SOIL REGEN!

Brown's Ranch

- 1,000 Acres Cropland
- 2,000 Acres of Cropland That Has Been Seeded Back To Perennials For Grazing
- 2,ooo Acres Native Rangeland

Conventional Practices

Ranch History

- Cropping System:
- 16” Total Yearly Precipitation
- Tillage – Half Summer Fallow, Half Crop
- Monocultures – Spring Wheat, Oats, Barley
- Continual Use of Synthetics: Herbicides, Pesticides, and Fungicides but Not High Rates
- Organic Matter Levels on Cropland: **1.7 to 1.9%**
- Infiltration Rate: ½” per hour

Ranch History

- Grazing System:
- Three Pastures – Season Long
- Pairs Run on Crop Aftermath Following Harvest
- Calved in April in Corrals
- Cattle Confined To Lots During Winter Months
- Fed Hay 6+ Months

1994 Purchased A 750 No-till Drill

1994 First Year No-Till

1994 Added Peas for N Fixation

Nitrogen

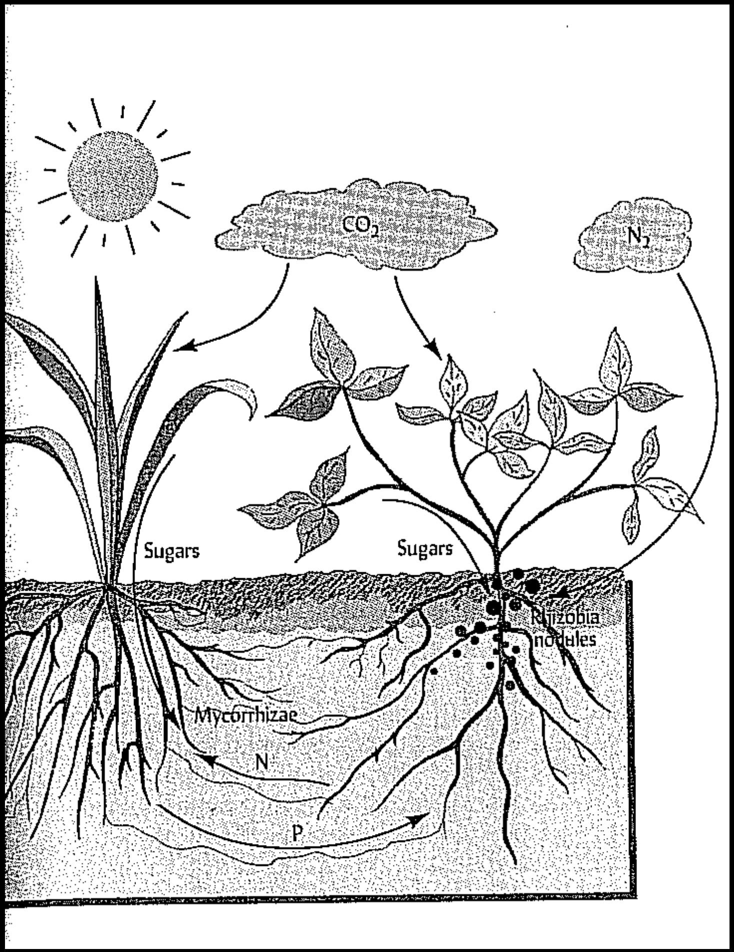
- Approximately 34,000 Tons of Atmospheric Nitrogen Above Every Acre.

- Is There Any Reason Why We Convert Fossil Fuels Into Nitrogen?

August 1995

Winter Triticale & Hairy Vetch

Plants Interacting with Mycorrhizal Fungi

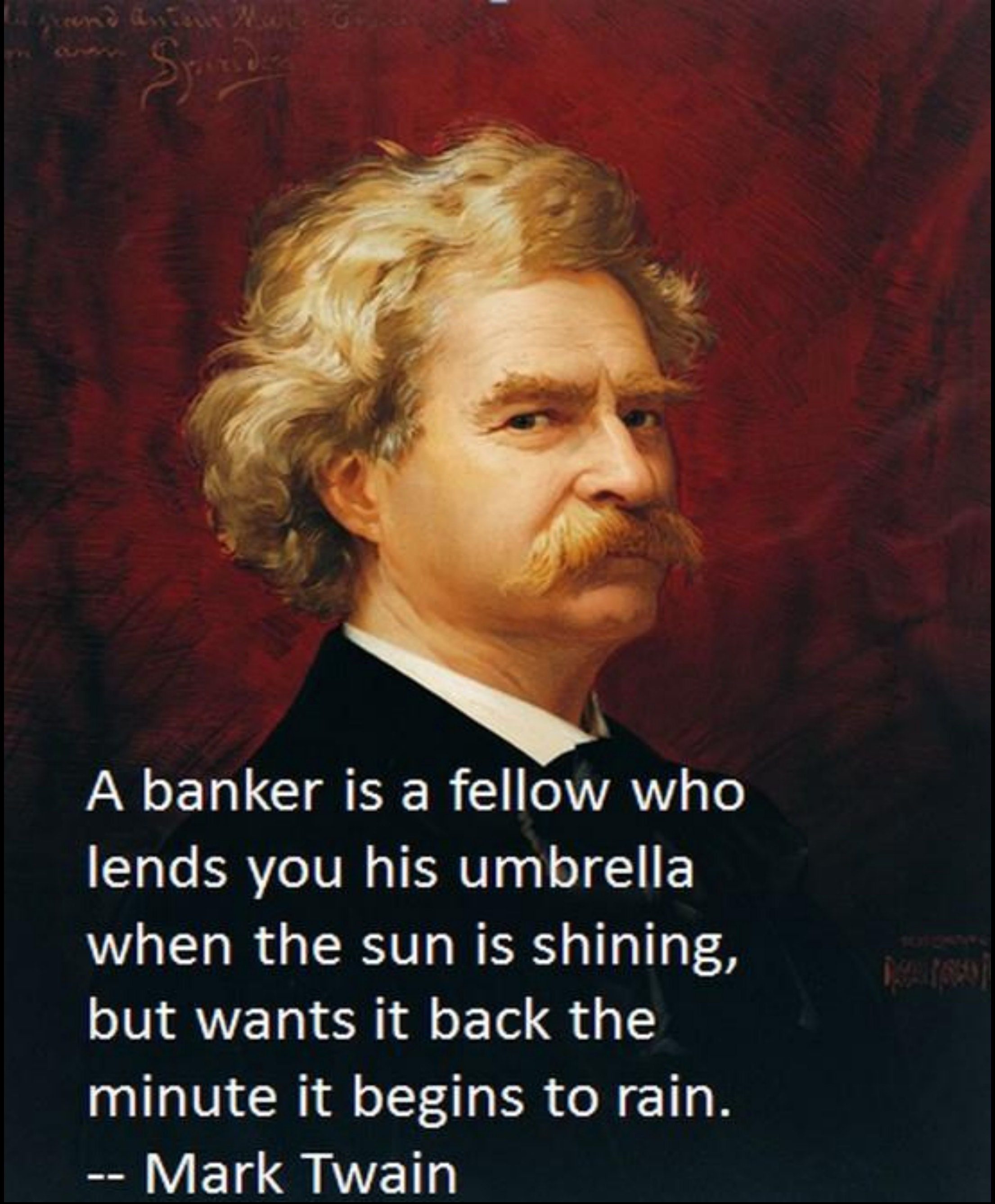


- Assists with P uptake from the soil
- Moves P from the non-legume plant to the legume plant
- Moves N from the legume plant to the non-legume plant

The Nature and Property of Soils, Brady and Weil

1996 Added Corn to the Rotation

August 1996, Again…


A banker is a fellow who lends you his umbrella when the sun is shining, but wants it back the minute it begins to rain.
-- Mark Twain

1997 Drought


June 1998

And yet again…


NEVER EVER GIVE UP !

Cowpea & Sudan Grass

Livestock Integration

And, things were changing…

Tracking Organic Matter…

Upward Trend

After God slapped me in the face four times, I came to the conclusion that he was showing me a better path!

His Path!

- Limit mechanical and chemical disturbance
- Armor on the soil surface
- Cycles water efficiently
- Living plant-root networks
- Nutrient cycling via biology
- Thousands of years of

  R & D

Nature always acts in context

"If you want to make small changes, change how you do things. When you want to make major changes, change how you see things!"

- Don Campbell

I Realized That:

I needed to "unlearn"

and "relearn"

This sent me on a 25+ year journey of "Dirt to Soil"

A Soil Owner's Manual

How to Restore and Maintain Soil Health

Jon Stika

1998

Dr. Dwayne Beck

The Godfather of Zero-Till and Diversity.

No-Till Planting Through Heavy Residue

1998
Jay Fuhrer

The Importance of Carbon and Armor on the Surface

Carbon mat: feeds the soil, keeps it cool, suppresses weeds, and protects the soil from erosion

2003 Dr. Kris Nichols

"Your soils will never become sustainable as long as high rates of synthetic fertilizers are used"

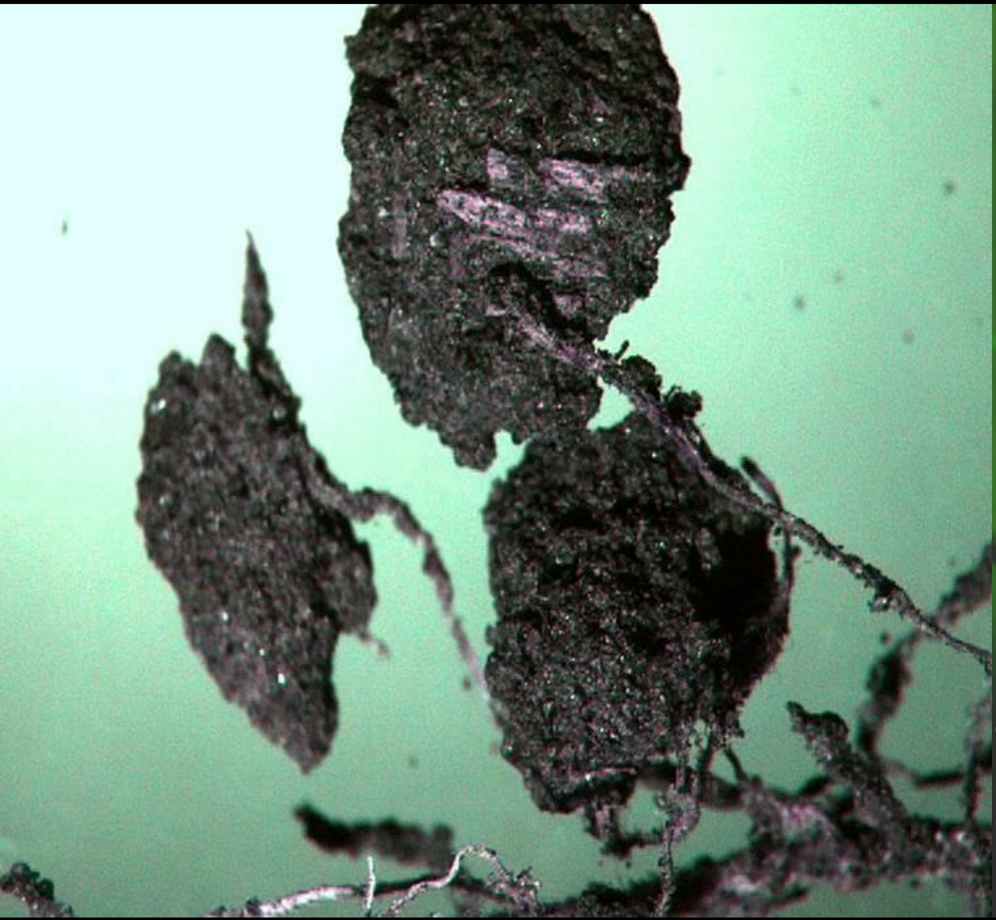
- We Eliminated All Synthetic Fertilizer On Our Owned Land in 2008
- On Rented Land In 2010

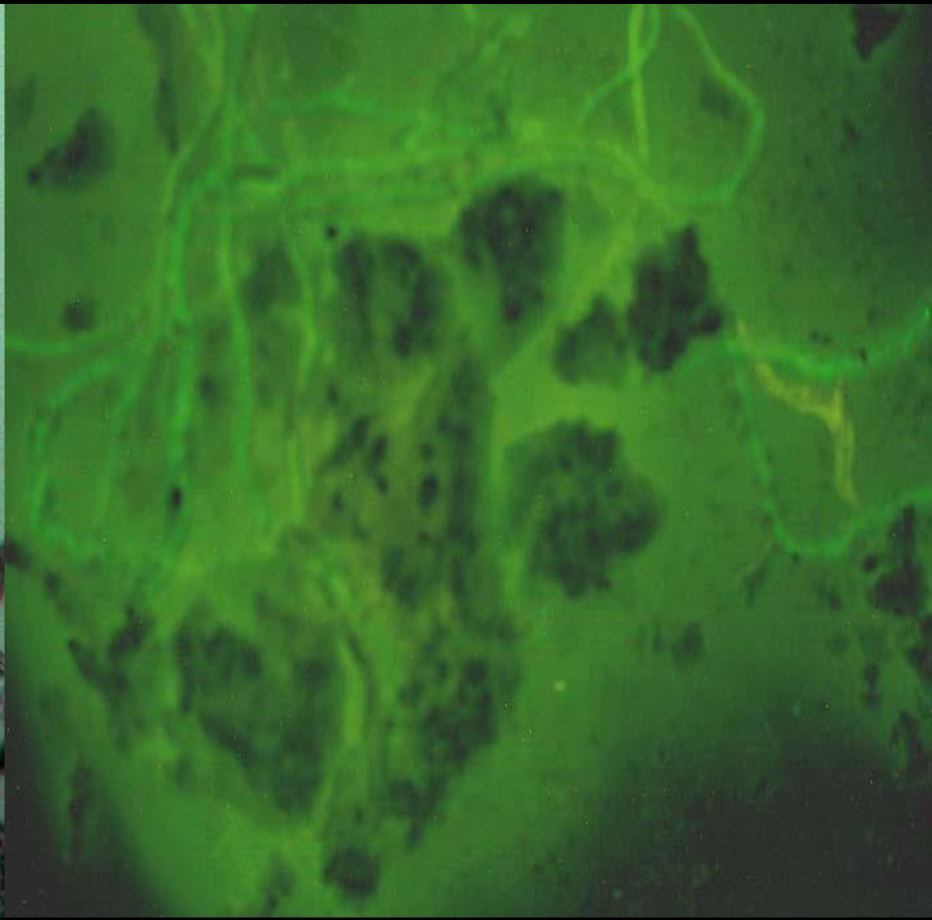
- We noticed an immediate improvement in the aggregation of our soils when I removed synthetic fertilizers.

Photo courtesy Aberdeen Mycorrhiza Research Group

Enlarged Soil Aggregates

Glomalin and Hyphae





Dr. Kris Nichols, Microbiologist, ARS, Mandan, ND

Mycorrhizal Fungi and Biology Build Soil Aggregates

The Pore Spaces Are Essential For Biology And Water Infiltration

Organic Matter and Available Water Capacity
Inches of Water/One Foot of Soil

Percent SOM	Sand	Silt Loam	Silty Clay Loam
1	1.0	1.9	1.4
2	1.4	2.4	1.8
3	1.7	2.9	2.2
4	2.1	3.5	2.6
5	2.5	4.0	3.0

Berman Hudson

Journal Soil and Water Conservation 49(2) 189-194

March – April 1994

Summarized by:

Dr. Mark Liebig, ARS, Mandan, ND

Hal Weiser, Soil Scientist, NRCS, Bismarck, ND

- RESILIENCY!

