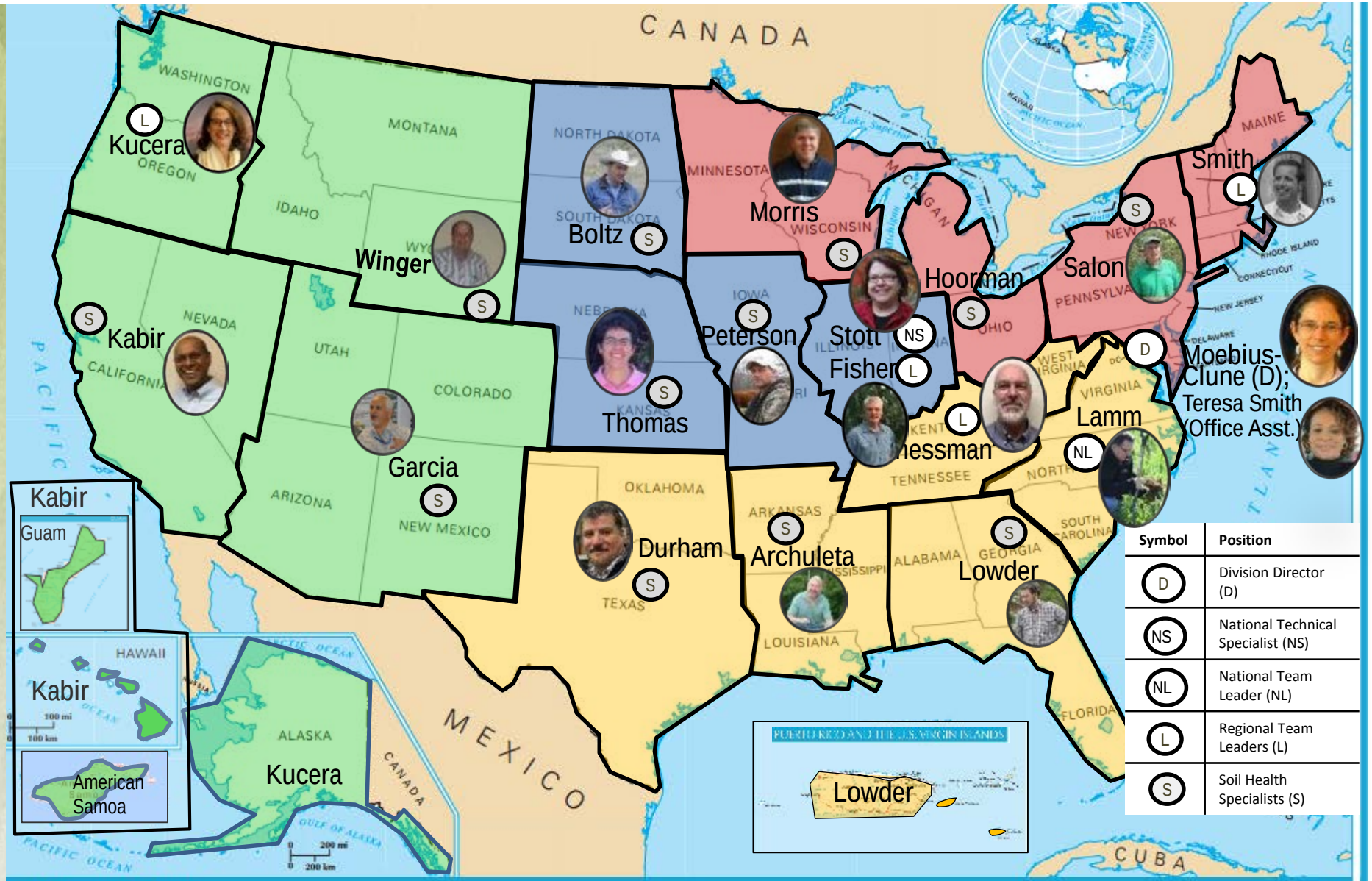
Soil Health Challenges of High Disturbance Crops

Principles of Soil Health and Their Application

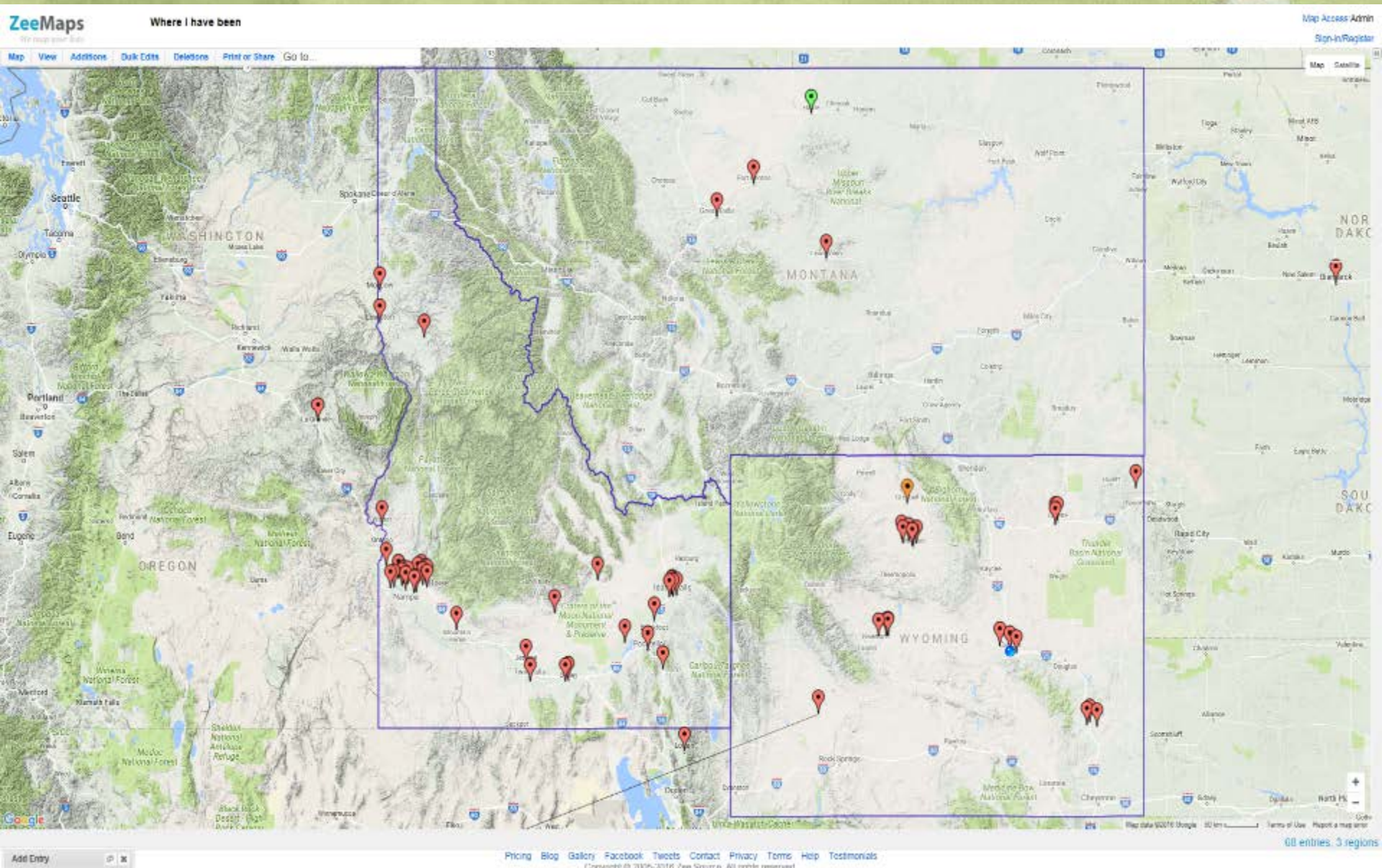
Marlon Winger
USDA-NRCS, Soil Health Division
MT, WY & ID

