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

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College of Engineering

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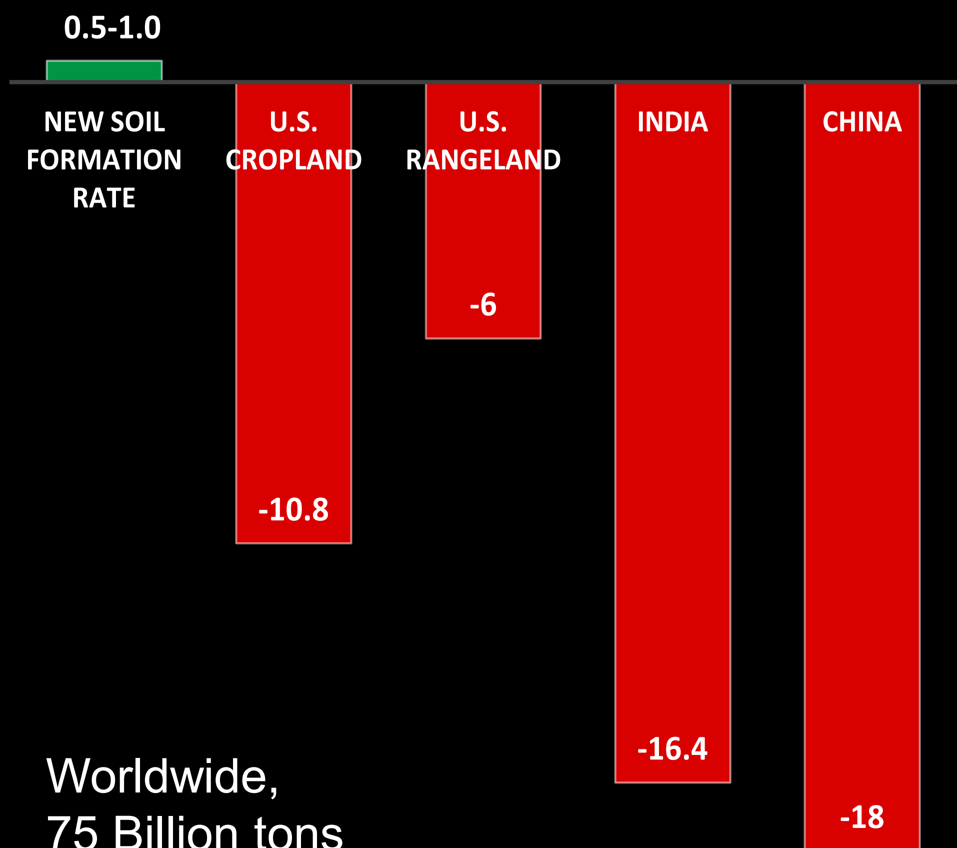
Soil Loss From Water and Wind Erosion

(Metric Tons/Hectare/Year)



Worldwide,
75 Billion tons
of fertile soil are lost each year

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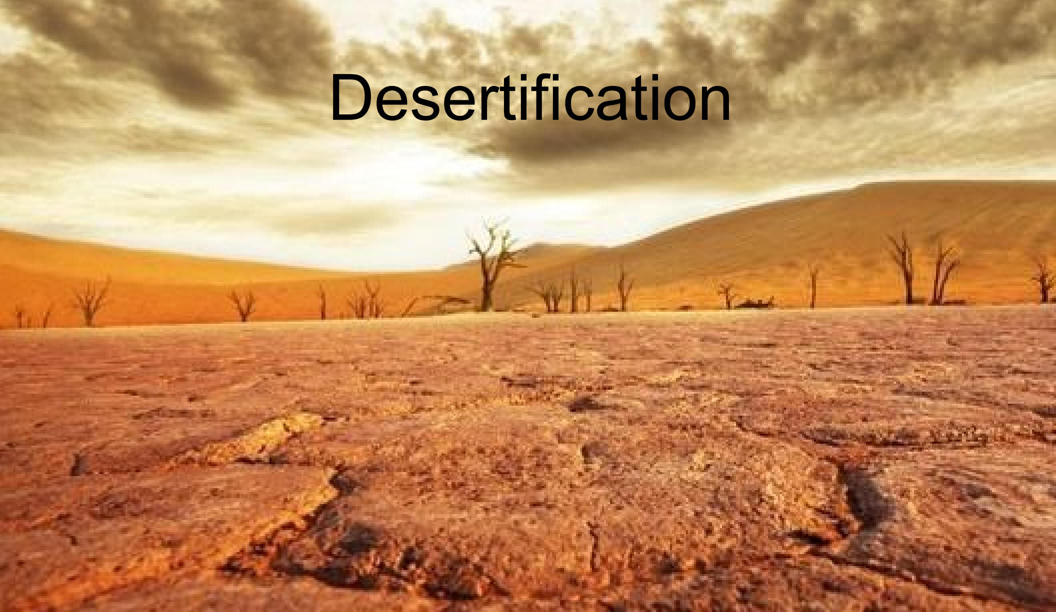

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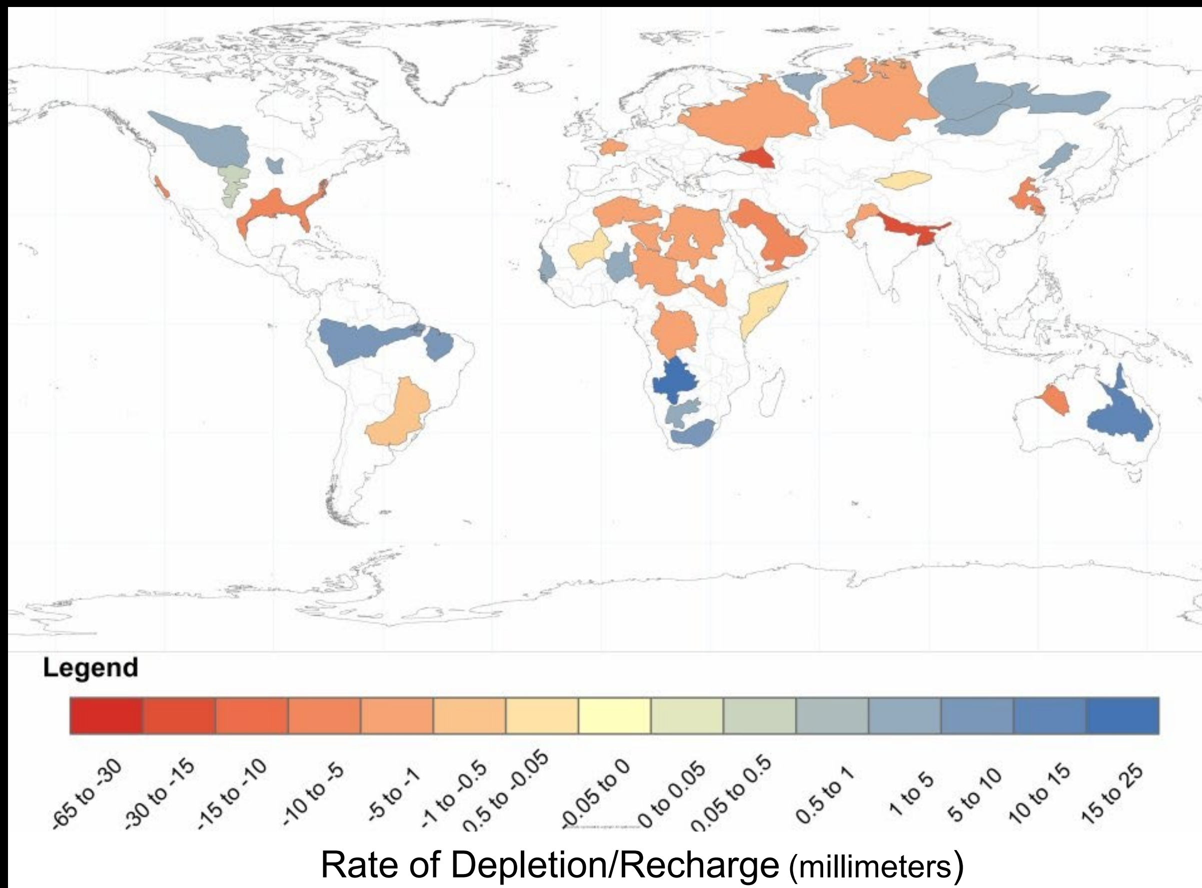
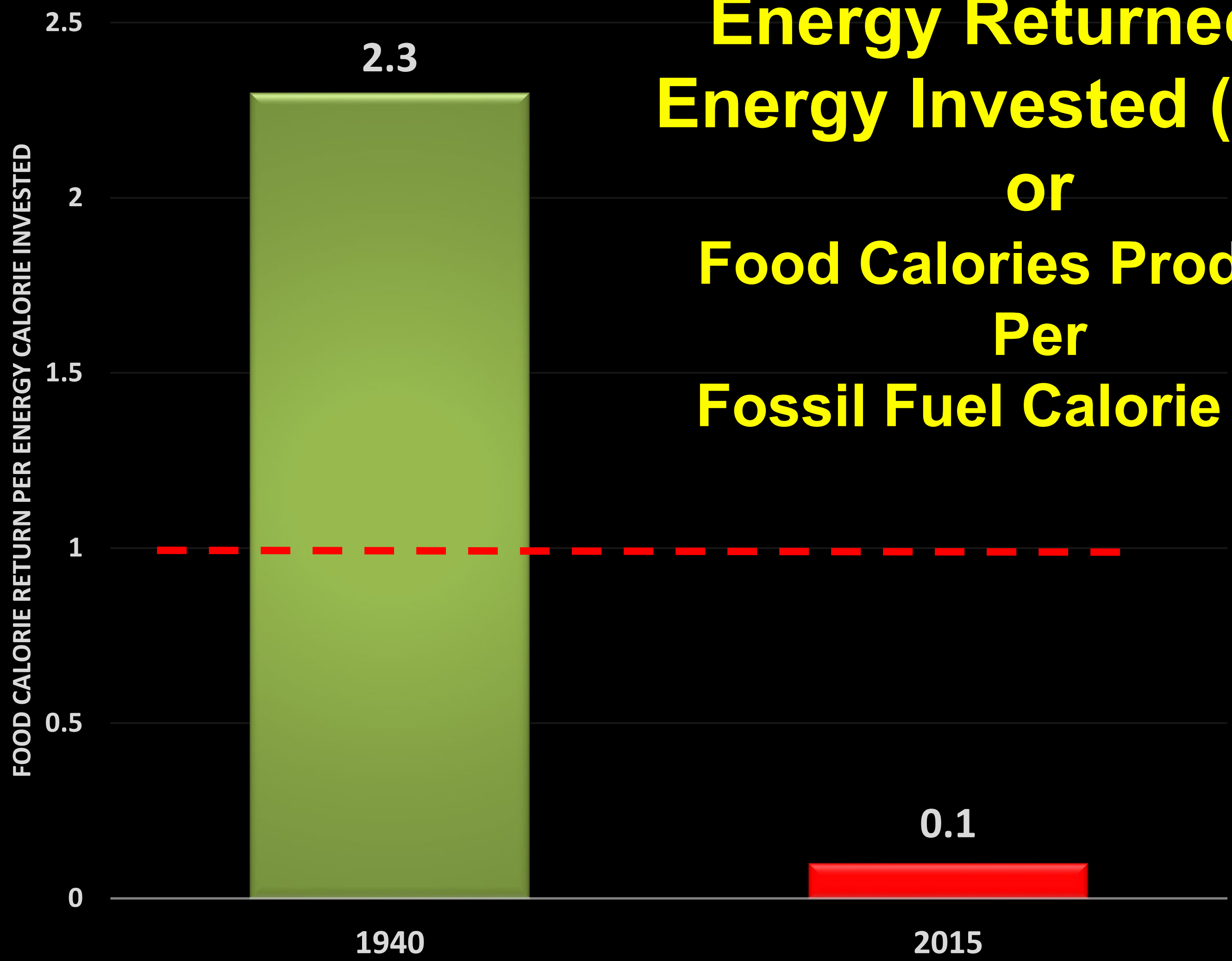
60% of the World's Aquifers are Being Depleted Faster Than They can be Refilled…



http://www.businessinsider.com/nasa-data-shows-the-world-is-running-out-of-water-2015-6

Energy Returned on Energy Invested (EROI) or Food Calories Produced Per Fossil Fuel Calorie Used



Food, Land, Population and the U.S. Economy, Pimentel, David and Giampietro, Mario. Carrying Capacity Network

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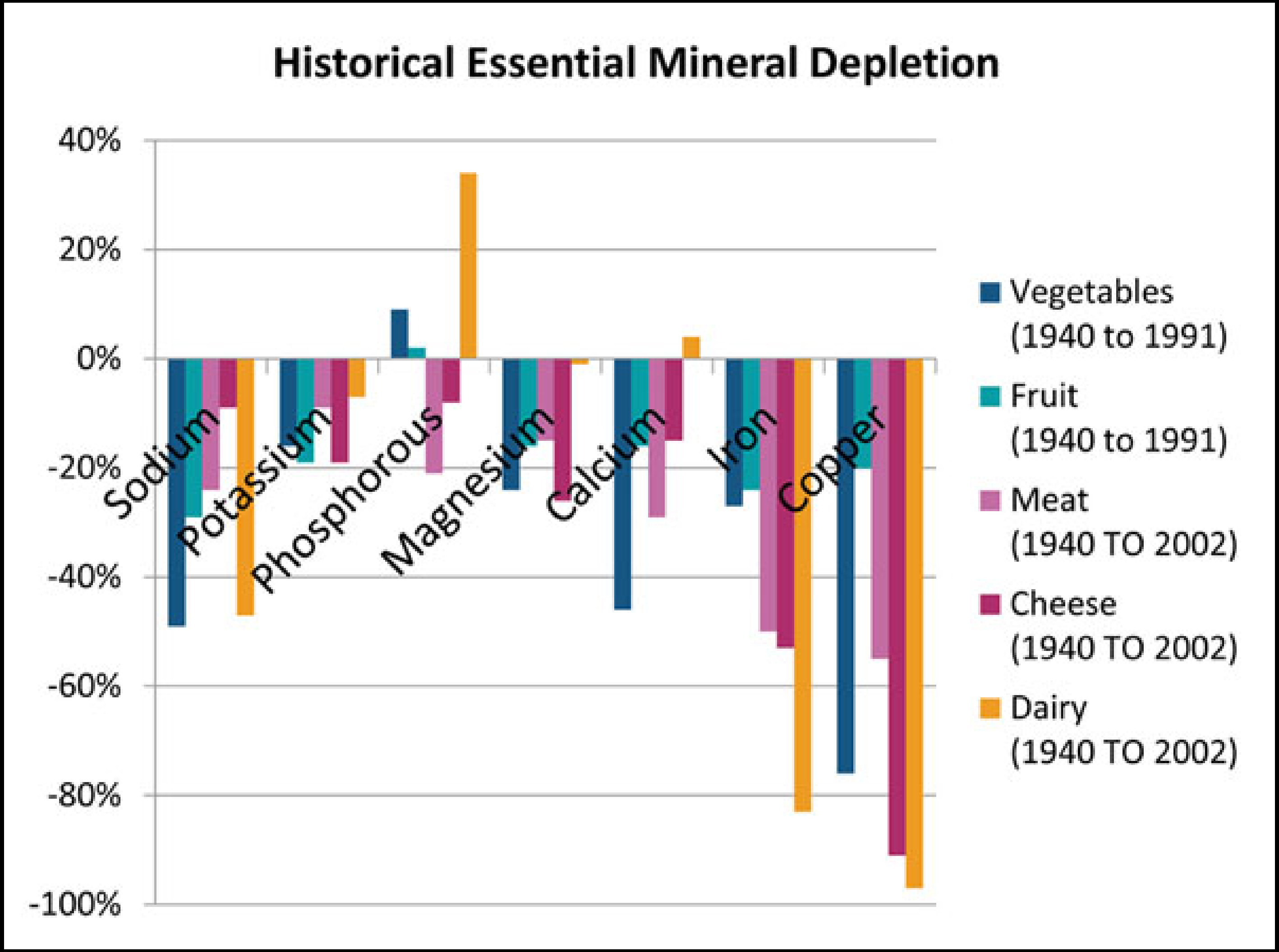

McCance and Widdowson, 2007

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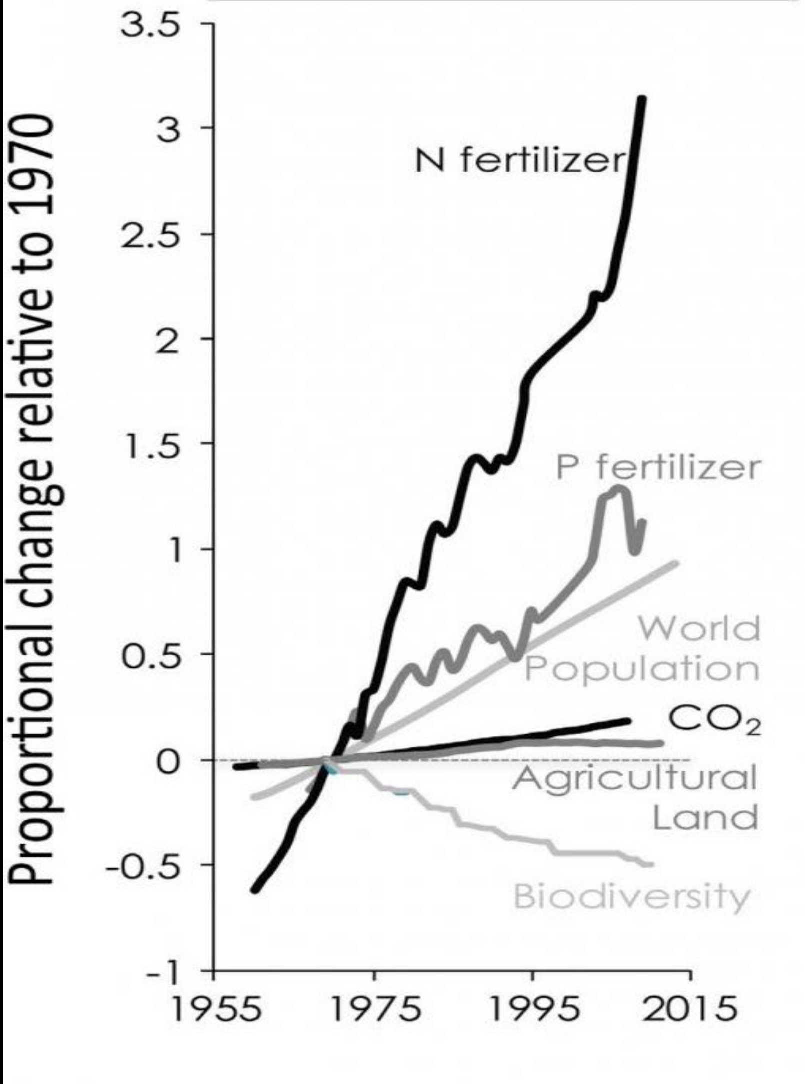


https://desdaughter.com/2017/02/08/production-of-synthetic-chemical/

Nitrogen

Phosphorus

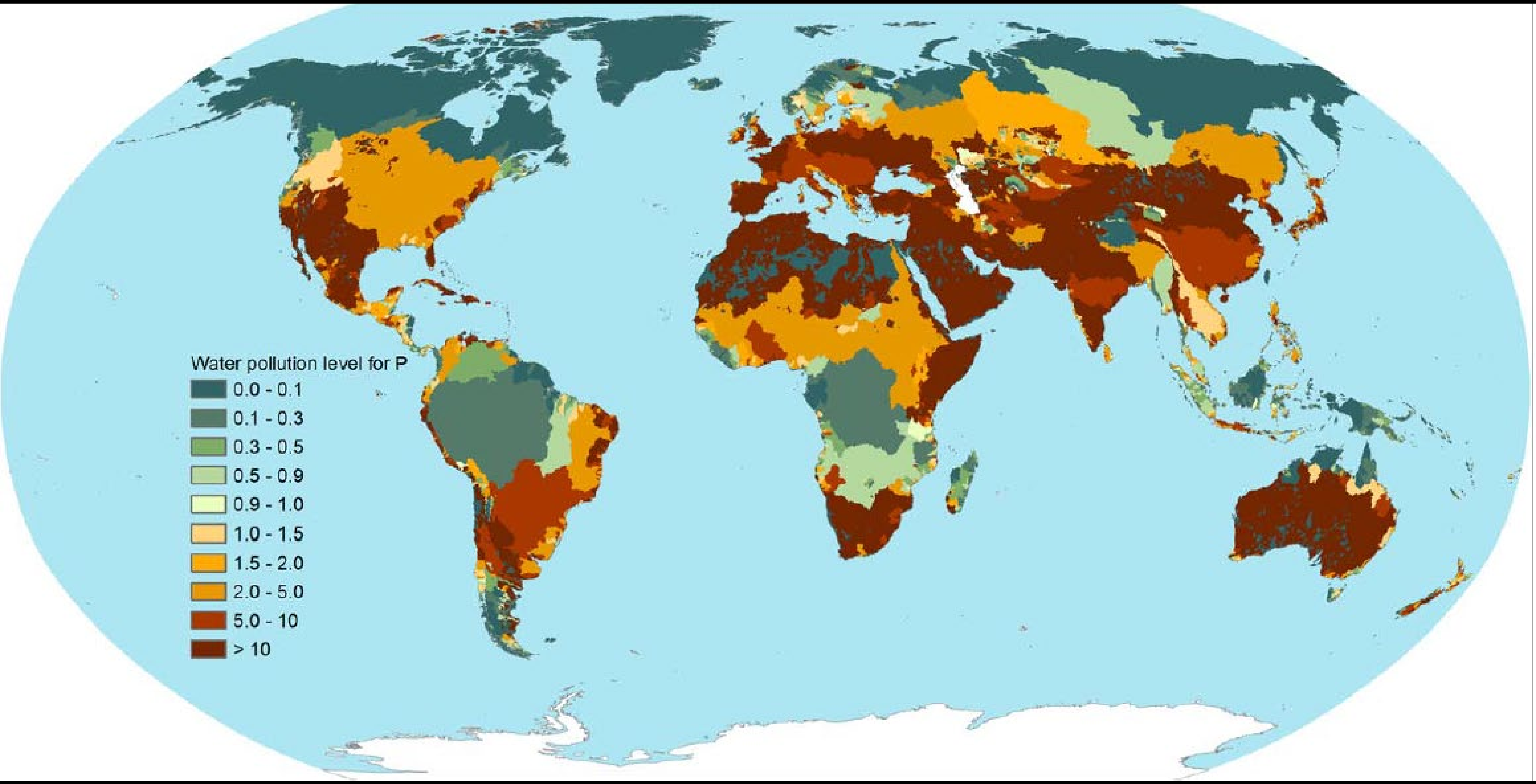
~10%-30% Utilization Efficiency

Nitrogen (NOX) gases emanating from N Fertilizers have been linked to:

- upper respiratory disease,
- asthma,
- cancer,
- birth defects,
- cardiovascular disease, and
- sudden infant death syndrome

A. R. Townsend, R. W. Howarth, F. A. Bazzaz, M. S. Booth, C. C. Cleveland, S. K. Collinge, A. P. Dobson, P. R. Epstein, E. A. Holland, D. R. Keeney, M. A. Mallin, C. A. Rogers, P. Wayne, A. H. Wolfe, Human health effects of a changing global nitrogen cycle. Front. Ecol. Environ. 1, 240–246 (2003)

E. A. Davidson, M. B. David, J. N. Galloway, C. L. Goodale, R. Haeuber, J. A. Harrison, R. W. Howarth, D. B. Jaynes, R. R. Lowrance, N. B. Thomas, J. L. Peel, R. W. Pinder, E. Porter, C. S. Snyder, A. R. Townsend, M. H. Ward, Excess nitrogen in the US environment: Trends, risks, and solutions. Issues Ecol. 15, 1–16 (2011)



http://waterfootprint.org/media/downloads/Mekonnen-Hoekstra-2017.pdf

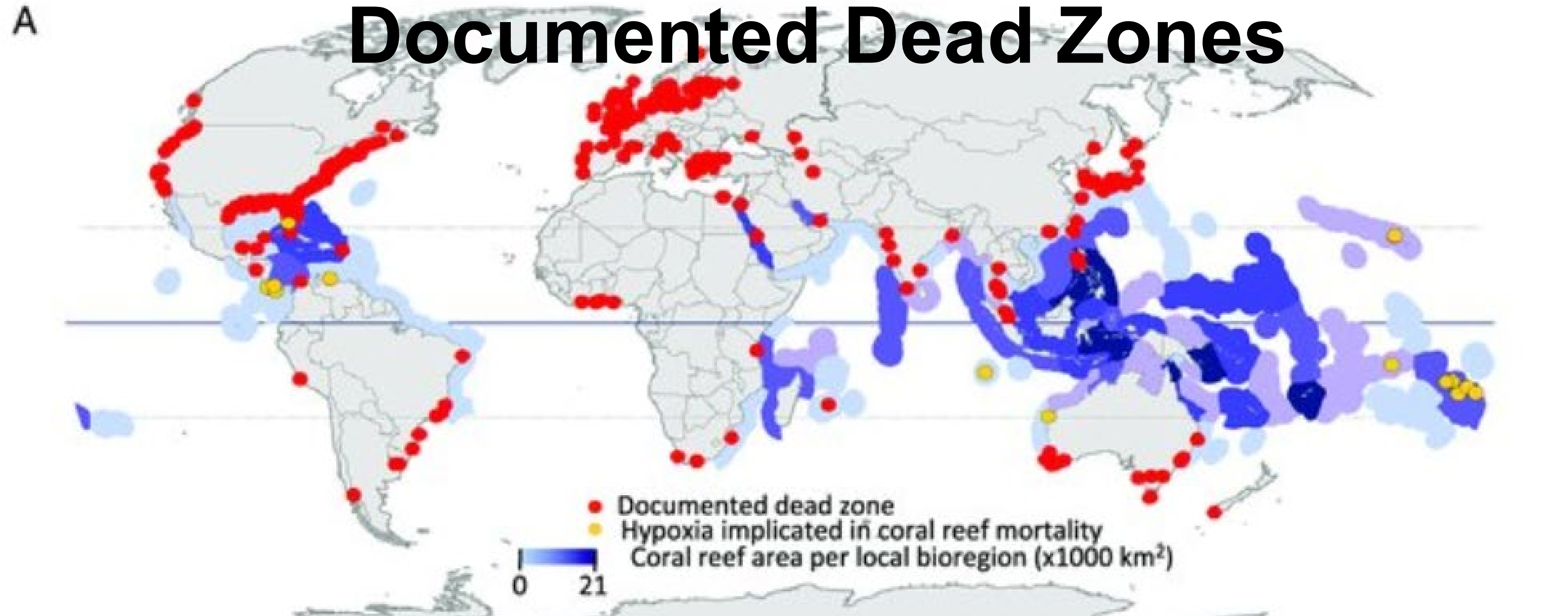

Lake Erie
http://news.algaeworld.org/2018/03/how-a-10-million-competition-takes-aim-at-algae-blooms-worldwide/


Yellow Sea, China
https://www.youtube.com/watch?v=P2q_FzFDMWk

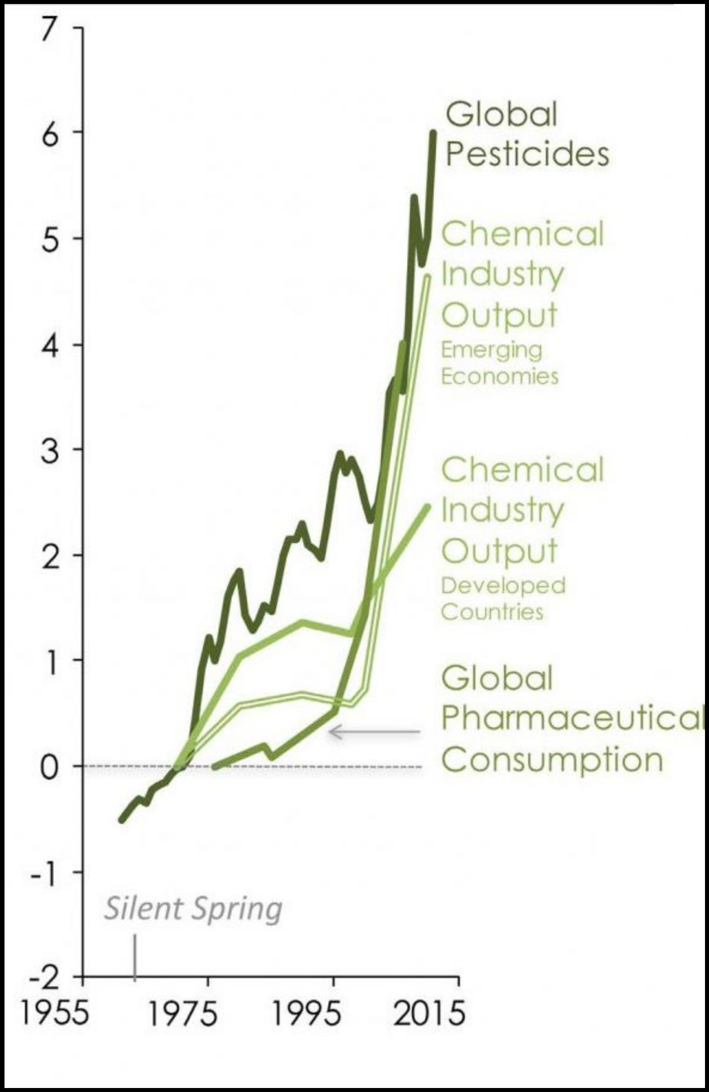

Baltic Sea
https://news.nationalgeographic.com/news/2010/02/100305-baltic-sea-algae-dead-zones-water/

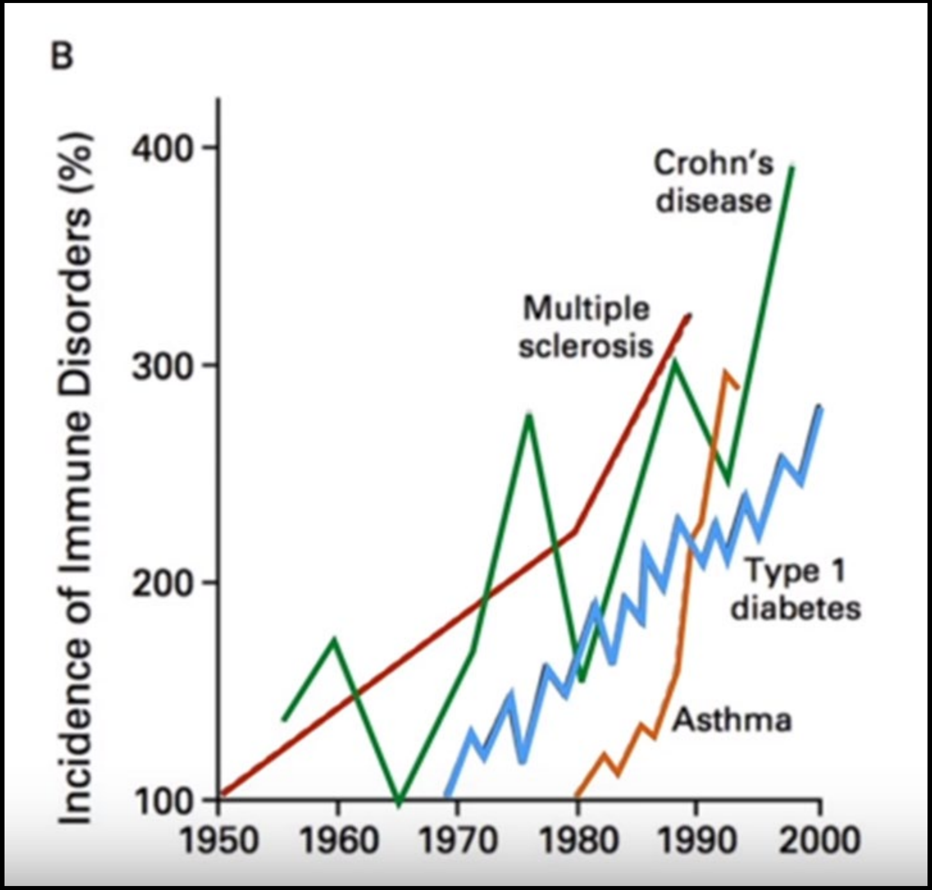

Lake Okeechobee
Tom Archer

Documented Dead Zones



https://www.researchgate.net/publication/315464204_Tropical_dead_zones_and_mass_mortalities_on_coral_reefs/figures?lo=1





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

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

The Environmental and Health Impacts of our Current Agricultural Management Systems are Unmanageable and Unsustainable….

