Regenerative Agriculture and Organic: Intersections and Differences

April 5, 2022

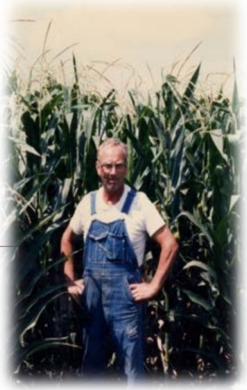
The Center for REGENERATIVE AGRICULTURE
CALIFORNIA STATE UNIVERSITY, CHICO

Regenerative Agriculture
Climate Smart Production: Theory & Practice

Organic/Regenerative Webinar: Oregon Tilth 2022

Cynthia Daley, Ph.D.
Director of *The Center for Regenerative Agriculture, CSU, Chico*
Rawlins Endowed Professor for Environmental Literacy

Bio CA Daley



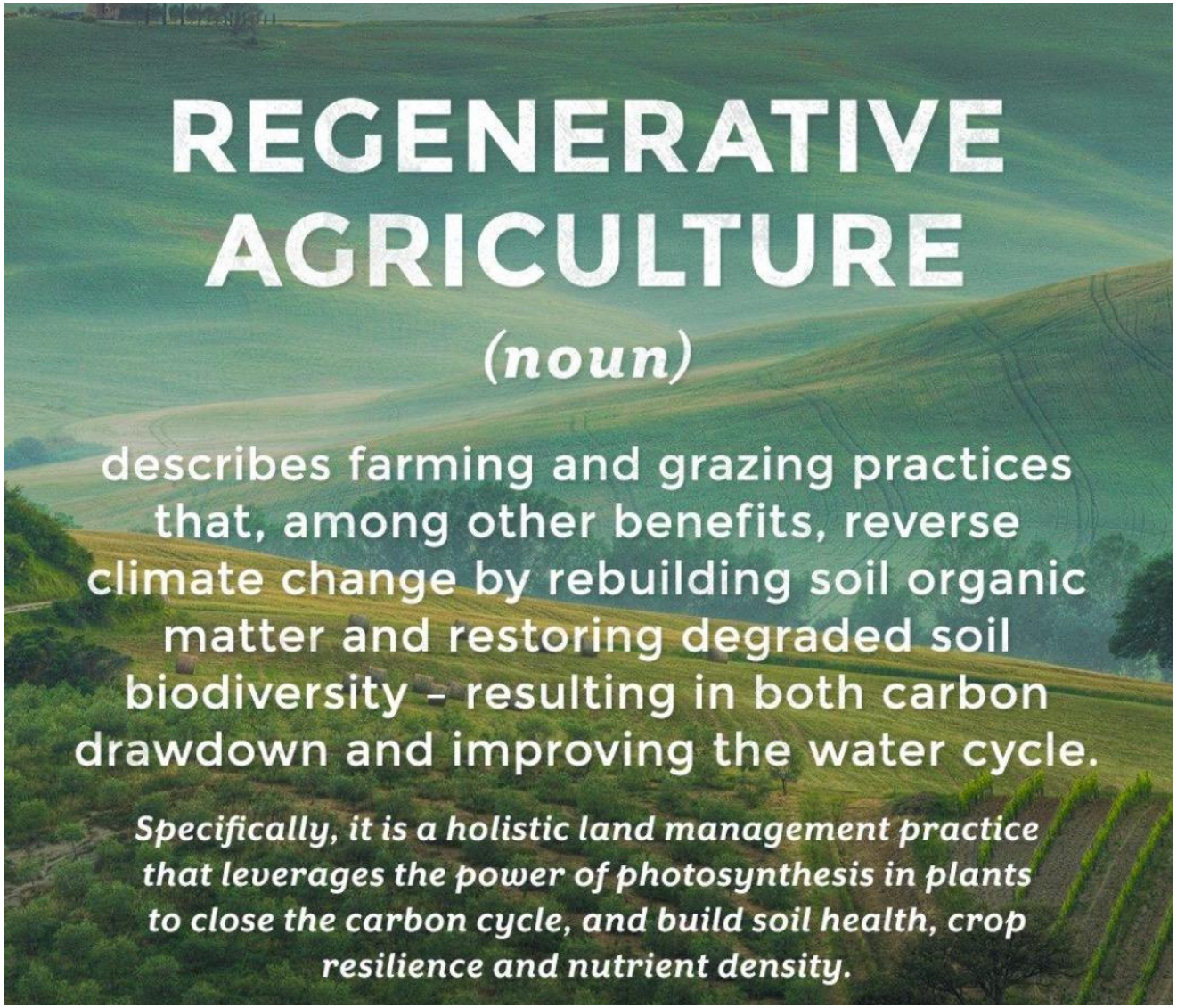
University of Illinois - Bachelor's degree

University of California Davis – Ph.D. 1997

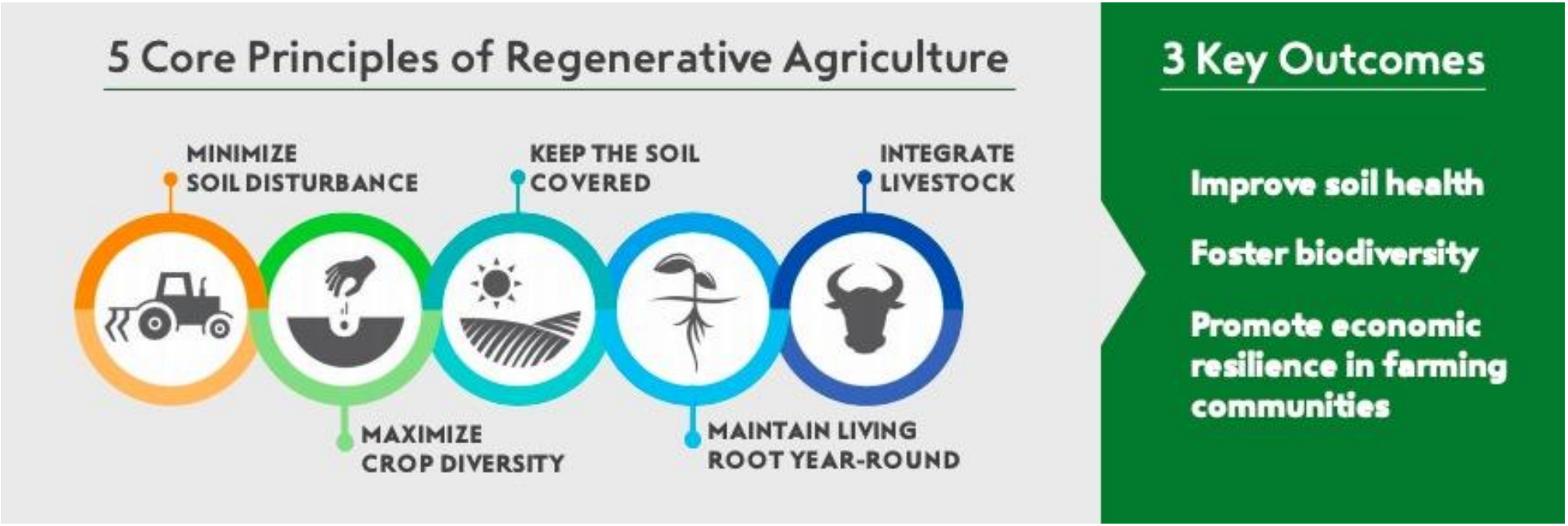
- 1997 – Professor within the College of Agriculture
- 2006 - Organic Dairy Education & Research Program
- 2016 – Regenerative Agriculture Initiative
- 2019 – Center for Regenerative Agriculture & Resilient Systems - Director

2020 - Rawlins Endowed Professor for Environmental Science

Definition


REGENERATIVE AGRICULTURE
(noun)
describes farming and grazing practices that, among other benefits, reverse climate change by rebuilding soil organic matter and restoring degraded soil biodiversity – resulting in both carbon drawdown and improving the water cycle.
Specifically, it is a holistic land management practice that leverages the power of photosynthesis in plants to close the carbon cycle, and build soil health, crop resilience and nutrient density.

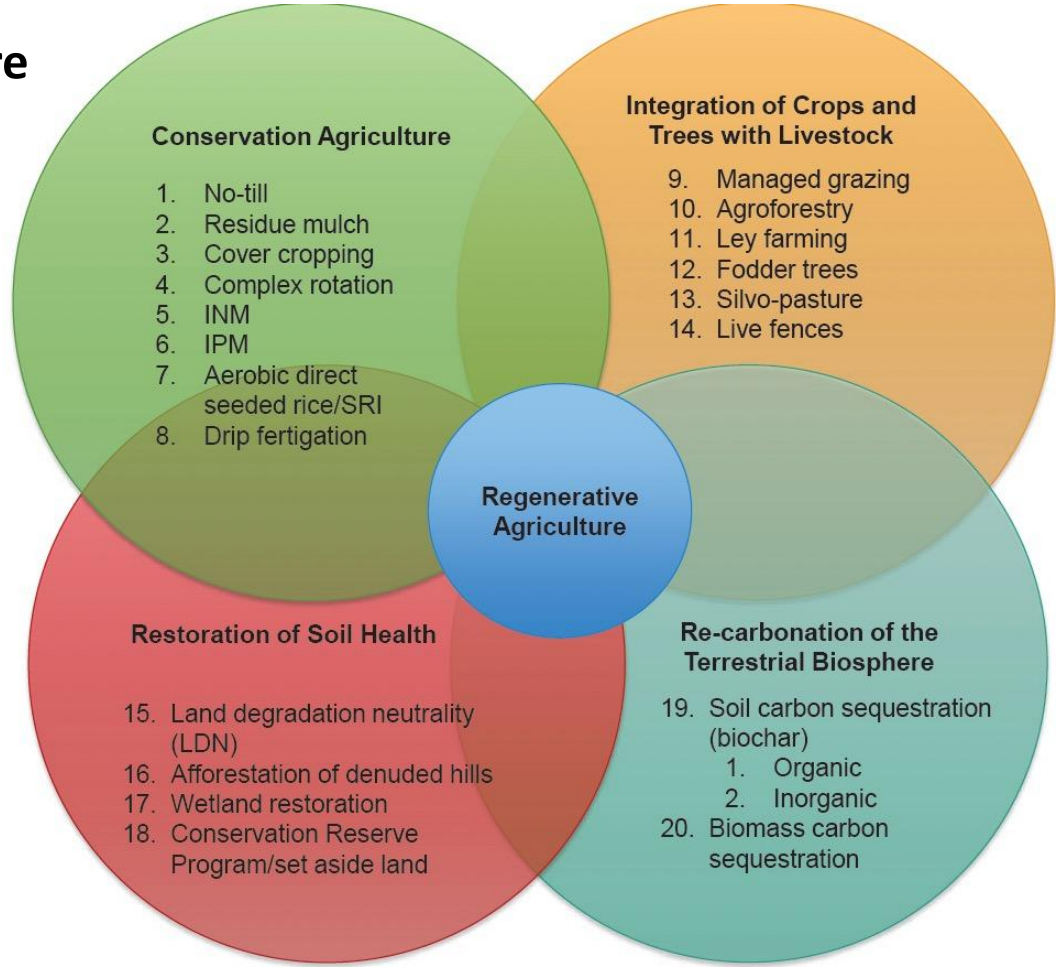
RA based on the NRCS 5 core Soil Health Principles