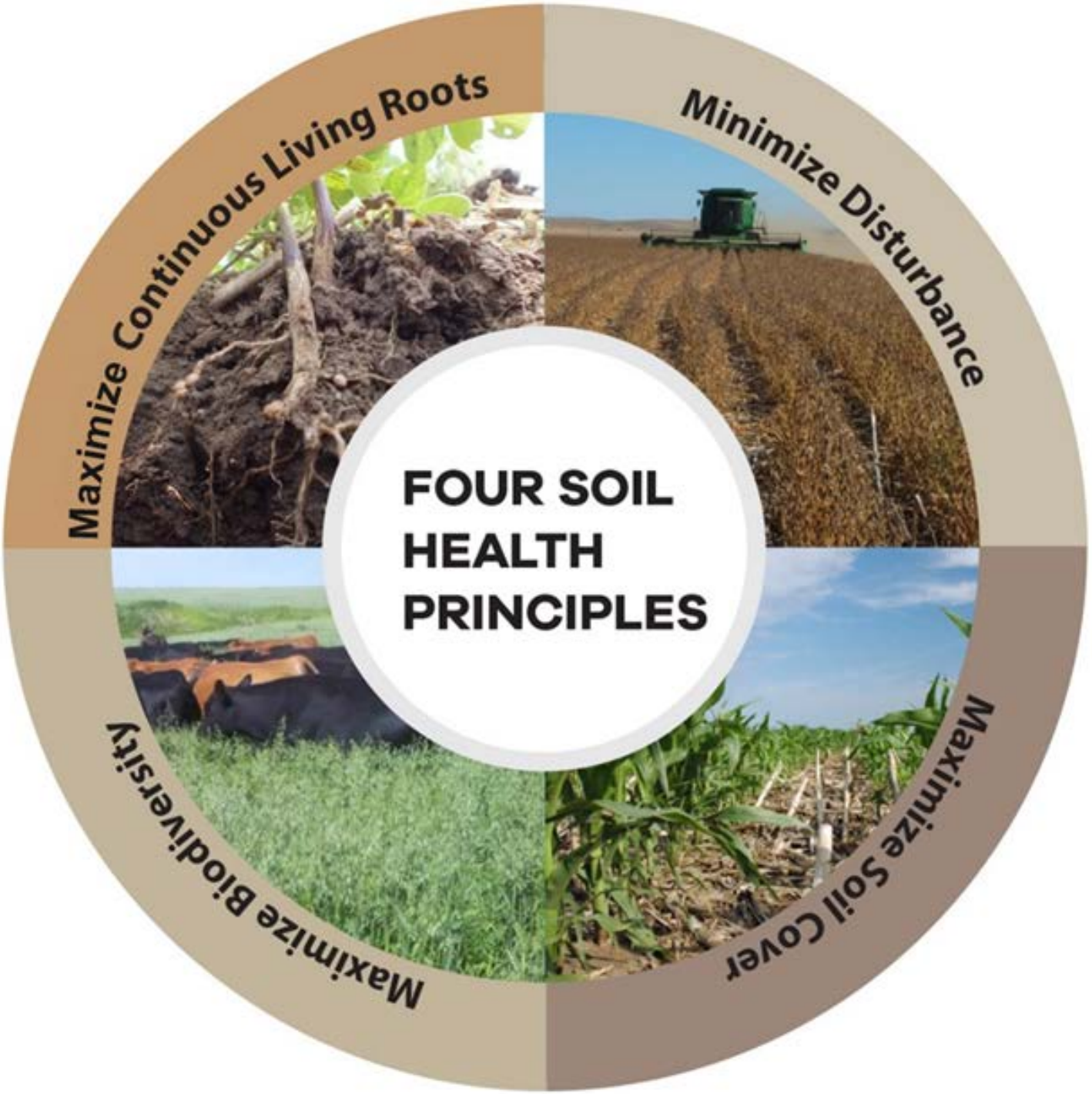
National USDA-NRCS Soil Health Division



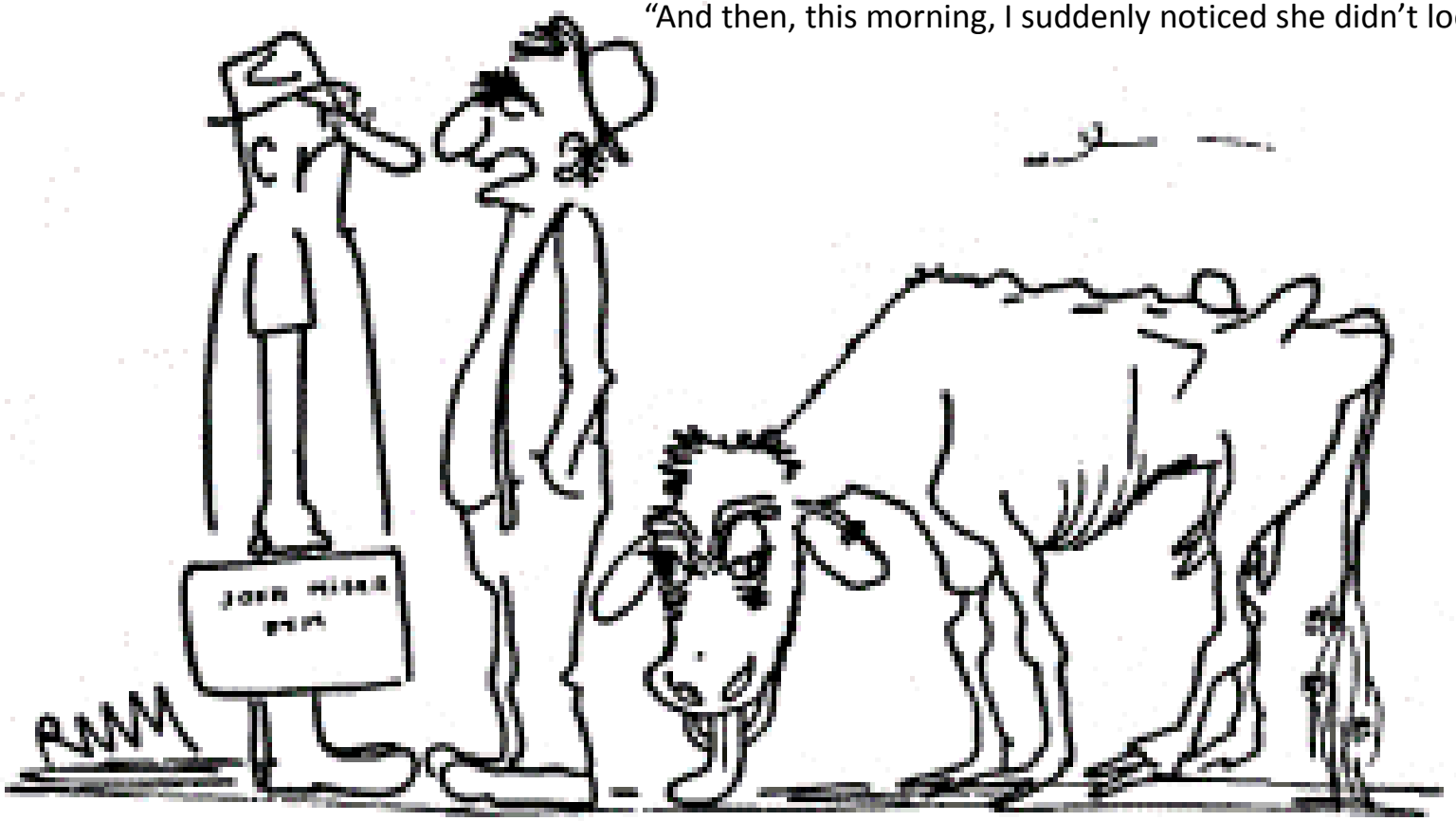
Contacts: http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/contact/conservation/st/#soil

Soil health taught 2015-16