The Environmental and Health Impacts of our Current Agricultural Management Systems are Unmanageable and Unsustainable….

We are slowly digging ourselves into a hole!

If you find yourself in a hole,
Stop Digging!

Will Rodgers

Challenges Ahead!

- **Produce more food,**
- **On declining land area,**
- **With soils and ecosystems that are continually being degraded,**
- **Using less water,**
- **Fewer energy and natural resources**
- **And do all of this under difficult economic circumstances!**

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"You never change things by fighting the existing reality.

To change something, build a new model that makes the existing model obsolete."

R. Buckminster Fuller

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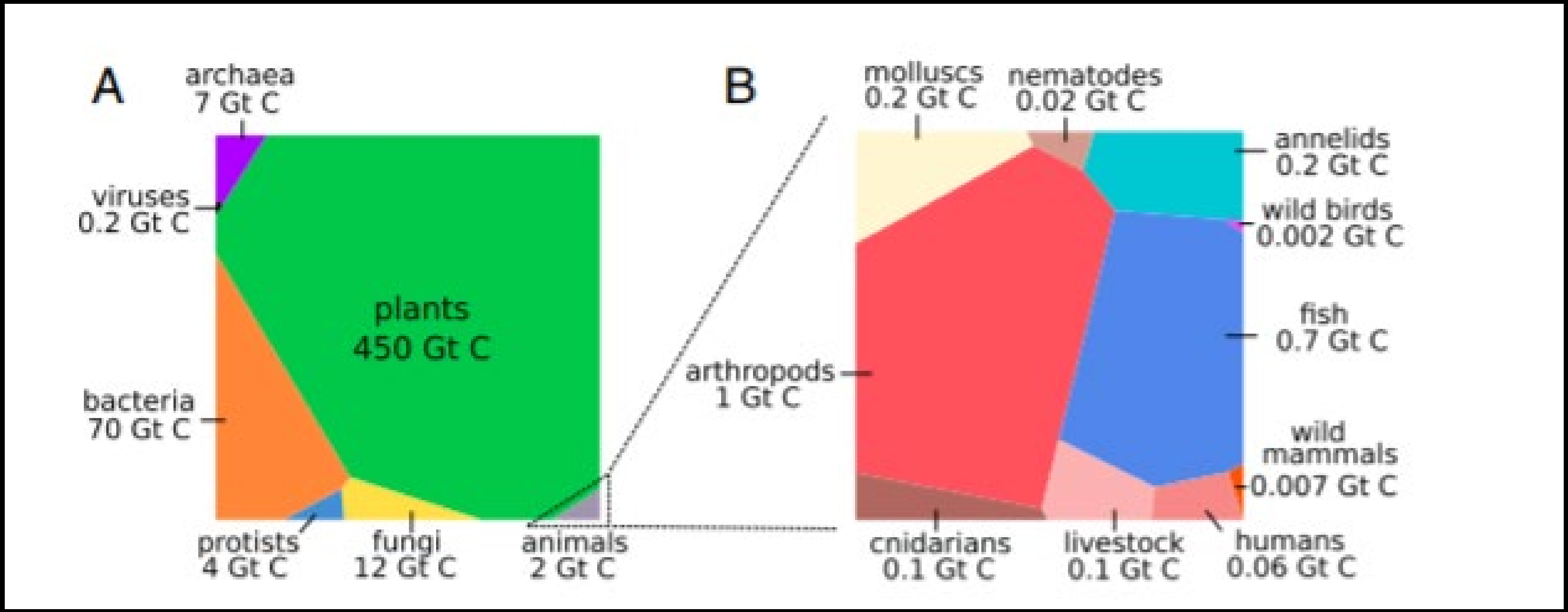
Biomass of Life on Earth is Equivalent to ~550 Gigatons C



0.000000009% of the Earth's Mass

http://www.pnas.org/content/pnas/early/2018/05/15/1711842115.full.pdf

Glomeromycota
~400 to 500 MYA

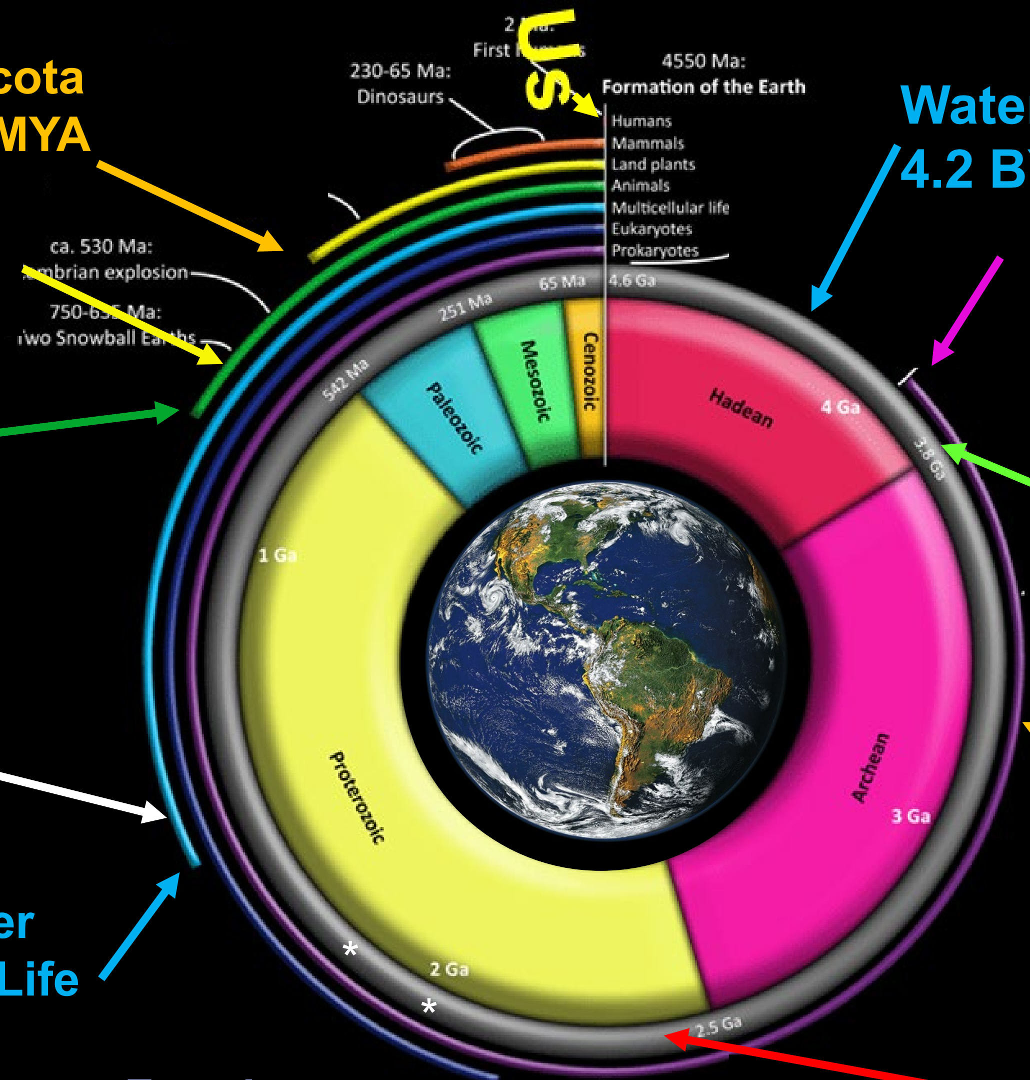
Land Plants
~700 MYA

First Single
Cell Animals
~750 MYA

Mitochondria
Evolved
~1.45 bya

Ozone Layer
Multicellular Life
~1.6 bya

Fungi
~2.2 BYA



Water
4.2 BYA

Bacteria
~4 BYA

Cyanobacteria
Anoxygenic
Photosynthesis
~3.8 BYA

Nitrogen Fixation
~3.2 BYA

<u>Oxygenic</u>
<u>Photosynthesis</u>
Oxygen Rich
Atmosphere
~2.4 BYA

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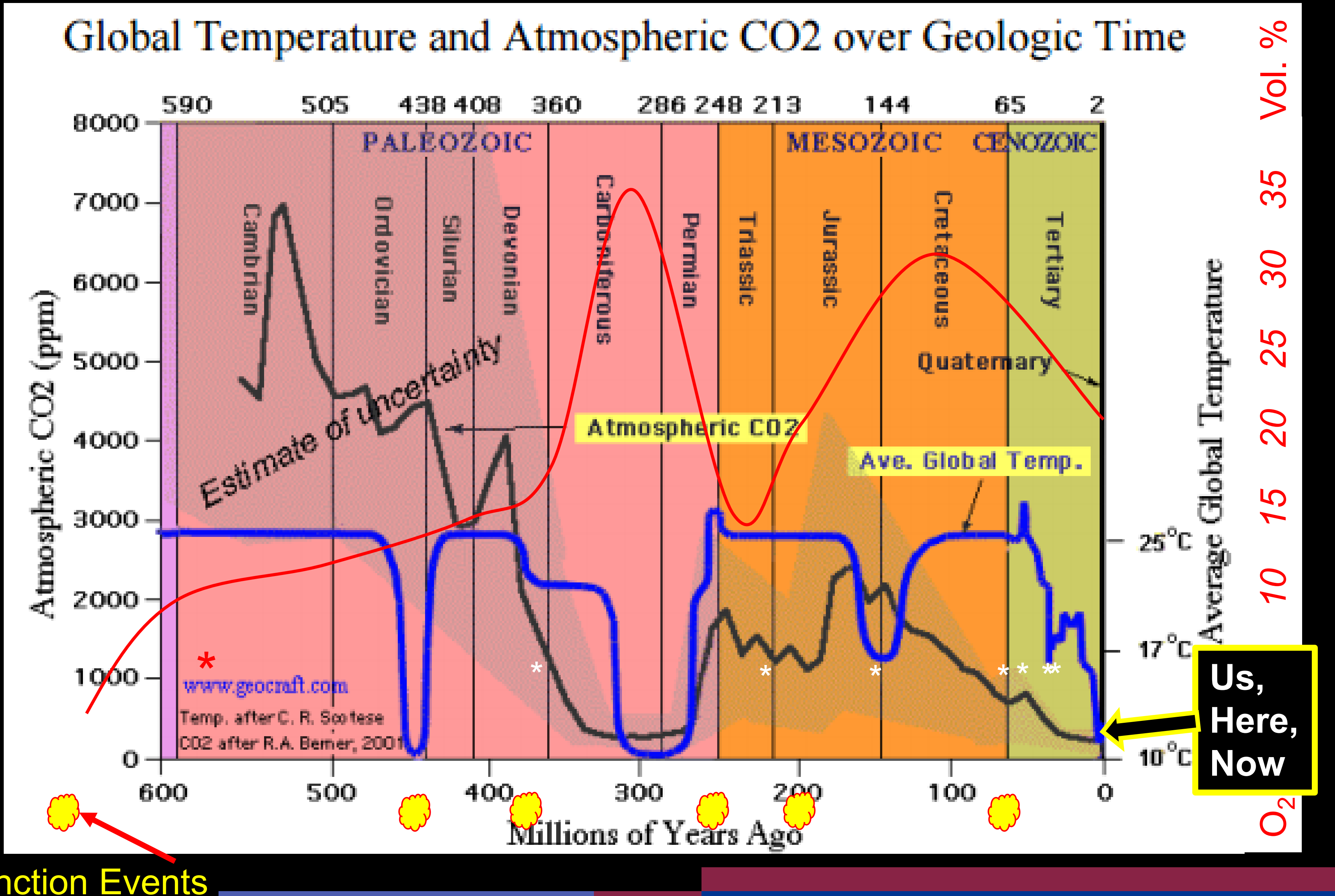

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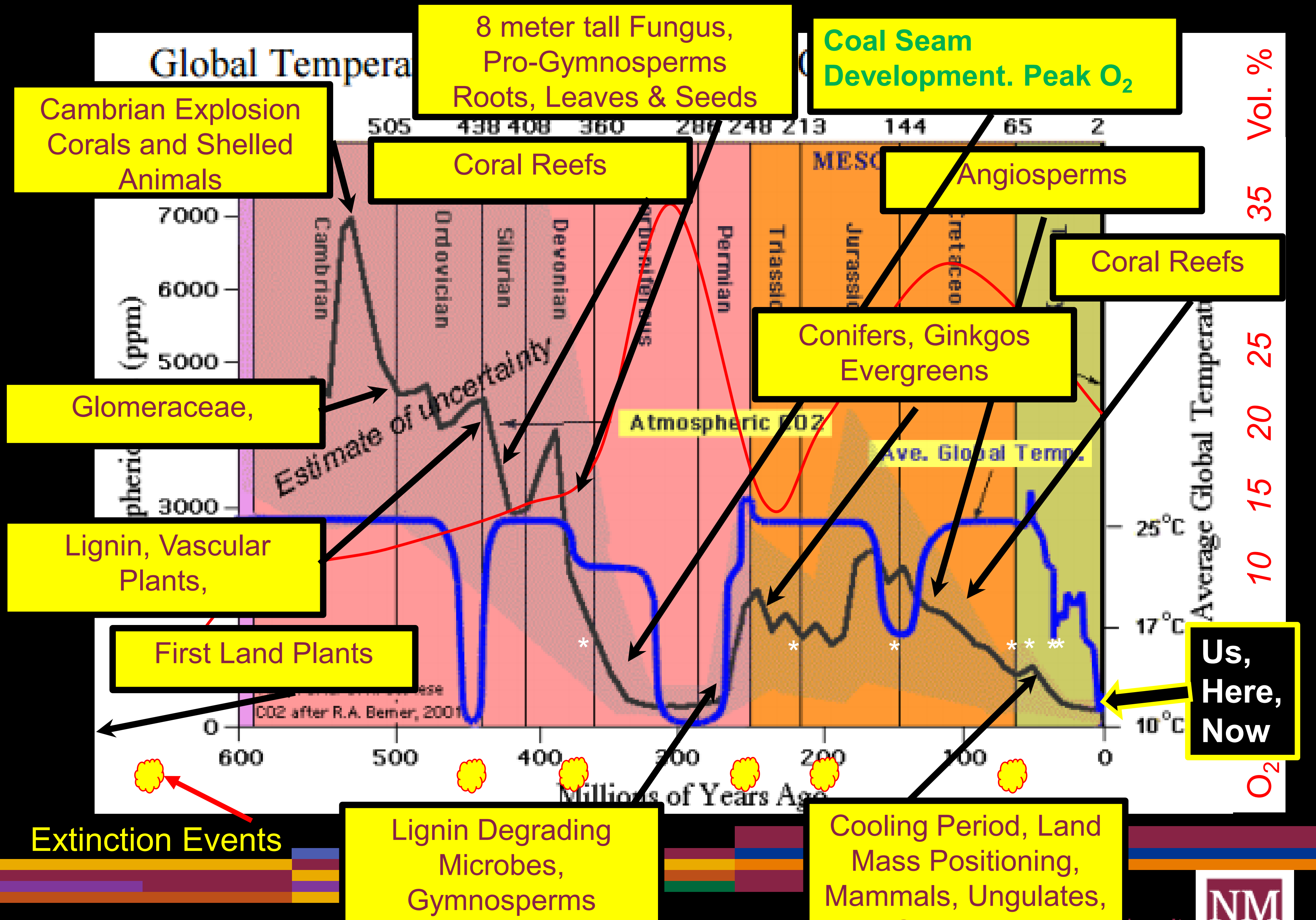

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University NM STATE

How Critical to Life on this Planet are These Elements at the Global and Personal Scale

https://sciencenotes.org/printable-periodic-table/

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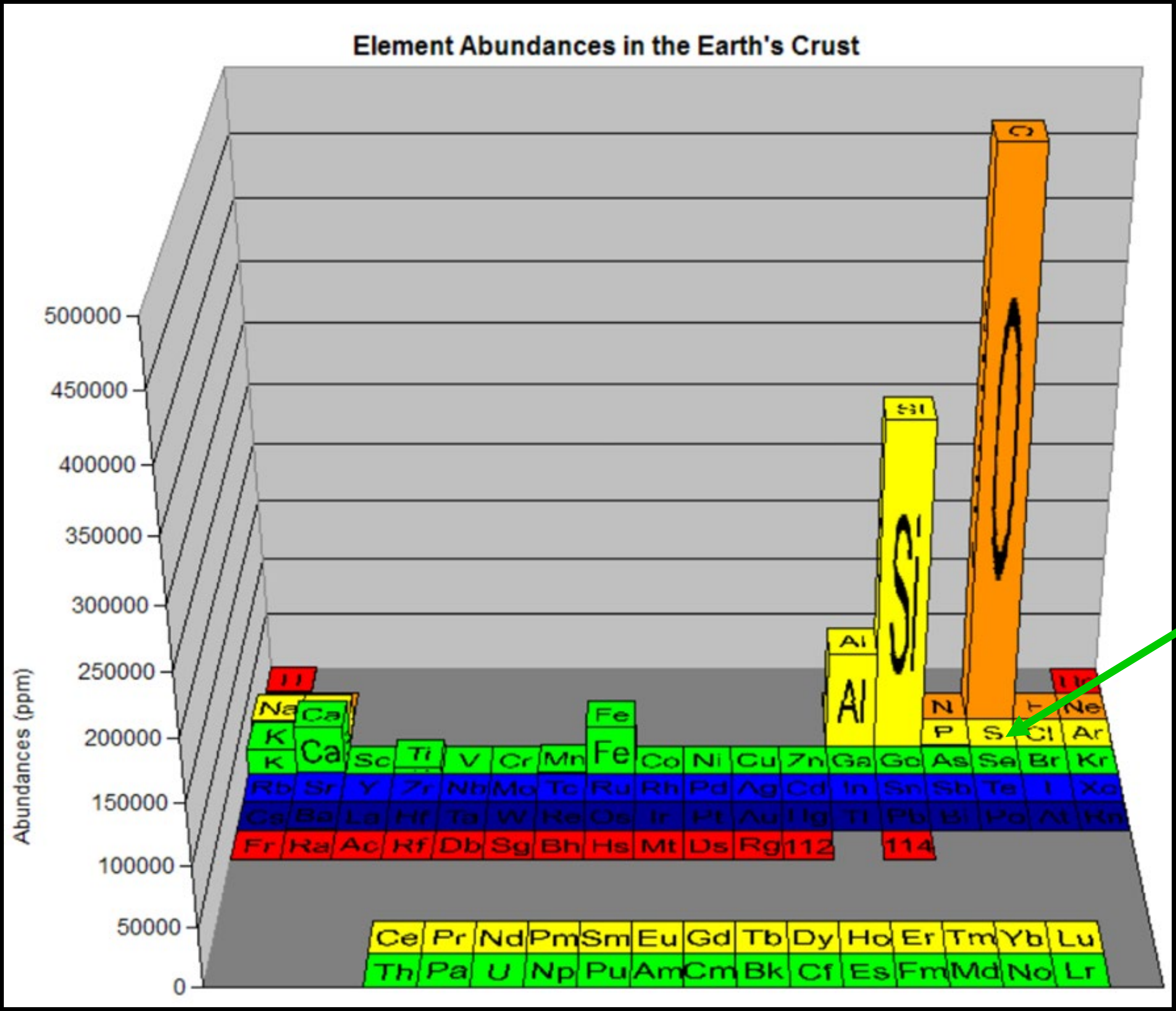
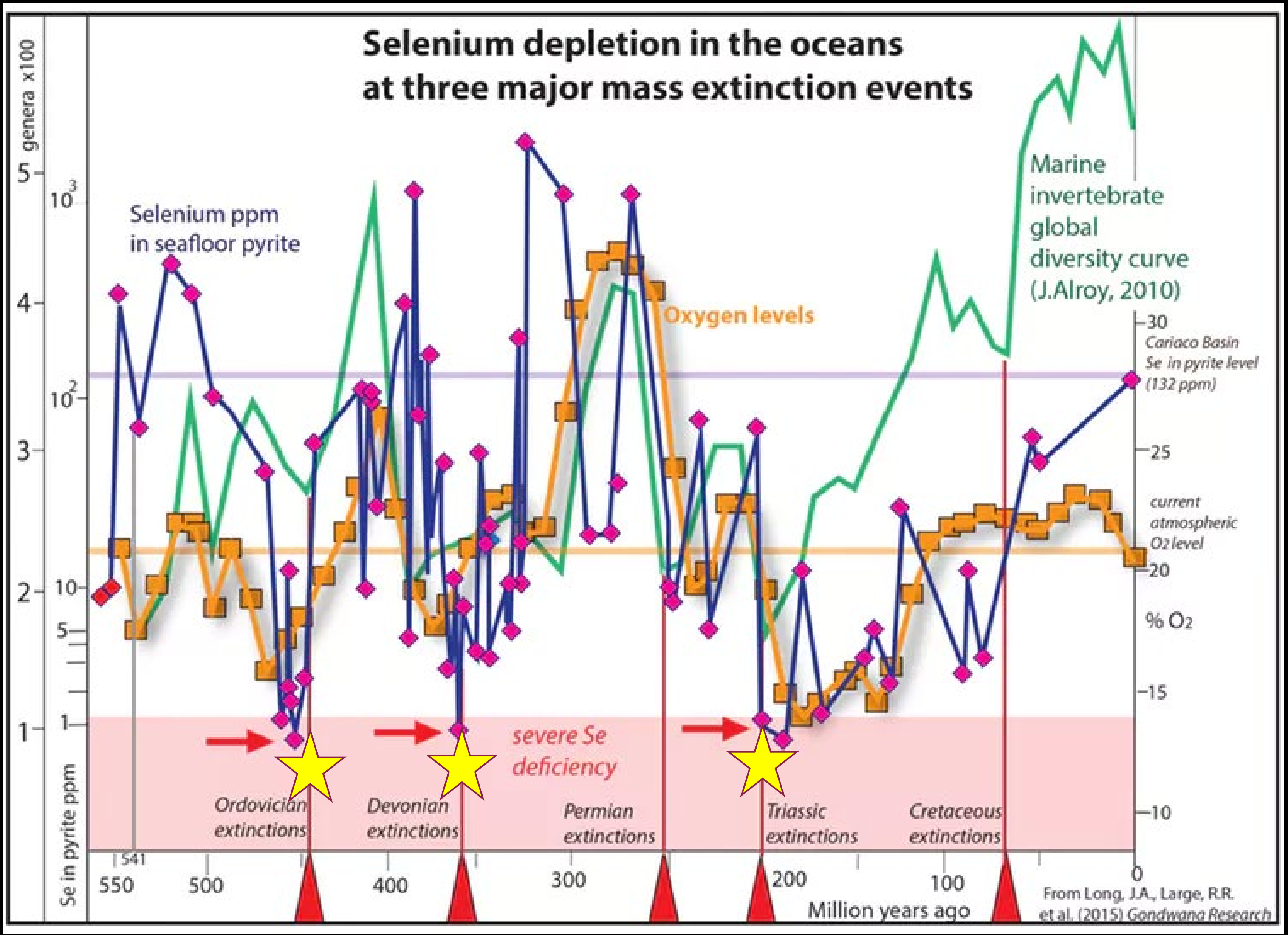
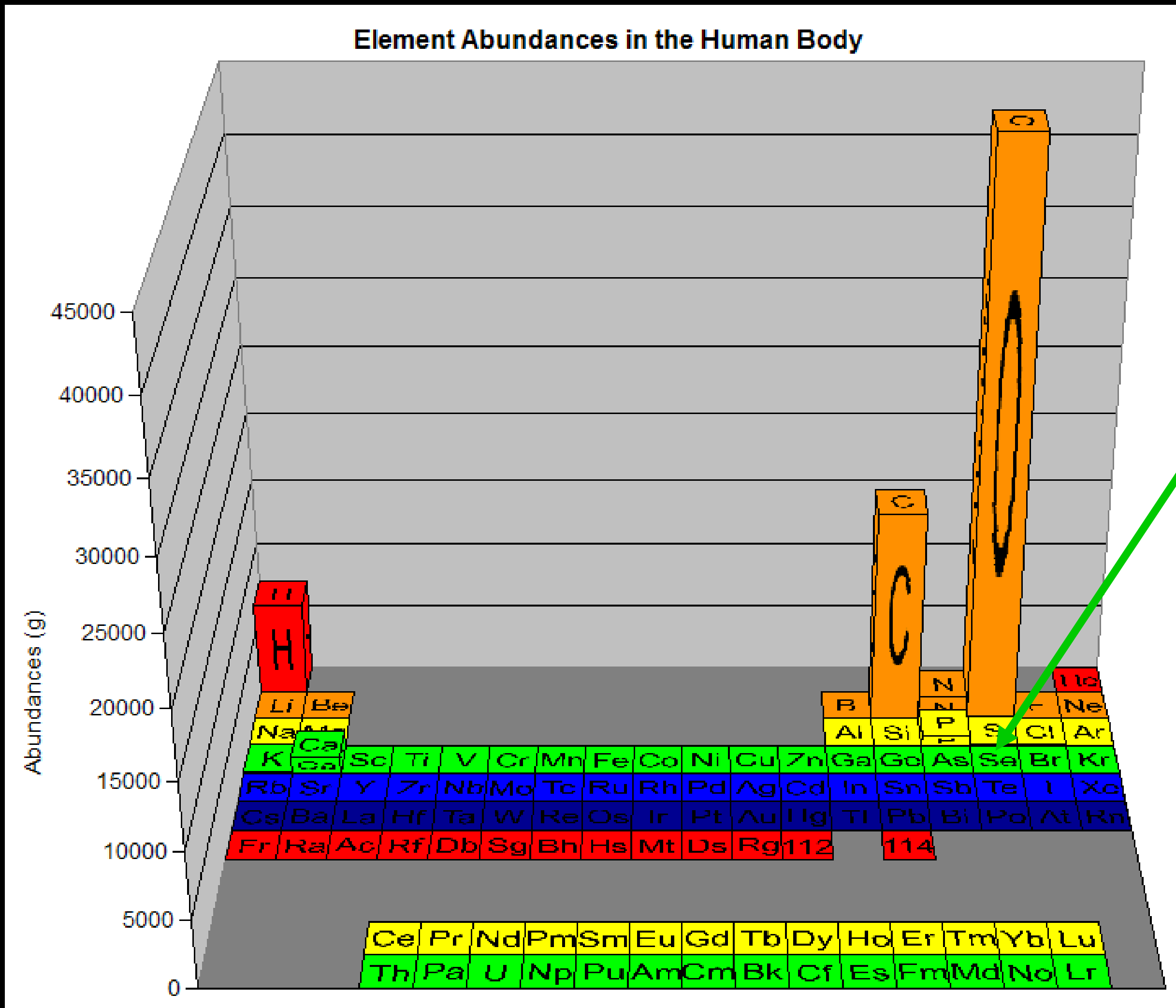


