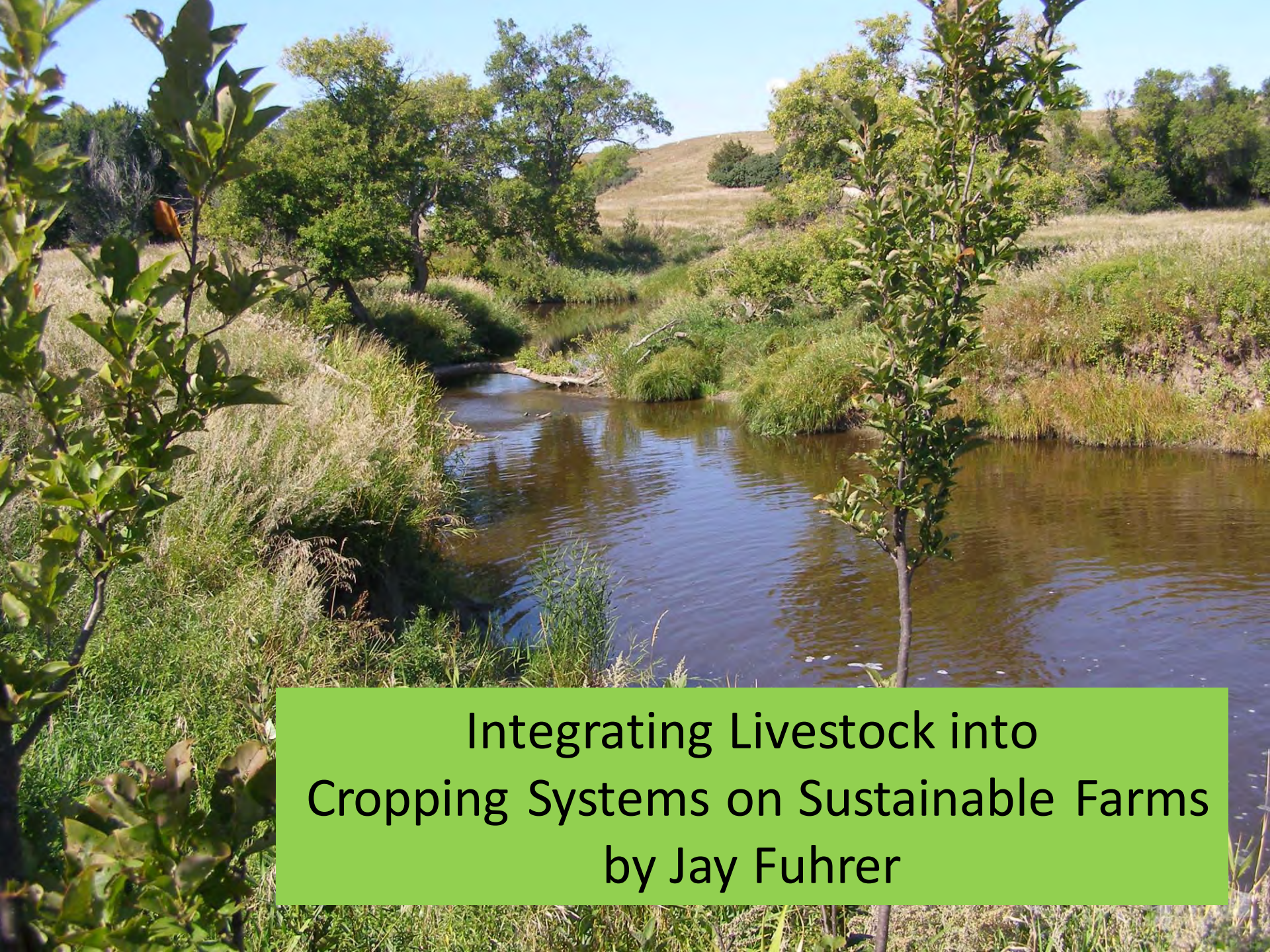
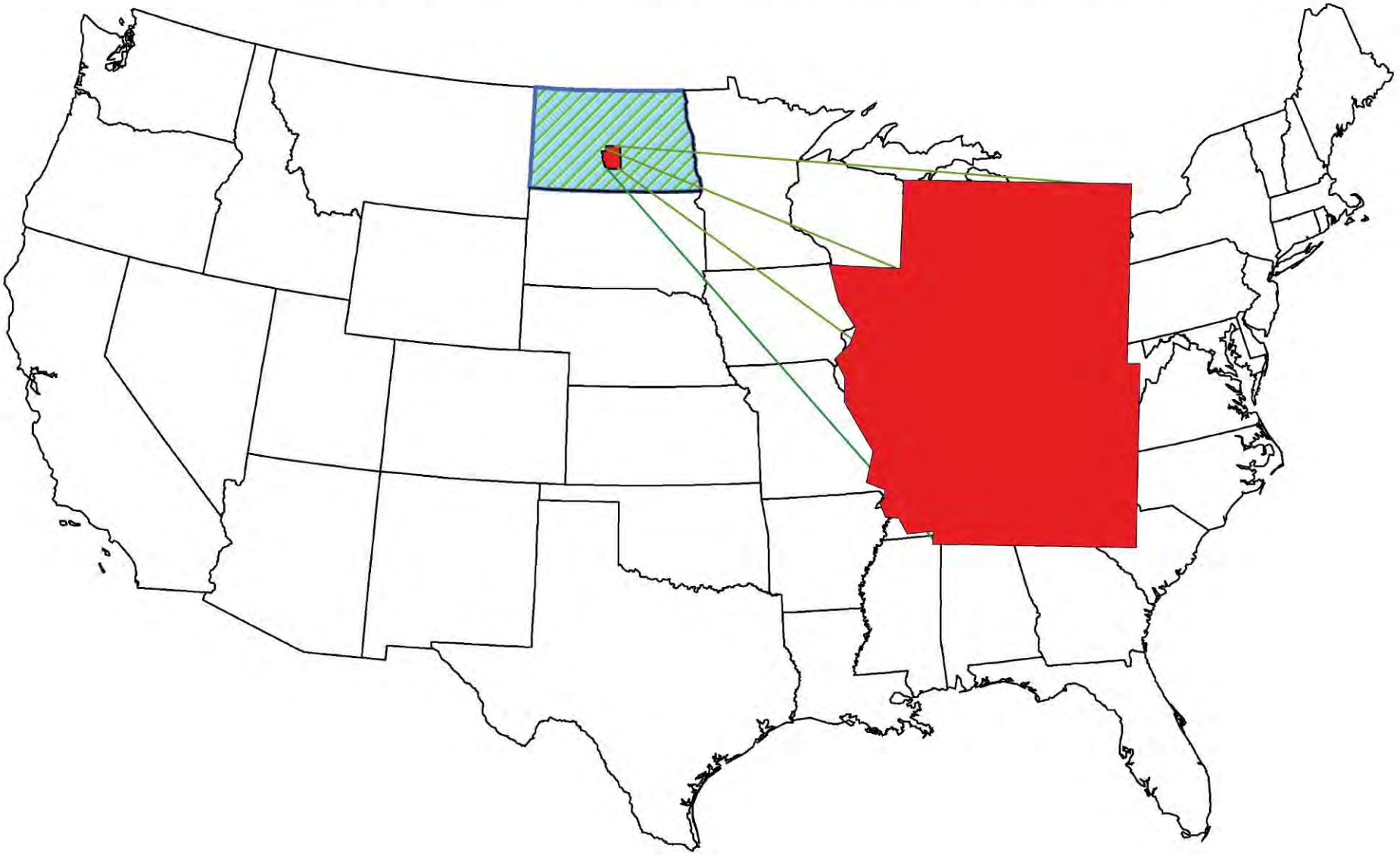