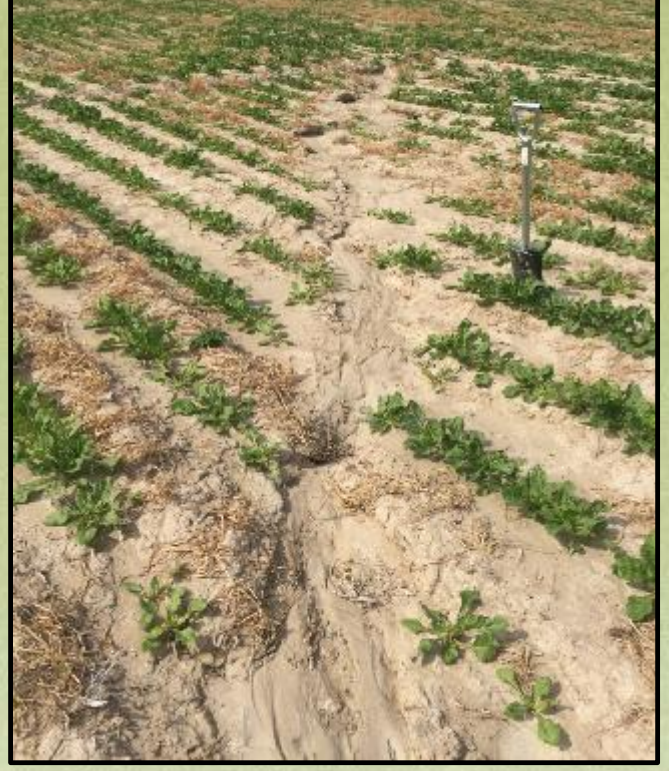



Maximize Continuous Living Roots
Minimize Disturbance
FOUR SOIL HEALTH PRINCIPLES
Maximize Biodiversity
Maximize Soil Cover

What is your resource concern?



“These fields are naked, hungry, thirsty and running a fever” (R. Archuleta)