Selenium
Earth's Crust
50 ppb

https://www.angelo.edu/faculty/kboudrea/periodic/physical_abundances.htm



https://theconversation.com/elementary-new-theory-on-mass-extinctions-that-wiped-out-life-48806



https://www.angelo.edu/faculty/kboudrea/periodic/physical_abundances.htm

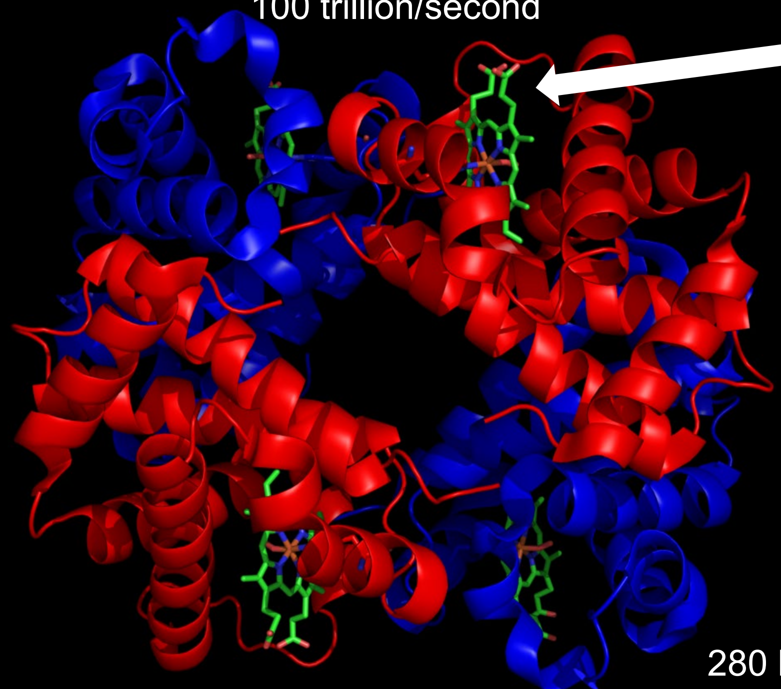
Human Body
200 ppb

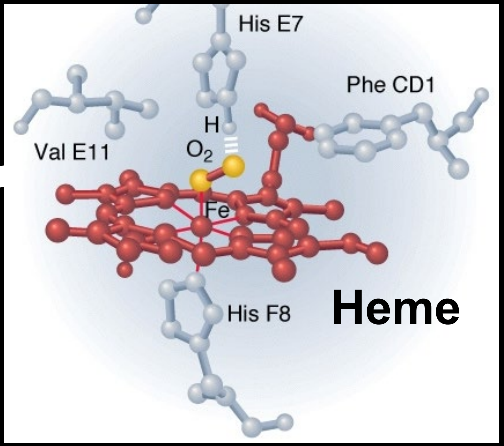
Critical in:

- Immune function
- Viral Infection
- Reproduction
- Mood
- Thyroid Function
- Cardiovascular Disease
- Cancer

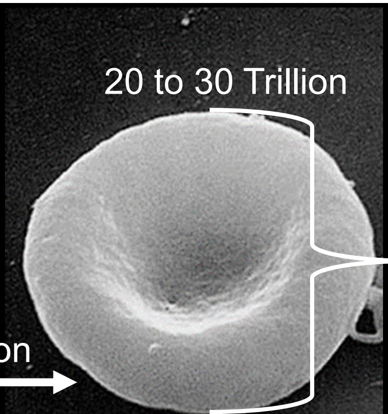
Hemoglobin (metalloprotein)

100 trillion/second





280 Million



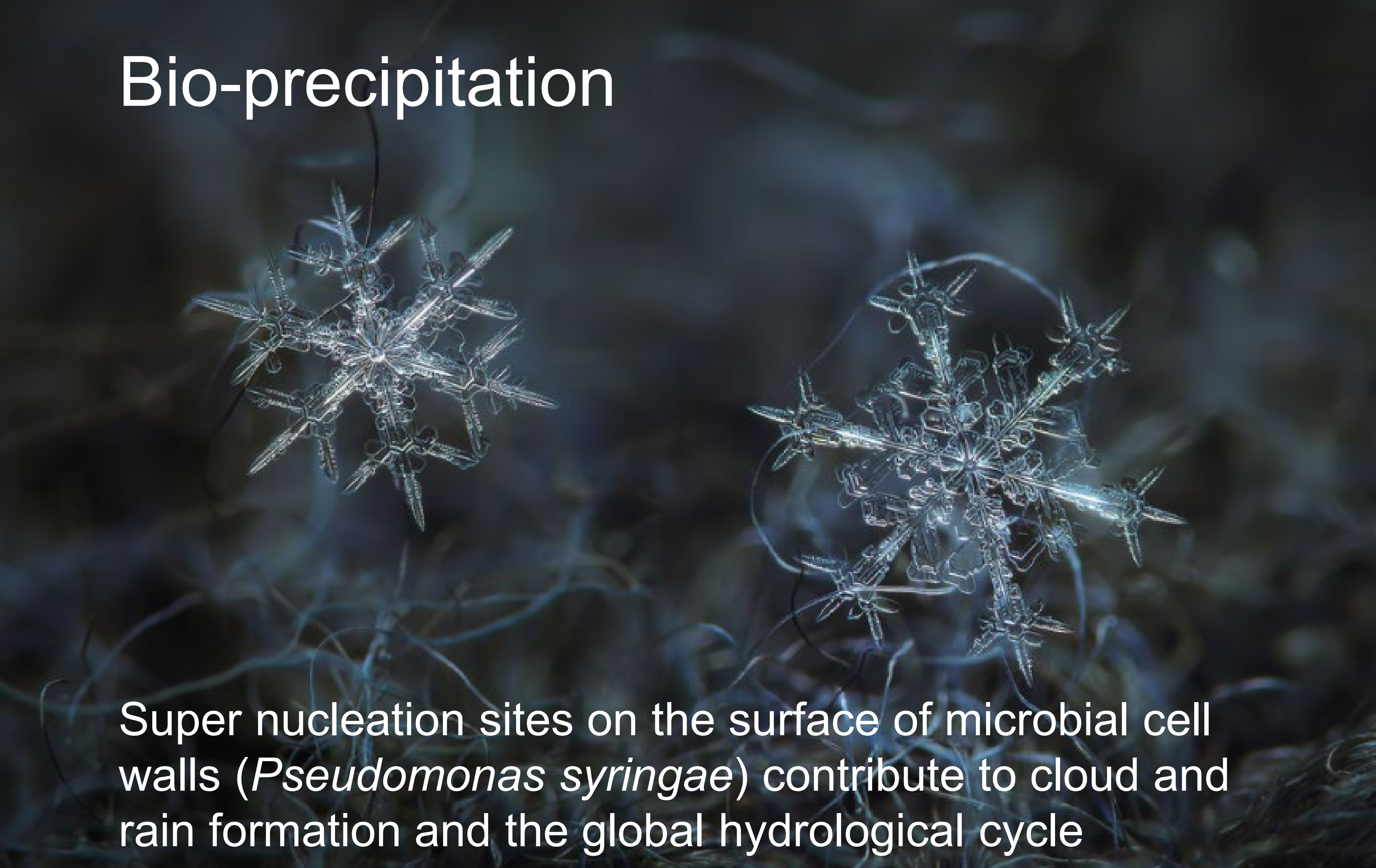
8 µm

By Zephyris at the English language Wikipedia, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=2300973

http://case.ntu.edu.tw/CASTUDIO/Files/speech/Ref/CS0100S2B03_11.pdf

https://en.wikipedia.org/wiki/Red_blood_cell#/media/File:Red_White_Blood_cells.jpg

Bio-precipitation



Super nucleation sites on the surface of microbial cell walls (*Pseudomonas syringae*) contribute to cloud and rain formation and the global hydrological cycle

https://www.flickr.com/photos/chaoticmind75/34923158776/in/album-72157626146319517/

$\sim 1 \times 10^{22}$

10,000,000,000,000,000,000,000

10 sextillion

https://cradio.org.au/wp-content/uploads/2015/11/MilkyWay_Woods.jpg

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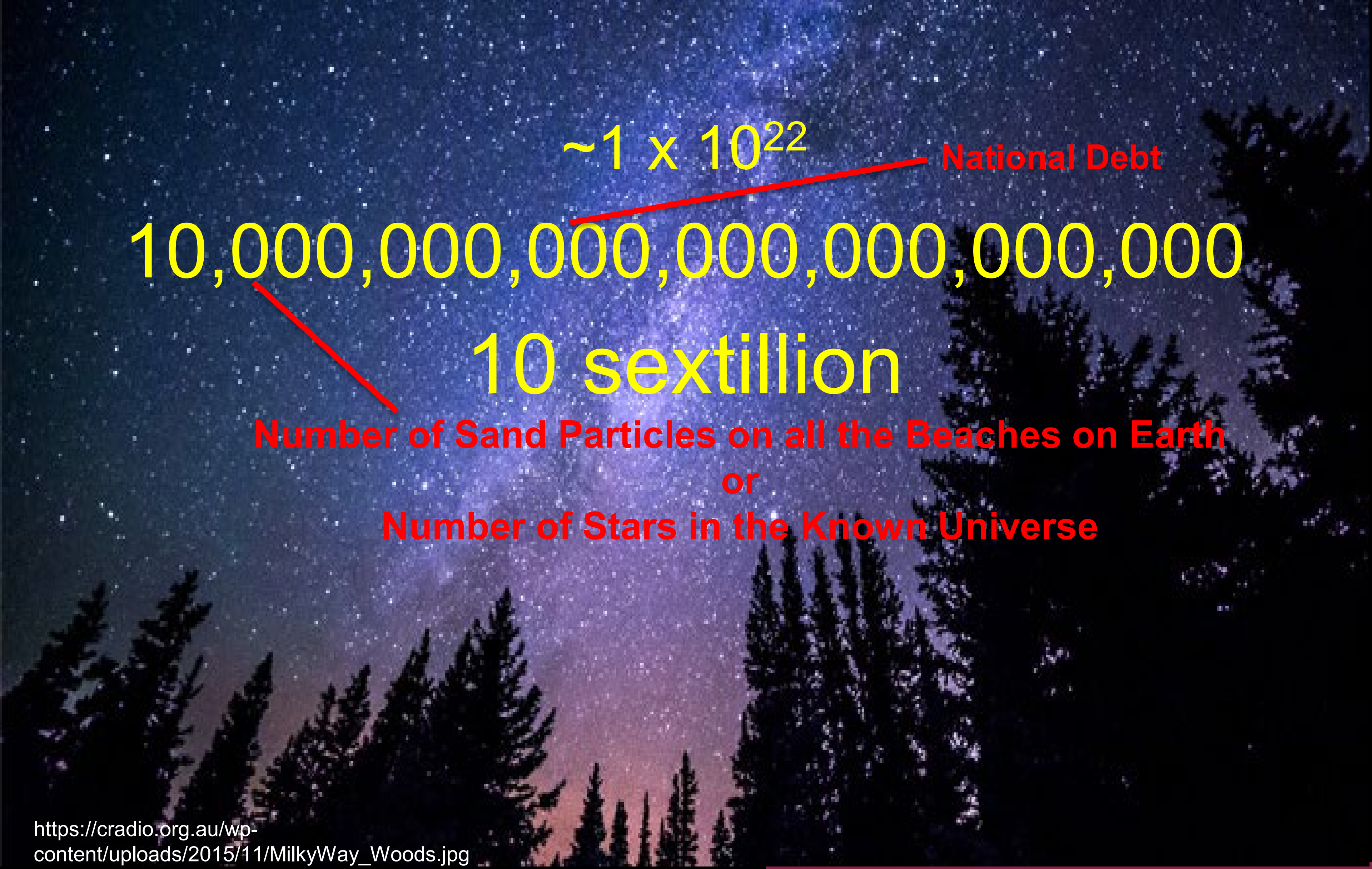

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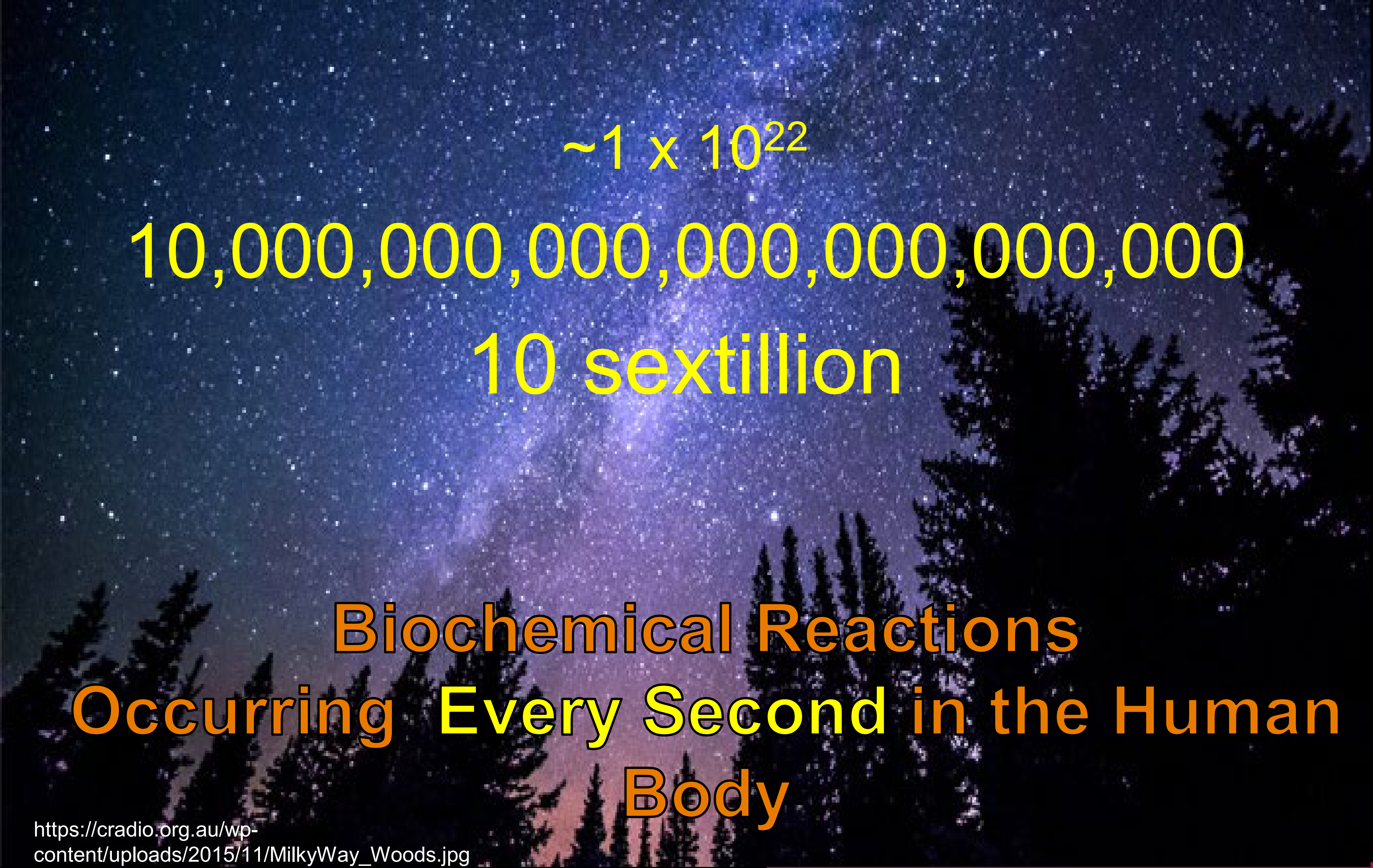

$\sim 1 \times 10^{22}$

10,000,000,000,000,000,000,000

10 sextillion

Biochemical Reactions Occurring Every Second in the Human Body

https://cradio.org.au/wp-content/uploads/2015/11/MilkyWay_Woods.jpg

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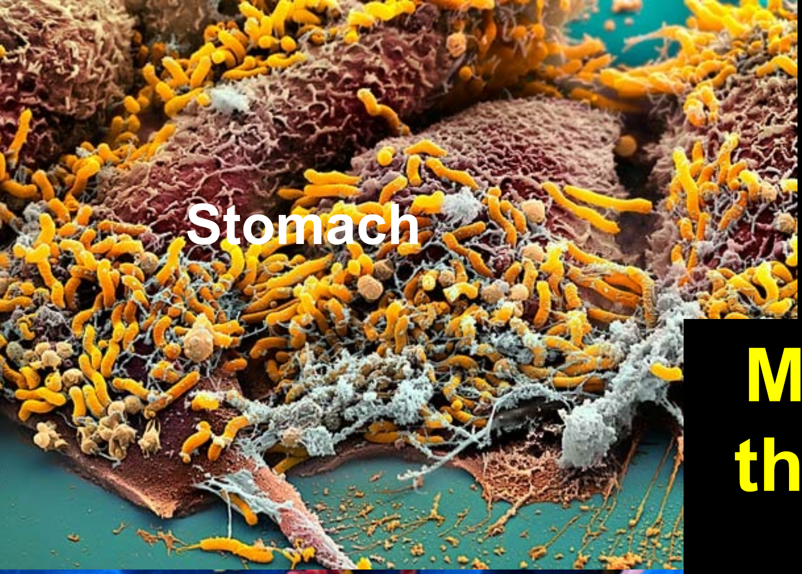
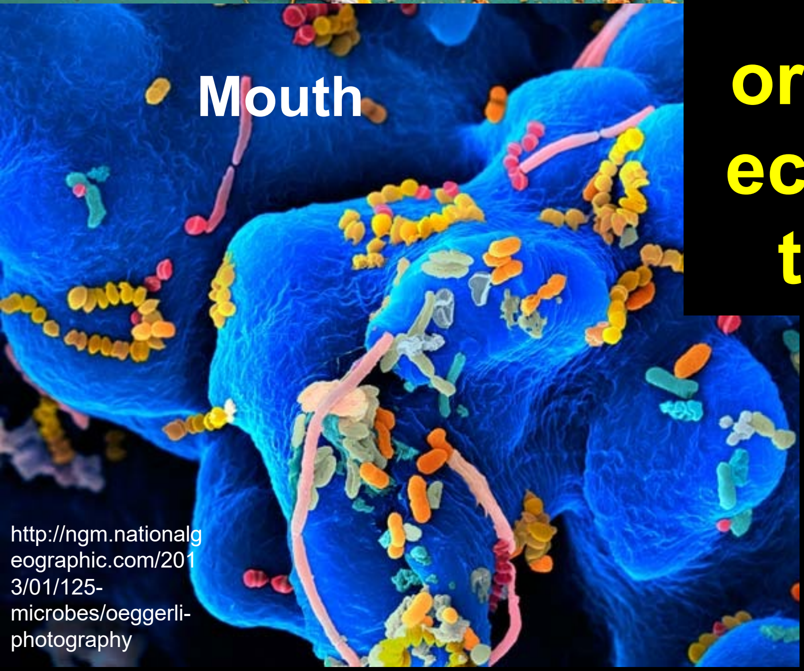


Microbes are the backbone of every organism and ecosystem on this planet.



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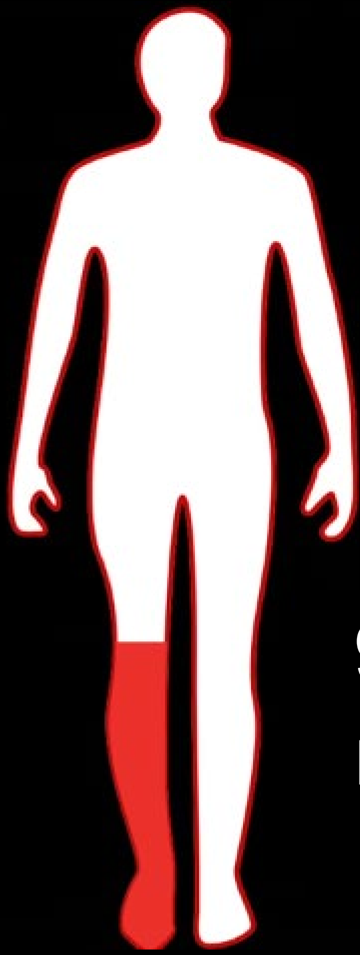
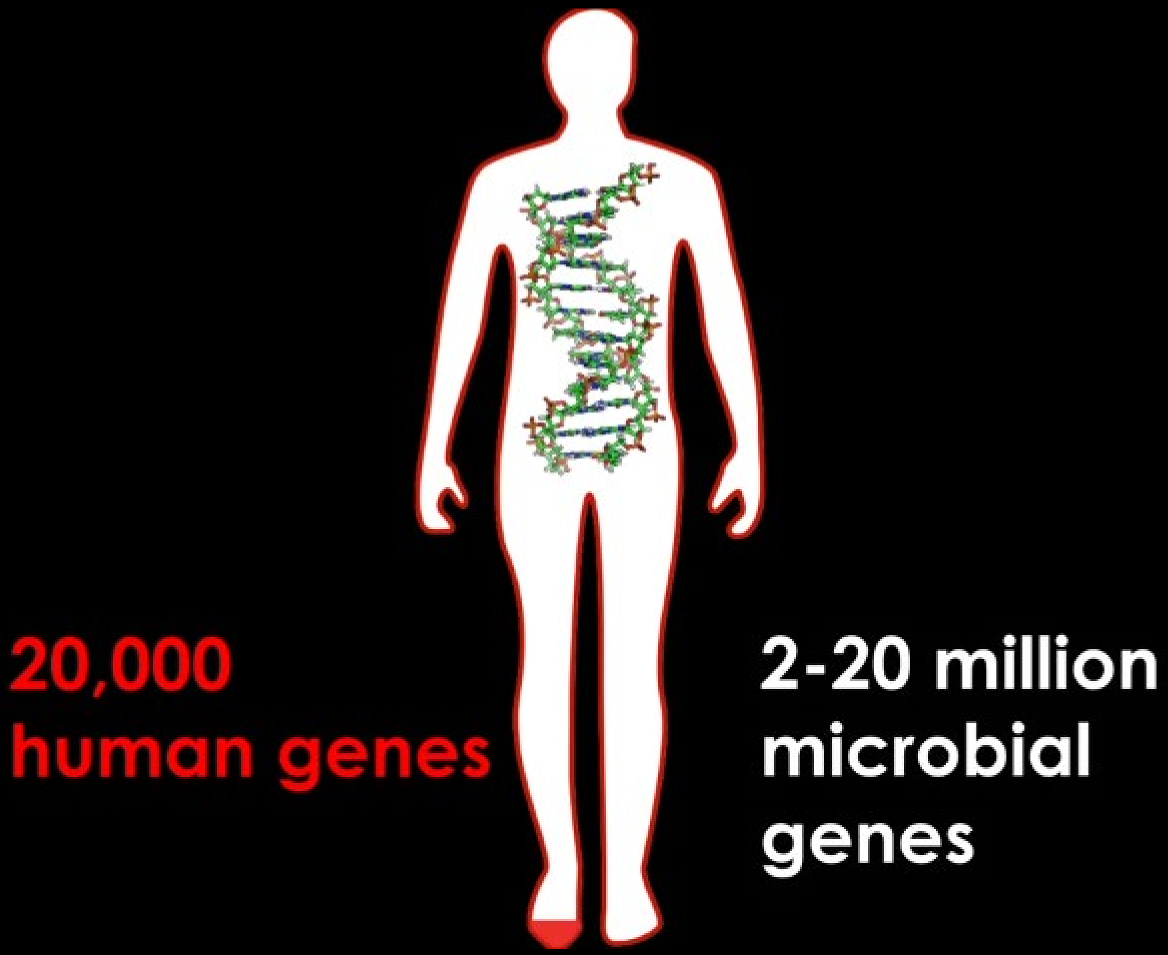
1 Quadrillion Resident Viruses



10 trillion human cells

90 trillion microbial cells

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



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

Food Digestion

Cell Renewal

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

Nutrient Generation

Controls Appetites and Cravings

Vitamin Synthesis

Detoxify Carcinogens

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

Prevents Allergies, Skin Diseases and Asthma

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

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What Happens When These Microbial Communities Are Disrupted Through Either

Administration of Antibiotics
or
Diet Related Issues?

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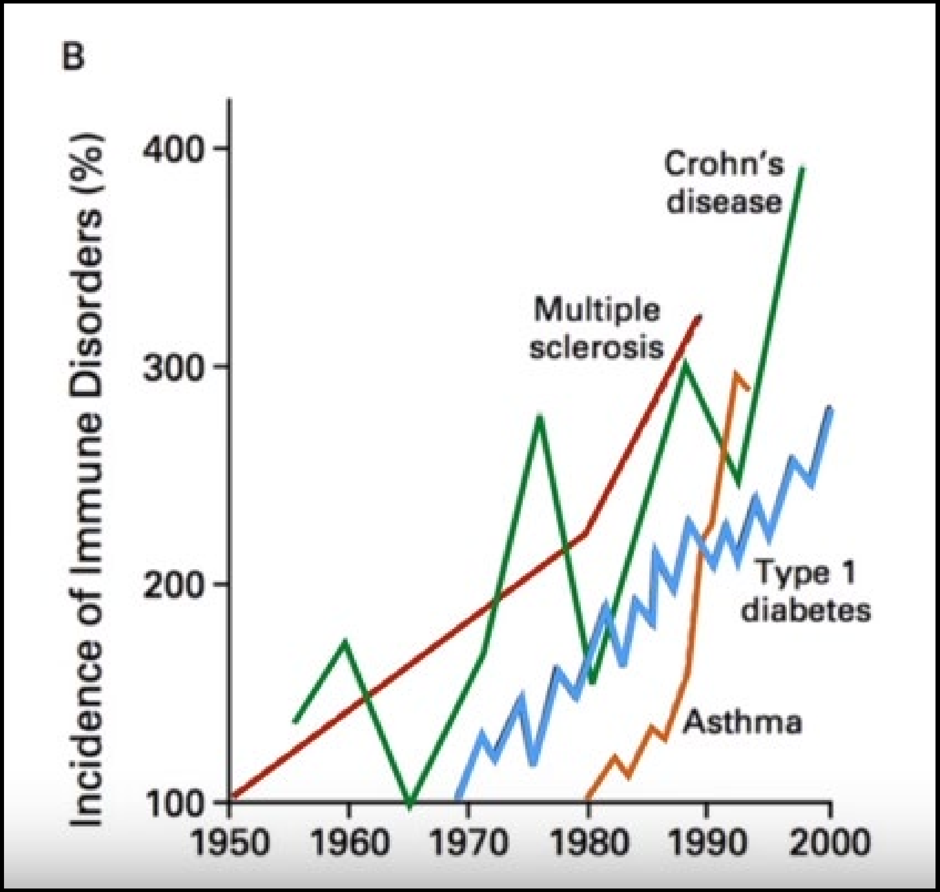
Cancer; Inflammatory bowel disease; Irritable bowel disease; Diverticulosis; Surgical infections; Liver disease; Metabolic syndrome; cardiovascular disease; diabetes; obesity; Acne; Atopic dermatitis; Psoriasis; Auto-immune diseases; Sarcoidosis; Asthma; Seasonal allergies; hormonal imbalance; Dry eyes; Response to vaccines; Food-Pet allergies; Antibiotic recovery; C. difficile colitis; MRSA colitis; Sinusitis; Influenza; HIV/AIDS; Depression; Anorexia; PTSD, Anxiety, Autism, Alzheimer's, Dental caries; Body odor; Parkinson's; Dementia; Hyperphagia; Exercise; Smoking; Alcohol; Breast milk vs. Formula; Household Pets; Artificial Sweeteners; Prematurity; Caesarian vs. vaginal birth; polycystic ovaries; Sickle cell disease; Anemia; Renal disease; Chronic pulmonary disease; Type I and Type II Diabetes; Encephalothopy; incontinence; Diarrhea; Rheumatoid arthritis; Cardiovascular Disease; ETC....

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

Cancer; Inflammatory bowel disease; Irritable bowel disease;
Diverticulosis; Surgical infections; Liver disease; Metabolic
syndrome; cardiovascular disease; diabetes; obesity; Acne;
Atopic dermatitis; Psoriasis; Auto-immune diseases;
Sarcoidosis; Asthma; Seasonal allergies; hormonal imbalance;
Dry eyes; Resp ergies; Antibiotic
recovery; C. di usitis; Influenza;
HIV/AIDS; De nxiety, Autism,
Alzheimer's, D son's; Dementia;
Hyperphagia; Breast milk vs.
Formula; Hous rs; Prematurity;
Caesarian vs. ies; Sickle cell
disease; Anem monary disease;
Type I and Type II Diabetes; Encephalothopy; incontinence;
Diarrhea; Rheumatoid arthritis; Cardiovascular Disease; ETC....