2006 Dr. Ademir Calegari

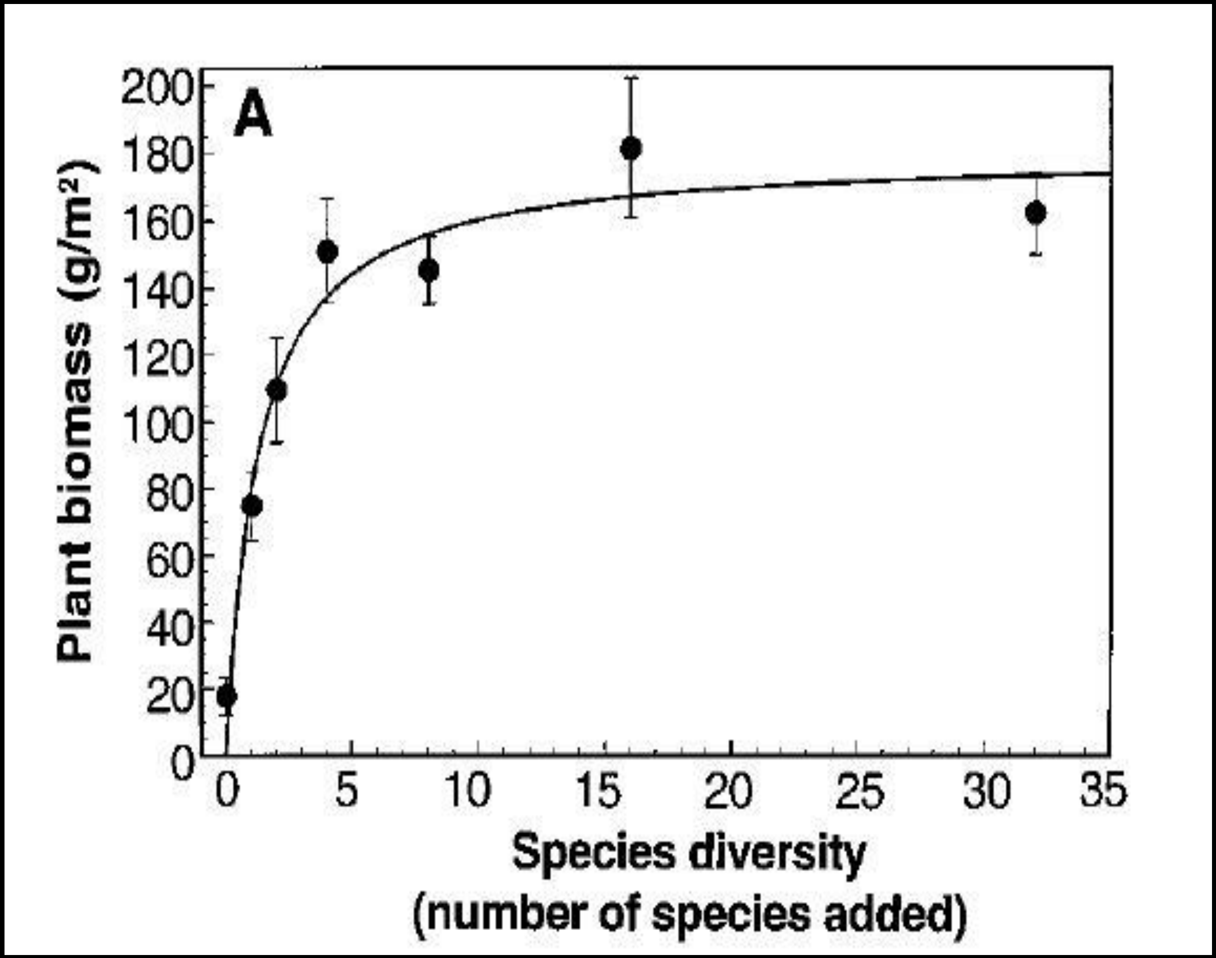
"Cover crops should be seeded as a multi-species cocktail."

Oilseed Radish July 31

Cover Crop Mix July 31

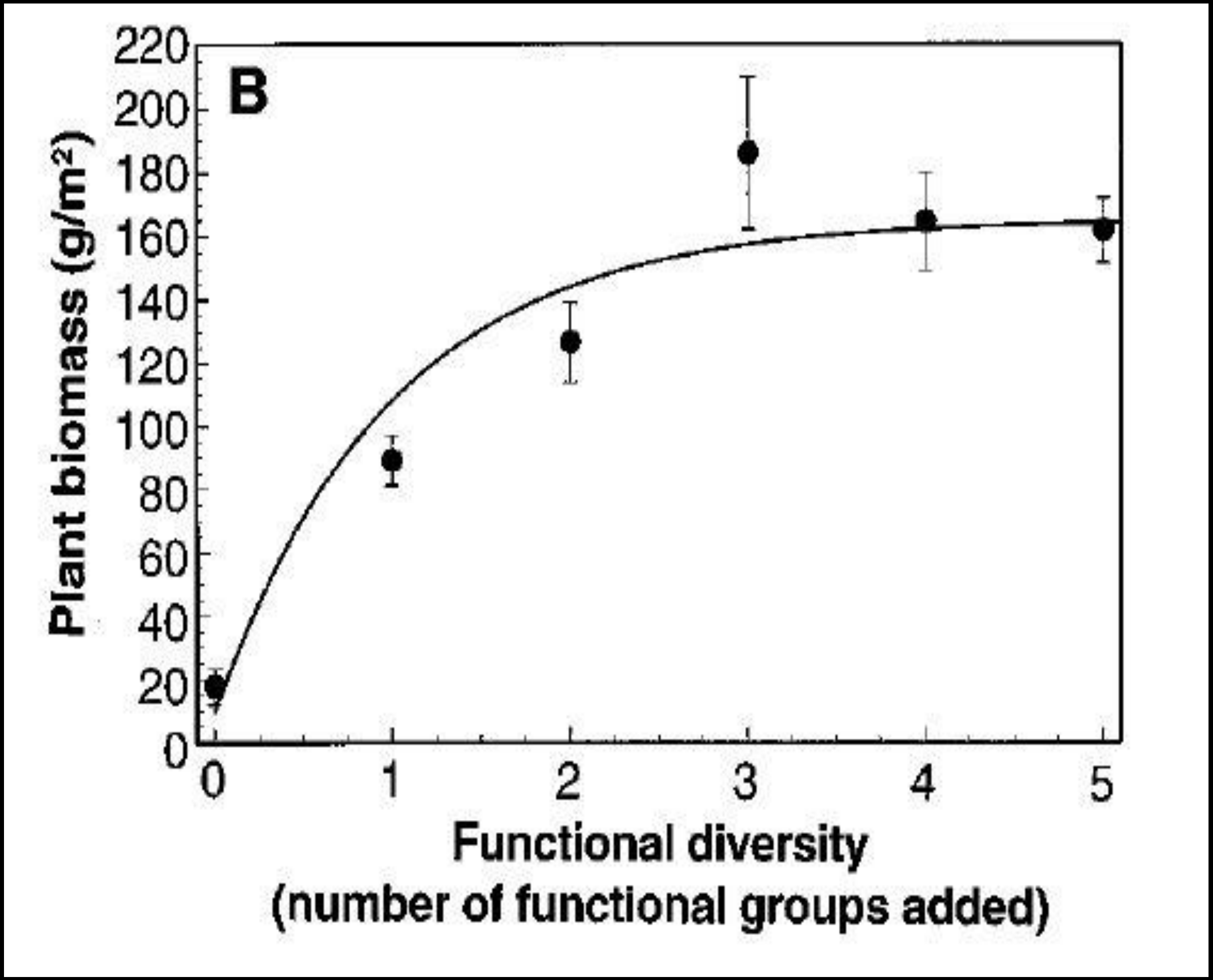
The Power of Diversity

The Influence of Functional Diversity and Composition on Ecosystem Processes



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

The Influence of Functional Diversity and Composition on Ecosystem Processes

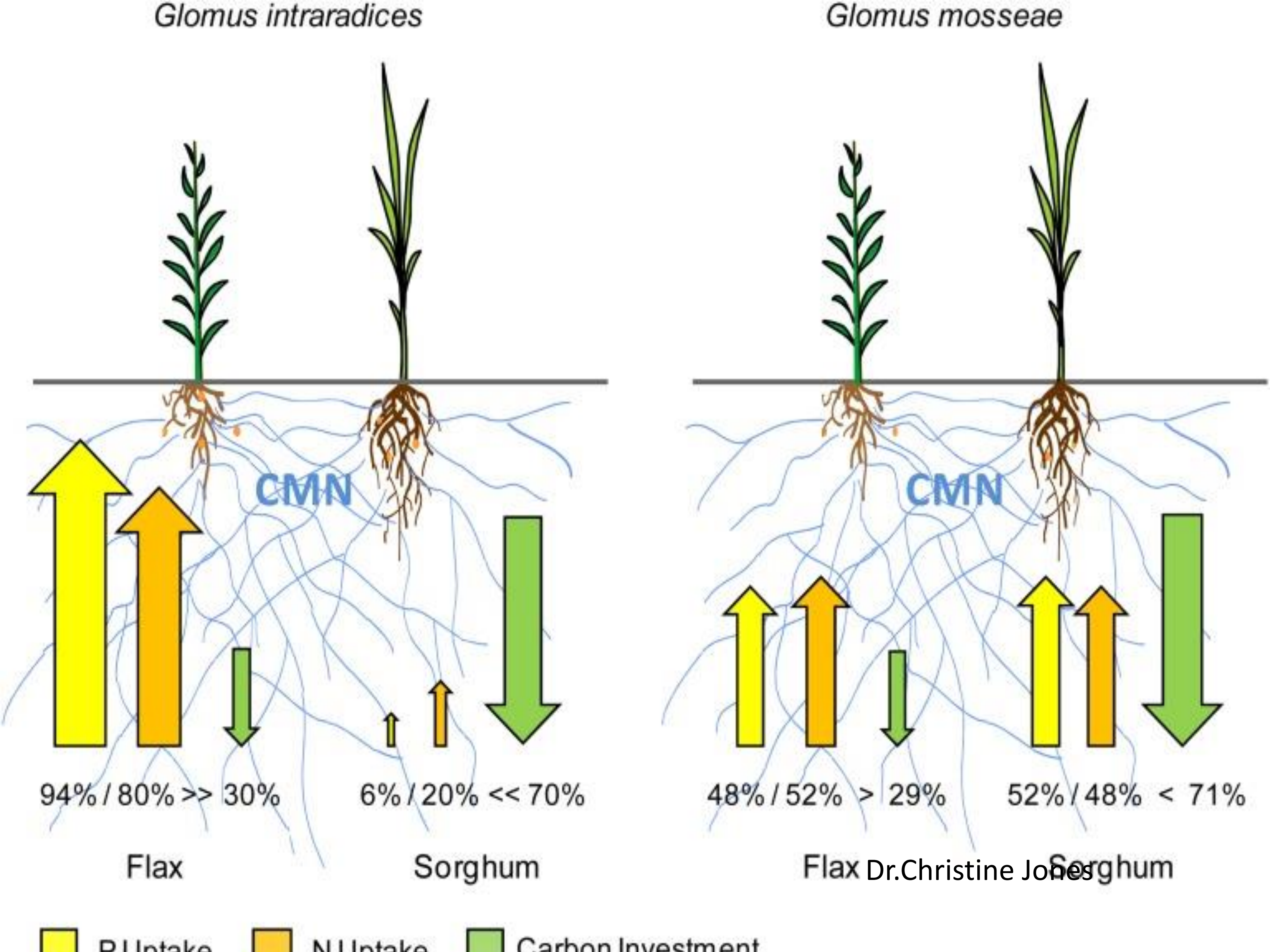


David Tilman,* Johannes Knops, David Wedin, Peter Reich,
Mark Ritchie, Evan Siemann

Rule of Three

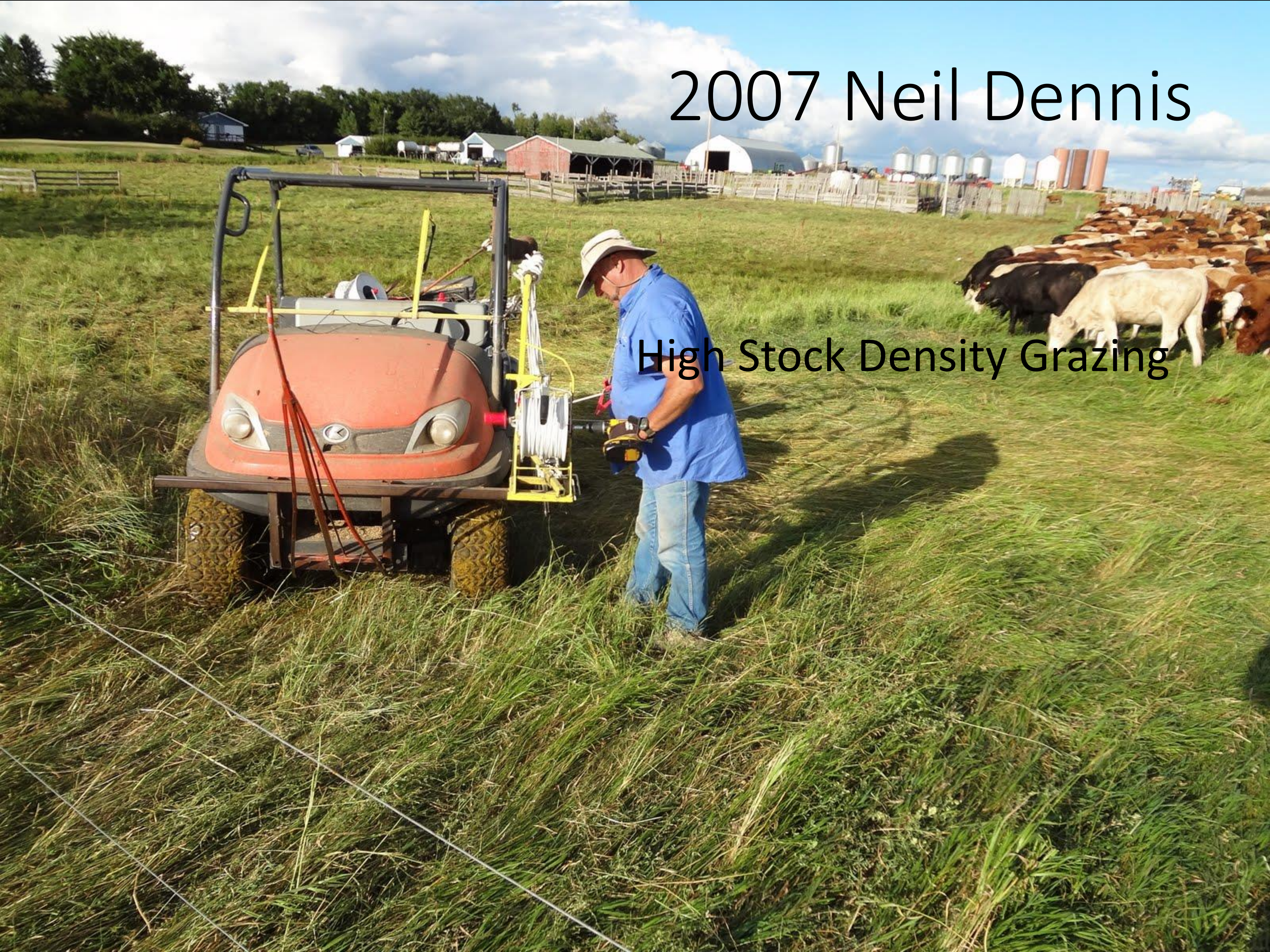
- Grasses
- Legumes
- Forbs

Optimizing Solar Energy Collection


Glomus intraradices
Glomus mosseae
CMN
CMN
94% / 80% >> 30%
6% / 20% << 70%
48% / 52% > 29%
52% / 48% < 71%
Flax
Sorghum
Flax
Sorghum
Dr.Christine Jones
P Uptake
N Uptake
Carbon Investment

Diversity in the Cropping System

Polyculture Cash Crop


2007 Neil Dennis
High Stock Density Grazing

BMR S/S, Cowpea, Soybean, Millet

- ADG 3.0+
- Brix 20+

Allow Your Livestock To Do What They Do Best!