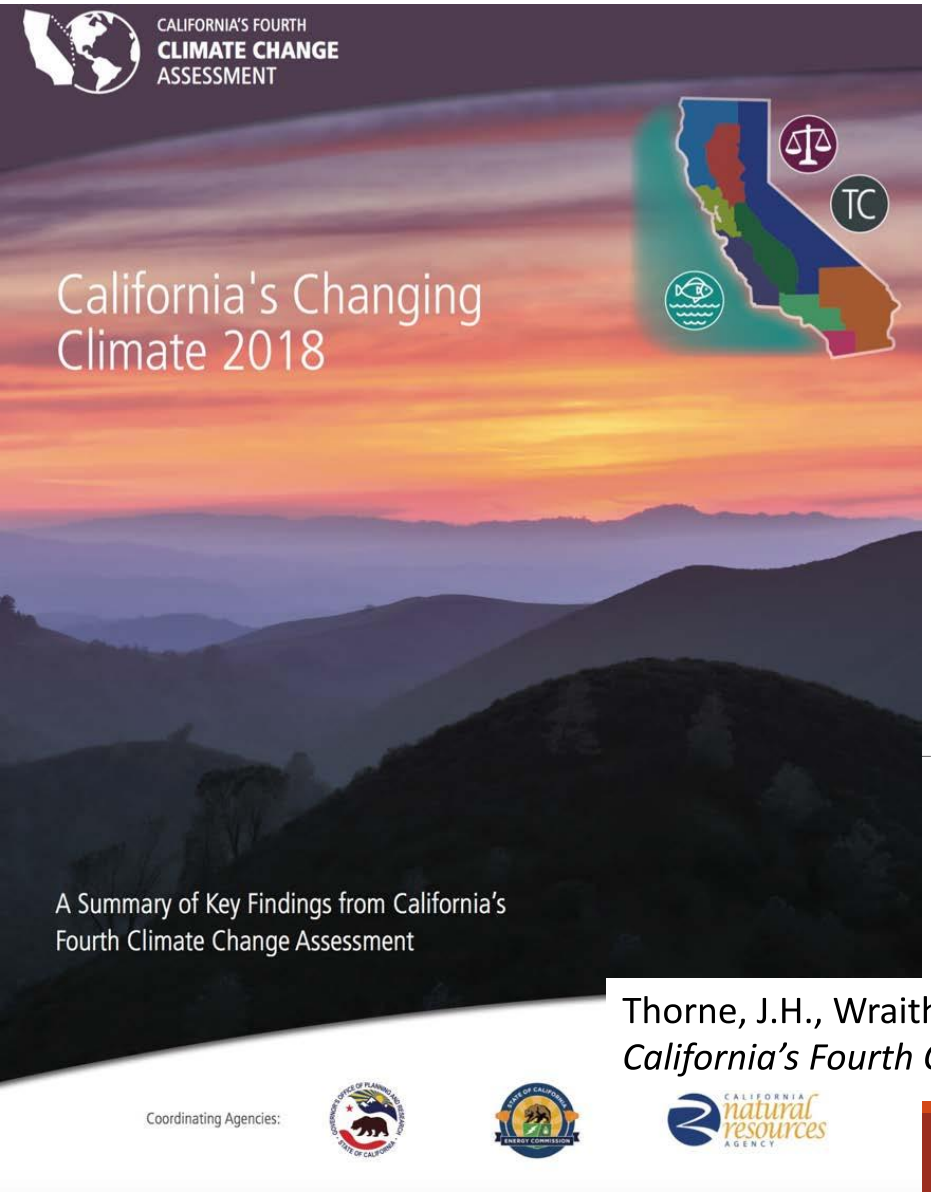
Basic tenets of regenerative agriculture

- designed to draw carbon dioxide from the atmosphere
- specific packages of practices depends on site-specific biophysical

INM = integrated nutrient management.
IPM = integrated pest management
SRI = system of rice intensification



Dr. Rattan Lal 2020
doi:10.2489/jswc.2020.0620A



CALIFORNIA'S FOURTH
CLIMATE CHANGE
ASSESSMENT

"California is one of the most "climate-challenged" regions of North America"

Californian's need to prepare

- *Temperatures are warming*
- *Heat waves are more frequent/intense*
- *Precipitation continues to be highly variable*

Thorne, J.H., Wraithwall, J., Franco, G. 2018. California's Changing Climate 2018. *California's Fourth Climate Change Assessment*, California Natural Resources Agency.

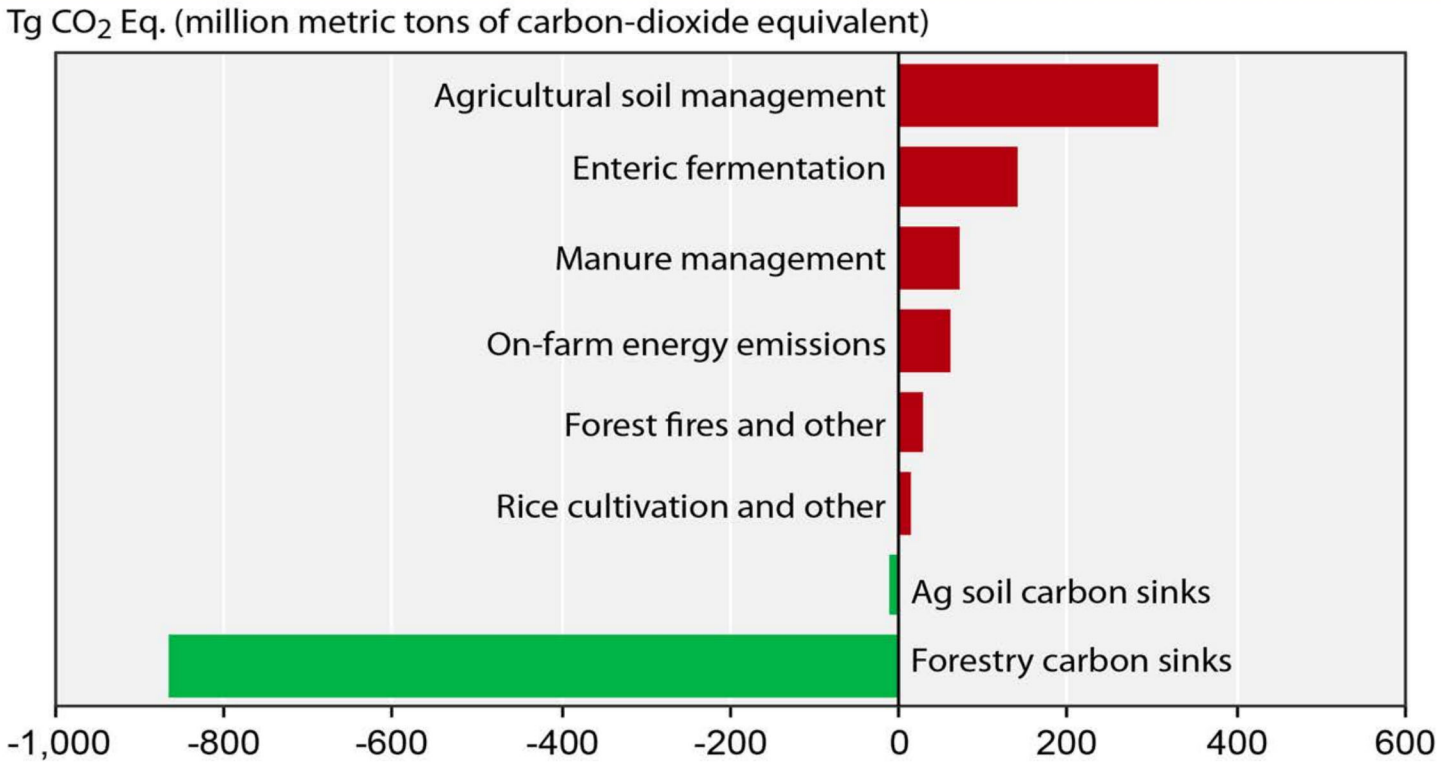
Agriculture accounts for approximately **one-third** of global greenhouse gas emissions

(FAO, 2017; CGIAR, 2015)

Get beyond the plow….

- Oxidation
- Erosion
- Disrupts microbial populations

Agriculture and forestry greenhouse gas emissions and sequestration, 2012



Note: Negative values indicate carbon sequestration. Forestry sink includes afforestation and forest management.
Source: USDA, Economic Research Service using U.S. Environmental Protection Agency, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012, Tables 2-12, 2-14, and 7-1.

Soil Degradation & Soil Loss Crisis

US loses 1% of topsoil every year

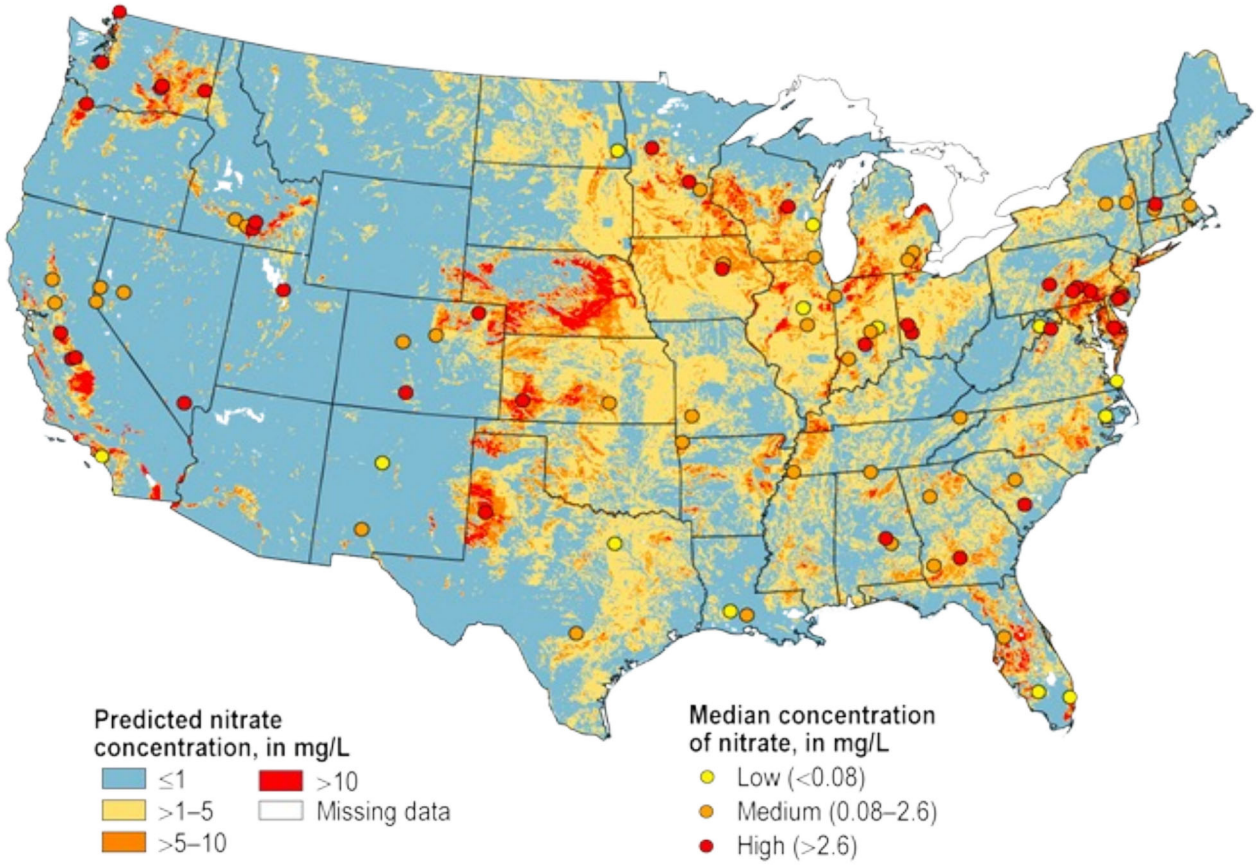
"Annual cost of erosion from agriculture in USA is $44 billion per year…"

$70/person per year

https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/edu/college/?cid=nrcs142p2_054028