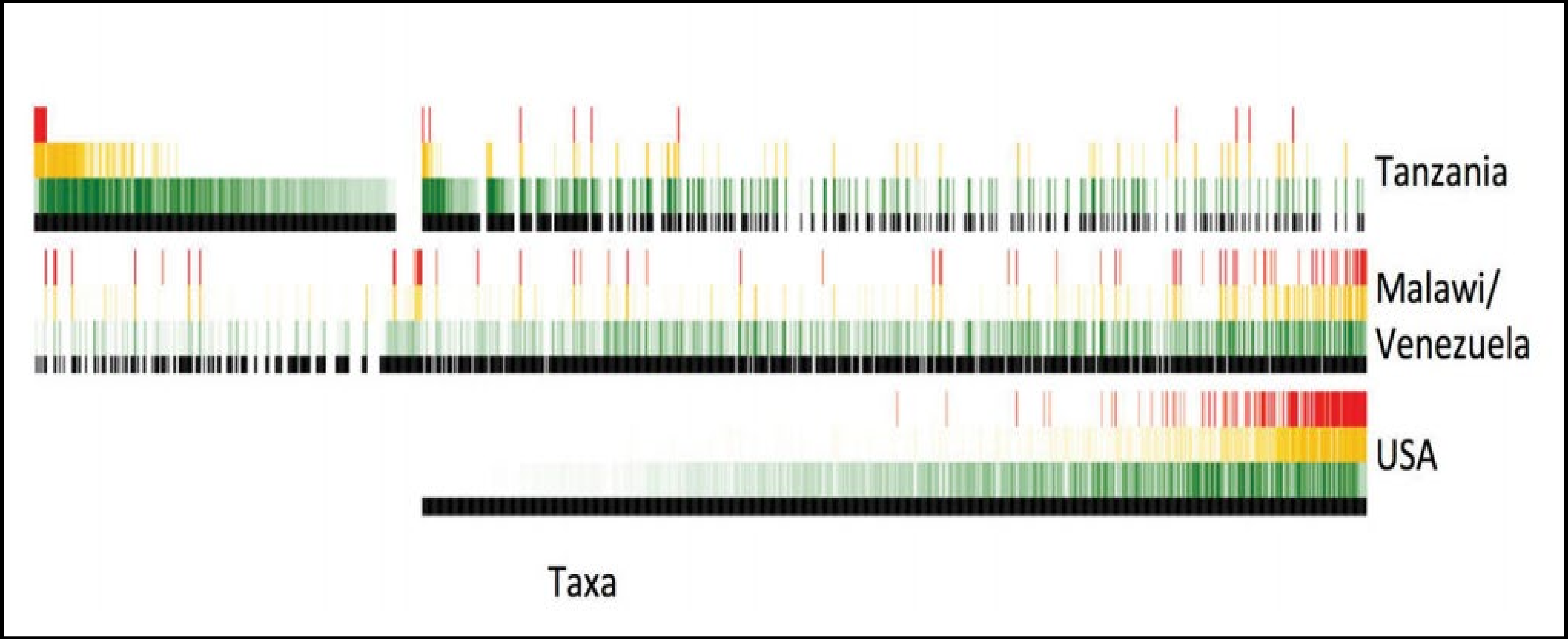
Almost all of these are Autoimmune Diseases and closely related to dysbiosis of gut microbiota

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



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

Diet Induced Differences in Gut Microbiota

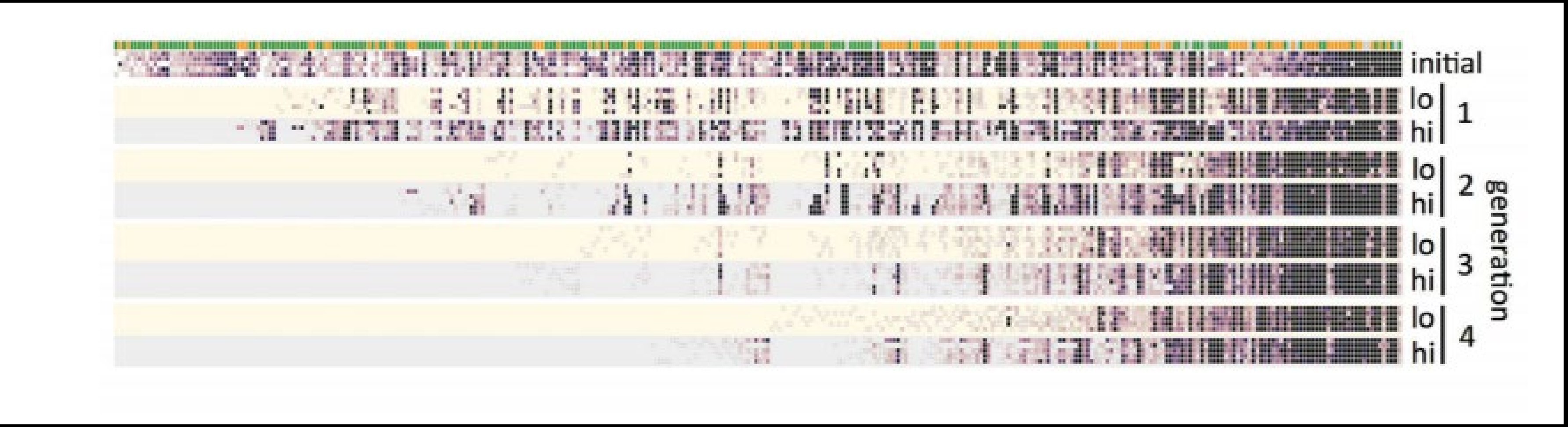


https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4850918/pdf/nihms742543
.pdf

Diet Induced Extinction of Microbiota

Microbiota-accessible Carbohydrates (MAC) FIBER

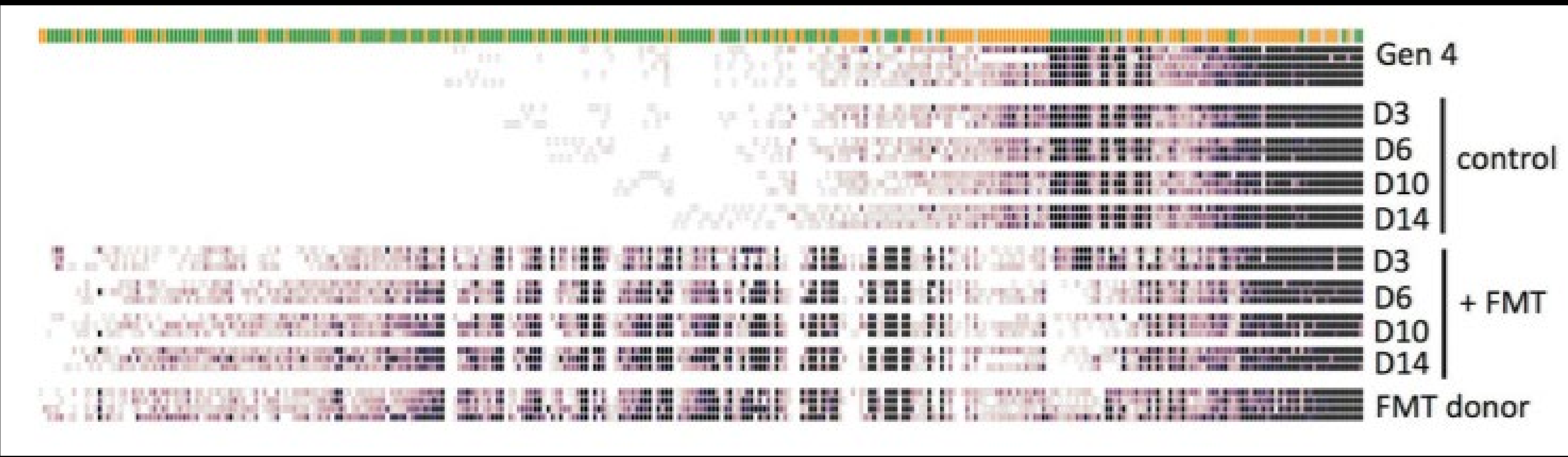
Low MAC Diet



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

Re-establishment of Gut Microbiome

Increased MAC in Diets



Increased MAC Diets + Fecal Matter Transfers

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

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

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

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

Fungal ↑ / ↓ Bacterial

- F:B = 100:1 to 1000:1 → Conifer, Old Growth Forests (2200)
- F:B = 5:1 to 100:1 → Deciduous Trees (1200)
- F:B =2:1 to 5:1 → Shrubs, Vines, Bushes (700)
- F:B = 1:1 → Late Successional Grasses, Row Crops (600)
- F:B = 0.75 → Mid-grasses, Vegetables
- F:B = 0.3 → Early Grasses, Bromus, Bermuda (600)
- F:B = 0.1 → Weeds (High NO_3, Lack of Oxygen)
- F:B = 0.01 → Cyanobacteria, True Bacteria, Protozoa, Fungi, Nematodes
- 100% Bacterial → Bare Soil Parent Material, Deserts (90)

Increasing Ecosystem Productivity (NPP =g/m^2/year)

Elaine Ingham- www. soilfoodweb.com

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

Agriculture is Controlled Disturbance

Fungal

Bacterial

F:B = 100:1 to 1000:1 → Conifer, Old Growth Forests

F:B = 5:1 to 100:1 → Deciduous Trees

F:B =2:1 to 5:1 → Shrubs, Vines, Bushes

F:B = 1:1 → Late Successional Grasses, Row Crops

F:B = 0.75 → Mid-grasses, Vegetables

F:B = 0.3 → Early Grasses, Bromus, Bermuda

F:B = 0.1 → Weeds (High NO_3, Lack of Oxygen)

F:B = 0.01 → Cyanobacteria, True Bacteria, Protozoa, Fungi, Nematodes

100% Bacterial → Bare Soil Parent Material

Increasing Ecosystem Productivity

Where we are currently in agroecosystems!

Elaine Ingham- www. soilfoodweb.com

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Nature's Controlled Disturbance

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NM STATE

Johnson-Su **No-Turn** Composting Bioreactor

https://youtu.be/DxUGk161Ly8

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Johnson/Su Static Composting Technology

- Results in a low salinity compost (~2-3 mS/cm)
- Amenable to incorporation of vermicomposting after thermophilic phase

Produces a

FUNGAL DOMINANT and BIOLOGICALLY DIVERSE Compost

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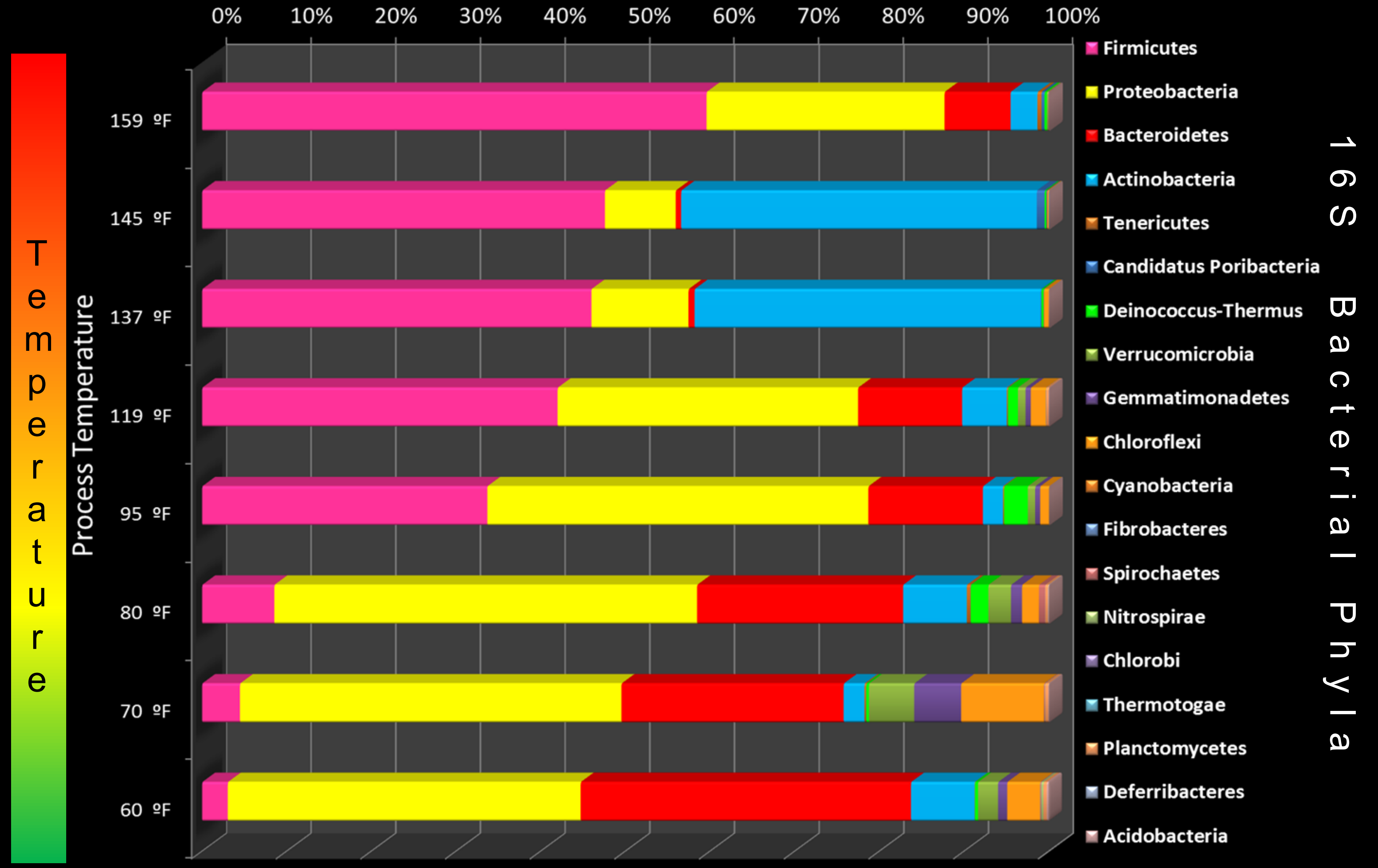

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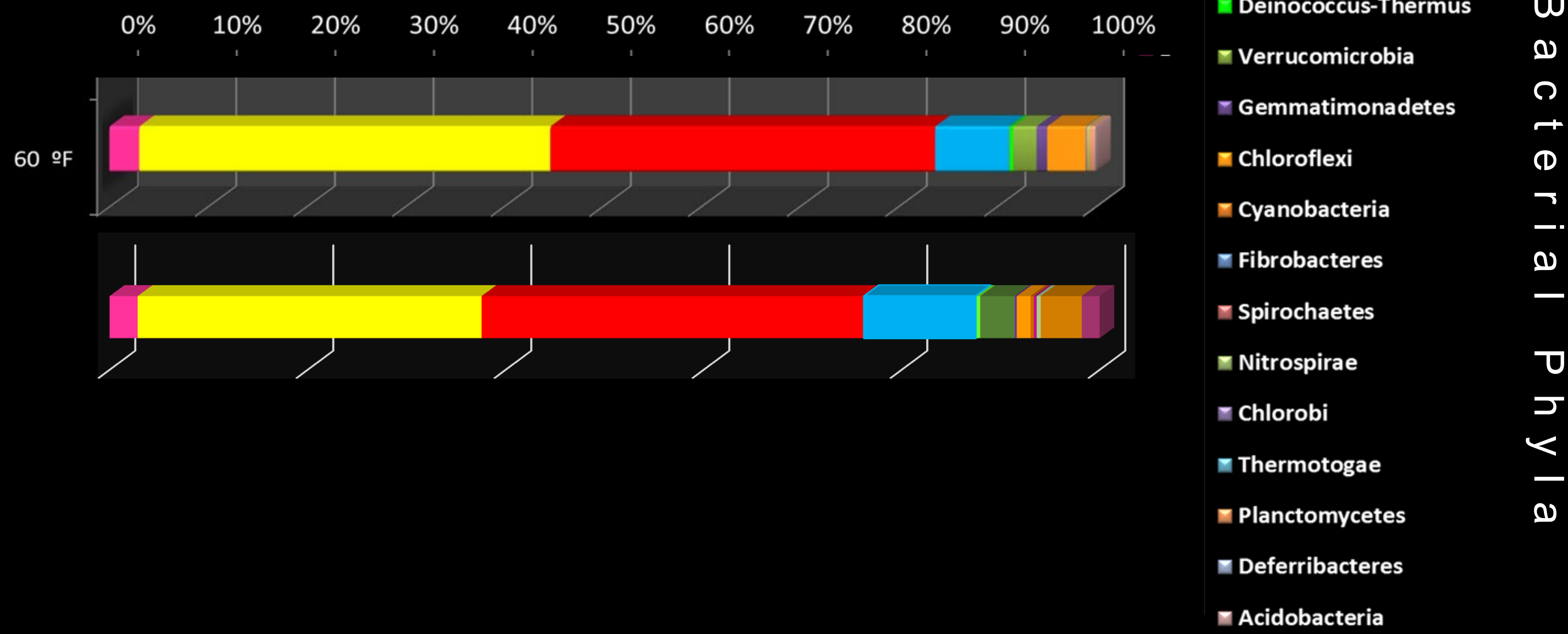
Two Compost Samples
Ten Years Apart
16S Bacterial Diversity Assay



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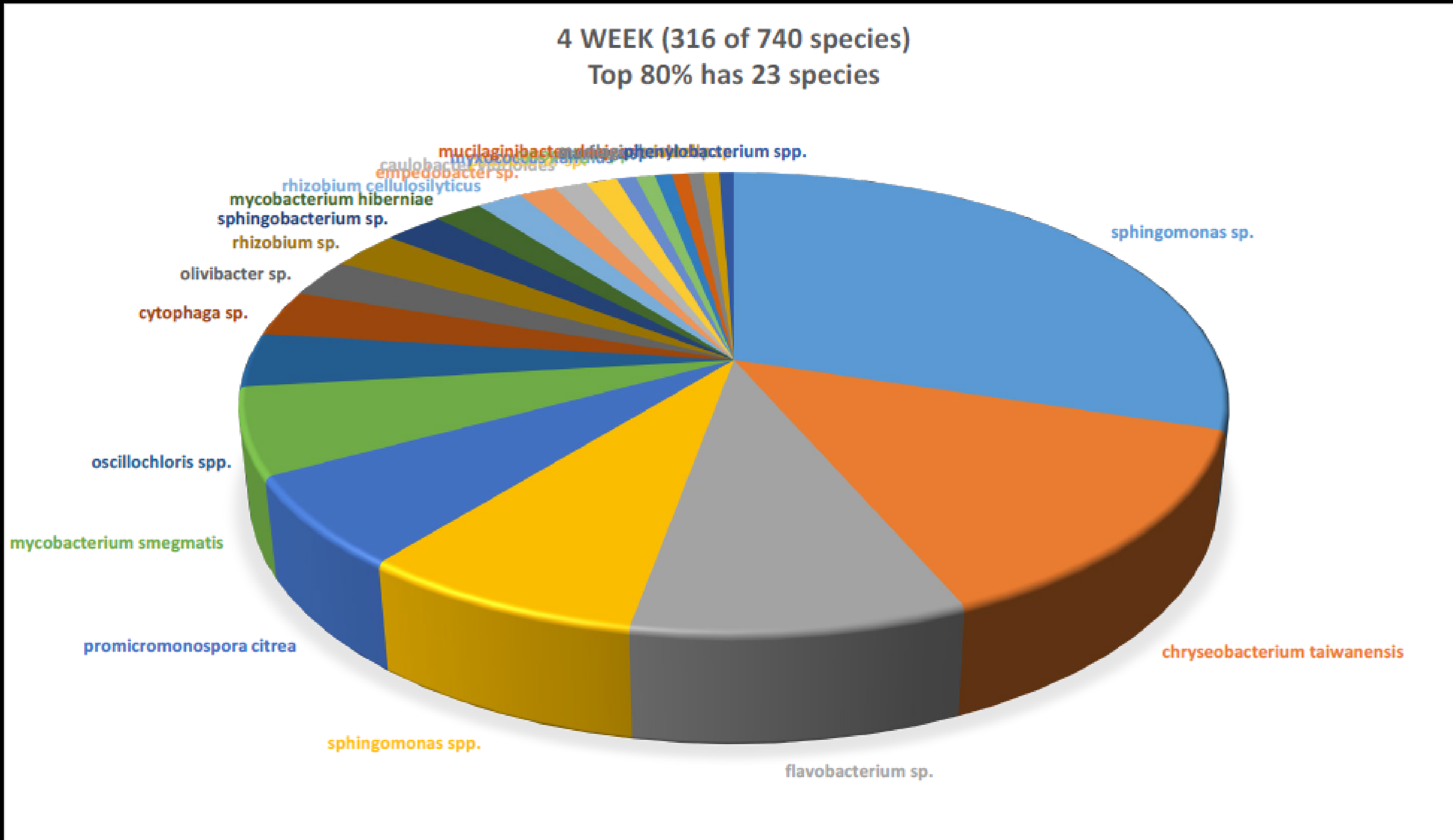

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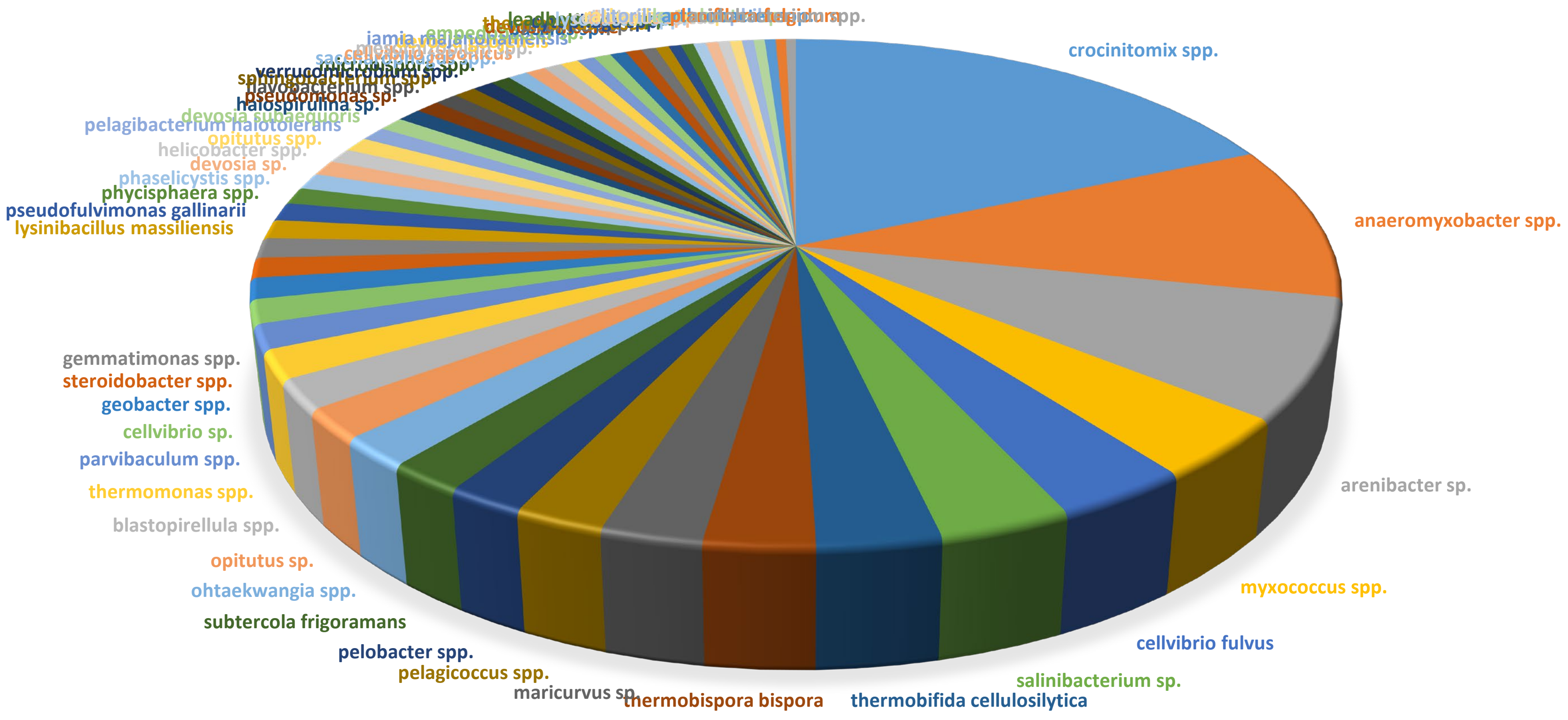
22 WEEKS (424 of 740 species)
Top 80% has 57 species



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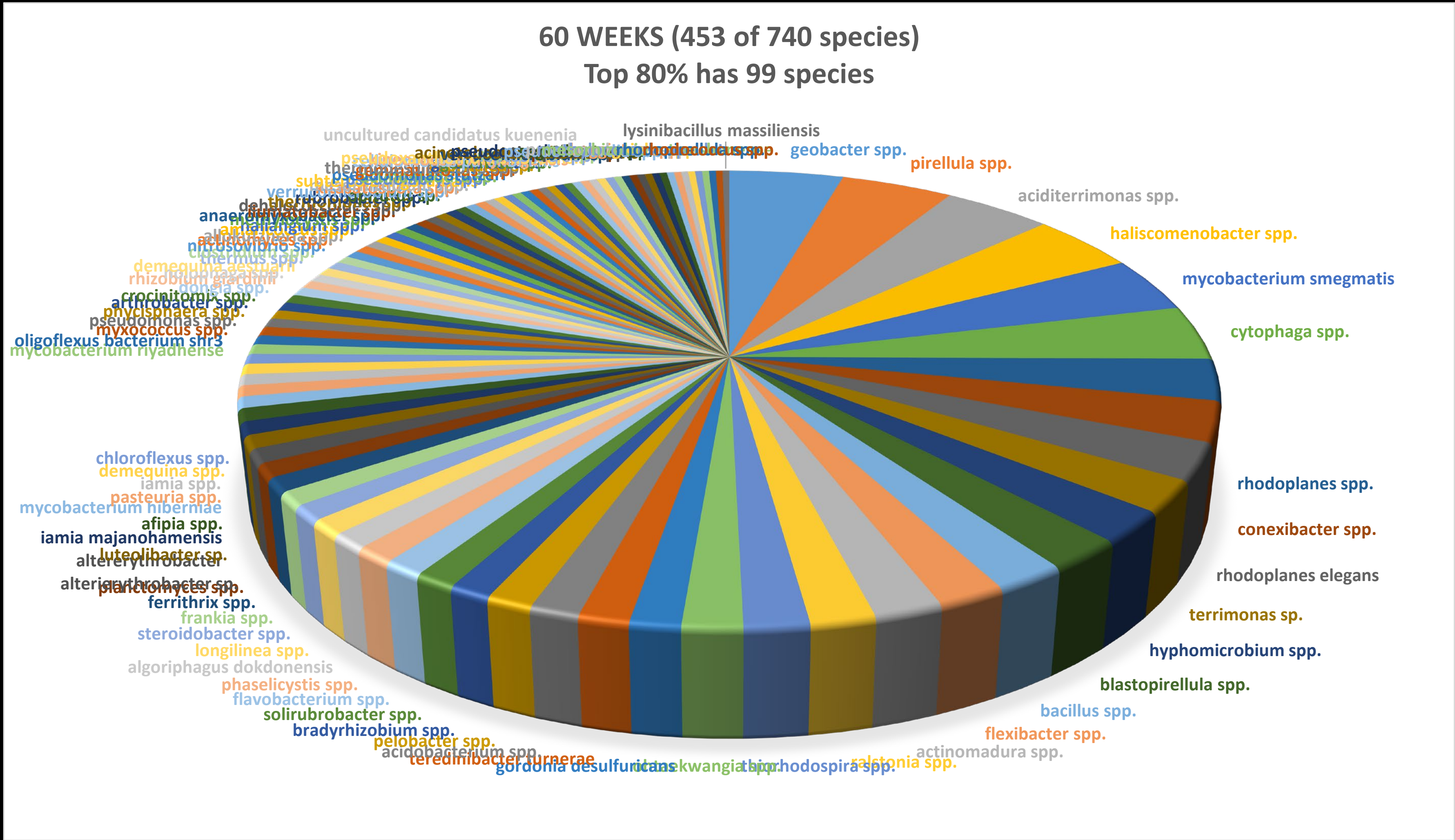

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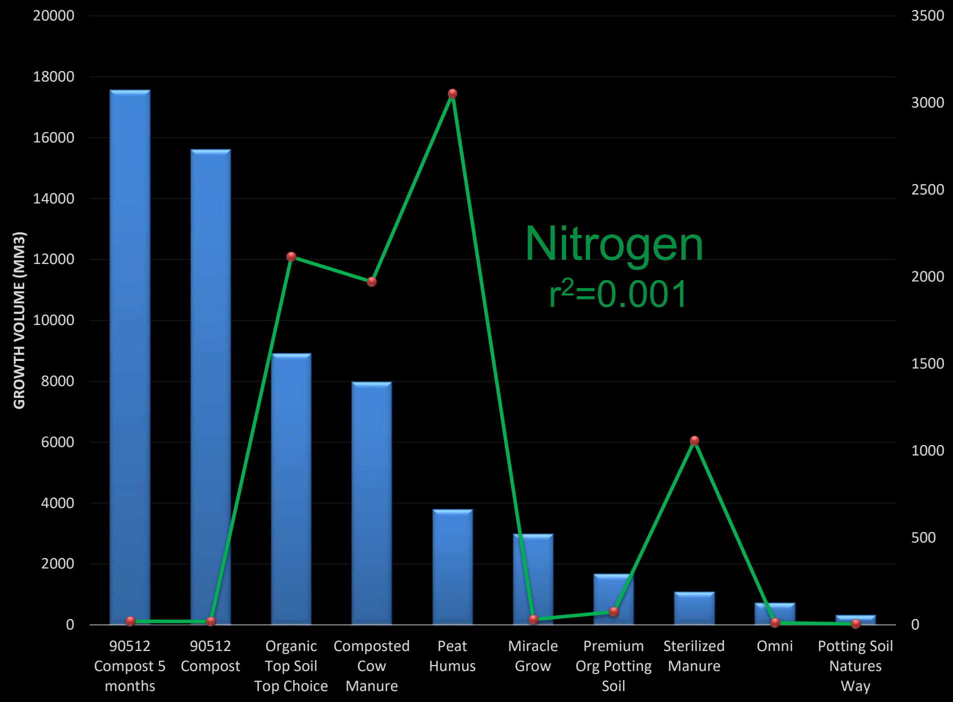