2007
Ray Archuleta

The Role of Biology

Plant and Soil are One

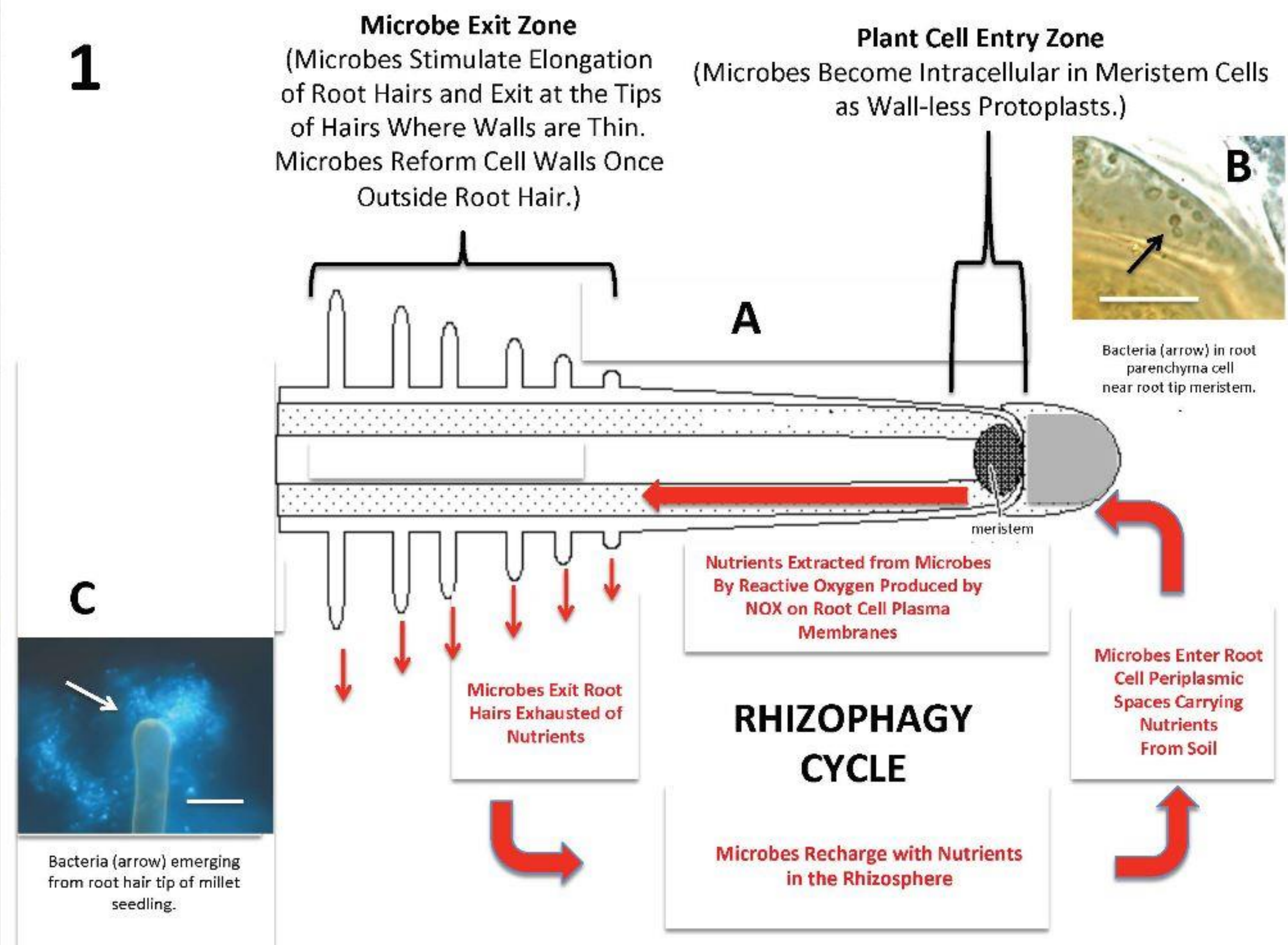
Ray Archuleta

2012
Dr. Jon Lundgren

- The Importance of Biodiversity

Insects

- The noenicitinoid seed treatment on one kernel of corn seed is enough to kill 170,000 bees!


1
Microbe Exit Zone
(Microbes Stimulate Elongation of Root Hairs and Exit at the Tips of Hairs Where Walls are Thin. Microbes Reform Cell Walls Once Outside Root Hair.)
Plant Cell Entry Zone
(Microbes Become Intracellular in Meristem Cells as Wall-less Protoplasts.)
A
B
Bacteria (arrow) in root parenchyma cell near root tip meristem.
meristem
Nutrients Extracted from Microbes By Reactive Oxygen Produced by NOX on Root Cell Plasma Membranes
C
Microbes Exit Root Hairs Exhausted of Nutrients
RHIZOPHAGY CYCLE
Microbes Enter Root Cell Periplasmic Spaces Carrying Nutrients From Soil
Microbes Recharge with Nutrients in the Rhizosphere
Bacteria (arrow) emerging from root hair tip of millet seedling.

A Scientist that is strong in the force!

- Farmers and Ranchers tend to think that the soils they have is what they are stuck with.

- We think that what we have is what we have.
-
- BUT IS IT?

Are You Satisfied With Your Soils?

Let’s Compare Systems

- Four Producers
- Located In Close Proximity
- Same Soil Types

Producer A

- Tillage – High Diversity

- Cash Crops: Spring Wheat, Winter Wheat, Soybeans, Peas, Dry edible beans, sunflowers, flax, barley, canola and alfalfa
- Synthetics: None; but uses organic soil amendments
- Cover Crops: None
- Livestock: None

Tillage-High Diversity

Producer B

- No-Till – Low Diversity

- Cash Crops: Spring Wheat, flax and soybeans
- Synthetics: Anhydrous Ammonia, insecticides and fungicides
- Cover Crops: None
- Livestock: None

No-Till Low Diversity

Producer C

- No-Till, Medium Diversity, High Input

- Cash Crops: Corn, sunflowers, barley, soybeans, spring wheat
- Synthetics: Liquid and dry fertilizers, insecticides, fungicides
- Cover Crops: None
- Livestock: None

No-Till-Medium Diversity-High Syn.

Producer D

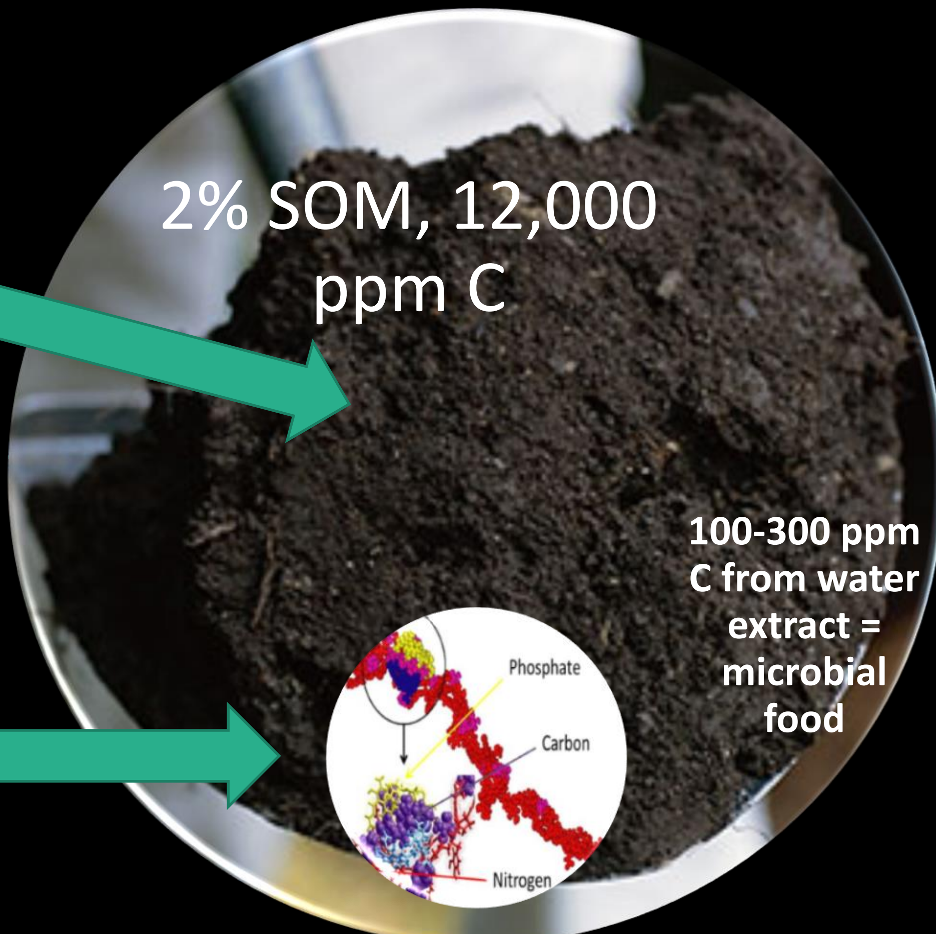
- Regenerative – No-Till, High Diversity, Low Inputs

- Cash Crops: Corn, peas, rye, winter triticale, hairy vetch, oats, barley, spring wheat
- Synthetics: Occasional herbicide; once every 3-6 years. No Glyphosate
- Cover Crops: Almost every field, every year.
- Livestock: Integrated on to as many fields as possible, beef, sheep, hogs, poultry and bees


Regenerative; No-Till, HD, LI, Livestock

Soil Organic Matter is the "House" microbes live in, Water Extractable Organic Carbon is the "**Food**" they eat.

House



Food

Stewardship	N	P	K	WEOC
	#	#	#	ppm
Tillage, MD, ZS	2	156	95	233
No-Till, Low Diversity	27	244	136	239
No-Till, MD, High Syn.	37	217	199	262
No-Till, HD, ZS, Lvst,	281	1006	1749	1095

- Tested by Dr. Rick Haney, ARS, Temple, TX

Stewardship	OM %	Infil. In/Hr.
Tillage, MD, ZS	1.7	.5
No-Till, Low Div.	1.7	.7
No-Till, MD, HS	1.5	.45
No-Till, HD, ZS, Lvst.	6.9	30.+

- What About Micronutrients?

Soil Nutrients

	Avail	*Total*
Ca	234%	277%
Mg	110%	152%
Zn	250%	195%
Cu	185%	215%
B	150%	161%
Si	116%	113%
N	103%	151%
P	102%	155%
K	198%	150%
S	92%	159%
Fe	87%	130%
Na	45%	88%
Al	28%	140%

102.7 t carbon/Ha 43.4 t carbon/Ha

- Winona's soil now has over 200% more organic carbon.
- Has sequestered 59.3 t /Ha of carbon

  (213 ton/Ha of carbon dioxide)

- Holds over 200% more water.

All of the soil nutrients including trace elements have increased by an average of 162%

e.g. Calcium increase of 8166 kg/ha or 277%

- Ph has changed from

  5.2 - 6.01


FARMER'S MARKET

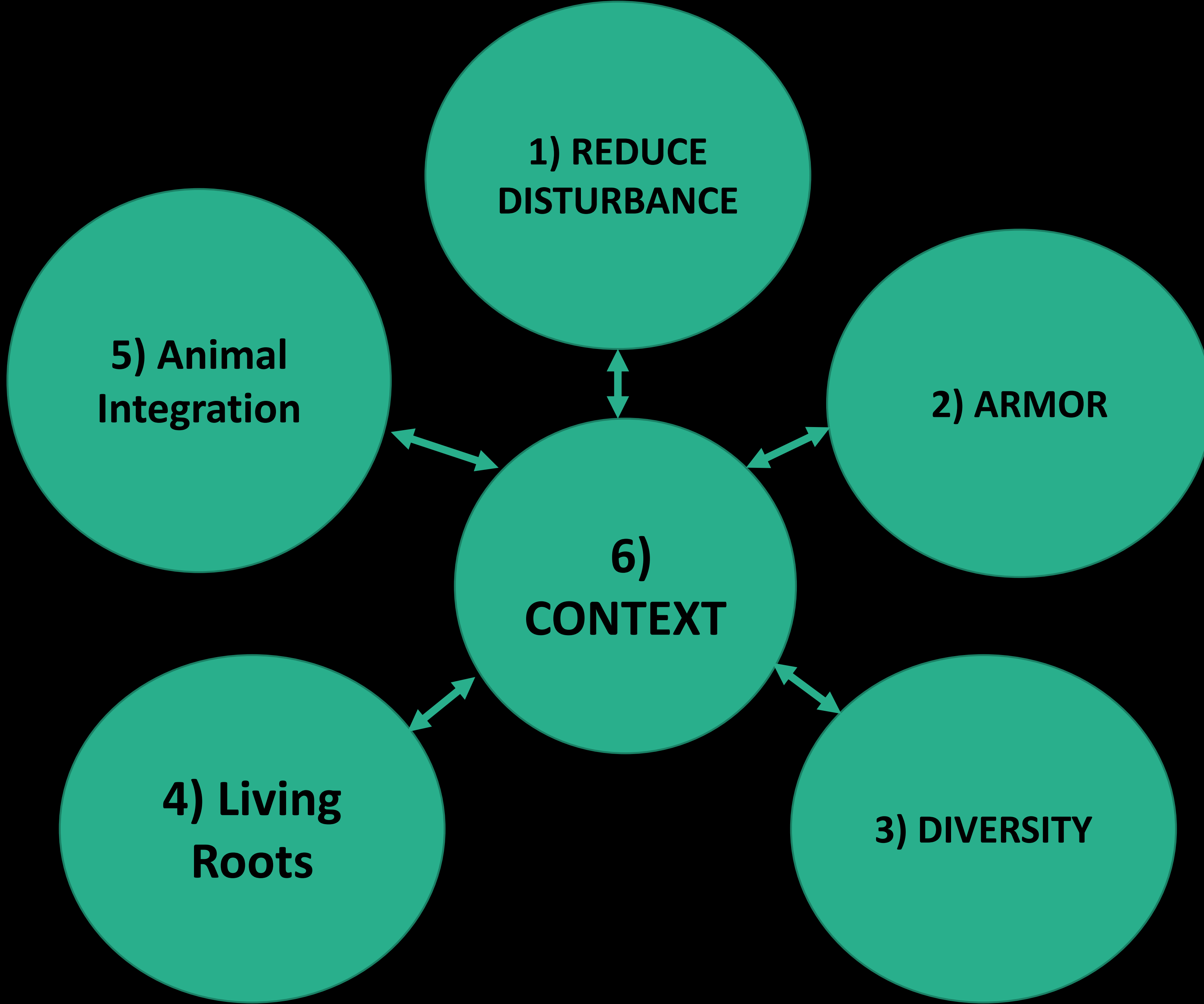
Quote from Dr. John Norman

- Results from over 140 soil samples to 48" on the Brown's Ranch home section shows an amazing 92 tons of carbon/acre. This is the equivalent of 60,400 tons of thermal coal.
- Soil cores showed aggregation down to 48".
- "A" horizon topsoil reached a depth of 29" as compared to local samples of only 5".

We Can Regenerate Our Soils!

- Our Management (Stewardship) Makes The Difference!

Your Farm Is A Reflection Of You!


1) REDUCE DISTURBANCE
5) Animal Integration
2) ARMOR
6) CONTEXT
4) Living Roots
3) DIVERSITY

- These Principles Work On Any Operation, Regardless Of Size Or Location!

CONTEXT

Ecological – Environment

Financial – Capital

Community – Family through Society

Spiritual – Faith in the Creation

- We have to understand our CONTEXT before we can make decisions.
- This CONTEXT will be different for each person, family, farm or ranch.

As Producers We Are Told That We Need To Produce More To Feed An Ever-growing Population

- We are told that we need to focus on YIELD and POUNDS.

So, We Produce More Corn

More Soybeans

More Wheat

More Pounds of Meat and Milk

- Every segment of the industry; from research to extension to universities to industry is focused on producing higher yields and more and more pounds to feed more and more people.

We are told to apply more and more inputs

After Water Is Removed From A Plant

- 97% f The Plant Is:
- Carbon 47%
- Oxygen 43%
- Hydrogen 4%
- Nitrogen 3%

- All Of These Elements Are In The Air

- AND ARE BASICALLY FREE!!!

- Why do we want to write checks for things we can get from simply growing plants?

Are we really feeding the world?

Corn Production

- Over 40% goes to produce ethanol.
- Over 36% goes for livestock feed.
- A large percentage of that goes to feed cattle.
-

- Have you ever seen a ruminant with a gizzard?

- BUT; Is that really necessary?

Current World Population: 7.2 Billion

- In 2018 farmers produced enough food to feed **10.2** billion people!

- Higher and higher yields and more and more pounds lead to larger and larger supplies and lower and lower prices!

