



BEAM

Biologically Enhanced Agricultural Management

Regenerating the Diversity of Life in Soils-
Hope for: Farming, Ranching, Environment and Climate!

Biologically Enhanced Agricultural Management

The **BEAM** approach views soils from a
“Systems Perspective”

and includes all practices that enhance or improve populations of beneficial microbes in the soil microbiome!

Biologically Enhanced Agricultural Management

BEAM practices include:

- NO, or Reduced Chemical inputs or disturbance from tillage
- Year-round Living Roots from Full Time Ground Cover of Cover Crops and/or Commodity Crops
- Implementation of livestock using Adaptive Multipaddock Grazing methods for range management. (carboncowboys.org)

or....

- Inoculation with Beneficial Microbes (i.e. from a Johnson Soil Composting Bioreactor; <https://youtu.be/DxUGk161Ly8>)

Microorganisms have shaped almost every facet of development on this living planet for the last 4.2 billion years...

They have accomplished this by:

Increasing System Biodiversity

and

**Improving the Efficiency of the
Capture, Storage and
Utilization of Energy**



Land Plants & Glomeromycota
~400 to 500 MYA

**Multi-cellular Photosynthesizing
Organisms**
~700 MYA

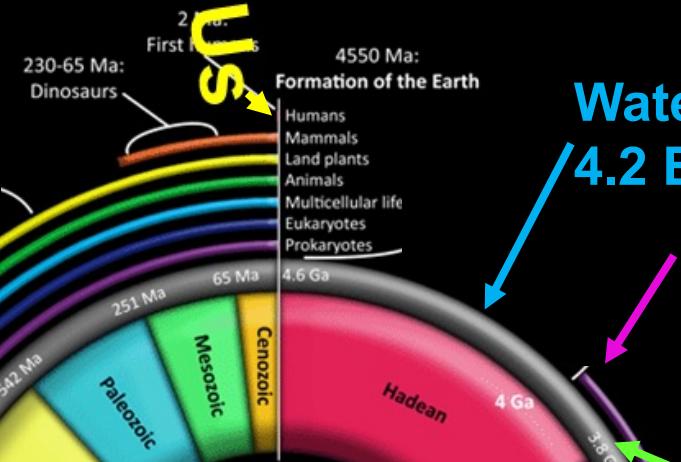
**First Single
Cell Animals**
~750 MYA

Aerobic
Respiration
18-times
increase in
Energy Use
Efficiency

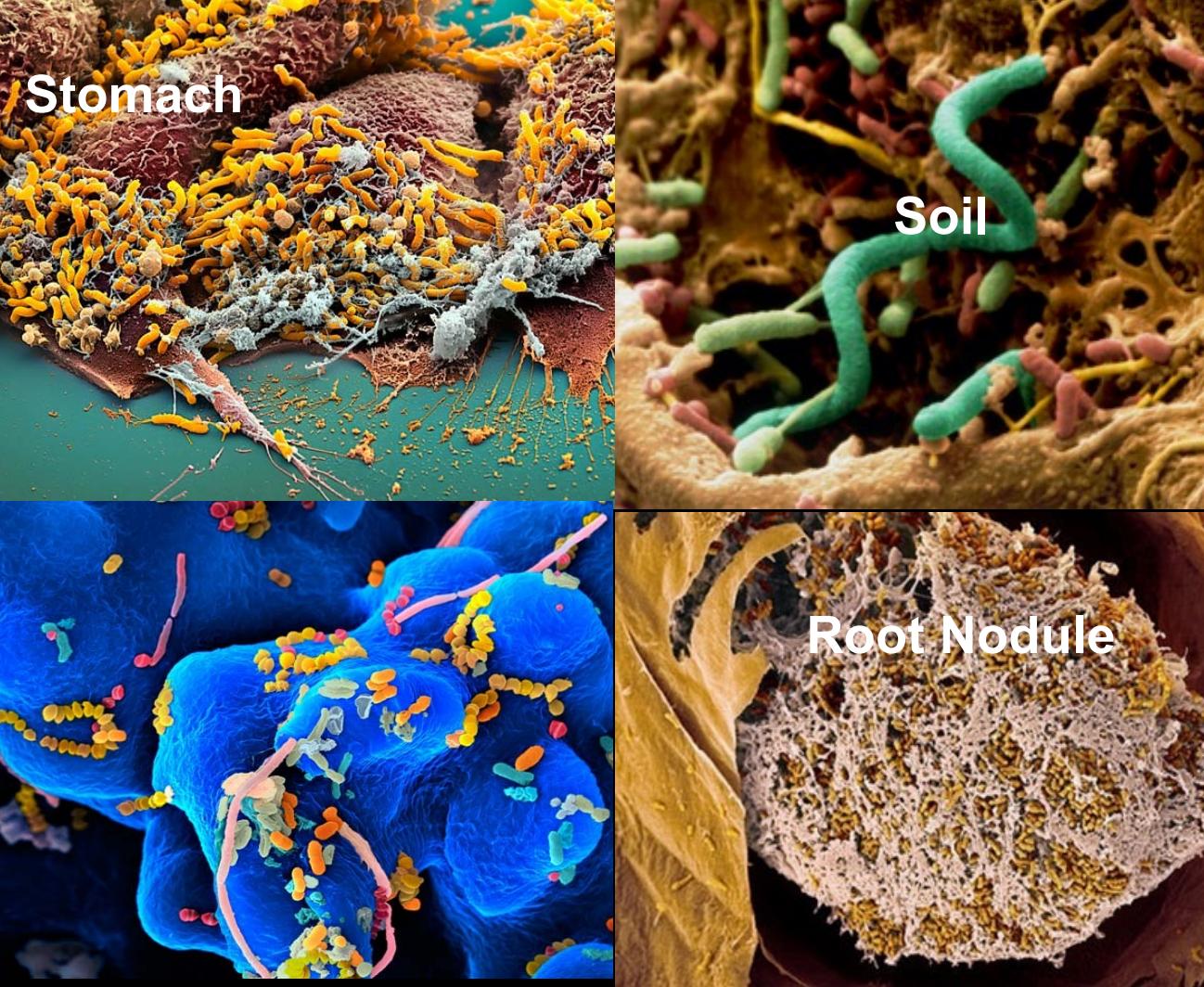
**Mitochondria
Evolved**
~1.45 bya

**Ozone Layer
Multicellular Life**
~1.6 bya

Fungi
~2.2 BYA



**Microbes
are the
Foundation
of
Every Organism
and
Ecosystem
on this
“Living Planet”.**



<http://ngm.nationalgeographic.com/2013/01/125-microbes/oeggerli-photography>

Cell Count Comparison

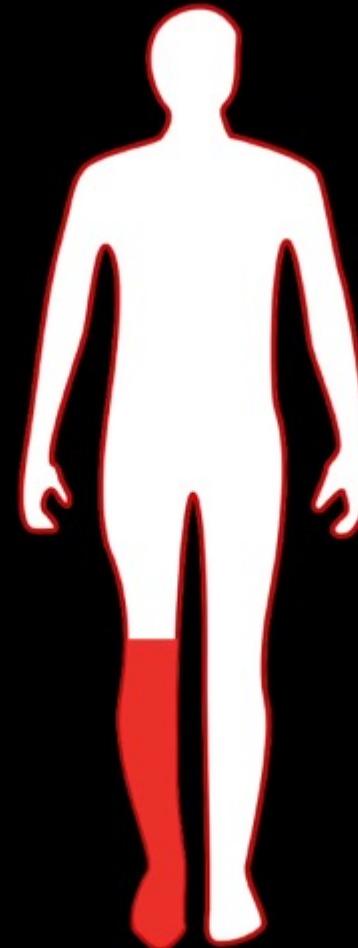
1 Quadrillion Resident Viruses

The human
microbiome is
comprised of all the:

- bacteria,
- fungi,
- protozoa and
- viruses

in our bodies

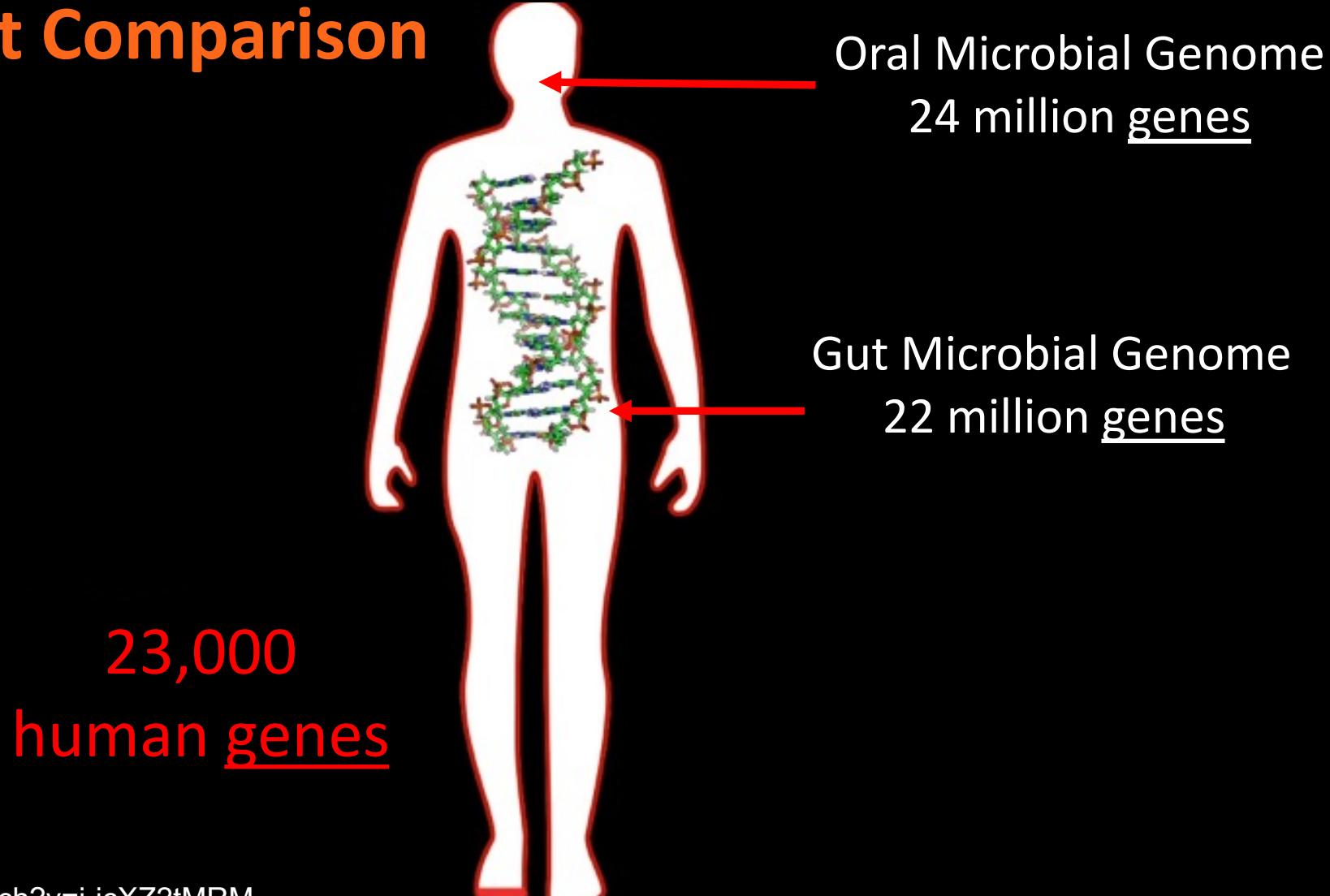
10 trillion
human
cells



90 trillion
microbial
cells

<https://www.youtube.com/watch?v=i-icXZ2tMRM>

Gene Count Comparison



<https://www.youtube.com/watch?v=i-icXZ2tMRM>

<https://www.sciencedaily.com/releases/2019/08/190814113936.htm>

Food Digestion

Nutrient Generation

Vitamin Synthesis

**Detoxify
Carcinogens**

**Prevents
Allergies,
Skin
Diseases
and Asthma**

**Cell
Renewal**

**Controls Appetites
and Cravings**

**Turn off and on
our genes that
regulate brain
development,
anxiety,
depression, autism,
arthritis and
emotional behavior**

**Comprises
>60 **80%** of Immune
System**

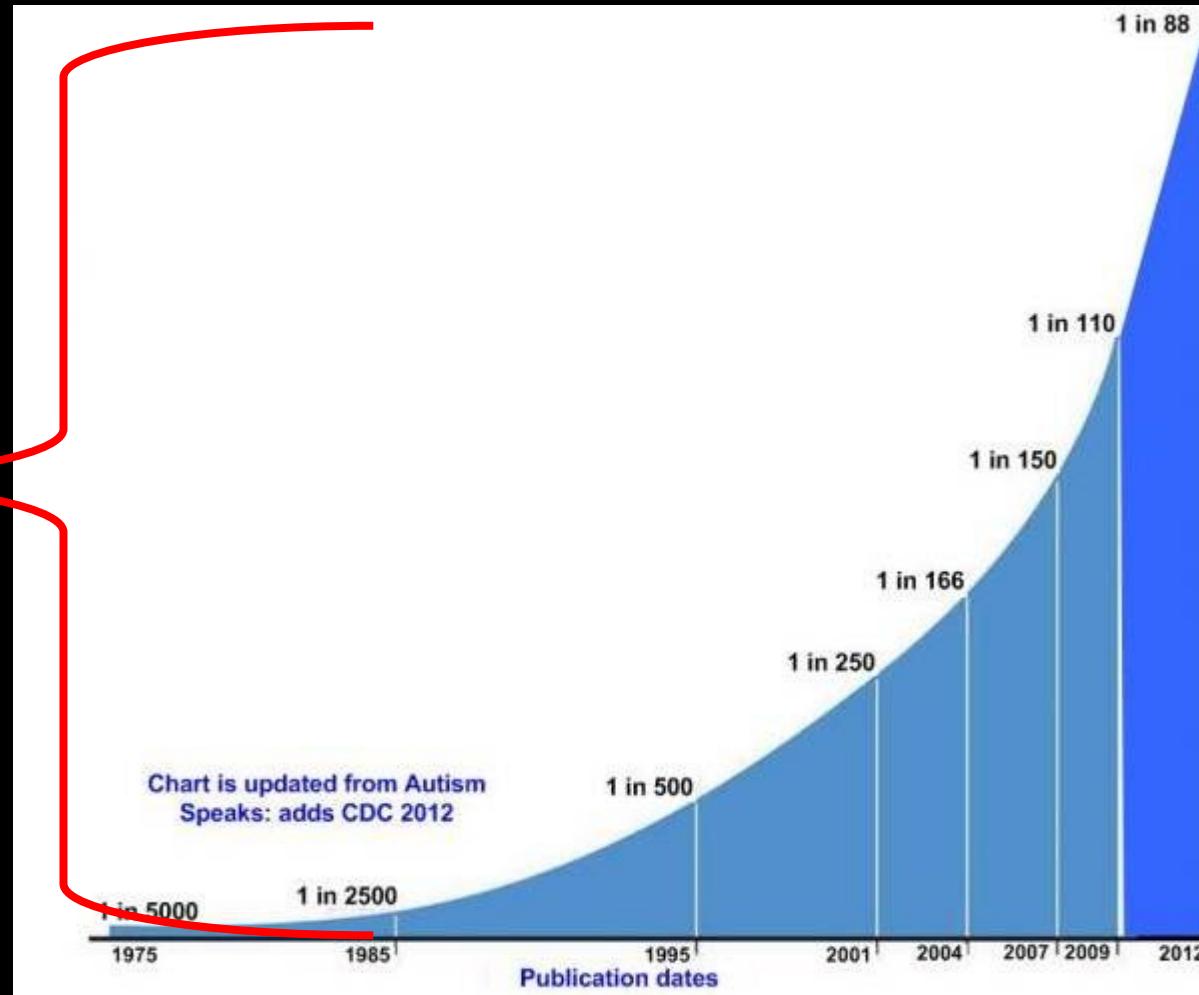


<https://thesocietypages.org/socimages/2014/11/07/visualizing-the-fetus/>

What Happens When These Microbial Communities Are Disrupted Through

- Administration of Antibiotics
- Exposure to Chemicals
- Diet Related Issues

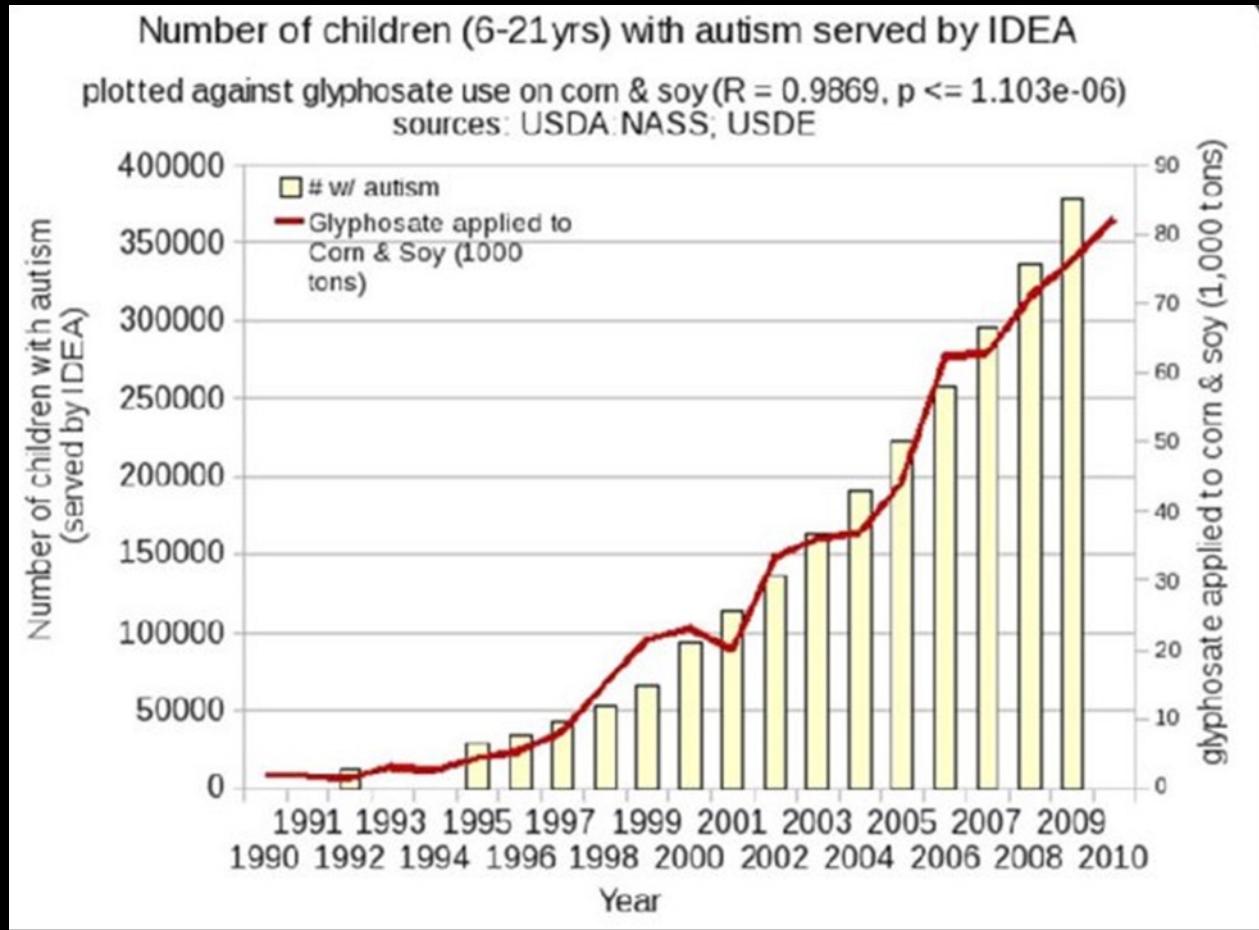
83 Times
Increase
in Autism



2018= 1 in 59

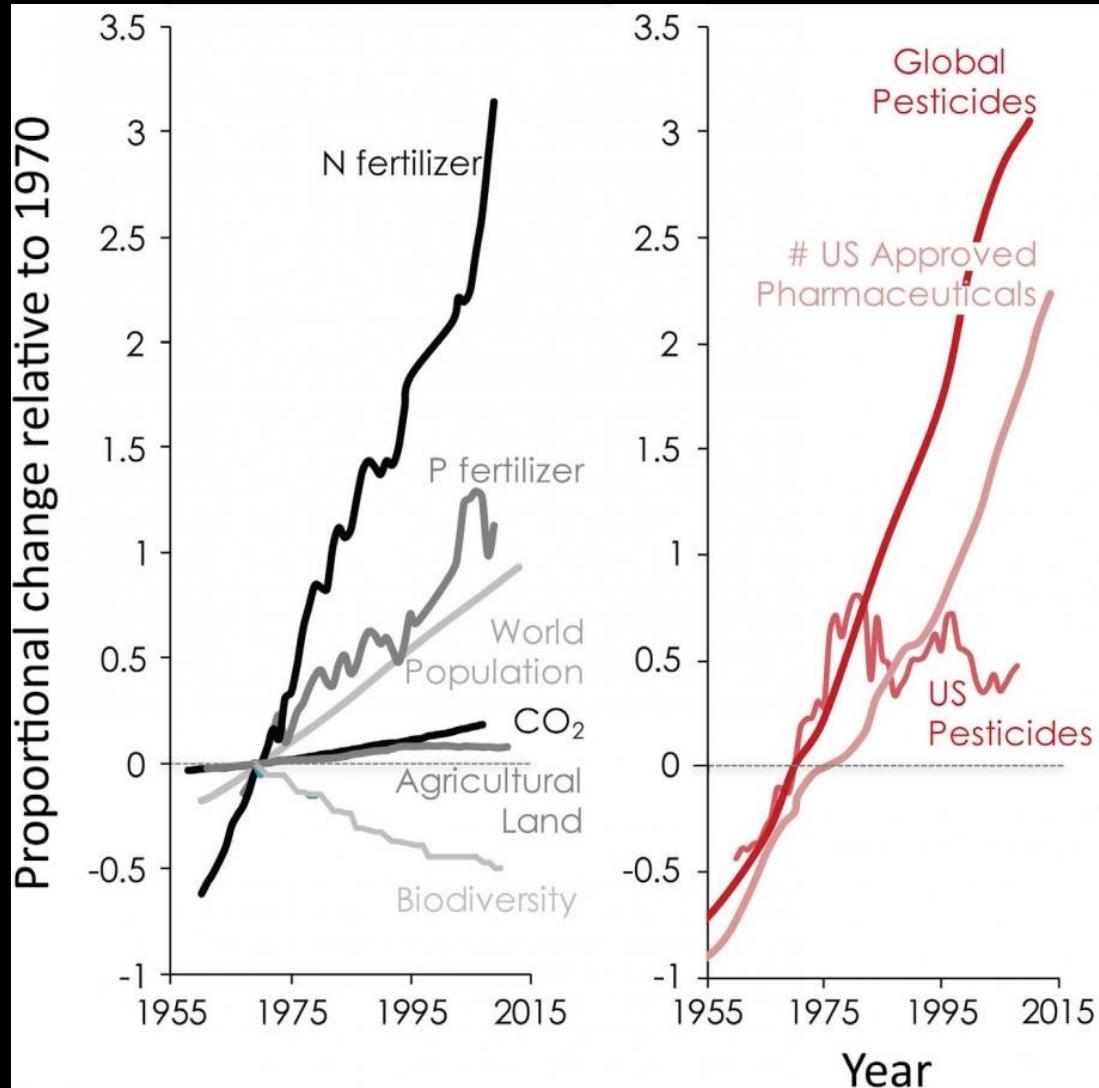
2022= 1 in 30

<https://gumbo.blogspot.com/2018/04/why-incidence-of-autism-keeps-rising.html>



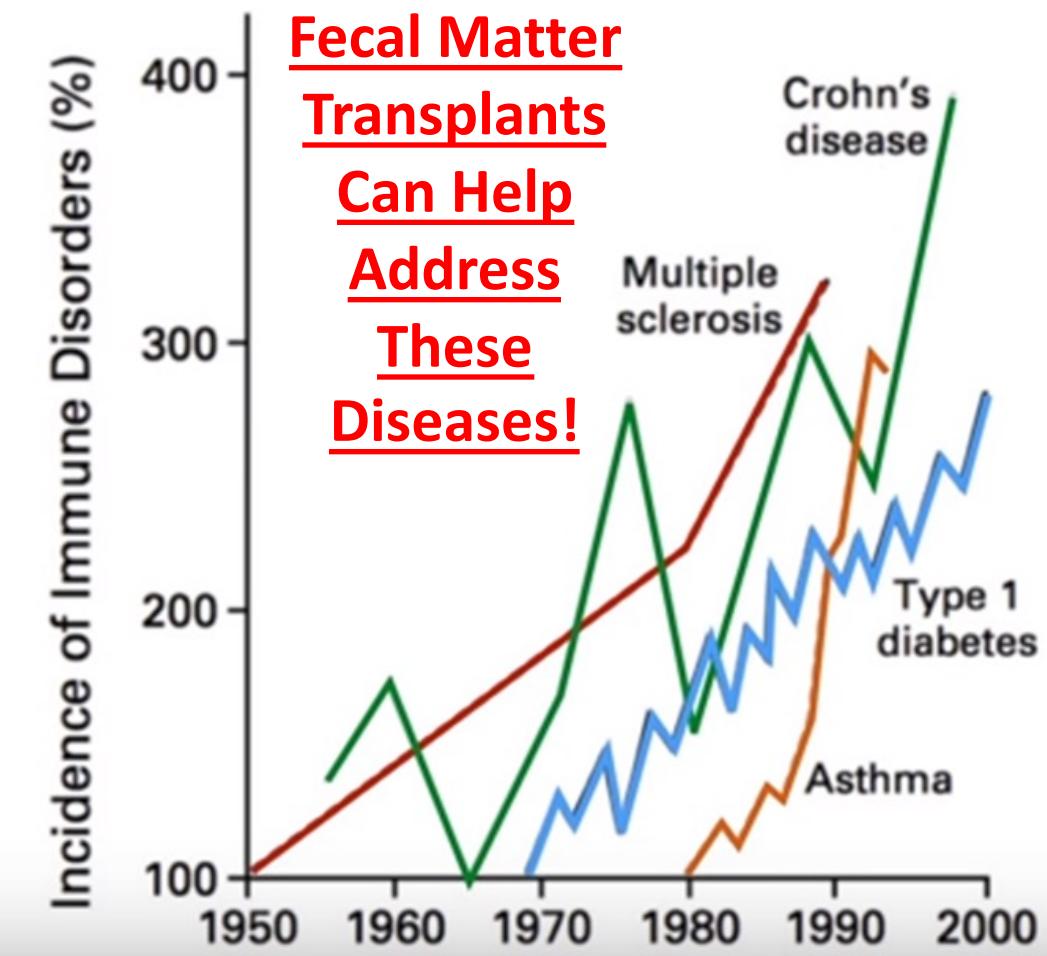
https://www.researchgate.net/publication/291186663_Is_there_a_link_between_autism_and_glyphosate-formulated_herbicides/figures