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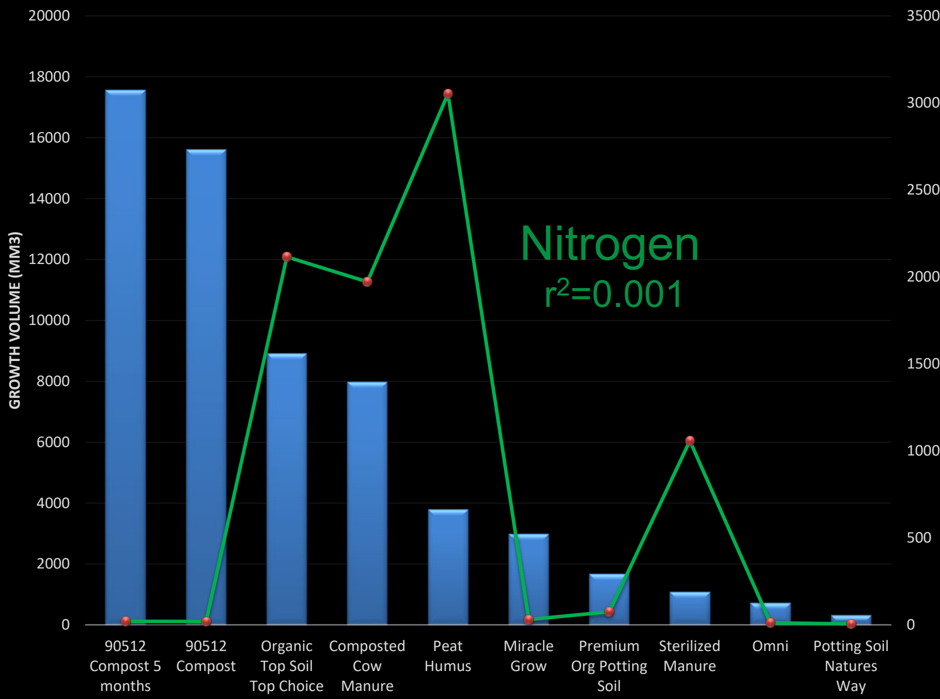

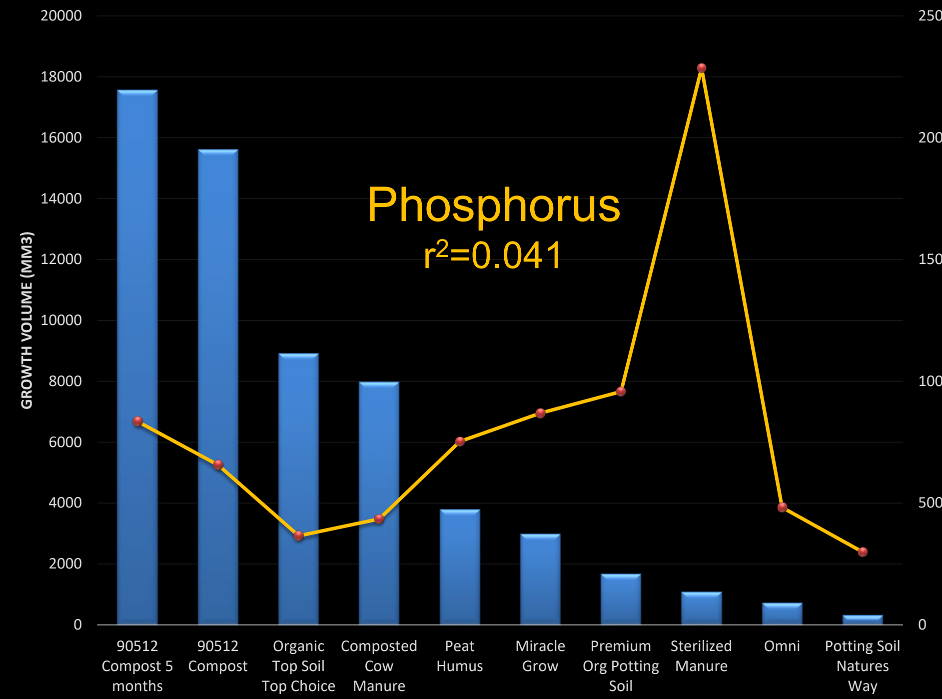

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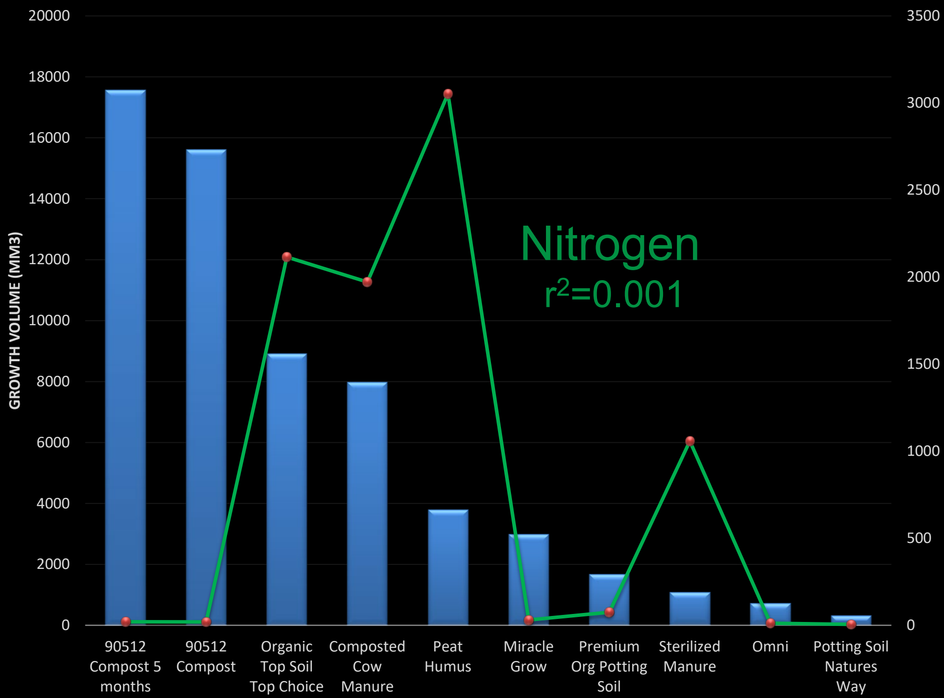

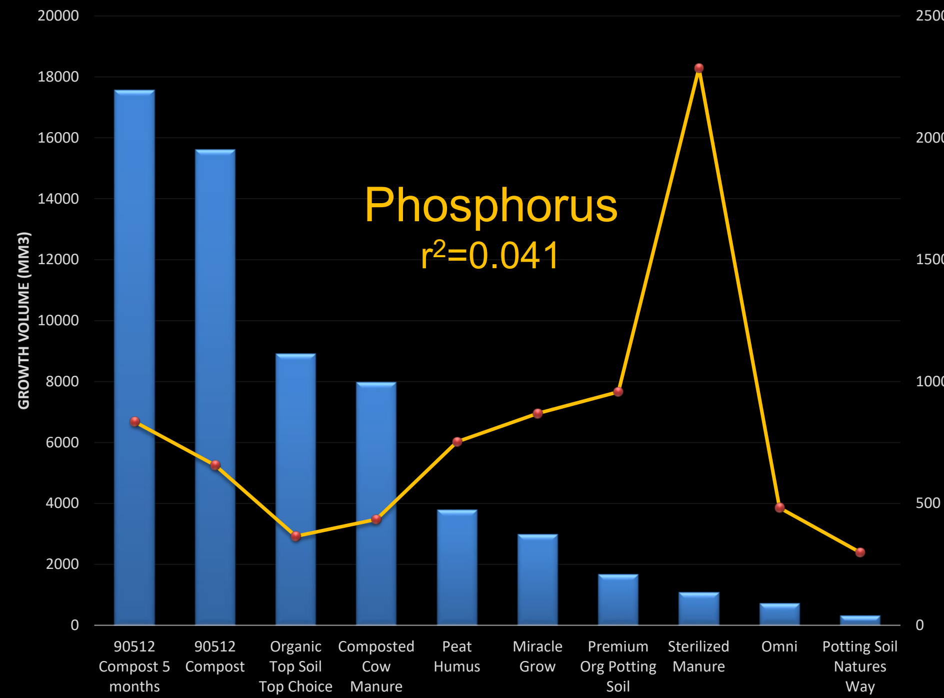

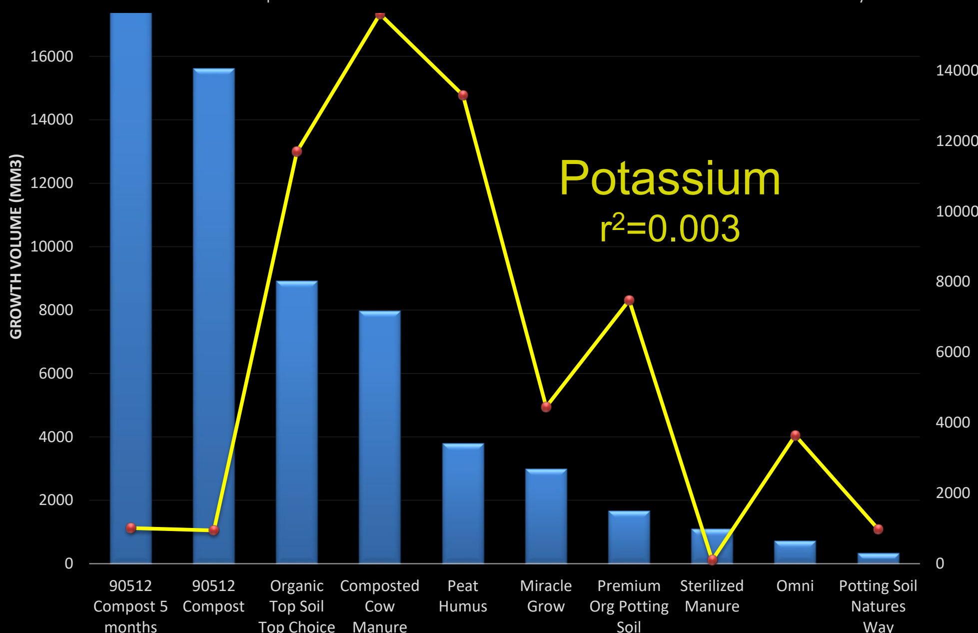

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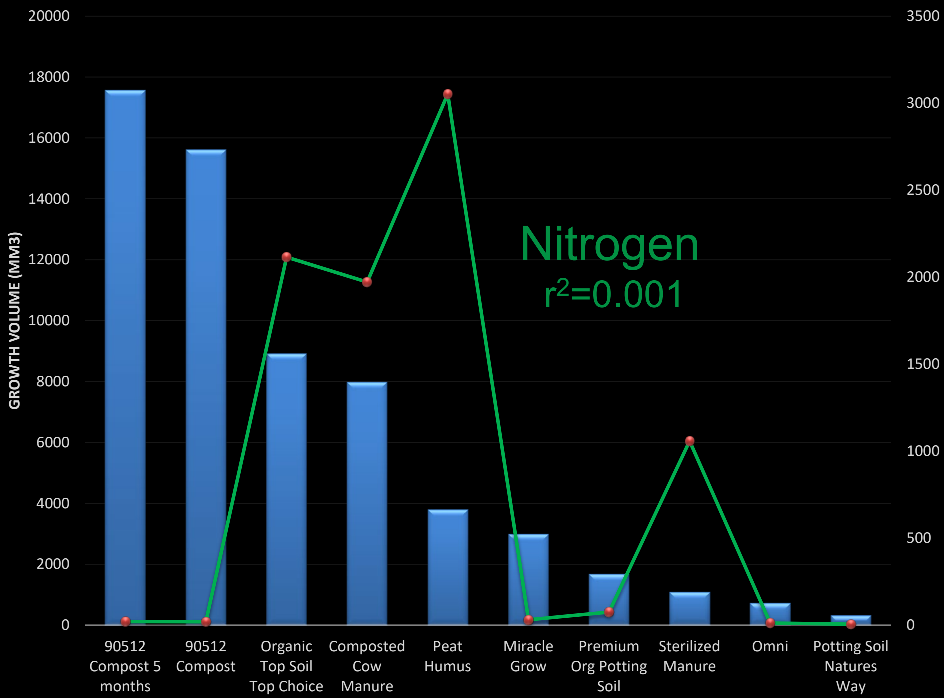

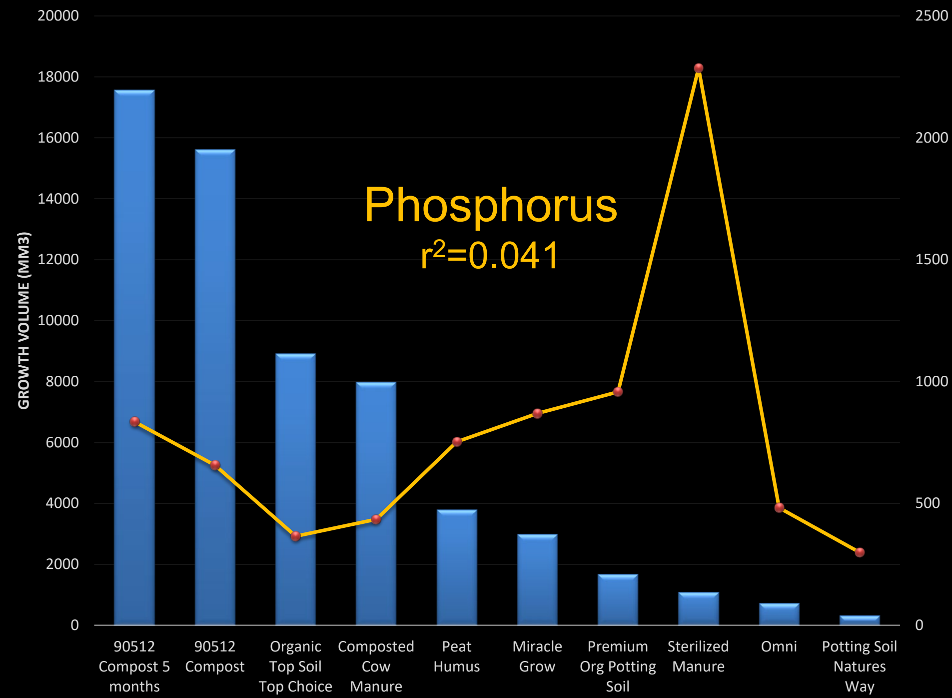

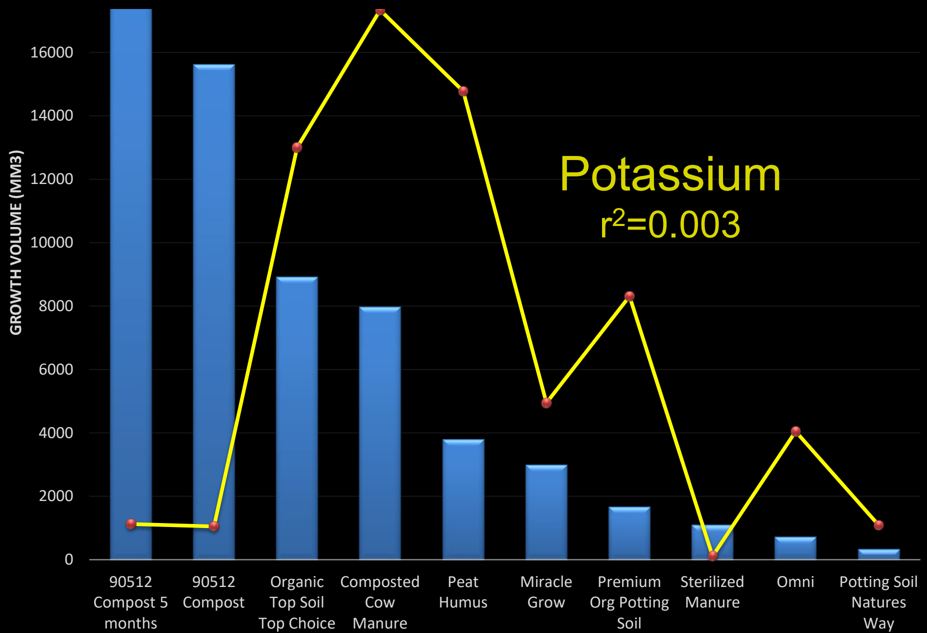

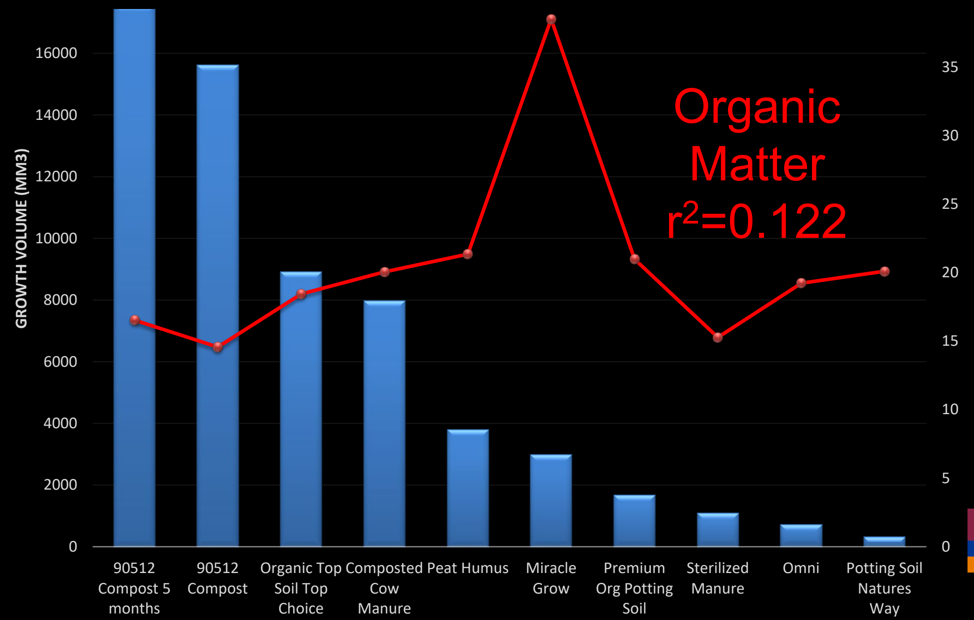

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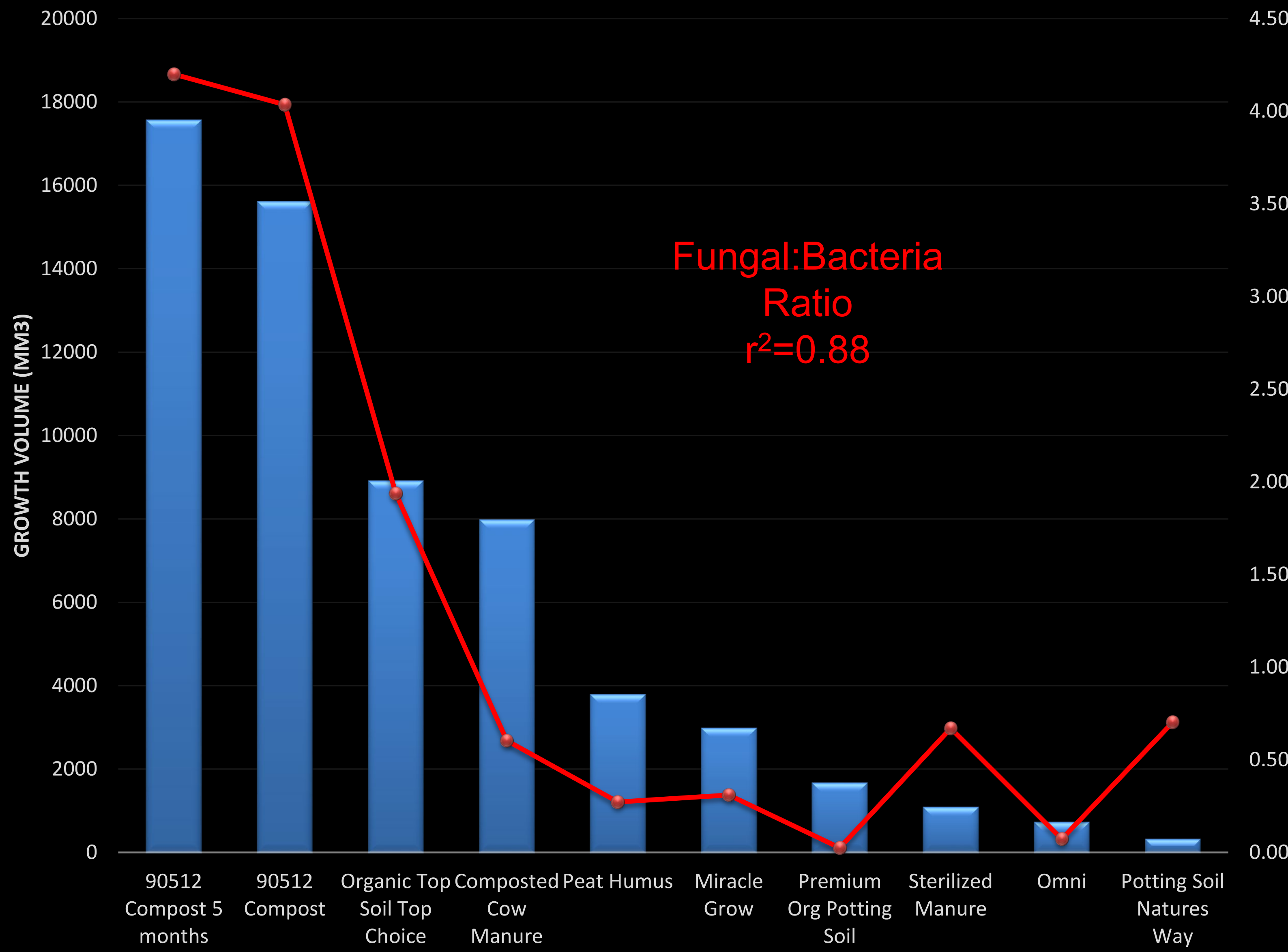

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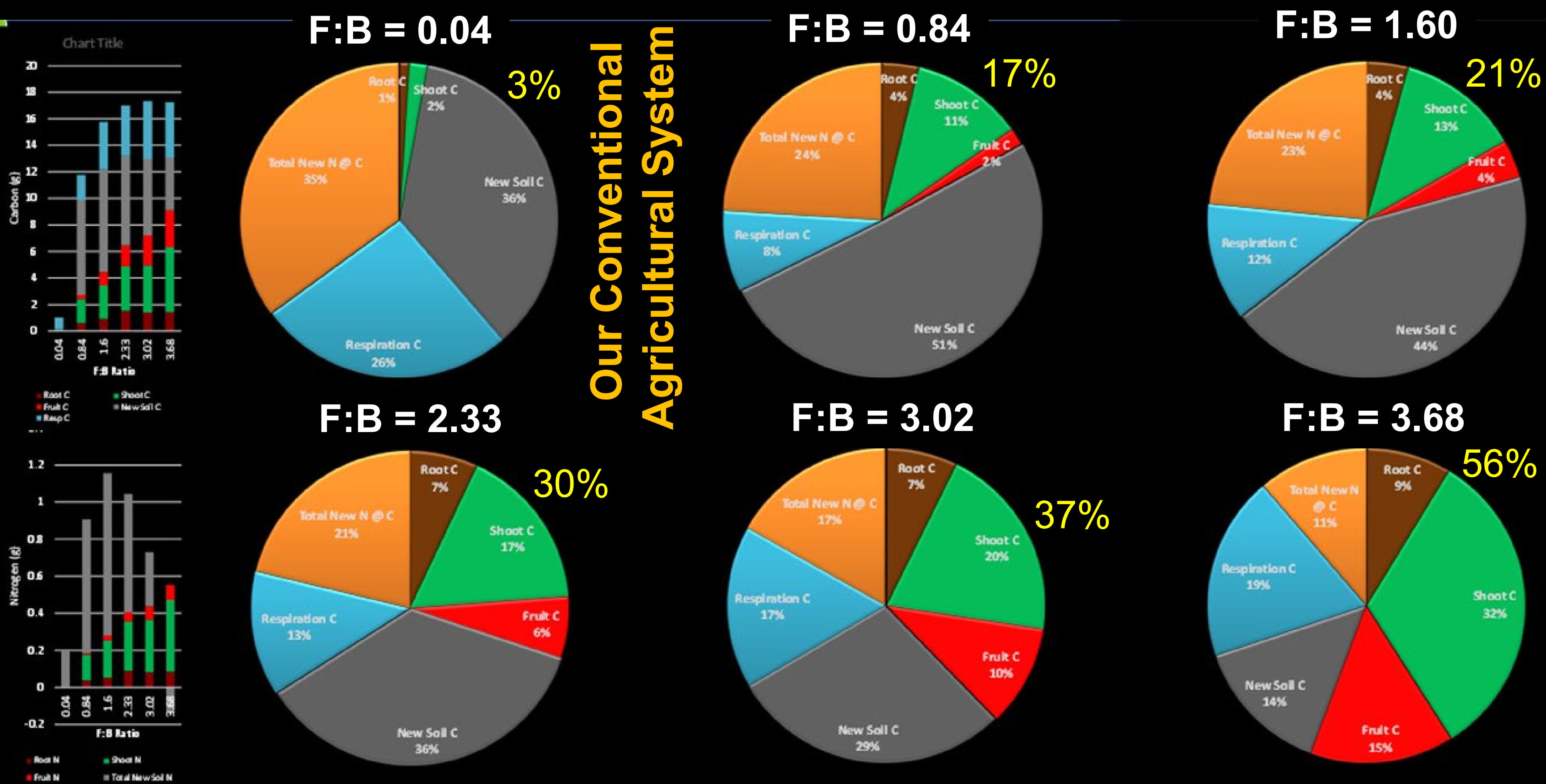
Efficiency of Carbon Flow to Plant Biomass



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How Well Does This Work in the Real World?