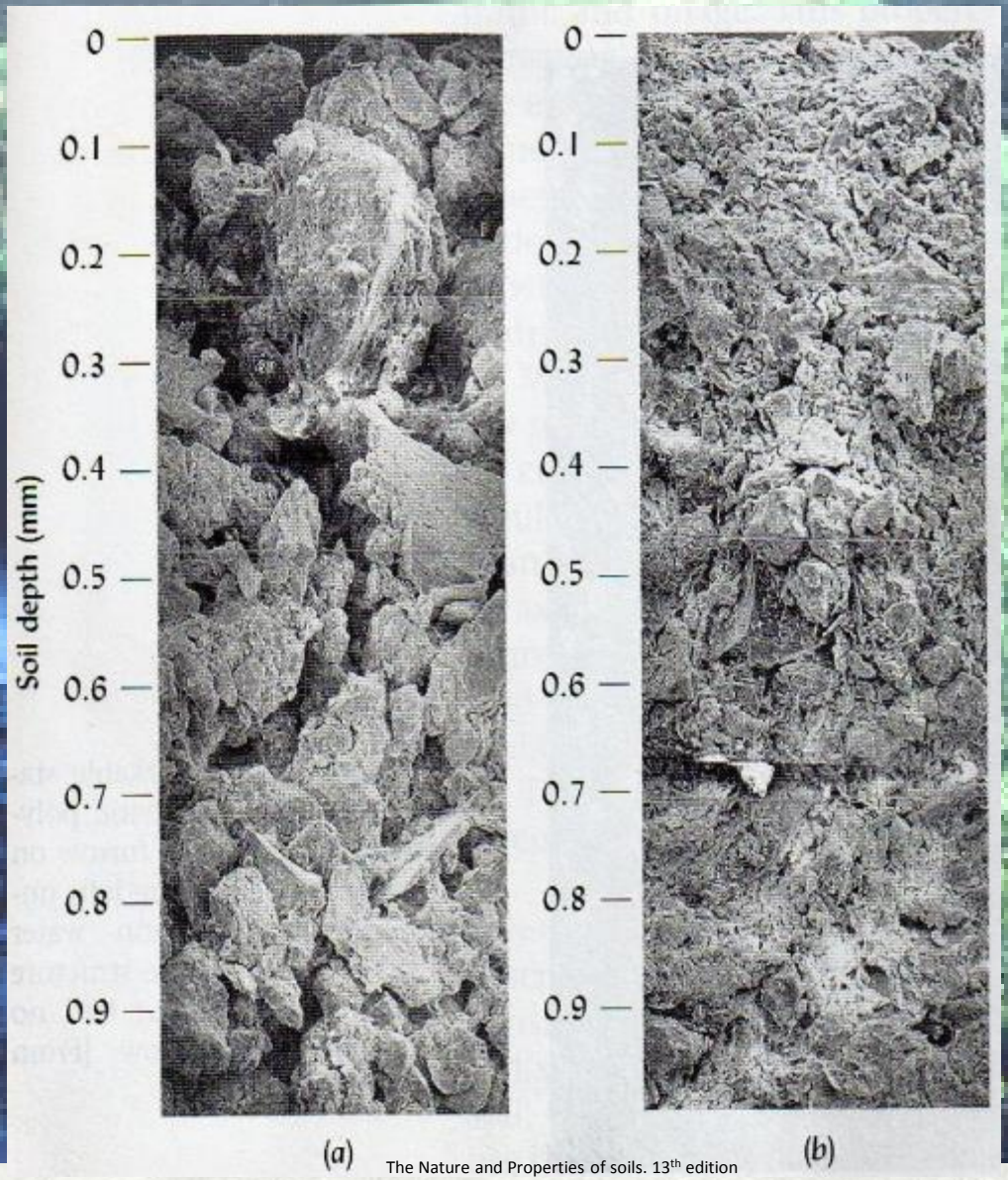



Logan, UT 2016


Blackfoot Id
5 wire fence


Aberdeen ID 2013

The Battle is Won or Lost Here

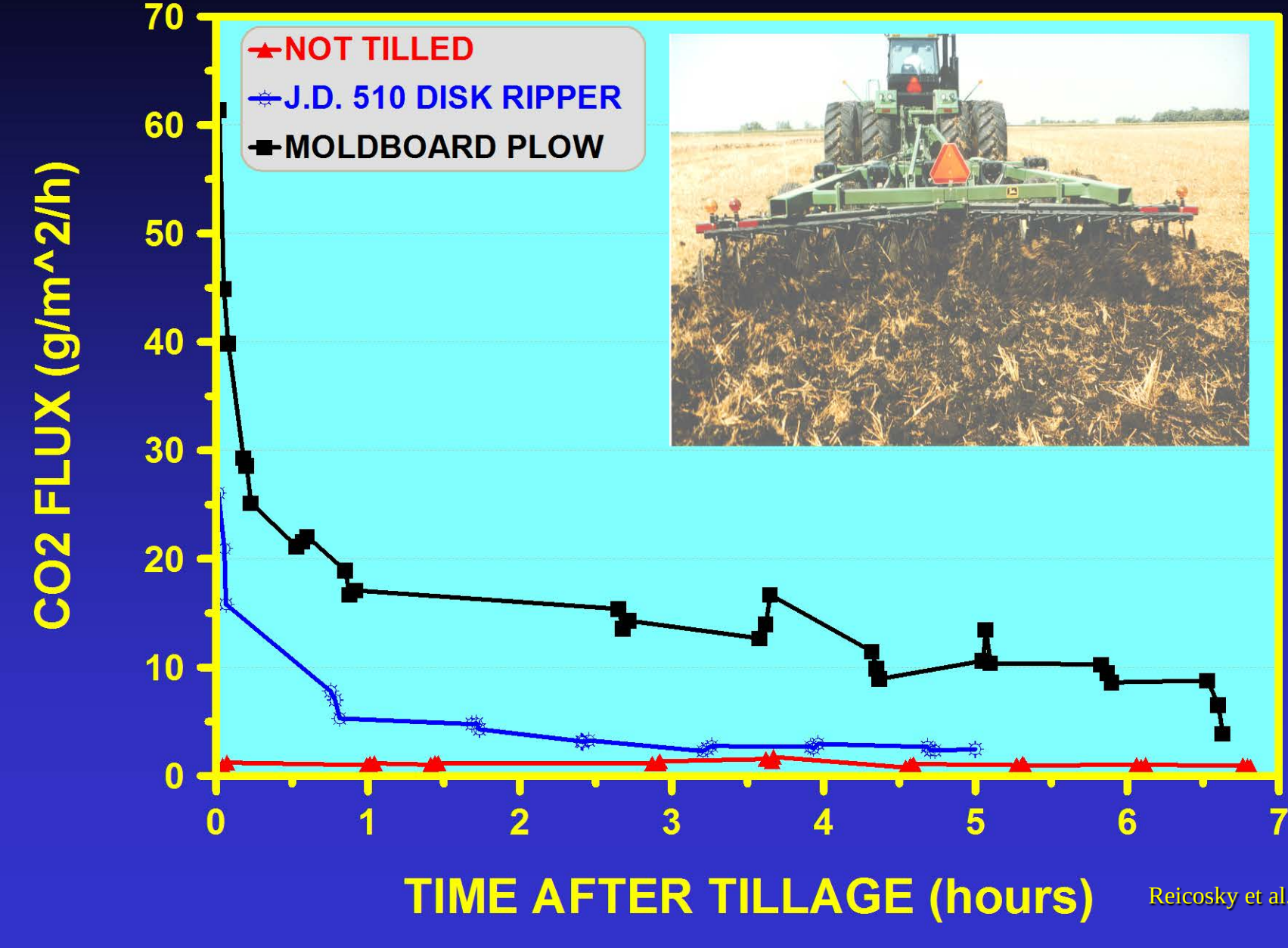


The Nature and Properties of soils. 13th edition

Photo: R. Archuleta

JOHN DEERE 510 DISK RIPPER CO2 FLUX DATA

SWAN LAKE TILLAGE DEMONSTRATION AUGUST 24,1994



Reicosky et al., 1995

Working with Producers / Employees to:

- Regenerate our soils
- Fundamental change
- Understand the carbon cycle
- Realize the potential of a soil health system
- Knowledge changes our paradigms
- Identify and fix the symptom or problem
- Implement soil health principles

1. Minimize Soil Disturbance

- Physical (tillage)
  - Water and wind erosion –transport soil, nutrient & water
  - Ponding water, reduced infiltration
  - Crusting, breakdown of aggregate
- Biological
  - Overgrazing, limits ability to implement the carbon cycle (CO_2 & sunlight)
- Chemical
  - Over application of nutrient and pesticide can disrupt the soil food web functions. (80 ppm P2O5 can't get in the plant)

Will it work in furrow irrigated ground?