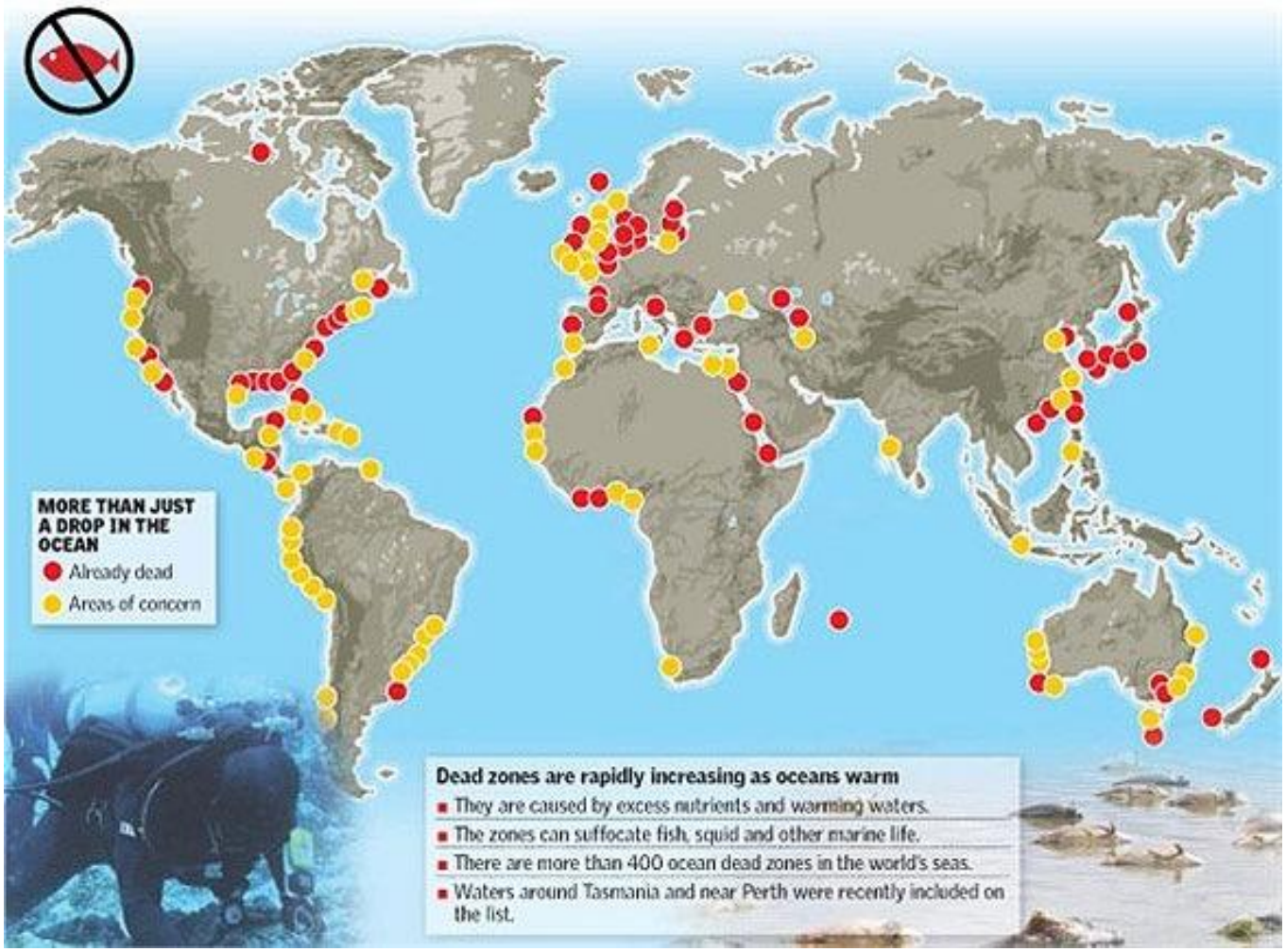
Groundwater aquifer contamination is a national concern

http://nemwuppermiss.blogspot.com/2013/10/usgs-mississippi-river-nitrate-levels.html



More than 405 Dead Zones occupy coastal waters worldwide covering 95,000 square miles

https://robertscribbler.com/2015/05/05/ocean-dead-zones-swirl-off-africa-threatening-coastlines-with-mass-fish-kills/



Sustainable Ag vs. Regenerative Ag

It’s NOT about sustaining a degraded system

We must “regenerate”

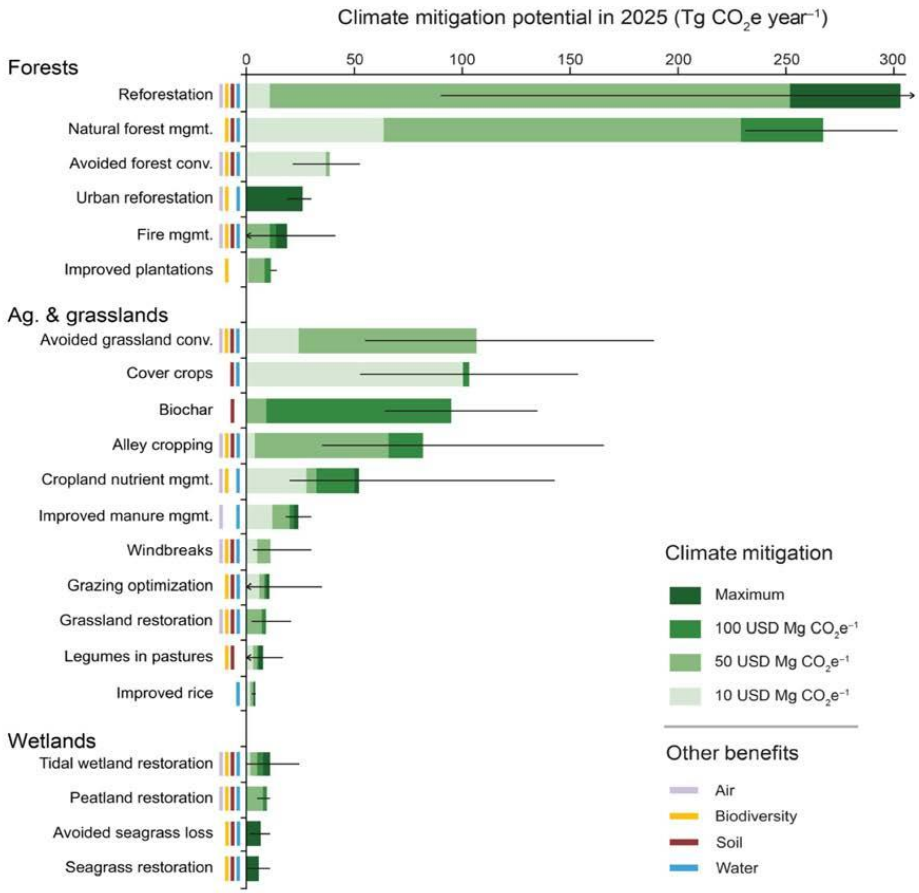
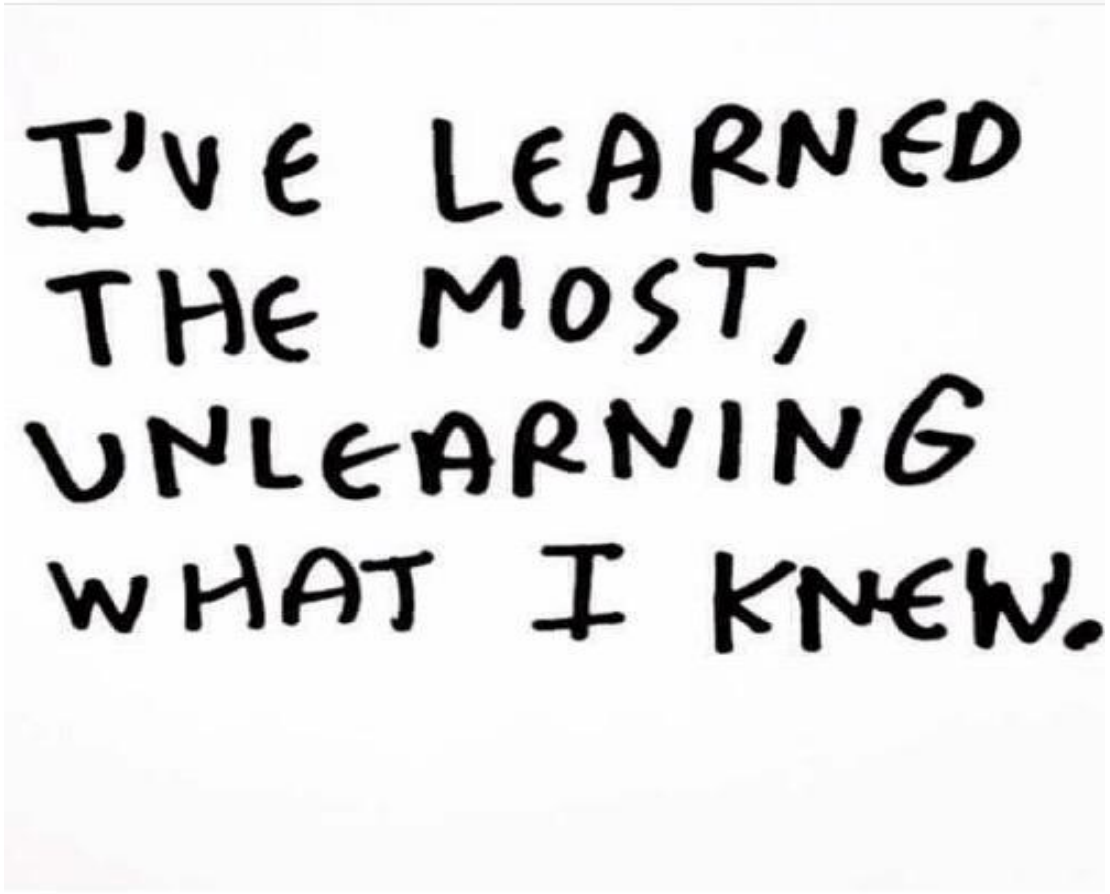


Fig. 1. Climate mitigation potential of 21 NCS in the United States. Black lines indicate the 95% CI or reported range (see table S1). Ecosystem service benefits linked with each NCS are indicated by colored bars for air (filtration), biodiversity (habitat protection or restoration), soil (enrichment), and water (filtration and flood control). See the Supplementary Materials for detailed findings and sources.


I'VE LEARNED
THE MOST,
UNLEARNING
WHAT I KNEW.