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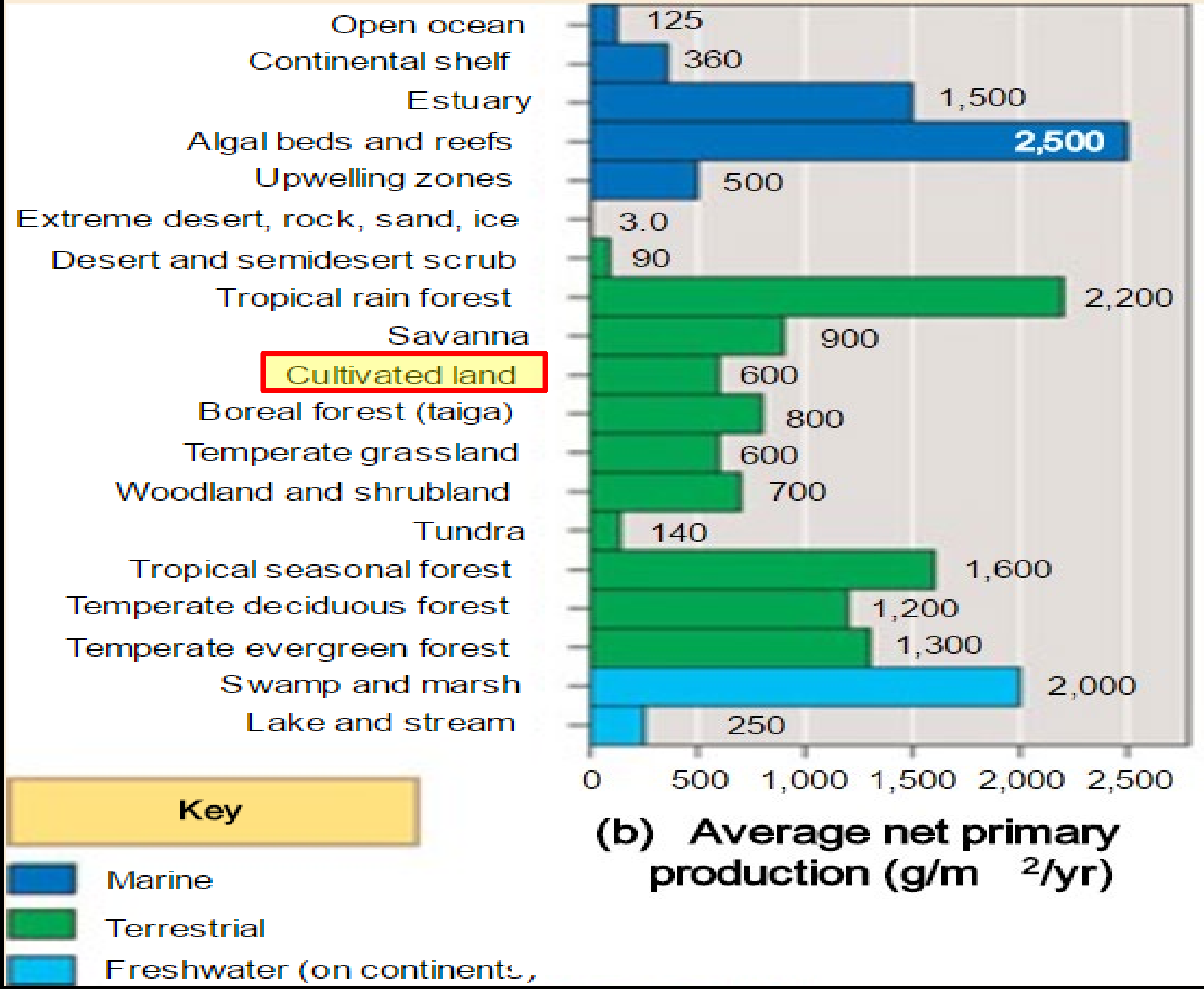
Net Primary Production



http://slideplayer.com/slide/7735151/

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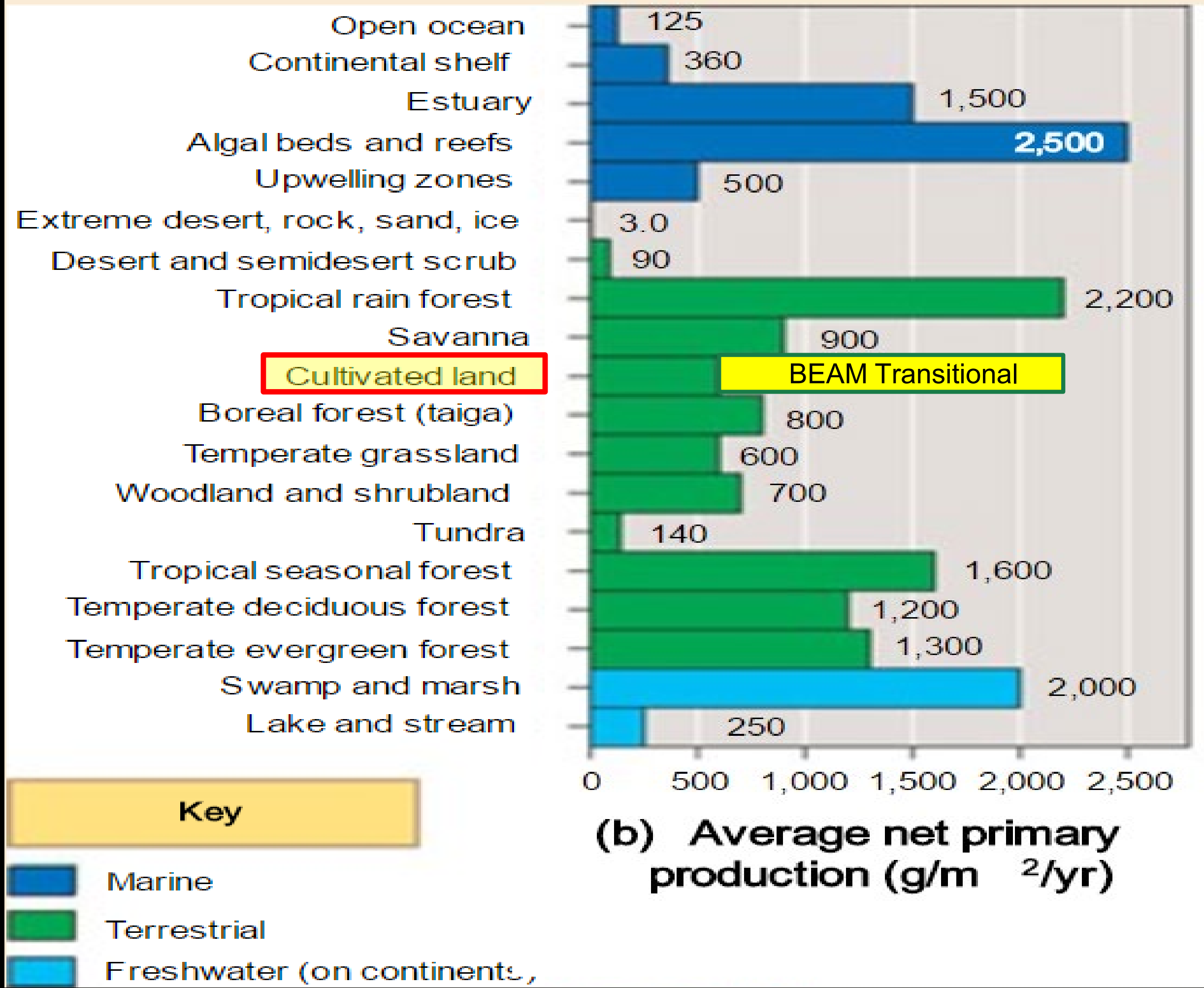
Net Primary Production



http://slideplayer.com/slide/7735151/

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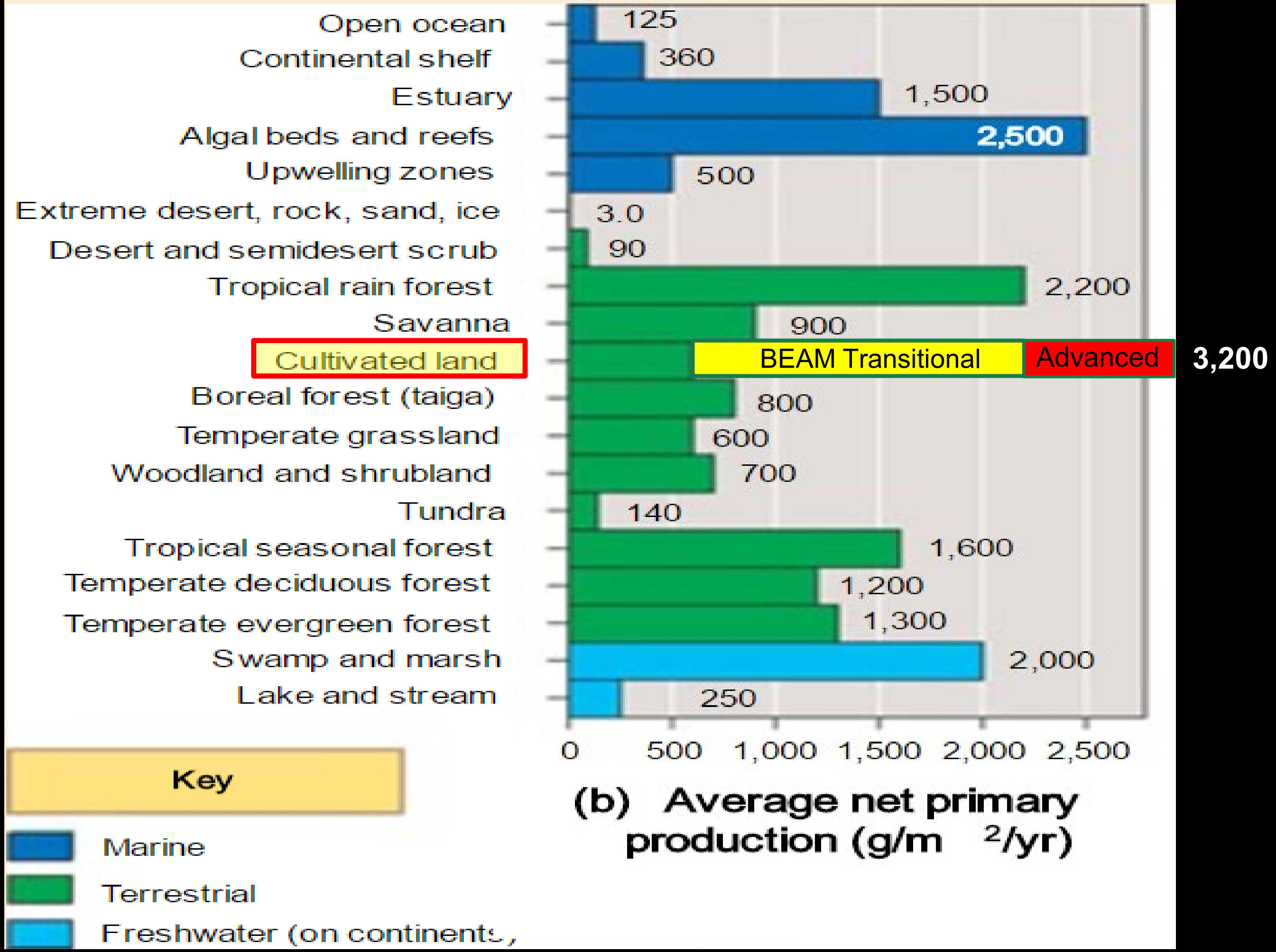
Net Primary Production



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Spread Rate
(wet) =
450 kg/hectare

45 g /m^2

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Net Primary Productivity

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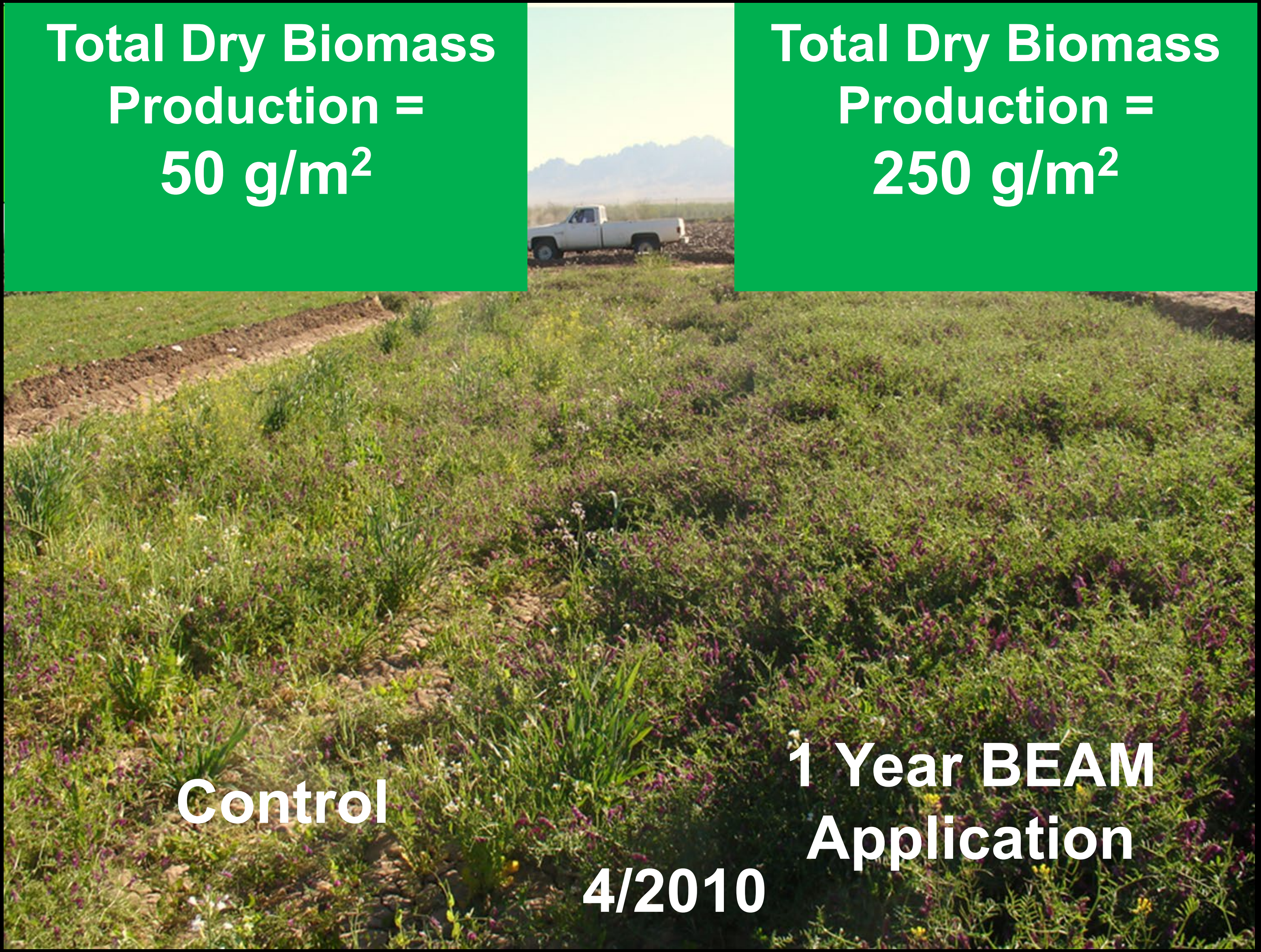

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6/23/2016

7/21/2016

29 Days Later

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2015 Desert Sandy Soil Trial

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2016 Desert Sandy Soil Trial

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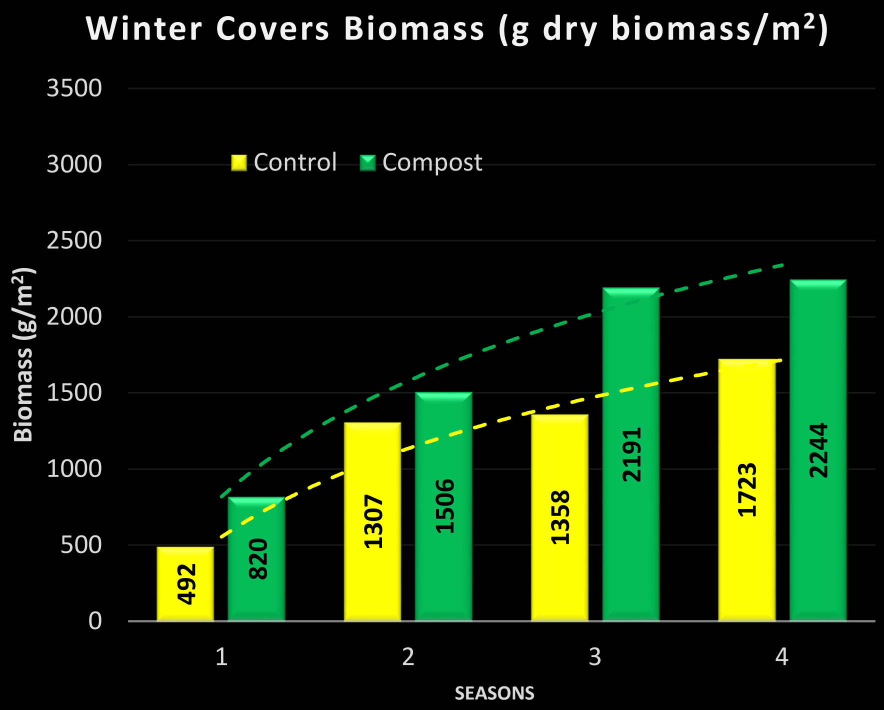

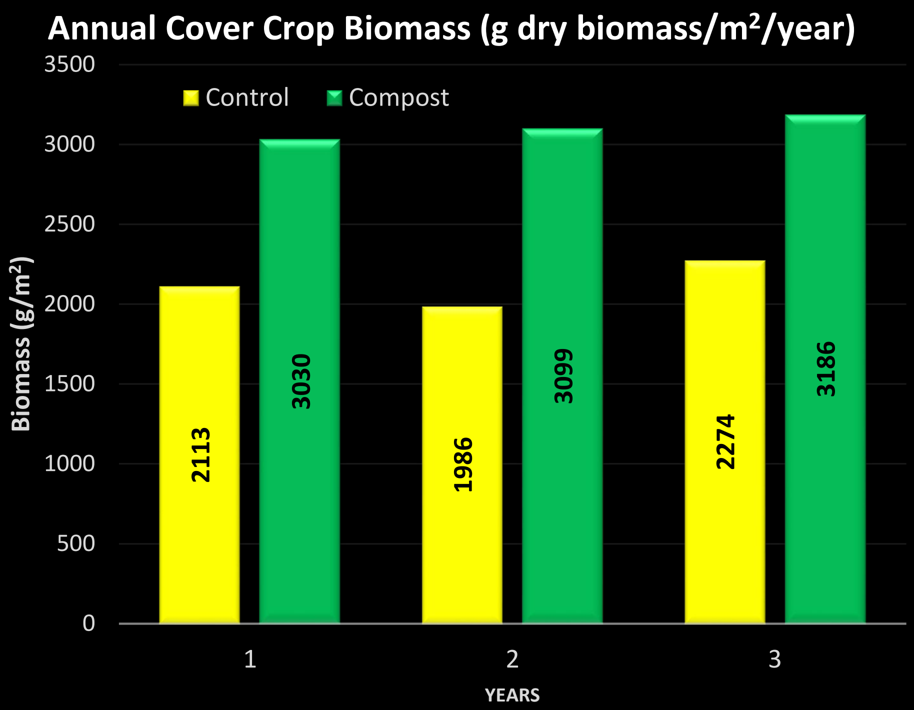

3186 grams of dry biomass/m^2/year
14.37 tons/acre
872 kg N/ hectare/ year (777 lbs N/acre/year)

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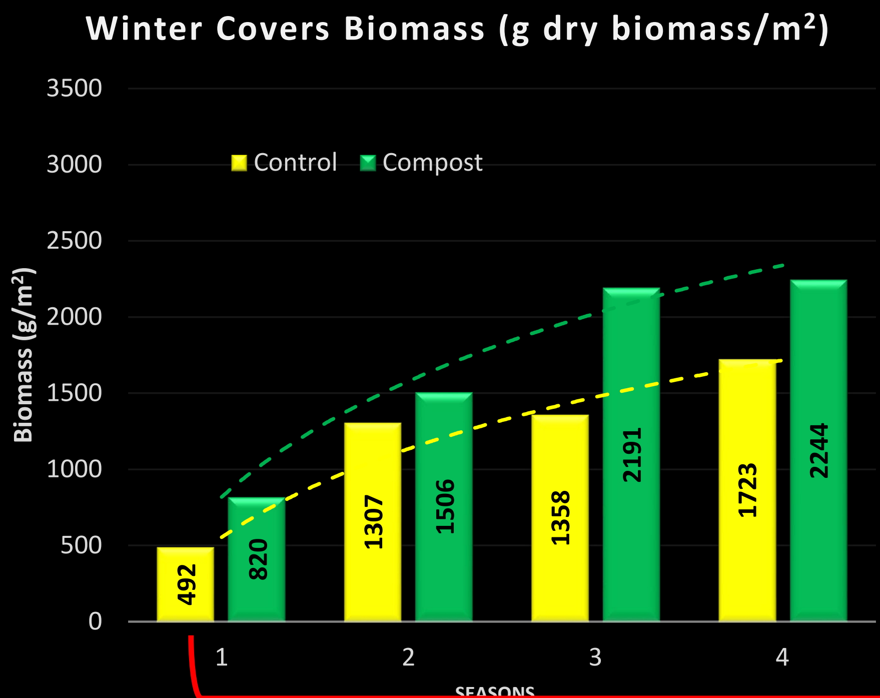

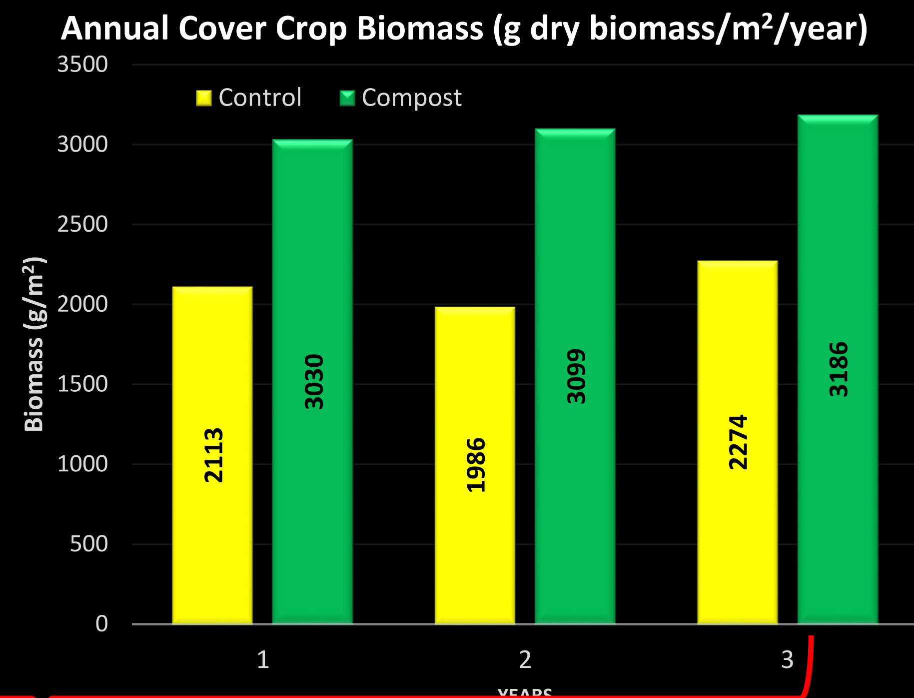

Five time increase in Net Primary Productivity

3186 grams of dry biomass/m^2/year

14.37 tons/acre

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

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Starting Desert Soil- No A Horizon

New Mexico State University

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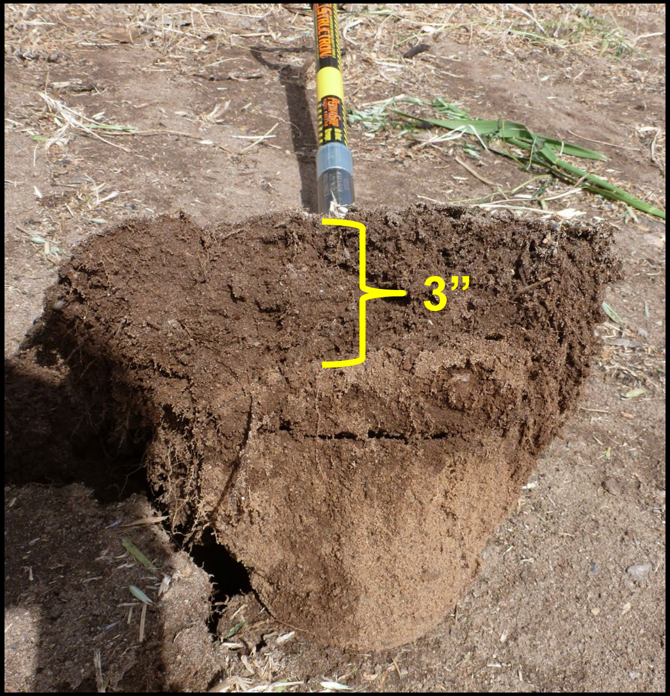
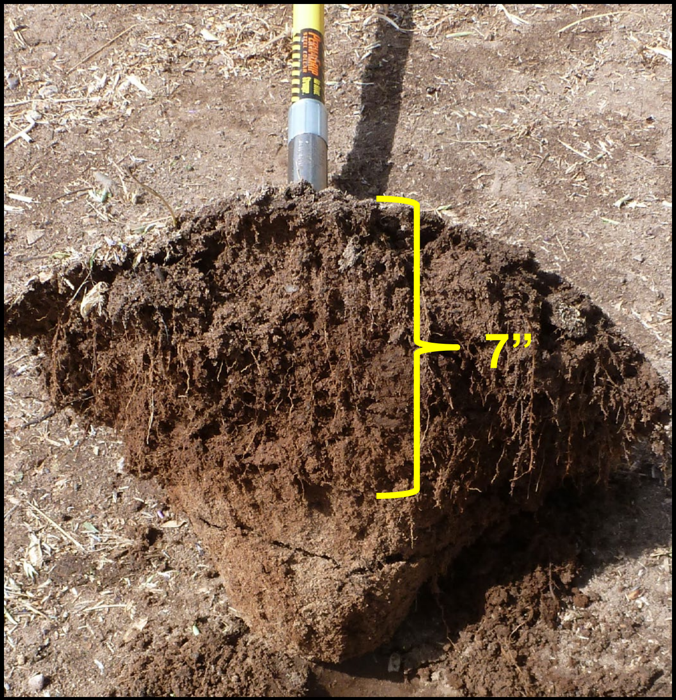
Results After 3.5 years of Enhancing Soil Microbiology (7 successive crops)



Control



Compost

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Species	Compost Treated	Control	Desert	Total Count	Nitrogen Fixation	Nitrogen Cycling	Carbon Cycling	Metal Oxidation	Phosphorus Solubilizin	Antibiotic/Antimicrobia	Biofilm/Quorum	CO Oxidation	Degrade Pesticides/Xen	Phytohormone Producin	Specialty
Nitrosopumilus maritimus	3,882	7,901	951	12734											
Acidobacterium capsulatum	2,631	3,534	1,147	7312											
Acidobacterium sp. MP5ACTX8	1,418	1,639	254	3311											
Candidatus Solibacter usitatus	17,913	22,435	9,691	50039				Fe							Cellulose Production
Candidatus Koribacter versatilis	7,496	10,138	1,921	19555											
Acidothermus cellulolyticus	3,190	2,421	522	6133											
Arcanobacterium haemolyticum	155	108	45	308											
Cellulomonas flavigena	2,226	1,255	19	3500											
Corynebacterium glutamicum	767	481	38	1286											
Dermacoccus sp. Ellin185	684	424	9	1117											
Frankia sp. CcI3	2,895	2,157	229	5281	F/S										15% of World Biologically Fixed N
Frankia sp. EAN1pec	2,299	1,796	258	4353	F										
Frankia sp. EUN1f	1,148	822	70	2040	F										
Frankia sp. EuI1c	1,685	1,434	243	3362	F										
Frankia symbiont of Datisca glomerata	781	595	53	1429	F										
Geodermatophilus obscurus	12,050	7,959	349	20358				Mn							
Gordonia bronchialis	1,006	588	30	1624											
Janibacter sp. HTCC2649	2,792	1,921	70	4783											
Jonesia denitrificans	909	457	5	1371											
Kineococcus radiotolerans	4,486	2,799	92	7377											Radiation Resistant/Self Re-assembling
Clavibacter michiganensis	4,739	2,242	20	7001											
Leifsonia xyli	4,001	1,679	46	5726											
Arthrobacter arilaitensis	1,042	377	31	1450											Pesticides Herbicides
Arthrobacter aurescens	4,268	2,304	133	6705											Atrazine
Arthrobacter chlorophenolicus	2,399	1,114	62	3575											4-Chlorophenol
Arthrobacter nitroguajacolicus	16	2	-	18				Cr							Acrilonitirle
Arthrobacter sp. FB24	4,837	2,635	160	7632											Xylene
Kocuria rhizophila	1,928	752	23	2703											
Micrococcus luteus	1,440	565	24	2029											Malathione & Chlopyriphos
Renibacterium salmoninarum	1,593	847	14	2454											
Rothia dentocariosa	498	205	9	712											
Rothia mucilaginosa	498	282	24	804											
Salinispora tropica	7,392	6,293	176	13861											Anti-cancer agents
Mycobacterium abscessus	478	319	16	813											
Mycobacterium gilvum	1,371	906	84	2361											
Mycobacterium leprae	427	279	14	720											
Mycobacterium marinu			15	1374											
Mycobacterium smegma			29	4340											
Mycobacterium sp. JLS			45	1585											PAH & Pyrene Degrading w/ Humics
Mycobacterium tubercu			59	3126											
Mycobacterium ulceran			24	1048											
Mycobacterium vanbaal			49	3421											PAH Degradation
Nakamurella multipartit			19	6164											
Rhodococcus jostii	4,505	3,048	441	7994											Toluene, Naphthalene,Herbicides, PCBs.
Aeromicrobium marinum	1,857	1,052	4	2913											Alkanes
Kribbella flavida	4,524	2,998	280	7802											
Nocardioides sp. JS614	11,260	7,472	1,126	19858											Vinyl Chloride and Ethane
Nocardiopsis dassonvillei	1,260	971	176	2407											Antimicrobial, Anticancer, Immunomodulators
Thermobifida fusca	2,926	2,290	308	5524											
Xylanimonas cellulosilytica	1,783	834	49	2666											
Propionibacterium freudenreichii	494	306	9	809											Cheese Production
Amycolatopsis mediterranei	2,504	1,925	138	4567											
Saccharomonospora viridis	1,714	1,171	49	2934											Pentachlorophenol
Saccharopolyspora erythraea	5,922	4,329	372	10623											Multidrug Resistant