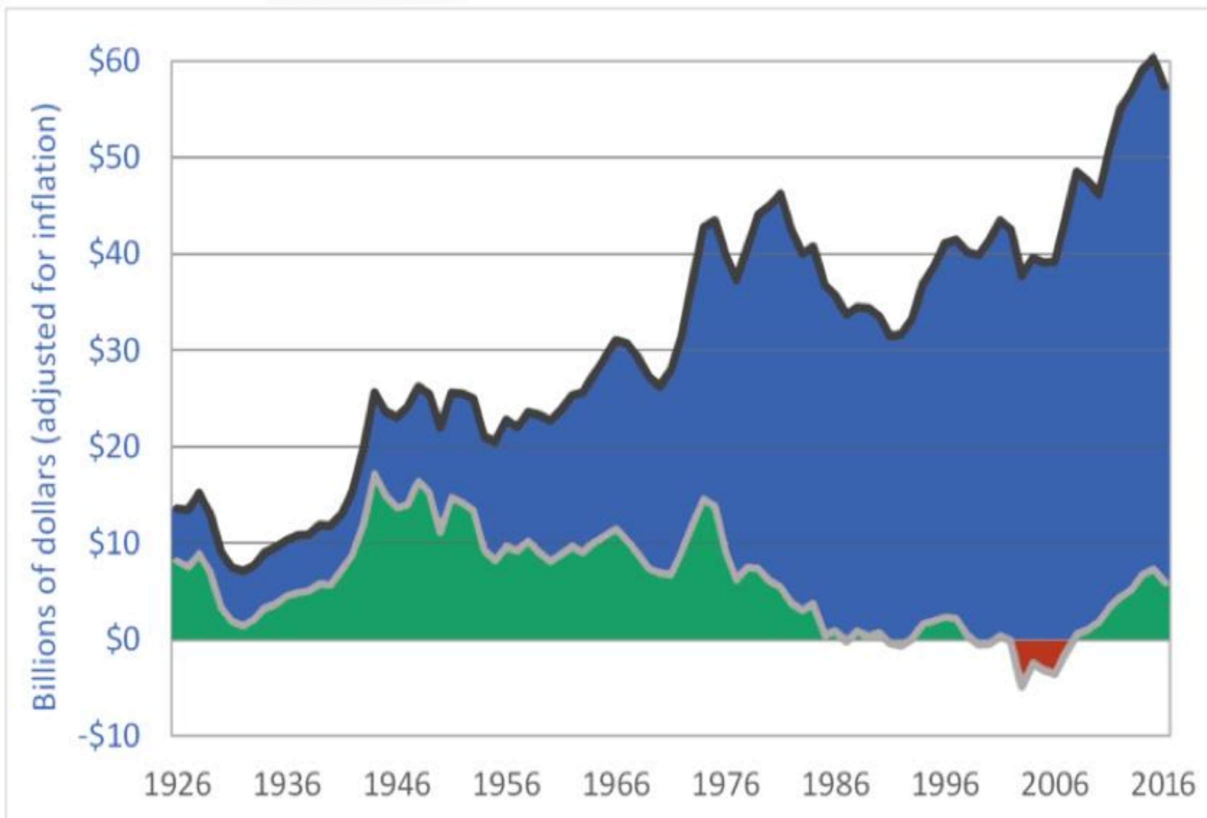
- We are kidding ourselves if we think the growing population will cure low commodity prices.

Proof

- Look at the current farm program.
- Revenue insurance is based off of last year's prices.
- Did not overproduction (supply) last year lead to the low prices that we are seeing this year?

Profit vs. Expenses

Wealth extraction by agribusinesses.



Canadian data.

theguardian

On the Ground: reporting from all corners of America

Why are America's farmers killing themselves in record numbers?

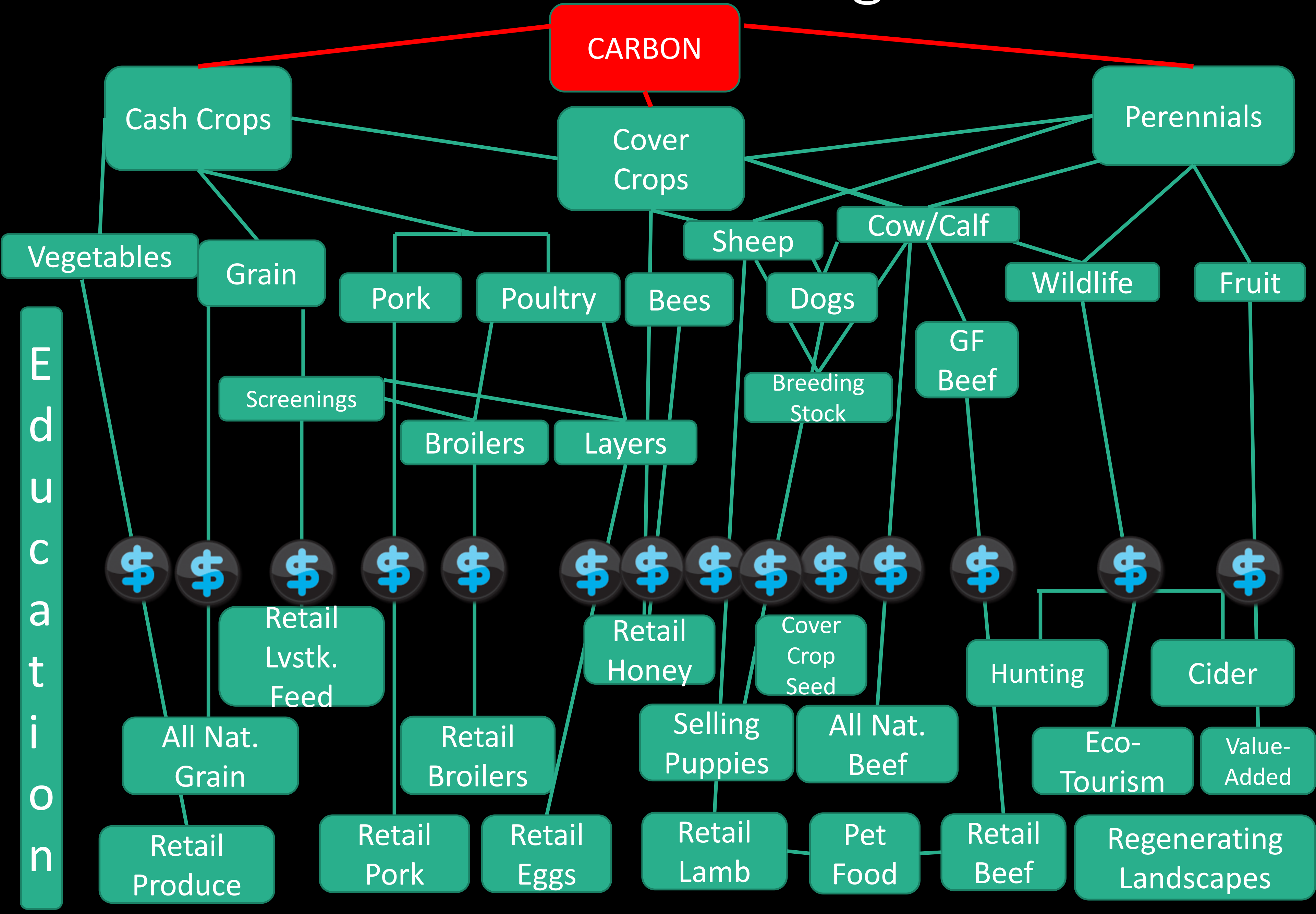
The suicide rate for farmers is more than double that of veterans. Former farmer **Debbie Weingarten** gives an insider's perspective on farm life - and how to help

● I wrote about farmers' suicides - and the reaction has been overwhelming

L HEALTH
ADEMY


BROWN'S RANCH
Specializing in
NOURISHED BY
nature
REGENERATIVE
AGRICULTURE

Soil-Water-Sunlight



Diversity in the Cropping System

- People laugh at me because I’m different;
- I laugh at them because they are all the same!

Fall Seeded Biennials

Winter Triticale/ Hairy Vetch

Income

- Yield: 55 x $7.00 =$385.00
- Yield: 450# x $1.75=$787.50
- Total Income: $1,172.50

Expense

Land Cost:	$50.00
Seed:	40.
Seeding:	24.
Herbicide:	24.
Combining:	35.
Trucking:	6.
Storage:	18.
Cleaning:	26.
Marketing Labor:	32.50
Total Expenses:	$257.50

Net Profit/Acre
$915.00


Oats:
No Fertilizer, Pesticides or Fungicides

Oats

Income

- Yield: 112
- Price/bu.: $5.50
- Total Crop Income: $588.
- Grazing Income: $110.
- Total Income: $698.

Expense

Land Cost:	$50.
Seed:	$16.
C/C Seed:	4.45
Seeding:	24.
Herbicide:	23.
Combining:	25.
Trucking:	22.40
Storage:	11.20
Cleaning:	15.
Marketing Labor:	25.
Total Expenses:	$216.05

Net Profit/Acre: $481.95

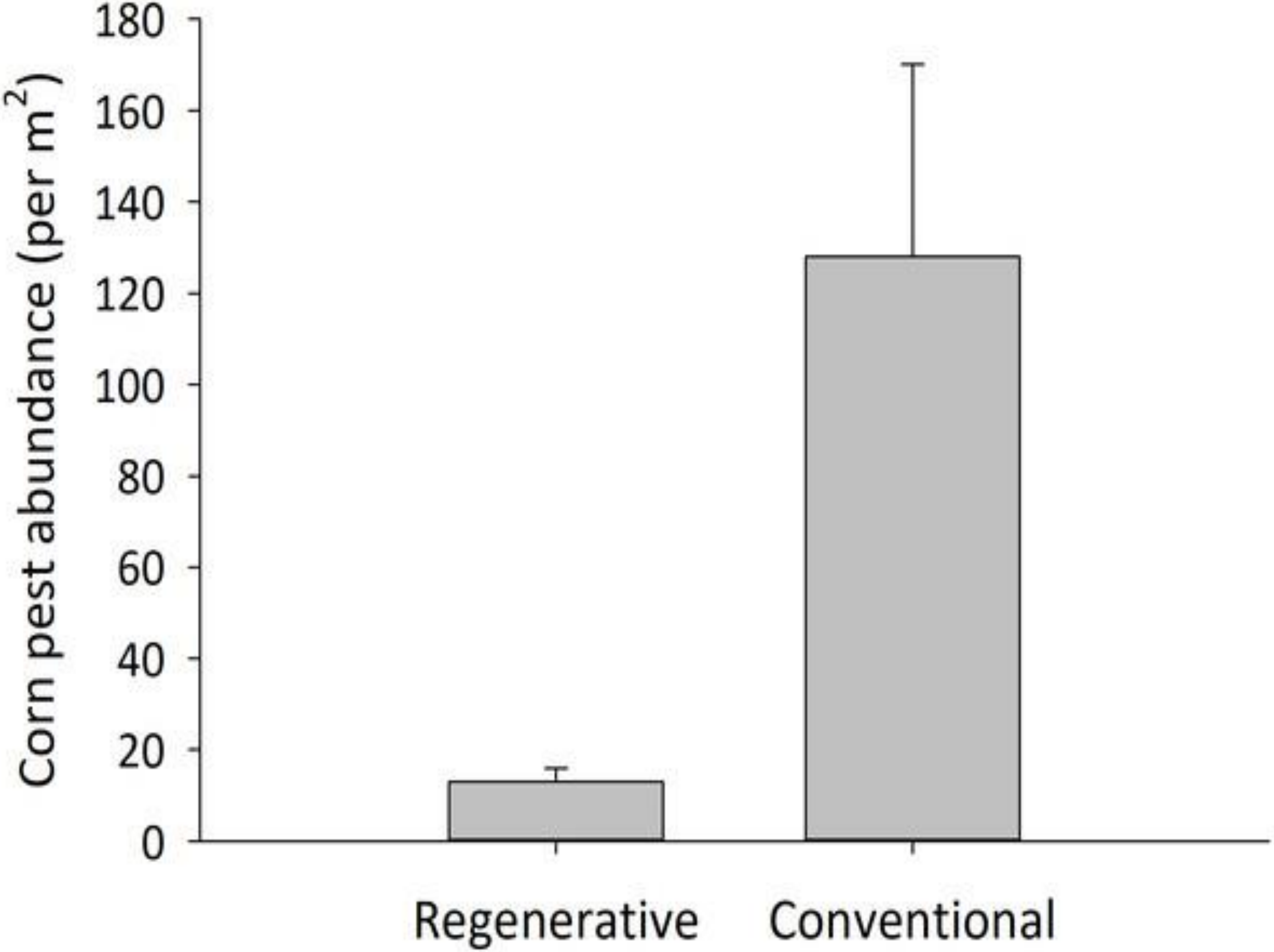
Cost of Production Including Land Cost 2008-2018

• Corn	$1.41/bu
• Oats	.97
• Peas	2.78
• Wheat	1.82

- We save our own seed. We know it will work in our environment.
- Same goes for livestock.

Peer Reviewed Documentation

- LaCanne, CE; Lundgre, JG
- Regenerative agriculture; merging farming and natural resource conservation profitably.
- Jhttps://doi.org/10.7717/peerj.4428


Corn pest abundance (per m^2)
180
160
140
120
100
80
60
40
20
0
Regenerative
Conventional

Corn Comparison

	Regenerative	Conventional
• Pests:		• 10x Higher
• Yield:	29% Lower	
• Profitability:	**78%** Higher	

Cropland Acres

- We Grow Cash Crops on 70-80% of Our Cropland Acres Every Year.
- On Those Acres We Also Grow a Cover Crop Either Before, Along With or After the Cash Crop.
- The Other 20-30% Is Double Crop Cover Crop, grazed by livestock.

AMP Grazing High Carbon Biennials

Next Move

Carbon!


Soil Armor

Economics

- 187 yearlings x 31 days x \$.80/hd./day = \$4637.6/ 16 acres = Gross Profit \$289.85

- Seed Cost/acre (\$38.50) + Seeding Cost/acre(\$14)
  + Land Cost/acre (\$22.50) (1/2) + Labor/acre (\$29)

  Total Cost/acre = \$104

  Net Profit/acre = \$185.85

  Value of enhanced Soil Health???

Continue Regeneration

Diversity

- Sorghum/Sudangrass
- German Millet
- White Millet
- Hybrid Pearl Millet
-
- Berseem Clover
- Crimson Clover
- Soybean
- Cowpea
- Hairy Vetch
- Fava Bean

Sunflower
Safflower
Buckwheat
Flax

Turnip
Daikon Radish

Phacelia
Plantain

Emerging Warm Season Cover Crop 8/5

Cover Crop 9/14 Grown on less than 2” of moisture.

Grazing A Living Cover Primes The Carbon Pump

107 Finishing Steers & Heifers

- 35 Ac. of warm season high-carbon 7 way mix
- Started September 7^{th}
- Finished October 10^{th}
- 32 days of grazing 1176# avg. liveweight
- 115 ADAs
- 4.05# ADG.

Economics

- 107 finishers x 32 days x 4.05# ADG x $1.10/# = $7020/35 acres= Gross Profit $435.83/acre
- Seed Cost/Acre ($40.36) + Seeding Cost/Acre ($14) + Land Cost/Acre ($22.50) (1/2) + Labor Cost ($10)
- Total Cost/Acre = $86.86
- Net Profit/Acre = **$348.97**

Total Net Income Per Acre:

- Rye/Triticale/Vetch Cover: $185.85
- Warm Season Cover: $348.97
- Total Net Income Per Acre: **$534.82**

- **Value to Soil Health: Priceless!**

- I will take profit over yield any day!

Fruit Trees

20% Higher Production

Honey


NOURISHED BY
nature
NOURISHED BY
nature
NOURISHED BY
nature
ETABLES

Easy Money!