Change the paradigm

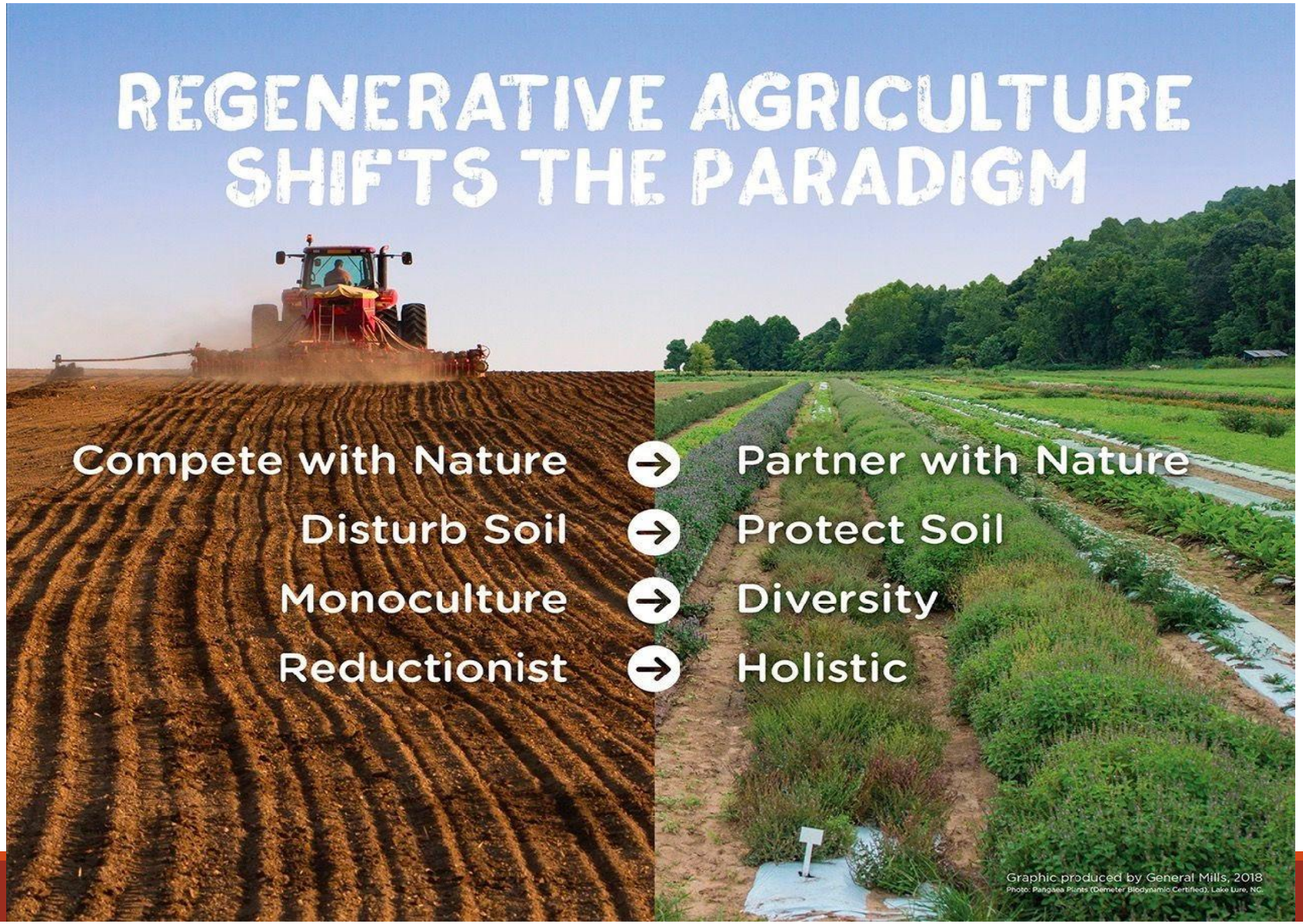
Standard practice

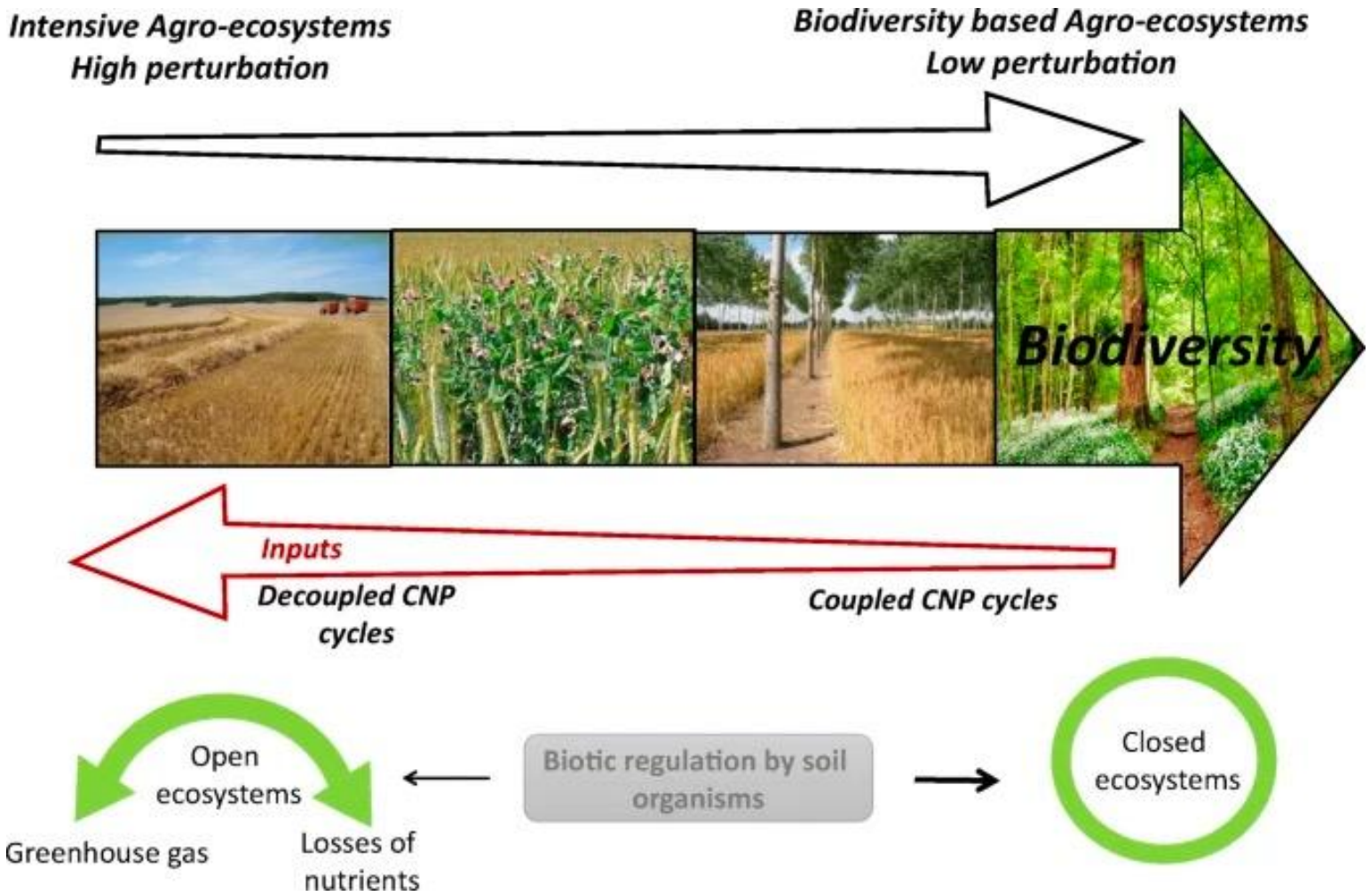
Diverse, enlivened, resilient, nutrient dense

Change the paradigm

Standard practice

Diverse, enlivened, resilient, nutrient dense


REGENERATIVE AGRICULTURE SHIFTS THE PARADIGM
Compete with Nature → Partner with Nature
Disturb Soil → Protect Soil
Monoculture → Diversity
Reductionist → Holistic
Graphic produced by General Mills, 2018
Photo: Pangaea Plants (Demeter Biodynamic Certified), Lake Lure, NC


Intensive Agro-ecosystems
High perturbation
Biodiversity based Agro-ecosystems
Low perturbation
Biodiversity
Inputs
Decoupled CNP cycles
Coupled CNP cycles
Open ecosystems
Greenhouse gas
Losses of nutrients
Biotic regulation by soil organisms
Closed ecosystems

Regenerative Agriculture is:

- Systems based management – looking at the entire farm/ranch ecosystem
  - Conservation planning + Carbon Farm planning + Holistic Management
- Holistic planning essential to include ecological, social and economic components (includes sustainable principles)
- Builds biological diversity
- Improves on-farm/ranch economic resiliency due to reduced inputs
- Based in soil centric management strategies - that build soil health
  - Builds soil carbon for improved water management
  - Sequesters carbon – as a drawdown tool - inexpensive

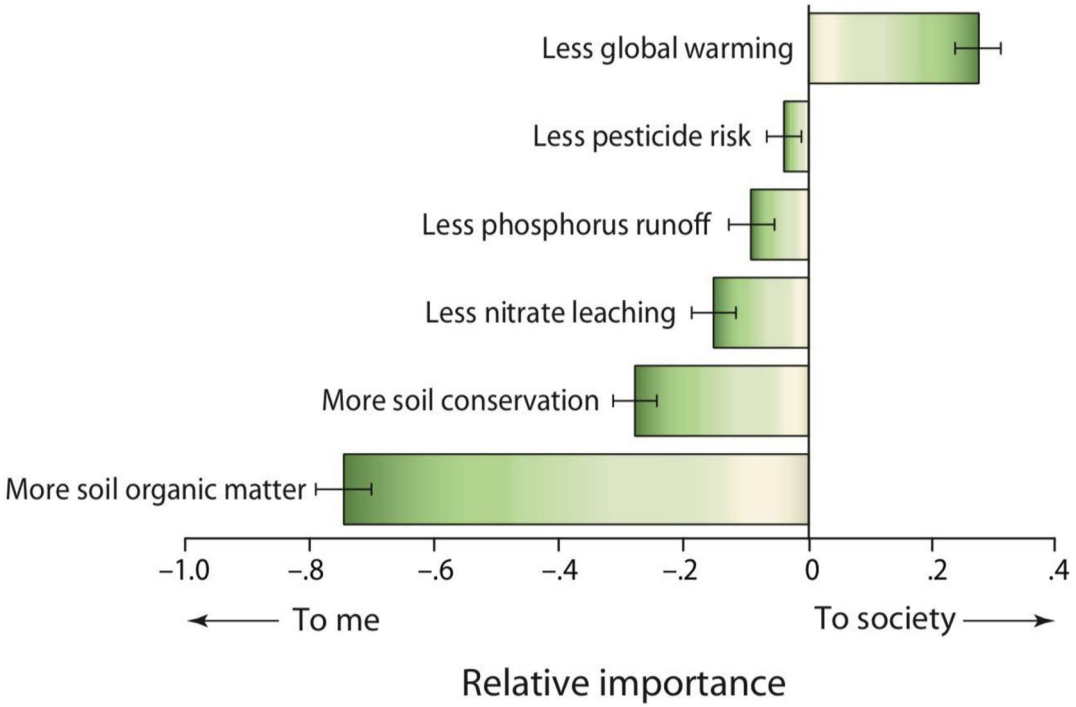


Figure 7. The relative importance to Michigan farmers and to society (as ranked by the farmers) of various environmental benefits potentially provided by agriculture. Source: Adapted from Swinton and colleagues (2014a).

Relative Benefits of Regenerative Farming Practices

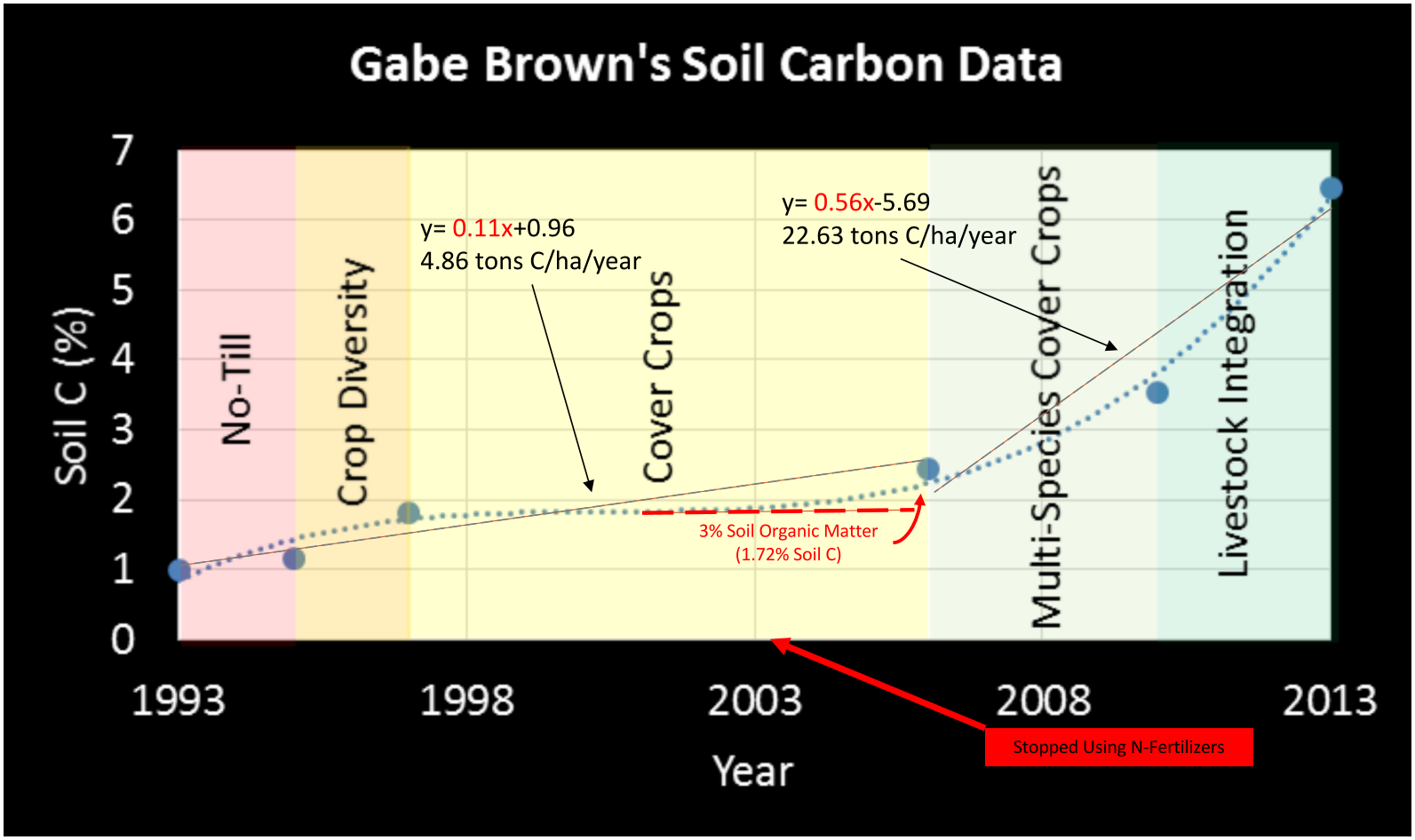
Swinton, et al., 2014. The Ecology of Ag Ecosystems: Long-Term Research on the Path to Sustainability. Oxford University Press.