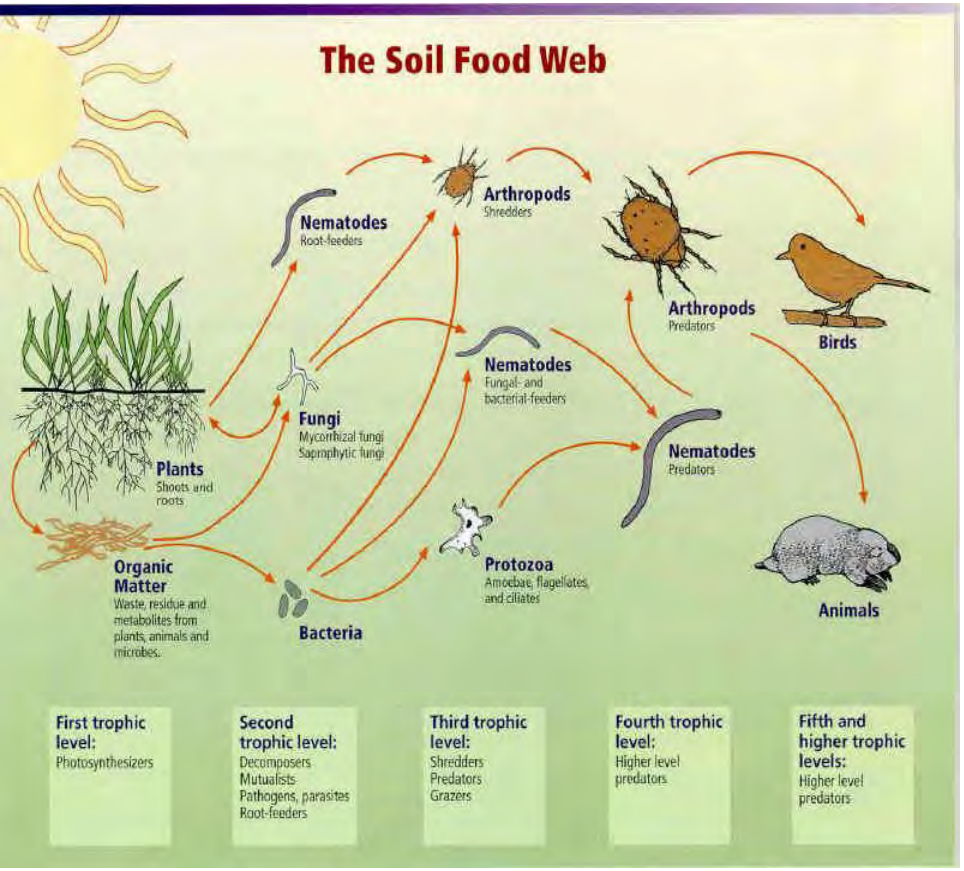
Integrating Livestock into Cropping Systems on Sustainable Farms

by Jay Fuhrer

Burleigh County, North Dakota



The Soil Food Web
Working Toward A Higher Quality No-till
The "Below Ground" Players…



- **Bacteria**-

  Decomposer of simple carbon chains (low carbon residue).

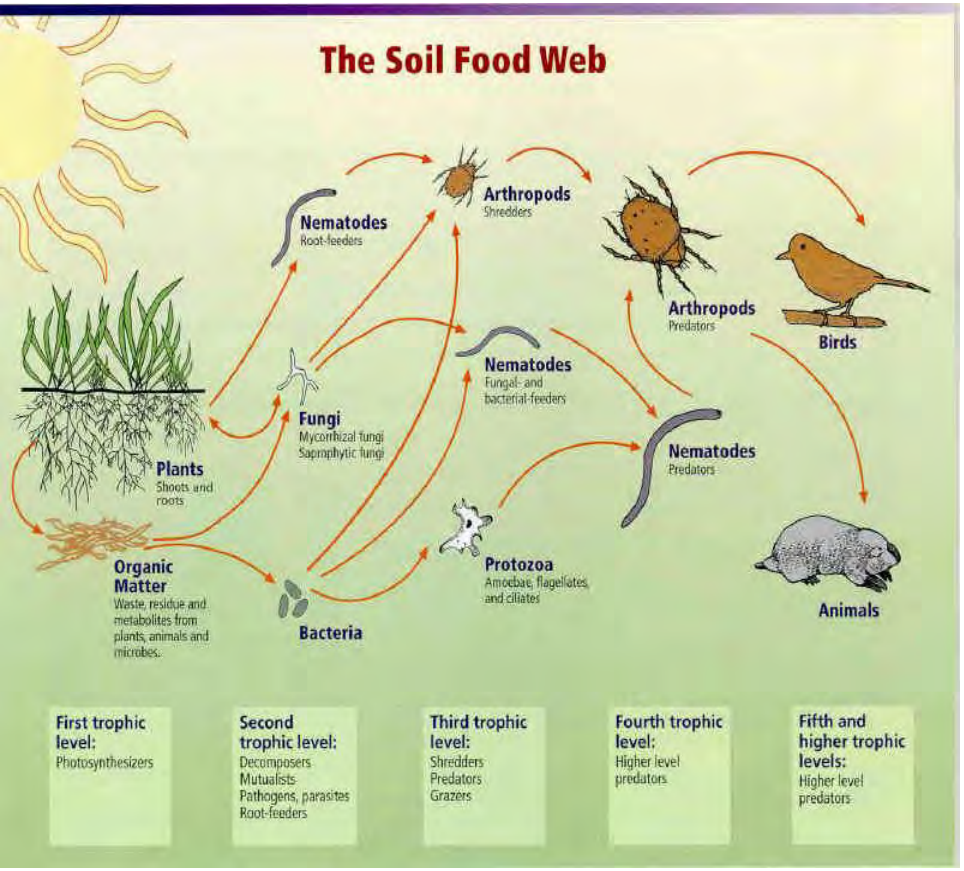
  Little bag of fertilizer.

  One bacterium can produce 5 billion offspring in 12 hours (food available).

  Feed on root exudates.

Soil Biology Primer

The Soil Food Web
Working Toward A Higher Quality No-till
The "Below Ground" Players…



- **Fungi**-

  Saprophytic-primary decomposer of complex

  carbon chains (high carbon chains).

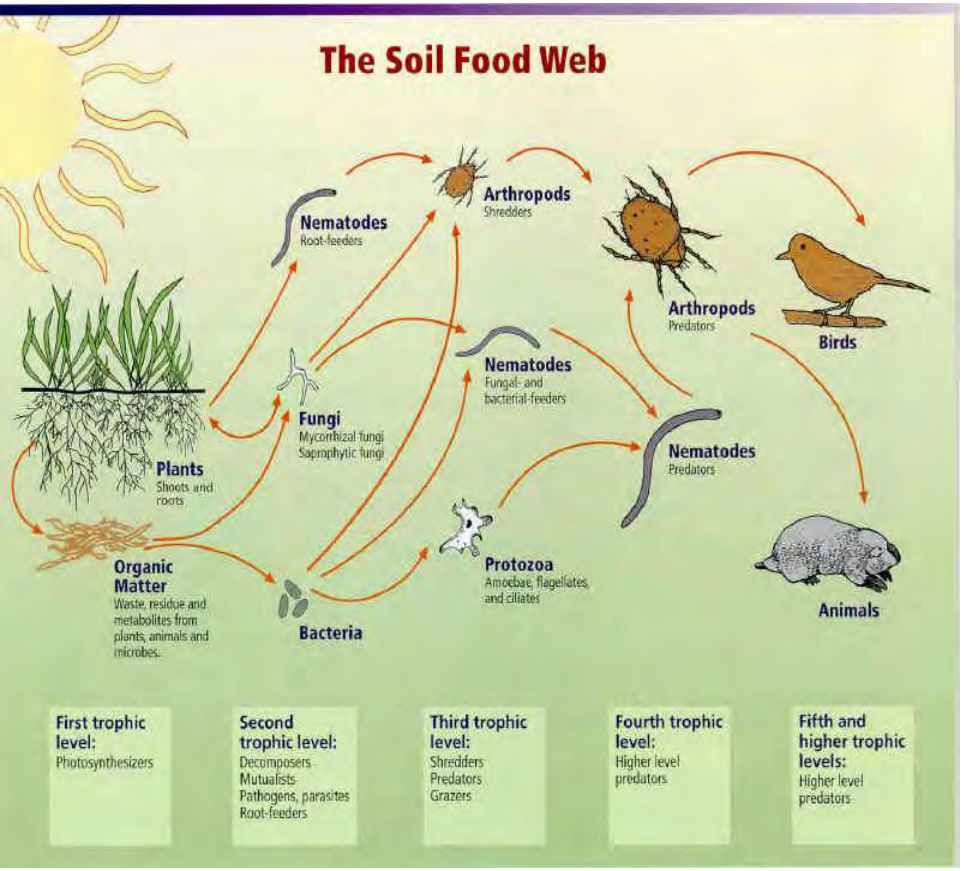
  Mycorrhizal-transports nutrients.

  Little bag of fertilizer.

  Forms the soils glue (glomalin) along with the plant roots exudates.

Soil Biology Primer

The Soil Food Web
Working Toward A Higher Quality No-till
The "Below Ground" Players…



- **Protozoa**-

  Mineralize nutrients by eating the little guys (fungi and bacteria).

  Consumes an average of 10,000 bacteria per day.