• Cost of Honey	$1.80/#
• Packaging	.45
• Marketing	.50
• Total Cost/#	$2.75
• Retail /# Average	$5.50
• Profit/#	$2.75/#

BEEF

- Avg. Carcass Weight 647.40#
- Processing Cost $1052.06
- Paid to Ranch $1600.00
- Marketing, Electricity & Fuel $ 203.00
-
- Steaks 66.43# $12.22/# $ 811.77
- Roasts 49.99# $8.20/# $ 409.92
- Ground 279.34# $6.96/# $ 1944.21
- Misc. Cuts 77.50# $7.69/# $ 595.98
- (Brisket, Cheek, Ribs, etc.)
- Bones 11.28# $6.05/ $ 68.24
- Organs & Tallow 43.56# $4.00/ $ 174.24
-
- Total 528.10# $4004.36
- Net $1159.30
-

Total Beef Profit

• Ranch	$ 468.
• Retail	$1,159.
• Total Profit Per Beef	$1,627.

Grass Finished Lamb

Stacking Enterprises

Lamb

- Avg. Carcass Weight 71.63#
- Processing Cost $125.14
- Paid to Ranch $175
- Marketing, Electricity & Fuel $74
-
- Chops 9.58# $13/# $124.54
- Roast 3.53# $10/# $ 35.30
- Leg 1.76# $10/# $ 17.60
- Stew 3.82# $7/# $ 26.74
- Shanks 4.86# $6/# $ 29.16
- Ground 27.38# $10/# $273.80
-
- Total 50.93# $507.14
- Net $143.00

Total Lamb Profit

• Ranch	$ 45.
• Retail	$145.
• Total Net Profit Per Lamb	$190.

- 1.6 Lambs/Ewe
- Net Profit/Ewe $304.

Livestock Guard Dogs

Stock Dogs

Livestock Dog Income

- Two Litters Per Year X 7 Pups Per Litter = 14 Pups
- Guard Dogs and Stock Dogs x2
- Total Pups For Sale = 28
- Average Price Per Pup x$500.
- **Extra Gross Income from Pups $14,000.**

Generating Profit

- The way to generate large profits is by taking the "waste" products of one enterprise to fuel another enterprise.

GRAIN CLEANER

Pastured Pork

PORK

- Processing Cost $381.49
- Paid to Ranch $275.00
- Marketing, Electricity & Fuel $102.00
-

Chops	18.74#	$10.00/#	$187.40
Roasts	19.86#	$ 8.00	$158.88
Ribs	8.21#	$ 10.00	$ 82.10
Bacon	32.29#	$ 9.00	$290.61
Ham	20.46#	$ 7.50	$153.45
Ground	39.33#	$ 8.50	$334.31
Hocks	6.05#	$ 5.00	$ 30.25

-
- Total 144.89# $1237.00
- Net $ 478.51

Total Pork Profit

• Ranch	$120.
• Retail	$478.
• Total Net Profit Per Pig	$598.

- 7 Pigs Harvested/Sow/Farrow
- Net Profit/Sow/Farrowing $4,186.

Pastured Broilers

Pastured Broilers

Income / Bird	$25.00
(4# Bird + Gizzard +Feet)	2.00
Minus Expenses:	
Cost / Bird (including death loss)	$ 1.55
Feed (Starter and Screenings)	$ 2.45
Labor and Marketing	$ 5.75
Net Profit/Bird	$17.25

Pastured Laying Hens

Eggmobile

Pastured Laying Hens

Layers follow beef by 3 days

There Is A Difference!

Dual Purpose Hoop House

Comfortable Even At -20

Pastured Layers

- Free-Range Eggs (1,400 Hens)
  - Gross Income $82,140.
  - Expenses: Feed, Mktg. Hen Cost 17,120.
  - **Net Profit** **$65,020.**

- DO NOT TELL ME THERE IS NOT MONEY IN PRODUCTION AGRICULTURE!

- Do not tell me that we cannot bring the next generation into the operation!

$$$$$

- We are now profitable EVERY year, regardless of price!

- Because we set our own prices.
- We will not sell our products for less than the cost of production.

- We Enjoy Signing The Back Of The Checks –
- NOT THE FRONT!

We Do This Without Any Government Subsidies Of Crop Insurance, EQIP, CSP Or Any Other Program!

Brown’s Ranc

Topsoil Depth

3”

14”

1993

No-till

1.7% OM

1995

Cash Crop Diversity

2.0% OM

2013

Plot including high diversity of plants, livestock and carbon.

High nutrient densities

11.1% OM


3 Year No-till vs. Conventional Till
Michael Thompson
Farm

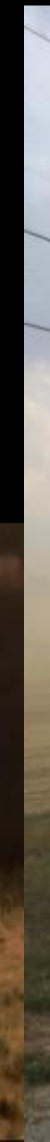
- One’s Ability To Be Successful With Regenerative Agriculture Is Directly Related To One’s Understanding Of How Ecosystems Function!

Cliff - Minnesota

Questions?


Loss of Our Soil Resource

What Have WE Learned In 79 Years?



- Every decision we make on our operation has compounding and cascading effects.
- That decision not only affects our operation and our ecosystem but our health and the health of our children and grandchildren as well.

Our Management (Stewardship) Makes The Difference

Regenerative Management

What is Regenerative Agriculture?

- Is a renewal of food and farming systems which aims to regenerate topsoil, increase biodiversity, improve the mineral, carbon and water cycles while improving farm, ranch and community profitability while insuring an enjoyable quality of life.

This Takes Observation!

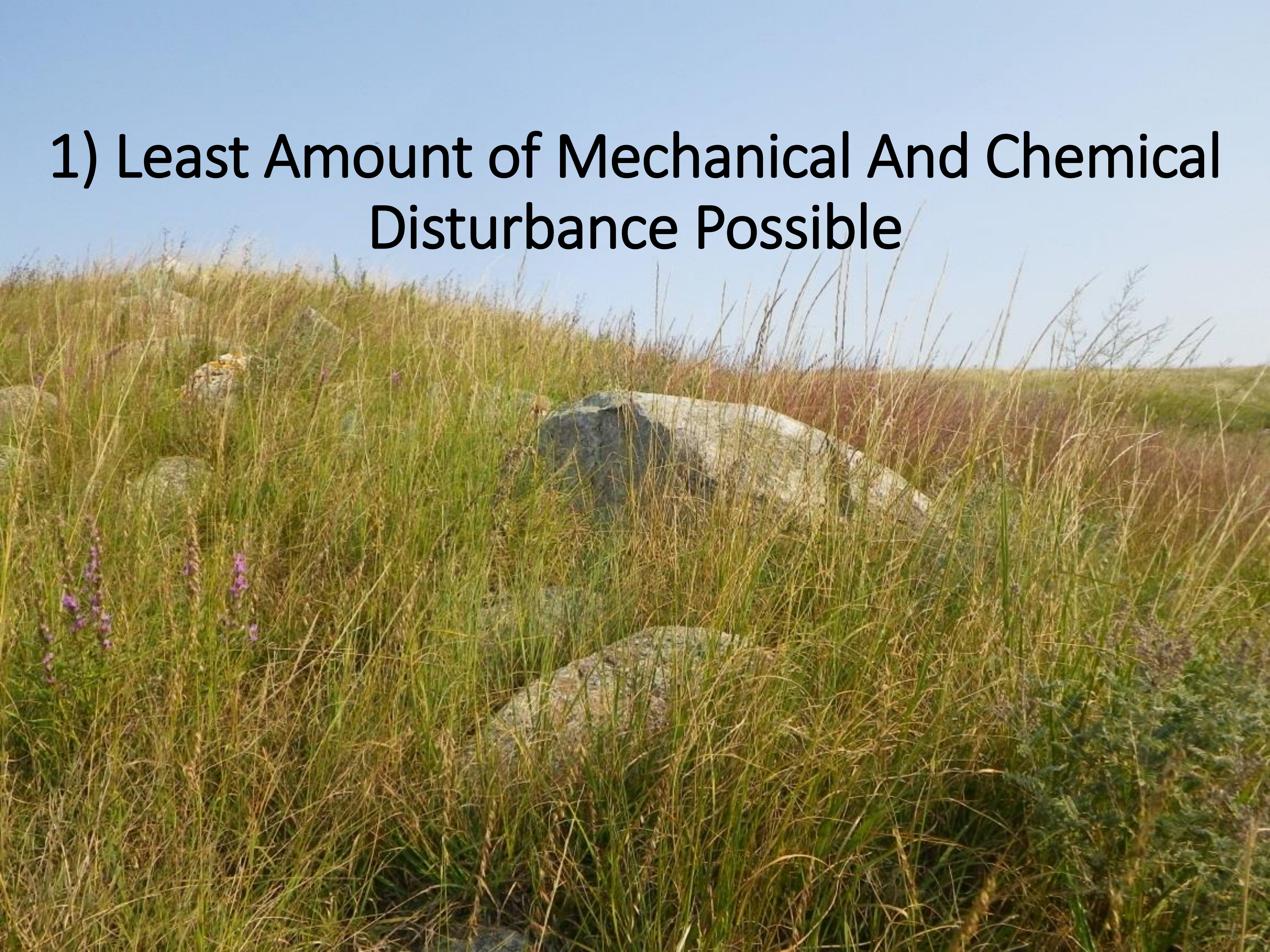
How do we improve soil health?

The Answer is to Imitate a Native Ecosystem

Nature’s Way:

- No mechanical/synthetic chemical disturbance
- Armor on the soil surface
- Cycles water efficiently
- Living plant-root networks
- Nutrient cycling via biology
- Thousands of years of Research and Development

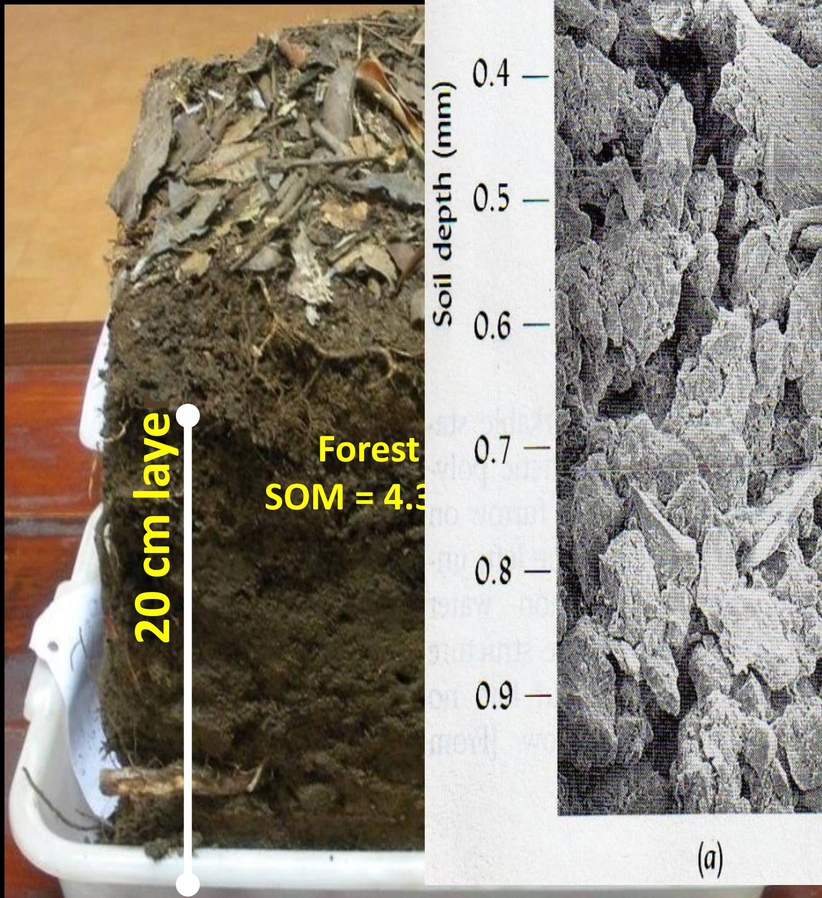
1) Least Amount of Mechanical And Chemical Disturbance Possible

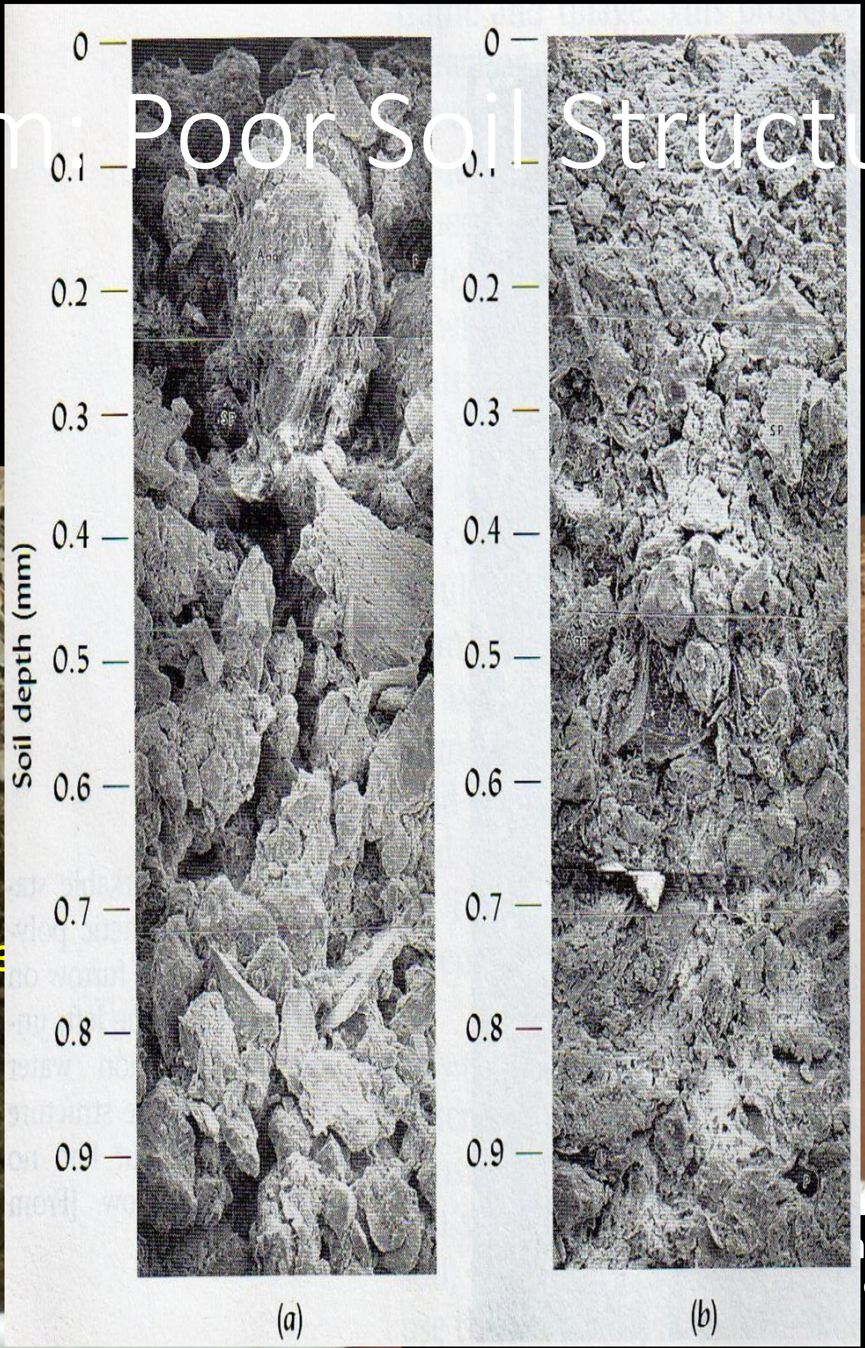


Commonality Amongst Tillage Tools

- All Tillage Tools Destroy Soil Structure
- All Tillage Reduces Water Infiltration
- All Tillage Reduces Organic Matter
- All Tillage Increases Weeds

Symptom: Poor Soil Structure





onoculture
%

Here's Proof:

- Soil Depth In Walsh County ND:
  - 1960 34 inches
  - 2014 15 inches
- A 56% LOSS!!!

Soil Organic Matter Levels

- 1960 8%
- 2014 <3%
- A 62% Loss!!!

1994 Purchased A 750 No-till Drill

Zero-Till

- The amount of moisture one receives is IRRELEVANT!

- What is relevant is EFFECTIVE rainfall!

- EFFECTIVE rainfall is the amount that can be infiltrated and stored in the soil.


I question the rational?

½” of rainfall cannot infiltrate

June 15, 2009

Adequate Infiltration: 13.6” in 22 Hours

Too Much Or Too Little

- If you have too much water you need to increase your crop intensity to use more water, in other words grow covers!!

