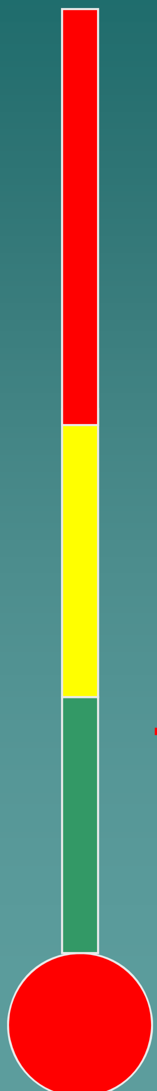

Sandy soil (92 % of sand) – Saint Pierre des Corps – France (47° 23' North Latitude)
Conventional Tillage (10 years)
No-tillage (10 years)
Soil temperature - 4° C = 24 ° F
Air Temperature at noon 8° C at noon
Soil temperature + 4° C = 39 ° F
Air temperature 8° C at noon
Why do we still have a thicker layer of snow on the plot under CT than in NT?
29 1 2006


Sandy soil (92 % of sand) – Saint Pierre des Corps – France (47° 23’ North Latitude)
Conventional Tillage (10 years)
No-tillage (10 years)
In sandy soils the silica is an excellent heat conductor and the freezing of water is higher, while the residues on the soil surface causing an insulating effect and the freezing is lower.
Wax and Fat 2 %
Cellulose 45%
Sugars and gomes 5 %
Hemicellulose 20 %
Lignin 20 %
Protein 8 %
+ O_2
Enzimatic oxidation
CO_2 + H_2O + energy
CO_2
Heat
No-till has higher content of labile C and higher microbial population compared to conventional tillage. In this case, biological activity will be higher due to rising temperatures and therefore higher energy as heat is released.

Soil Temperatures



When soil temperature reaches...



140 F Soil bacteria die

130 F 100% moisture is lost through evaporation and transpiration

113 F

Some bacteria species start dying

100 F 15% of moisture is used for growth
85% moisture lost through evaporation and transpiration

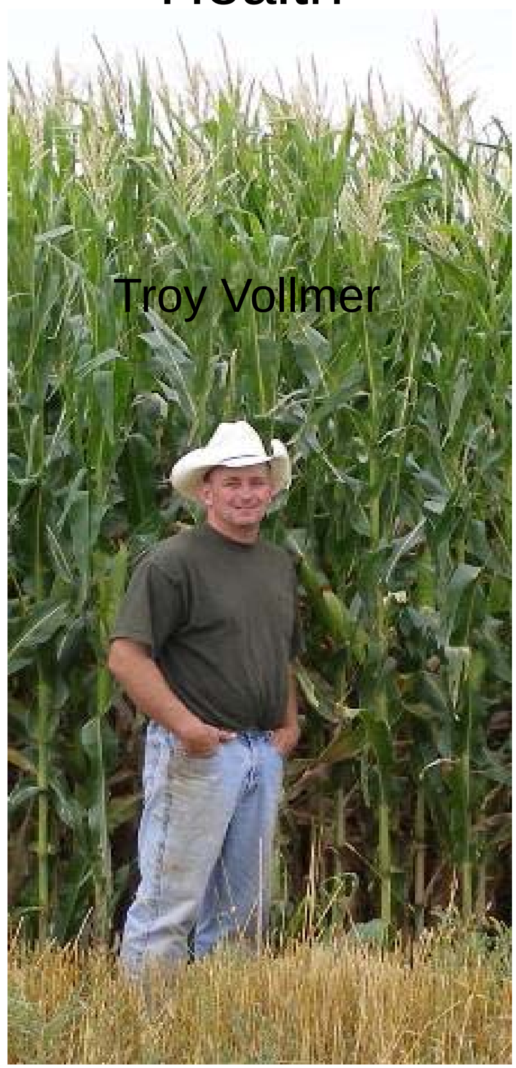
95 F

70 F 100% moisture is used for growth

J.J. McEntire, WUC, USDA SCS, Kernville TX, 3-58 4-R-12198. 1956

Diversity conduit for energy and nutrients

Farmers Talking To Farmers About Soil Health



The Answer is to Imitate Native Rangeland

Utilize energy efficiently- understand the power of diversity: Collaboration is more apparent than Competition: ND case study: 2006 Production On Burleigh District Plot with 1.8 in. of rain

TABLE 15.3 Yield of a corn–bean–squash polyculture compared to yields of the same crops grown as monocultures in Tabasco, Mexico

	Low-density monoculture*	High-density monoculture*	Polyculture
Corn density (plants/ha)	40,000	66,000	50,000
Corn yield (kg/ha)**	1,150	1,230	1,720
Bean density (plants/ha)	64,000	100,000	40,000
Bean yield (kg/ha)**	740	610	110
Squash density (plants/ha)	1,875	7,500	3,330
Squash yield (kg/ha)**	250	430	80
Land Equivalent Ratio (LER)			1.97a 1.77b

Agroecology pg. 224 (Gliessman

FIGURE 15.6
The traditional corn–bean–squash intercrop system from mesoamerica. Complex species interactions are key to the success of this cropping system.

Turnip July 31

Oilseed Radish July 31

Cocktail July 31


Burleigh County
Soil Conservation District
ADVANCING SOIL HEALTH
Menoken Farm
www.bcscd.com
Established 2009


Menoken Farm
Building Site
Field 1
Filed 2
Field 3
Field 4
Field 5
Field 6
Field 7
Field 8
Field 9
Field 10

September 4, 2009
No Commercial Fertilizer

- Sunflower 1 lb
- Soybean 15 lbs
- Cowpea 10 lbs
- Turnip 1 lb
- Radish 2 lbs
- Proso Millet 4 lbs
- Pearl Millet 4 lbs
- Sweet Clover 1 lb

Planting Corn Into Last Year's Cover Crop Residue
May 20, 2010


West Side
No Commercial Fertilizer
No Compost
No Compost Tea
122.3 Bushels per Acre
East Side
No Commercial Fertilizer
1-2 Ton of Compost
2 Compost Tea Applications
128.8 Bushels per Acre
The Menoken Farm
Power of Crop Diversity
Both Sides were Planted into Last Year’s Cover Crop Residue
2006 – 2010 Burleigh County FSA Committee Reasonable Yield Established by Year = 100 Bushels per Acre


Darrell Oswald Ranch: Cover crop Mix


Tundra?

Brown’s Ranch:

WORKING TOWARDS SUSTAINABILITY

Brown's Ranch
Home of Sustainable Ranching
www.sustainableranching.com

Hail

Brown's Ranch
Same Field

June 16, 2009
Corn planted into last years cover crop residue

July 1, 2009
Rapid residue decomposition

More natural pest control

Winter Triticale & Hairy Vetch

Cool Season Cocktail

Combine


Phacelia and Native Pollinator

Cowpea/Proso Millet/Buckwheat

Soil Armor

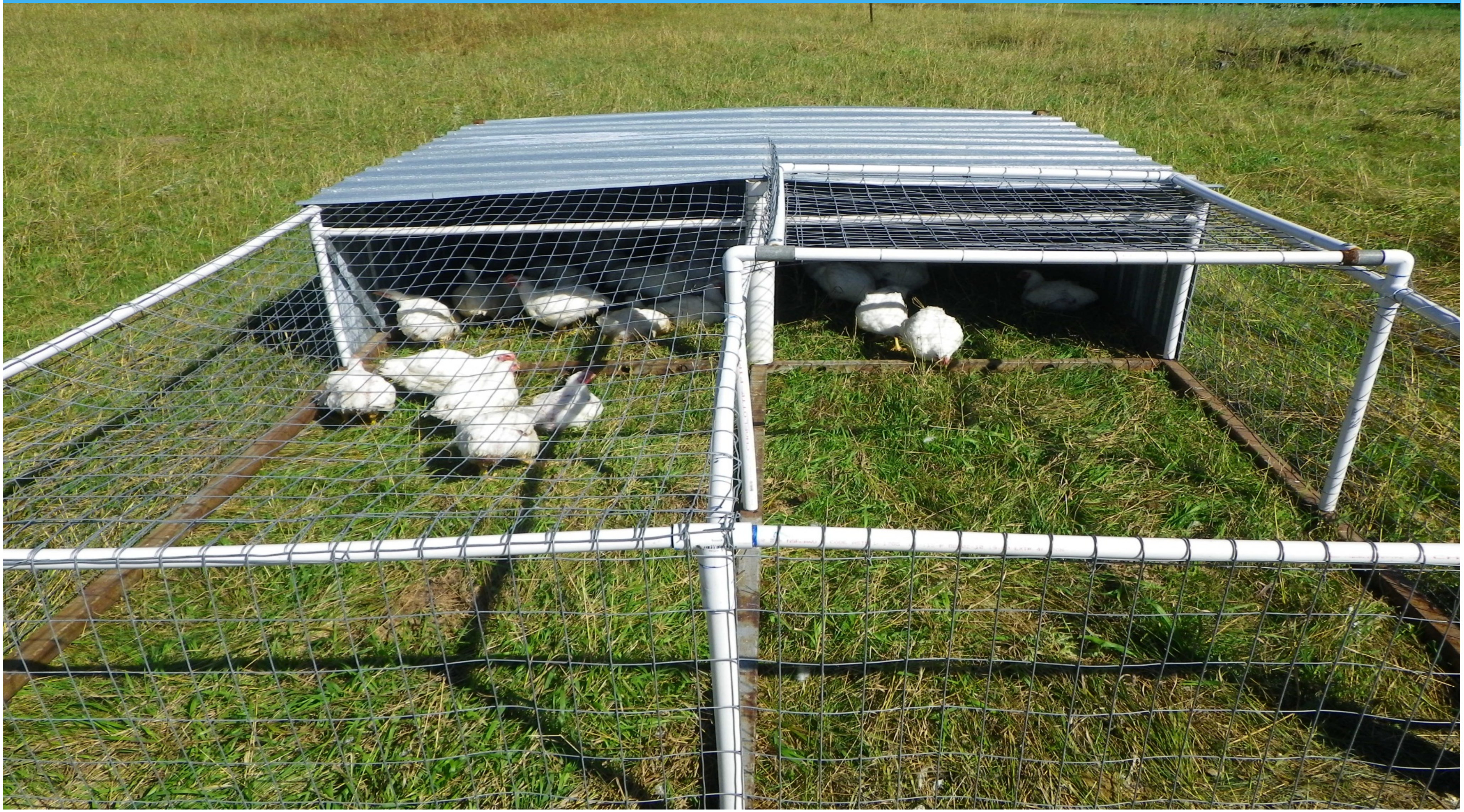
Residue buffers August heat

Noxious weeds: 20 years of no animal impact (Symptom)

Eggmobile

Layers enjoying the cover crop

Broilermobile




Sheep


Diversity attracts Diversity
Ringneck Pheasant, Sharptail Grouse, Hungarian Partridge,
Canada Geese,
Duck, Whitetail Deer, Song Bird, Raptors, Mink, Weasel,
Raccoons, Coyote, Fox and more

Share your experiences.

