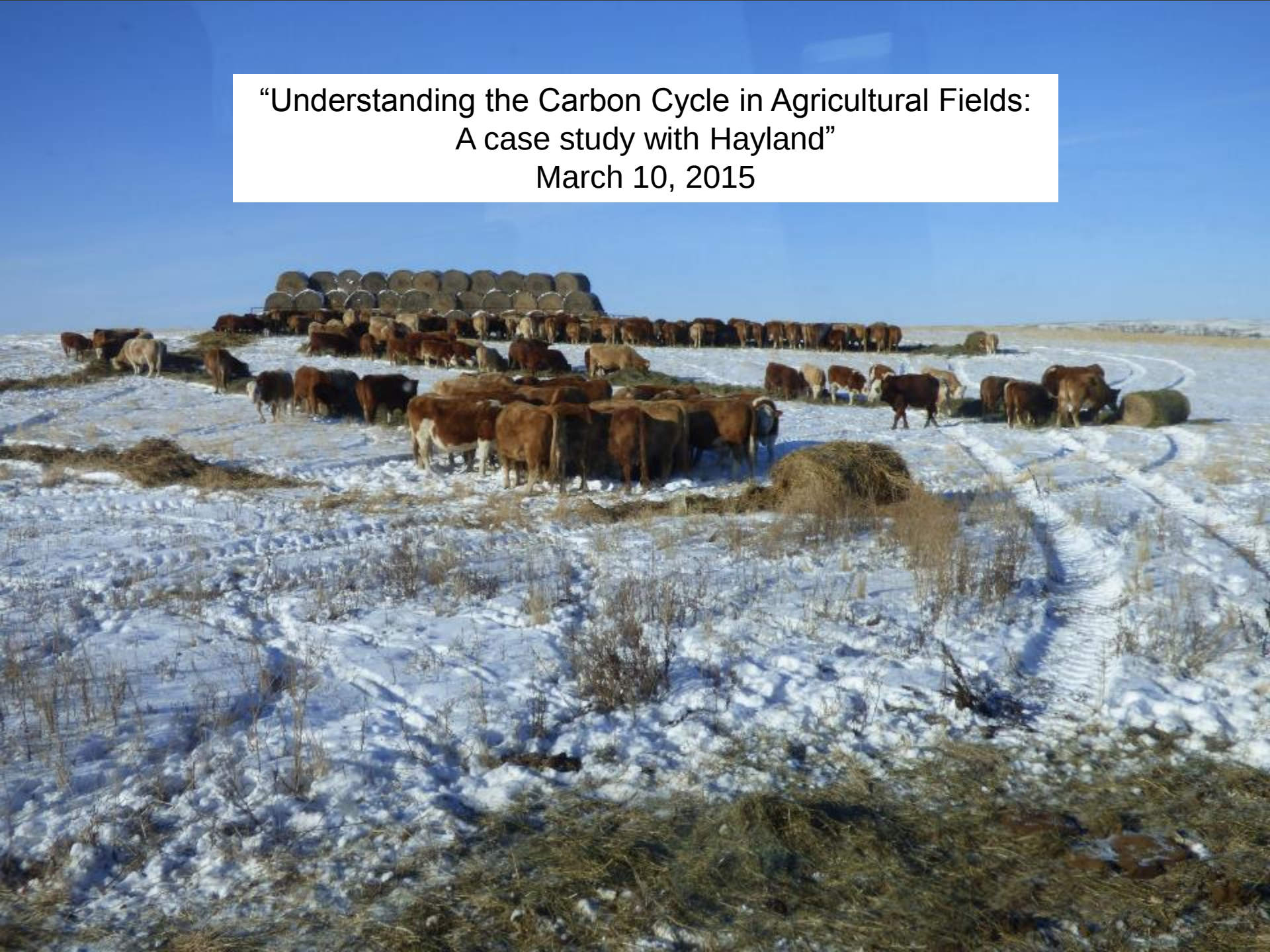

“Understanding the Carbon Cycle in Agricultural Fields: A case study with Hayland”