Layering RA practices may be synergistic

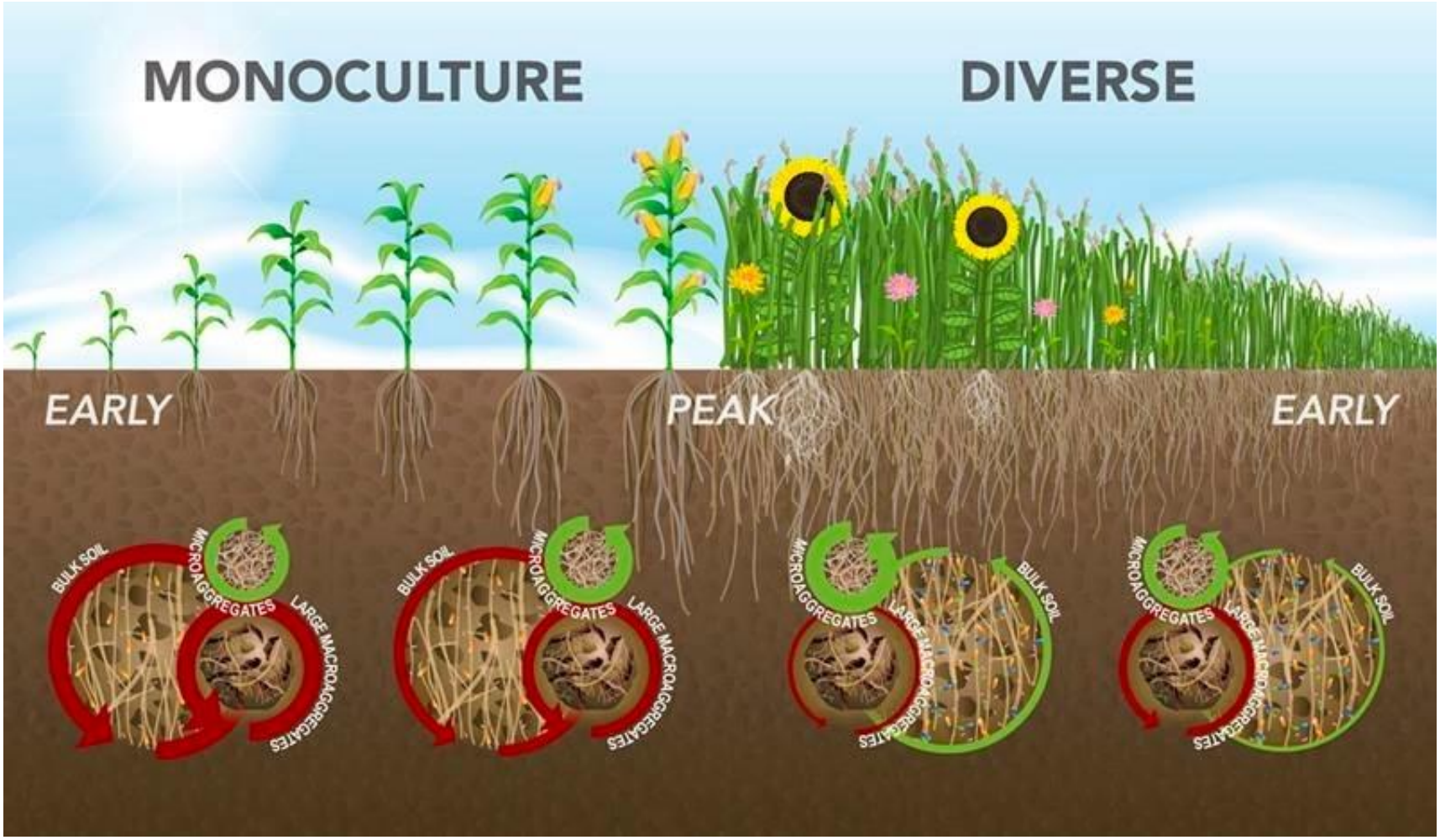
Stacking Practices

- No-Till/Minimum Till
- Multi-Species Cover Crops
- Crop Rotation
- Compost Applications
- Adaptive Multi-paddock Grazing
- Maximizing diversity

Regenerative Farmer – Gabe Brown – North Dakota



David C. Johnson- NMSU Institute for Sustainable Agricultural Research (ISAR) davidcjohnson@nmsu.edu


MONOCULTURE
DIVERSE
EARLY
PEAK
EARLY
BULK SOIL
MICROAGGREGATES
LARGE MACROAGGREGATES
BULK SOIL
MICROAGGREGATES
LARGE MACROAGGREGATES
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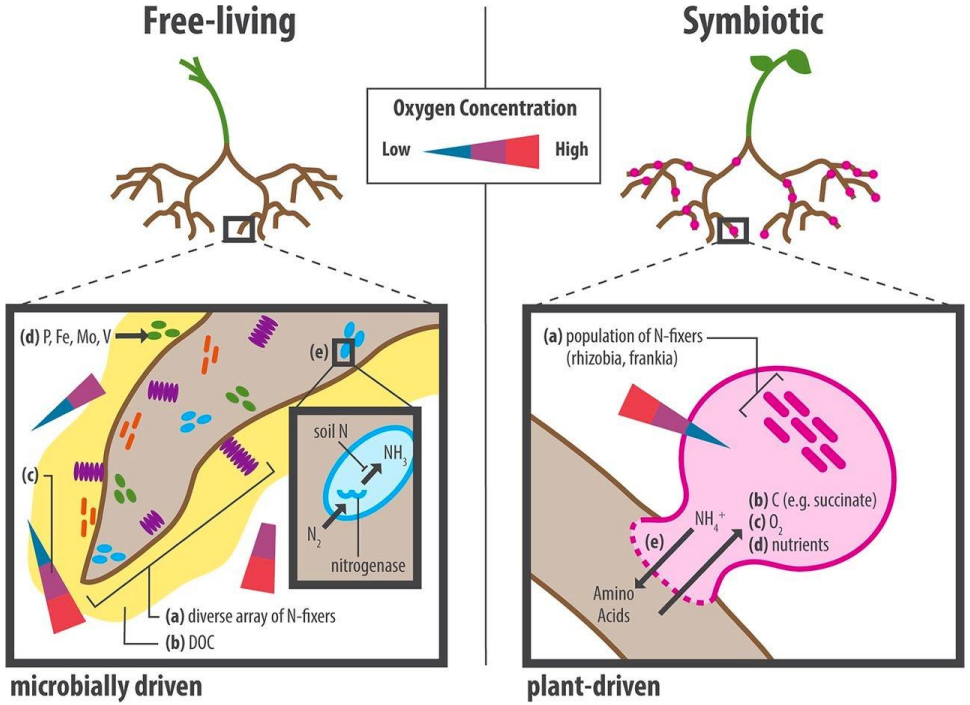
MICROAGGREGATES
LARGE MACROAGGREGATES
BULK SOIL

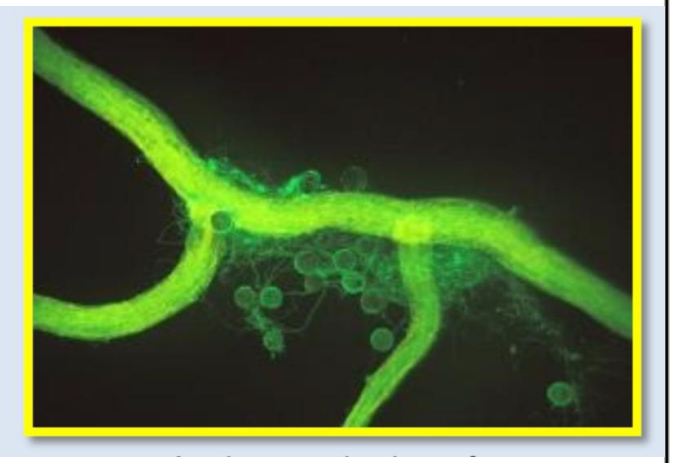
Free Living Nitrogen Fixing Bacteria

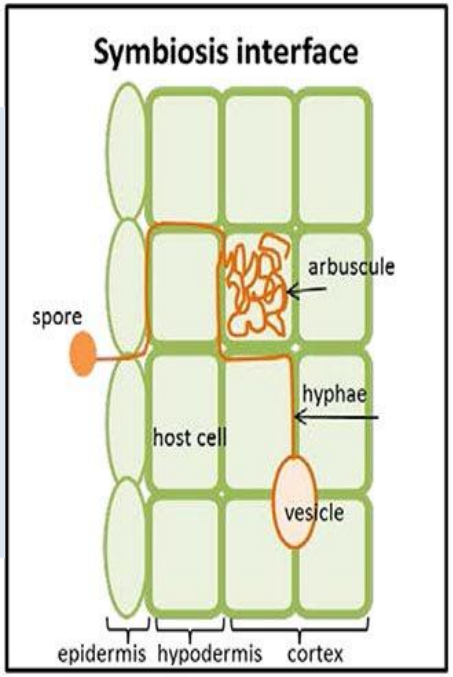


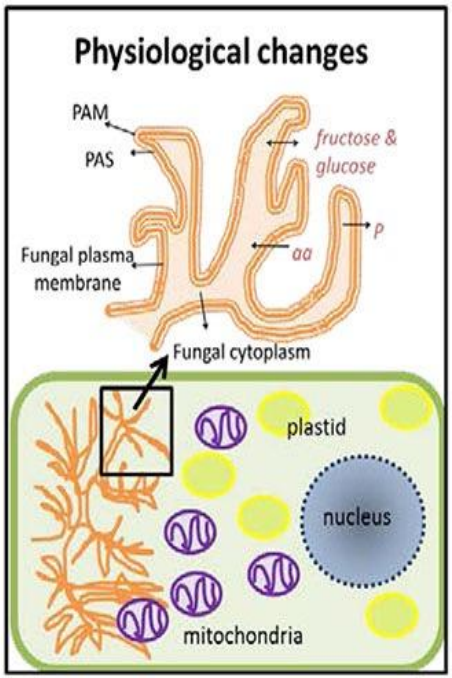
Some nitrogen fixing organisms

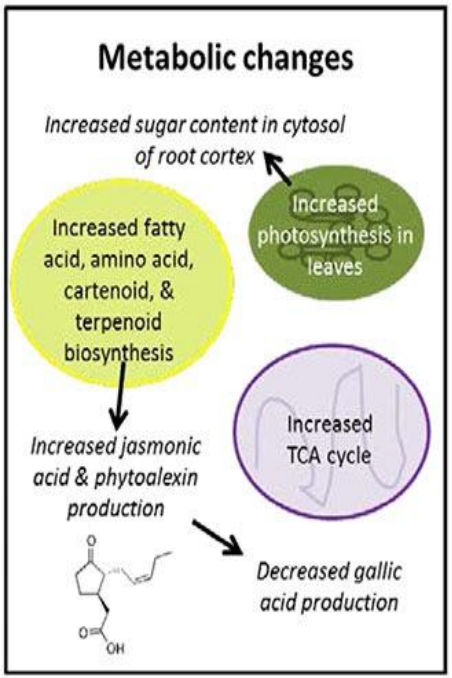
- **Free living aerobic bacteria**
  - ***Azotobacter***
  - ***Beijerinckia***
  - ***Klebsiella***
  - ***Cyanobacteria*** **(lichens)**
- **Free living anaerobic bacteria**
  - ***Clostridium***
  - ***Desulfovibrio***
  - ***Purple sulphur bacteria***
  - ***Purple non-sulphur bacteria***
  - ***Green sulphur bacteria***
- **Free living associative bacteria**
  - ***Azospirillum***
- **Symbionts**
  - ***Rhizobium*** **(legumes)**
  - ***Frankia*** **(alden trees)**