Help others get started

Help others get started


12 species

All Plots Harvested October 18, 2011

Study 3

190 bu/ac corn grown with zero N input at planting

Cover Crop Economics

All Data is Per Acre Except Where Noted

Nitrogen input:
60/40 blend of Super U and Ammonium Sulfate, at $0.795 / lb

190.8 bu/ac
Zero Units / N

205.6 bu/ac
60 Units / N

198.1 bu/ac
90 Units / N

196.9 bu/ac
120 Units / N

RESEARCH SPONSORED BY

COVER CROP SOLUTIONS
Home of the Tillage Radish


10.02.2011

Multiple species cover crops August 2, 2011

Plot #1

Pearl Millet -4#

Sorghum Sudan Grass-4#

Soybean-10#

Cowpea-15#

Tillage Radish-2#

Turnip- 1#

Sunflower -1#

Clover – 5#

Vetch – 6#

Plot #2

Sunn Hemp – 10#

Cowpea – 15#

Soybeans – 10#

Pearl Millet – 8#

Tillage radish – 2#

Turnip – 1#

Sunflower -1#

Ryegrass – 5#

Sweet Clover – 2#

Plot #3

Triticale – 60#

Austrian Winter Pea – 30#

Vetch – 15#

Turnip – 2#

Rape Seed – 5#

Phacelia – 5#

Plot#4

Sunn Hemp – 10#

Cowpea – 10#

Tillage Radish – 2#

Triticale – 30#

Pearl Millet – 8#

Ethiopian Cabbage – 2#

Soybeans – 15#

Buckwheat – 5#

Blend of High Carbon Species:

Pearl Millet
Sorghum Sudan Grass
Soybean
Cowpea
Tillage Radish
Turnip
Sunflower
Clover


08.22.2011


08.22.2011


09.10.2011


10.02.2011


12.22.2011


06.30.2012


What the heck did
Archuleta get me into..
Last time I am go to
North Dakota with him…
What am I going to do
with all this material?

John Pickler Planting Corn into cover crop Mix

No-drill Plants into Residue

Cotton Planted without Rye: Different farmers

United States Department of Agriculture
Natural Resources Conservation Service

USDA NRCS

Curtis Furr Cotton planted into 8 Way Rye Cover Crop Mix

[redacted]

Ray Styer from Rockingham County North Carolina has not used chemical fertilizer in 5 years

1970 Started Using Annual Rye As A Cover Crop

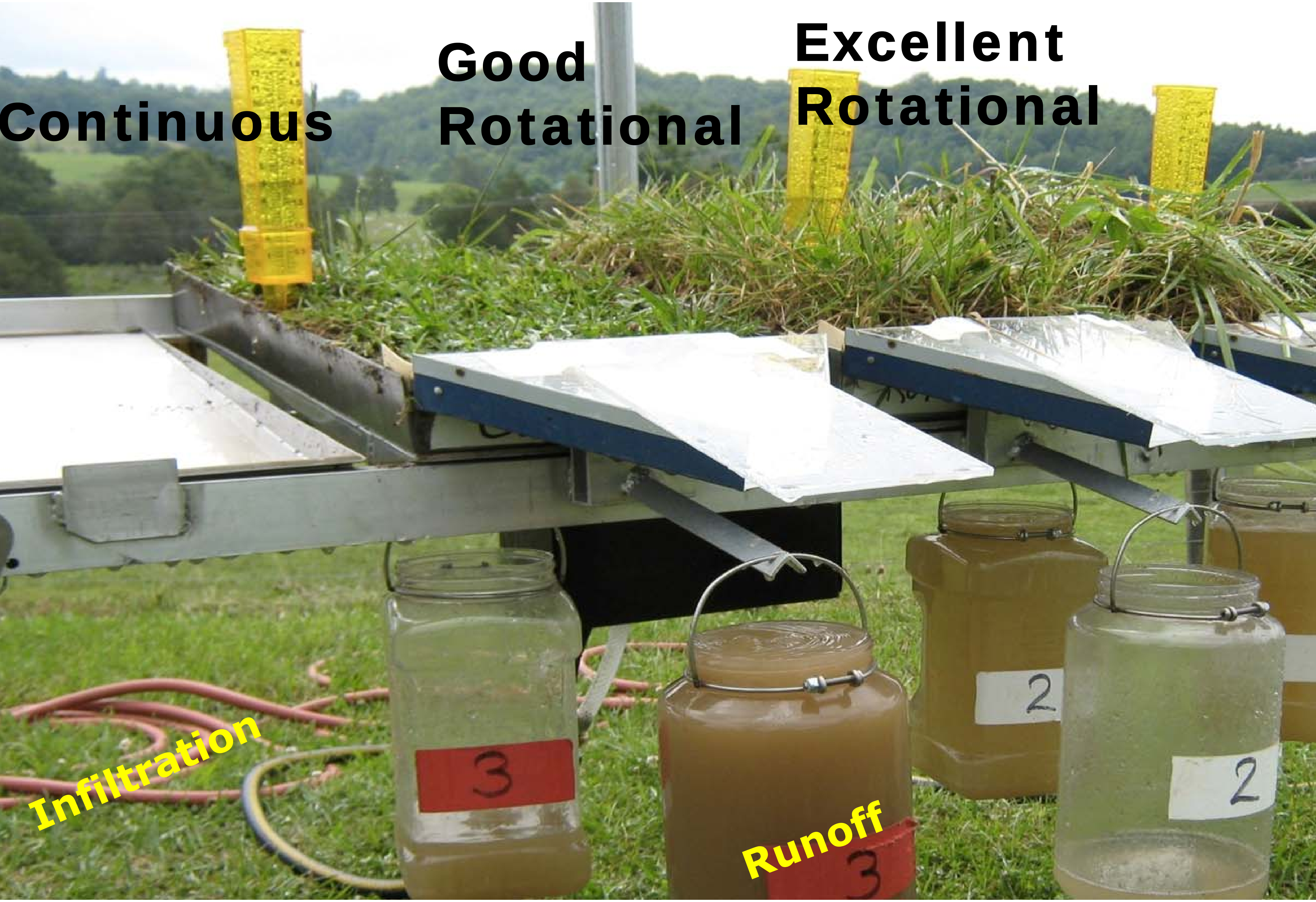

Roll down the cover crop
Spray Roundup on Cover Crop
Cover crop after: rolling and spraying
Plant Crop
How Ray Does It!

Ray Styer uses <u>cheap</u> and <u>undependable</u> government labor to roll down his cover crop