March 10, 2015

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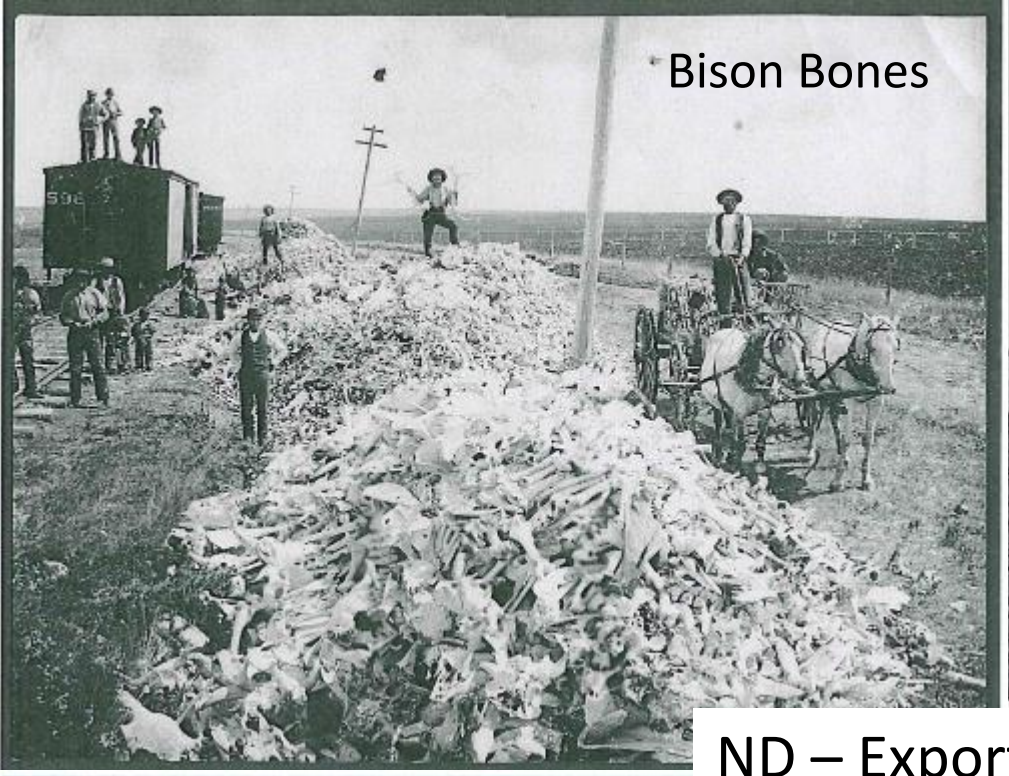
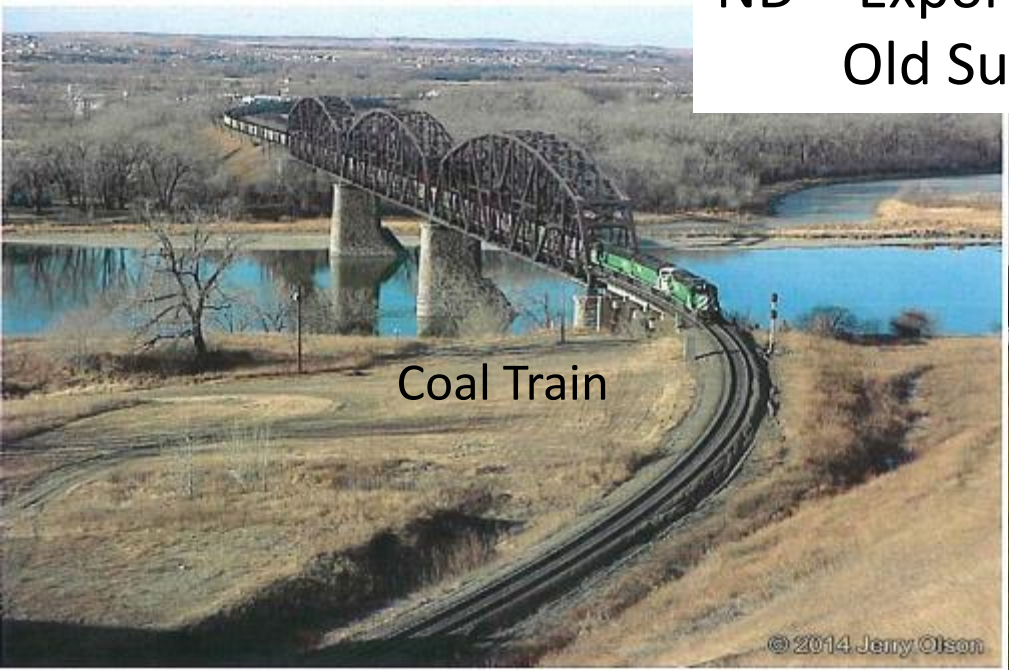