Glyphosate Found in More than 80% of U.S. Urine Samples



<https://desdaughter.com/2017/02/08/production-of-synthetic-chemical/>

Increased Incidence of Auto Immune Diseases

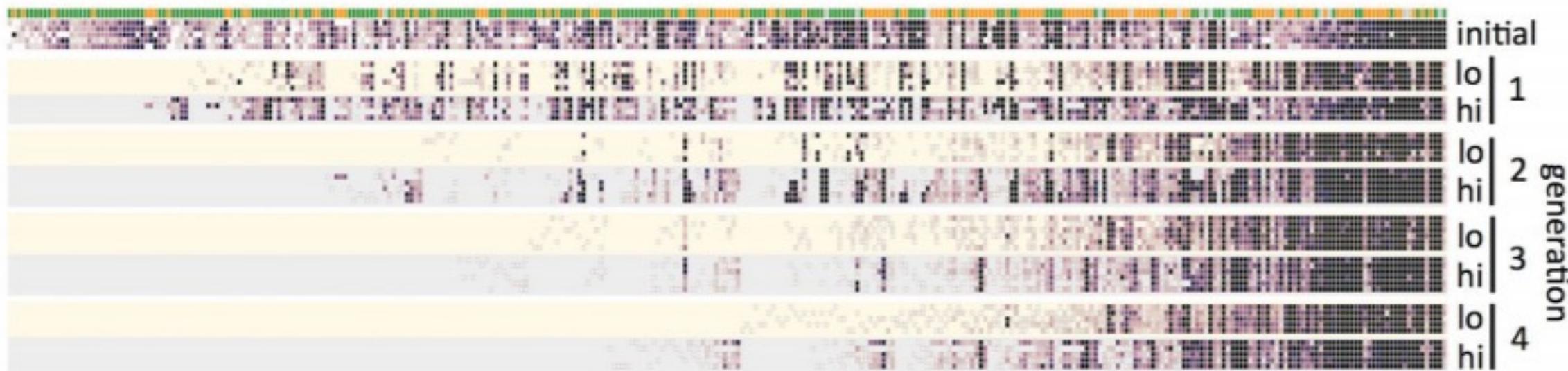


<https://www.youtube.com/watch?v=47csmddyZMM> Bach (2002) N Engl J Med. Vol. 347, 911-920 Med

Diet Induced Extinction of Microbiota

Microbiota-accessible Carbohydrates (MAC) FIBER

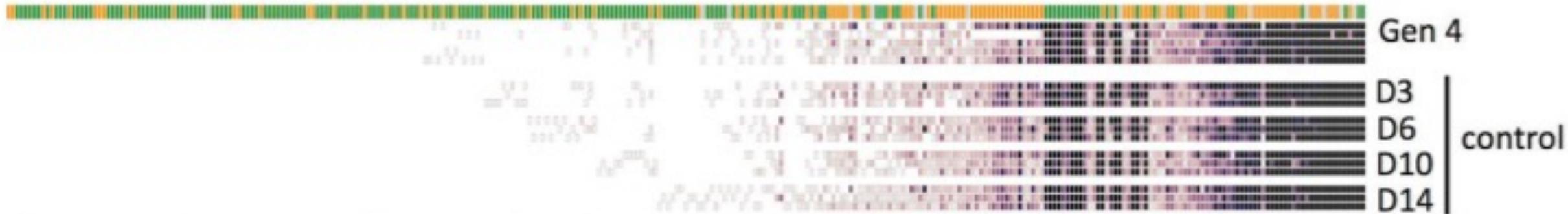
Low Fiber Diet



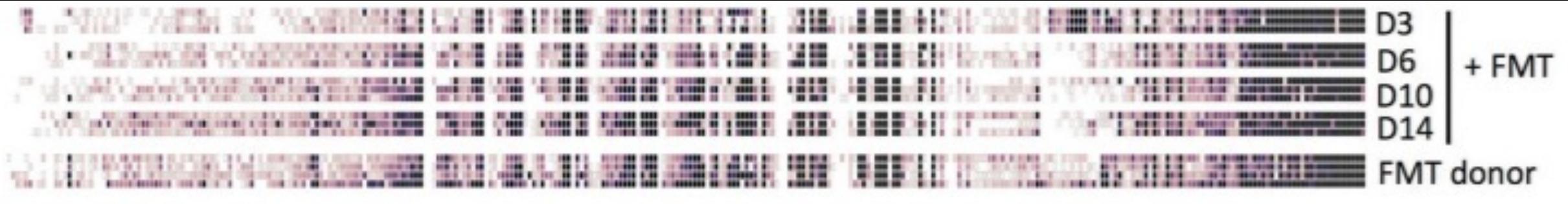
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4850918/pdf/nihms742543.pdf>

Re-establishment of Gut Microbiome

Re-introduce Fiber into the Diet



Increased Fiber Diets + Fecal Matter Transfers



<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4850918/pdf/nihms742543.pdf>

Two Things have Happened Over the Last 120 years as a Result of our Farming management:

- We have significantly altered the soil microbiome with our agricultural management practices.
- Soil microbial biomass has changed from fungal dominant to bacterial dominant.

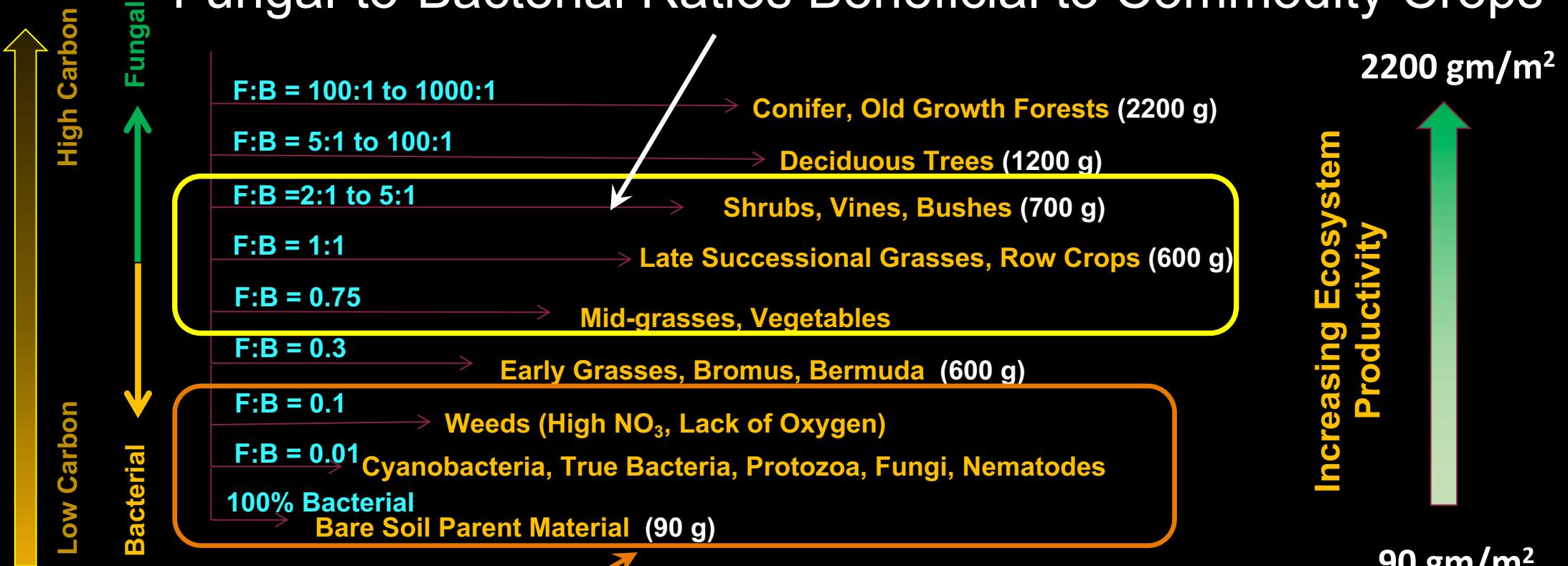
These have created a soil that has lost its biological functionality..... decreasing the ability for the soil microbiome to supply necessary elemental nutrients to plants from the soil parent material and our atmosphere.

If Microbiota Transfers Work in the Human Microbiome.....

Can a simple inoculation of
beneficial microbes help restore
microbiome structure and function
in agricultural soils?

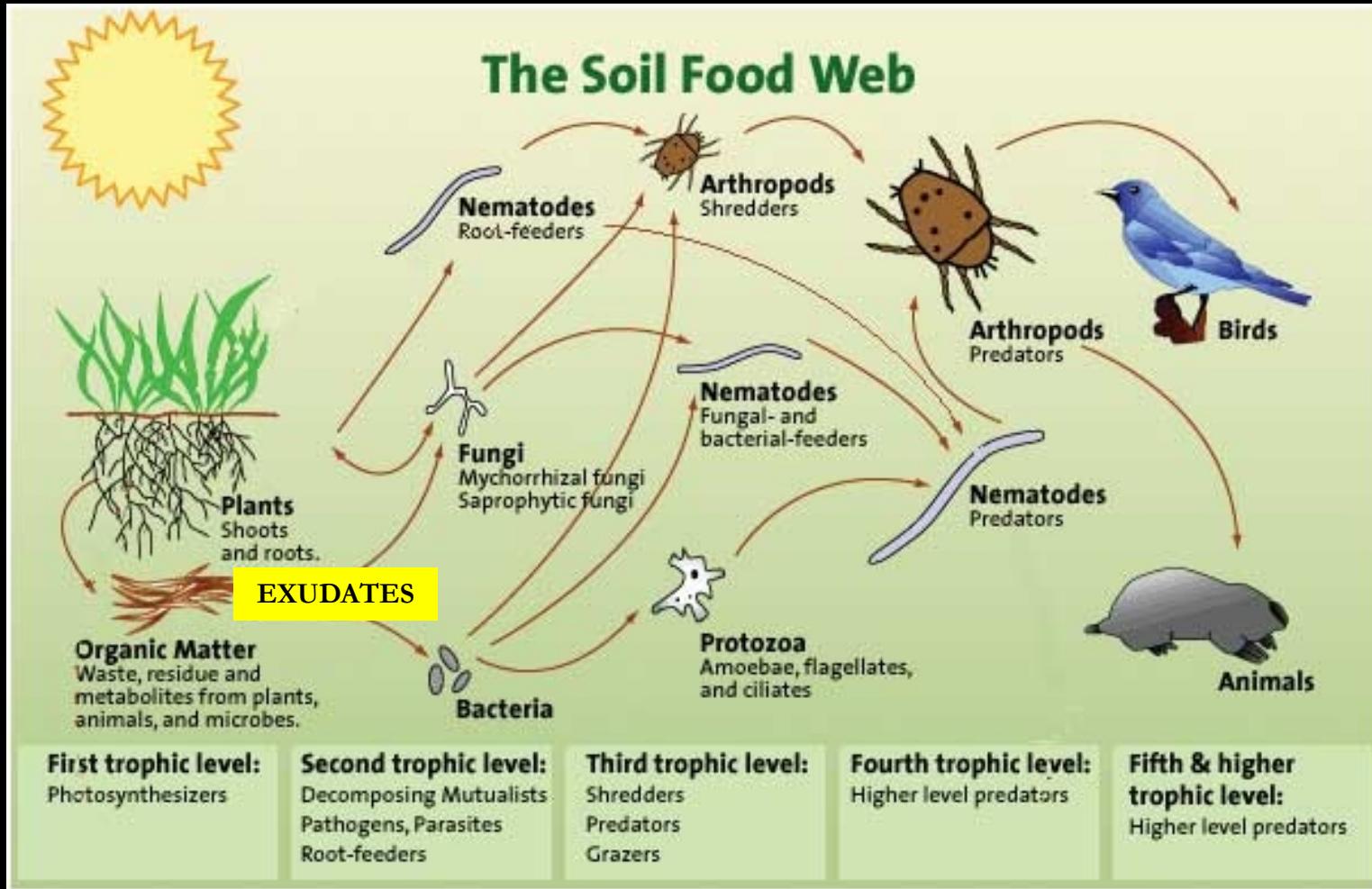
Plant Succession Ladder as a Function of Fungal:Bacterial Ratio (F:B)

Fungal-to-Bacterial Ratios Beneficial to Commodity Crops



Where we are currently in agroecosystems!

Elaine Ingham- www.soilfoodweb.com



C:N Ratio

4-5:1

15:1

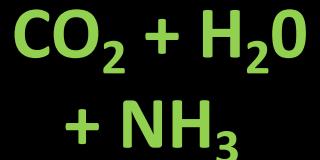
20:1



Living Organisms

C_{18%}H_{10%}O_{65%}N_{3%}Ca_{1.4%}P_{1%}X_{4.9%}

Respiration



<https://www.britannica.com/science/cellular-respiration>

<https://www.soilfoodweb.com.au/about-our-organisation/benefits-of-a-healthy-soil-food-web>

Nature's System of Soil Building



<https://www.smithsonianmag.com/science-nature/these-non-lethal-methods-encouraged-science-can-keep-wolves-killing-livestock-180976505/>

<https://www.nationalgeographic.com/animals/article/150418-insects-dung-beetles-animal-behavior-navigation>

<https://www.panna.org/blog/got-worms-why-healthy-soil-matters>

Johnson-Su Bioreactor



<https://youtu.be/DxUGk161Ly8>

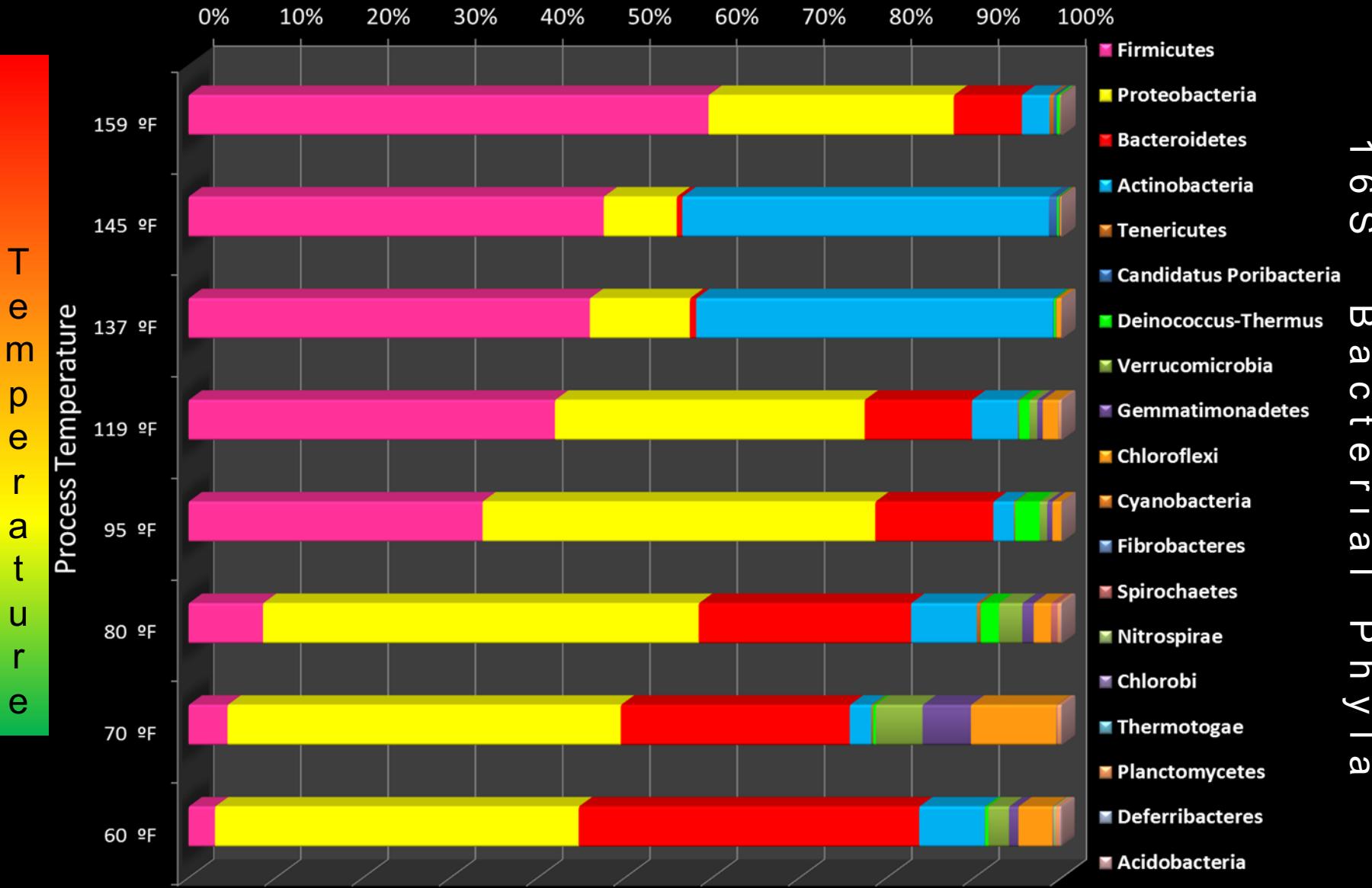
Johnson/Su

Static Composting Technology

- ~70% moisture content !
- No-Turning !
- Aerobic (6 air columns up through the pile)
- Do Not Let It Freeze or Dry Out !!!!!
- Worms added after temperature goes below 80° F (27° C)
- One year to reach maturity
- Follow the instructions closely on the first try...no short cuts, please !