David Garcia’s Rye

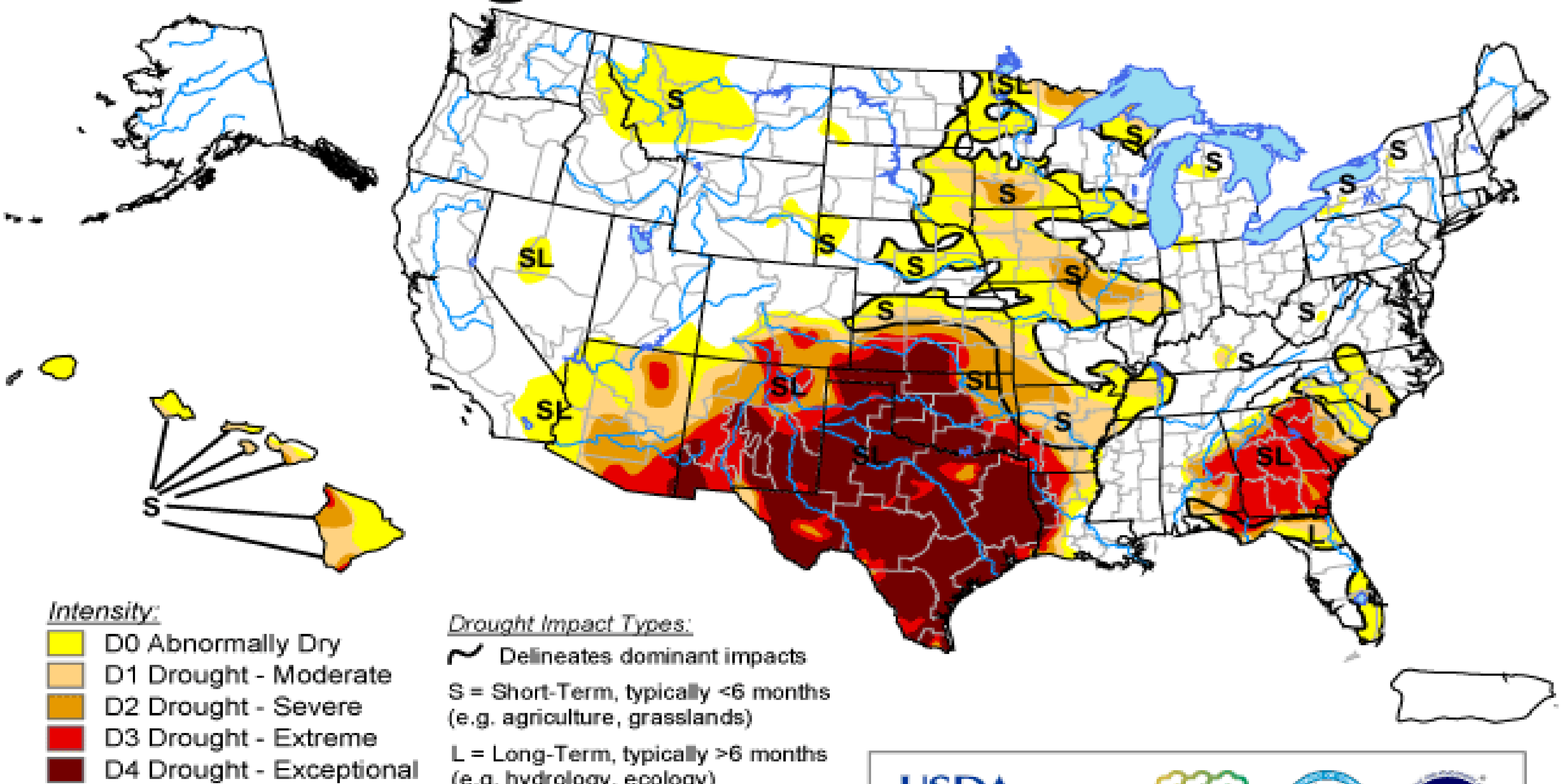
David Garcia’s Rye

Conventional Beans


Continuous
Good
Rotational
Excellent
Rotational
Infiltration
Runoff
3
3
2
2

U.S. Drought Monitor

October 4, 2011
Valid 8 a.m. EDT



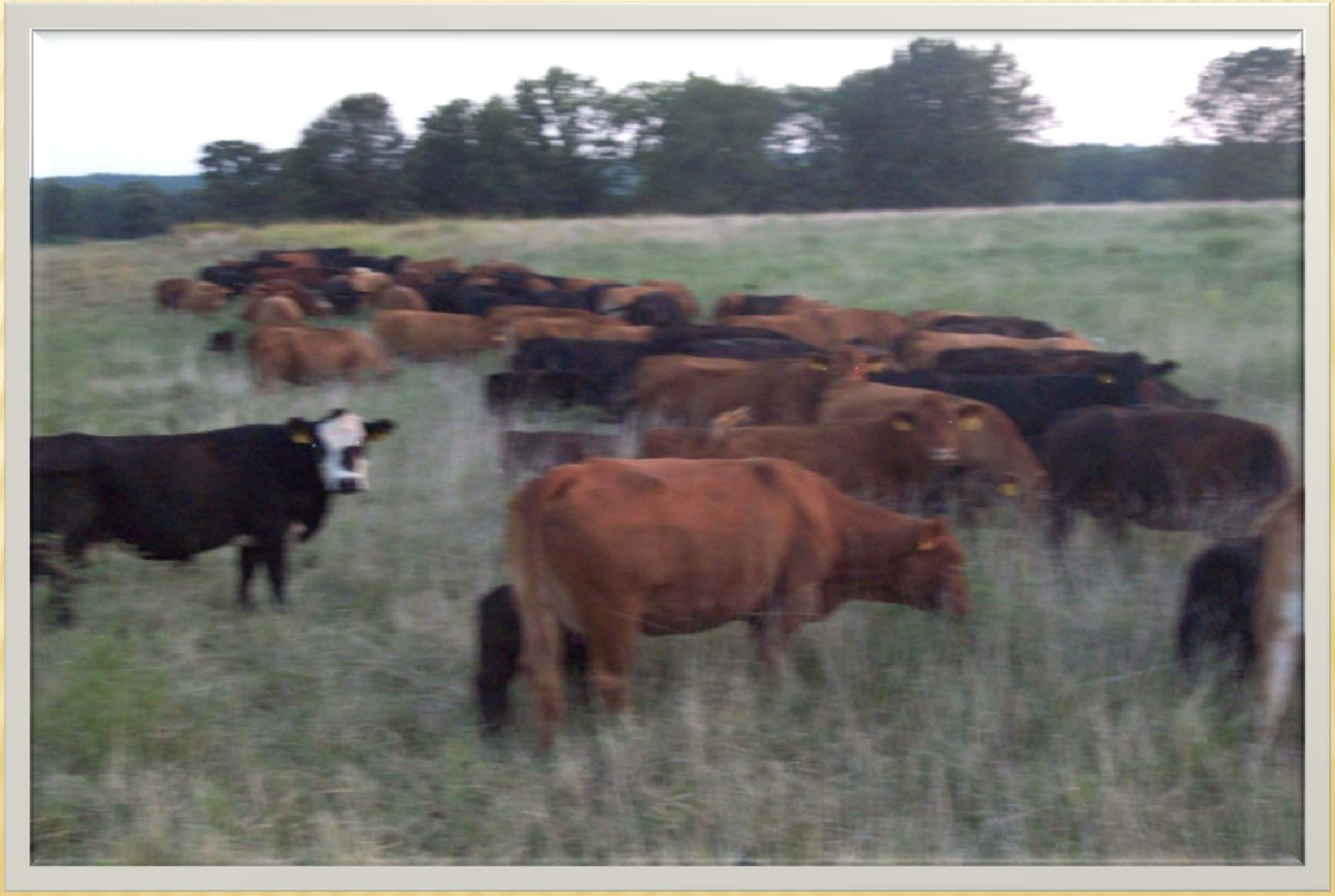
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://droughtmonitor.unl.edu/

Released Thursday, October 6, 2011

Author: Rich Tinker, CPC/NCEP/NWS/NOAA

May 5, 2008- Started Moving cows 2 times per day



Weed and Brush Control

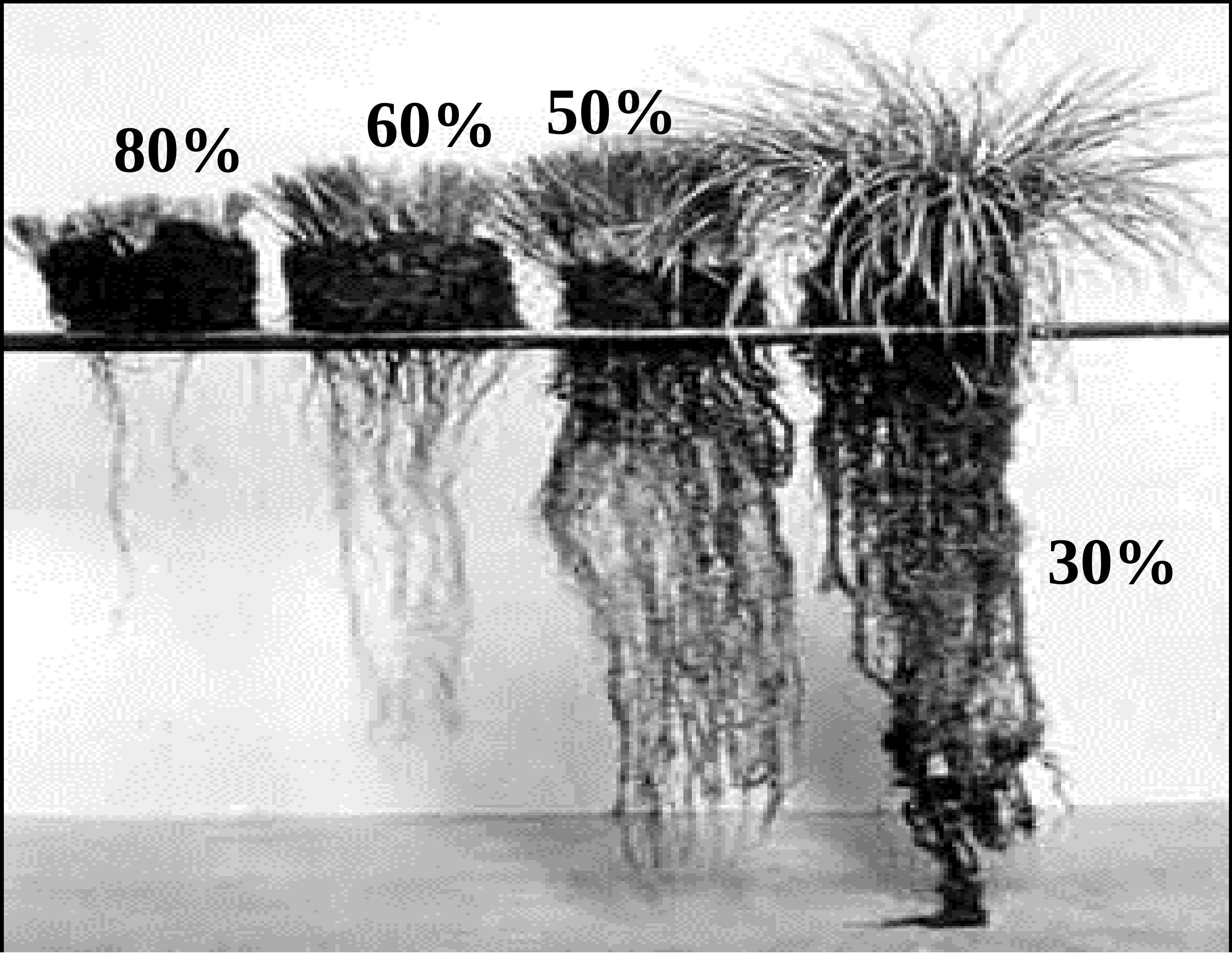
Smooth Sumac in St. Clair County

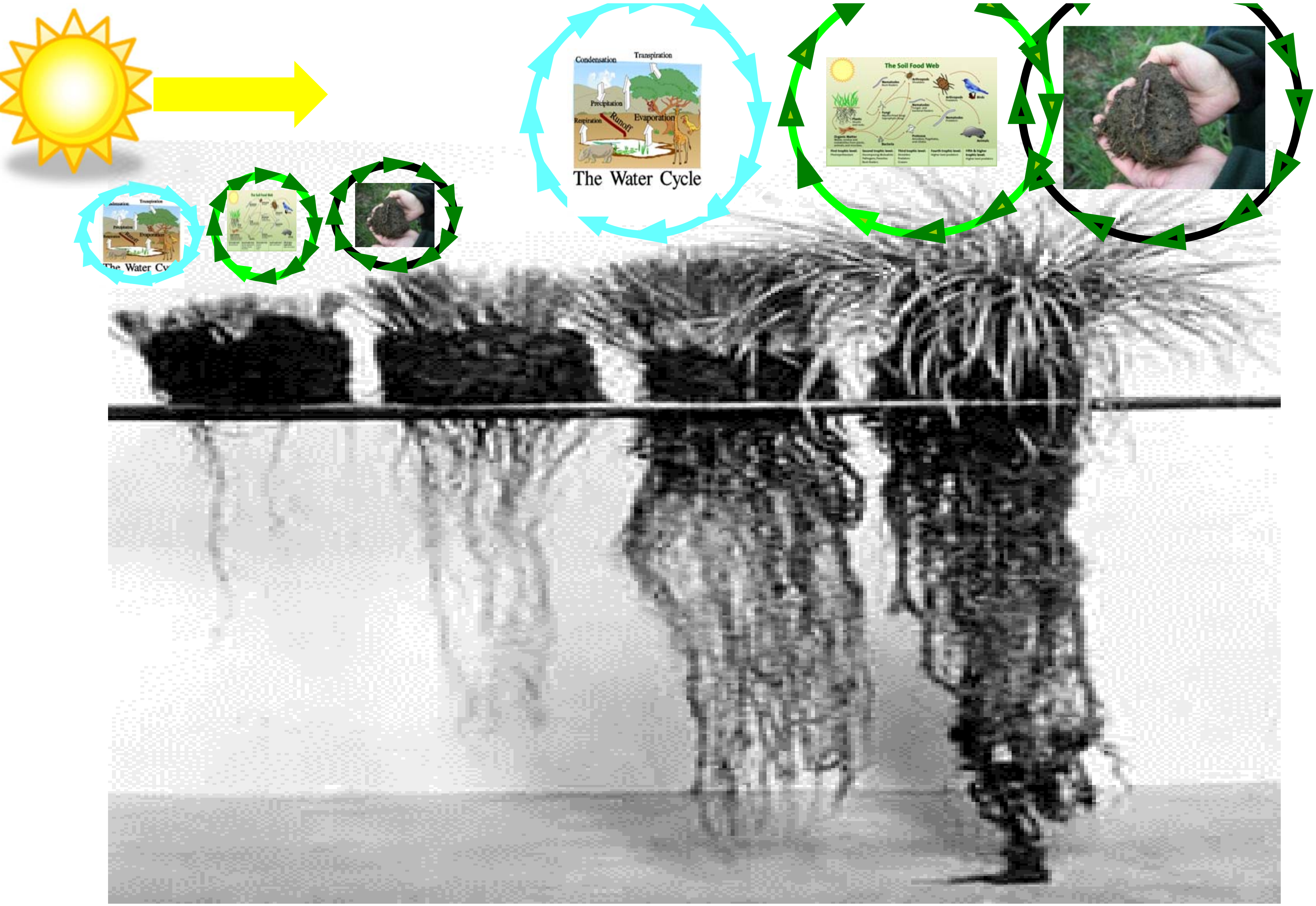
Neighbor’s Pastures **2011 Drought** Mark Brownlee’s Pastures

February 2010

Strip Grazed Hayfield – Fall Re-Growth

Overgrazing: another source of disturbance




Condensation
Transpiration
Precipitation
Runoff
Respiration
Evaporation
The Water Cycle
The Soil Food Web

100 120
140
80
160
60
180
200
40
20
0 220
°F


TAYLOR
100 120
80
140
60
160
40
180
20
200
0 220
°F
NSF-C2
TCA Juarez
5989

Texas: Multi-Species Mix in Bermuda Stand

Results

Wal-Mart to Buy More Local Produce

As Wal-Mart is doing with consumer products, it will begin asking agricultural producers questions about water, fertilizer and chemical use. The eventual goal is to include that information in a sustainability index.