- If you do not have enough water you need to increase the water holding capacity of your soils, in other words grow covers!!

- This is only going to happen with good soil aggregation/structure.
- One must have high populations of mycorrhizal fungi!

2003 Dr. Kris Nichols

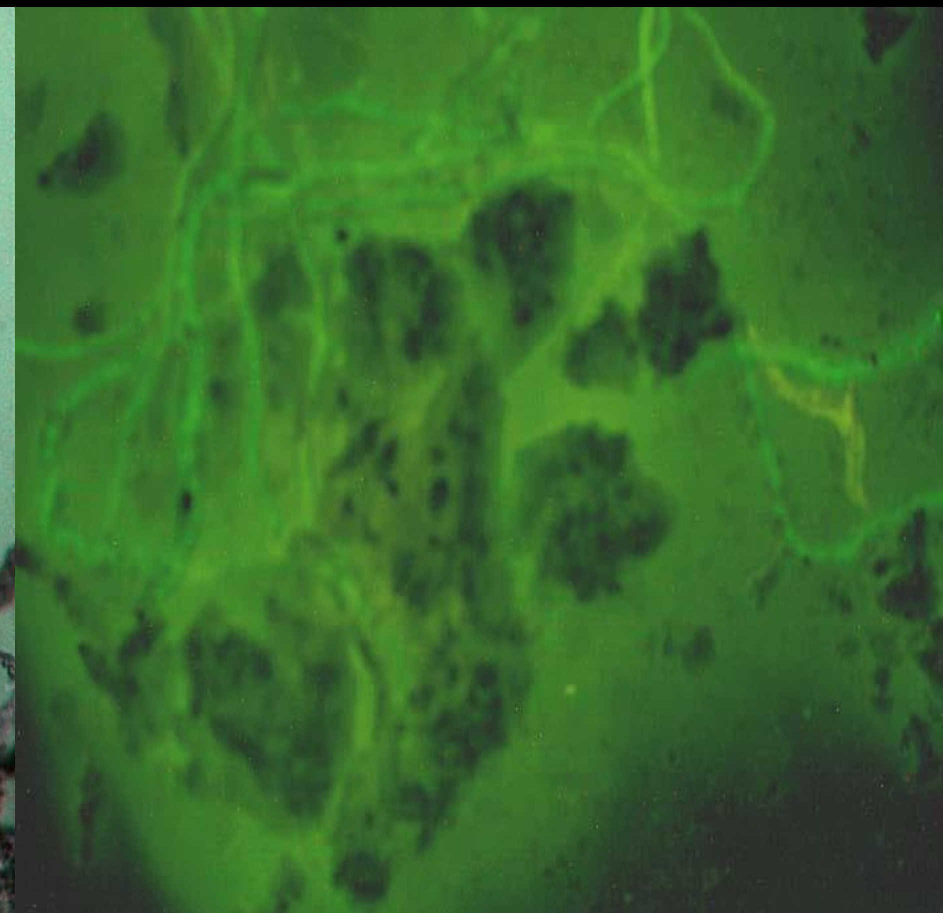
"Your soils will never become sustainable as long as high rates of synthetic fertilizers are used"

- We Eliminated All Synthetic Fertilizer On Our Owned Land in 2008
- On Rented Land In 2010

- We noticed an immediate improvement in the aggregation of our soils when I removed synthetic fertilizers.

Enlarged Soil Aggregates

Glomalin and Hyphae



Dr. Kris Nichols, Microbiologist, ARS, Mandan, ND

Mycorrhizal Fungi and Biology Build Soil Aggregates

Organic Matter and Available Water Capacity
Inches of Water/One Foot of Soil

Percent SOM	Sand	Silt Loam	Silty Clay Loam
1	1.0	1.9	1.4
2	1.4	2.4	1.8
3	1.7	2.9	2.2
4	2.1	3.5	2.6
5	2.5	4.0	3.0

Berman Hudson

Journal Soil and Water Conservation 49(2) 189-194

March – April 1994

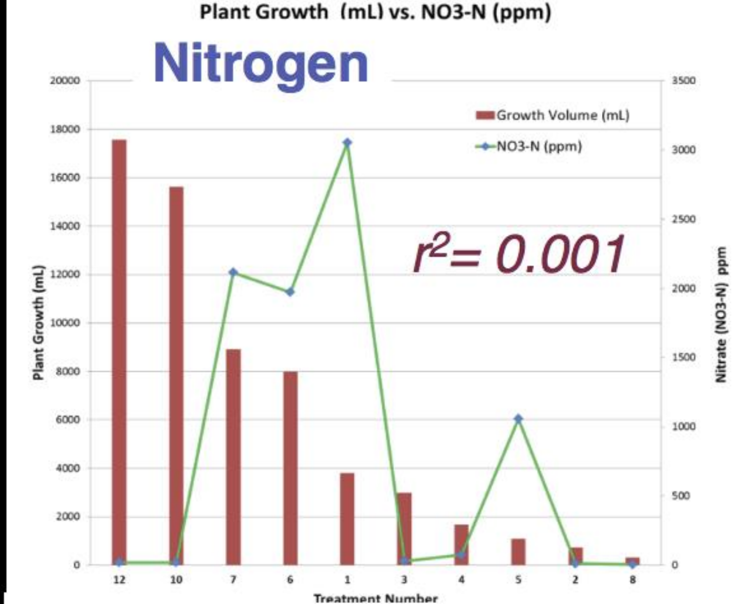
Summarized by:

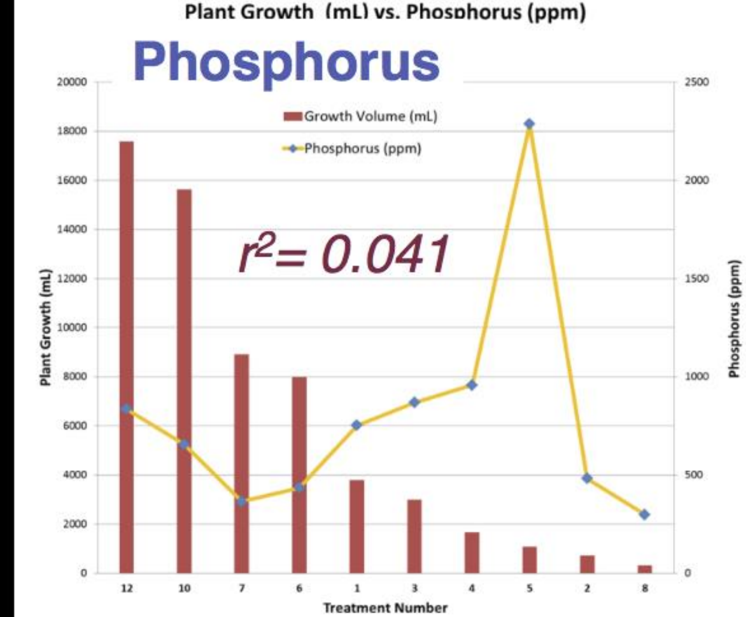
Dr. Mark Liebig, ARS, Mandan, ND

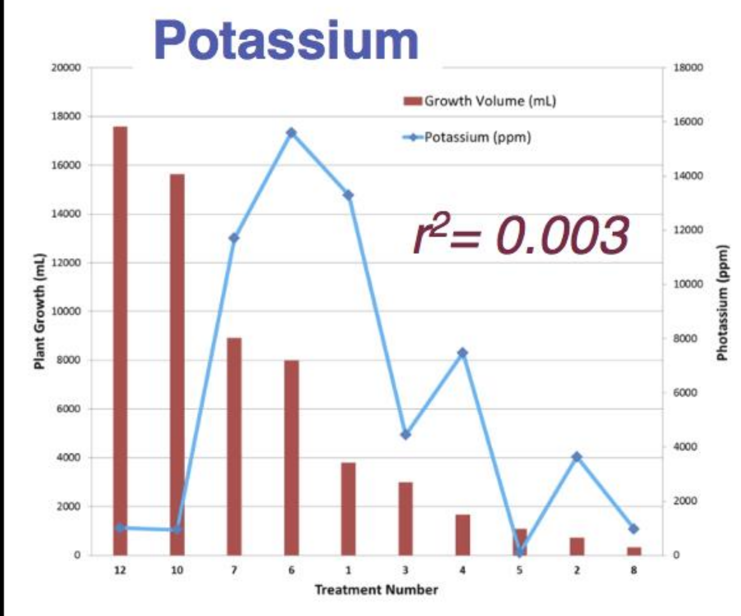
Hal Weiser, Soil Scientist, NRCS, Bismarck, ND

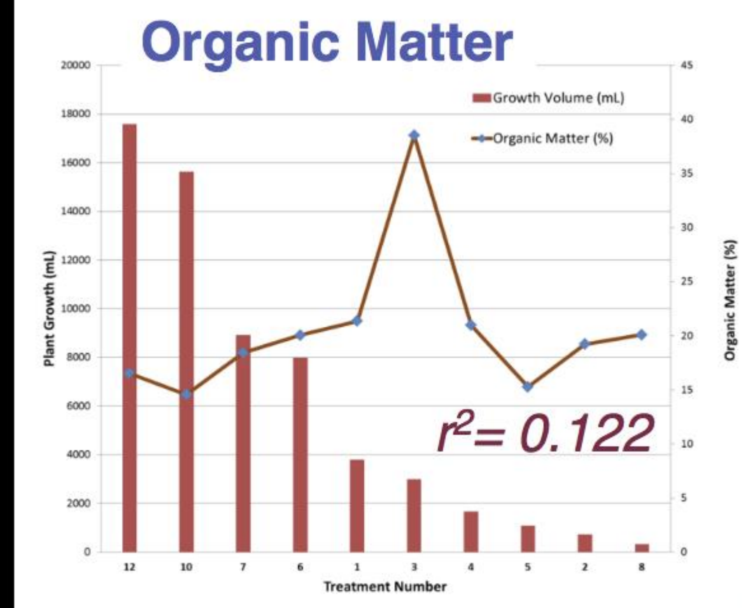
- RESILIENCY!

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









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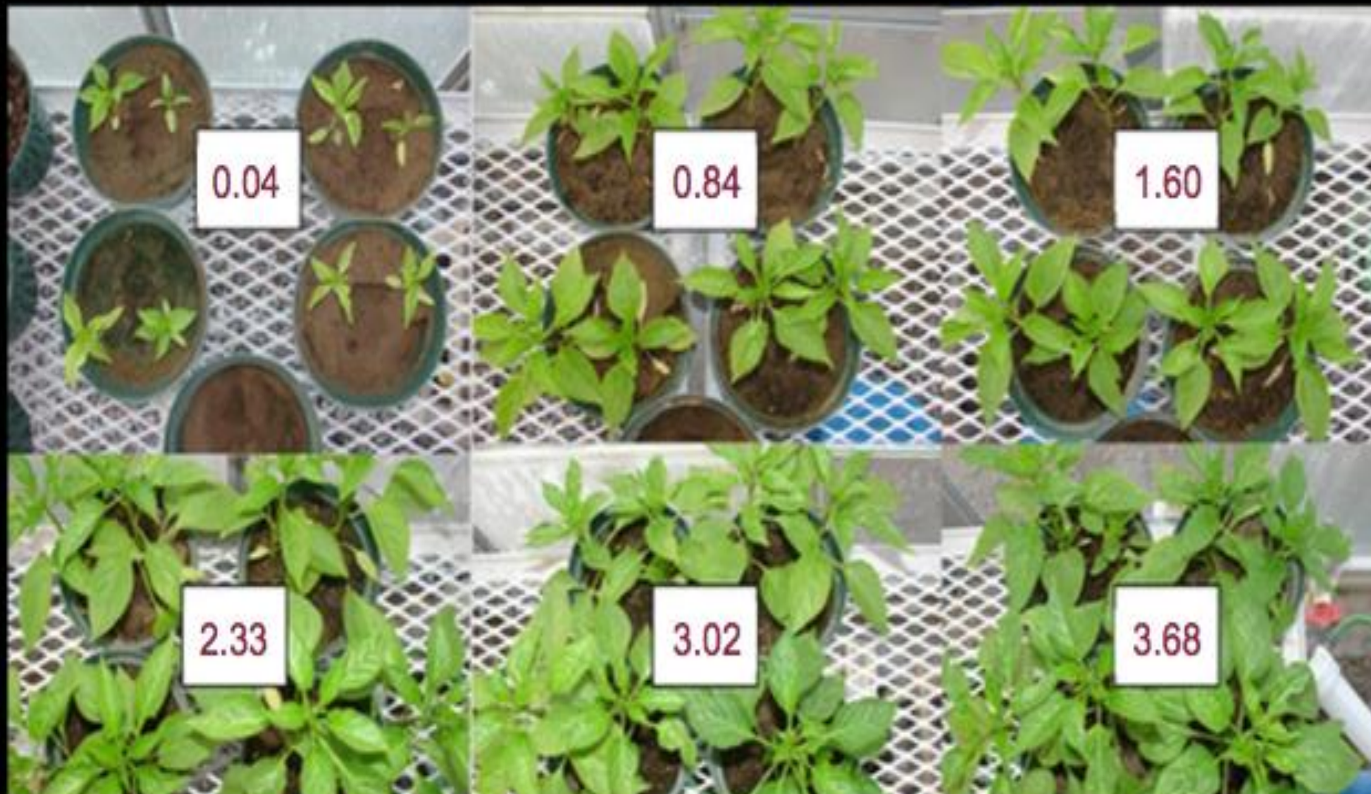

F:B Ratio

New Mexico State University
NM STATE
David C. Johnson- NMSU Institute for Sustainable Agricultural Research (ISAR)
davidcjohnson@nmsu.edu

Soil Foodweb Analysis

Report prepared for:

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

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

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

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

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

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

Nematodes per Gram of Soil
Identification to genus

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

Long Term No-Till

Soil Foodweb Analysis

Report prepared for:

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Vicki Bailey
1511 E. Interstate Avenue
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(701) 250-4363
vicki.bailey@nd.nacdnet.net

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

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

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

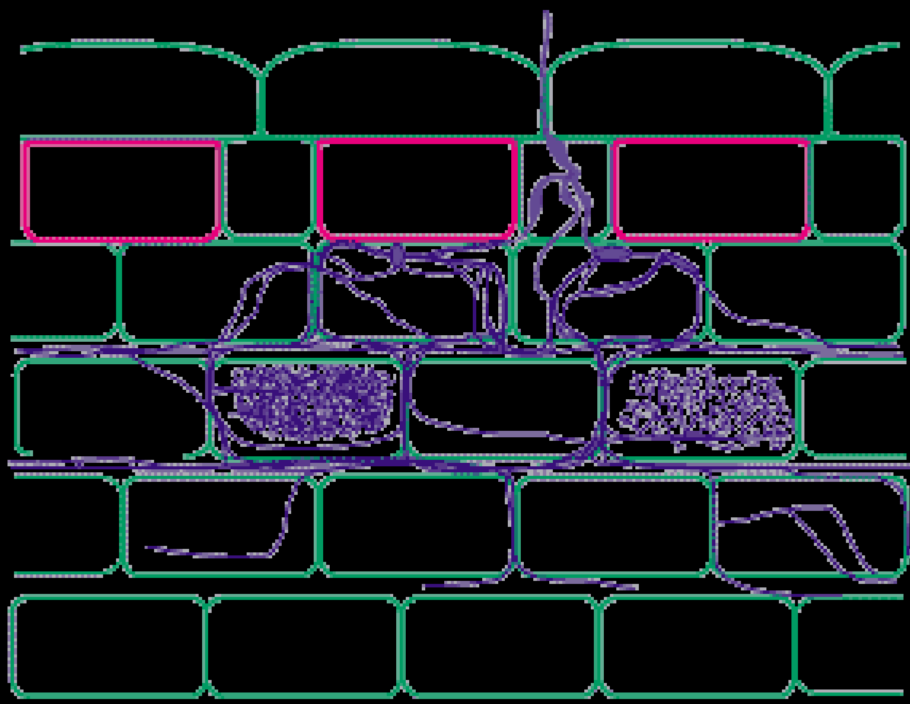
		Protozoa Numbers/g			Total Nematodes #/g	Percent Mycorrhizal Colonization	
		Flagellates	Amoebae	Ciliates		ENDO	ECTO
Results		178500	9736	331	4.45	31%	0%
Comments		High	Low	High	Low	Low	Low
Expected Range	Low	10000	10000	50	20	40%	40%
	High			100	30	80%	80%