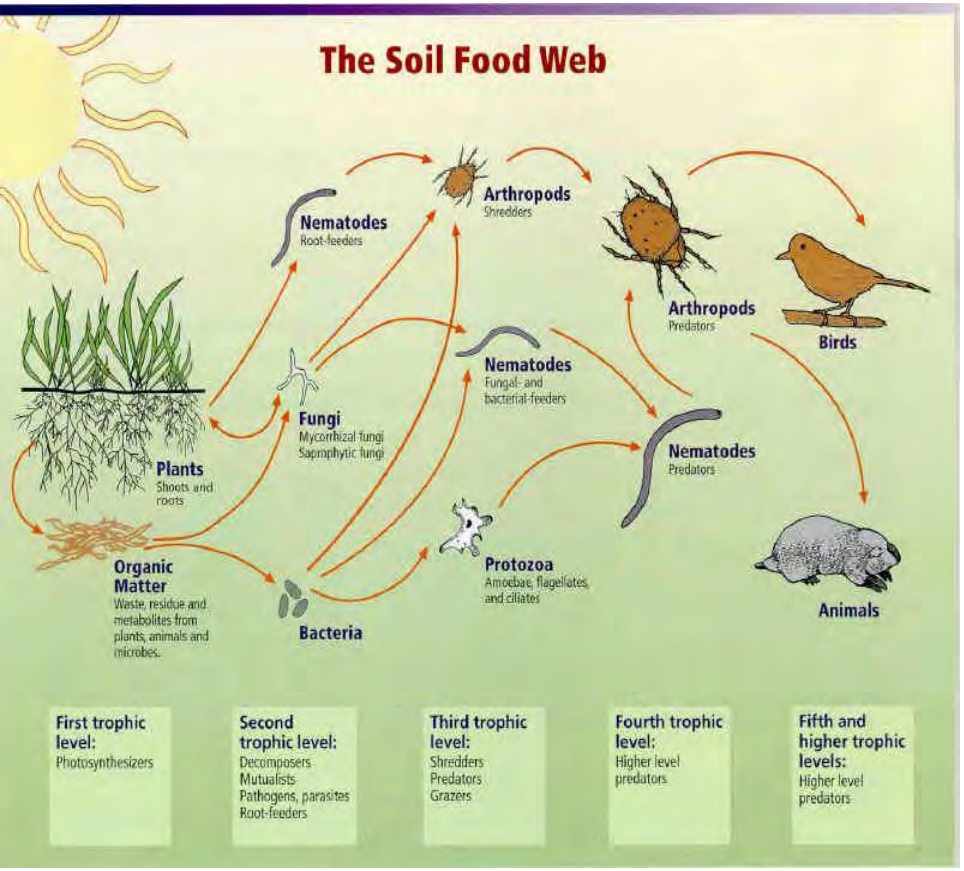
  Amoebae – large

  Ciliates – medium

  Flagellates - small

Soil Biology Primer

The Soil Food Web
Working Toward A Higher Quality No-till
The "Below Ground" Players…



- **Nematodes**-

  Mineralize nutrients by eating the little guys (fungi and bacteria).

  Taxi for the bacteria & fungi.

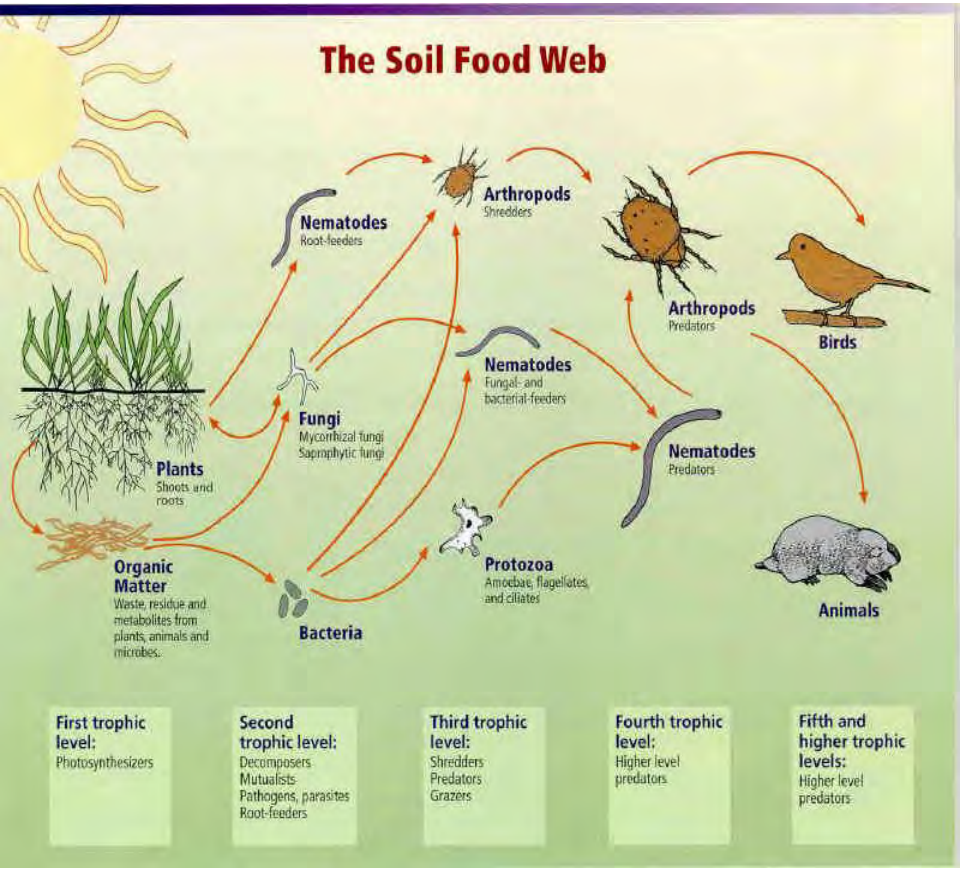
  Locate food by temperature.

  Types: Herbivore, Bacterivores, Fungivores, and Predator.

  Large in size, compacted soil restricts their travel.

Soil Biology Primer

The Soil Food Web
Working Toward A Higher Quality No-till
The "Below Ground" Players…



- **Actinomycetes-**

  Source of antibiotics: tetracycline, neomycin, streptomycin.

  Controls bacteria in the soil and in humans.

  Convert dinitrogen gas to ammonia.

  Decompose SOM.

  Cure compost.

Soil Biology Primer

What Do They Weigh?

- Bacteria — 2,000 - 2,500 Lbs/Ac
  2,200 - 2800 Kilograms/Hectare
- Fungi — 1,000 - 15,000 Lbs/Ac
  1,200 – 17,000 Kilograms/Hectare
- Protozoa — 20 - 300 Lbs/Ac
- Nematodes — 10 - 300 Lbs/Ac
  13 – 340 Kilograms/Hectare
- Microbes in Humans — 3 lbs/Person

Source:

- The Nature and Properties of Soils
  Brady and Weil, Fourteenth Edition.
  Soil Biology Primer.
  National Geographic, Nathan Wolfe, January 2013.