Fungal species become a part of the plant root structure









Fungal Farming…

Microscopic view of arbuscular mycorrhizal fungus growing on corn root

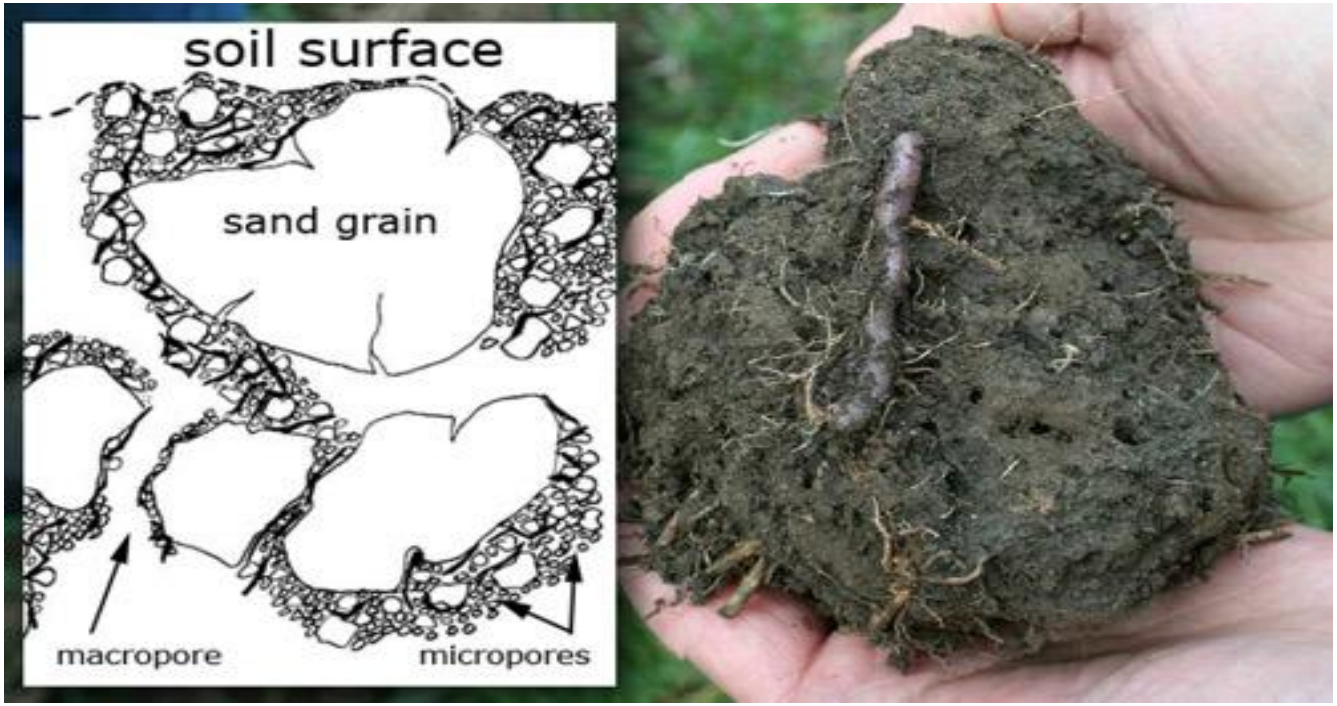
- The round bodies are spores
- Threadlike filaments are hyphae
- Substance coating them is glomalin (revealed by a green dye tagged to an antibody against glomalin

Soil Aggregation/ Slake Test

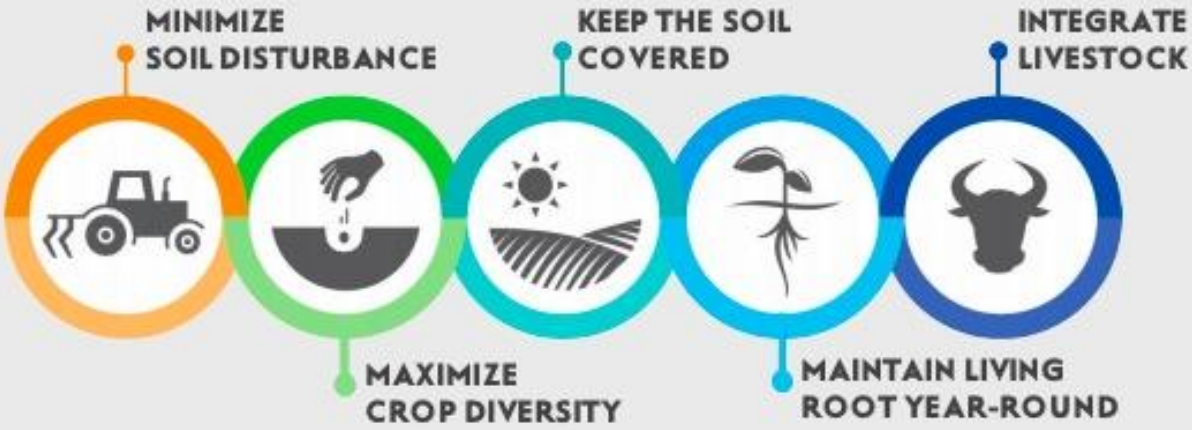
Conventional Till | No-Till | Minimum till

Conventional Till | No-Till | Pasture

Signs of regenerative farming practices



5 Core Principles of Regenerative Agriculture



3 Key Outcomes

Improve soil health

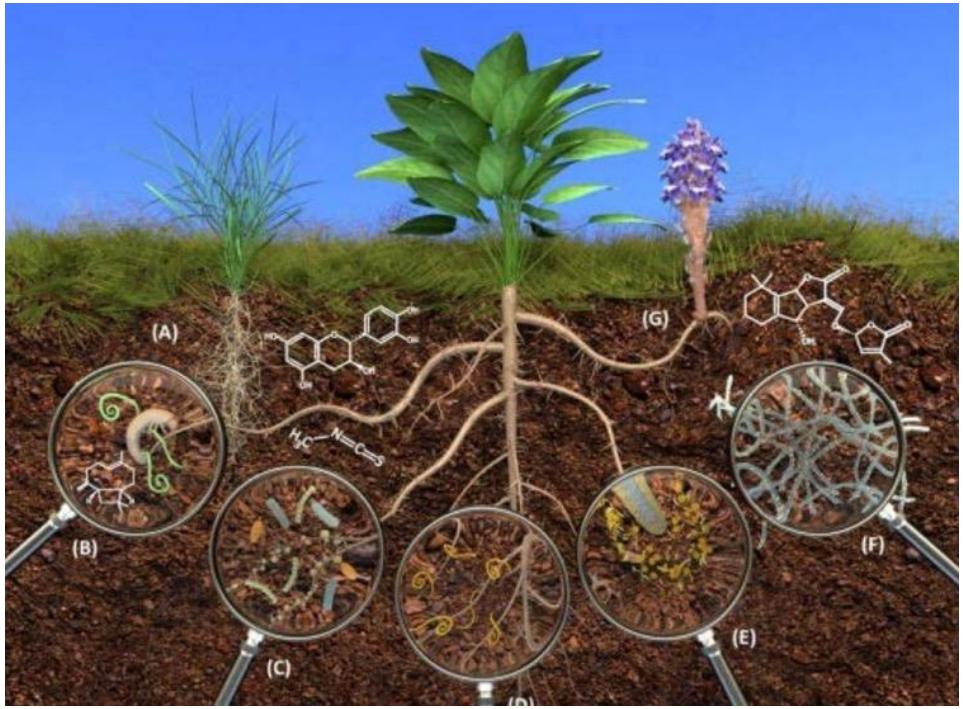
Foster biodiversity

Promote economic resilience in farming communities

Five Principles to Improve Soil Health

1. Keep living roots in the soil year around

Root exudates stimulate and feed soil biology



Five Principles to Improve Soil Health

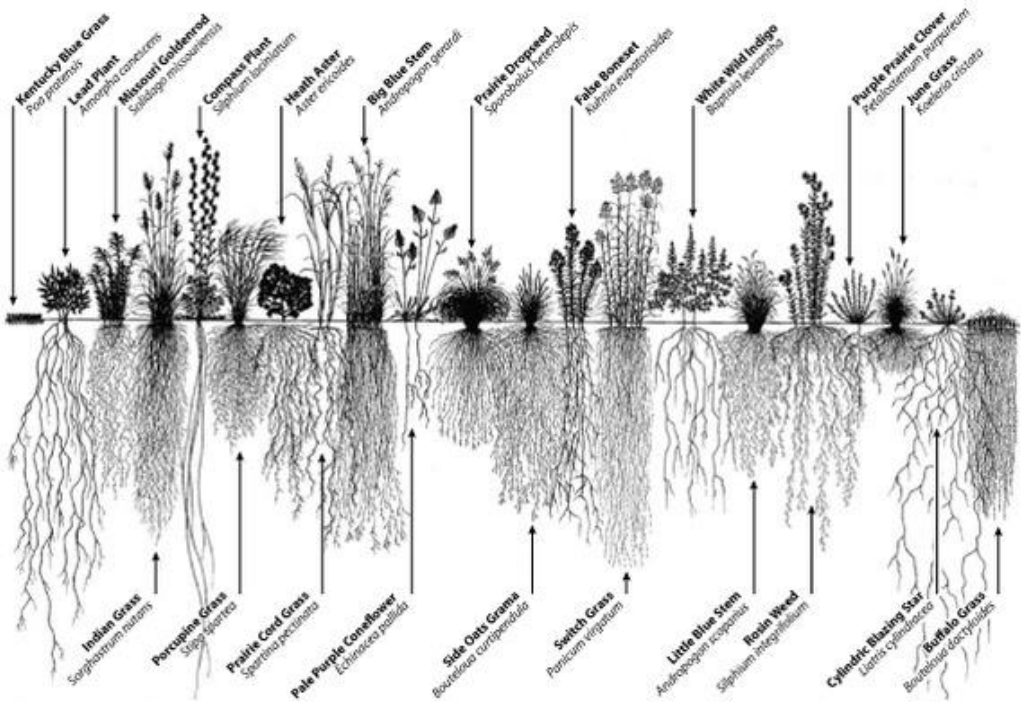
2. Maximizing soil diversity through plant diversity

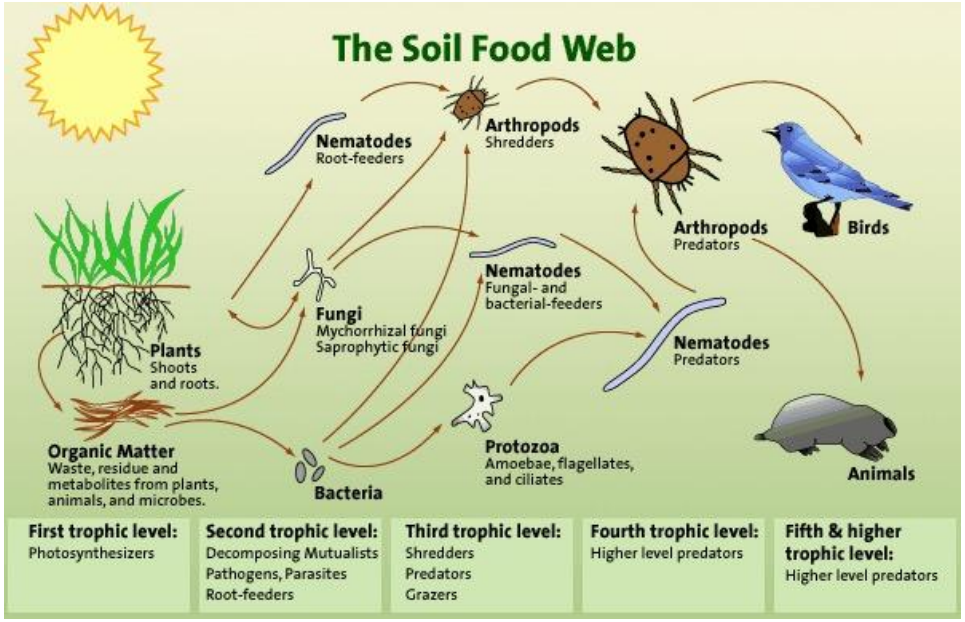
Crop Rotation

Mixture Plantings

Five Principles to Improve Soil Health

2. Maximizing soil diversity through plant diversity – cont'd





Five Principles to Improve Soil Health

3. Minimizing soil disturbance – Conversation Tillage

No-Till

Strip-Till

Reduced-Till

- Maintaining living root system and soil organic matter
- Increasing soil aggregate stability and structure
- Reducing soil erosion