(1,000 acres 2014)
(6,000 acres 2015)
in Boise, Idaho

No till, furrow irrigated w. wheat into grain corn residue, Walker Farms Weiser, ID 2015


Payette, ID 2014 no till wheat into corn silage residue flood irr

Strip Till: alfalfa for seed, seeded into WW cover crop, Nampa ID

6 way mix: wheat, turnip. radish, soybean, cowpea, sudan grass

Planted: July 25, 2012

Marsing, ID
Deruyter dairy

Oct 31, 2012


Photosynthesis 365


No Till winter wheat into alfalfa stubble
Drilled 10-1-15
Yield 156 bu/ac
McIntyre Farms, Caldwell Id

J. Parkinson, St. Anthony, ID

I've been doing the no-till for a couple of years now for wheat," Parkinson said. "I thought, 'Why wouldn't it work for potatoes?'" Parkinson, who farms on the Egin Bench between Rexurg and St. Anthony, has highly erodible sandy-loam soil. "Wind erosion is a big problem for us here. That's why I went into no-till," Parkinson said. Within a 35-acre quarter of a pivot, Parkinson cut his wheat short at harvest, leaving residue and a couple of inches of stubble. After harvest, using his no-till grain drill, he direct-seeded radish into the stubble as a cover crop, planted solely for soil-health benefits. By the next spring, the cover crop had broken down. (Capital Press, Feb 9, 2016)


No Till Potato, 2016 Bismarck, ND

Adoption of Residue Management in Owyhee County, Idaho

Owyhee District Idaho (2014-2016)

- " In 2014, 60% of all growers in the Owyhee District were using strip tillage on 3,411 acres (31% of all beet acres grown) with 36% of those acres strip tilled into established alfalfa.
- 2015, 90% of all growers in the Owyhee District were using strip till, no till or cover crops on at least part or all of their beet acreage.
- 2016, estimated all but one grower is using a combination of strip till, no till or growing cover crops on part or all of their sugar beet acres".
- Quote - Terry Cane, Senior Crop Consultant
  The Amalgamated Sugar Co. LLC

2. Maximize Soil Cover (Armored)

Karl Ritchie, Walther Farms, MI

- Soil armor
- Reduce soil erosion
- Take E out of ET
- Moderates temperature
- Water drop energy dissipated
- Reduced sunlight to weed seeds

Photo: K. Ritchie


Simplot: Dr. Terry Tindall
Arena Valley, ID
cover crop: winter wheat – following potato

If you can’t keep the soil covered then
consider reducing the length of unsheltered distance

Biofumigation

white mustard, oriental mustard, pacific gold

J, Raybould – St. Anthony, ID
Planted 9/7/2012
40 DAP = Oct 17

2014 St. Anthony

Strip Till Equipment

Soil and residue is undisturbed from harvest to planting except for a tilled strip of the crop row.

2011 sugar beet summer field day in Burley, ID
8 companies demonstrated strip till machines


Strip till Aberdeen, Id
2013

One pass vertical tillage / strip till beets into grain corn residue

Grandview, ID 2016


Strip till: Pinto beans into wheat stubble, Hazelton, ID

No till Sugar Beet

Rupert, ID 2017

Starts with learning how soil functions!

Idaho Falls, Id
Stripper header

Nearly perfect residue mgt.
Wind erosion ?
Capture your neighbors snow
Armor your fields

3. Maximize Diversity

- Native landscapes covered with abundant plant diversity
- Polyculture landscapes been replaced by monoculture annuals
- Rotations: high / low water use, tap /fibrous root, high / low carbon, legumes and non legumes
- Include 4 crop types back into rotations
  - WSG, WSB, CSG,CSB

Brendon Rockey, Potato producer: CO

Diversity ?