193 Species (7%)
$r^2>0.95$

5,545,925 OTU's | 2,750 species

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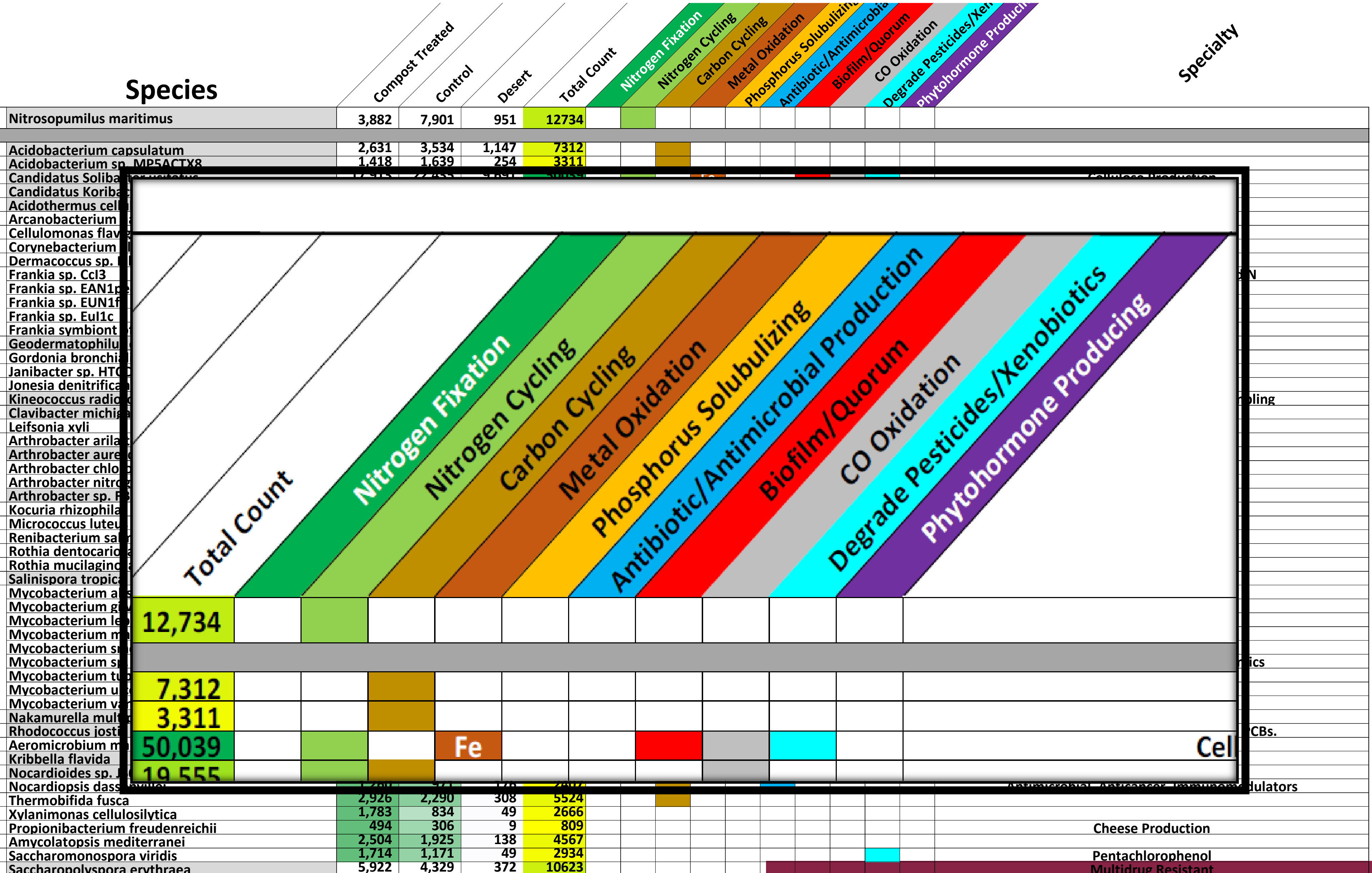

5,545,925 OTU's | 2,750 species

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Species	Compost Treated	Control	Desert	Total Count	Nitrogen Fixation	Nitrogen Cycling	Carbon Cycling	Metal Oxidation	Phosphorus Solubulizing	Antibiotic/Antimicrobial Production	Biofilm/Quorum	CO Oxidation	Degrade Pesticides/Xenobiotics	Phytohormone Producing	Specialty
Leptothrix cholodnii	5,092	4,791	279	10,162									■		MTBE Degradation
Methylibium petroleiphilum	8,054	7,242	344	15,640											
Methylobacillus flagellatus	2,696	2,522	407	5,625									■		Methane Oxidation
Nitrosospira multiformis	3,244	3,741	946	7,931											Ammonia Oxidizing
Aromatoleum aromaticum	2,488	3,039	494	6,021									■		p-ethylphenols Degradation
Azoarcus sp. BH72	2,939	3,536	605	7,080	■										Endophyte
Dechloromonas aromatica	2,793	2,730	615	6,138									■		Toluene, Benzoate, and Chlorobenzoate Degradation
Stigmatella aurantiaca	5,776	6,617	1,252	13,645			■			■					
Haliangium ochraceum	7,992	10,529	435	18,956						■					
Anaeromyxobacter dehalogenans	6,405	8,216	860	15,481											
Anaeromyxobacter sp. Fw109-5	5,408	7,200	1,508	14,116				■							As, U, Se
Myxococcus xanthus	9,357	11,960	2,256	23,573			■				■				Forms Cooperative Hunting Groups
Plesiocystis pacifica	4,025	5,589	700	10,314											
Sorangium cellulosum	16,125	20,806	1,684	38,615							■				Can Grow Soley on Antibiotics
Saccharophagus degradans	2,280	3,013	5,331	[illegible]			■								10 Distinct Complex Polysaccharide Degraders
Escherichia coli	1,544	1,692	15,099	18,335											
Escherichia sp. 3_2_53FAA	152	228	451	831											
Pantoea sp. At-9b	535	292	12	[illegible]	■		■			■			■	■	Bioremediation and Herbicide Degraders
Pantoea sp. aB	244	[illegible]	1	366											Endophytic
Pantoea vagans	615	365	4	984					■					■	Epiphyte/Microbial Pesticide
Azotobacter vinelandii	1,153	1,011	156	2,320	F										
Cellvibrio japonicus	3,304	4,489	30	7,823			■								
Pseudomonas aeruginosa	5,293	3,809	377	9,479					■			■	■	■	PAH's Degradation
Pseudomonas amygdali	548	307	18	873					■						
Pseudomonas fluorescens	8,975	5,790	458	15,223				Fe	■	■			■	■	Pathogen Biocontrol
Pseudomonas mendocina	4,475	2,810	114	7,399		■									
Pseudomonas putida	6,651	2,678	401	9,730					■				■	■	BioPesticide/Toluene Degradation
Pseudomonas syringae	1,262	911	99	2,272						■					Frost Damage/Artificial Snow
Pseudomonas syringae group genomosp. 3	1,372	846	85	2,303											
Photobacterium profundum	730	589	79	1,398											
Vibrio splendidus	453	173	3	629											
Vibrio vulnificus	1,062	709	88	1,859											
Stenotrophomonas sp. SKA14	1,457	732	18	2,207	■								■		Aflatoxin Production Inhibitors
Xanthomonas axonopodis	1,803	1,405	141	3,349											
Xanthomonas campestris	6,106	4,731	251	11,088											
Xanthomonas euvesicatoria	1,763	1,169	60	2,992											
Xanthomonas fuscans	597	358	9	964											
Thermobaculum terrenum	2,786	3,250	779	6,815											
Chthoniobacter flavus	4,893	5,219	813	10,925											
Opitutus terrae	5,911	6,801	1,264	13,976											

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Quorum Sensing- regulation of gene expression in response to fluctuations in cell-population density

Quorum sensing promotes:

Symbiosis,
Virulence,
Competence,
Conjugation,
Antibiotic production,
Motility,
Sporulation, and
Biofilm formation.

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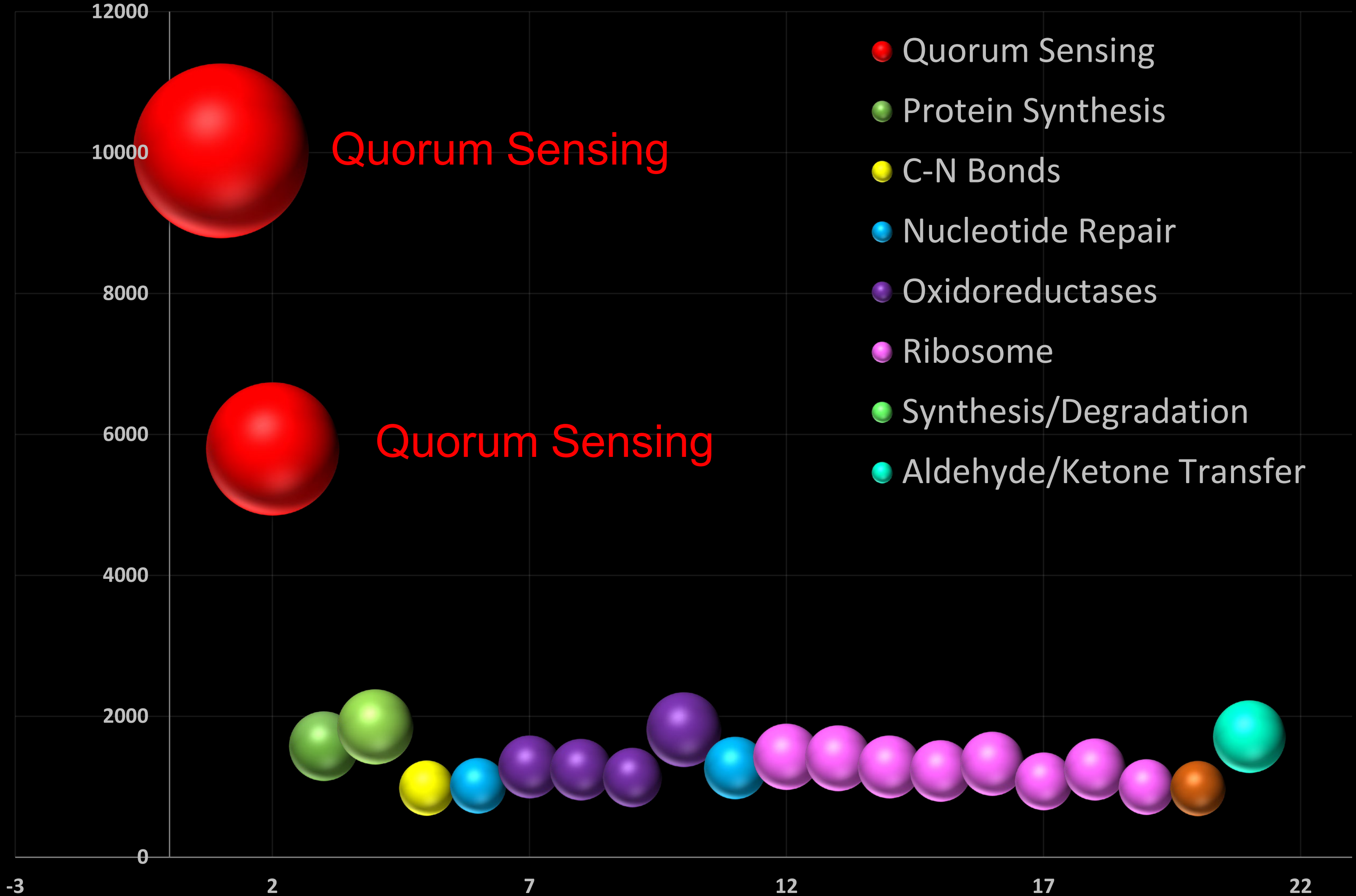
Metatranscriptome Analysis: Top 21



4,687 mRNA, Average= 62

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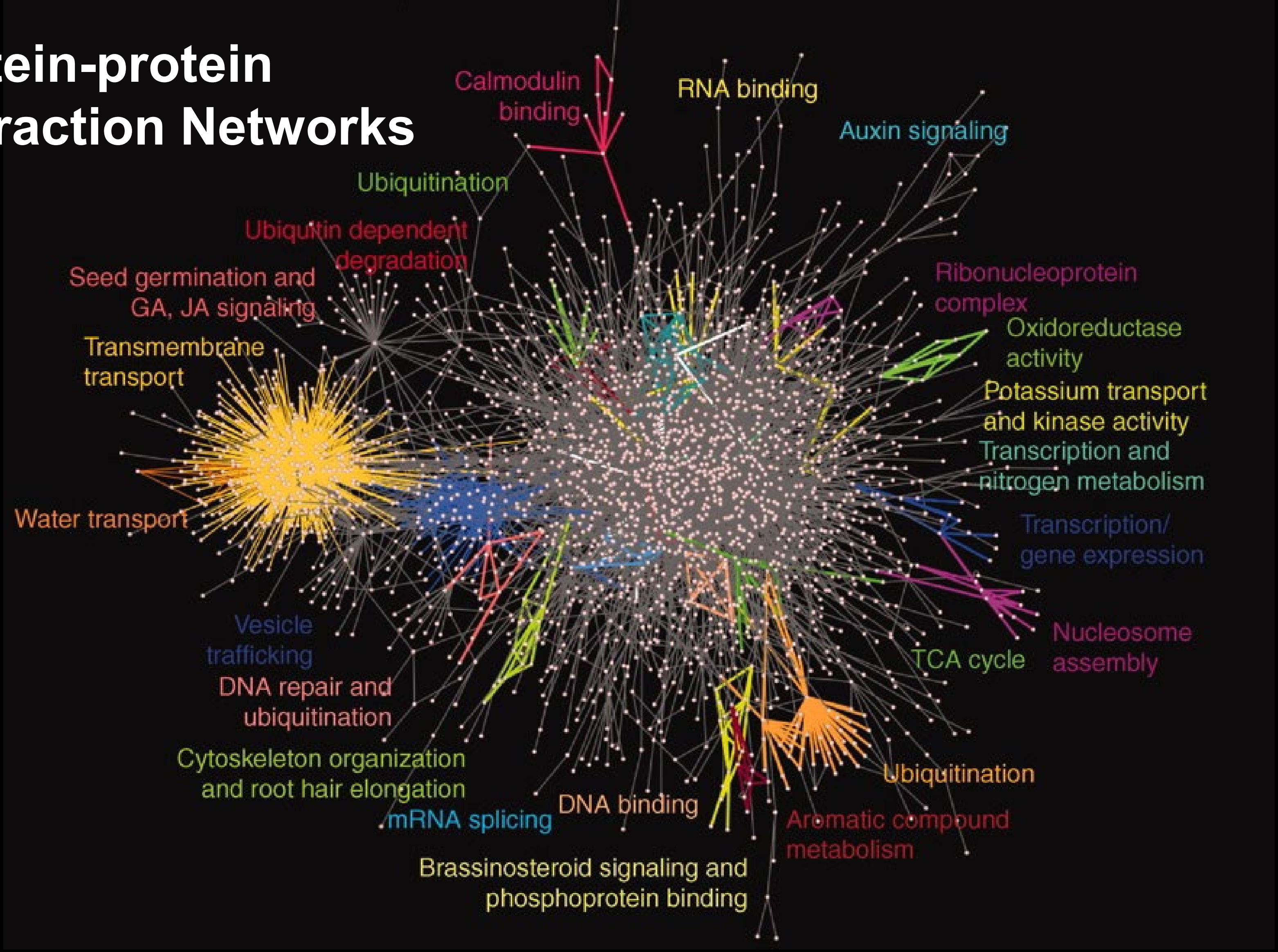
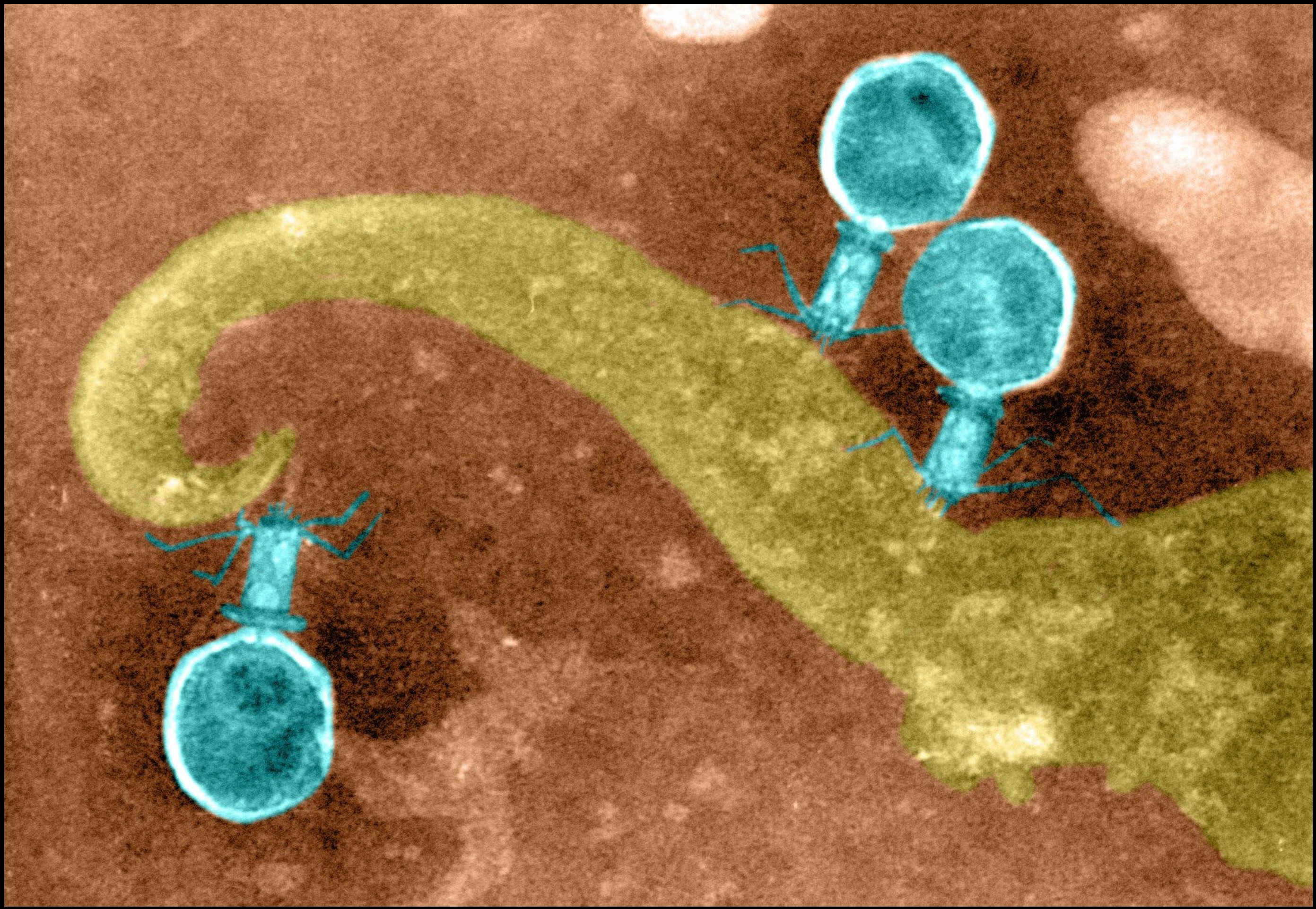
Protein-protein Interaction Networks



http://ibts.hkbu.edu.hk/one_show.php/coid_3.htm

Viruses modulate the function and evolution of all living things," Matthew B. Sullivan , Ohio State



800 million viruses cascade onto every square meter of the planet each day!

https://static01.nyt.com/images/2018/04/17/science/17SCI-VIROSPHERE1/merlin_136706406_cb36d32c-466f-4743-b2e4-90bbc7af41f5-superJumbo.jpg

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To Improve Soil Carbon Capture Three Things Must Happen

New Mexico State University

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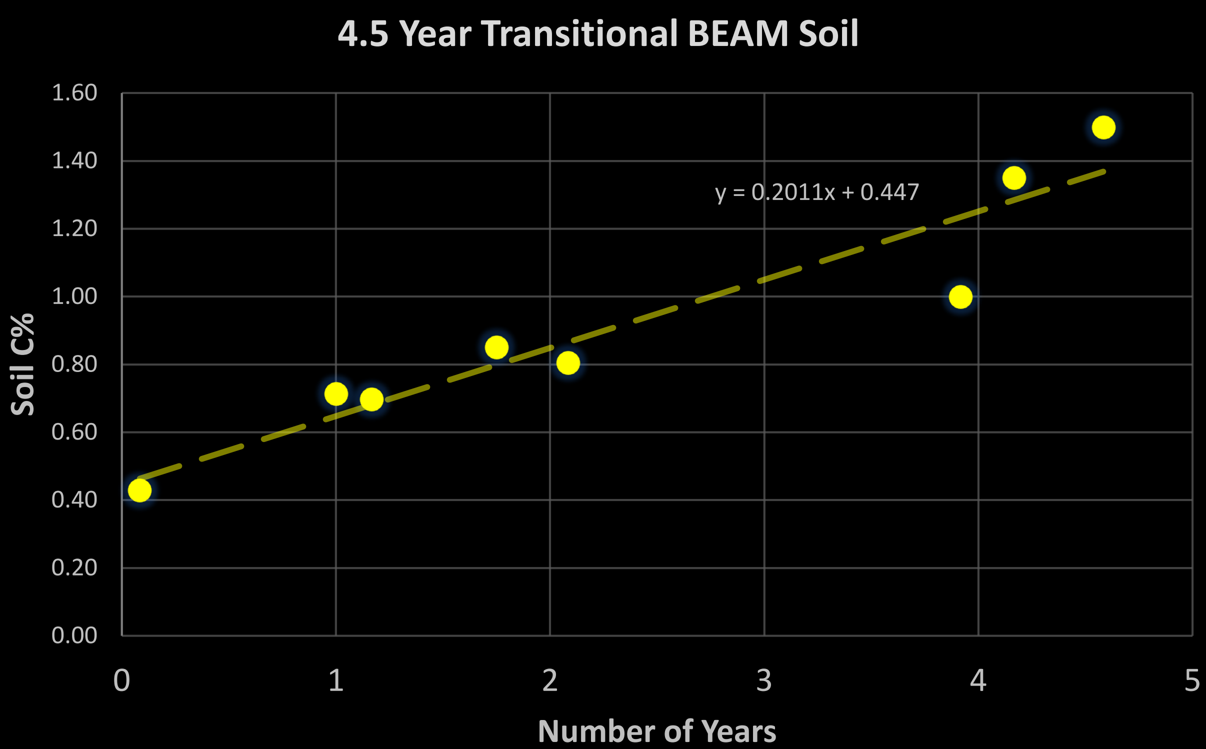
1. Capture more carbon by improving system photosynthetic capacity. (demonstrated above)
2. Increase the flow of photosynthate C into soil
3. Increase soil microbial community carbon use efficiency (reduce relative respiration)

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 CO_2/hectare/year captured

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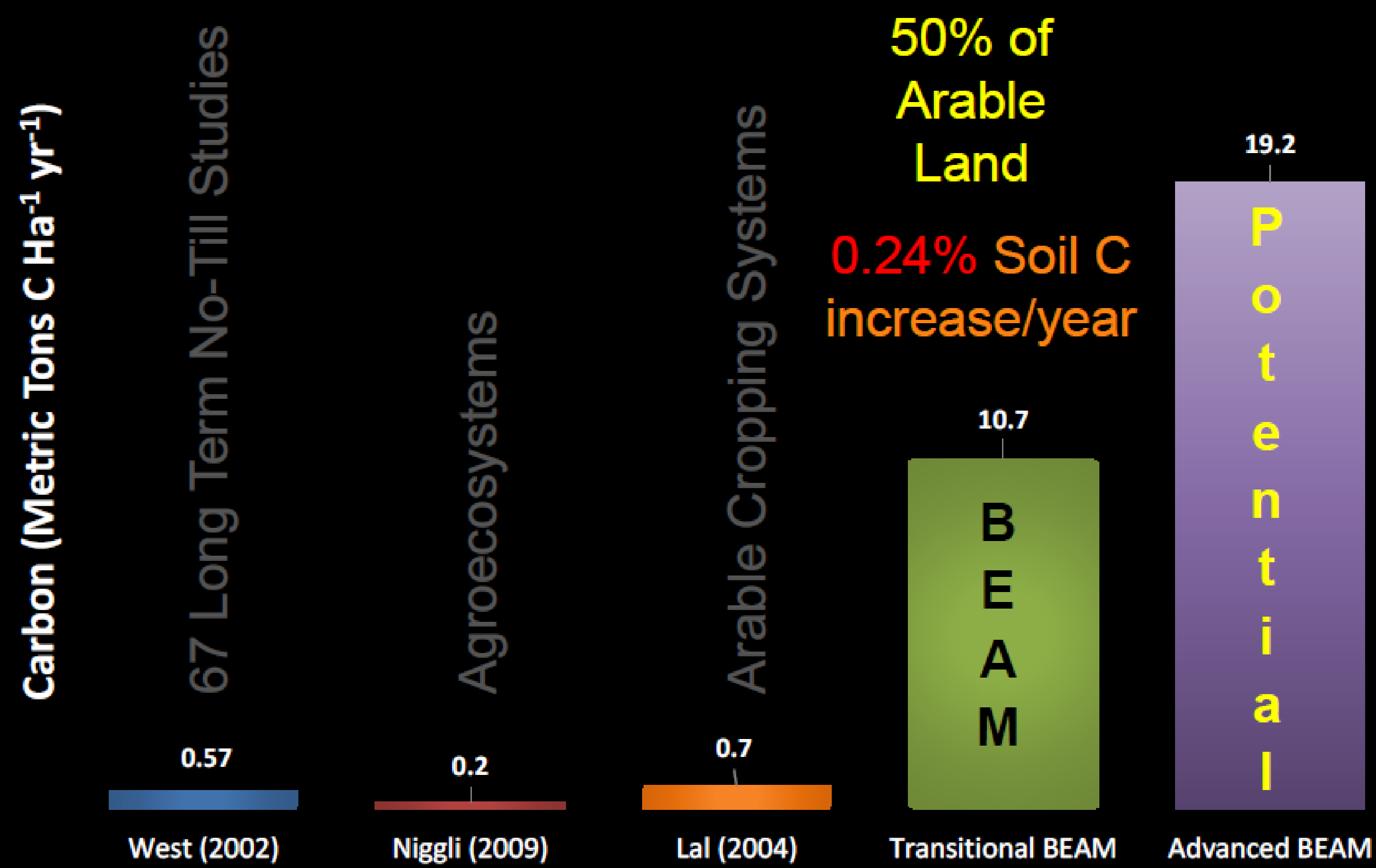
Comparing the BEAM Approach to Other Long Term Agroecosystem Studies



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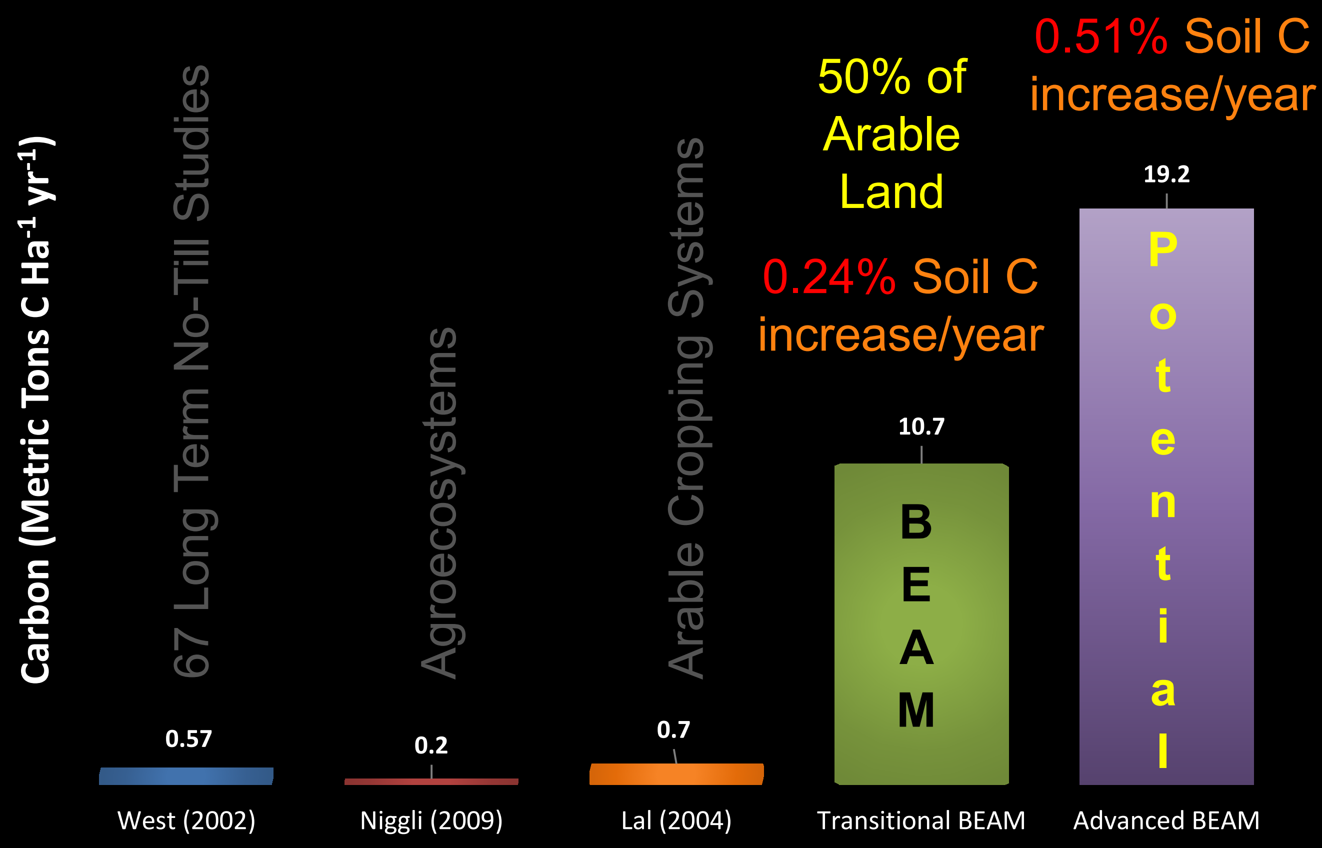