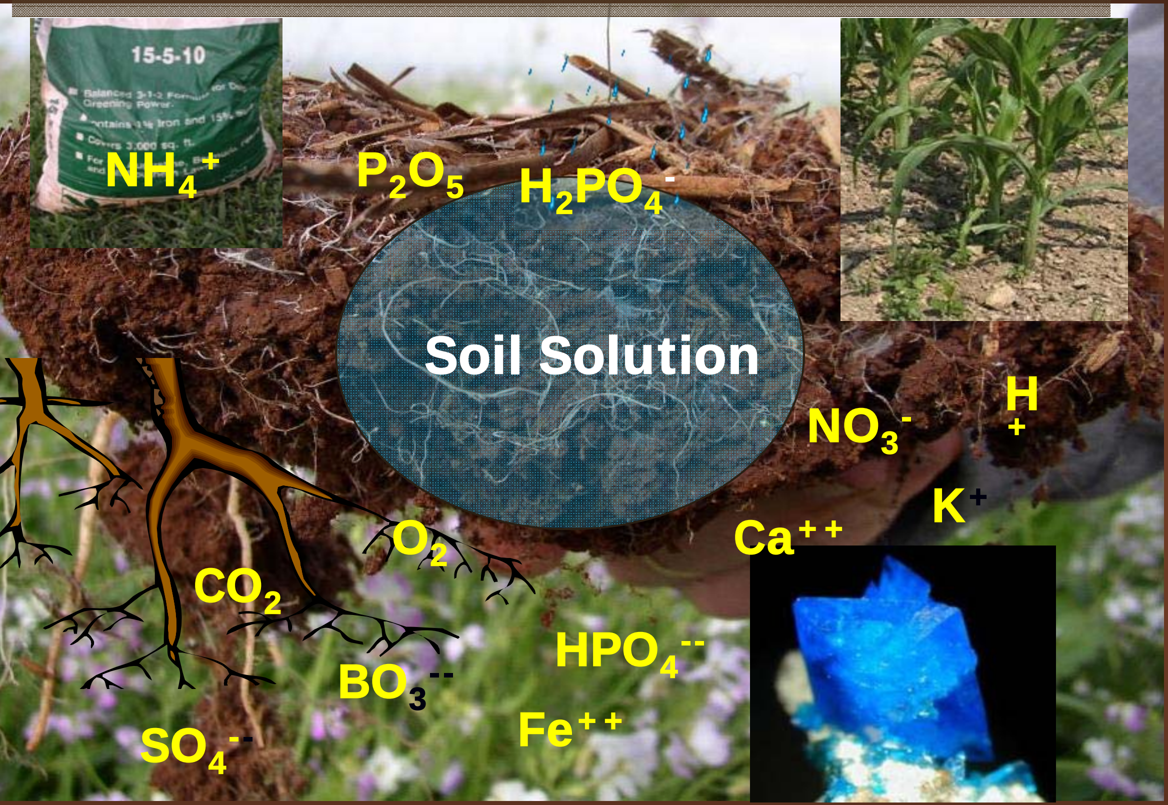
Customers would see sustainability ratings, so they could decide whether to choose one avocado over another based on how efficiently it was grown and shipped. Wal-Mart could use index information when it decided from whom to buy.

Energy Information Administration (EIA) (2008) Report : Estimated world oil consumption for the next 21 years (2009 to 2030)

Country/Region	Estimated Percent Increase
United States	6.3%
China	71.4%
India	58.8%
Middle East	42.0%
Africa	33.6%
Central and South America	29.4%
Total World	**25.2%**

China and India combined will increase there oil consumption by 65.1% in next 21 years

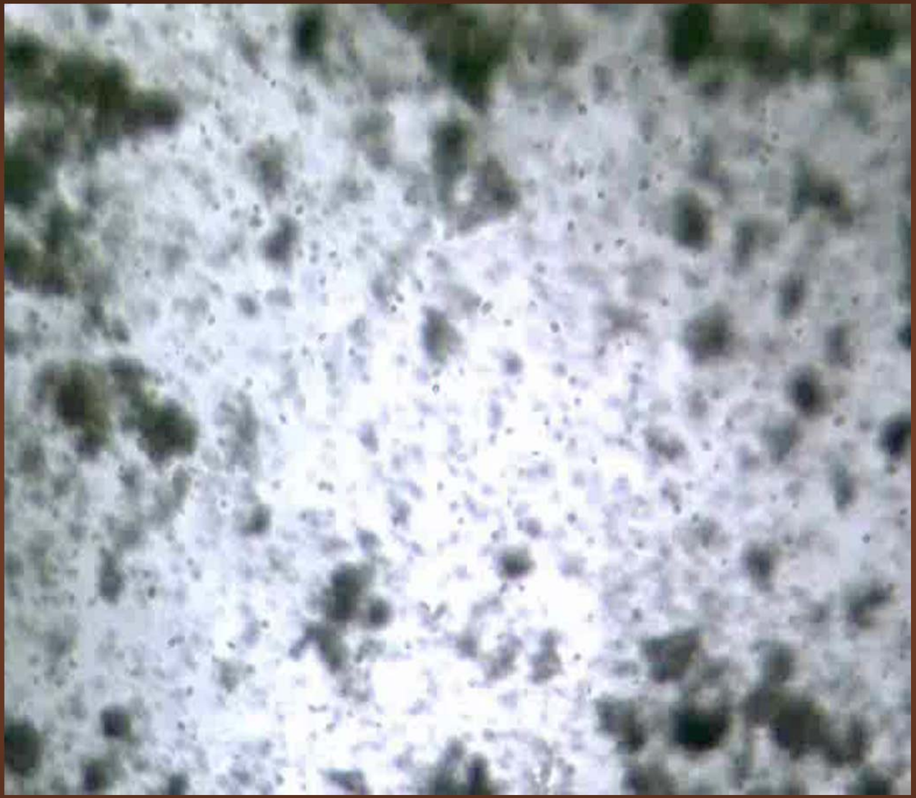
Inorganic Based Soluble State



- 40 to 60 % N and P Loss Cassmen 2002
- Bare fallows 4-8 months
- Decoupled C,N,P cycle

- Dr.Drinkwater, Dr. Swift

Ecologically Based



- Organic-mineral pools
- Microbially plant mediated process
- Strategic use of variable nutrients sources

Elephant in the room: In most no-till systems we use too much fertilizer!

Tart Albrechtisms

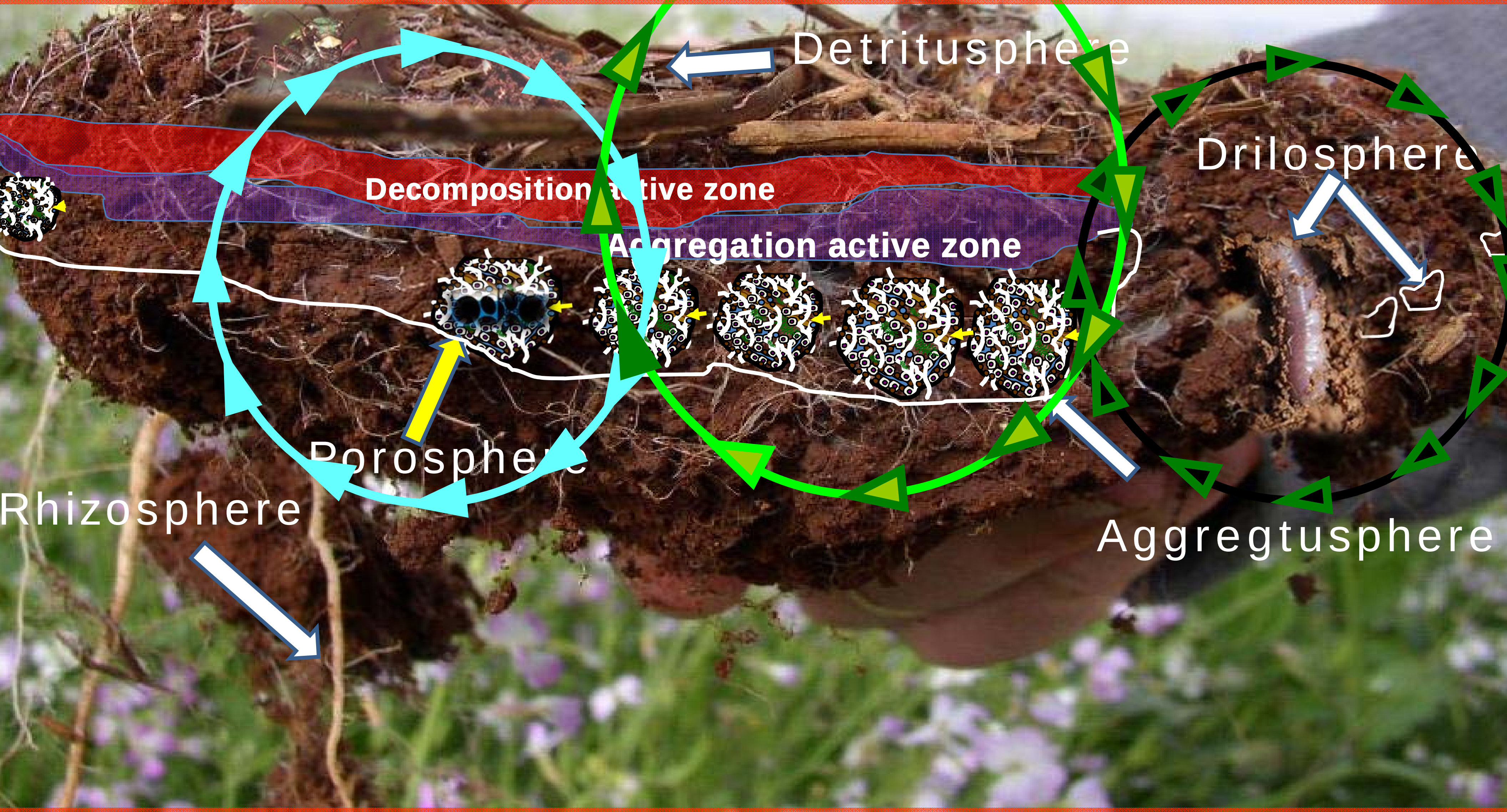
- Fertilizer placement is the art of putting the salts in the ground so the plant roots can dodge it

- Don't Lime to fight soil acidity. Use lime to feed the plant.