Soil Biology – Plant Interaction

The Menoken Farm

Crop Diversity

Nurture Nature with System Synergies

No Tillage

Minimum carbon loss

Cover Crops

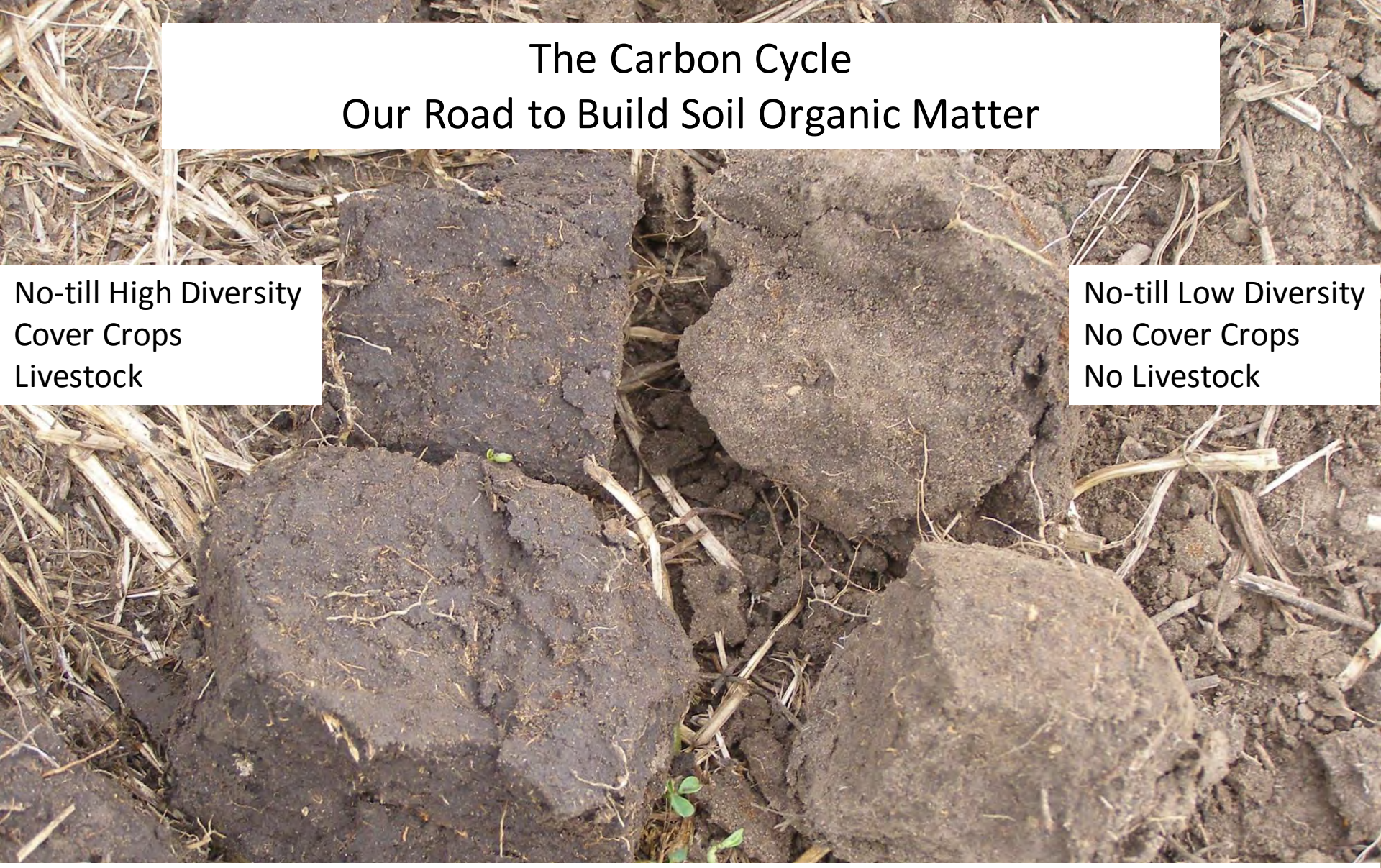
Maximum carbon input

Carbon management

Sustainability

Dr. Don Reicosky

The Carbon Cycle
Our Road to Build Soil Organic Matter



No-till High Diversity
Cover Crops
Livestock

No-till Low Diversity
No Cover Crops
No Livestock

Twice as much C is stored in the soil than in
the world's vegetation and atmosphere combined

The Menoken Farm

The Carbon Cycle
Our Road to Build Soil Organic Matter

Plants take in CO_2 through the stomata:

- The oxygen portion is returned through the stomata.
- Part of the carbon portion is used to grow the plant.
- Part of the carbon is used as root exudates to attract biology.

The Menoken Farm

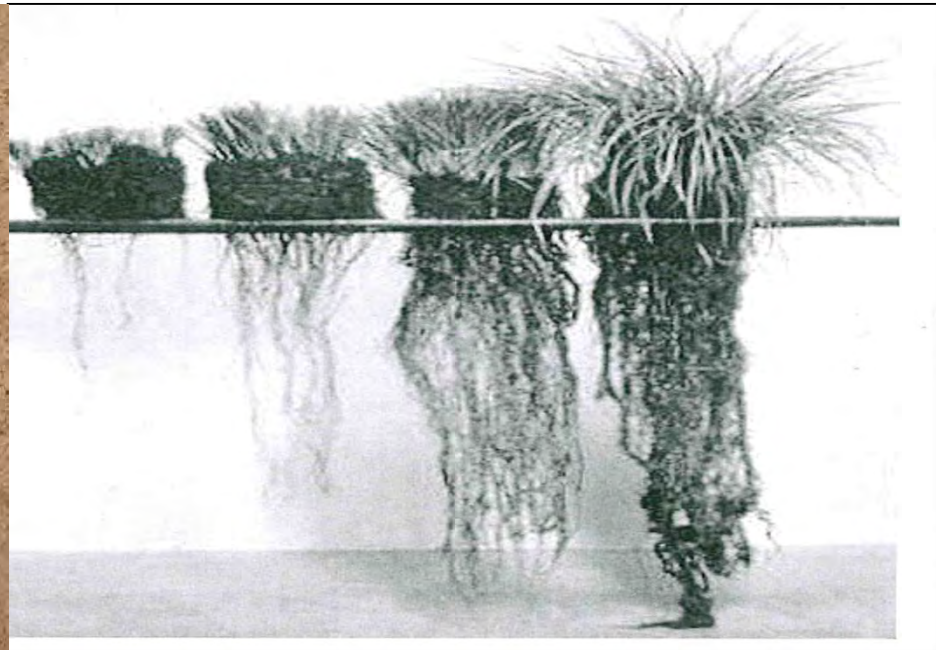
The Carbon Cycle
Our Road to Build Soil Organic Matter

The soil releases CO2 back into the atmosphere, primarily from the Soil Food Web respiration. Prior to civilization; the C entering and leaving the soil was in balance.