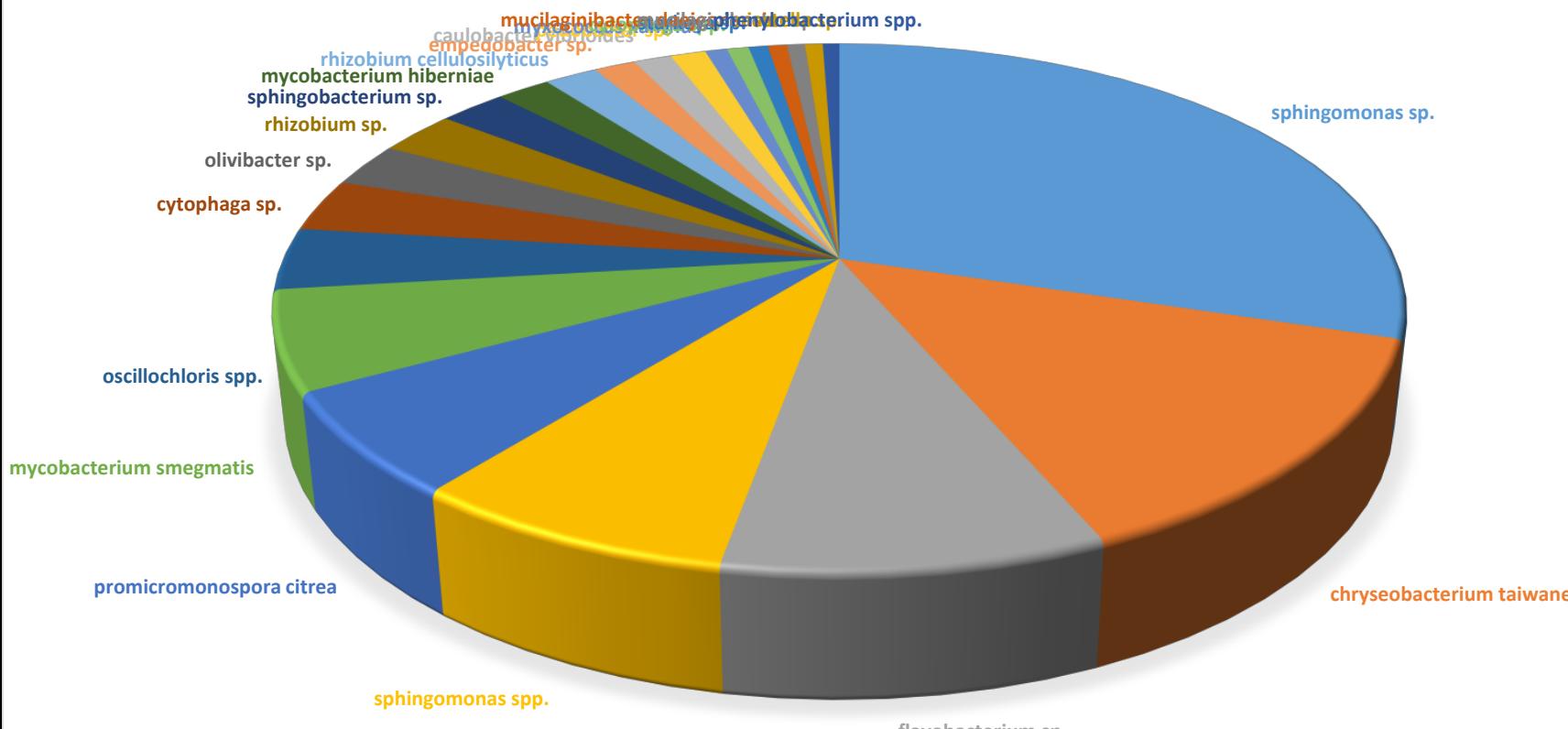
<https://youtu.be/DxUGk161Ly8>

60°C

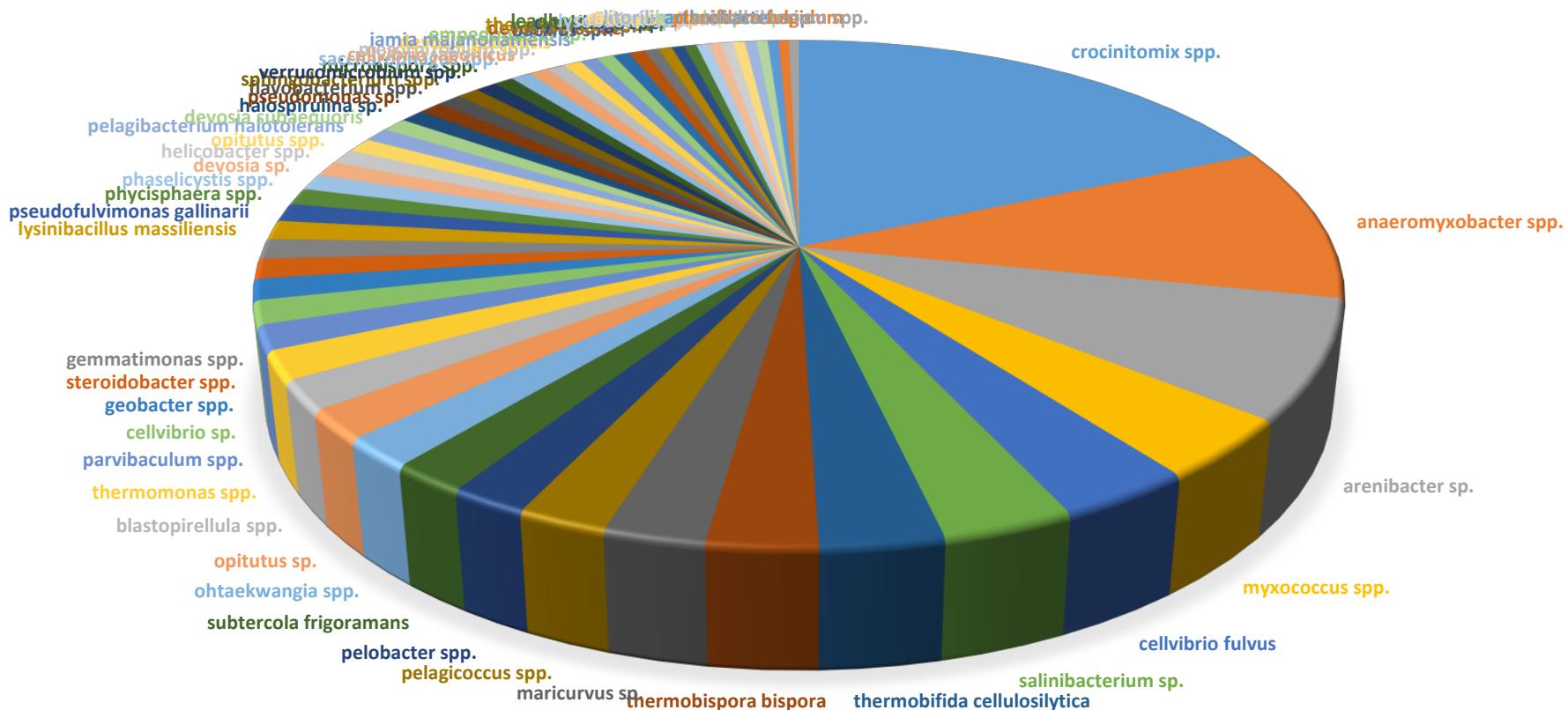


15°C

4 WEEK (316 of 740 species)
Top 80% has 23 species

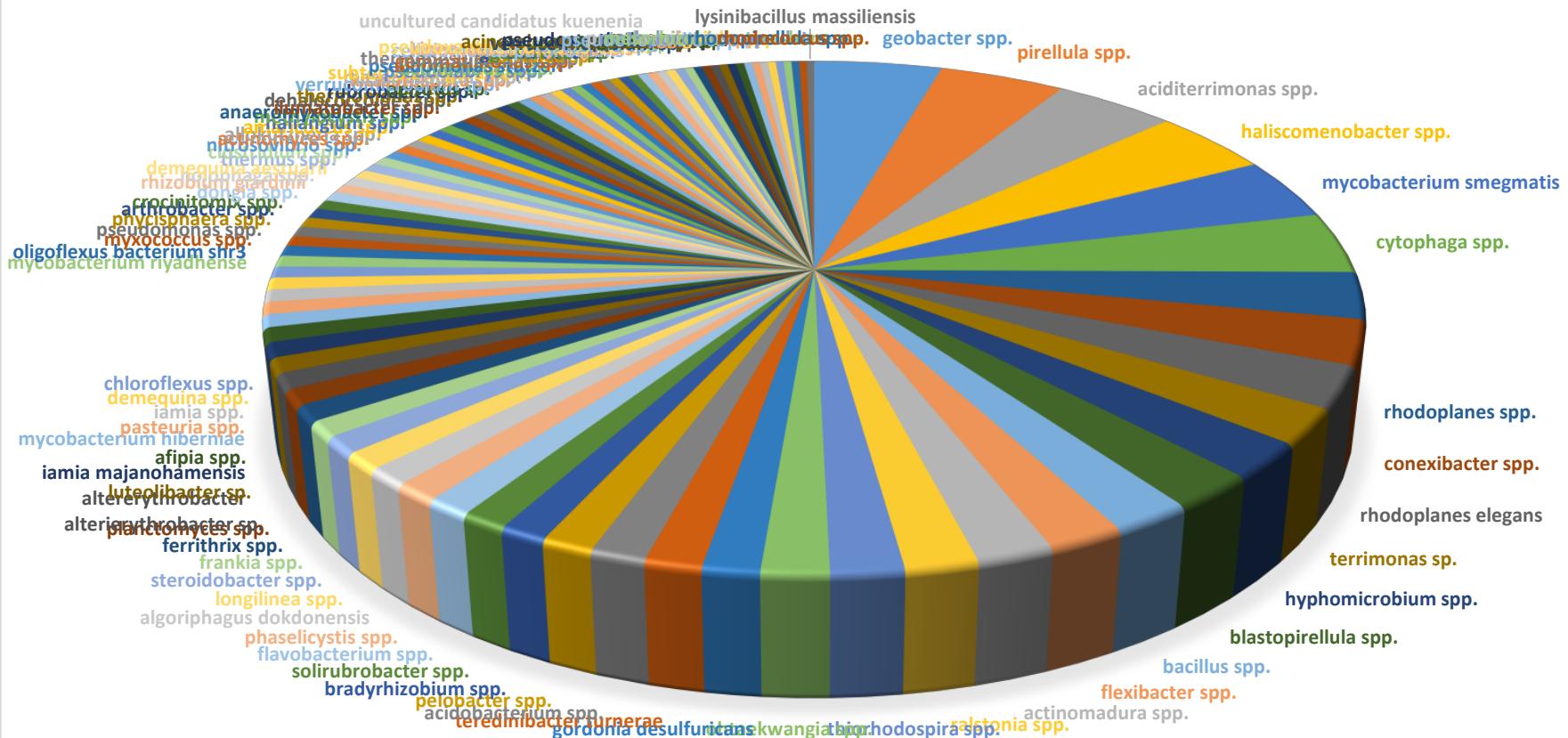


22 WEEKS (424 of 740 species)
Top 80% has 57 species

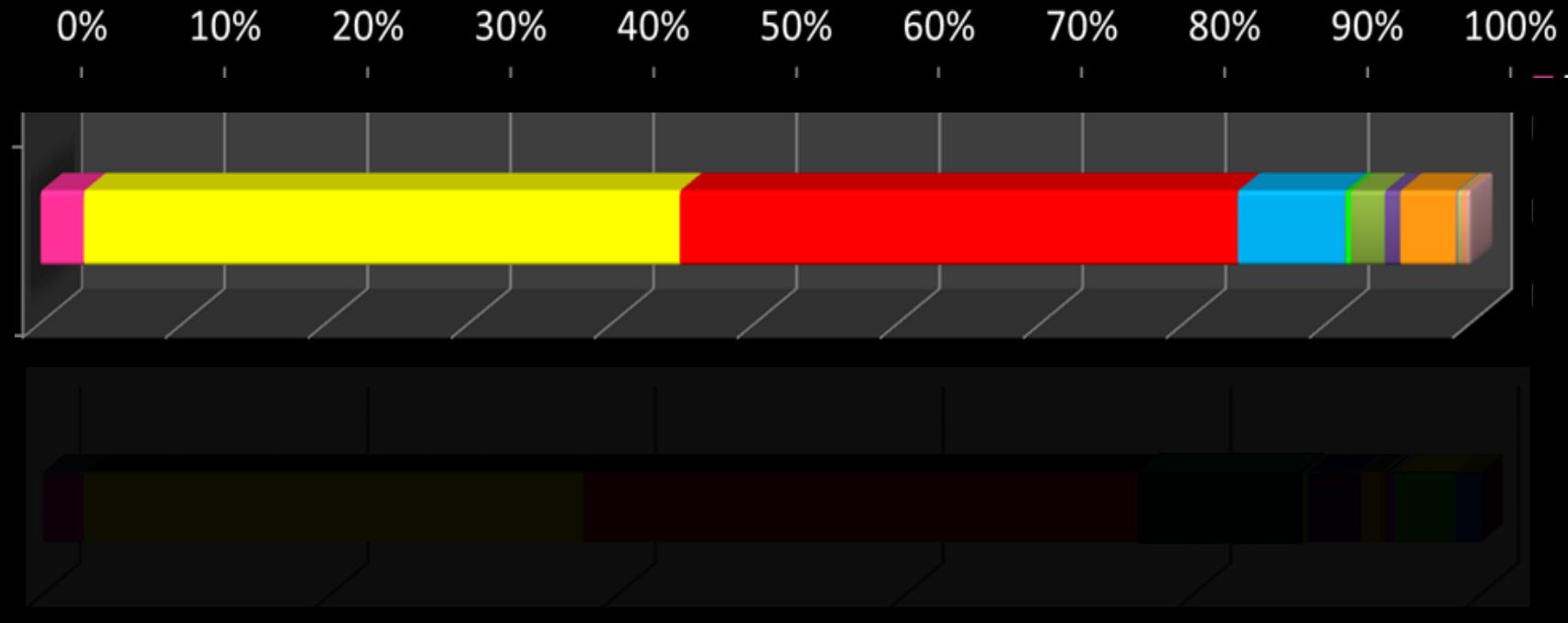


60 WEEKS (453 of 740 species)

Top 80% has 99 species



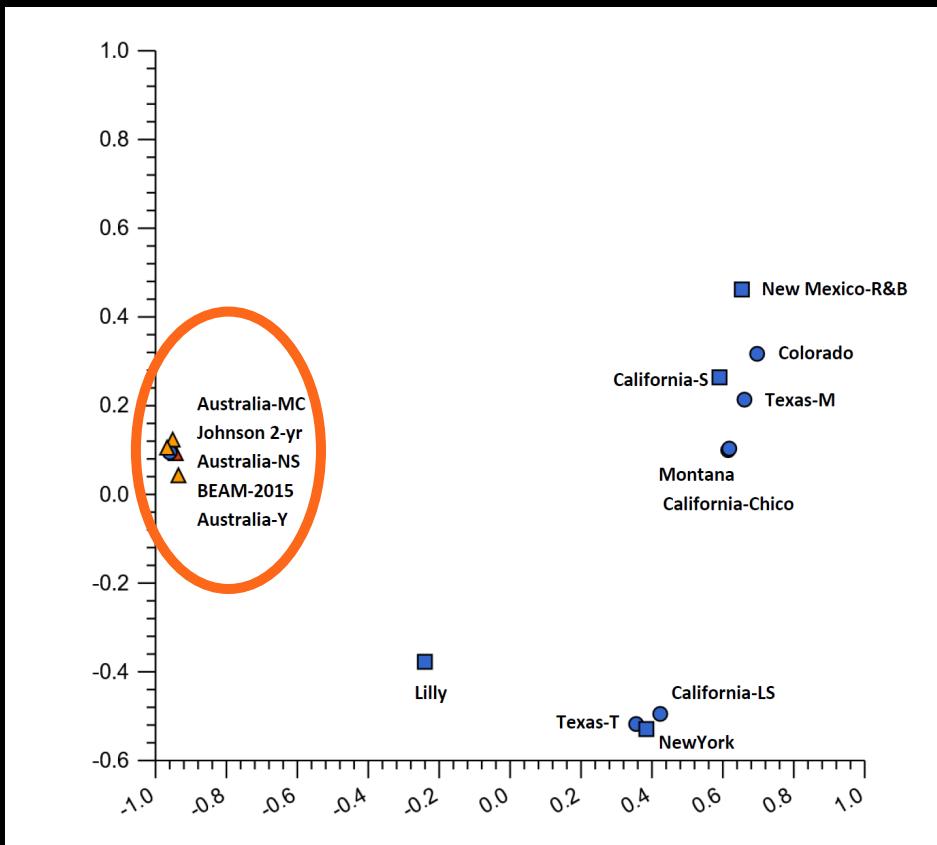
Two Compost Samples Ten Years Apart with Different Materials



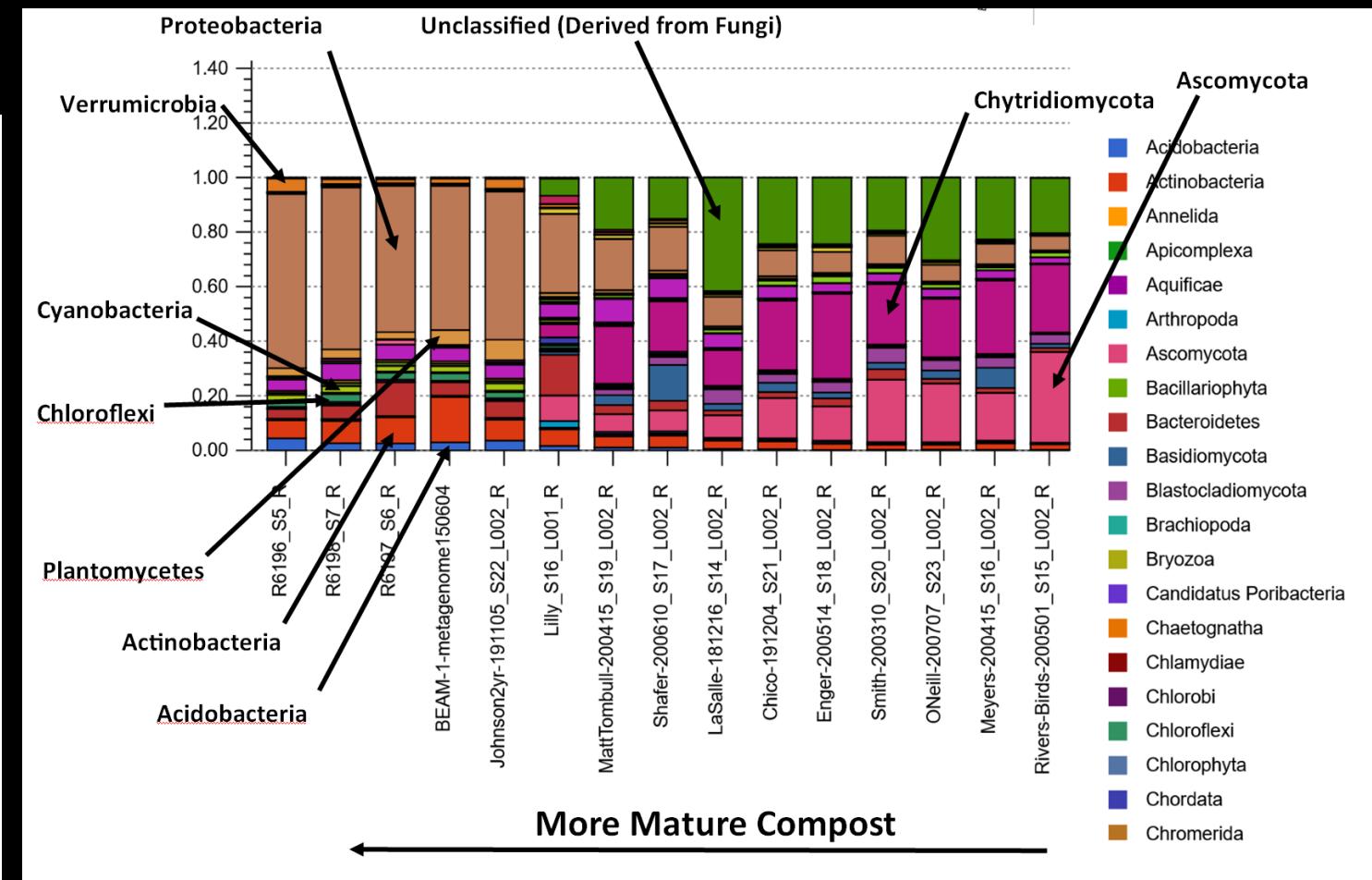
16S Bacterial Diversity Assay

Firmicutes	—
Proteobacteria	—
Bacteroidetes	—
Actinobacteria	—
Tenericutes	—
Candidatus Poribacteria	—
Deinococcus-Thermus	—
Verrucomicrobia	—
Gemmatimonadetes	—
Chloroflexi	—
Cyanobacteria	—
Fibrobacteres	—
Spirochaetes	—
Nitrospirae	—
Chlorobi	—
Thermotogae	—
Planctomycetes	—
Deferribacteres	—
Acidobacteria	—

Principal Component Analysis:
Euclidean Distance Method, Genus
Level, w/Normalization

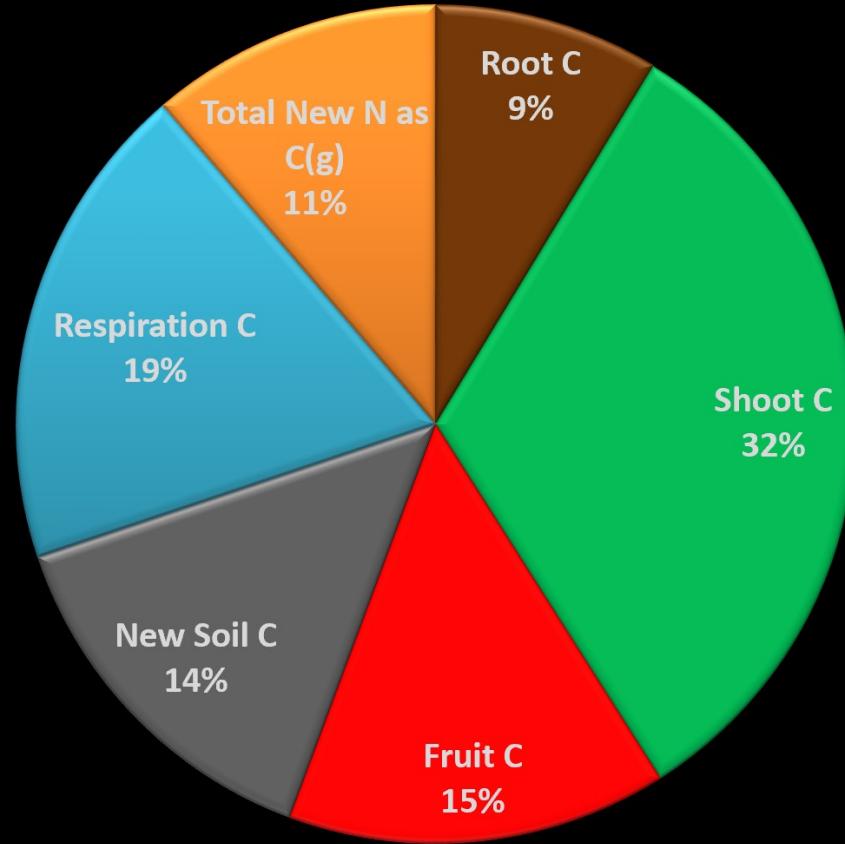


Metagenome Analyses (phyla level)

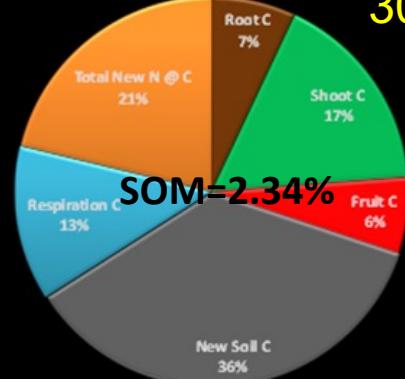
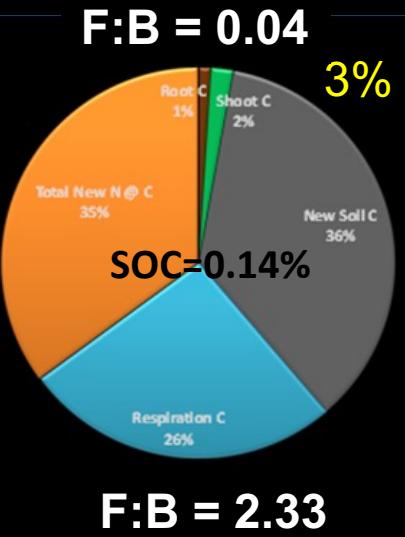
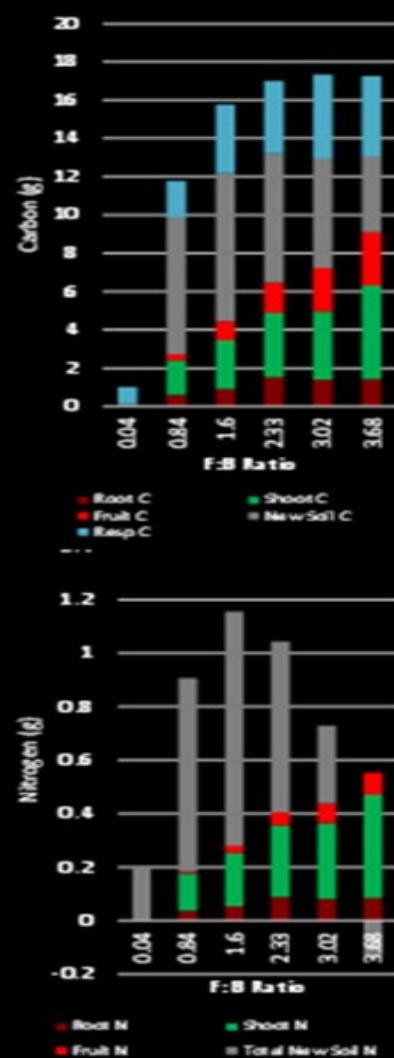




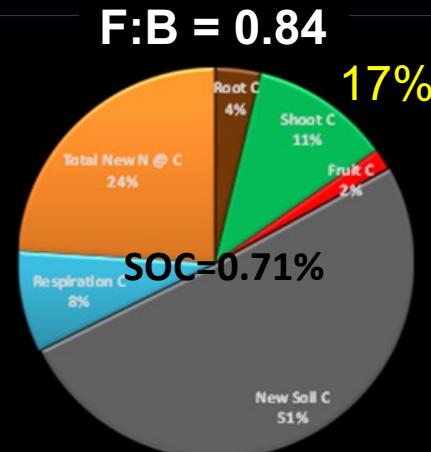
Greenhouse Trials with Green Chile Assessing the Influence of F:B On C & N Partitioning



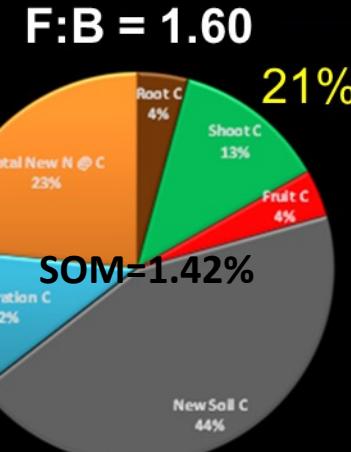
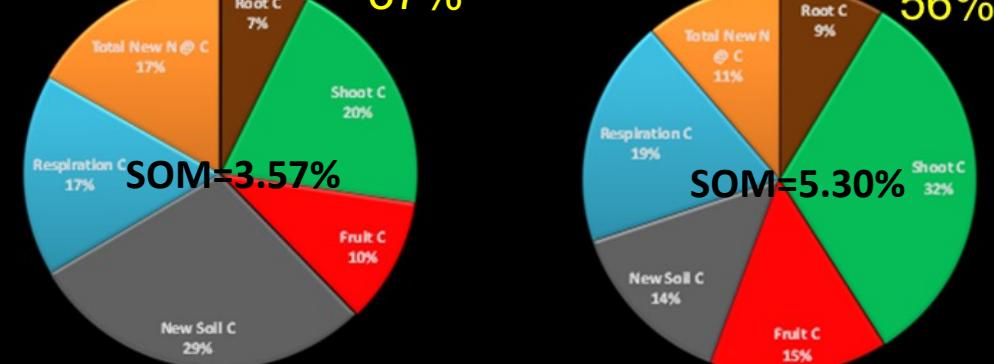
Efficiency of Carbon Flow into Plant Biomass