- Potatoes
- Peas
- Chickling Vetch
- Buckwheat
- Desi Chick Pea

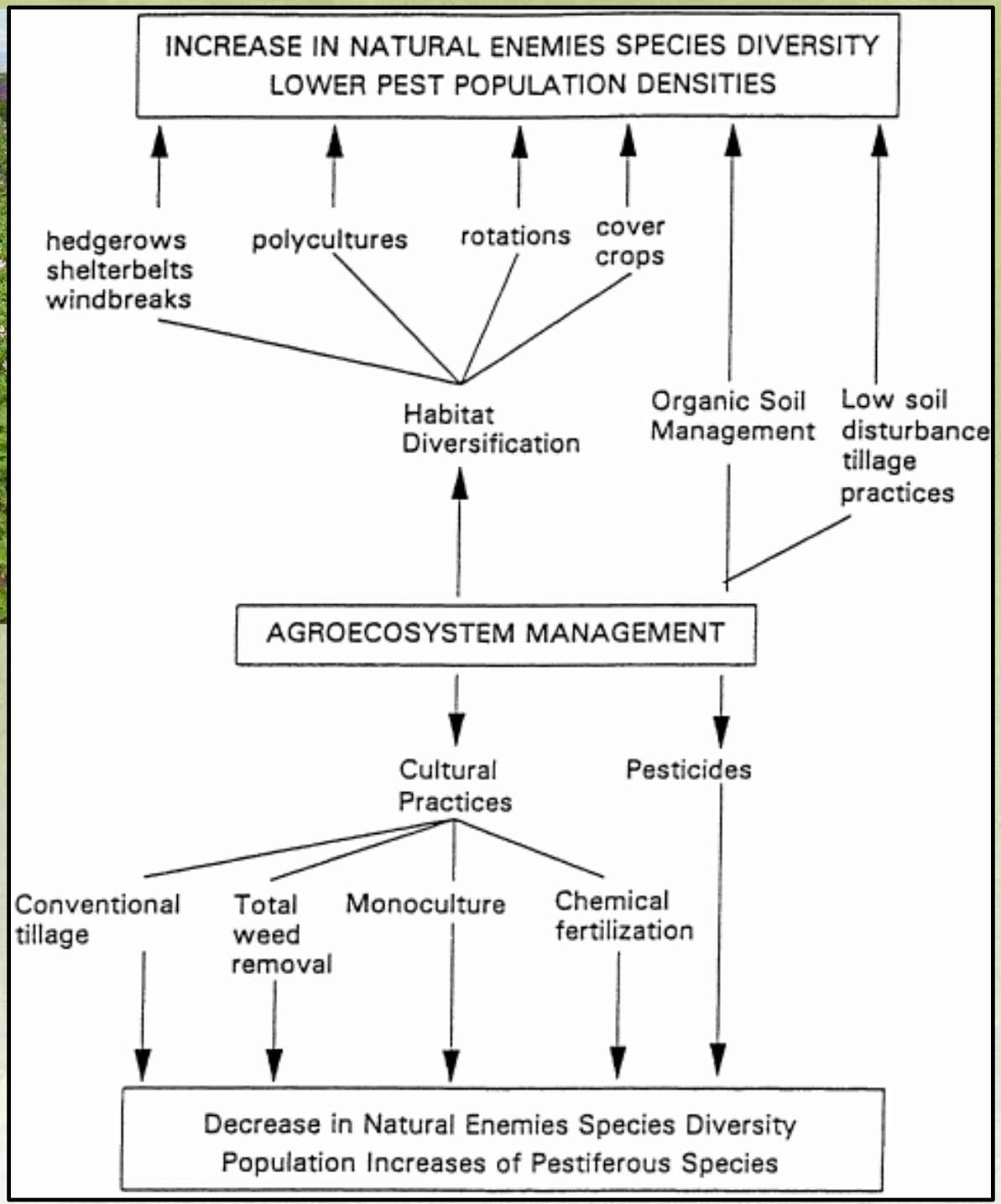
- Persian Clover
- Berseem Clover
- Crimson Clover
- Brown Mustard
- White Mustard
- Nitro Radish
- Phacaleia

- Wooly Pod Vetch
- Lentils
- Spring Forage Peas
- Buckwheat
- Flax
- Sunflower
- "Flower Mix"

- Chickling Vetch
- Desi Chick Pea
- Pearl Millet
- Brown Top Millet
- Buckwheat
- BMR Graze Corn
- Radish
- Broadleaf Mustard
- Impact Forage Collards

- Purple Top Turnip
- Peas
- Oats
- Lentils
- Flax
- Sunflower

Cover crop strip. Brendon Rockey, CO



Altieri M.A. The ecological role of biodiversity in agroecosystems. Agriculture, Ecosystems & Environment 74: 19-31

Derek Axten, Saskatchewan, Canada

7 broadleaf crops
wheat, barley, rye Crop Rotation

Intercrops we have grown:	***Benefits***
•Clearfield Canola/Yellow Peas:	Reduced N input/Reduced Harvest Loss
•Yellow Mustard/Maple Peas:	“”
•Yellow Mustard/Red Lentils:	“”
•Golden Flax/Desi Chickpea:	Reduced N&P input in Flax/No fungicide in Chicks

•All intercrops never receive fungicide


Working With Mother Nature
Improving Soil Health
EST. 1973
Axten Farms Ltd.

Beets strip tilled into Alfalfa residue

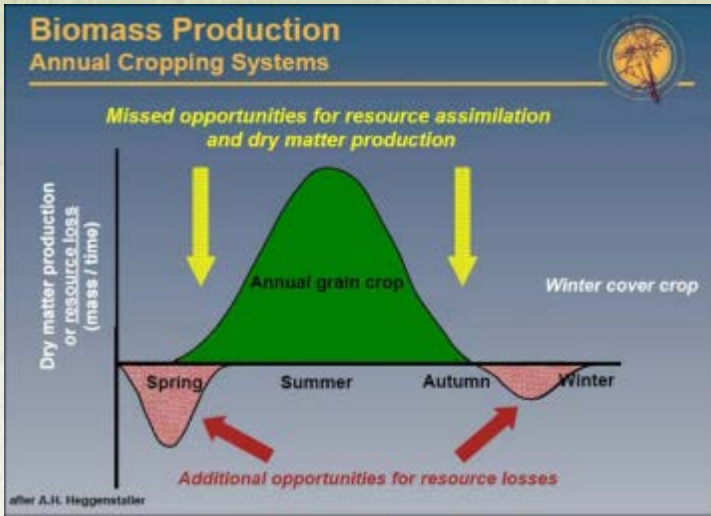
– Grandview, ID 2016

"Highest beet yields often follow alfalfa in rotation. When considering beets following alfalfa on flood irrigated ground make beds on 22" centers" Michael Cane

J. Clapperon "Every type of plant exudes substances from its roots that attract specific microorganisms. The more diverse the community, the more extensive will be its services".

4. Maximize Continuous Living Root

- Cropland typically grows cool or warm season cash crops, dormant periods before planting and /or after harvest.
- Cover crops: Harvest CO_2 provides C exudates
  - Builds aggregates – pore space – H_2O infiltration
  - Armor soil, soil erosion, soil temperature, rainfall compaction
  - Catch & release nutrients
  - Pollinator/ predator food /habitat
  - Crop diversity – adjusts C:N ratio