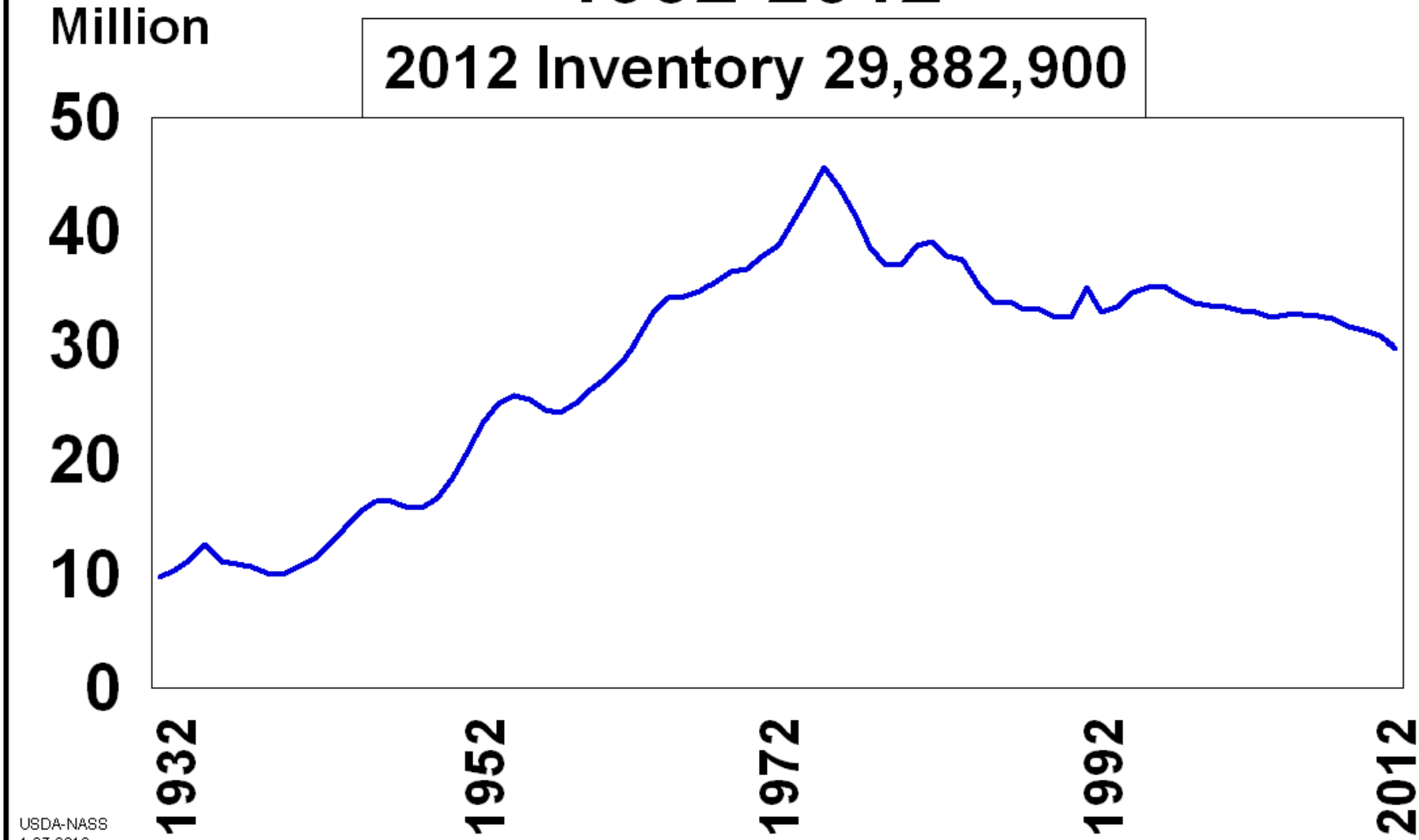
The Menoken Farm

The Carbon Cycle
Our Road to Build Soil Organic Matter

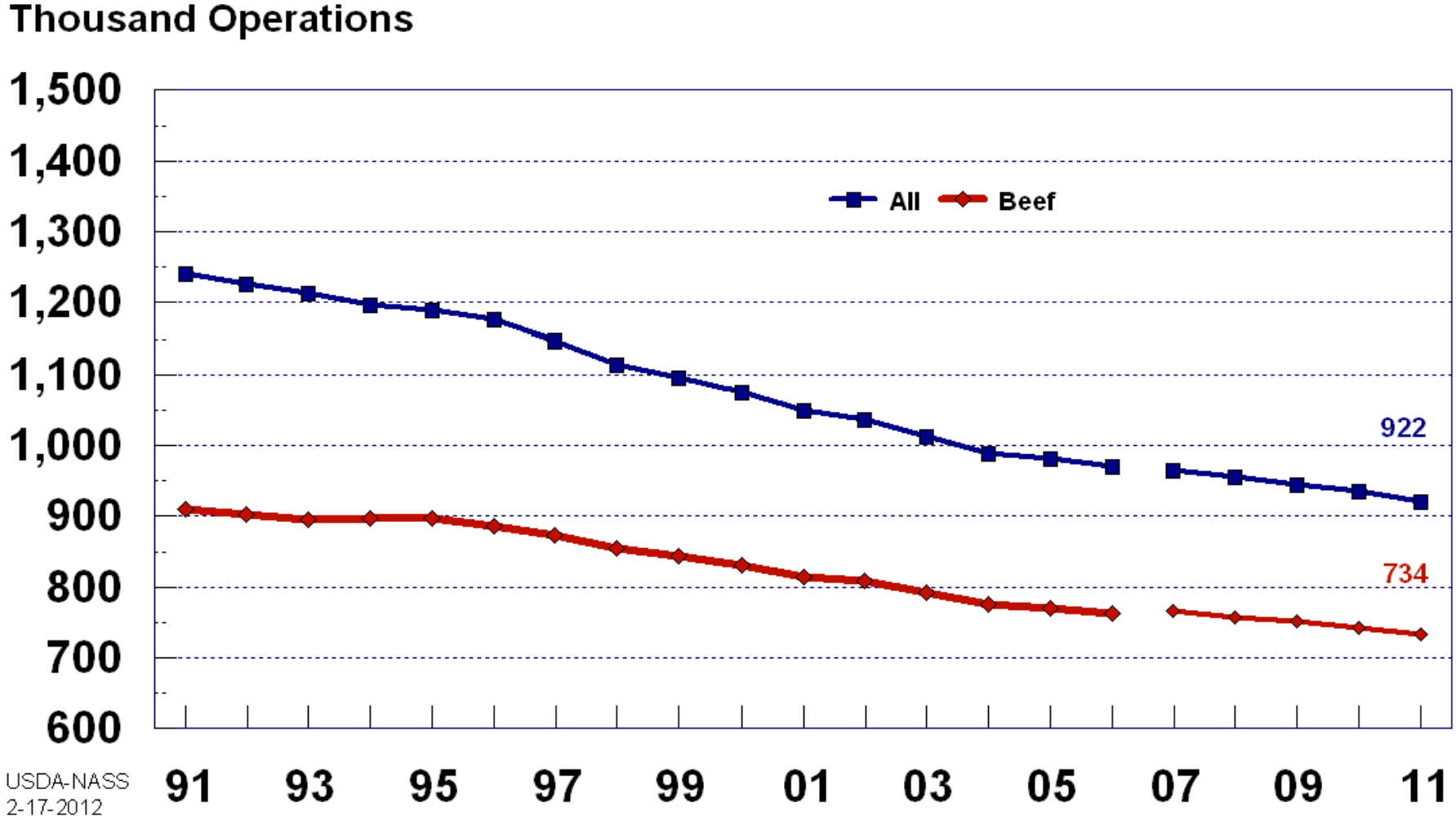
CO_2 loss from the soil is accelerated by tillage on cropland; and the intake is restricted due to lack of cover crop use.
CO_2 intake is restricted on grasslands due to reduced photosynthetic capacity (short leaf length)



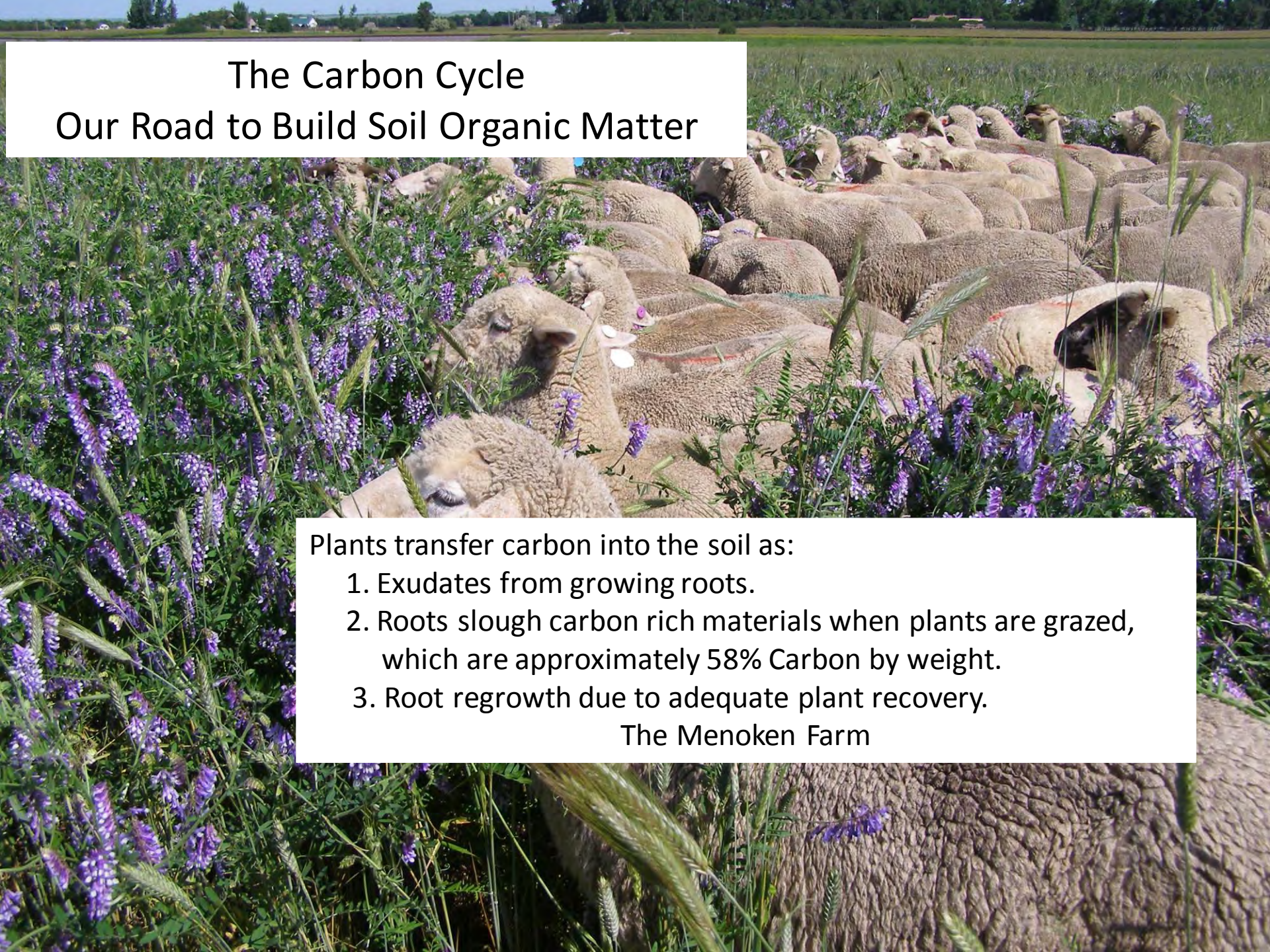
January 1 U.S. Beef Cow Inventory 1932-2012



Number of All Cattle and Beef Cow Operations, United States, 1991-2011



The Carbon Cycle
Our Road to Build Soil Organic Matter



Plants transfer carbon into the soil as:

1. Exudates from growing roots.
2. Roots slough carbon rich materials when plants are grazed, which are approximately 58% Carbon by weight.
3. Root regrowth due to adequate plant recovery.