IDEX FRESH

Five Principles to Improves Soil Health

4. Keep the soil covered

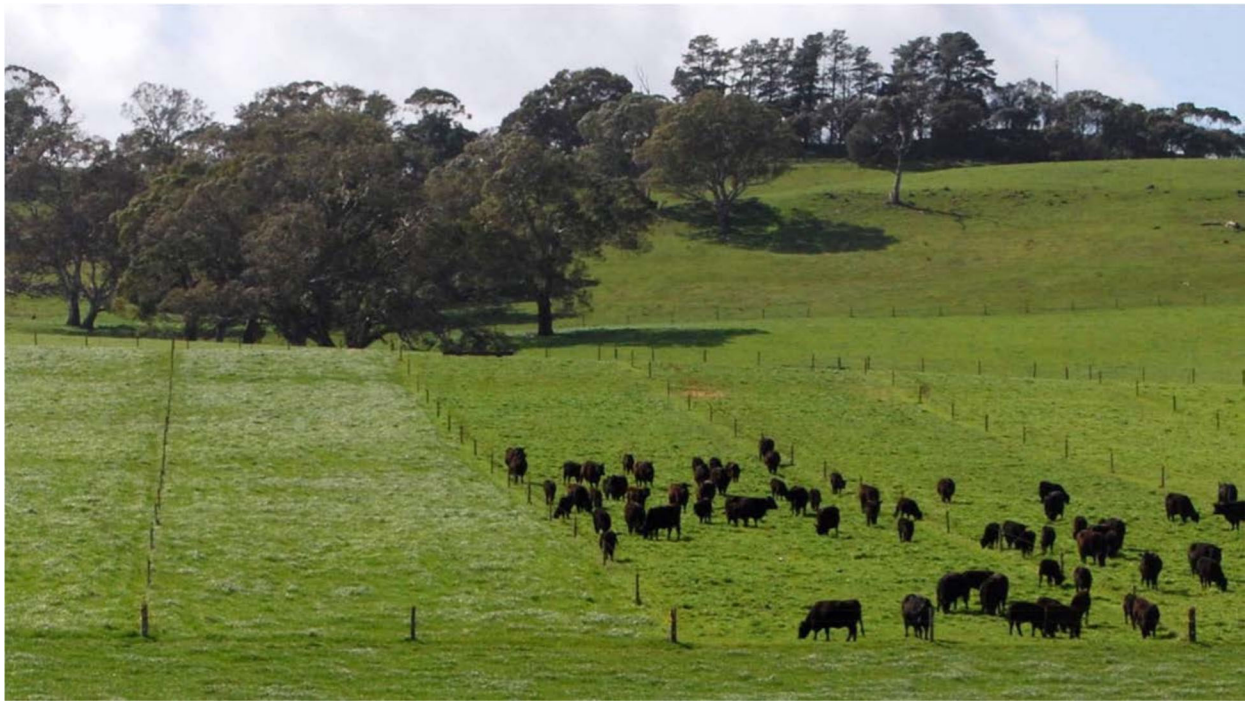
by residue, mulch and live plants

- **Returning nutrients and organic matter to soils**
- **Improving water infiltration and reducing soil erosion**
- **Regulating soil temperature and conserving soil moisture**

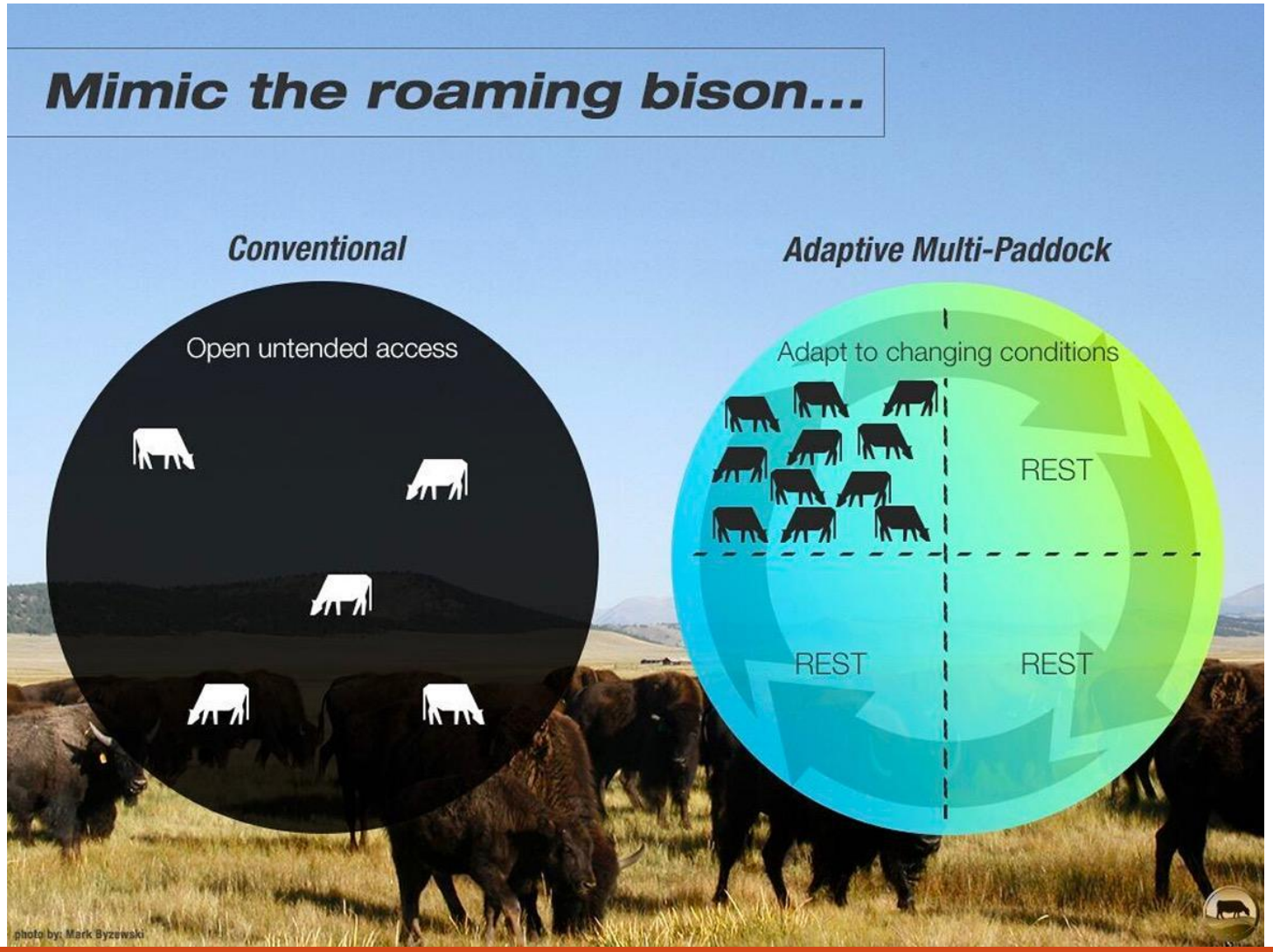
IDEX FRESH

Five Principles to Improve Soil Health

5. Integrate livestock




Grazing management has the potential to sequester significant amounts of carbon and build soil organic matter


Mimic the roaming bison...
Conventional
Open untended access
Adaptive Multi-Paddock
Adapt to changing conditions
REST
REST
REST
photo by: Mark Byzewski

Agriculture, Ecosystems and Environment 141 (2011) 310–322

Contents lists available at ScienceDirect

Agriculture, Ecosystems and Environment

journal homepage: www.elsevier.com/locate/agee

Grazing management impacts on vegetation, soil biota and soil chemical, physical and hydrological properties in tall grass prairie

W.R. Teague[a,*], S.L. Dowhower[a], S.A. Baker[a], N. Haile[b], P.B. DeLaune[a], D.M. Conover[a]

[a] *Texas AgriLife Research, Texas A&M University System, P.O. Box 1658, Vernon, TX 76384, USA*
[b] *Natural Resource Conservation Service, 532 Santa Fe Street, Weatherford, TX 76086, USA*

https://vernon.tamu.edu/research-project/grazing-ecology-management/

Agriculture, Ecosystems and Environment 287 (2020) 106647

Contents lists available at ScienceDirect

Agriculture, Ecosystems and Environment

journal homepage: www.elsevier.com/locate/agee

Soil greenhouse gas emissions as impacted by soil moisture and temperature under continuous and holistic planned grazing in native tallgrass prairie

Steven L. Dowhower[a], W. Richard Teague[a,*], Ken D. Casey[b], Rhonda Daniel[a]

[a] Texas A&M AgriLife Research Center, Vernon, TX, USA
[b] Texas A&M AgriLife Research Center, Amarillo, TX, USA

The goal was to determine if AMP grazing would decrease net soil emissions of CO2, CH4 and N2O exchange between the soil surface and the atmosphere - relative to continuous grazing and the management practice options of prescribed fire, and production of hay.

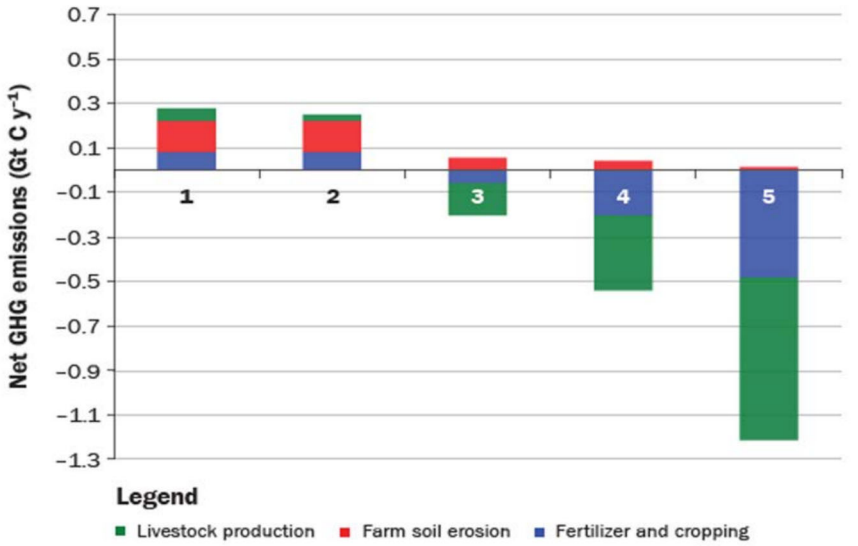
Richard Teague, et al., Texas A&M University

The role of ruminants in reducing agriculture's carbon footprint in North America
Journal of Soil & Water Conservation (2016) 71(2), 156 - 164

Stacking practices
Creates a synergy

1. Current agriculture
2. Current ag with 50% less livestock
3. 25% conservation cropping and AMP grazing
4. 50% conservation cropping and AMP grazing
5. 100% conservation cropping and AMP grazing

Figure 2
Hypothetical North American net greenhouse gas (GHG) emission scenarios for: (1) current agriculture; (2) current agriculture with 50% current ruminants; (3) 25% conservation cropping and adaptive multipaddock (AMP) grazing with current numbers of ruminants; (4) 50% conservation cropping and AMP grazing with current numbers of ruminants; and (5) 100% conservation cropping and AMP grazing with current numbers of ruminants.



Impacts of RA in Conventional Systems

- Wilcox AZ – corn/bean rotation
  - Multispecies cover crop in NT system
- Los Banos, CA – cotton system
  - Cover crop and CT vs No cover and FT
- Blythe, CA – alfalfa rotation
  - Multi-species CC vs No CC
- Palermo/Oregon House/Chico – Rangeland
  - Multi-species CC vs No CC

Figure 3: Change in soil organic carbon (SOC%) from 2015 to 2019 during adoption of no-till farming practices and after adoption of no-till farming practices + multispecies cover crops from 2019 to 2021.