CCPI – St.Anthony field office: 1,000 acres of cover crops

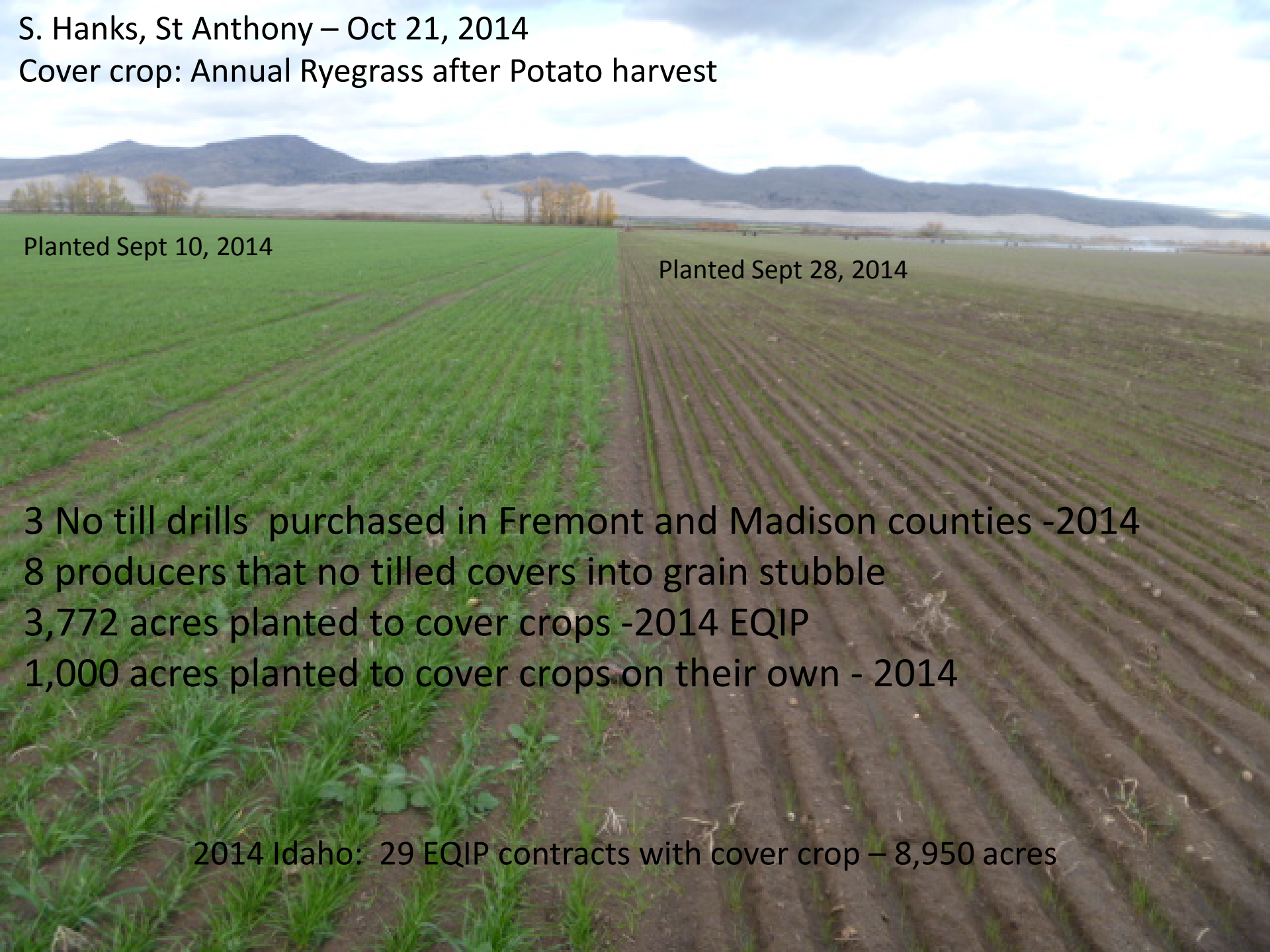
“If you do nothing you still have nothing”
Gabe Brown = 40 cover crops

Sid Hanks = 8 cover crops / 2 mixes

Crimson clover: St. Anthony , 150 lbs /A

A. Peas: St. Anthony 650 lbs /A

Some years you take what you can get! Maybe a biopore 12’ deep
Rexburg, ID 2013


S. Hanks, St Anthony – Oct 21, 2014
Cover crop: Annual Ryegrass after Potato harvest
Planted Sept 10, 2014
Planted Sept 28, 2014
3 No till drills purchased in Fremont and Madison counties -2014
8 producers that no tilled covers into grain stubble
3,772 acres planted to cover crops -2014 EQIP
1,000 acres planted to cover crops on their own - 2014
2014 Idaho: 29 EQIP contracts with cover crop – 8,950 acres

Arugula / Turnip
Planted after potato harvest

S. Hanks, Idaho: Turnip/ Pea


Hanks, St. Anthony, ID 2013

Simplot: (Boise, ID)
Cover crop planted after potato harvest in fall and terminated before sugar beets are planted in spring

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service
Idaho

Cover Crop Periodic Table

unlock the SECRETS in the SOIL

Cool Season Plants						Warm Season Plants		
Grass							Grass	
Barley	Broadleaf Plants							Pearl Millet (wk)
Oat (wk)	Arugula						Safflower (wk)	Foxtail Millet (wk)
Ryegrass	Flax (wk)		Legumes				Buckwheat (wk)	Proso Millet (wk)
Wheat	Rape	Turnip	Winter Field Pea	Chickling vetch (wk)	Medic	Chickpea (wk)	Sunflower (wk)	Sudan grass (wk)
Cereal rye	Phacelia	Radish (wk)	Lentil	Red clover	Ladino clover	Cowpea (wk)	Amaranth (wk)	Teff (wk)
Triticale	Canola / Mustards	Beet	Spring Pea (wk)	Crimson clover	Bean (wk)	Soybean (wk)	Chicory	Grain Sorghum (wk)
Forage Oat	Ethiopian Cabbage	African Cabbage (wk)	Vetch	Sweet clover	Alfalfa	Sun Hemp (wk)	Flower mix	Corn (wk)

(wk) = winter killed

Dr. Leibrig, USDA-ARS

Cool Season Early Cover crop	Seed rate PLS/A
Barely	8
Oat	8
Lentil or Vetch	2
Pea	15
Clover, Crimson	1
Radish	1
Canola or Rape	1
Turnip	1
Total	37 Lbs / ac

Warm Season cover Crop	Seeding rate PLS/ac
Pearl Millet	3
Sudangrass	4
Buckwheat	3
Safflower	2
Radish	1
Oat	7
Turnip	1
Canola	1
Spring Lentil	2
Pea	15
Crimson Clover	1
Total	40 lbs /ac

2nd most important biological process?
Nitrogen fixation

What is the most important biological process?