The Menoken Farm

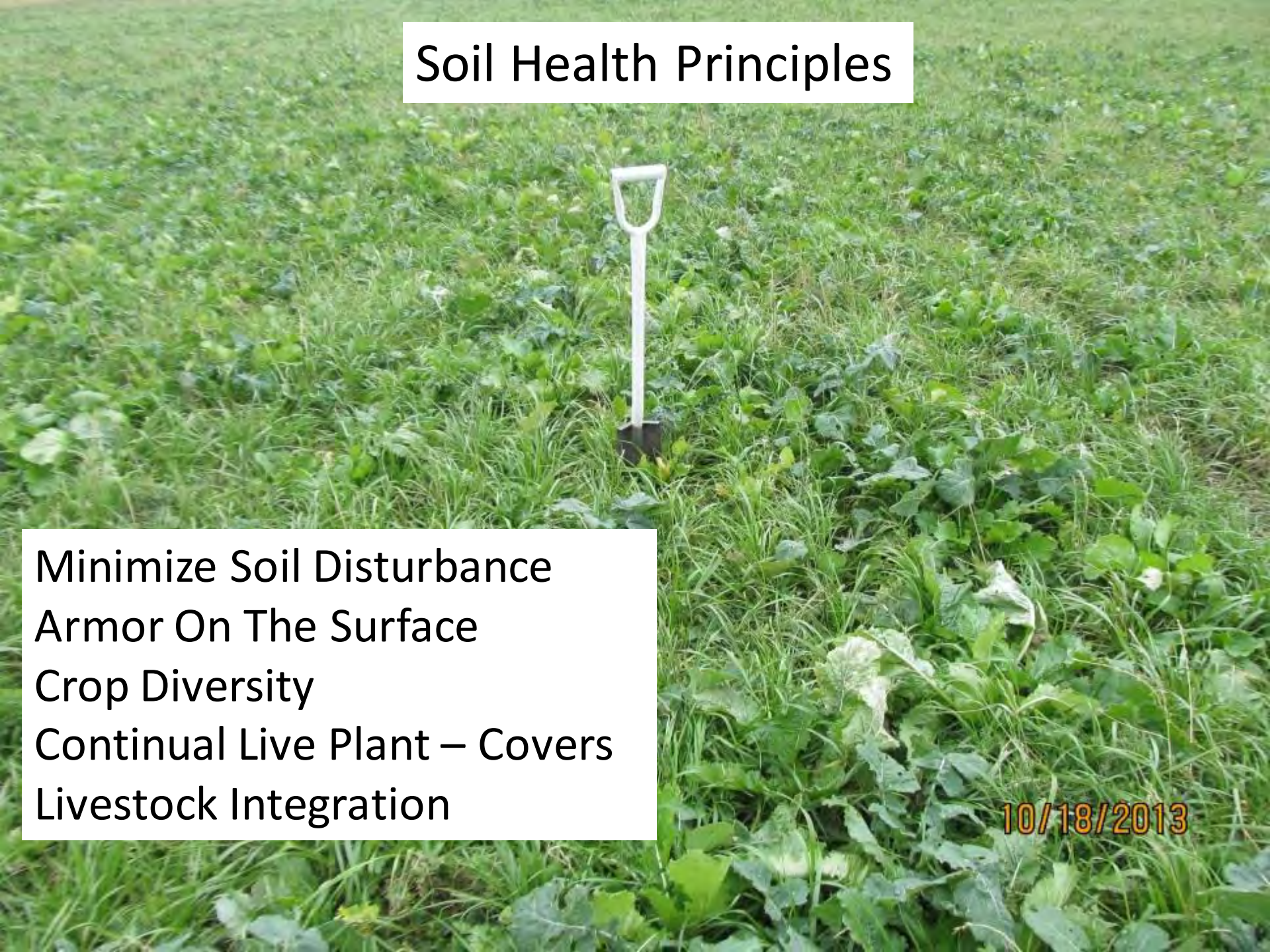
The Carbon Cycle
Our Road to Build Soil Organic Matter

Grazing Systems and livestock can be used as a tool to stress the plants during the growing season. Creating root sloughing; and to assure adequate recovery periods for regrowth for the plant/root. Just as this herd creates root sloughing on native rangeland, Ken Miller will show this concept on cropland with cover crops.

Black Leg Ranch

Let's Take a Closer Look at Winter Grazing Cover Crops on Black Leg Ranch

Soil Health Principles



Minimize Soil Disturbance
Armor On The Surface
Crop Diversity
Continual Live Plant – Covers
Livestock Integration

Black Leg Ranch

- Rotates 300 Acres Of Cover Crops Annually
- Nutrient Management (Reduced Fertility)
- Integrated Pest Management
- Water Quality (High Leach Sands)
- Wildlife
- Livestock Integration
- Livestock Health
- Soil Health

Black Leg Ranch
Yearling System
One group, 100 Day Season
22 Pastures, Primarily Once Over


Black Leg Ranch
Cow/Calf System
One Group, 180 Day Season,
14 Pastures, Primarily Once Over

Black Leg Ranch
Cover Crop Mixtures
2010-2014

- Pearl Millet
- Proso Millet
- Sudan
- Soybean
- Cowpea
- Sunflower
- Radish
- Turnip
- Sweet Clover
- Corn

- Cowpea
- Soybean
- Forage Pea
- Crimson Clover
- Sorghum
- Brown Top Millet
- Proso Millet
- Corn – BMR Grazing
- Collards
- Kale
- Radish
- Sunflower


Black Leg Ranch
Diversity


Black Leg Ranch

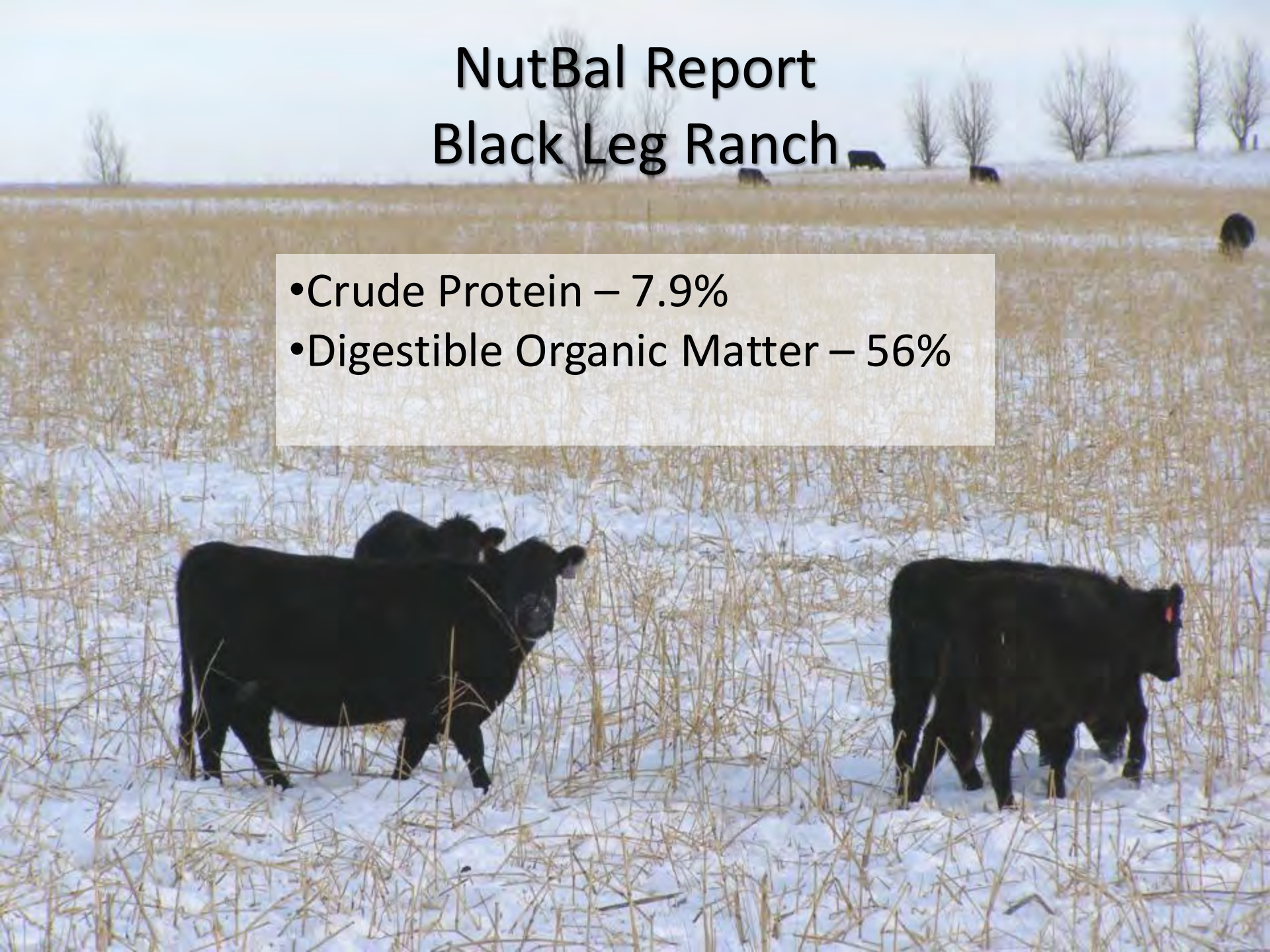
Black Leg Ranch
Biological Ag Waste System