- The excessive use of the chemical salts in fertilizers is upsetting plant nutrition.

William A. Albrecht Ph.D

A hierarchical approach to evaluating the significance of soil biodiversity to biogeochemical cycling



M.H. Beare, D.C. Coleman, D.A. Crossley Jr., P.F. Hendrix and E.P. Odum (1995)

Soil Health

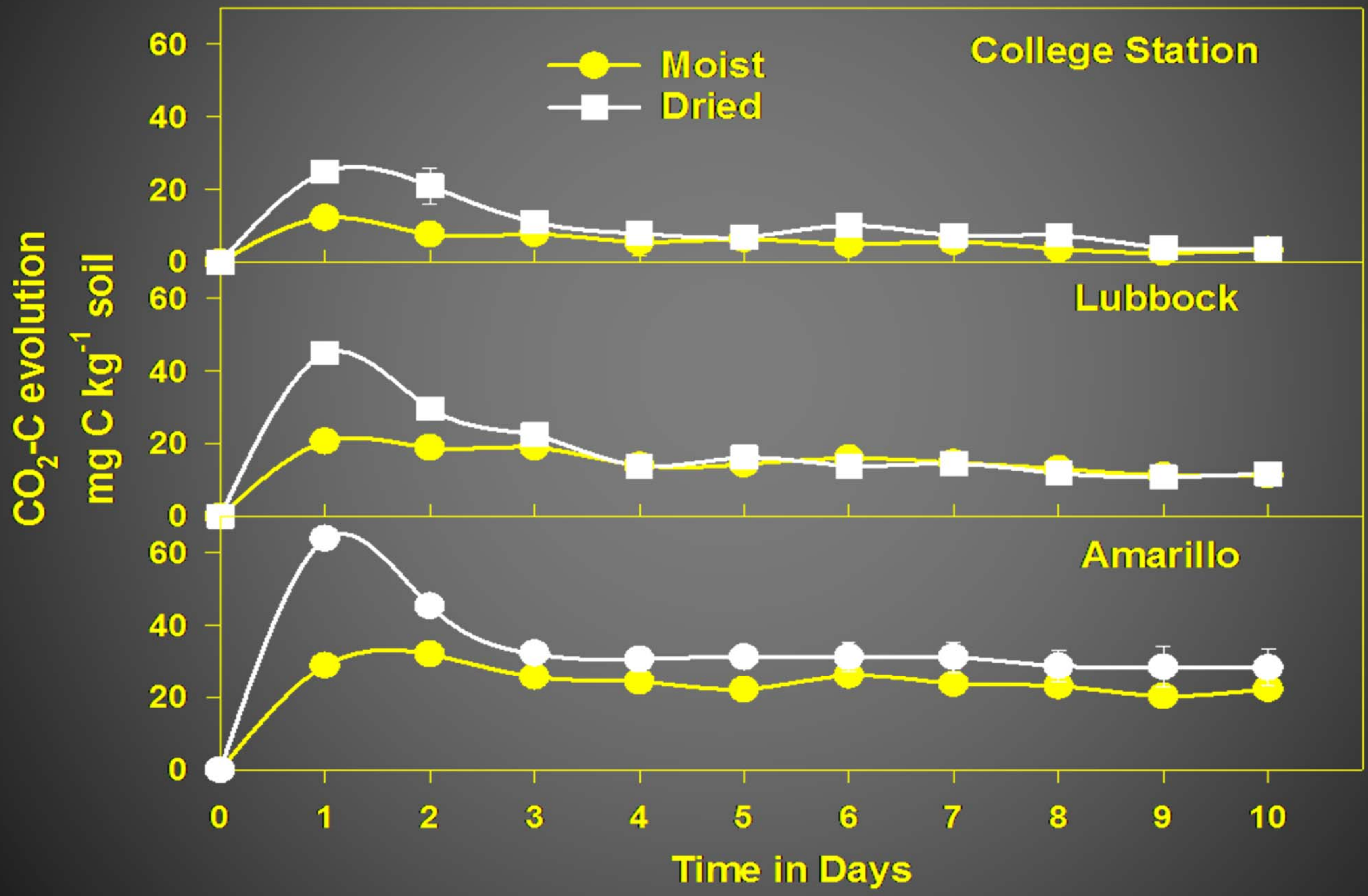
Dr. Rick Haney, USDA-ARS, Temple, TX: Ray Archuleta USDA-NRCS

Soil Health Tool

Much like a doctor assesses your health, the SHT is designed to assess soil health by asking our soil the following questions:

- How are you doing?
- Are you in balance?
- What can we do to help?

Research History - 1994

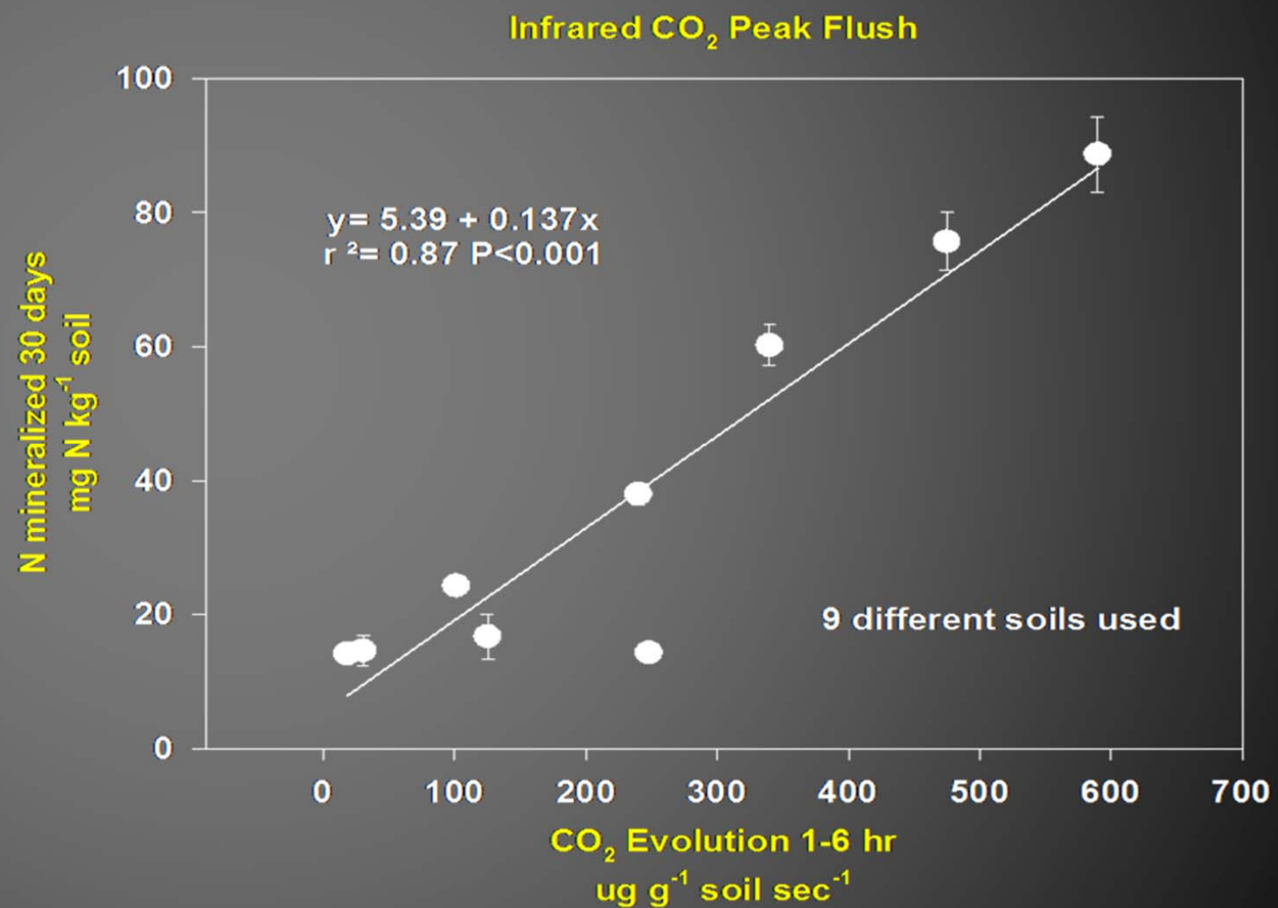


Research History 1995

- 1995: Haney's first attempt at publishing using a technique involving drying and rewetting soil and recording the flush of CO_2 in 1 day to estimate N mineralization is rejected (finally published in 2000).

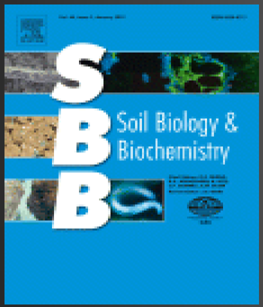
- It's deemed "too simplistic" by reviewers in spite of the data presented.

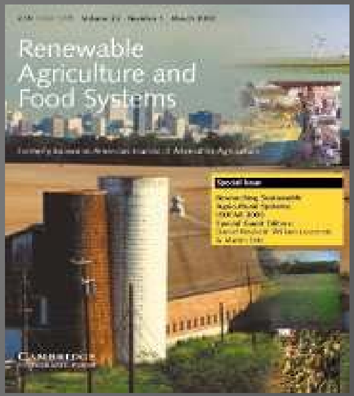
- Haney becomes emotionally disturbed.

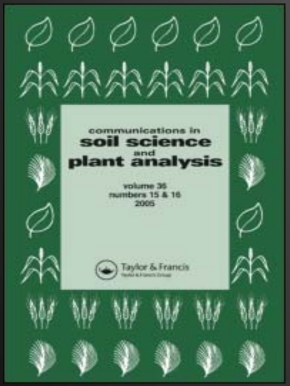


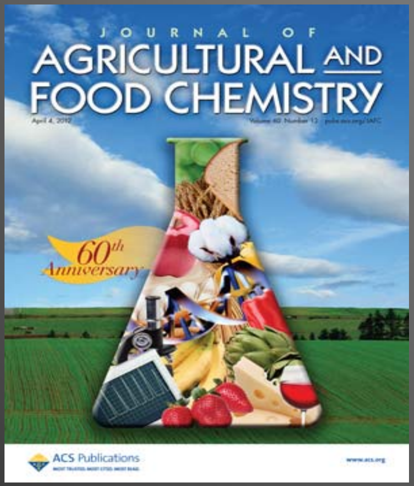
2000-2011

- There are at least 17 peer reviewed journal articles by Haney and others to support the science behind these soil analysis tests.