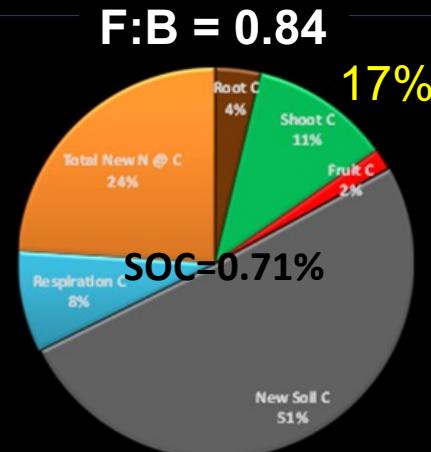
Our Conventional Agricultural System



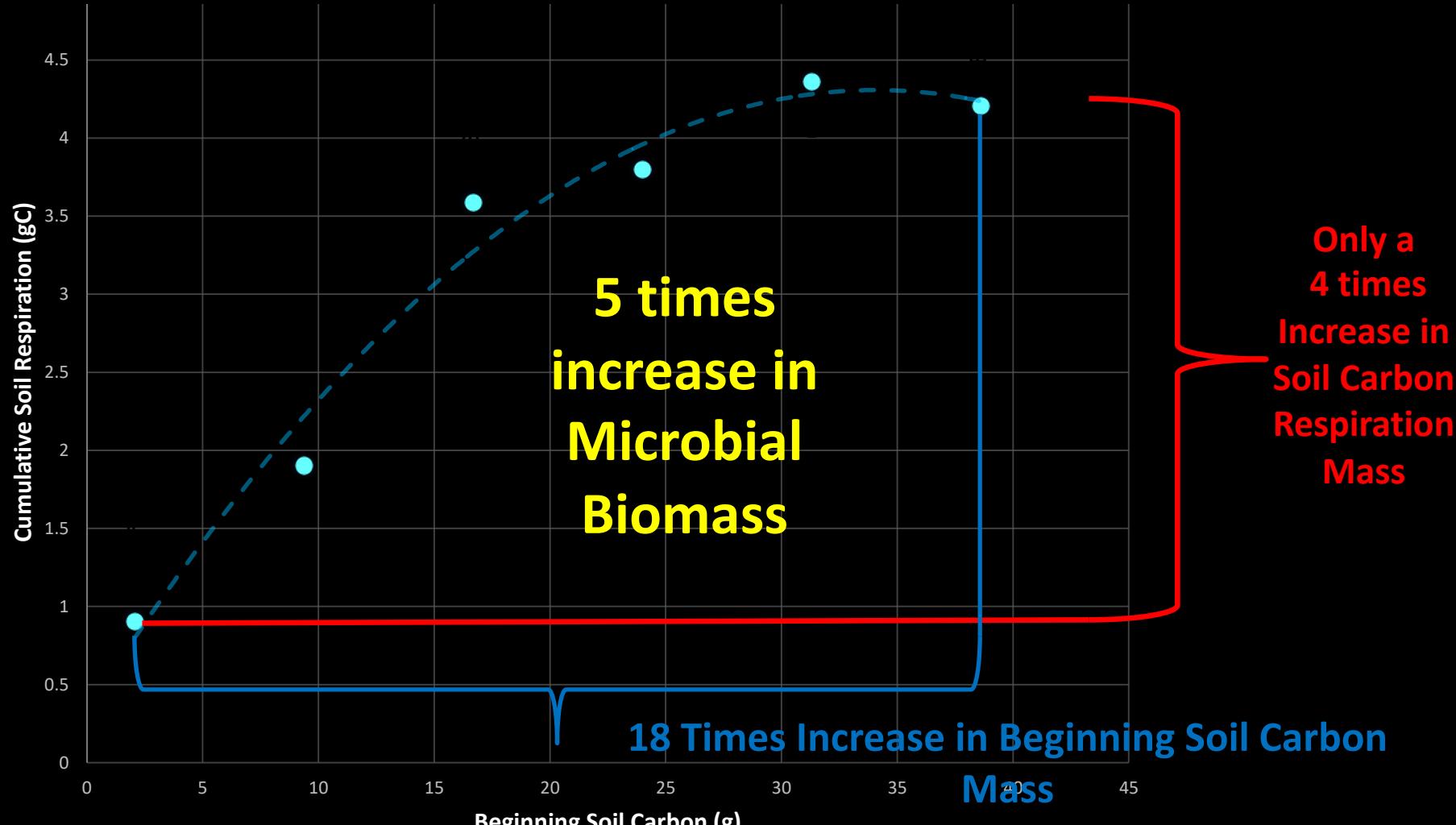
F:B = 3.68



F:B = 0.84

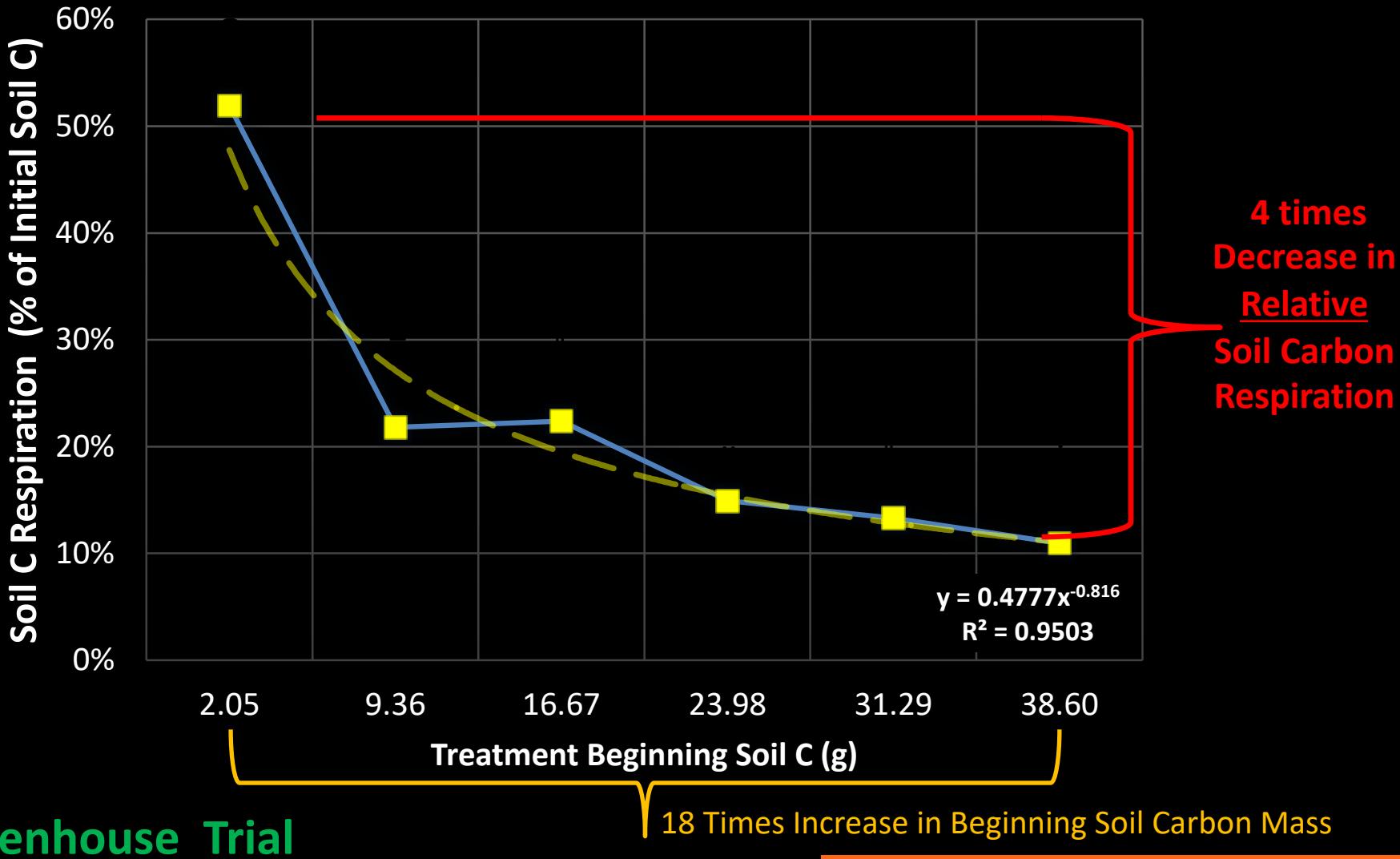


Cumulative Soil Respiration (gC)

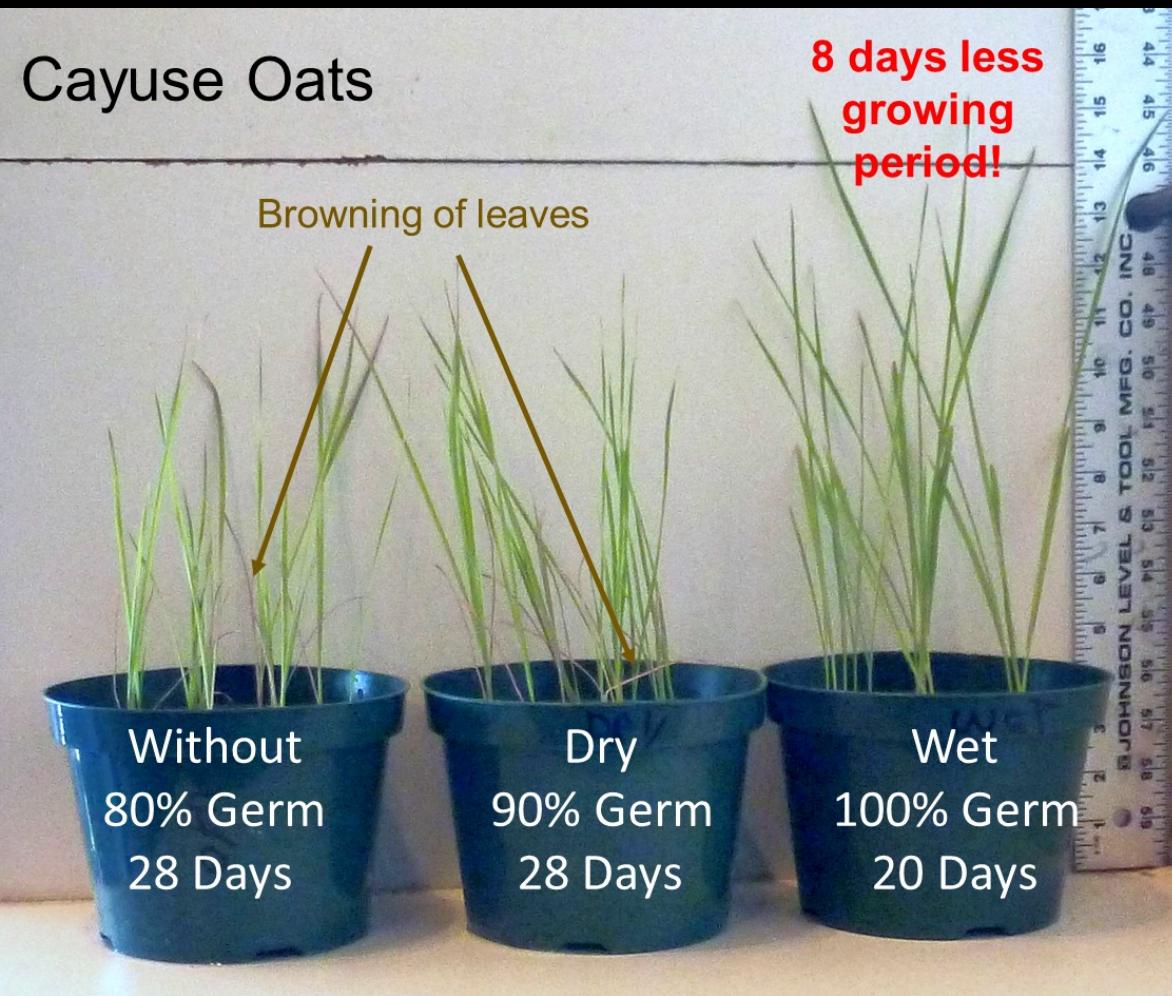


Greenhouse Trial

Percent of Initial Soil Carbon Respired



Cayuse Oats



Bell Beans



Small Plot Trials



Second Winter Cover
1,608 grams dry biomass/m²
540 kg N/ha (486# of N/acre)

2015 Desert
Sandy Soil Trial
One Time Compost
Application Rate
504 kg/ha (450 lbs/ac)
12 inches (30 cm)



12 inches (30 cm)

Small Plot Trials



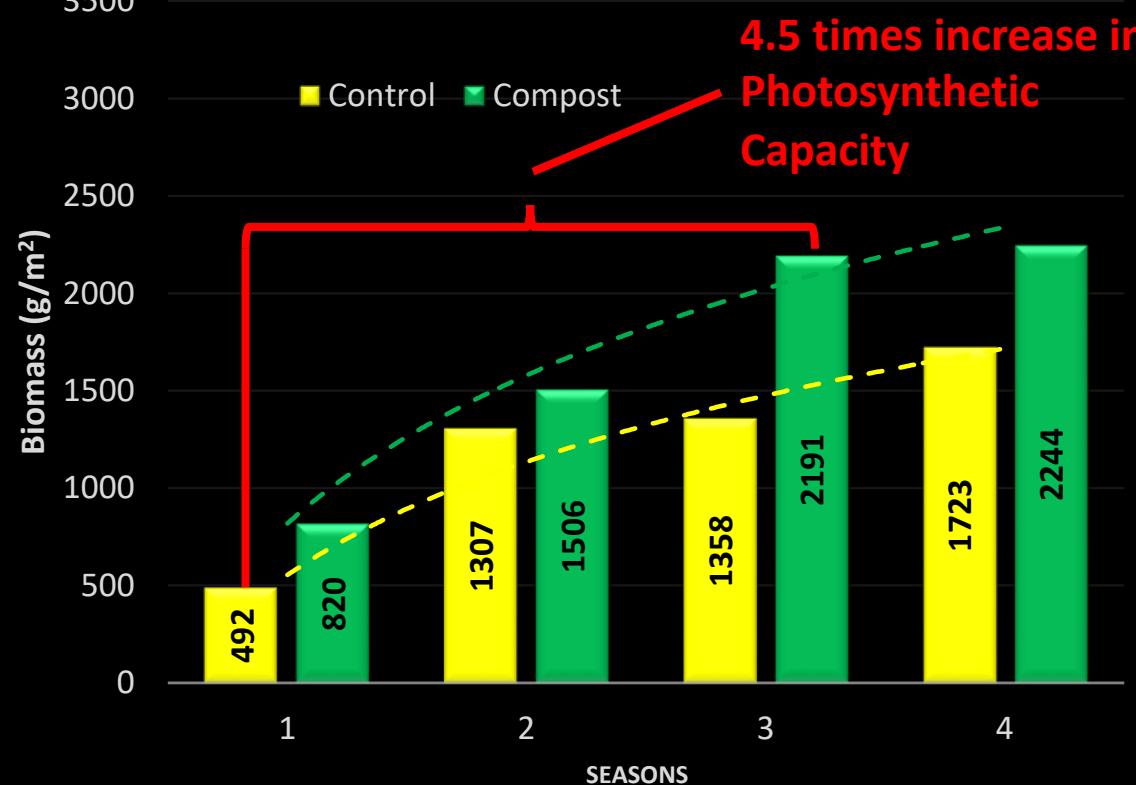
No Fertilizers, Just Biology

2016 Desert Sandy Soil Trial

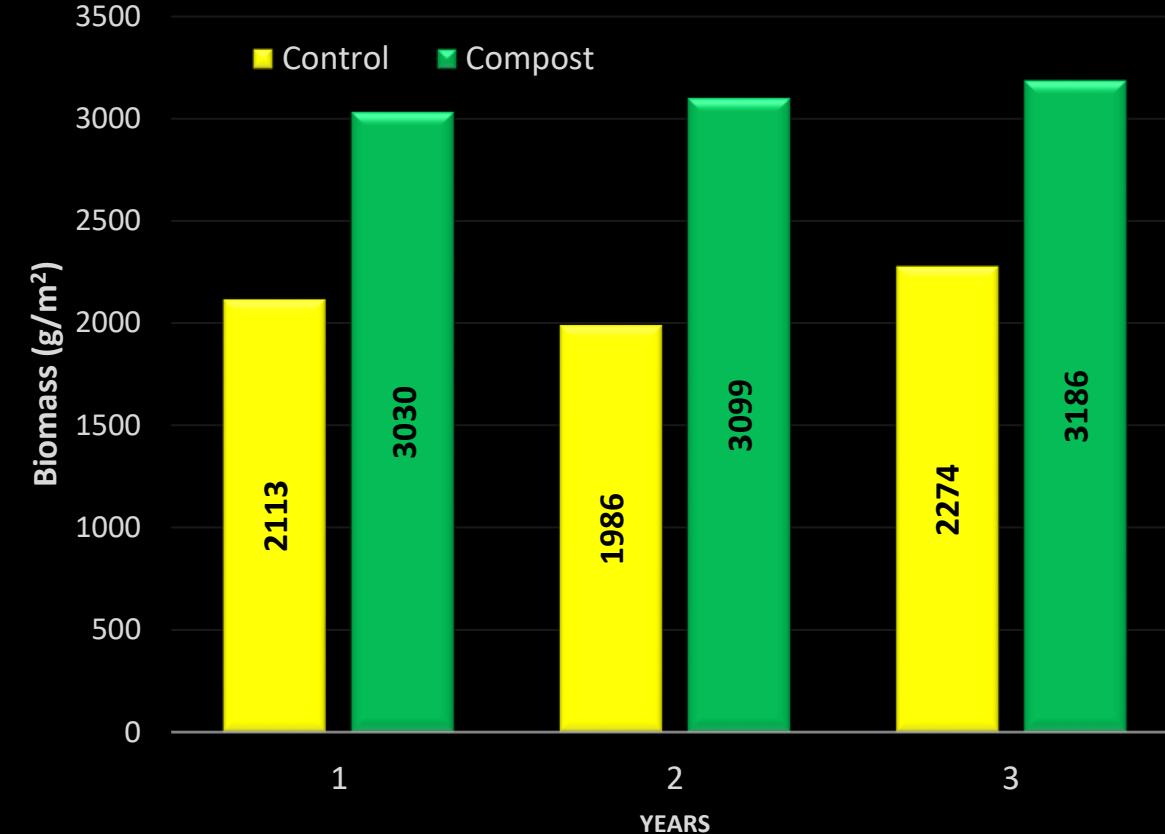
Third Winter Cover

2,190 grams dry biomass/m² 21.9 tons Dry Biomass/ha
654 kg N/ hectare (588# N/acre)

Winter Covers Biomass (g dry biomass/m²)



Annual Cover Crop Biomass (g dry biomass/m²/year)



3,186 grams of dry biomass/m²/year (31.86 tons dry biomass/ha/year)

14.19 tons dry biomass/acre

872 kg N/ hectare/ year (777 lbs N/acre/year)

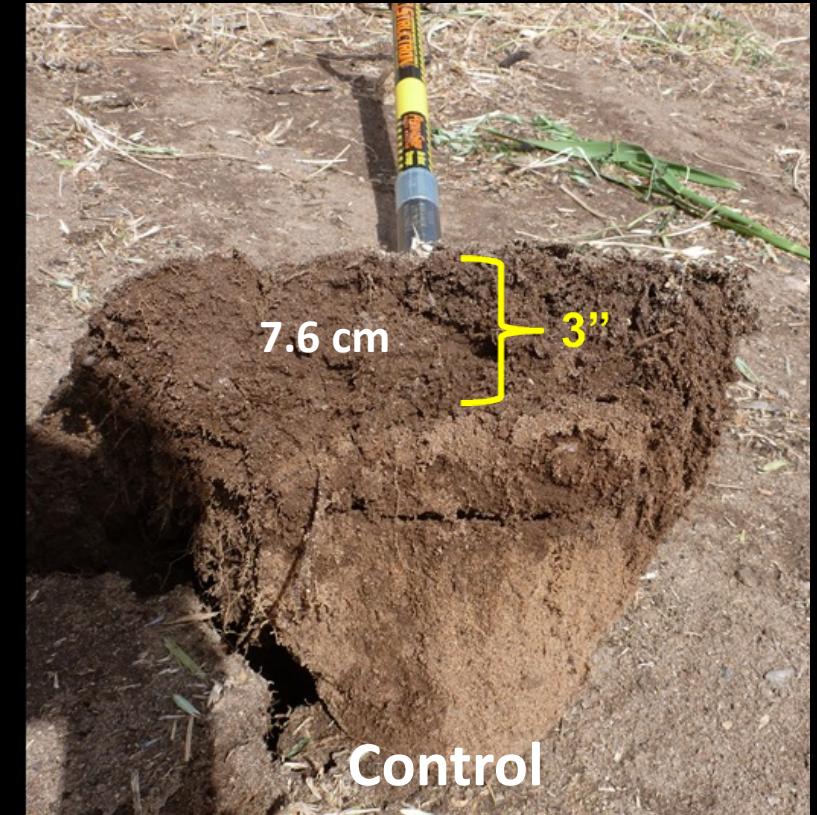
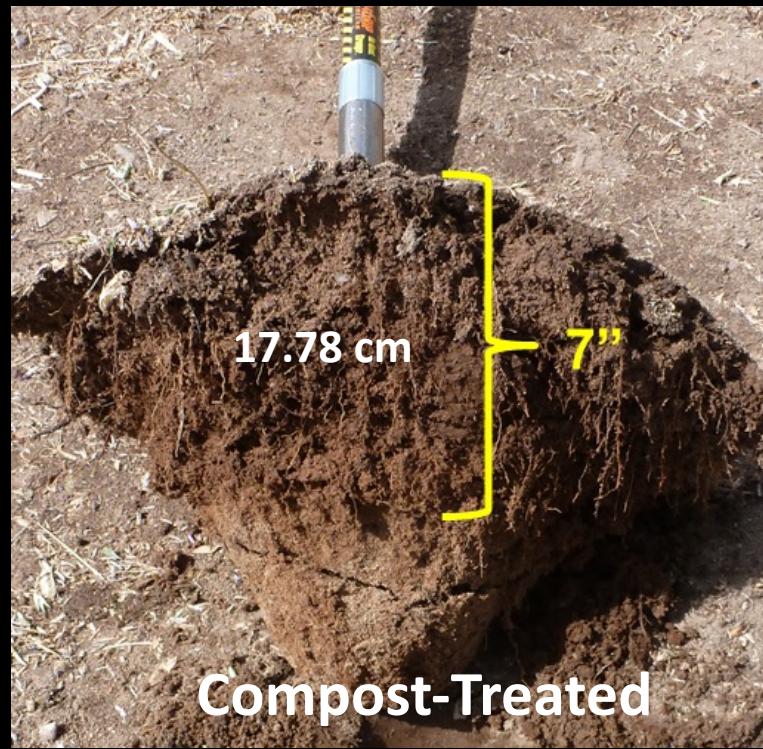
Metagenome Analysis

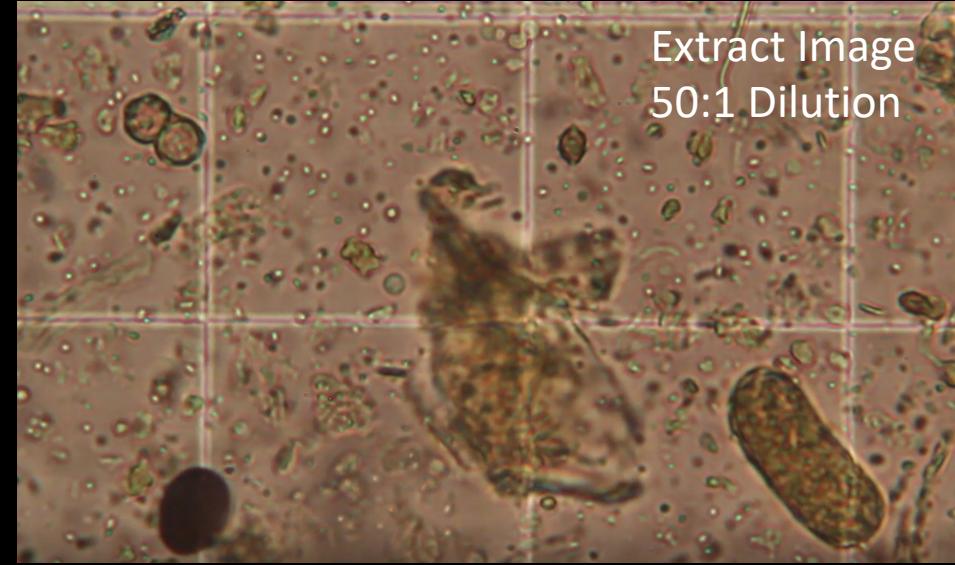
		Phyla			
		Compost Treated Soil	Control	Desert	
Eukaryota					
★★★★★		0.0025296 0.000739 0.0033539 0.173095 0	0.00044 0.00055 0.00399 0.15609 2.6E-05	5.5E-05 0 0.09006 0.635556 0	Crenarchaeota Euryarchaeota Korarchaeota Thaumarchaeota unclassified
Bacteria		0.0046045 0.0474377 0.0013927 0.1310008 0.0014496 0.0001705 0.005173 0.0006537 5.685E-05 0.0006253 0.0001421 0 2.842E-05 0.0156325 0.0003127 0.0009095 0.0021886 0.0388256 0.1308302 0.0009664 2.842E-05 0.0004832 0.0003695 0.0006253 0.0208623 0.4059915	0.0024 0.02007 0.0006 0.05387 0.0017 0 0.00245 0.0006 2.6E-05 2.6E-05 5.2E-05 1.1E-05 1.1E-05 0 2.6E-05 0.11783 0.001 9.9E-05 0.00115 0.00365 0.00034 0.02271 8.8E-05 0 0.00078 0.00021 0.00029 0.01086 0.64178	0.0008 0.0724 2.2E-05 0.00084 0 0.00097 0.00082 1.1E-05 1.1E-05 Deinococcus-Thermus Dictyoglomi Elusimicrobia Fibrobacteres Firmicutes Fusobacteria Gemmatimonadetes Nitrospirae Planctomycetes Proteobacteria Spirochaetes Synergistetes Tenericutes Thermodesulfobacteriia Thermotogae Verrucomicrobia unclassified	Acidobacteria Actinobacteria Aquificae Bacteroidetes Chlamydiae Chlorobi Chloroflexi Cyanobacteria Deferribacteres Deinococcus-Thermus Dictyoglomi Elusimicrobia Fibrobacteres Firmicutes Fusobacteria Gemmatimonadetes Nitrospirae Planctomycetes Proteobacteria Spirochaetes Synergistetes Tenericutes Thermodesulfobacteriia Thermotogae Verrucomicrobia unclassified

Diversity
is the
currency
of
survival....