Livestock Integration

- Animals, plants and soils - synergistic roles together
- Recent years animals placed in confinement
- Balance C:N ratios, convert high C to lower C:N ratio
- Harvest additional sunlight and CO_2
- Reduce nutrient export:
  - feed to feedlot vs cattle to the feed
- Manage weed pressure, grazing in lieu of herbicide
- Higher nutritional diets
- Reduce livestock waste

McIntyre Farms: 2013

Caldwell, ID

Cover crop mix: Radish, Turnip, Sudangrass, Millet, Buckwheat, Oats, Soybean, Rape, vol wheat

Planted: 8/10/2013

Grazed beginning on 10-17-13,

End grazed: Dec 17, 2013; grazed for 61 days

No till drilled cover crop mix into winter wheat stubble

Clipped 13,684 lbs DM/ ac

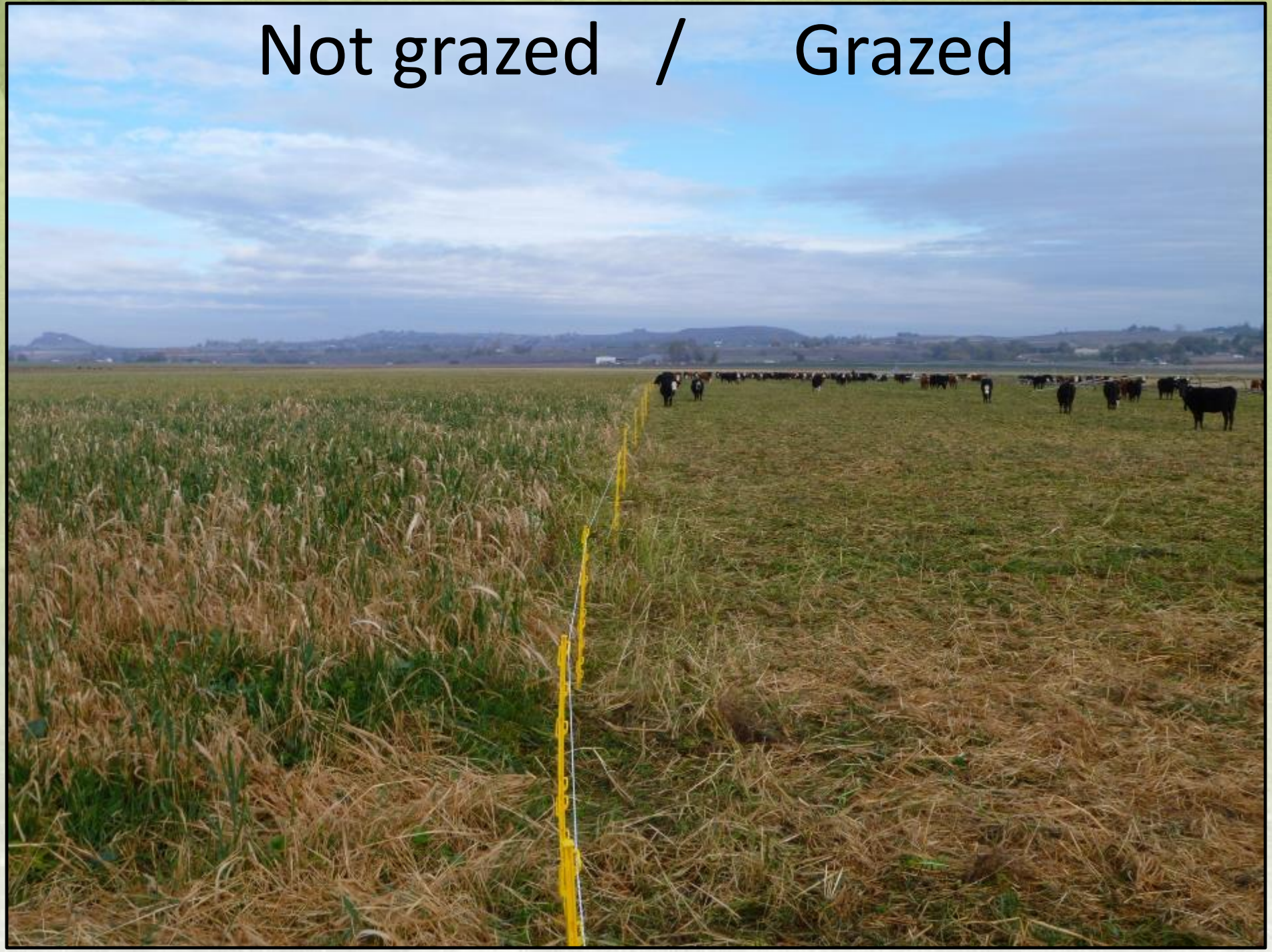
23.1 % DM

Great Plains Drill

Days After Planting 81

300 head of wild mother cows on 3 acres per day
Stock density: ~106,000 lbs / acre
Previous crop: winter wheat
Planned crop in spring 2014 grain corn

Not grazed / Grazed




Setting up single polywire fence, perimeter
two strand polywire

72% forage utilization
300 cows on 3 acres per day

April 29, 2014 evaluating soil of the cover crop field:

165 worms per cubic foot. 2.4 million worms per acre.

Worms underneath decomposing cow pie.

Soil Health Comparison

Positive

- Improved Organic matter
  - Water holding capacity
- Increased diversity of rotation
- Took the E out of ET (D. Beck)
- Take the T out of Can't (D. Beck)
- Nutrient cycling
  - Improved biology
- No Erosion - Building Soil (restorative system)
- Following the soil health principals

Negative

- Sometime your feelings will get hurt!

McIntyre – increasing diversity of livestock
-Pasture sanitation

McIntyre Farms, Caldwell, ID
Measuring Soil Health – Haney Test

2014						2016					
Field	1-day CO2-C	Organic C	Organic N	Organic C:N	Soil Health Calculation	Field	1-day CO2-C	Organic C	Organic N	Organic C:N	Soil Health Calculation
70 ac pivot 0702c	18.5	202.7	17.0	11.9	5.6	70 ac pivot	72.4	254.3	26.8	9.5	12.5
6 ac 0703c	11.6	215.0	17.8	12.0	5.1	6 ac	60.1	248.5	32.0	7.8	11.7

Gaining Knowledge and Humility!

McIntyre brothers and Ray Archuleta

White worm casts on brown top soil

No till w. wheat into Alfalfa stubble

Managing for Soil Health

- Minimize disturbance of the soil (mechanical, biological, chemical)
- Keep the soil Armored at all times with plants and plant residues
- Maximize diversity of plants in rotation
- Keep living roots in the soil as much as possible

- *Create the most favorable habitat possible for the soil food web*

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Marlon earned a MS and BS degree at Utah State University in Plant Science. He grew up on a family owned dairy farm in Dayton, Idaho, where he found is passion for life (Agriculture). Worked as a County Agricultural Agent for Utah State University Extension service for 9 years in Price, Utah. Has been working for the USDA - Natural Resource Conservation Service (NRCS) for about 12 years, as Area agronomist in Northern Utah and State Agronomist in Idaho, currently works as the Regional Soil Health Specialist for MT, WY, and Idaho. Marlon and his family lives on a ranchette in Casper, WY where the family raises, pasture, sheep, hogs, chickens a few calves and a large garden.