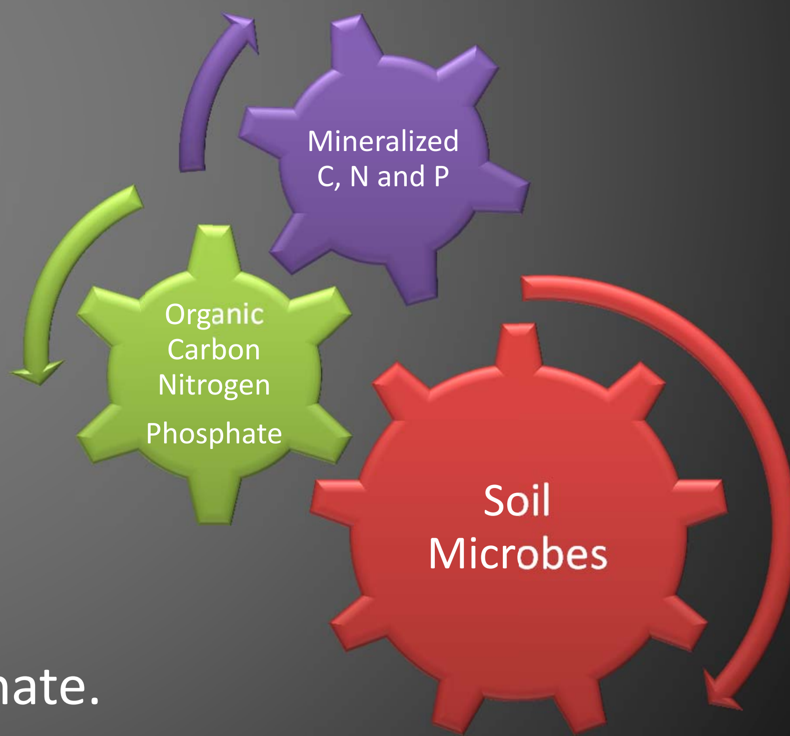


Soil Health Methods

The SHT relies on information gleaned from newly developed soil-testing methods geared towards soil microbial activity and the readily available substrate that they act upon. In other words, we assess the soil as a doctor might assess a living being, using many measurements of health viewed collectively to attain an overall picture of soil vigor.

The measurements include:

- water extractable organic C (WEOC)
- water extractable nitrogen (WEN)
- water extractable organic N (WEON)
- C: N ratio of the two
- Solvita microbial activity test
- inorganic N and P
- H3A extractable aluminum, iron, and phosphate.

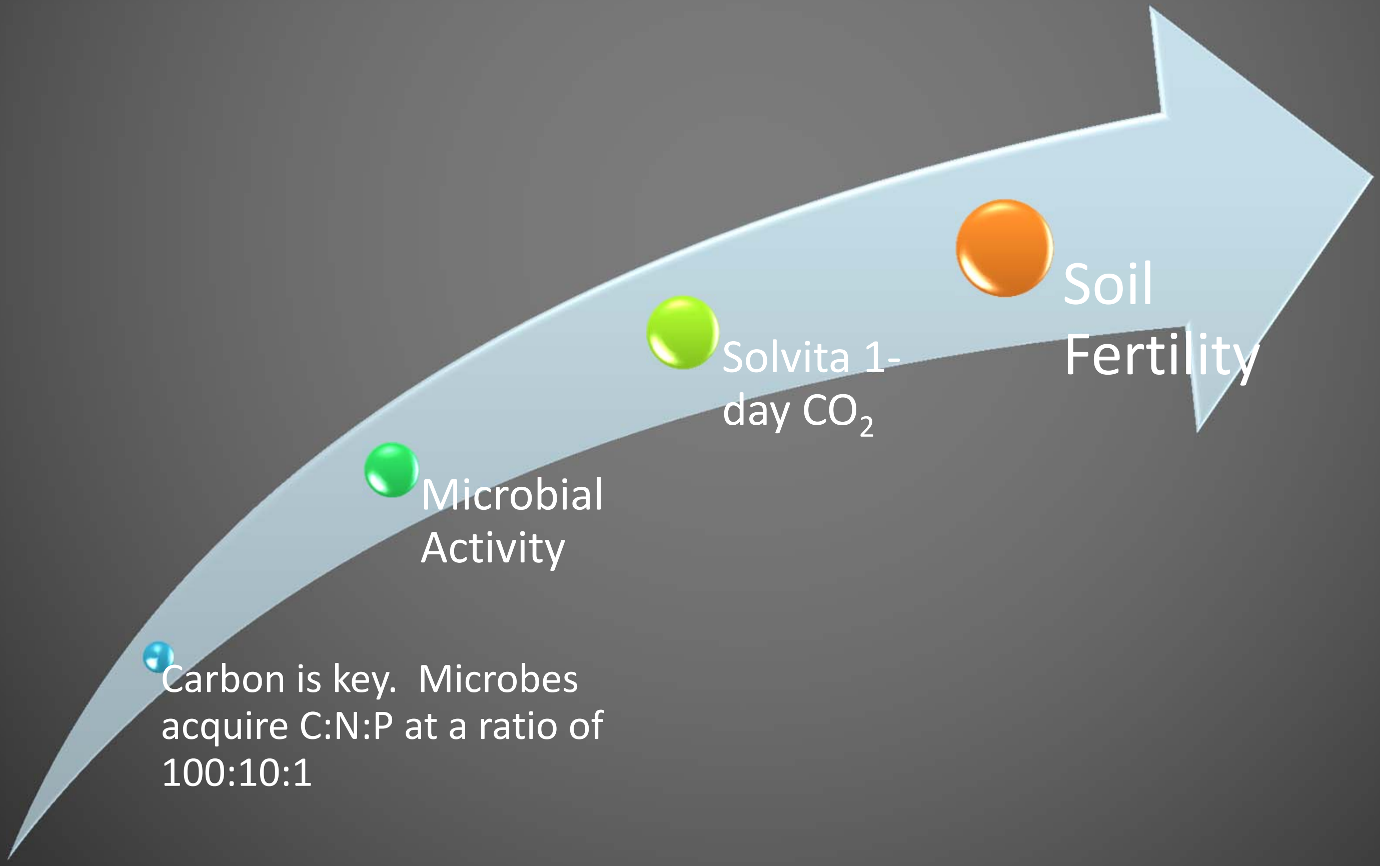


Soil Health


Organic C
% MAC
Organic N
% Organic N
Organic C:N
Organic N:P
Solvita 1-day CO_2
Soil Health Calculation

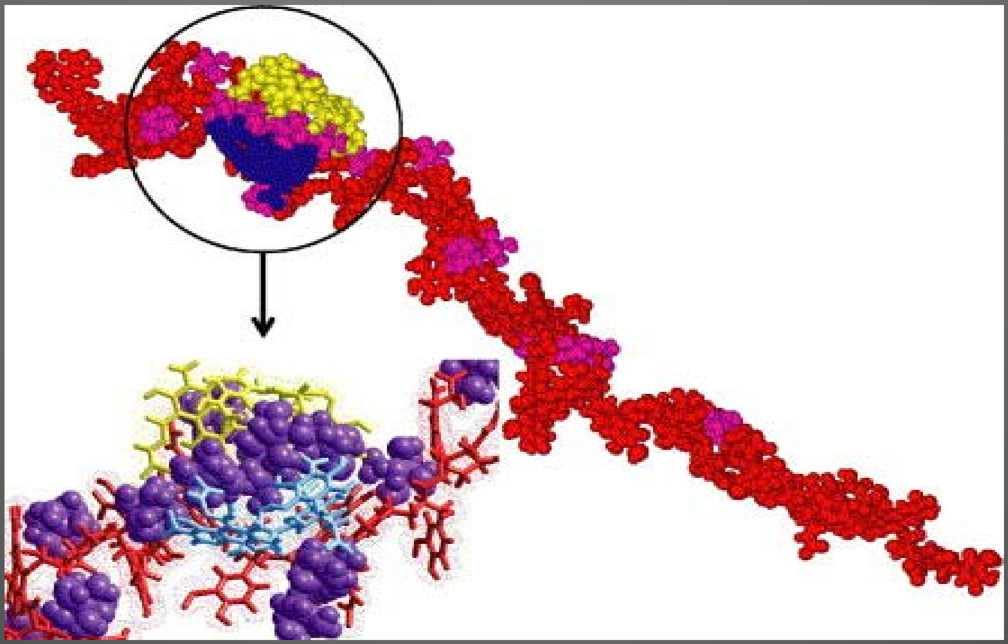
Soil Health

- Solvita 1-day CO_2 - This test is one of the most important numbers in soil testing. This number in ppm is the amount of CO_2-C released in 24 hr. from soil microbes after your soil has been dried and rewetted (a natural field event). This is a measure of the microbial activity in the soil and is highly related to the fertility of your soil.



Soil Health

- Organic C – This number in ppm is the amount of organic C extracted from your soil with water. This pool of carbon is roughly 80 times smaller than the total soil organic C pool (% Organic Matter) and reflects the energy source that is driving your soil microbes.



Complexity of Organic Matter

Soil Health

Sample ID	Solvita 1-day CO2-C	Organic C	% MAC	Organic N	% Organic N	Organic C:N	Organic N:P	Soil Health Calculation	Cover crop mix
Casper 7 NE4W	13.60	135.70	10.02	9.03	24.73	15.03	0.86	16.49	70% Legume 30% Grass
Casper 8 NW4 Corn	8.20	101.61	8.07	6.36	54.55	15.98	0.53	27.55	70% Legume 30% Grass
Casper 11 NR NW4	42.10	194.16	21.68	17.00	69.47	11.42	1.07	131.89	50% Legume 50% Grass
Casper 5 Dishman CRP2 Corn	19.60	149.48	13.11	10.64	56.75	14.05	5.29	52.96	40% Legume 60% Grass
Casper 4 Dishman CRP Parker	35.10	183.17	19.16	13.87	52.98	13.21	2.16	76.87	40% Legume 60% Grass
Casper 6 Dishman South	27.70	189.94	14.58	15.88	65.51	11.96	21.17	79.88	40% Legume 60% Grass
Capser 1 McEndree NR 1	26.40	136.63	19.32	10.60	53.21	12.89	1.16	79.77	40% Legume 60% Grass
Casper 3 Pipe Springs Crop	21.90	158.48	13.82	12.89	56.19	12.29	1.80	63.15	40% Legume 60% Grass
Casper 10 Ratlif NR-31	46.30	166.72	27.77	11.43	50.37	14.59	1.04	95.91	40% Legume 60% Grass
Casper 12 Ratlif sec 5	71.50	484.64	14.75	31.33	15.31	15.47	2.38	14.60	100% Grass
Casper 2 Reynolds go back	22.30	112.78	19.77	8.89	72.75	12.69	3.16	113.39	50% Legume 50% Grass
Casper 9 SAR Wheat SE4	44.60	197.87	22.54	17.22	50.22	11.49	1.24	98.51	20% Legume 80% Grass

Questions?