ND – Exporting Carbon
Old Sunshine



Nurture Nature with System Synergies

No Tillage

Minimum carbon loss

Cover Crops

Maximum carbon input

Carbon management

Sustainability

Dr. Don Reicosky
ARS, Morris, MN

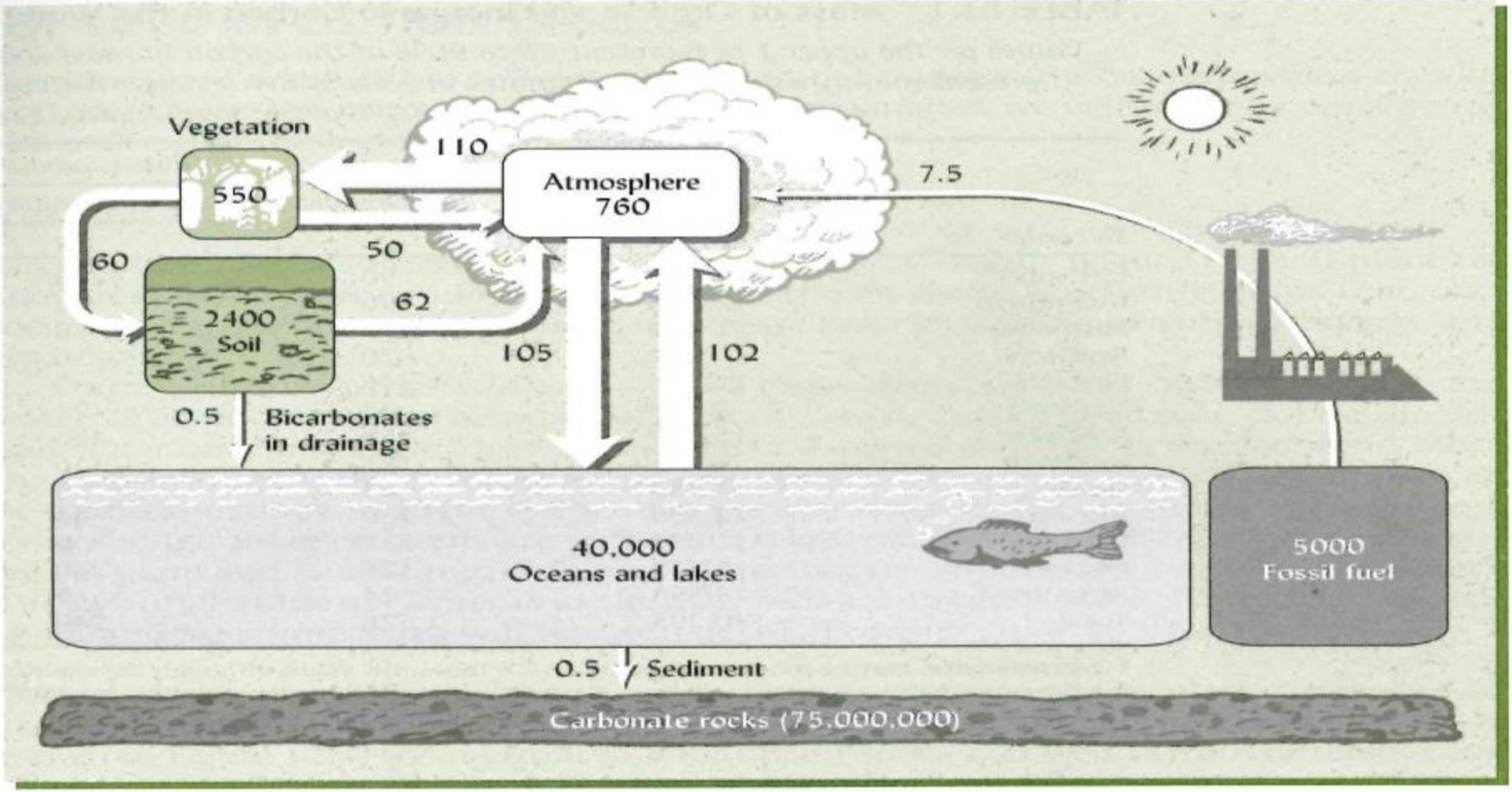


FIGURE 12.3 A simplified representation of the global carbon cycle emphasizing those pools of carbon which interact with the atmosphere. The numbers in the boxes indicate the petagrams (Pg = 10^{15} g) of carbon stored in the major pools. The numbers by the arrows show the amount of carbon annually flowing (Pg/yr) by various processes between the pools. Note that the soil contains almost twice as much carbon as the vegetation and the atmosphere combined. Imbalances caused by human activities can be seen in the flow of carbon to the atmosphere from fossil fuel burning (7.5) and in the fact that more carbon is leaving (62 + 0.5) than entering (60) the soil. These imbalances are only partially offset by increased absorption of carbon by the oceans. The end result is that a total of 221.5 Pg/yr enters the atmosphere while only 215 Pg/yr of carbon is removed. It is easy to see why carbon dioxide levels in the atmosphere are rising. [Data from IPCC (2007); soil carbon estimate from Batjes (1996)]