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

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

Photo courtesy Aberdeen Mycorrhiza Research Group

AMF – Protect their host plants from pathogens and nematodes in the soil



Ways To Increase Mycorrhizal Fungi

- Reduce/Eliminate Chemical Use
- Reduce/Eliminate Tillage
- Reduce/Eliminate Synthetic Fertilizers
- Living Plant Cover As Long As Possible

Mycorrhizal Friendly Species

- Oats
- Barley
- Flax
- Clovers
- Sunflowers

High Mycorrhizal Mix

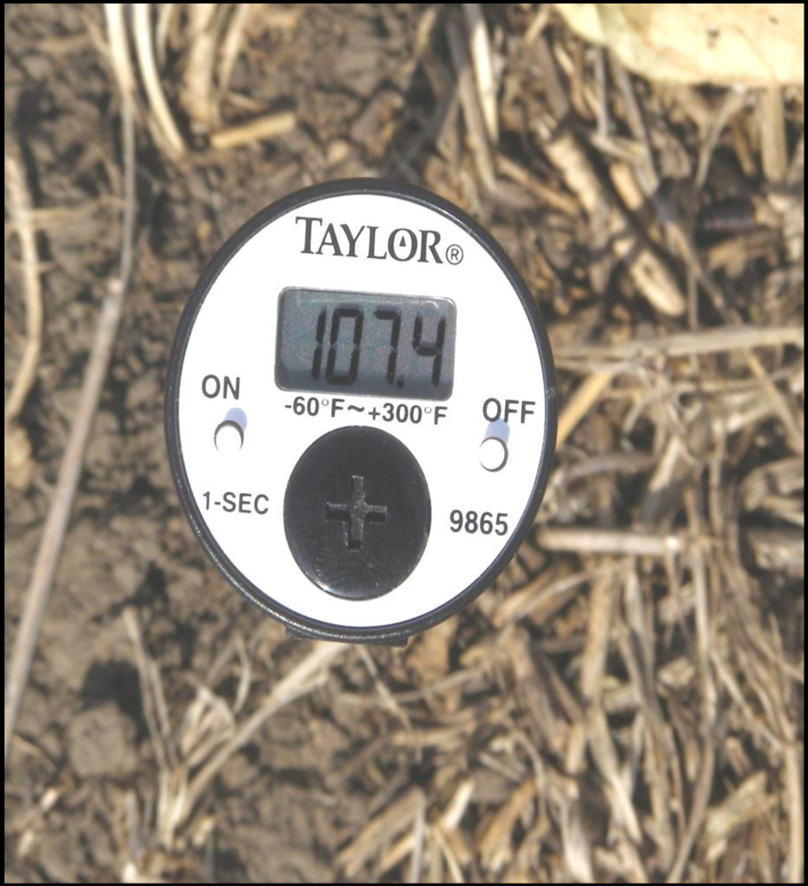
2) Armor On The Soil

Disrupted Soil Ecosystem

Dysfunctional Soil Ecosystem-Crust


No-Till Planting Through Heavy Residue

Soil Temperatures



Residue buffers August heat

SOIL TEMPERATURES

- 70 Degrees: 100% of moisture can be used for growth.
- 100 Degrees: 15% of moisture is used for growth, 85% is lost to evaporation and transpiration.
- 130 Degrees: 100% of moisture is lost through evaporation and transpiration.
- 140+ Degrees: Soil Biology is severely affected.


Soil Temperatures Are Acceptable

3)Diversity

The Importance Of Diversity

2006 Dr. Ademir Calegari

"Cover crops should be seeded as multi-species cocktails"

2006 Burleigh Co. ND

Turnip July 31

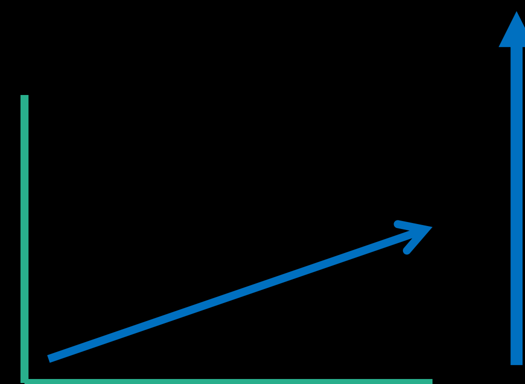
Production On District Plot

Oilseed Radish	1260 Lbs.
Purple Top Turnip	1513 Lbs.
Pasja Turnip	2070 Lbs.
Soybean	1496 Lbs.
Cowpea	1914 Lbs.
Lupin	1232 Lbs.
Cocktail Mix (1/2 Rate)	4785 Lbs.
Cocktail Mix (Full Rate)	4350 Lbs.

- “Not only do the fungi provide for the needs of one plant but the fungal/hyphae pipeline connect to multiple plants… This helps satisfy the nutritional and energy needs of microorganisms and the plants”
- Dr. Kris Nichols, ARS Mandan, ND

Monocultures: A Detriment to Soil Health

Soil Organic Matter



1993	1.7 to 1.9%
Present	5.3 to 7.9%

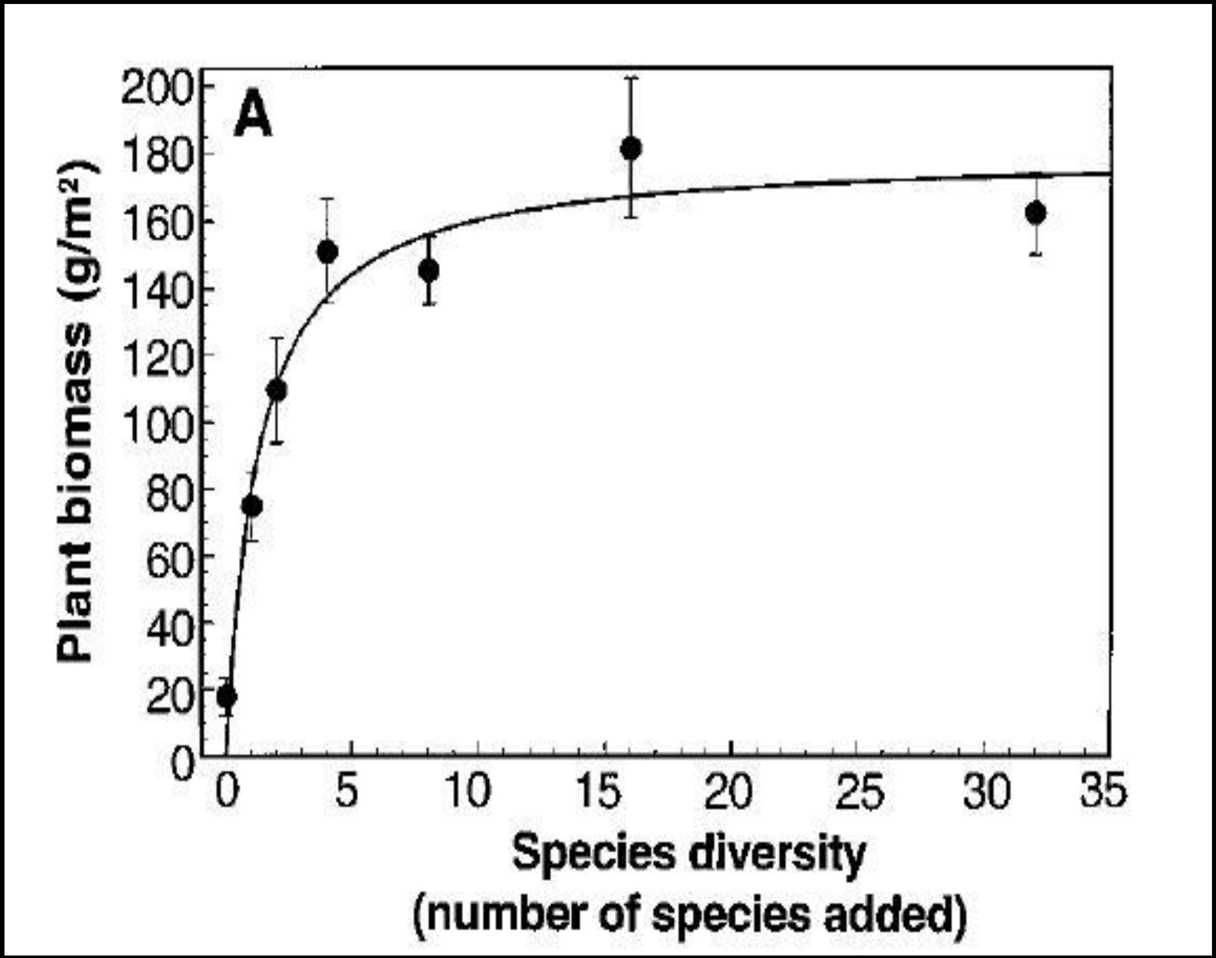
Value of SOM

Assumptions: 2,000,000 pounds of soil in top 6”.
1% OM = 20,000 pounds.
Nutrients:

Nitrogen:	1000#	$.56/lb.	N = $560
Phosphorus:	100#	$.67/lb.	P = $ 67
Potassium:	100#	$.54/lb.	K = $ 54
Sulfur:	100#	$.50/lb.	S = $ 50
Value of 1% SOM nutrients/acre			= $731
5% SOM			**= $3,655**

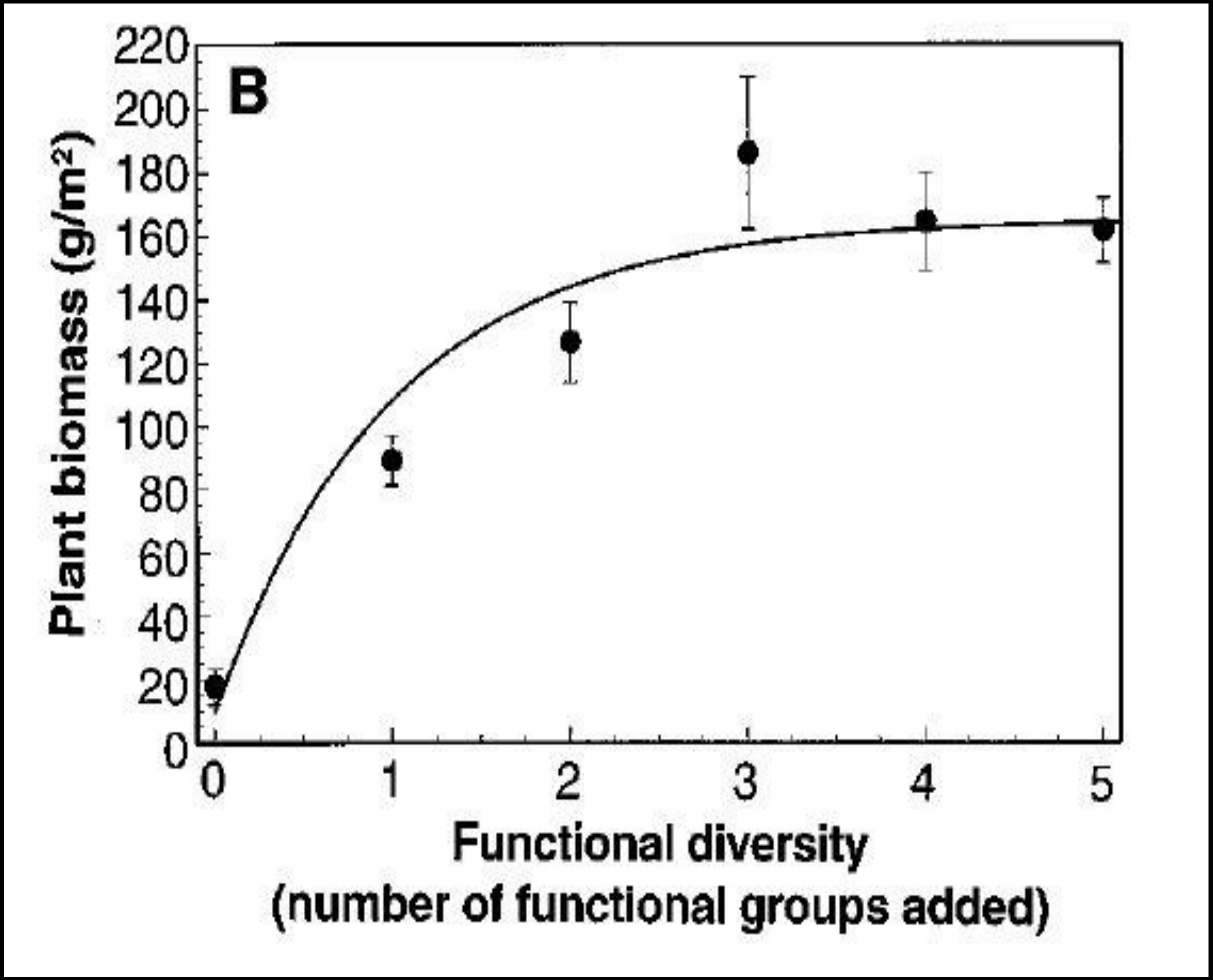
- Carbon is the key driver for the nutritional status of plants and therefore the mineral density in animals and people.
- Carbon is the key driver for soil moisture holding capacity.
- Soil carbon is the key driver for farm **PROFIT!**

The Influence of Functional Diversity and Composition on Ecosystem Processes



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

The Influence of Functional Diversity and Composition on Ecosystem Processes



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

- A key strategy in sustainable agriculture is to restore functional biodiversity of the agricultural landscape (Altieri, 1994).
- Biodiversity performs key ecological services and if correctly assembled in time and space can lead to agroecosystems capable of sponsoring their own soil fertility, crop protection and productivity. (Altieri, 1994)

Optimizing Solar Energy Collection

- Increasing Photosynthetic:
- Capacity
- Rate

Diversity Drives Soil Health

Brown’s Ranch Cash Crops

Wheat – CSG **Oats – CSG** **Triticale - CSG** **Barley – CSG** **Rye - CSG**	**Hairy Vetch – CSB** **Peas - CSB**
Corn – WSG **Millet-WSG**	**Sunflower – WSB**

- People laugh at me because I am different;
- I laugh at them because they are all the same!

Diversity in the Cropping System

Fall Seeded Biennials

Winter Triticale/ Hairy Vetch

Income

- Yield: 55 x \$7.00 =\$385.00
- Yield: 450# x \$1.75=\$787.50
- Total Income: \$1,172.50

Expense

Land Cost:	\$50.00
Seed:	40.
Seeding:	24.
Herbicide:	24.
Combining:	35.
Trucking:	6.
Storage:	18.
Cleaning:	26.
Marketing Labor:	32.50
Total Expenses:	\$257.50

Net Profit/Acre
\$915.00


Oats:
No Fertilizer, Pesticides or Fungicides

Oats

Income

- Yield: 112
- Price/bu.: $5.50
- Total Crop Income: $588.
- Grazing Income: $110.
- Total Income: $698.

Expense

Land Cost:	$50.
Seed:	$16.
C/C Seed:	4.45
Seeding:	24.
Herbicide:	23.
Combining:	25.
Trucking:	22.40
Storage:	11.20
Cleaning:	15.
Marketing Labor:	25.
Total Expenses:	$216.05

Net Profit/Acre: $481.95

Cost of Production Including Land Cost 2008-2018

• Corn	$1.41/bu
• Oats	.97
• Peas	2.78
• Wheat	1.82

Cropland Acres

- We Grow Cash Crops on 70-80% of Our Cropland Acres Every Year.
- On Those Acres We Also Grow a Cover Crop Either Before, Along With or After the Cash Crop.
- The Other 20-30% Is Double Crop Cover Crop, grazed by livestock.

New Paradigm

- Oats
- Barley
- Peas
- Flax
- Lentils

$$$

- I will take profit over yield any day!

4) Living Root As Long As Possible

Never Pass Up The Opportunity To Cycle Carbon

- It All Begins With Photosynthesis!
- The More Photosynthesis, The More Liquid Carbon Being Pumped Into The System!