William Knauss

3.5 year Small Plot Study





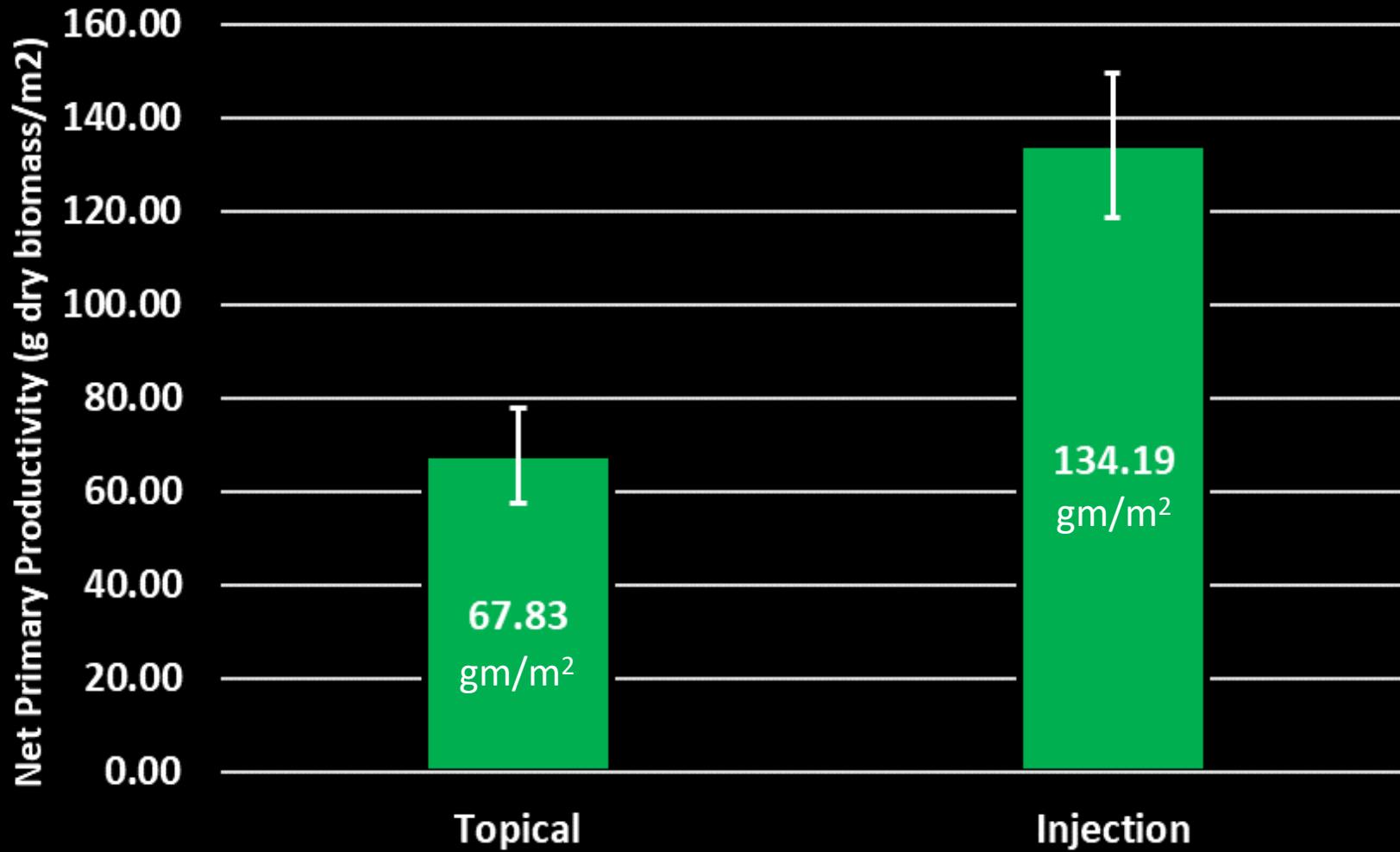
Extract Image
50:1 Dilution

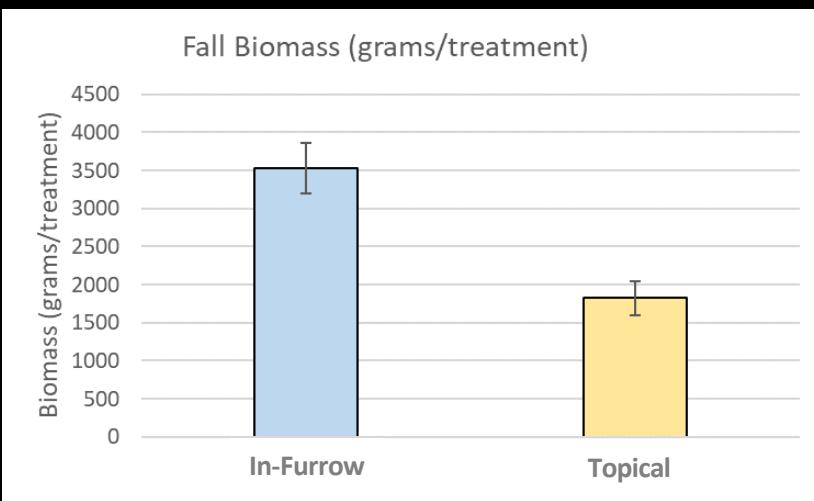
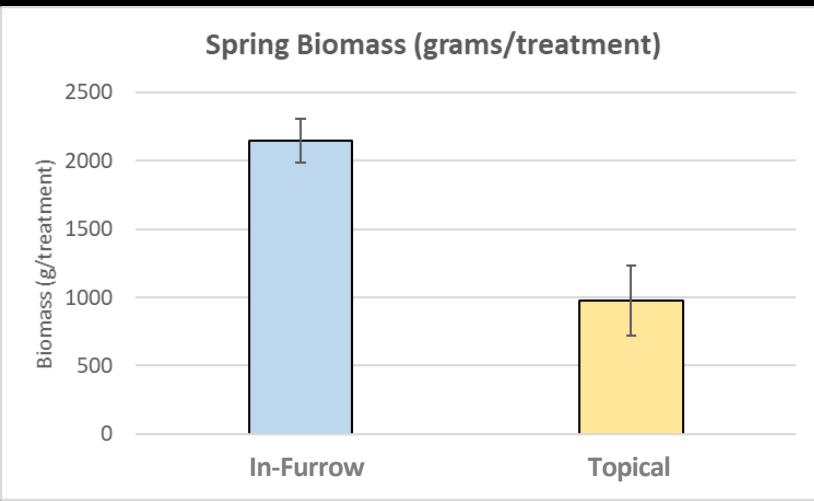
~ 50 bacteria/0.25nl and ~2-3 fungal spores/0.25 nl

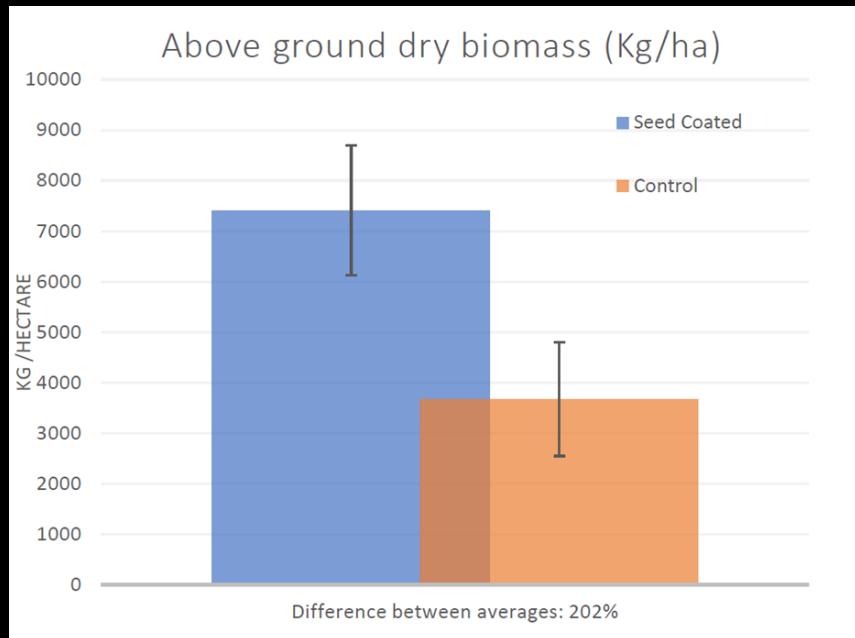
**Applied 2 Kg compost/hectare
in 180 liters water
No Brewing!**

~ 900 million bacteria/m²
~18-54 million fungal spores/m²

Topical vs. In-Furrow Injection





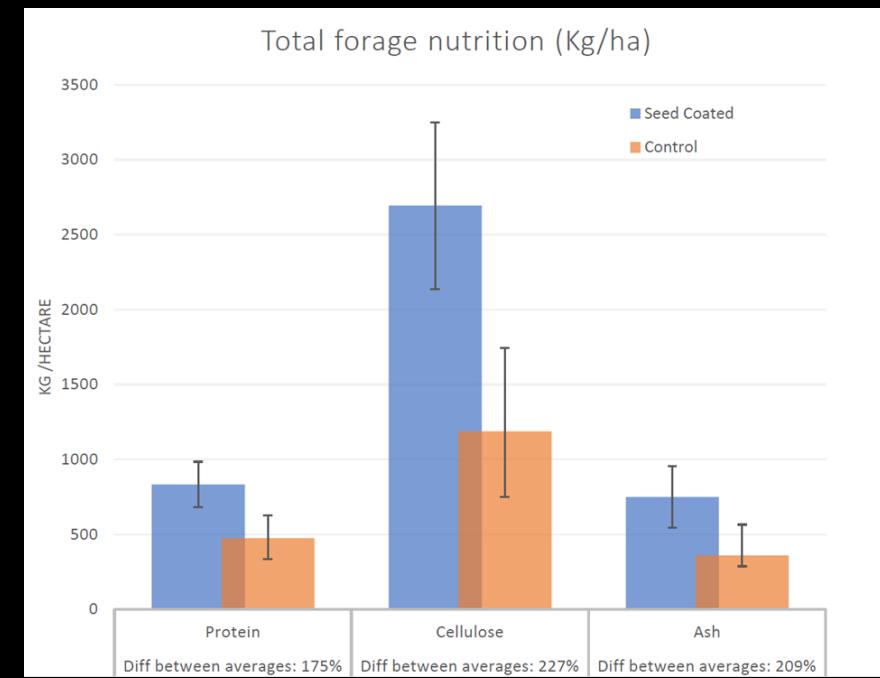


Seeding

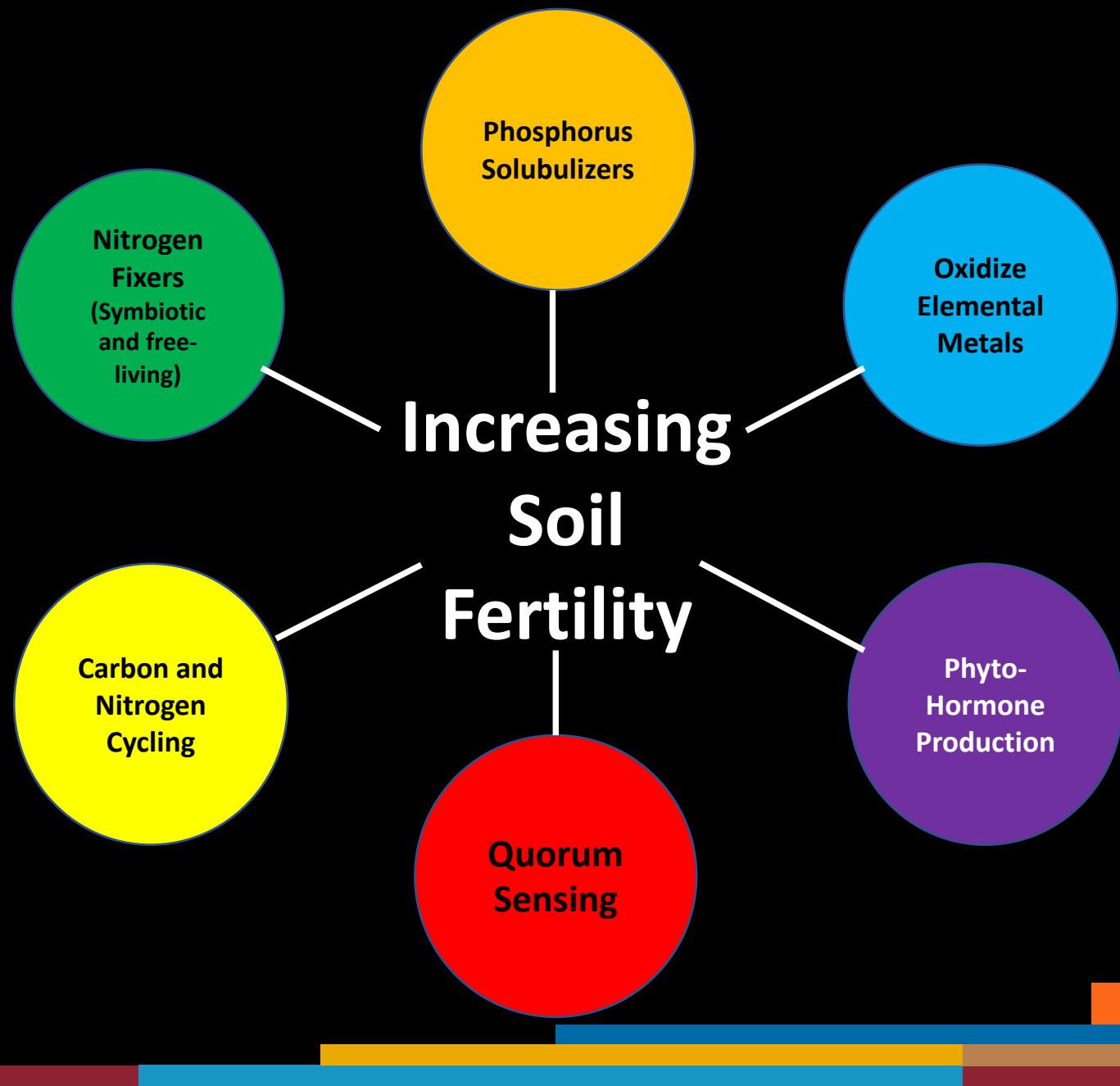
- Crops: Radish, field peas, moha, sorghum, alfalfa.
- Experimental area: 1ha with coated seeds, 1ha as control.
- Seeding rate : 90kg/ha.
- Seeding date : 9/05/2020.
- Clay-loam soil.
- No fertilizer or amendments.
- Seed coating: Dr. David Johnson recipe.

Information

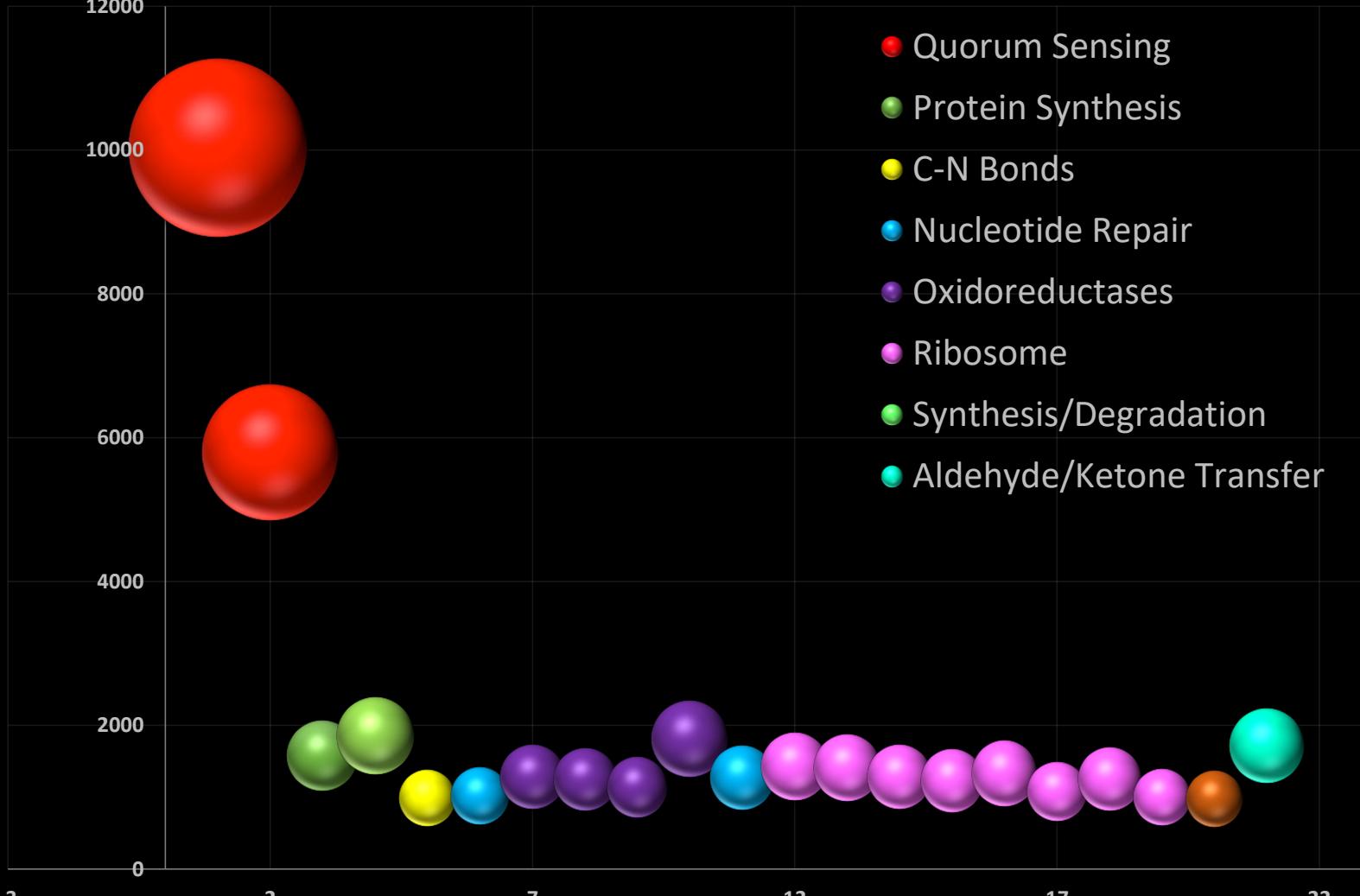
- Farmer: Géraud Dumont de Chassart
- Location: Ferme de la Sarte, Longueville, Belgium
- Seed coating: Juan de la Serna
- Data collection : David Verstraete
- Data Treatment : Juan de la Serna



What do
these
Microbes do
for your
Soils and
your Crops?