Black Leg Ranch
Winter Grazing 2013-2014


Black Leg Ranch
Windbreak Protection
01/20/2014

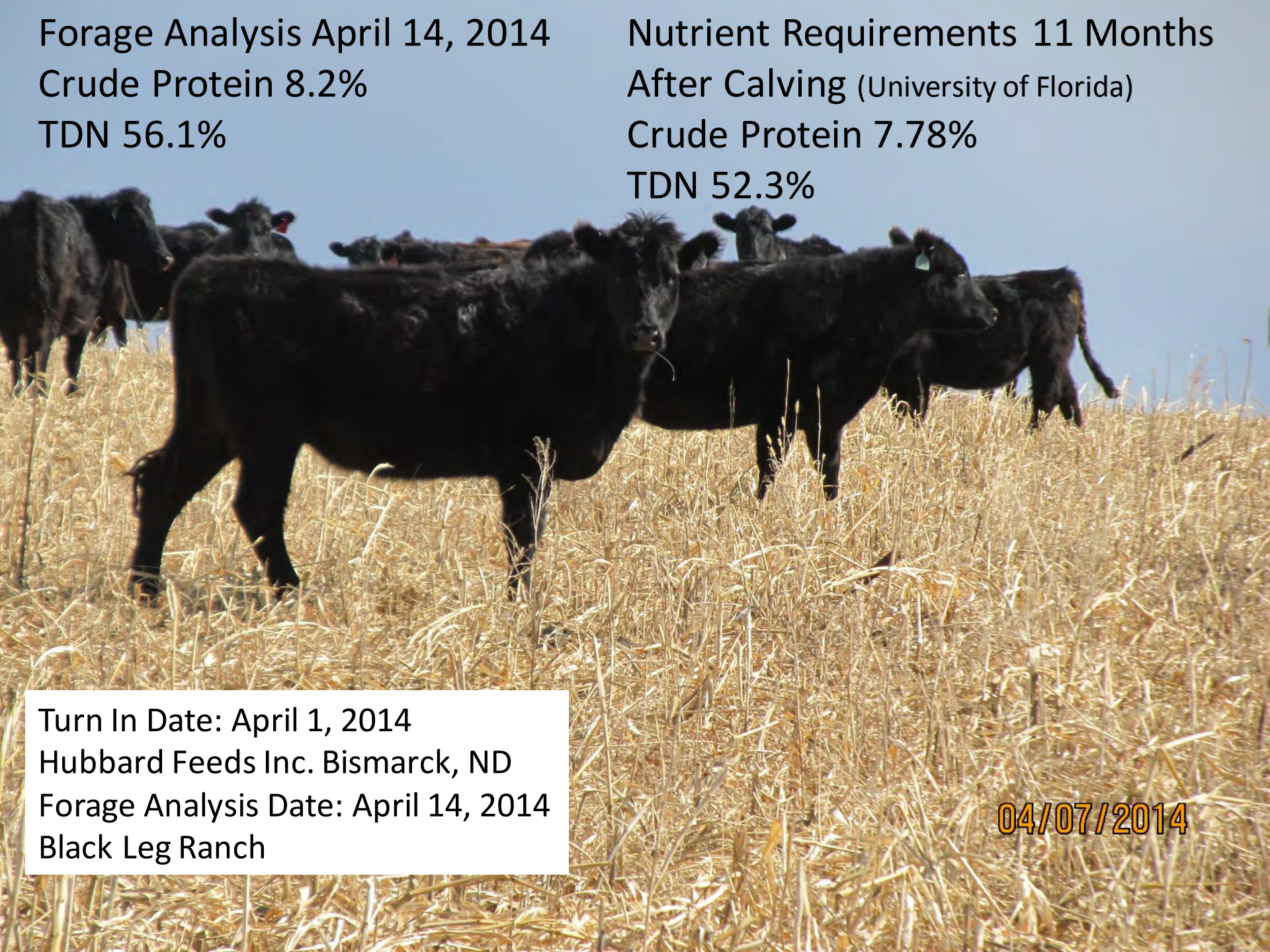
NutBal Report
Black Leg Ranch

- Crude Protein – 7.9%
- Digestible Organic Matter – 56%

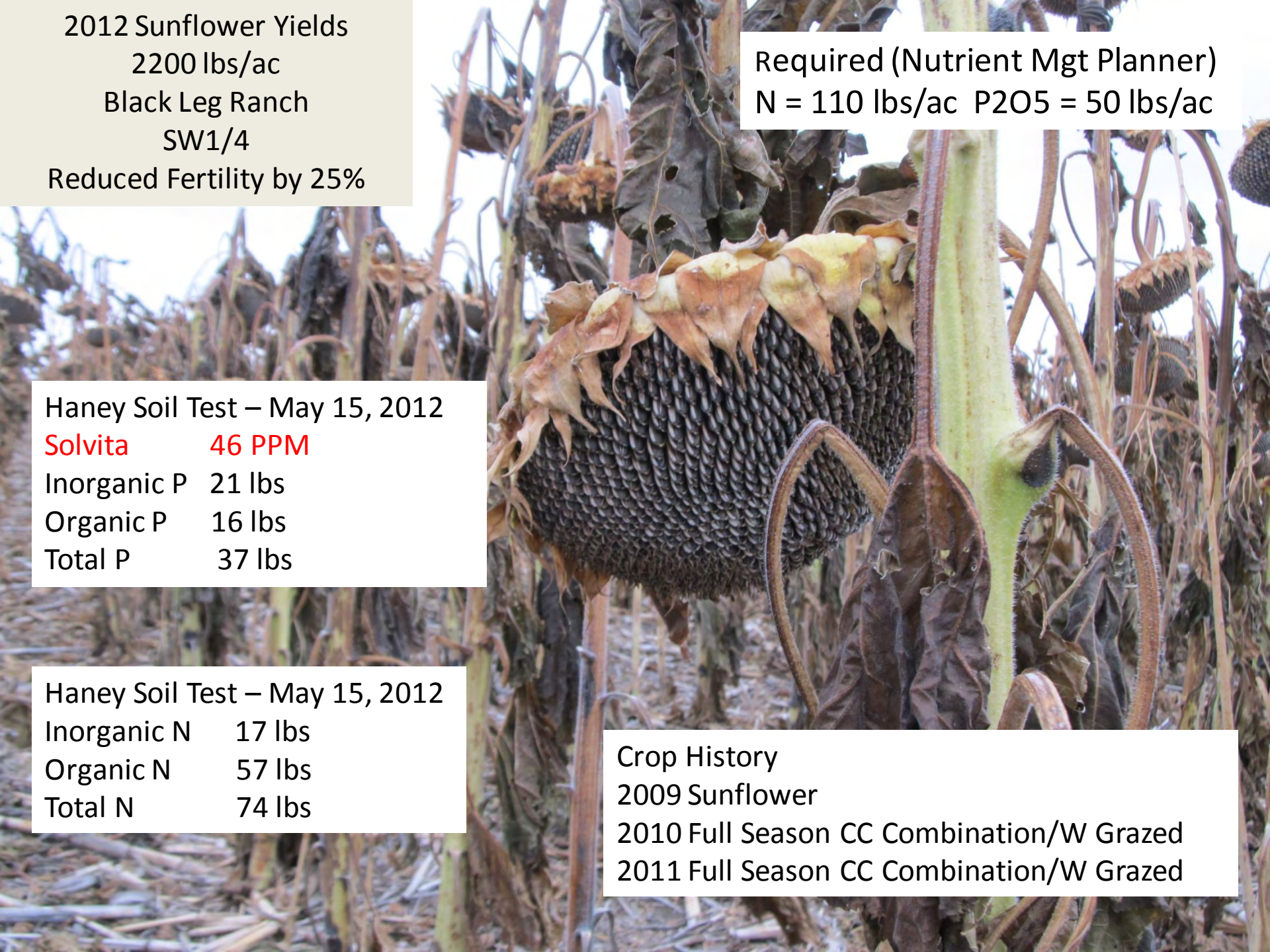


Forage Analysis April 14, 2014
Crude Protein 8.2%
TDN 56.1%

Nutrient Requirements 11 Months After Calving (University of Florida)
Crude Protein 7.78%
TDN 52.3%



Turn In Date: April 1, 2014
Hubbard Feeds Inc. Bismarck, ND
Forage Analysis Date: April 14, 2014
Black Leg Ranch