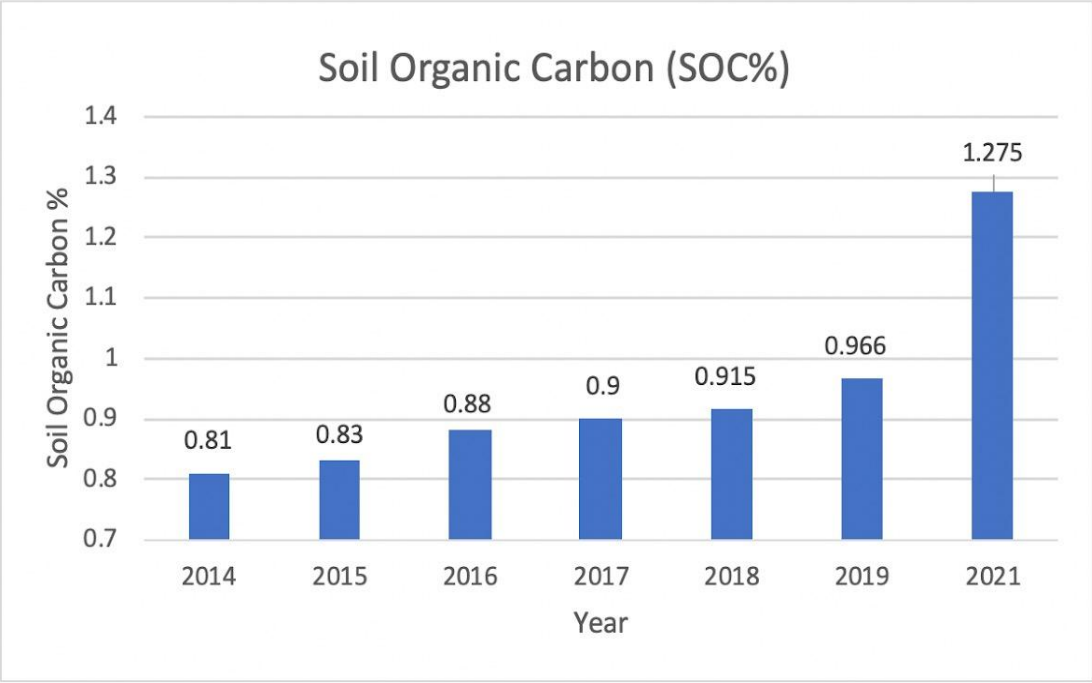
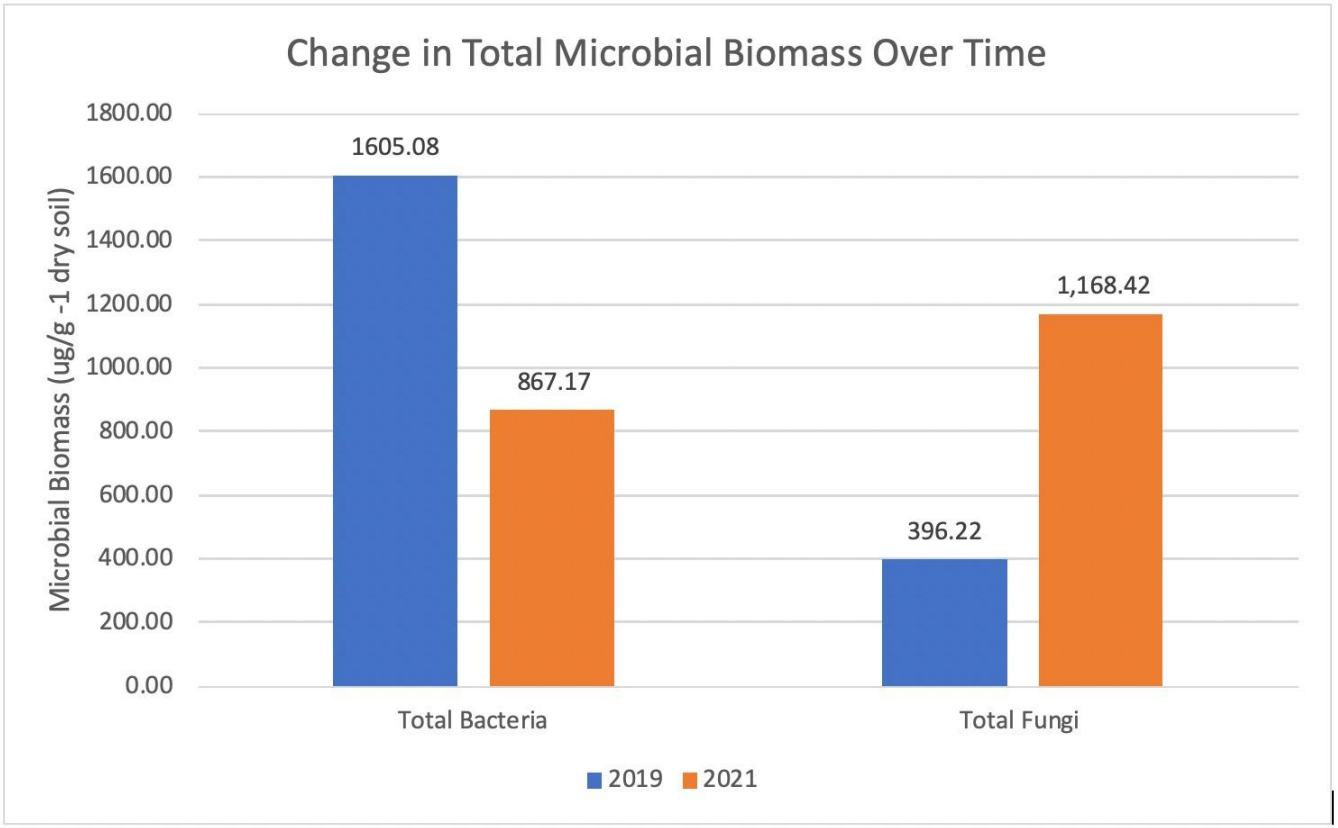


Figure 4. Soil foodweb measurements for bacteria and fungal components (ug/g-1 dry soil) demonstrating the changes from the 2019 to the 2021 sampling events.

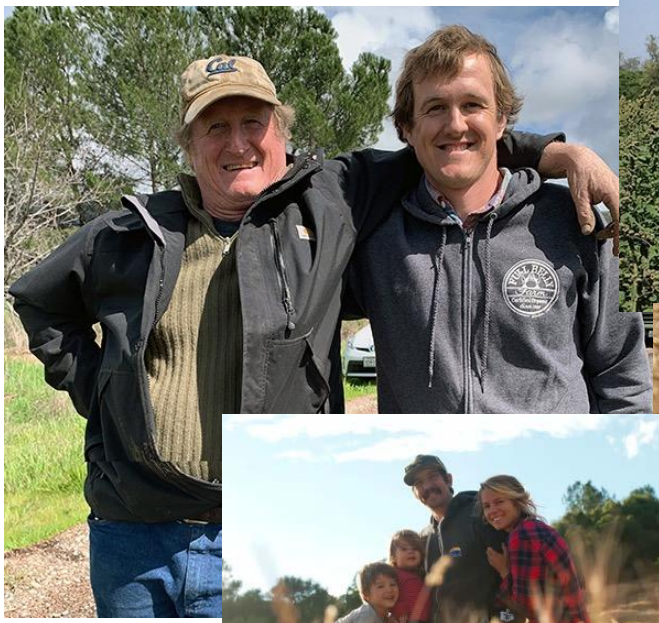


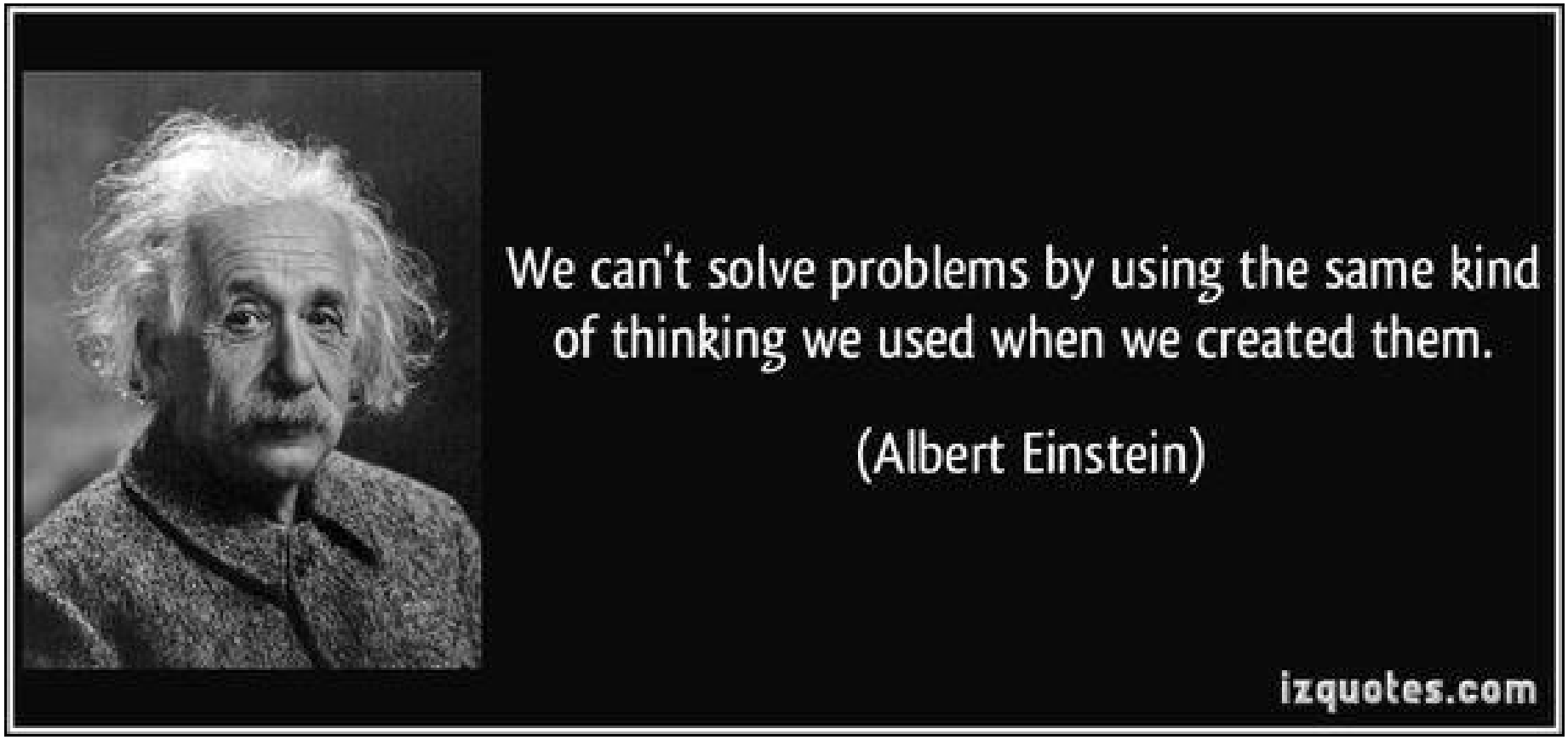
Conclusions

- Improves biodiversity – reducing the need for pesticides
- Improve water holding capacity through improvements in Soil C and nutrient cycling
- Reduced inputs (fertilizer, pesticides, irrigation)
- Improves return/acre by reducing input costs

Regenerative as a “Gateway” to Organic

Future of Farming…




We can't solve problems by using the same kind of thinking we used when we created them.
(Albert Einstein)
izquotes.com

Center for Regenerative Agriculture, CSU Chico

- **Applied Research**
  - 10 Active Applied Research Projects
- **Masters in Regenerative Agriculture**
  - 8 Graduate Students in Interdisciplinary Studies in RA
  - Working on OnLine Masters in Regenerative Agriculture
  - Working on a Professional Course Series in RA
- **Outreach & Education**
  - Educational Website, Workshops, & Forums
  - Farmer to Farmer Transition Programs
  - Technical Service Provide Training Program

www.csuchico.edu/regenerativeagriculture/

cdaley@csuchico.edu