Metatranscriptome Analysis: Top 21 mRNA



4,687 mRNA, Average= 62

Total Dry Biomass
Production =
 50 g/m^2



Total Dry Biomass
Production =
 250 g/m^2



Small
Field
Trials

No Nitrogen or
Fertilizers Added

Year 7

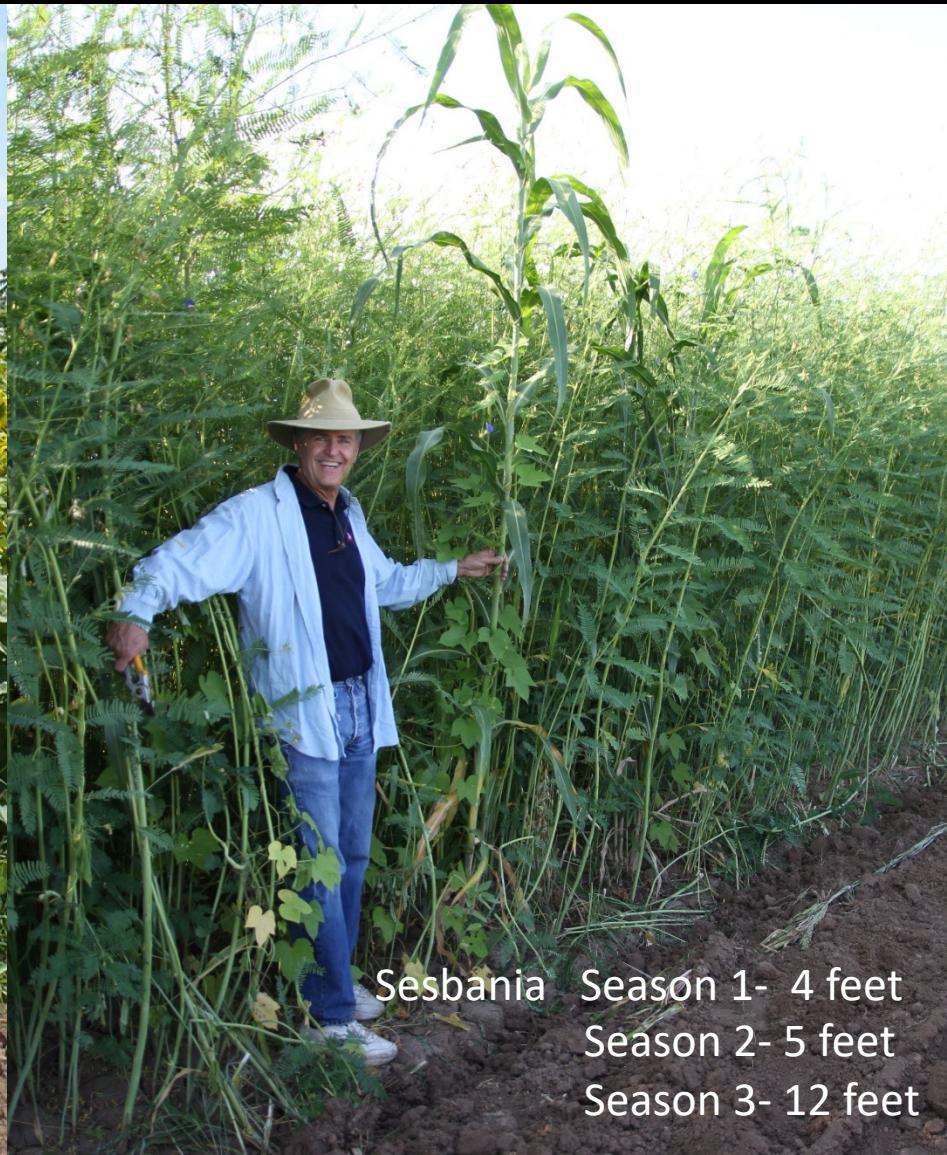


1141 g dry biomass/m²
387 kg N/ hectare

**4.5-times
Increase in
Photosynthetic
Capacity over
the Seven Year
Trial**



Black Oil Seed Sunflowers over 7 feet high



Sesbania Season 1- 4 feet
Season 2- 5 feet
Season 3- 12 feet

**Cotton 2,769 kg lint/ha (5 bales/acre)
3,764 kg seed/ha**

2017

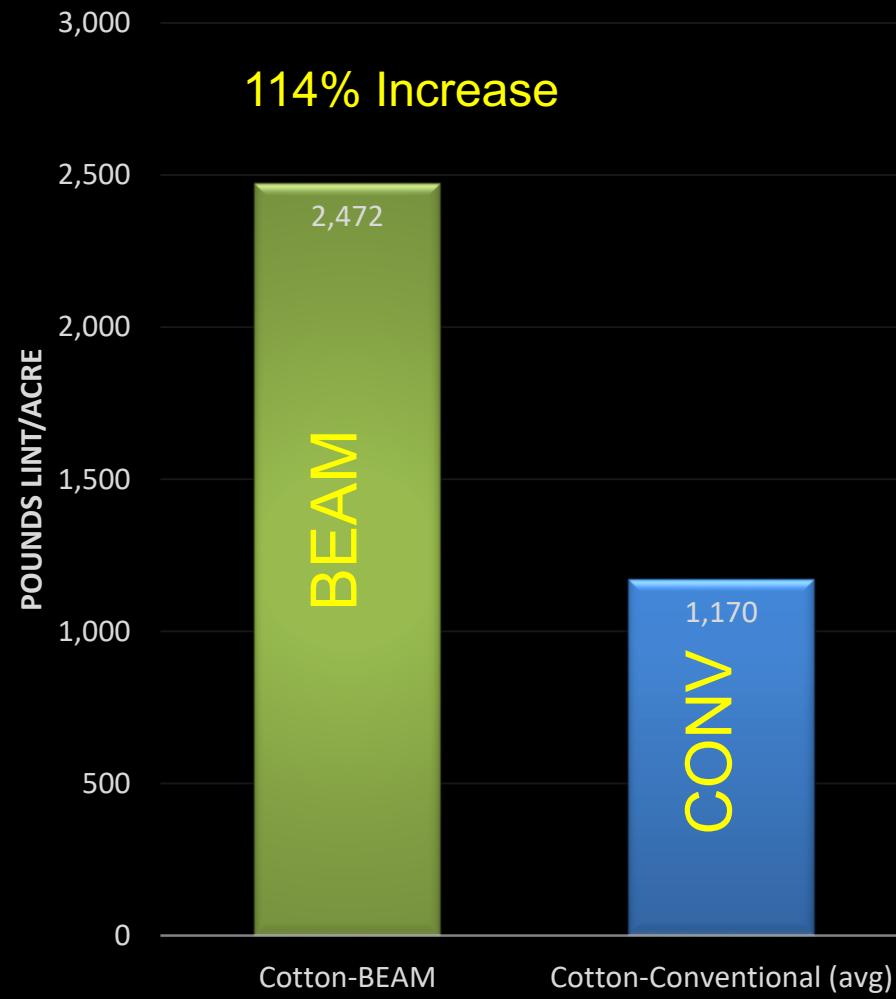


2018

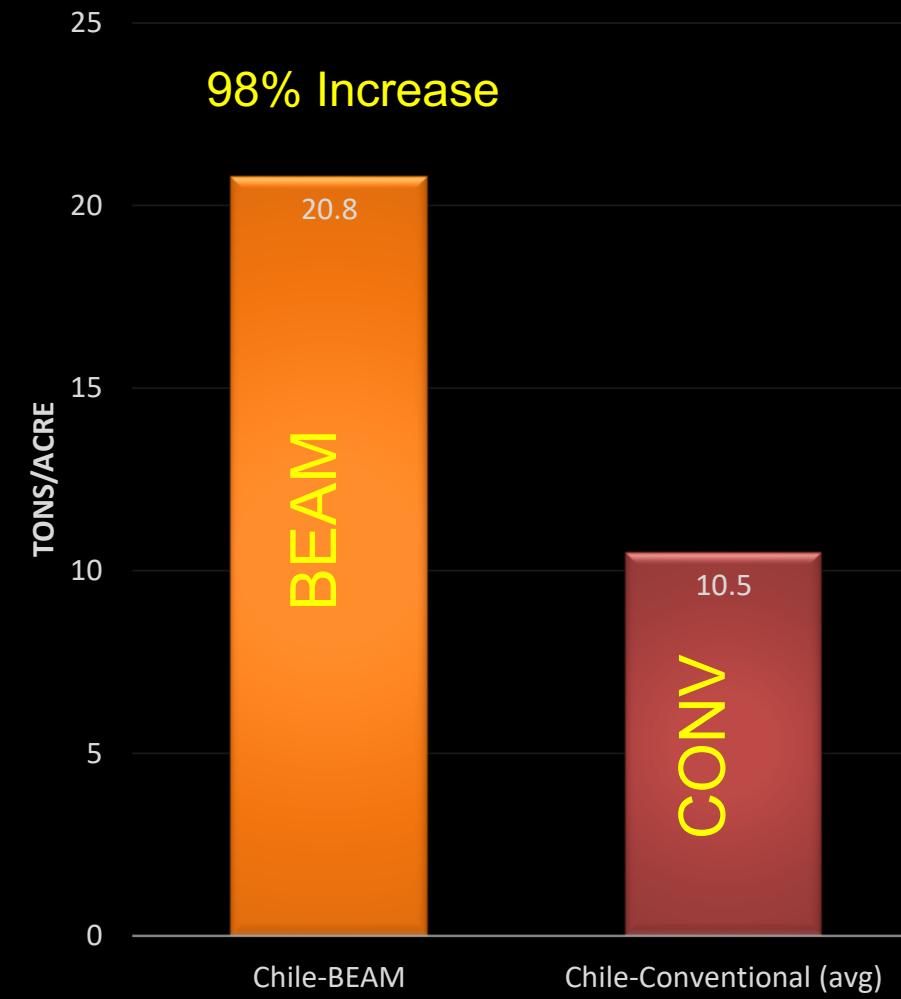


20.8 tons Chile/ac

Cotton Production

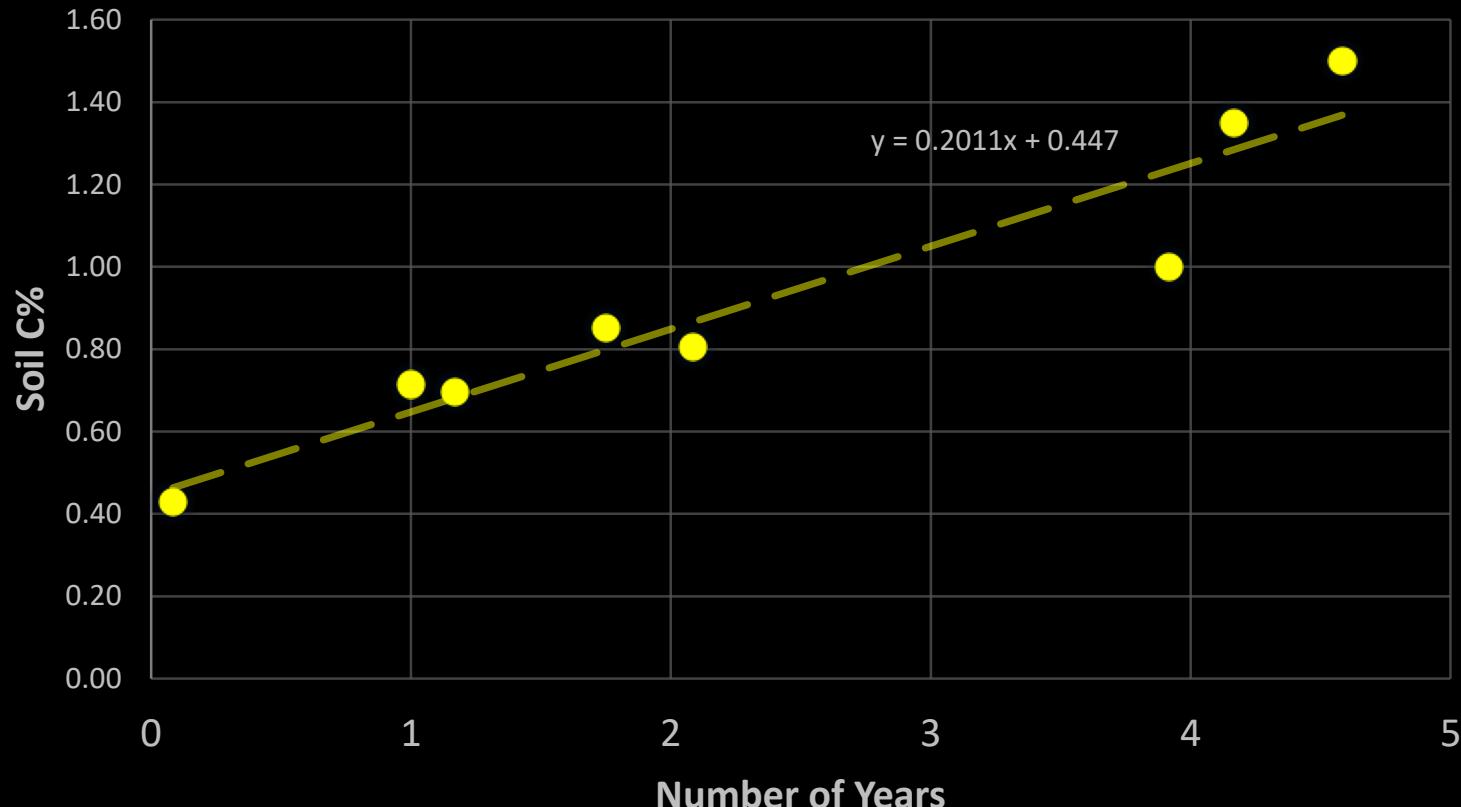


Chile Production



Soil Carbon Increase

4.5 Year Transitional BEAM Soil

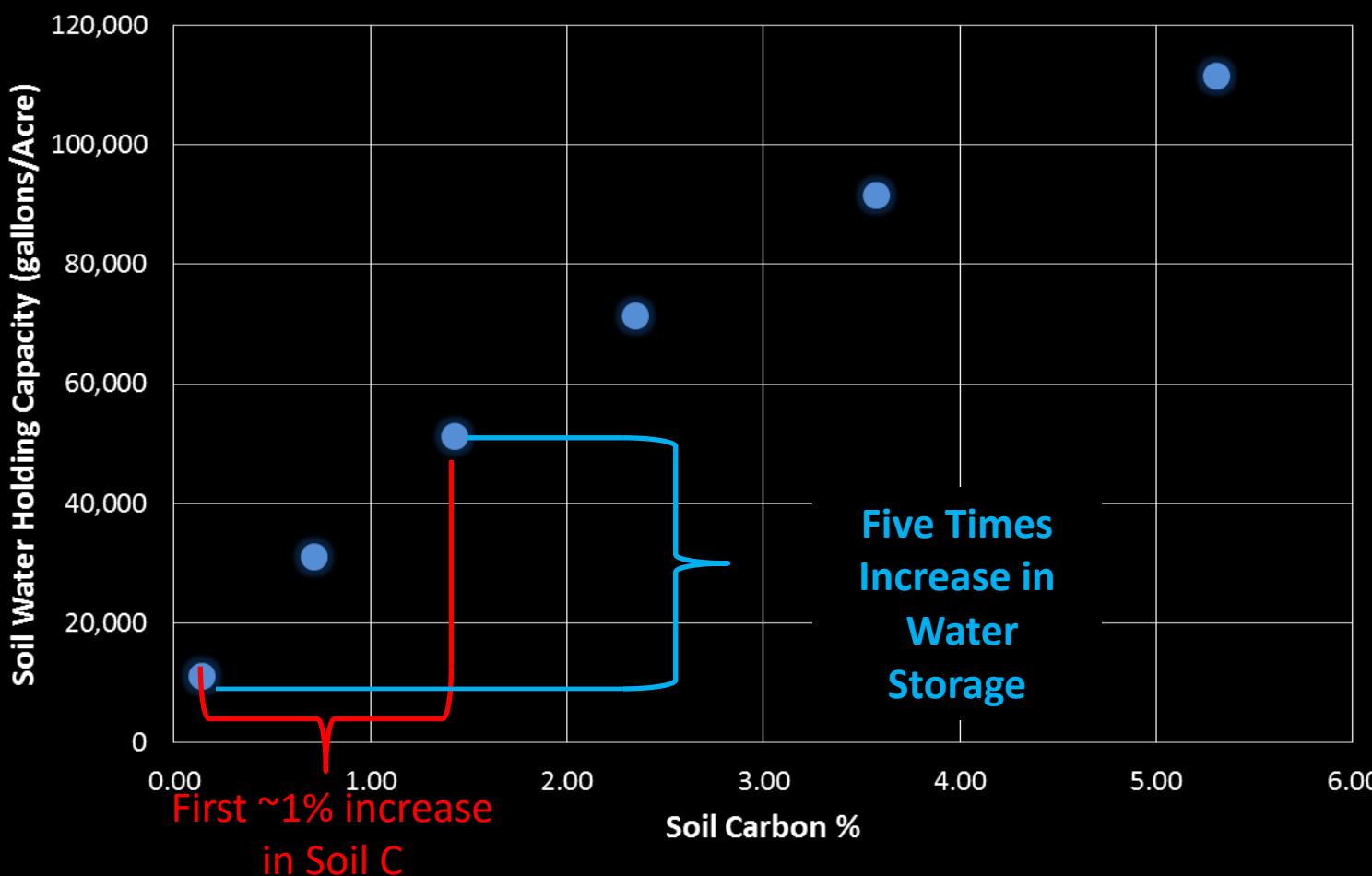


Annual 0.24% C
increase in the
top 30 cm

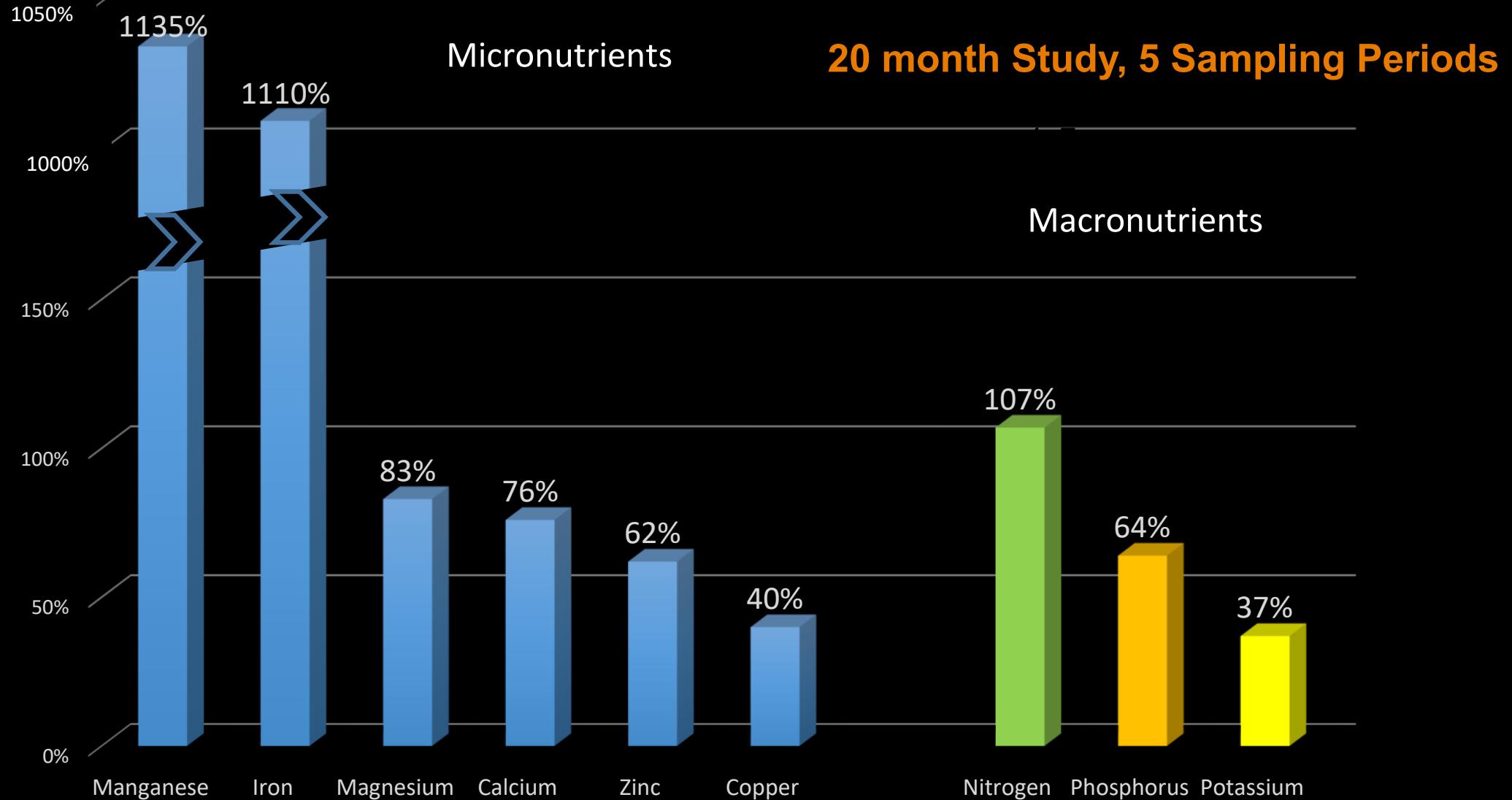
~10.7 metric
tons
C/hectare/year
or
37 metric tons
CO₂/hectare/year
captured

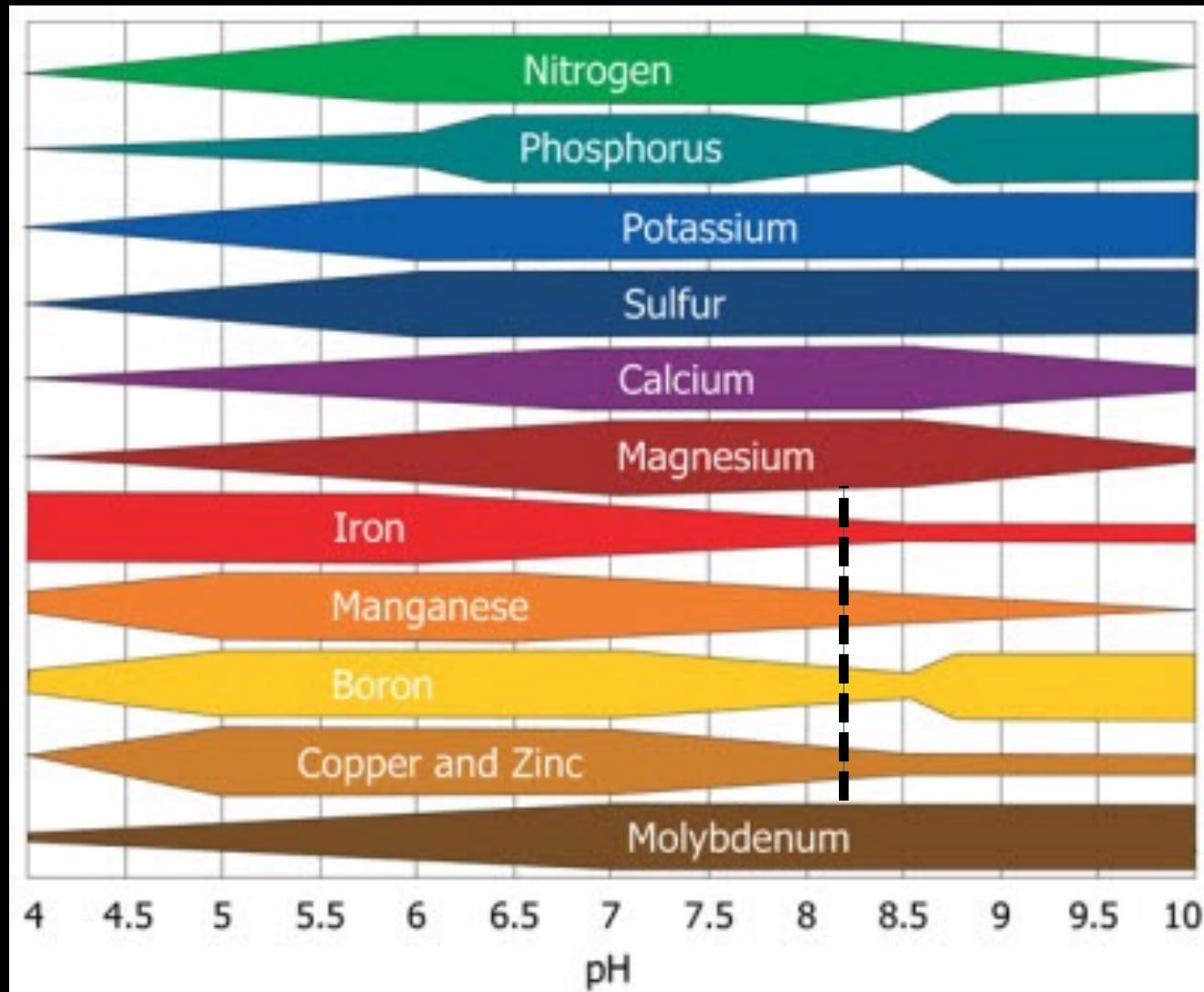
NMSU Leyendecker Plant Science Research Center; Las Cruces NM

Increases Storage and Availability Water



First 1% increase in Soil Organic Carbon Increases Soil Water Holding Capacity from 90,000 liters/ha to 450,000 liters/ha





<https://content.ces.ncsu.edu/north-carolina-soybean-production-guide/soybean-fertilization-and-nutrient-management>

Stephen Skierka (Chester, Montana)

Marias River Farms

- Farms 3000 acres and leases other land
- Saw nodulation on Chickpea roots
- 1 pound/acre rate inoculating seed before planting
- Tried chickpea intercropping with flax to control foliar disease was able to avoid applying fungicides

Chickpea side x side 2.2-acre trials

- 2 extra bushels per acre (\$55/acre extra profit)

Safflower

- Same production level
- \$25-\$35 less input costs
- Extra Profit

**BEAM
Transitioning
Results after 18 months**

Spring Wheat and Malt Barley

- 2 bushel/acre less compared to Conventional
- \$25-\$35/acre savings on inputs
- \$10/bushel/acre grain cost
- Subtract those two he was still \$15 -\$25/acre ahead
- Spring Wheat protein 18.5% for BEAM inoculated and Conventional was 16.5%

Field Research on Corn

Corn production has the highest land area
devoted to crop production in the US at 37
million hectaress,

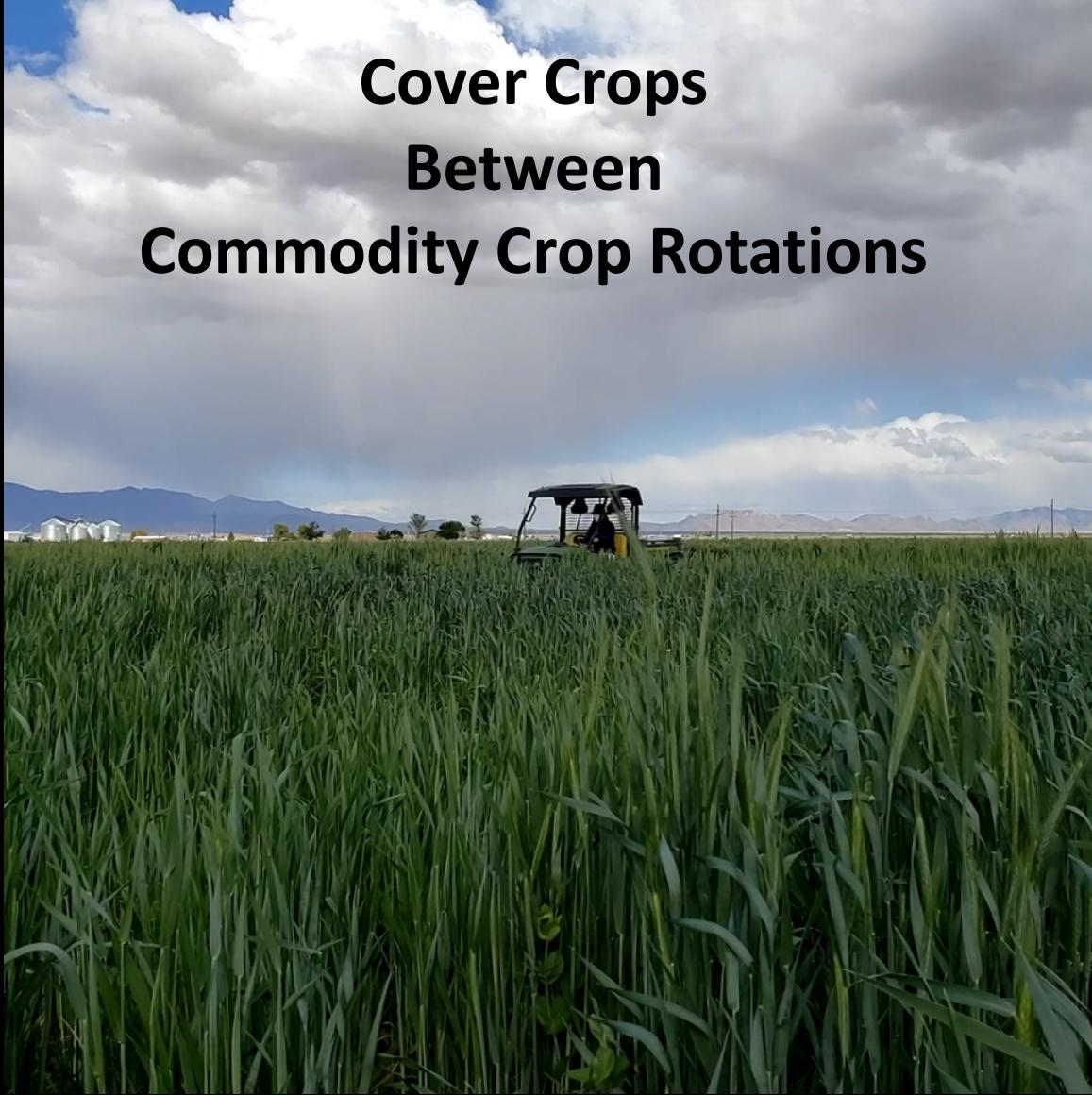
Uses 43% of total N applied in the US,

Uses three times more synthetic-N
than any other crop by mass

(USDA-EMIS, 2019)



Cover Crops Between Commodity Crop Rotations



**Plant into Rolled
Cover Crops**

200 bushel corn with no Nitrogen and No phosphorus. Only compost extract from Johnson Su Bioreactor

Jay Young
Young Red Angus
Greely County, Kansas



Johnson-Su Compost	No N or P	200 bu/acre	\$1,000/ac
Johnson-Su Compost	90# N	242 bu/acre	\$1,115/ac
Conventional	180# N + P	238 bu/acre	\$1,000/ac

https://www.youtube.com/watch?v=KrewSDMH_AI

Stella McCartney Cotton Project in Turkey Soktas



Images Courtesy of Soktas

nr	application	Terms of appl.	explanation	input	amount
1	Deep cultivator	april		-	-
2	fertilizer	april	npk	15-15-15 fert	350 kg/ha
3	fertilizer	april		urea % 46 azot	100 kg/ha
4	discharrow	april	mixing fert. With soil	-	-
5	Cultivator with roller	april		-	-
6	Harrow	april		-	-
7	Herbicide	end of apr-beg may	before seeding	stomp extra	3 kg/ha
8	Seed drill	end of apr-beg may	Seed type : Bayer Gloria	bayer Gloria	40/kg/ha
9	Herbicide	3-4 leaves	Syngenta Envoke 75		150 gr/ha
10	Pesticide	3-4 leaves	Abamectin	Abamectin	400 gr/ha
11	Insecticide	3-4 leaves	DİMETHOATE	DİMETHOATE	600 gr/ha
12	Insecticide	3-4 leaves		IMIDACLOPRİD +BETA CYFLUTHRİN	200 gr/ha
13	Insecticide	4-6 leaves		EMEMACTİN BENZOATE	400 gr/ha
14	fertilizer	before 1. irrigation		Amonium sulfate	250 kg/ha
15	fertilizer	before 1. irrigation		Amonium nitrate	250 kg/ha
16	Foliar nutrition		spray	amino acid	1000 gr/ha
17	Foliar nutrition		spray	zinc	1200 gr/ha
18	Herbicide		spray	Clethodim	750 gr/ha
19	Irrigation	40-45 days after germination			
20	Foliar nutrition	after 1. irrigation	spray	NPK content	1250 gr/ha
21	Irrigation	15-25 days after 1. irrigation			
22	Foliar nutrition		spray	K content	1000 gr/ha
23	Irrigation	15-25 days after 2. irrigation			
24	Defoliation	End of sep-mid of oct	Depending on wheather	Bayer Finish + Dropp Ult	600 gr+2500 gr/ha
25	Harvest				
26	Mulching	After harvest	Mulcher		

Observations of the Farmers from Turkey:

- 85% less fertilizer used with no yield impact. Yields were better than cotton fields that received 100% fertilizer application = **HUGE COST SAVINGS**
- Yields were 4.2 metric tons cotton/ha (3,748 lb/acre)
- Crops did well despite government restricted irrigation and low rainfall (two irrigation events)
- No herbicides were used due to good weed suppression from the cover crop (100% displacement!)
- Observed biodiversity in their soil that they had not seen since their childhood!
- Have now taken this method to Romania for grain and oil seed crop production.