2012 Sunflower Yields
2200 lbs/ac
Black Leg Ranch
SW1/4
Reduced Fertility by 25%

Required (Nutrient Mgt Planner)
N = 110 lbs/ac P_2O_5 = 50 lbs/ac

Haney Soil Test – May 15, 2012

Solvita	46 PPM
Inorganic P	21 lbs
Organic P	16 lbs
Total P	37 lbs

Haney Soil Test – May 15, 2012

Inorganic N	17 lbs
Organic N	57 lbs
Total N	74 lbs

Crop History
2009 Sunflower
2010 Full Season CC Combination/W Grazed
2011 Full Season CC Combination/W Grazed

Field 1

Corn 2010

Season Long Cover Crop 2011

- **Total Biology – 1774 ng/g soil**
- **Bacteria – 1473 ng/g soil**
- **Actinomycetes – 123 ng/g soil**
- **Fungi – 147 ng/g soil**
- **Ratio Bacteria:Fungi – 10.0**
- **Mycorrhiza – 37 ng/g soil**

Field 2

Season Long Cover Crop 2010

Season Long Cover Crop 2011

- **Total Biology – 3312 ng/g soil**
- **Bacteria – 2510 ng/g soil**
- **Actinomycetes – 249 ng/g soil**
- **Fungi – 513 ng/g soil**
- **Ratio Bacteria:Fungi – 4.9**
- **Mycorrhiza – 251 ng/g soil**

Jerry Doan
Biological Soil Tests

2014 Sunflower Fertilization
71 Bushel Yield Goal – 2000 lbs

Standard Production Model	Haney Data
Required: 50 lbs N & 28 lbs P2O5	Required: 50 lbs N & 28 lbs P2O5
Available: 26 lbs N & 10 lbs P2O5	Available: 48 lbs N & 18 lbs P2O5
Applied: 24 lbs N & 18 lbs P2O5	Applied: 2 lbs N & 10 lbs P2O5

Savings: 22 lbs N & 8 lbs P2O5

Black Leg Ranch

Black Leg Ranch

NutriSolutions by WINFIELD

Report Number: 14055
Sample Date: Aug 26 2014 2:53PM

Leaf Analysis
No Fertilizer

Result	Comparative
Nitrogen 3.70% / N - Adequate	Normal: 3.0% - 5.0%%
Potassium 4% / K - Adequate	Normal: 4% - 6%%
Phosphorous 0.38% / P - Adequate	Normal: 0.33% - 0.5%%
Magnesium 0.71% / Mg - Adequate	Normal: 0.33% - 1.0%%
Sulfur 0.42% / S - Responsive	Normal: 0.45% - 0.55%%
Calcium 3.35% / Ca - Excessive	Normal: 2.0% - 3.0%%
Zinc 49ppm / Zn - Adequate	Normal: 30 - 75 ppmppm
Boron 111ppm / B - Excessive	Normal: 45 - 60 ppmppm
Manganese 102ppm / Mn - Adequate	Normal: 70 - 150 ppmppm
Iron 90ppm / Fe - Adequate	Normal: 70 - 150 ppmppm
Copper 26ppm / Cu - Adequate	Normal: 9 - 30 ppmppm

Consult your local agronomist. The recommendations provided above are only recommendations
recommendations. Excessive Nutrient Levels - above the level for optimum growth and developme
Solutions control, such as weather and applicator factors; Winfield cannot predict or guarantee r

Black Leg Ranch

NutriSolutions by WINFIELD

Report Number: 14056
Sample Date: Aug 26 2014 2:53PM

Leaf Analysis
Half Rate Fertilizer

Result	Comparative
Nitrogen 3.70% / N - Adequate	Normal: 3.0% - 5.0%%
Potassium 4.20% / K - Adequate	Normal: 4% - 6%%
Phosphorous 0.43% / P - Adequate	Normal: 0.33% - 0.5%%
Magnesium 0.74% / Mg - Adequate	Normal: 0.33% - 1.0%%
Sulfur 0.48% / S - Adequate	Normal: 0.45% - 0.55%%
Calcium 3.28% / Ca - Excessive	Normal: 2.0% - 3.0%%
Zinc 55ppm / Zn - Adequate	Normal: 30 - 75 ppmppm
Boron 119ppm / B - Excessive	Normal: 45 - 60 ppmppm
Manganese 99ppm / Mn - Adequate	Normal: 70 - 150 ppmppm
Iron 80ppm / Fe - Adequate	Normal: 70 - 150 ppmppm
Copper 31ppm / Cu - Excessive	Normal: 9 - 30 ppmppm

Consult your local agronomist. The recommendations provided above are only recommendations
recommendations. Excessive Nutrient Levels - above the level for optimum growth and developme
Solutions control, such as weather and applicator factors; Winfield cannot predict or guarantee r

Soil Organic Matter.

- A furrow slice is 6 7/8 inches = 2,000,000 lbs of soil per acre.
- 1.0% SOM X 2,000,000 lbs = 20,000 lbs of SOM per acre.
- 1.0% SOM = approximately 10,000 lbs Carbon, 1,000 lbs Nitrogen, 100 lbs Phosphorous, and 100 lbs of Sulfur.

Soil 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
One Acre Foot = Approximately 326,000 Gallons

Native Rangeland - Nitrogen Balance Inorganic and Organic

Location	Inorganic	Organic
Small Angus Ranch	6 lbs	57 lbs
Berg Ranch	21 lbs	67 lbs
Winkler Ranch	5 lbs	80 lbs
Black Leg Ranch (Cropland)	26 lbs	49 lbs

Tying It All Together

Thank You
Jay.fuhrer@nd.usda.gov
1-701-250-4518 ext3

Self Education

- The Nature and Properties of Soils – 14th Edition : by Brady and Weil
- Buffalo Bird Women's Garden : by Gilbert Wilson
- The One Straw Revolution: by Masanobu Fukuoka
- Managing Cover Crops Profitably 3rd Edition
- Life in the Soil: by James Nardi
- Soil Biology Primer: by Elaine Ingham
- Dirt: by David Montgomery
- Undaunted Courage: by Stephen Ambrose

www.bcscd.com

www.dakotalakes.com

www.sustainableranching.com

www.mandakzerotill.org

Grazing Cover Crops, Winter Grazing, & Bale Grazing

Ken Miller

Burleigh County SCD

Grazing Cover Crops

Winter Grazing
Native Range

Bale Grazing


R4
R5
R6
R7
24
25
43
47
49
22
13A
41
40
39
19
20
44
21
16
14A
14
13A
13
15A
12A
46A
16
12
17A
16B
11A
17
11
10
18A
10A
5A
4A
6
4
6A
3
3A
7A
2
2A
7
5A
9A
1A

May 9 , Grazing Winter Triticale

May 11, 60 Head 2 days grazing
4 acres

High Stock Density on Pivot

Abby June 9

COVER CROP COCKTAIL SEEDED AUGUST 2

Late September
Grazing Cover Crop Mix

Late November

April 18, 2008

Harvest July 22, 2008

October 4, 2008

Cool Season Mix

- Forage barley 48 lbs
- Field pea 40 lbs
- Hairy vetch 12 lbs
- Pasja turnip 1 lb
- Radish 2 lbs
- Rye grass 2 lbs
- Sunflower 2 lbs
- Sweet clover 1 lb

Hayed July7, 2010
Yield 2.25 Ton/acre

Regrowth August 17, 2010

Grazing Cover Crops

Warm Season Cover Crop Mix

Cow Pea	10 #
Soybean	15 #
Pearl Millet	6 #
Sudan Grass	3 #
Corn	0.5 #
Sunflower	2 #
Turnip (Pasja)	1 #
Radish	2 #
Sweet Clover	1 #

Grazed Late in the Season

Bale Grazing
Winter of 2009 & 2010

6 Days of Feed

12 Days Grazing

Electric Fence

Have Fun

Bale Grazing
January 2011

January, 2011

June 4, 2010

June 4, 2010

June 15, 2014


R4
R5
R6
R7
24
25
43
47
49
22
13A
41
40
39
19
20
44
21
16
14A
14
13A
13
15A
12A
46A
16
12
17A
16B
11A
17
11
10
18A
10A
5A
4A
6
4
6A
3
3A
7A
2
2A
7
5A
9A
1A

Portable Shelter
With Energy Free Water System

Stockpiled Grass

January 5, 2012

January 15, 2012

January 1,2013

December 21, 2013
Started Bale Grazing

Area Not Bale Grazed

Baled Grazed

Concentrated Area

Non-Bale Grazed

Quality & Quantity Comparison

Bale Grazed

- 8573 lbs/ac
- 11.9% Crude Protein
- 59.4 TDN

Non-Bale Grazed

- 2559 lbs/ac
- 7.9% Crude Protein
- 60.7 TDN

June 23, 2013

June 23, 2013

Bale Grazing Results June 2013

Bale Grazing Results June 2013

Carbon Left

Soil Health, Priceless…

kenneth.miller@nd.nacdnet.net

1-701-250-4518 ext 3