Dr. Rick Haney
Soil Scientist
USDA – ARS
Grassland, Soil & Water Research Laboratory
808 E. Blackland Road
Temple, TX 76502
(254) 770-6503
rick.haney@ars.usda.gov

Soil Foodweb Analysis

Report prepared for:
Burleigh Co. Soil Conservation
Vicki Bailey
1511 E. Interstate Avenue
Bismarck, ND 58503-0560 US
(701) 250-4363
vicki.bailey@nd.nacdnet.net

Report Sent: 07/29/2005
Sample#: 01-100980
Unique ID:
Plant: Wheat
Invoice Number: 8357
Sample Received: 07/14/2005

For interpretation of this report please contact:
Local Advisor: or regional lab
Soil Foodweb, Inc
info@soilfoodweb.com
(541) 752-5066
Consulting fees may apply

Organism Biomass Data		Dry Weight	Active Bacterial (µg/g)	Total Bacterial (µg/g)	Active Fungal (µg/g)	Total Fungal (µg/g)	Hyphal Diameter (µm)
Results		0.850	44.2	2243	**7.02**	205	2.5
Comments		In Good Range	Excellent	Excellent	Low	Good	
Expected Range	Low	0.45	15	100	15	100	
	High	0.85	25	300	25	300	

		Protozoa Numbers/g			Total Nematodes #/g	Percent Mycorrhizal Colonization	
		Flagellates	Amoebae	Ciliates		ENDO	ECTO
Results		**5020**	**2520**	**32**	**1.98**	**2%**	**0%**
Comments		Low	Low	Low	Low	Low	Low
Expected Range	Low	10000	10000	50	20	40%	40%
	High			100	30	80%	80%

Organism Biomass Ratios		Total Fungal to Total Bacterial	Active to Total Fungal	Active to Total Bacterial	Active Fungal to Active Bacterial	Plant Available N Supply
Results		**0.09**	**0.03**	**0.02**	**0.16**	25-50
Comments		Low	Low	Low	Low	
Expected Range	Low	0.8	0.25	0.25	0.75	
	High	1.5	0.95	0.95	1.5	

Nematodes per Gram of Soil
Identification to genus

Bacterial Feeders		
Acrobeles		0.13
Acrobeloides		0.04
Cephalobus		0.18
Eucephalobus		0.04
Panagrolaimus		0.04
Rhabditidae		0.27
Fungal Feeders		
Eudorylaimus		0.04
Mesodorylaimus		0.13
Microdorylaimus		0.04
Fungal/Root Feeders		
Aphelenchoides	Foliar nematode	0.04
Aphelenchus		0.27
Ditylenchus	Stem & Bulb nematode	0.18
Filenchus		0.04
Root Feeders		
Helicotylenchus	Spiral nematode	0.04
Meloidogyne	Root-Knot nematode	0.09
Paratylenchus	Pin nematode	0.09

Long Term No-Till

Soil
Foodweb Analysis

Report prepared for:
Burleigh Co. Soil Conservation
Vicki Bailey
1511 E. Interstate Avenue
Bismarck, ND 58503-0560 US
(701) 250-4363
vicki.bailey@nd.nacdnet.net

Report Sent: 07/29/2005
Sample#: 01-100984
Unique ID: GB1
Plant: Corn
Invoice Number: 8357
Sample Received: 07/14/2005

For interpretation of this report please contact:
Local Advisor: or regional lab
Soil Foodweb, Inc
info@soilfoodweb.com
(541) 752-5066
Consulting fees may apply

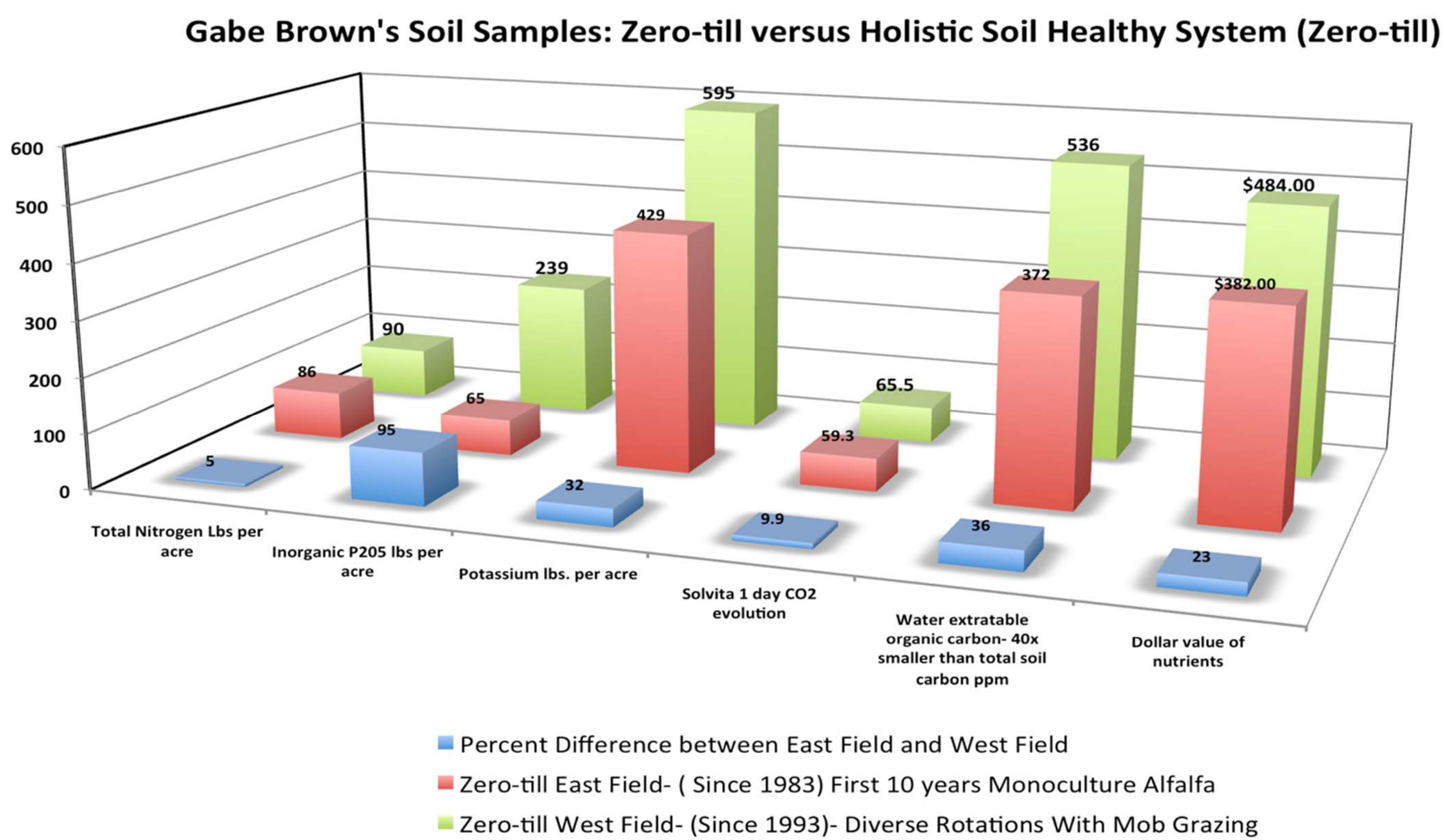
Organism Biomass Data		Dry Weight	Active Bacterial (µg/g)	Total Bacterial (µg/g)	Active Fungal (µg/g)	Total Fungal (µg/g)	Hyphal Diameter (µm)
Results		0.850	46.3	405	5.24	274	2.5
Comments		To Wet	Excellent	Excellent	Low	Good	
Expected Range	Low	0.45	15	100	15	100	
	High	0.85	25	300	25	300	

		Protozoa Numbers/g			Total Nematodes #/g	Percent Mycorrhizal Colonization	
		Flagellates	Amoebae	Ciliates		ENDO	ECTO
Results		178500	9736	331	4.45	31%	0%
Comments		High	Low	High	Low	Low	Low
Expected Range	Low	10000	10000	50	20	40%	40%
	High			100	30	80%	80%

Organism Biomass Ratios		Total Fungal to Total Bacterial	Active to Total Fungal	Active to Total Bacterial	Active Fungal to Active Bacterial	Plant Available N Supply
Results		0.68	0.02	0.11	0.11	200+
Comments		Low	Low	Low	Low	
Expected Range	Low	0.8	0.25	0.25	0.75	
	High	1.5	0.95	0.95	1.5	

Nematodes per Gram of Soil identification to genus		
Bacterial Feeders		
Acrobeles		0.81
Acrobeloides		0.18
Cephalobus		0.45
Cervidellus		0.18
Rhabditidae		0.45
Fungal Feeders		
Eudorylaimus		0.09
Fungal/Root Feeders		
Aphelenchoides	Foliar nematode	0.54
Aphelenchus		0.45
Ditylenchus	Stem & Bulb nematode	0.54
Filenchus		0.09

Tale of Two Fields



Dr. Rick Hanney ARS, USDA

2011 Corn

* Yield 159 bushels per acre
* Price $6.48
* Gross Income $1030.32 per acre

* Expenses:
* Seed $64.05
* Herbicide 12.50
* Crop ins. 17.94
* Planting 18.00
* Combining 22.00
* Trucking 24.40
* Storage 15.90

* Total $174.79 (excluding land cost)

* Return to labor, management and land cost $855.53 per acre

* (This does not include income
* from Direct payments, CSP and
* winter grazing.)

* Cost per bushel of corn **$1.10** (excluding land cost)

* Return to labor, management and land per bushel $5.38

Nitrogen Rate

Represents no cover @ nitrogen rate

Year	185#	100#	50#
1983	115	113	114
1985	135	132	136
1988	141	141	139
1991 *	148	132	130
1994	151	152	151
1995	125	115	100
1996	155	158	157
2000	160	151	153
2002	163	160	159
2004	175	178	177
2005	168	170	172
2006	164	163	165
2007	214	210	219
2008	146	170	174
2009	186	189	190
2010	196	226	230

Cost of Tillage Operations/Acre

• Chisel Plow	$14/A
• Disk Tandem	$13/A
• Field Cultivate	$11/A
• Plow	$17/A
• Soil Finishing Tools	$11/A
• Subsoil	$18/A

Ohio Farm Custom Rates 2010
Barry Ward, OSU Economist

Value of Soil Organic Matter

Assumptions: 2,000,000 pounds soil in top 6 inches
1% organic matter = 20,000#

Nutrients:

Nitrogen:	1000# * $0.75/#N	=	$750
Phosphorous:	100# * $0.50/#P	=	$ 50
Potassium:	100# * $0.40/#K	=	$ 40
Sulfur:	100# * $0.50/#S	=	$ 50
Carbon:	10,000# or 5 ton * $2/Ton	=	$ 10

Value of 1% SOM Nutrients/Acre
= $900

Jim Kinsella/Terry Taylor (2006) Jim Hoorman (2011)

No-till Nutrient Mgmt:

1) University Soil samples (% OM,P, K. CEC)
2) Soil Food web test
3) Check strip
4) Use SPAD Meter
5) Tissue test
6) HACH Colorimeter- test active carbon.