Images Courtesy of Soktas

Paul Tranfield of Victoria, Australia



Chestnut



<https://www.csuchico.edu/regenerativeagriculture/bioreactor/citizen-science/index.shtml>

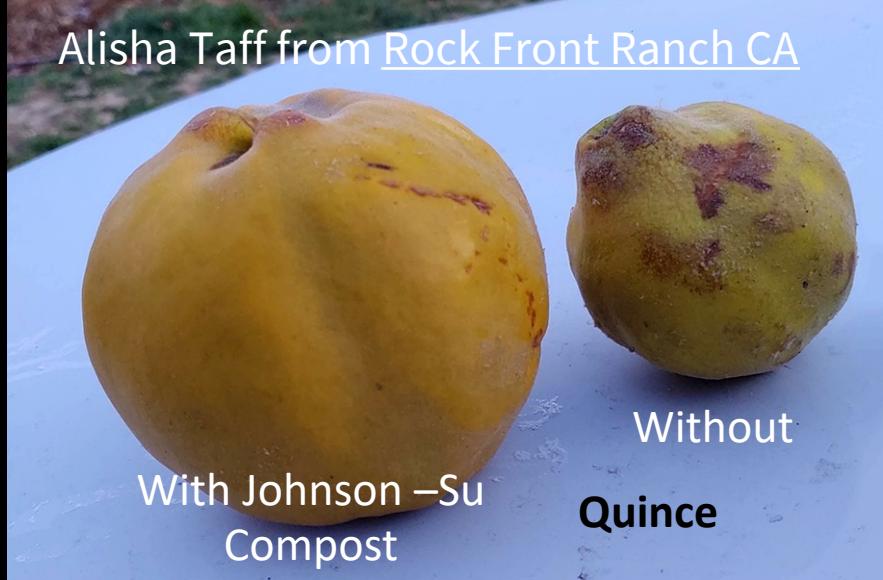
User Observations

Rod Rance & Rachel Ryan



4-5lbs. of flower
bud weight per
plant
Normal is 1-1.5lbs

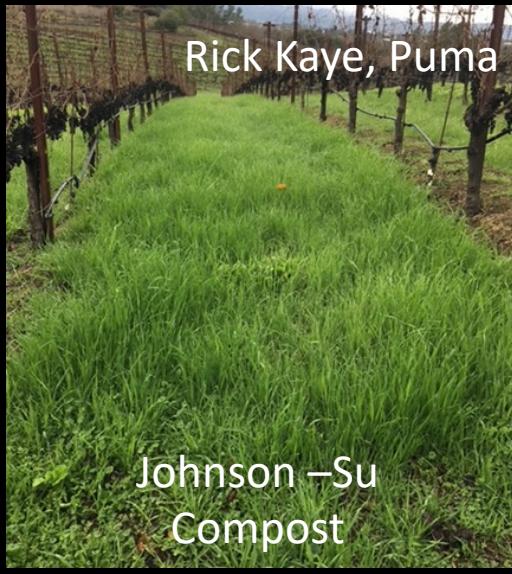
Alisha Taff from Rock Front Ranch CA



With Johnson –Su
Compost

Without
Quince

Rick Kaye, Puma



Johnson –Su
Compost

Springs Vineyards,
Healdsburg, CA



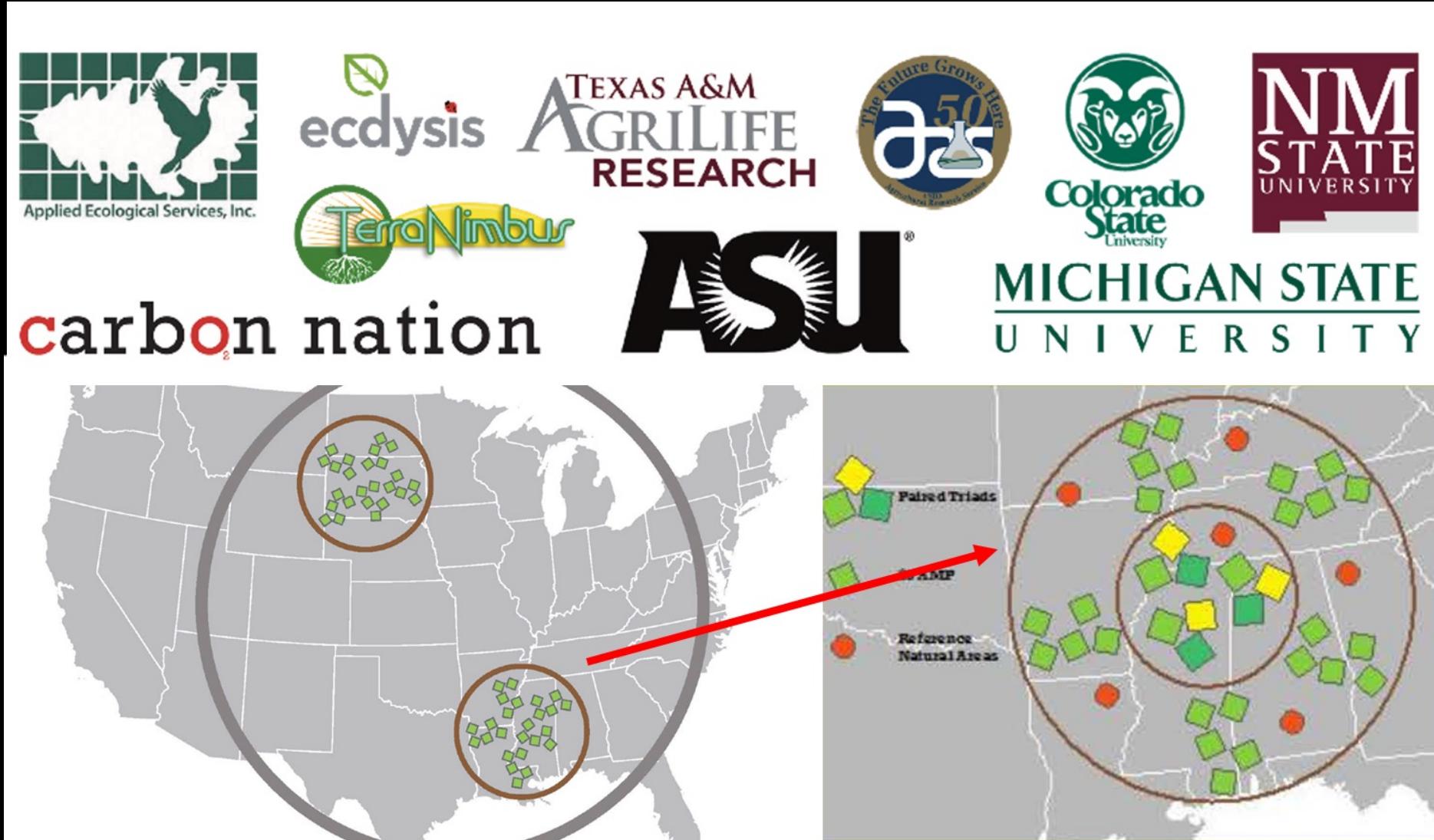
Organic
Compost

Regenerative Practices Using Cover Crops Promotes:

- 1. Soil Surface Protection and Lower Soil Temperature**
- 2. Reduced Evaporation and More Efficient Use of Water**
- 3. Soil Carbon Increase as Forage for Soil Microbes and Beneficial Insect Communities**
- 4. Increases Cycling and Availability of Nutrients for Commodity Crops**
- 5. Higher Profits and Fewer Inputs**
- 6. A Major Shift from Bacterial Dominance to Fungal Dominance**

Adaptive Multi- Paddock Grazing (AMP) vs. Continuous Grazing (CG)

<https://peerj.com/articles/13750>

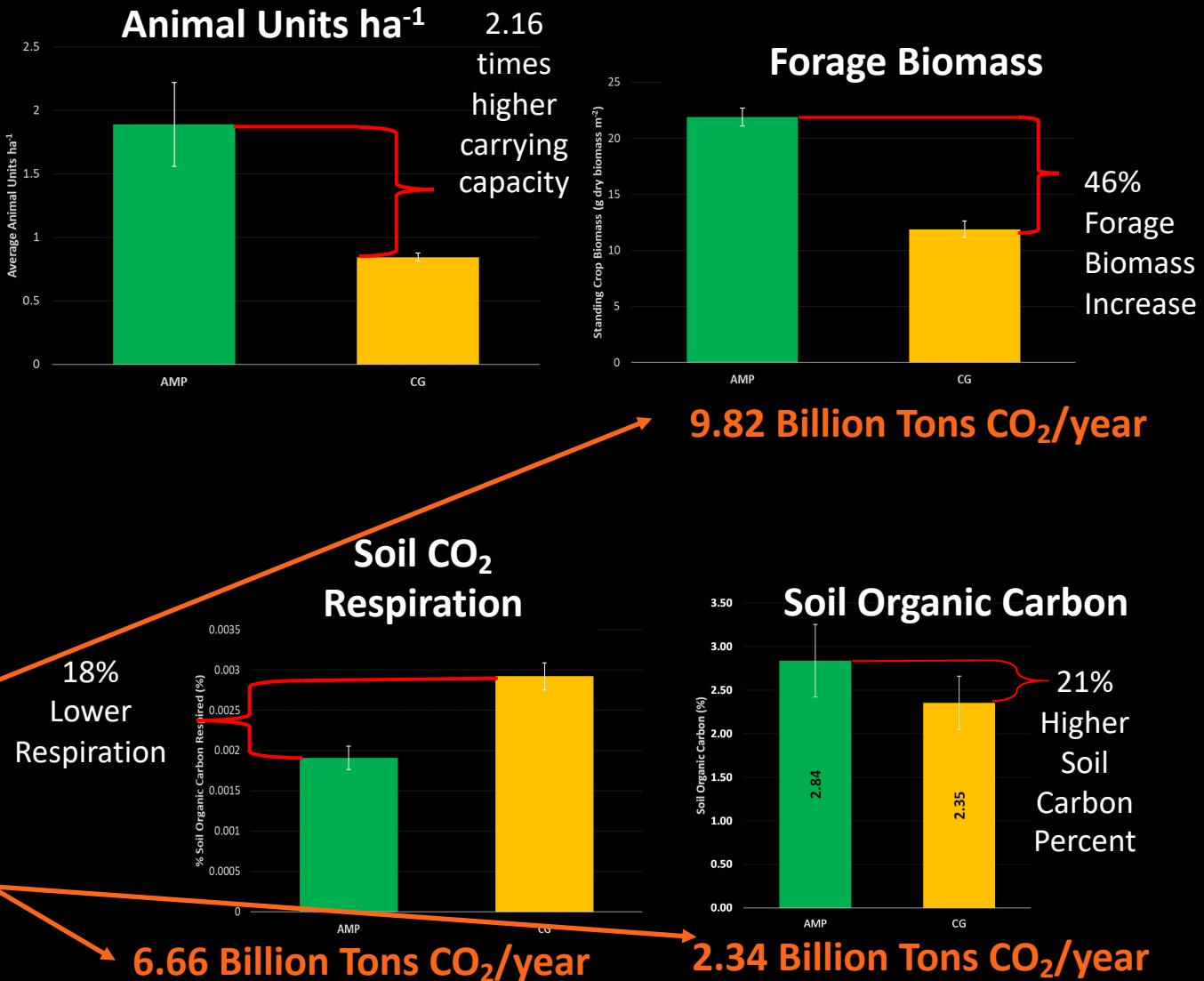


AMP Grazing Systems Promoted:

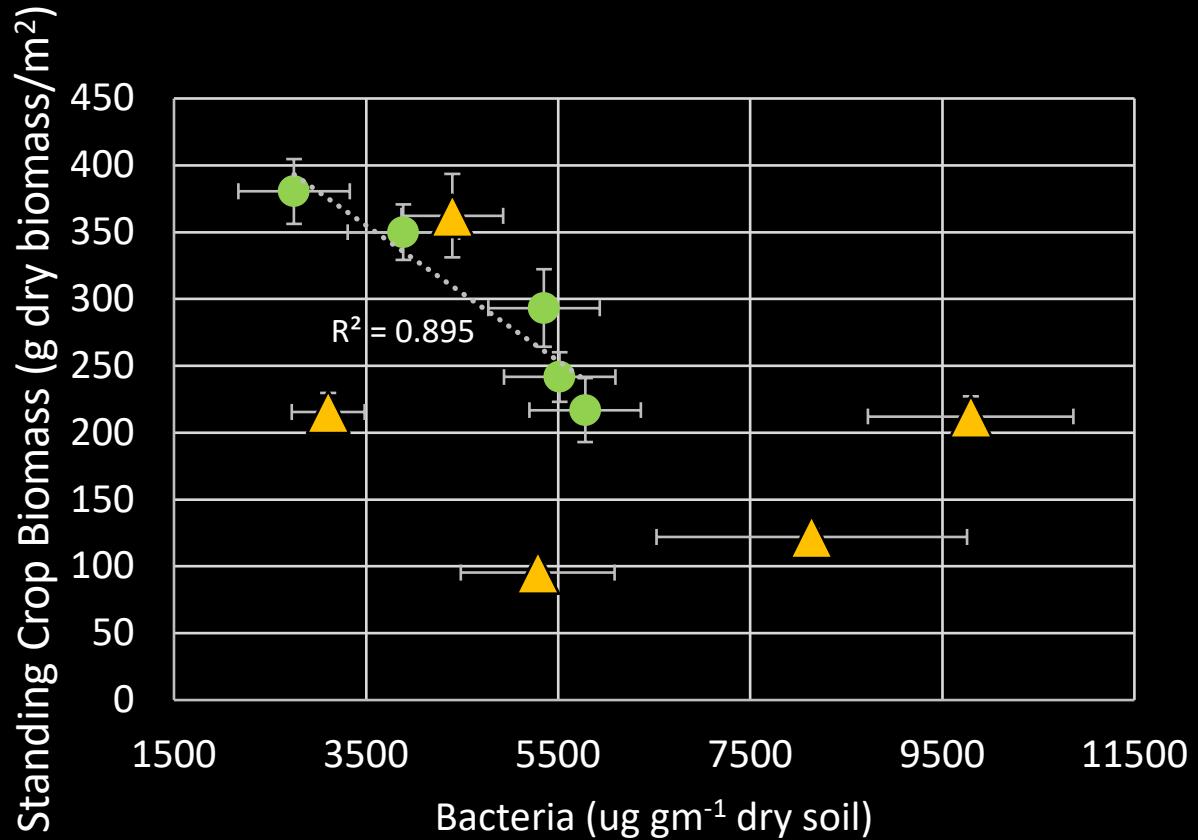


1.25 billion hectares of savannahs and grasslands

<https://peerj.com/articles/13750>



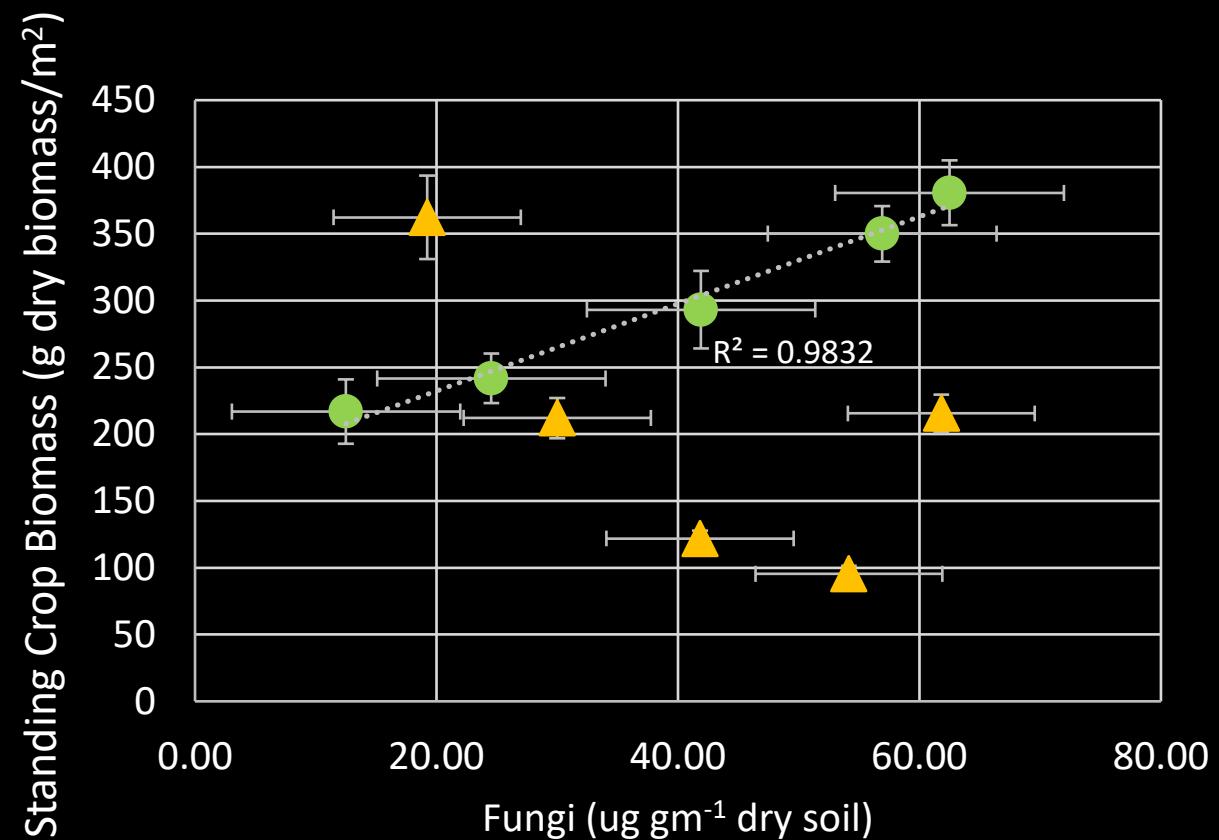
Soil Foodweb Analyses



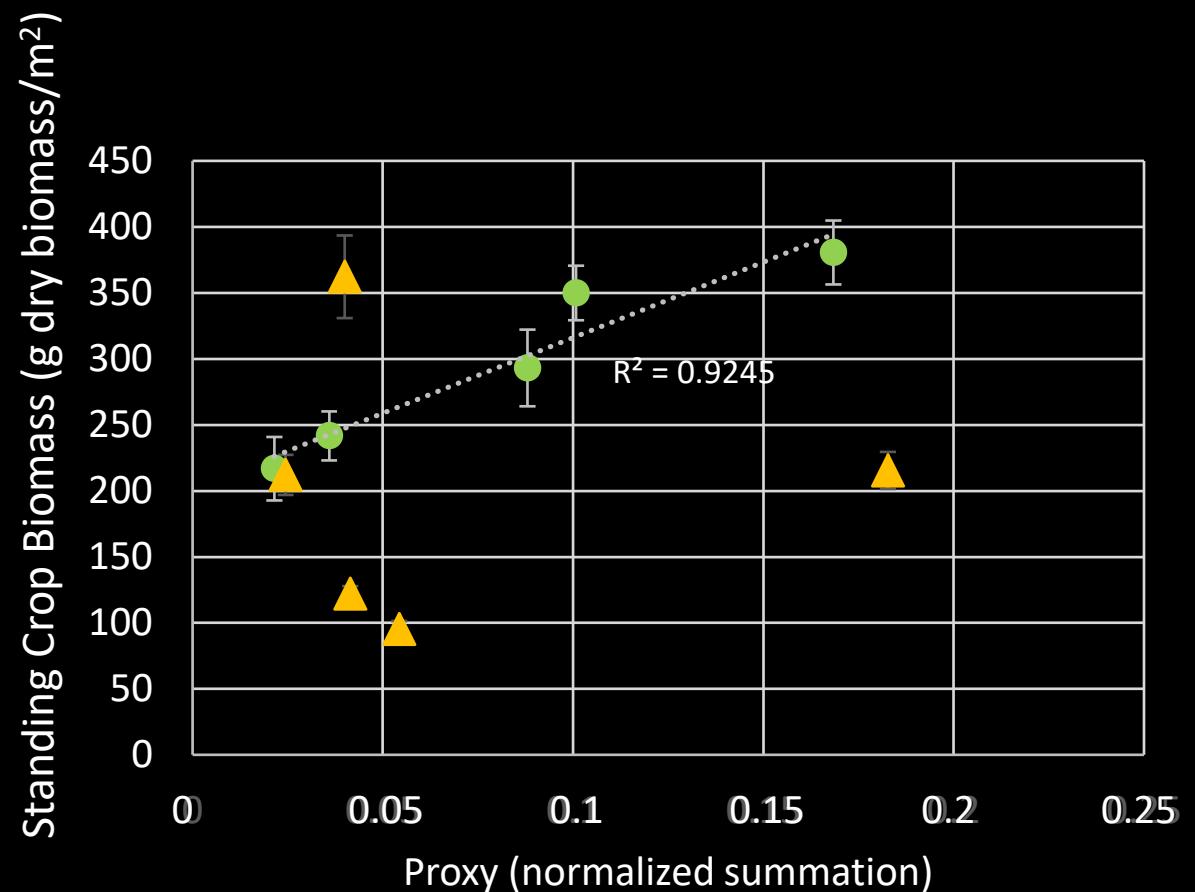
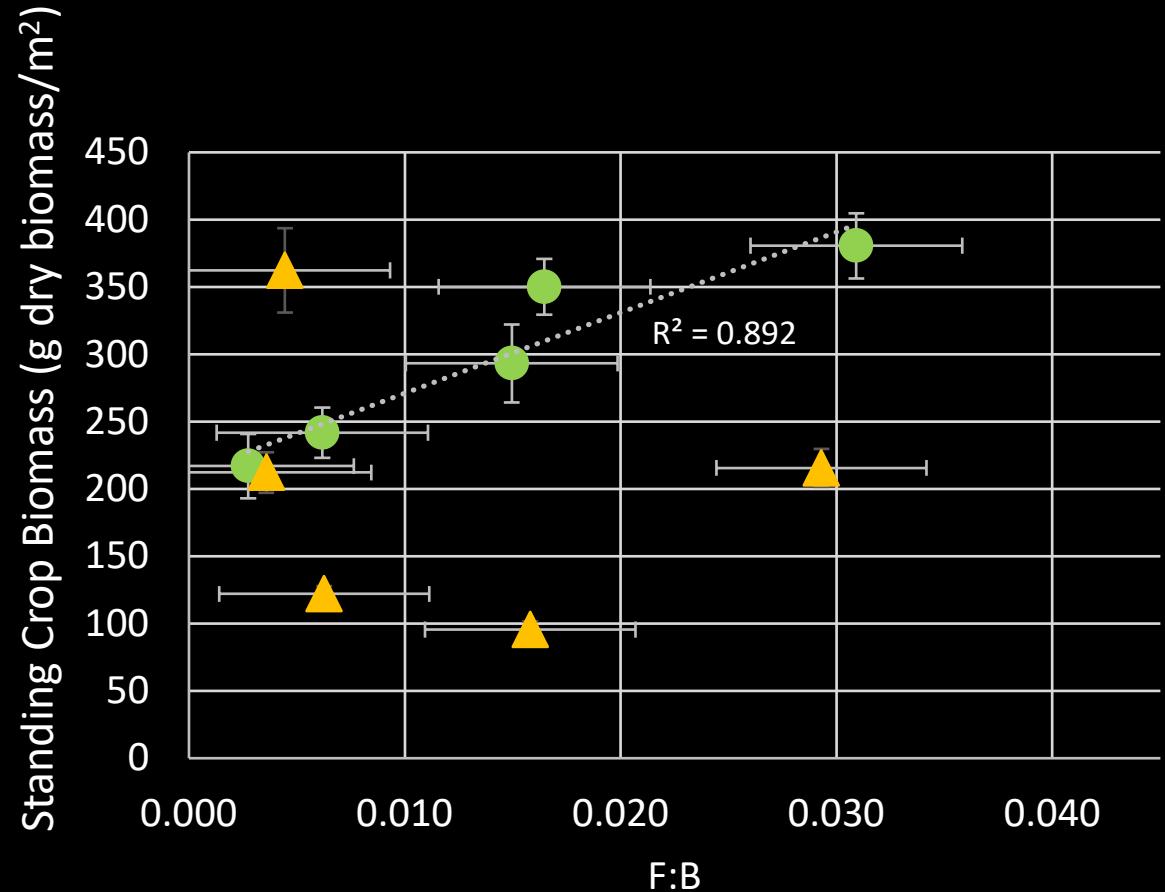
AMP-