Plant and Soil are One

Ray Archuleta

Brown's Ranch Cover Crops

Annual Ryegrass – CSG
Oats – CSG
Barley – CSG
Winter Triticale – CSG
Forage Winter Wheat - CSG
Rye - CSG

Canola – CSB
Radish – CSB
Turnip – CSB
Lentil – CSB
Sweet Clover – CSB
Phacelia – CSB
Sub Clover – CSB
Buckwheat – CSB
Kale – CSB
Flax - CSB
Crimson Clover - CSB
Berseem Clover - CSB
Persian Clover - CSB
Hairy Vetch - CSB
Winter Pea - CSB
Collards - CSB

Hybrid Pearl Millet – WSG
German Millet – WSG
Sorghum/Sudangrass – WSG
Brown Millet – WSG
Egyptian Wheat – WSG
Teff – WSG

Sugarbeet – WSB
Cowpea – WSB
Soybean – WSB
Sunn Hemp – WSB
Ethiopian Cabbage – WSB
Safflower – WSB
Fava Bean – WSB
Mung Bean – WSB

Cover Crops
Designing for your resource concern!

Resource Concerns:

CARBON

BIOLOGY

Provide crop diversity

Provide soil surface armor

Build soil aggregates

Improve the water cycle

Integrated Pest Management

Build soil organic matter

Nutrient cycling

Enhance pollinators

Adjust carbon/nitrogen ratios

Wildlife winter food & shelter

Livestock integration

Cover Crop Seed

Diversity!

- Sunflower
- Sorghum/Sudangras
- German Millet
- Soybean
- Cowpea
- Kale
- Radish
- Turnip
- Sunn Hemp
- Safflower
- Buckwheat
- Fava Bean

Persian Clover
Berseem Clover
Hairy Vetch
Hybrid Pearl Millet
Crimson Clover
White Millet
Oats
Flax

Optimizing Solar Energy Collection

Cover Crop 9/14

Roots: Build OM, and Cycle Nutrients

Photograph by Jim Richardson

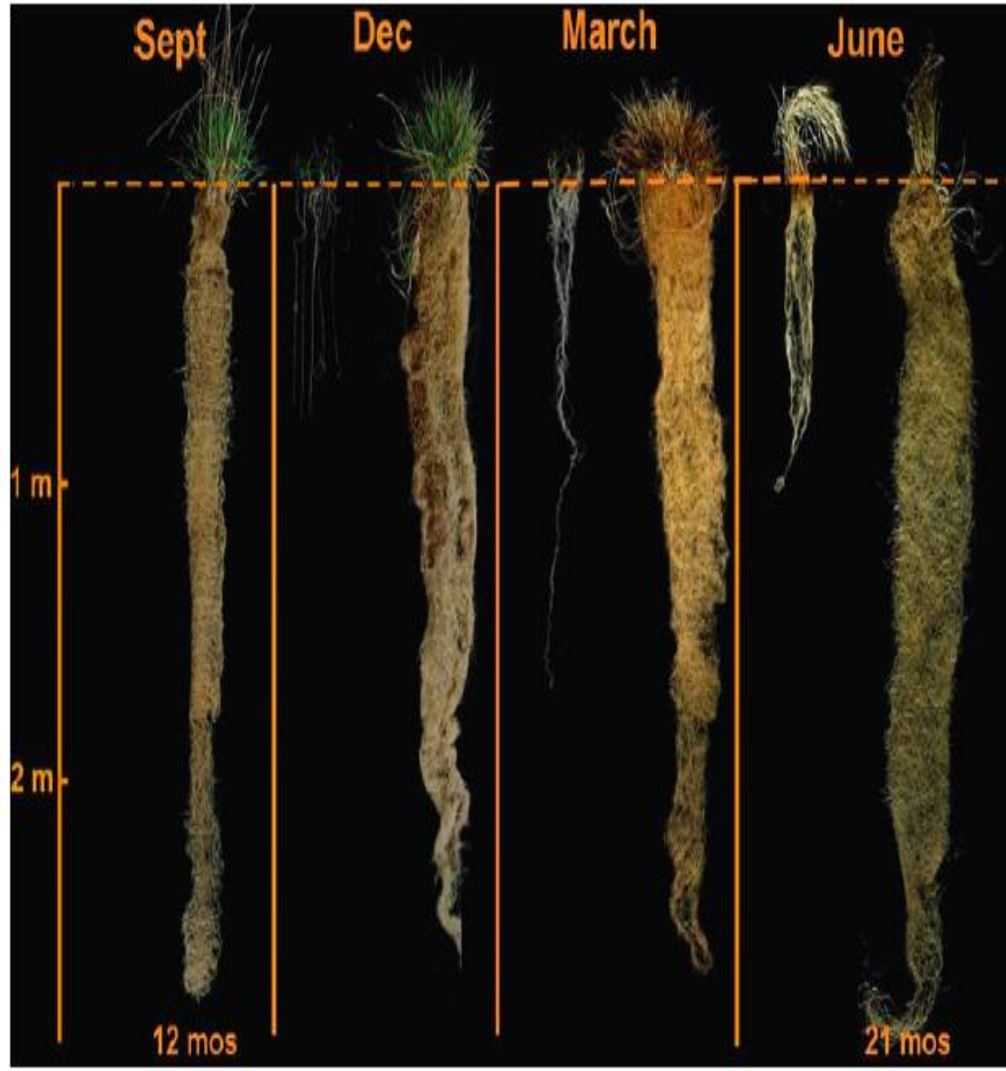
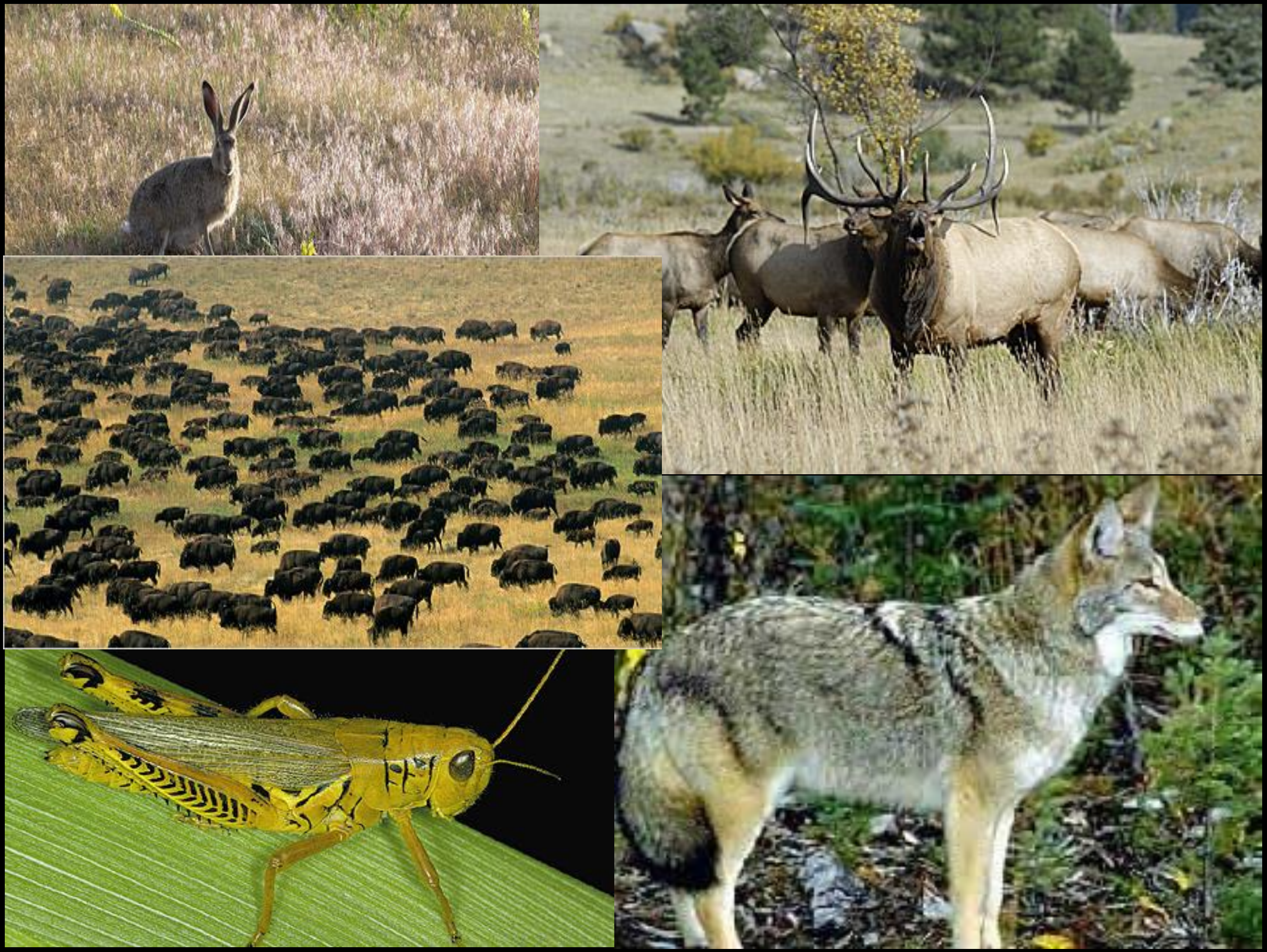


Figure 1. Root systems of annual wheat (on the left in each panel) and intermediate wheatgrass, a perennial, at four times of the year. Although roughly 25% to 40% of the wheatgrass root system dies off and must grow back each year, its longer growing season, and consequently greater access to resources, results in greater above- and belowground productivity than its annual counterpart.

5) Animal Impact



Fall Seeded Biennials

Adding a fall seeded bienniel into the rotation has many benefits, including providing the window of time to plant a diverse summer cover crop.

Rye

- One Rye plant can have 377 miles of roots!
- Along with 6,214 miles of root hairs!
- Total: 6,591 miles!

Option (Only in Emergency) – Haying

- For those of you with a feedlot, why would you not look at other types of haylage?

- Rye Monoculture: 9 tons/acre; 9%CP
- Rye/Vetch 14 tons/acre; 14%CP

Economics - 2006 Drought?

Combine

Option - Grazing


Hairy Vetch: 18% CP 70% TDN


Millet: 7% CP 50% TDN
Sorghum/Sudan: 12% CP 72% TDN


Radish: 14% CP 70% TDN

Allow Your Livestock To Do What They Do Best!

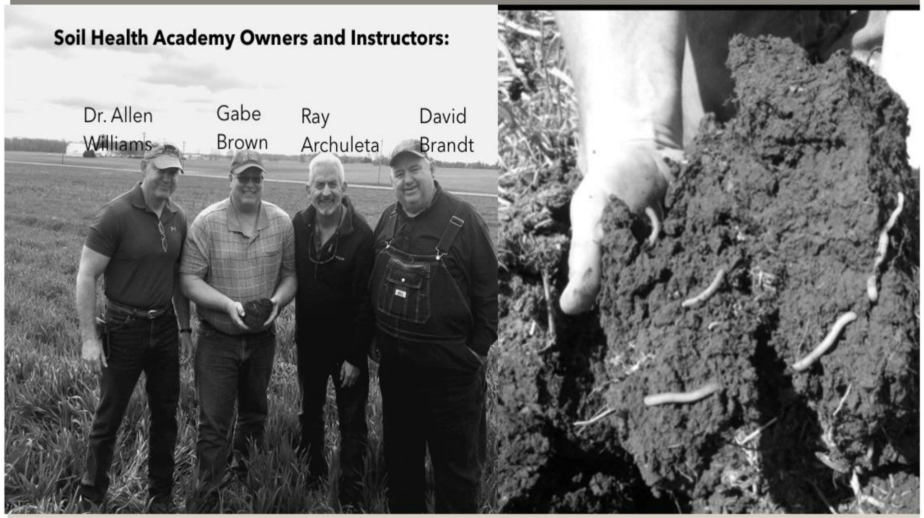
Converting Cover Crop to Dollars

- I used to wake up every morning trying to decide what I was going to kill that day; a weed, a pest, a fungus…
- Example: Seed Treatment

- Now I wake up every morning trying to decide how I can get more life on my ranch.
- It is much more fun (and profitable) working with LIFE than death!

- It’s not change that we are looking for, it’s understanding; through understanding, change will occur.

Soil Health Academy Course:
Regenerative Farming and Ranching



Location: Browns Regenerative Ranch in Bismarck, ND

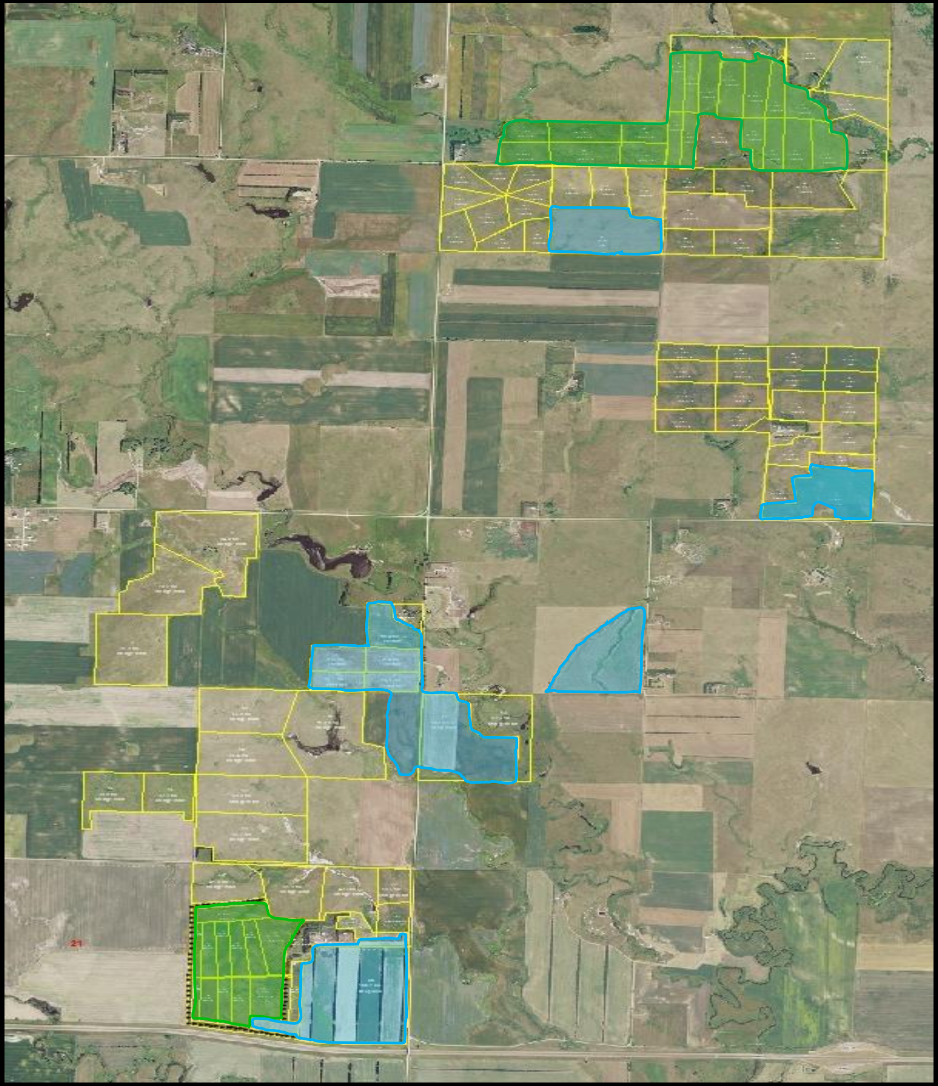
Purpose: Inspire, teach, and mentor future leaders on how to regenerate soils in farm and ranch ecosystems by mimicking intelligent design innate in natural systems- reducing dependency on man-centric programs, institutions, and costly chemical inputs.

Understanding Ag, LLC

Soil Health Academy. Org

Kathy Richburg, Operations Director:

kathy@understandingag.com


21

Stockpiled Forage

Stockpile Grazing in April

Stockpile Residue 3 Years Later

Today’s Model Misuses Carbon

Fertilizers Accelerate Carbon Release

Combining Removes Carbon (Obviously This Is Required)

Baling Hay Or Residue Removes Carbon

Tillage Releases Carbon