Know in inputs and outputs!

"Grain for Man and Residue for the land"!

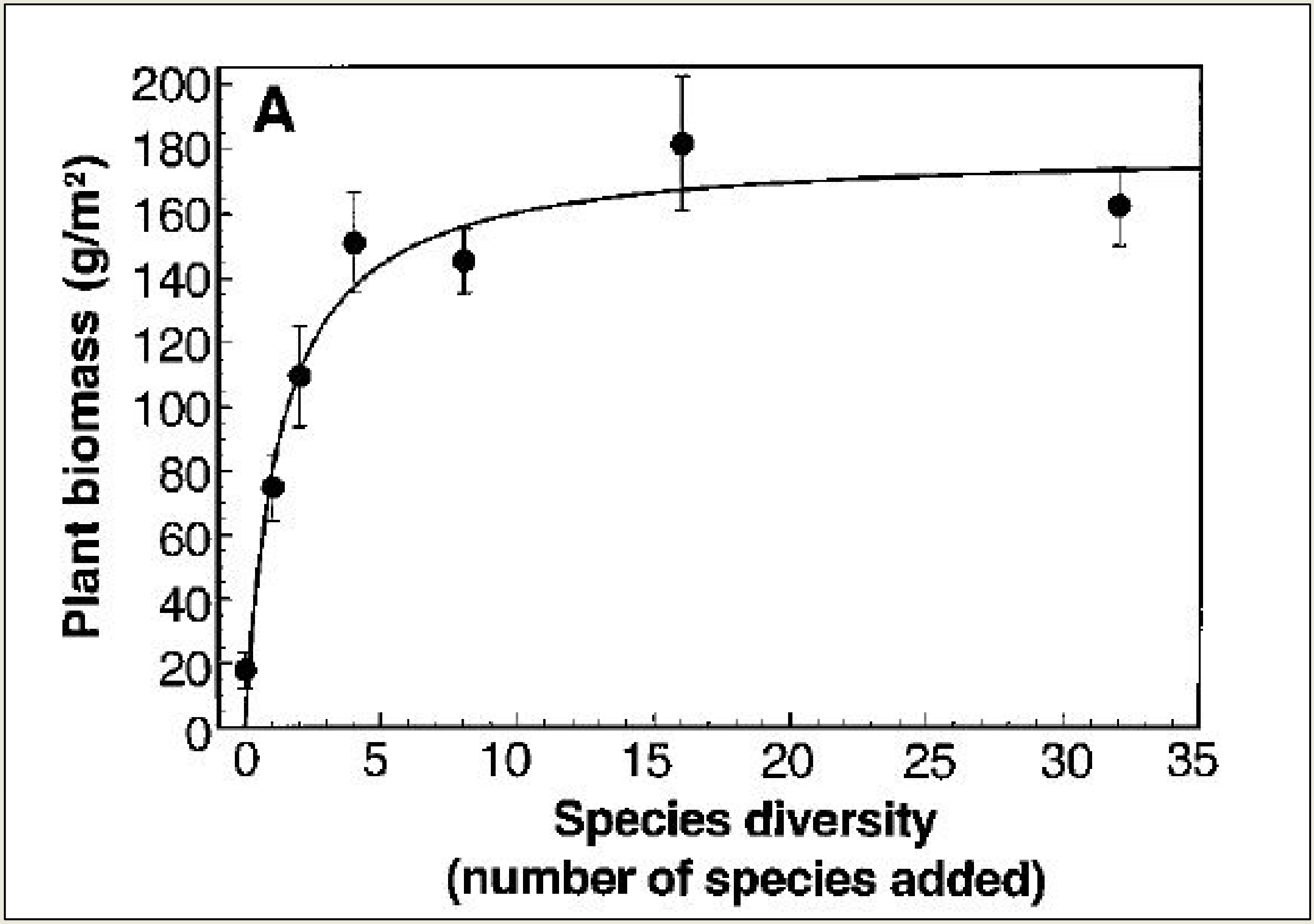
Carlos Corvetto!

Mimic Native Range

The Science of Conservation, We Deliver!

NRCS East NTSC

The Influence of Functional Diversity and Composition on Ecosystem Processes



David Tilman,* Johannes Knops, David Wedin, Peter Reich,
Mark Ritchie, Evan Siemann

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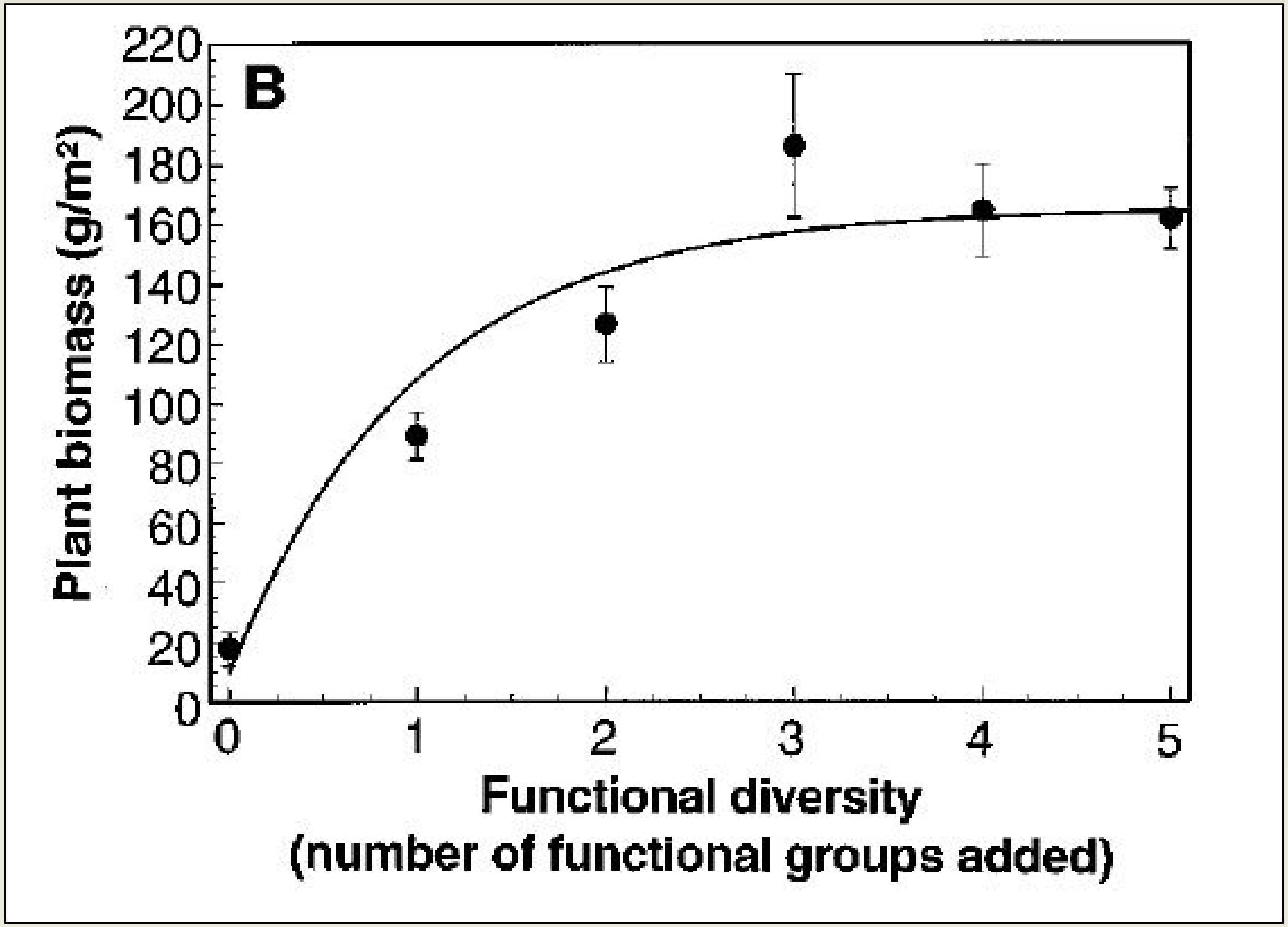

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Caution!

- Never make implementation of No-Till a goal.
- If your goal is improving soil quality; then no-tillage can be an excellent tool.
- Tools do not build houses, skilled workers do. Without a goal of building a house, tools and workers are wasted.
- You must become the skilled worker with a clear goal in mind; only then do the tools become of lasting value.

Managing for microbial habitat in the soil

- **Less Disturbance** of the soil.
- **More diversity** in what is grown in the soil.
- **Living roots** in the soil as much as possible.
- **Keep the soil covered** with crops and their residues.

- These are the 'keys to the kingdom' of improving soil quality and sustainable agriculture because they focus on soil biology and soil ecology; what really runs the soil and all that it does.

No-Till; a Different System – a Different Soil

What things change when you stop tilling the soil?

- Soil pores remain continuous
- Soil aggregates form and are not destroyed
- Soil Food Web increases and diversifies
- Weed seeds are not planted
- Water is captured and stored
- Bulk density increases slightly; then stabilizes
- Soil fungi and earthworms increase

Residue Management

- No-till begins at harvest – residue spread
  - Uniformity is the key
  - Uniform weed germination
  - Uniform nutrient cycling
  - Uniform crop establishment
  - Uniform crop development
- Keep the soil covered at all times
  - Crop residues
  - Cover Crop
  - Next Crop in the rotation
- Residue is habitat for microorganisms

Crop Rotation Diversity

1. What are your resource concerns:
   - Stop erosion
   - Build Organic Matter
   - Take up excess nutrients
   - Resilient against drought
   - Feed animals

- Balance your carbon/nitrogen ratio

Crop Rotation Diversity

2 . Make sure your rotation covers the soil with a diverse root 24/7

3. Plant the opposite crop type for your cover crop rotation

Warm Season Grass (Corn)

Warm Season Broadleaf (Soybean)

Cool Season Grass (Rye)

Cool Season Broadleaf (clover)

Crop Rotation Diversity

4. At least a two year break between crop types.
5. If you get a 4 to 6 weeks of growth on your cover crop.... you will get your money because of the “rotation” effect!

Soil Health
Planning Principles

- Manage more by Disturbing Soil Less
- Diversify with Crop Diversity
- Grow Living Roots Throughout the year
- Keep the Soil Covered as Much as Possible

The Science of Conservation, We Deliver!

NRCS East NTSC

Soil Health Conference: Farming like Nature: “The Supreme Farmer”!

"We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect."
- Aldo Leopold

We decided to wean our calves on a Cover Crop Combination.

Working To Improve:

Herd Health *– Healthier Calves*

Soil Health *– Adding Armor and Diversity*

Wildlife *– Providing Food and Habitat*

Next Years Crop *– Reducing Fertilizer in 2011*


Mike and Becky Small- Small
Angus Ranch: Brassicas
October 1, 2010
BURLEIGH COUNTY
NORTH DAKOTA

Healthy Profit$ From Healthy Soil$