CG-

<https://peerj.com/articles/13750>



Soil Foodweb Analyses

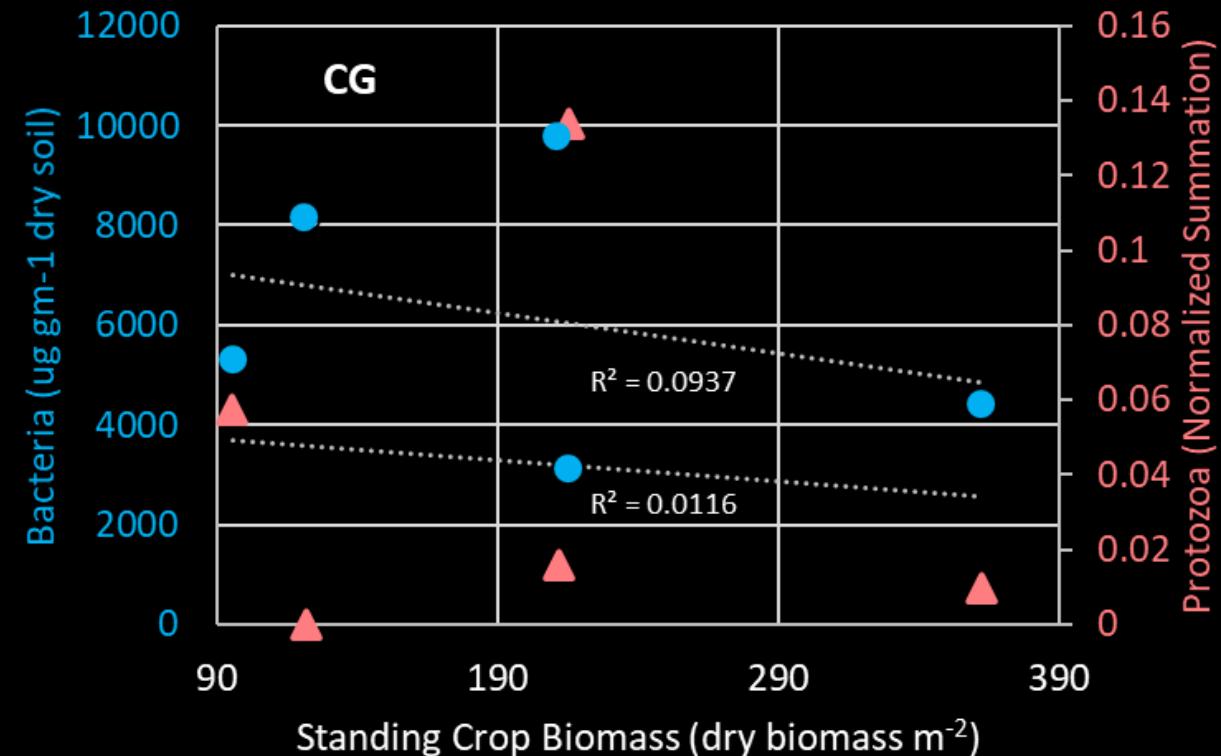
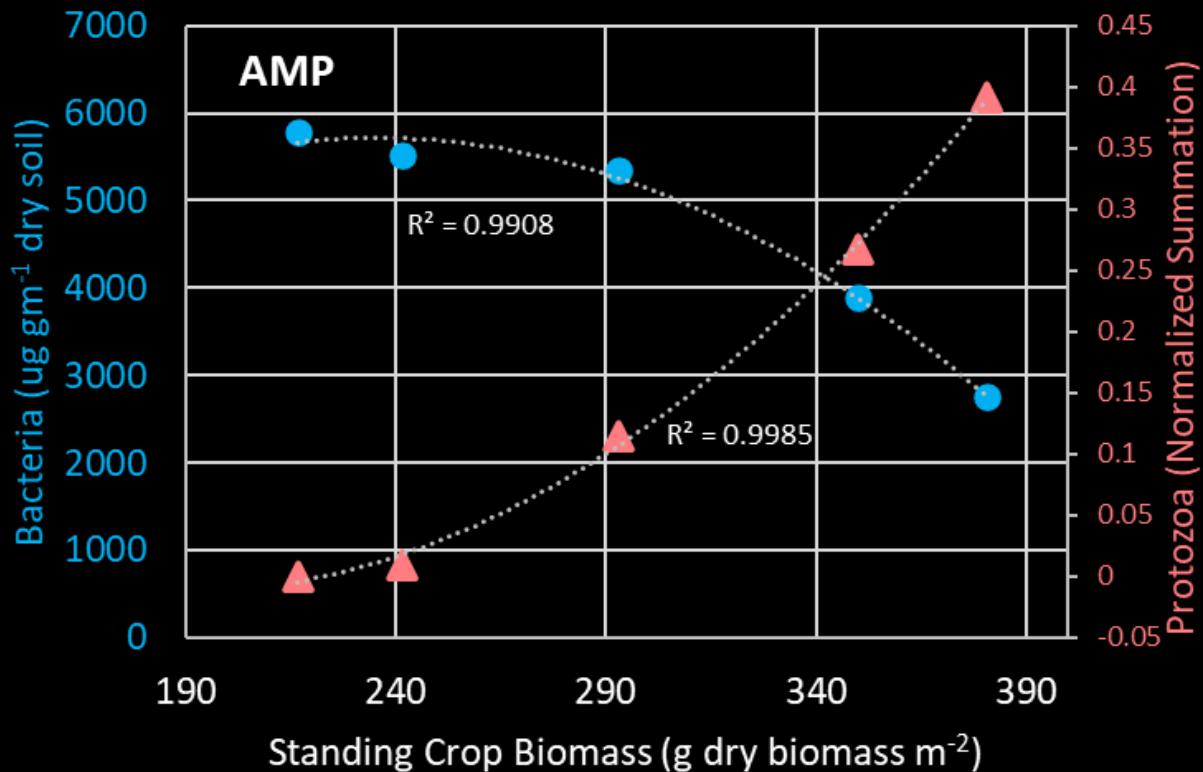


AMP-

CG-

<https://peerj.com/articles/13750>

Predator Prey Relationships



<https://peerj.com/articles/13750>

Against all odds: turning sand into profit



PROSPECT PASTORAL COMPANY

Farm Facts

Wyalkatchem, Dowerin, Cunderdin and Meckering districts, around 190 km north east of Perth, WA Central Wheatbelt

Enterprise: Crops. Sheep. Cereal grains and cereal hay crops; specially bred sheep for wool and premium grade fat lambs

Property Size: 8000 hectares

Average Annual Rainfall: 200-300 mm (home farm)

Elevation: 320 m (home farm)



Ian & Diane Haggerty
20,000 Hectares

<https://soilsforlife.org.au/prospect-pastoral-company-against-all-odds-turning-sand-into-profit/>

Ian & Di Haggerty's Field



Courtesy of Nicole Masters



Courtesy of Ian and Diane Haggerty



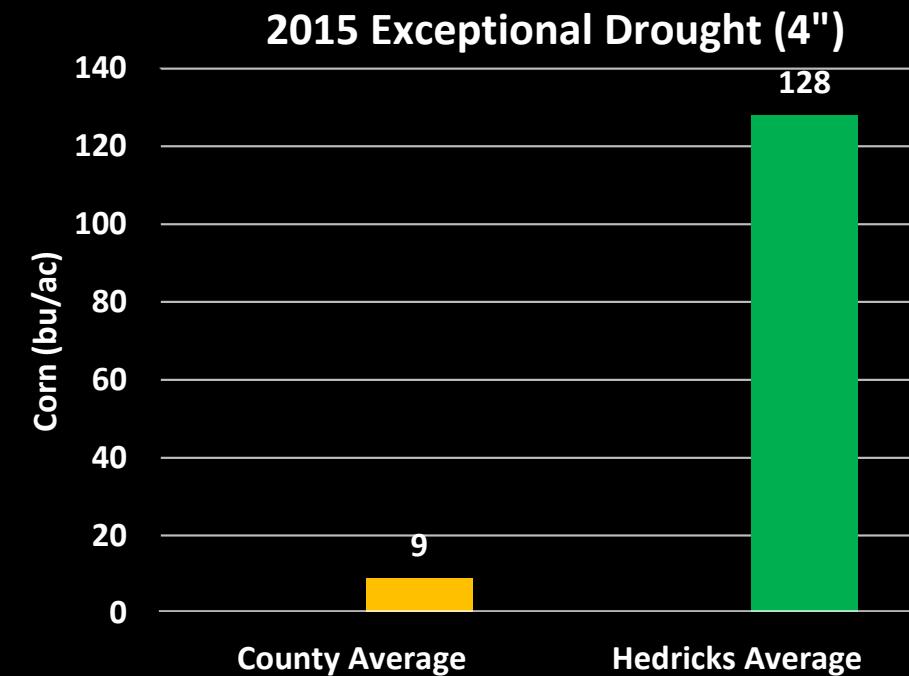
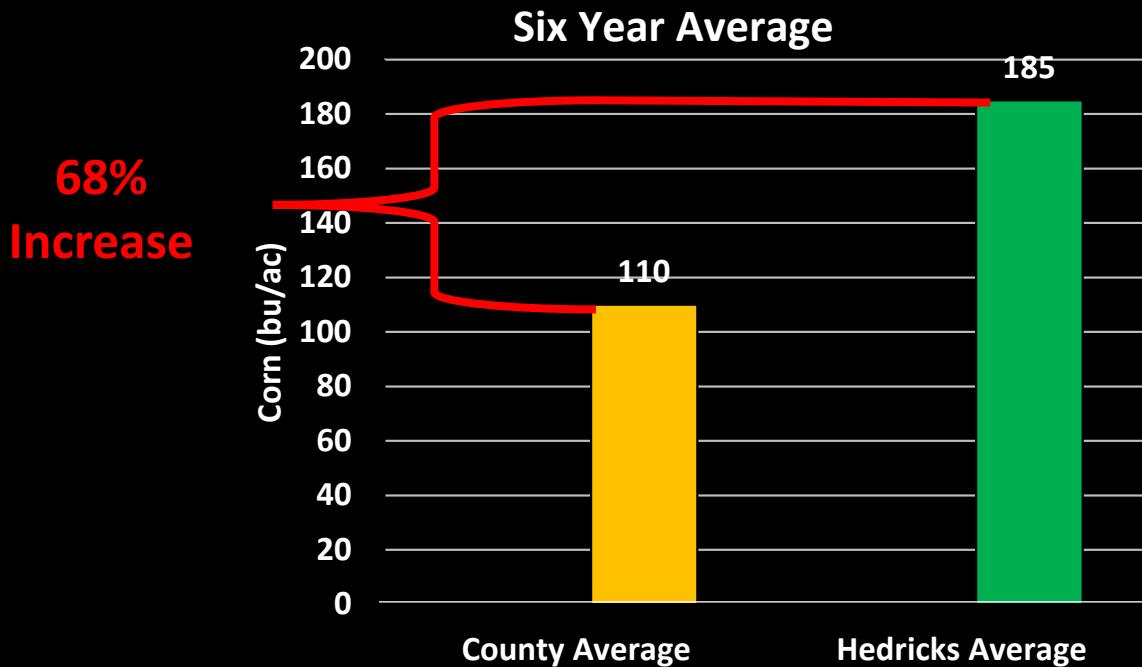
<http://www.futuredirections.org.au/wp-content/uploads/2017/08/FDI-Feature-Interview-Ian-and-Di-Haggerty.pdf>

Russell Hedrick (JRH Grain Farms)

Hickory, North Carolina

- Full-time Cover or Commodity Cropping
- Introduced Cows, Sheep & Pigs
- 80% reduction in fertilizer application
- No Fungicides or Pesticides in the last six years

Corn Production



<https://regenfarming.news/articles/454-us-farmer-interview-russell-hedrick>



Alejandro
Carrillo



Conventionally Managed



Images by Allen R Williams, Ph.D.

Adaptive MultiPaddock Grazing



Images by Allen R Williams, Ph.D.



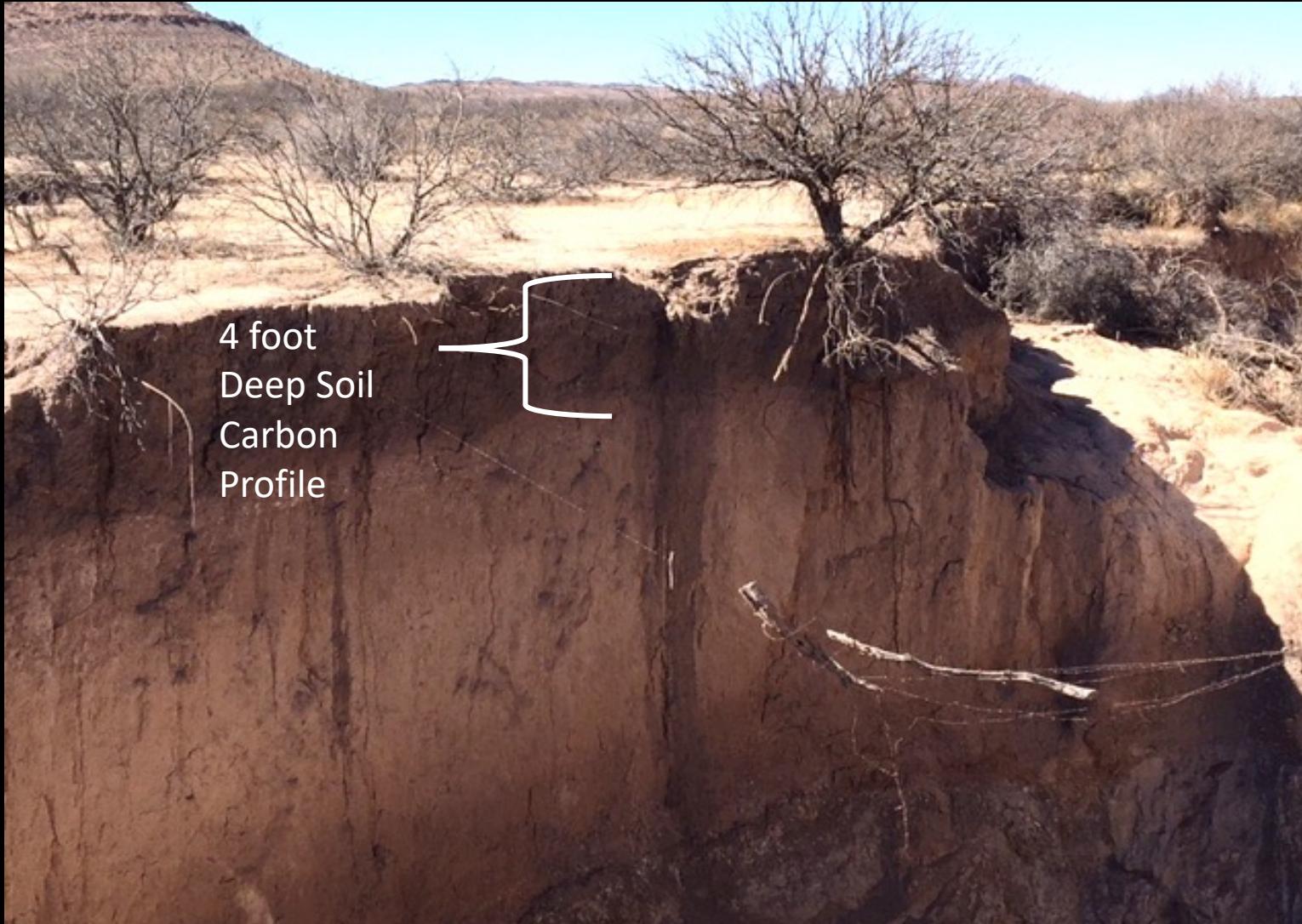
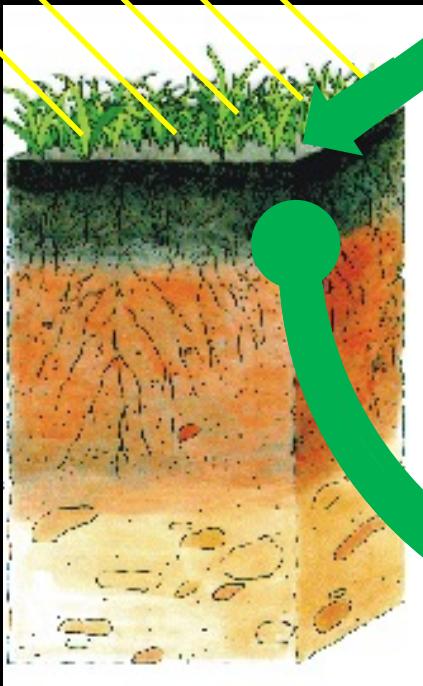


Image by Allen R Williams, Ph.D.

Positive Feedback Loop

Photosynthesis

Sunlight



Photosynthetic Capacity

Soil Microbiome Population

Photosynthates to Feed
Soil Microbes

Soil
Microbiome

Fix Nitrogen
from the
Atmosphere

Extract
Elemental
Nutrients from
Soil Parent
Material

https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/office/ssr7/profile/?cid=nrcs142p2_047970

Compost on a large scale: Regenerating 1000 acres: With Cory Miller and Kevin Lackey

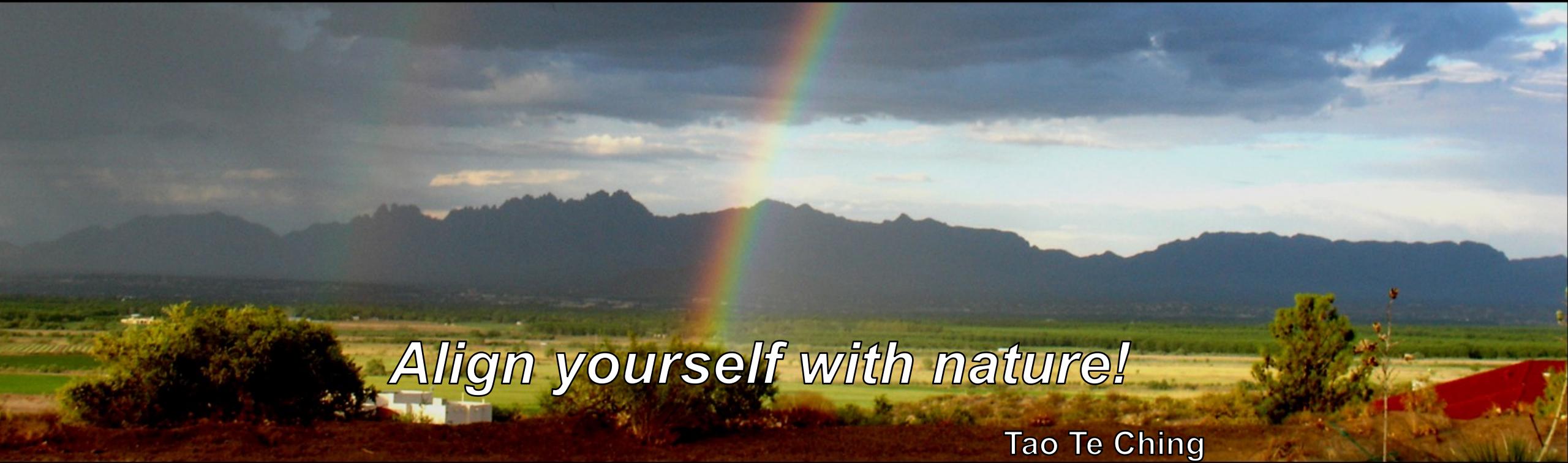
Regenerating 1000 acres: With Cory Miller and Kevin Lackey



Regenerating 1000 acres: With Cory Miller and Kevin Lackey



https://youtu.be/gZnIRC-9_O8



Align yourself with nature!

Tao Te Ching



<https://www.youtube.com/channel/UCVSSTOJVSSuRcCu68IMcsEA>

Regenerating 1000 acres: With Cory Miller and Kevin Lackey

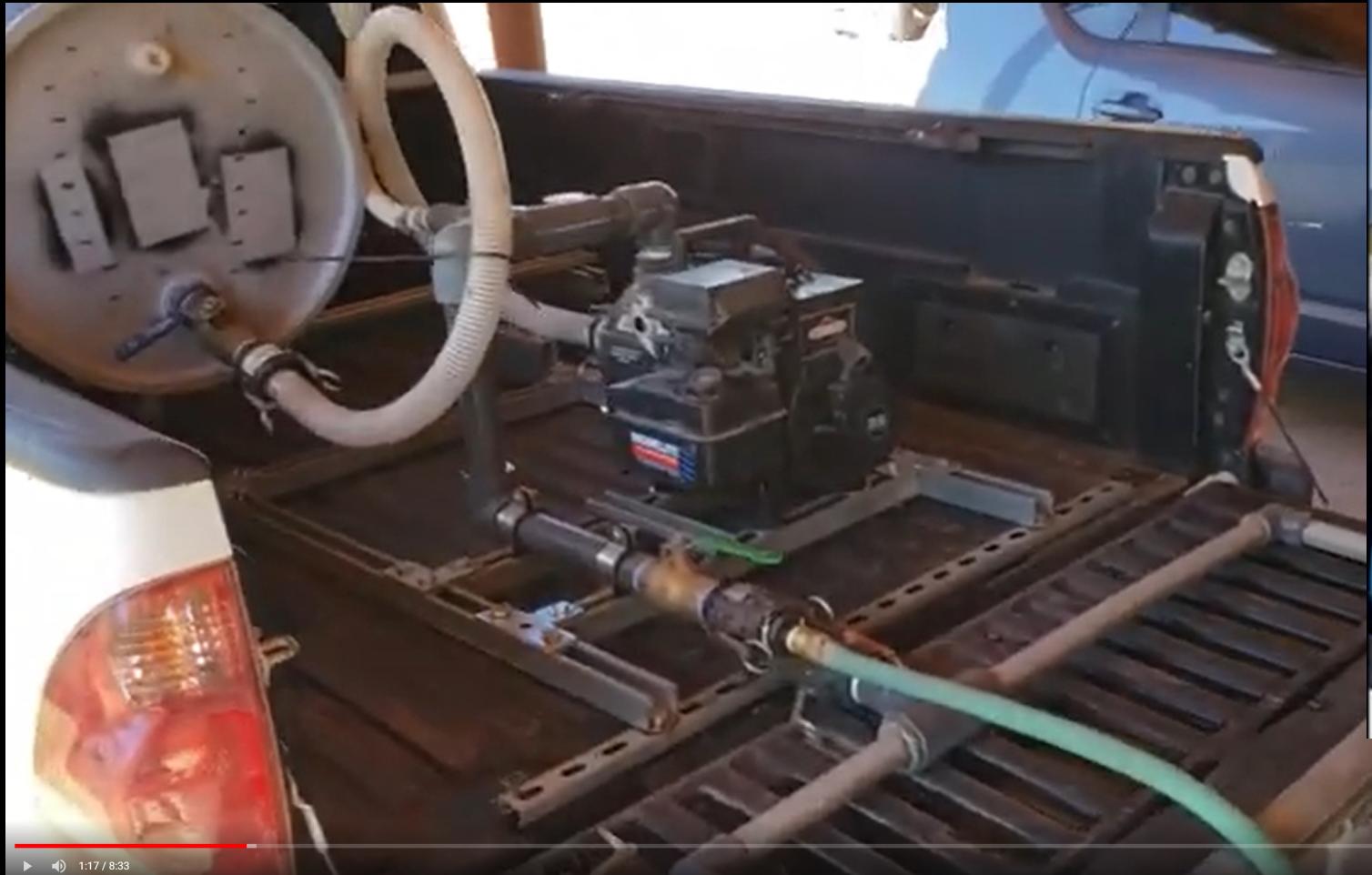


Cory Miller and Kevin Lackey Extraction And Application Methods

https://youtu.be/gZnIRC-9_O8

Extractor

<https://youtu.be/8ADdXIFdsqo>



Johnson-Su Bioreactor



<https://youtu.be/DxUGk161Ly8>



<https://youtu.be/DxUGk161Ly8>