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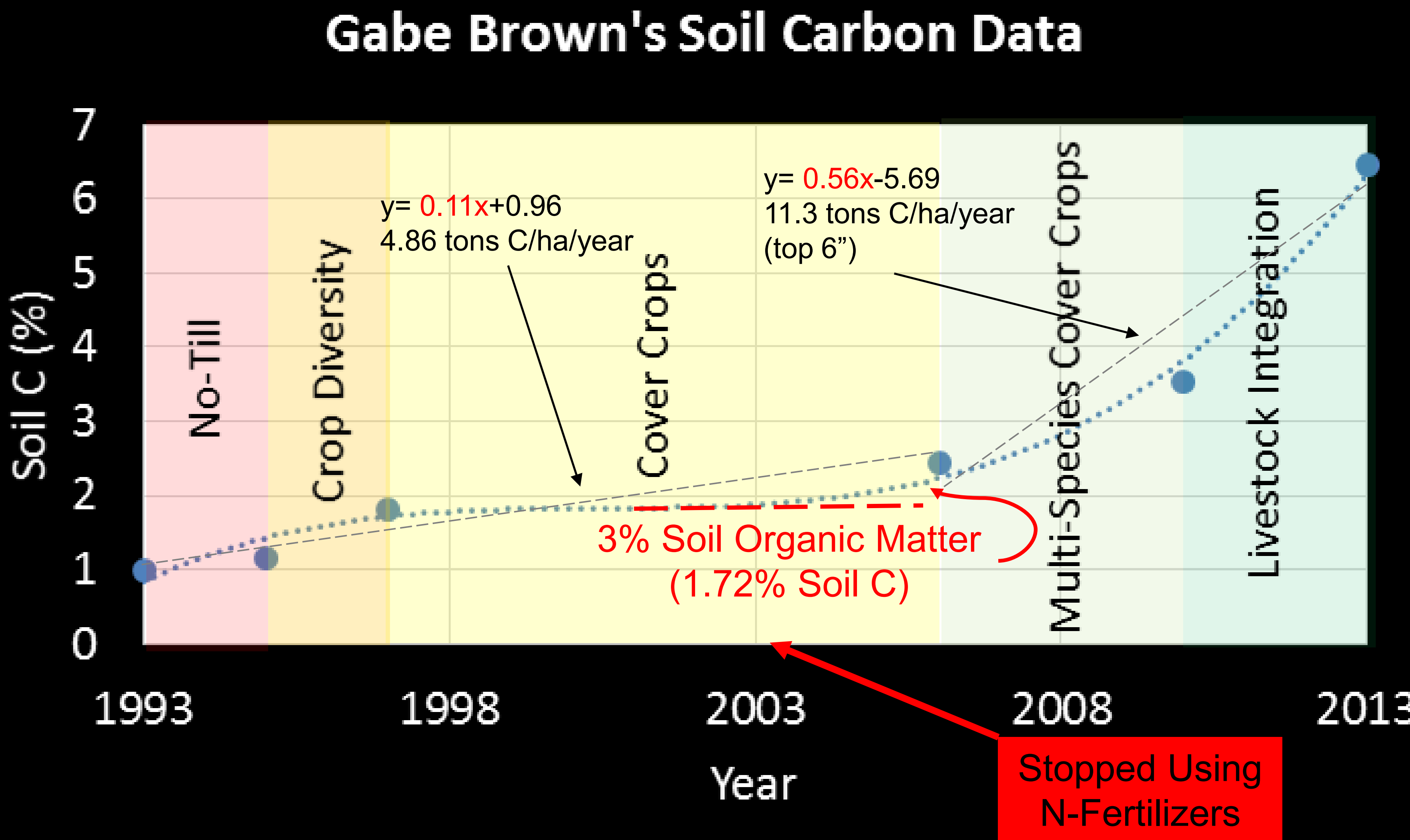

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Will Harris's Ranch
0.36% C Increase/year

0.75% C

7.9% C

Soil Carbon Use Efficiency

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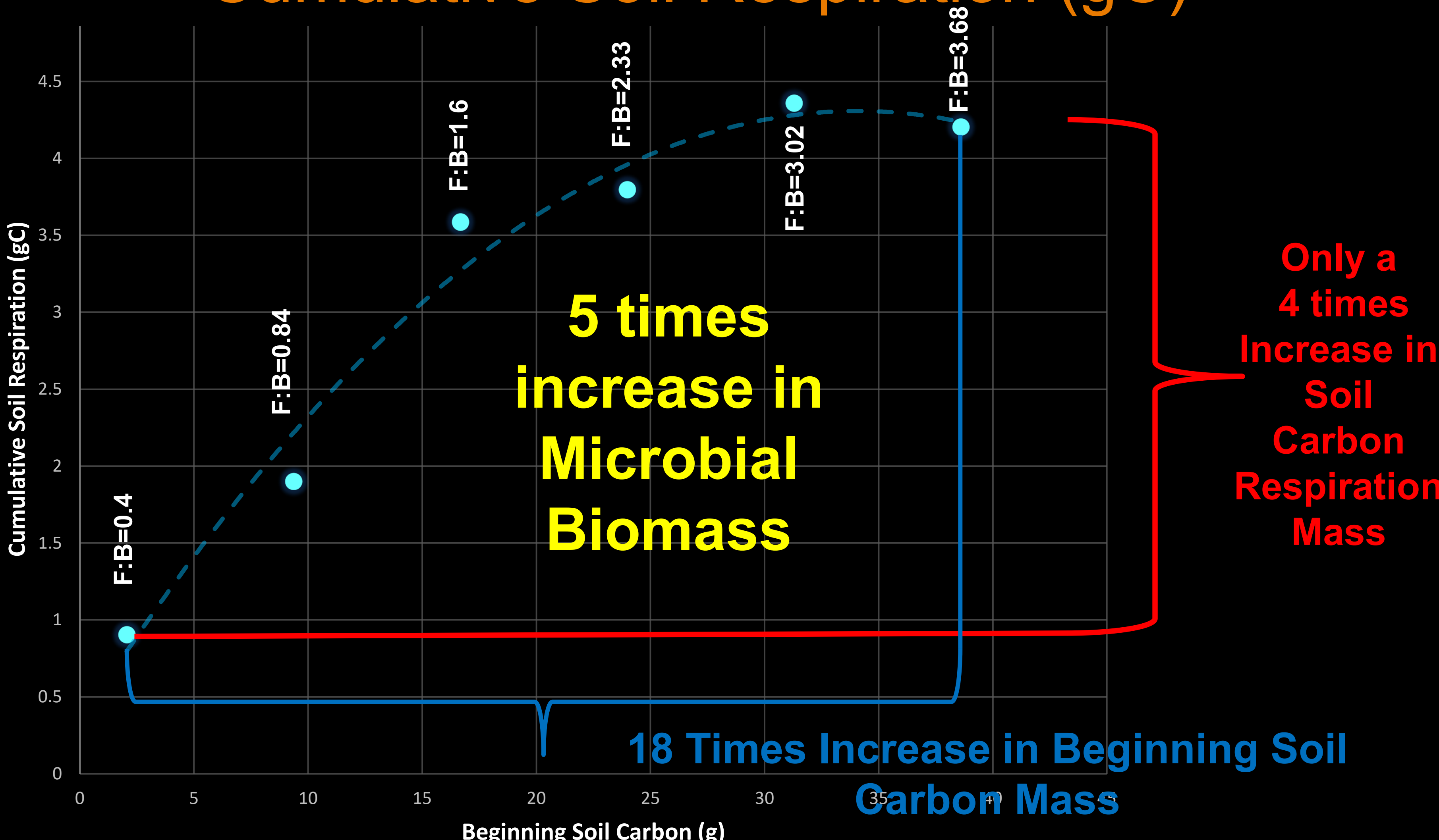
Cumulative Soil Respiration (gC)



Greenhouse Trial

New Mexico State University

NM STATE

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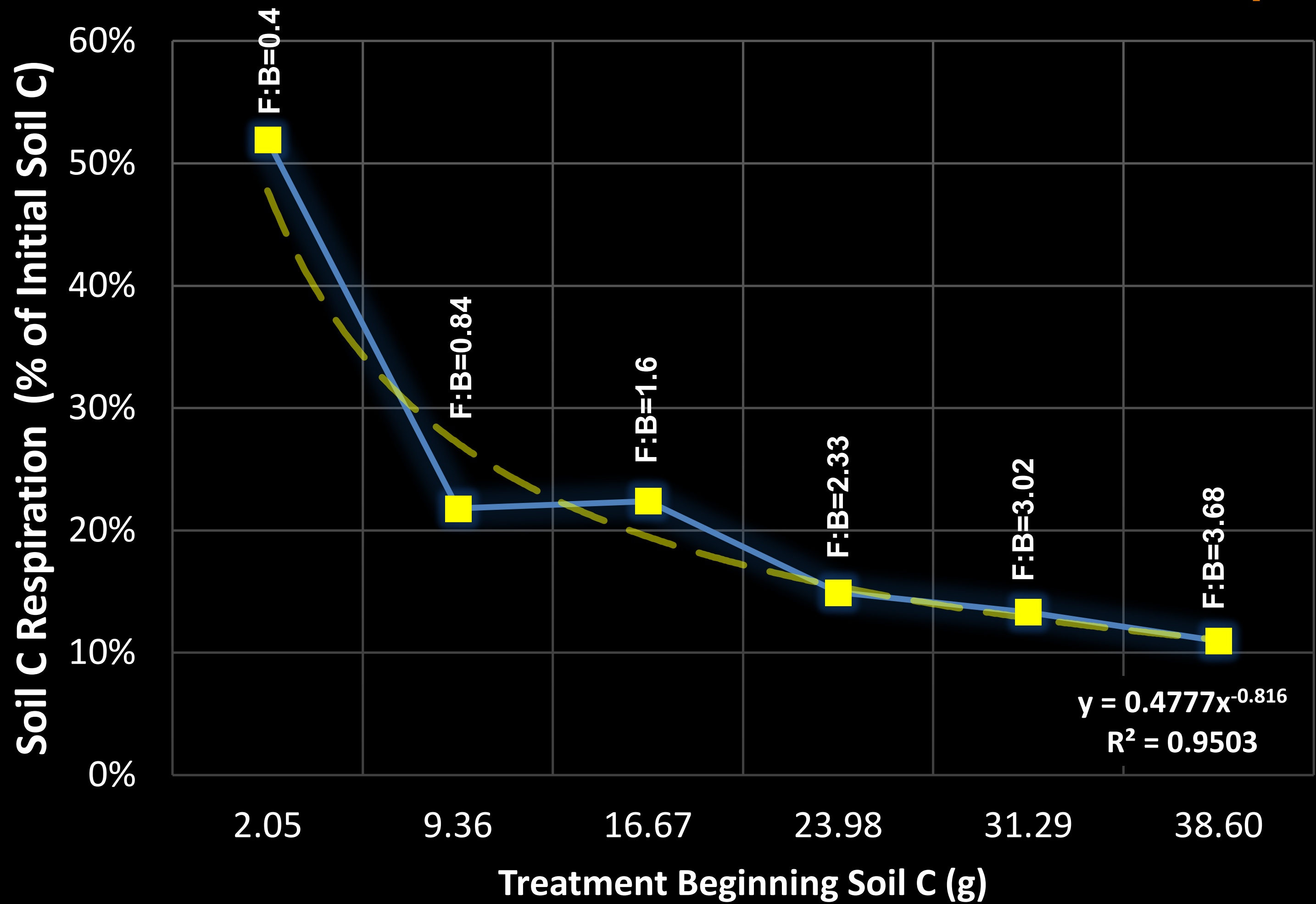
Percent of Initial Soil Carbon Respired



Greenhouse Trial

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What Other Benefits Are Observed in Regenerative Agriculture Approaches

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Soil Macro and Micro- Nutrients

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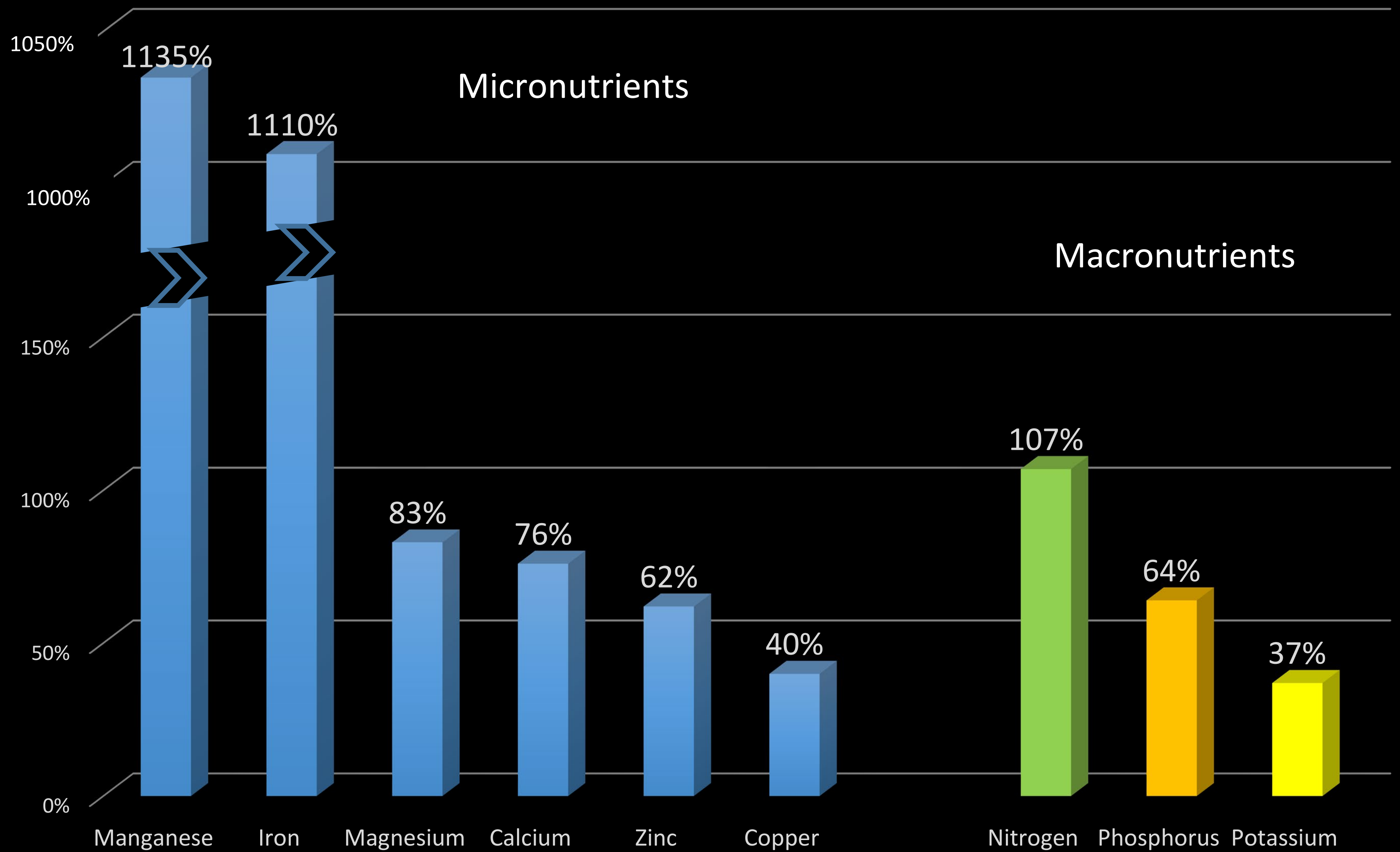

20 month Study, 5 Sampling Periods

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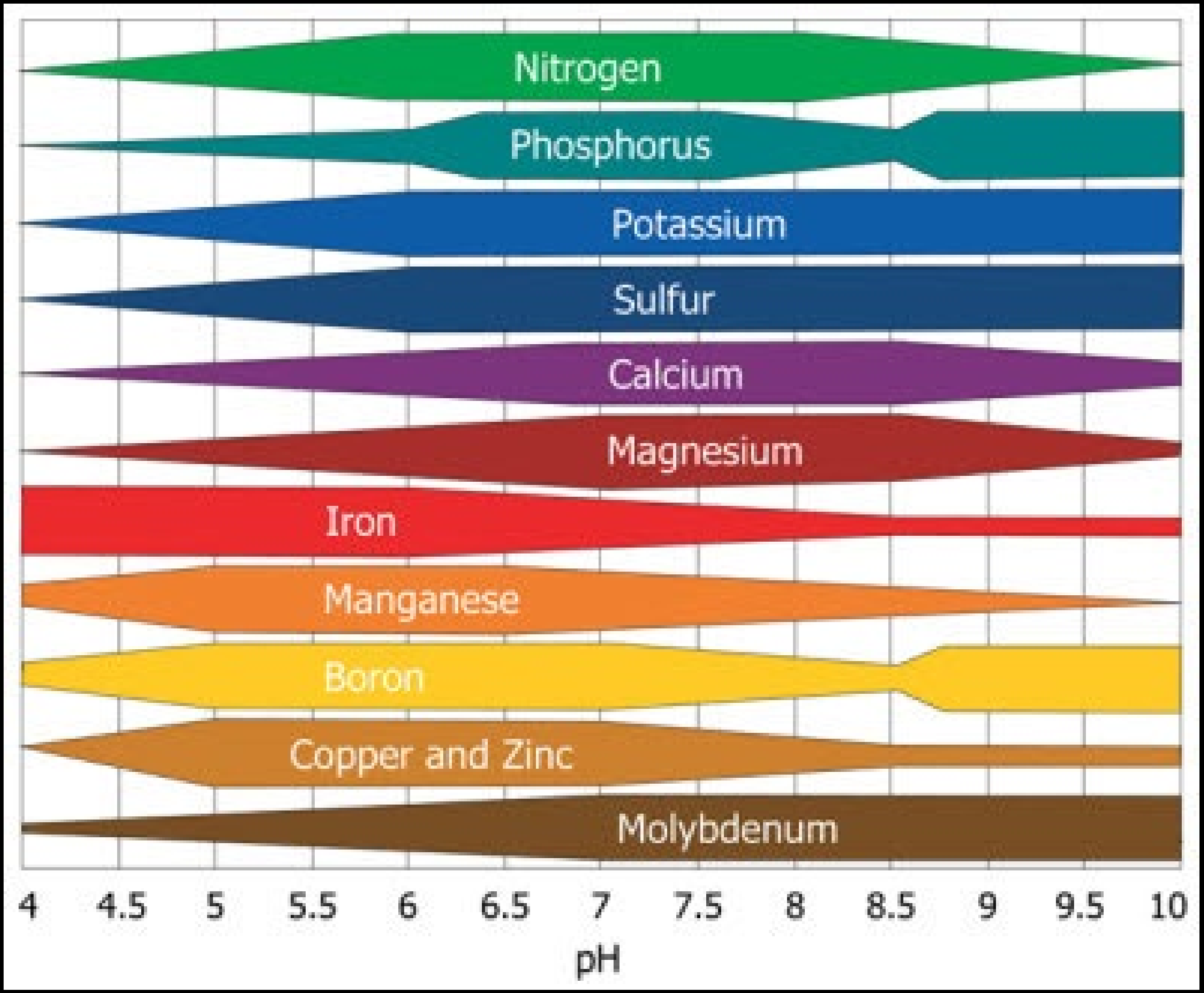

https://content.ces.ncsu.edu/north-carolina-soybean-production-guide/soybean-fertilization-and-nutrient-management

Soil Water Storage

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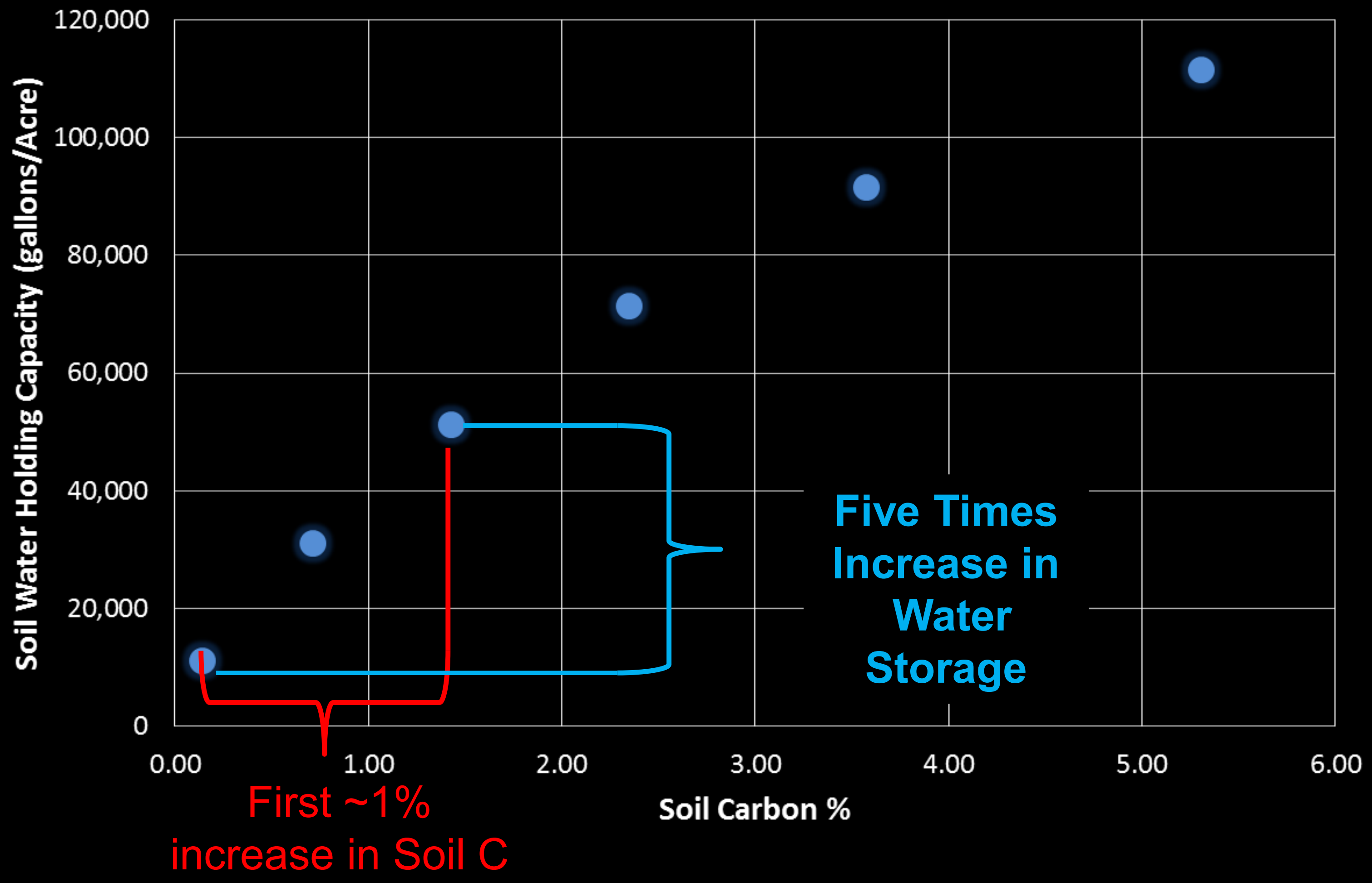
Increases Storage and Availability Water



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Improves Crop Yields

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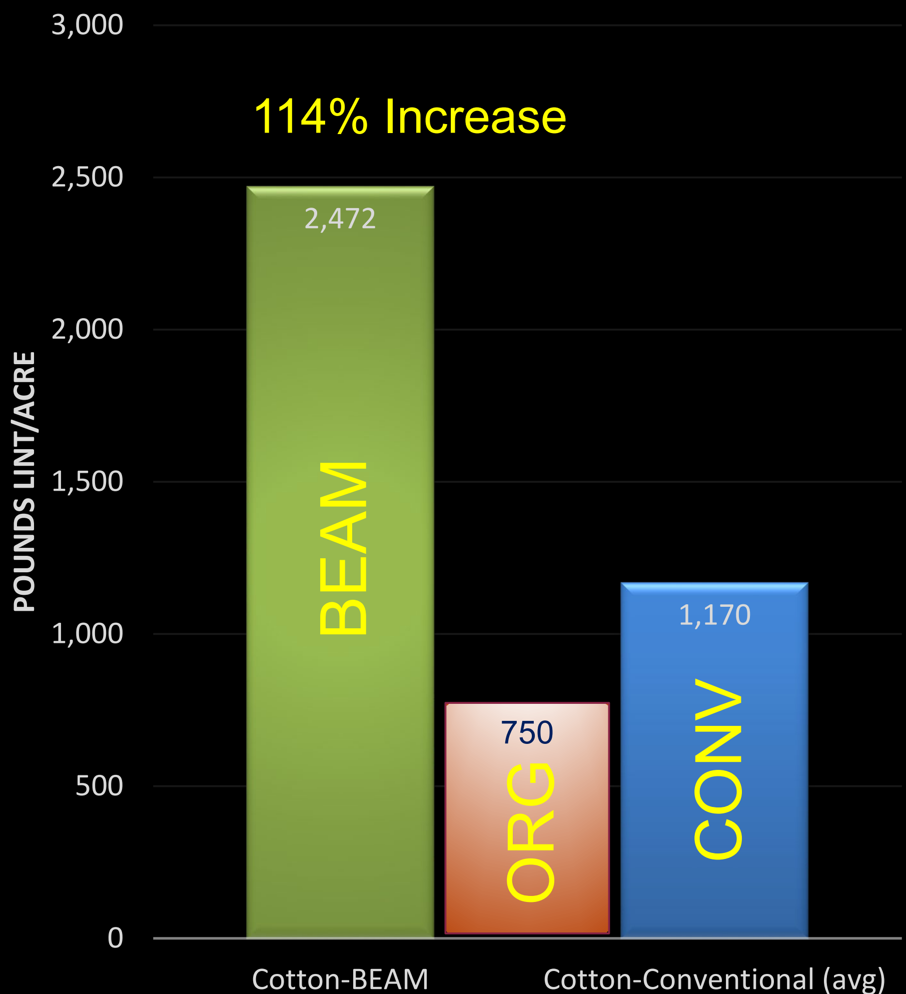
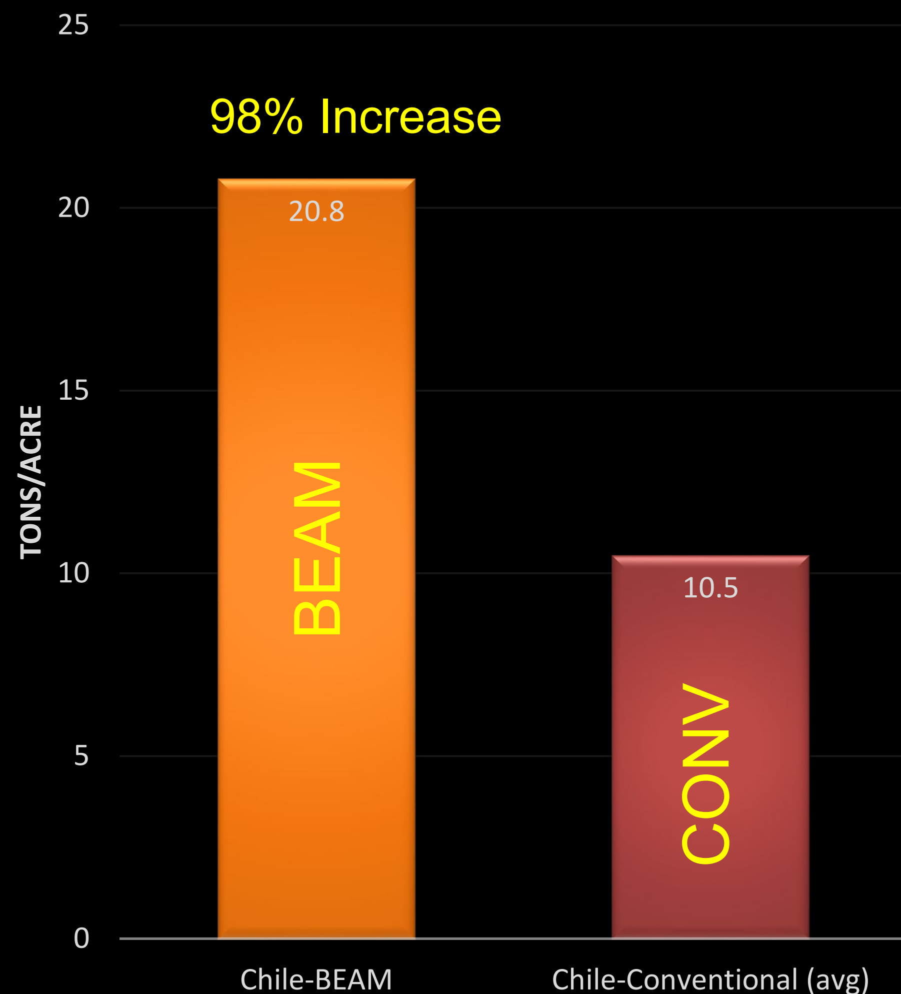
Cotton Production



Chile Production



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July 17, 2017

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August 2, 2017

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August 29, 2017

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2,282# of lint/acre (5 bales/acre)
3,334# seed/acre

November 30th, 2017

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2018


17 to 21 tons Chile/acre

Photo Courtesy of Nicole Masters

Ian & Di Haggerty's Field

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

Conventionally Managed (Chihuahuan Desert)

250+ Acres to Support One Cow

Images by Allen R Williams, Ph.D.

Adaptive Grazing (Pasticultores Del Desierto)

25 Acres to Support One Cow

Images by Allen R Williams, Ph.D.

We Can Meet the Challenges!

- Rebuild degraded soils and increase soil fertility,
- Produce more nutrient dense food and forage,
- Use less water to grow crops by increasing both plant water use efficiency and soil water storage capacity
- Reduce energy use by allowing nature to extract or "fix" essential nutrients,
- Reduce both agrichemical pollution and atmospheric CO_2 at the same time.
- Improve productivity and profitability!

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Why Should We Pursue This?

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Why Should We Pursue This?

Because there is no Planet B…!

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Align yourself with nature!

Tao Te Ching

Questions?

Thornburg Foundation

GLOBETROTTER FOUNDATION

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