Nature and Properties of Soils, Fourteenth Edition, Chapter 12, Global Carbon Cycle

Soil Biology – Plant Interaction

The Menoken Farm

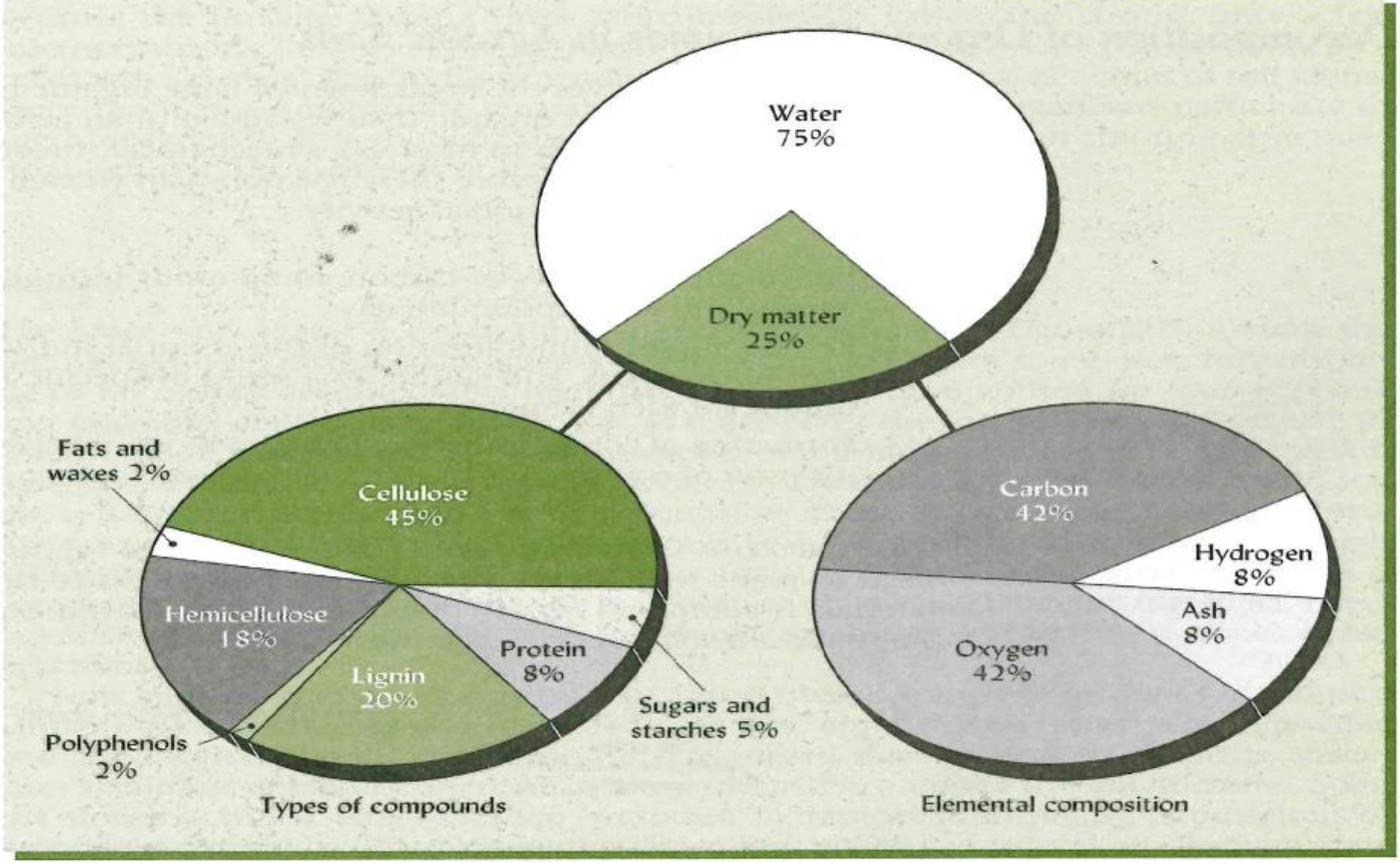


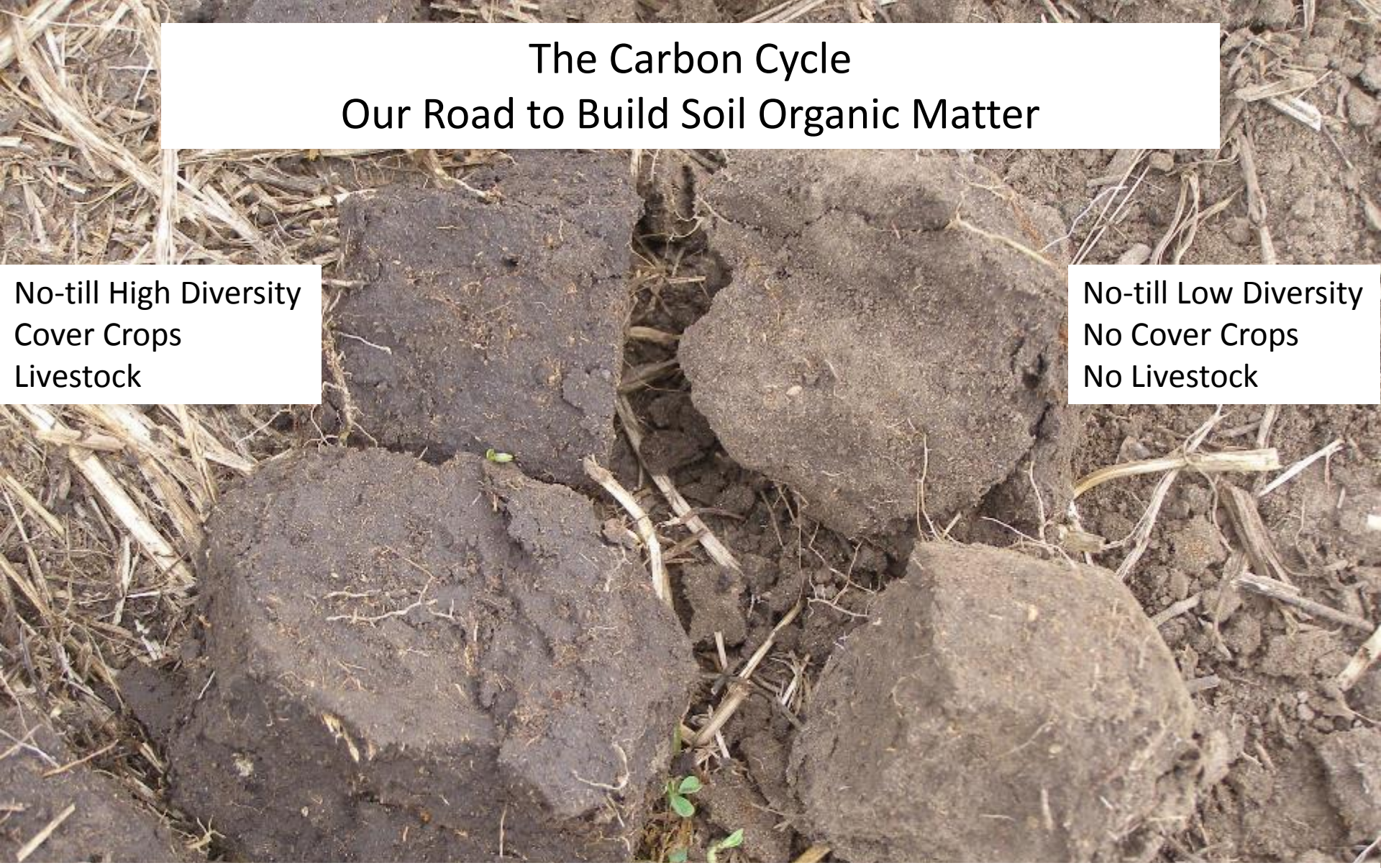
FIGURE 12.4 Typical composition of representative green-plant materials. The major types of organic compounds are indicated at left and the elemental composition at right. The *ash* is considered to include all the constituent elements other than carbon, oxygen, and hydrogen (nitrogen, sulfur, calcium, etc.).

Nature and Properties of Soils, Fourteenth Edition, Chapter 12, Composition of Plant Residues

Crop Diversity

"The type and diversity of organic residues added to a soil can influence the type and diversity of organisms that make up the soil community. " The Nature and Properties of Soils, 14th Edition; Chapter 12.5

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 Nature and Properties of Soils; 14th edition

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

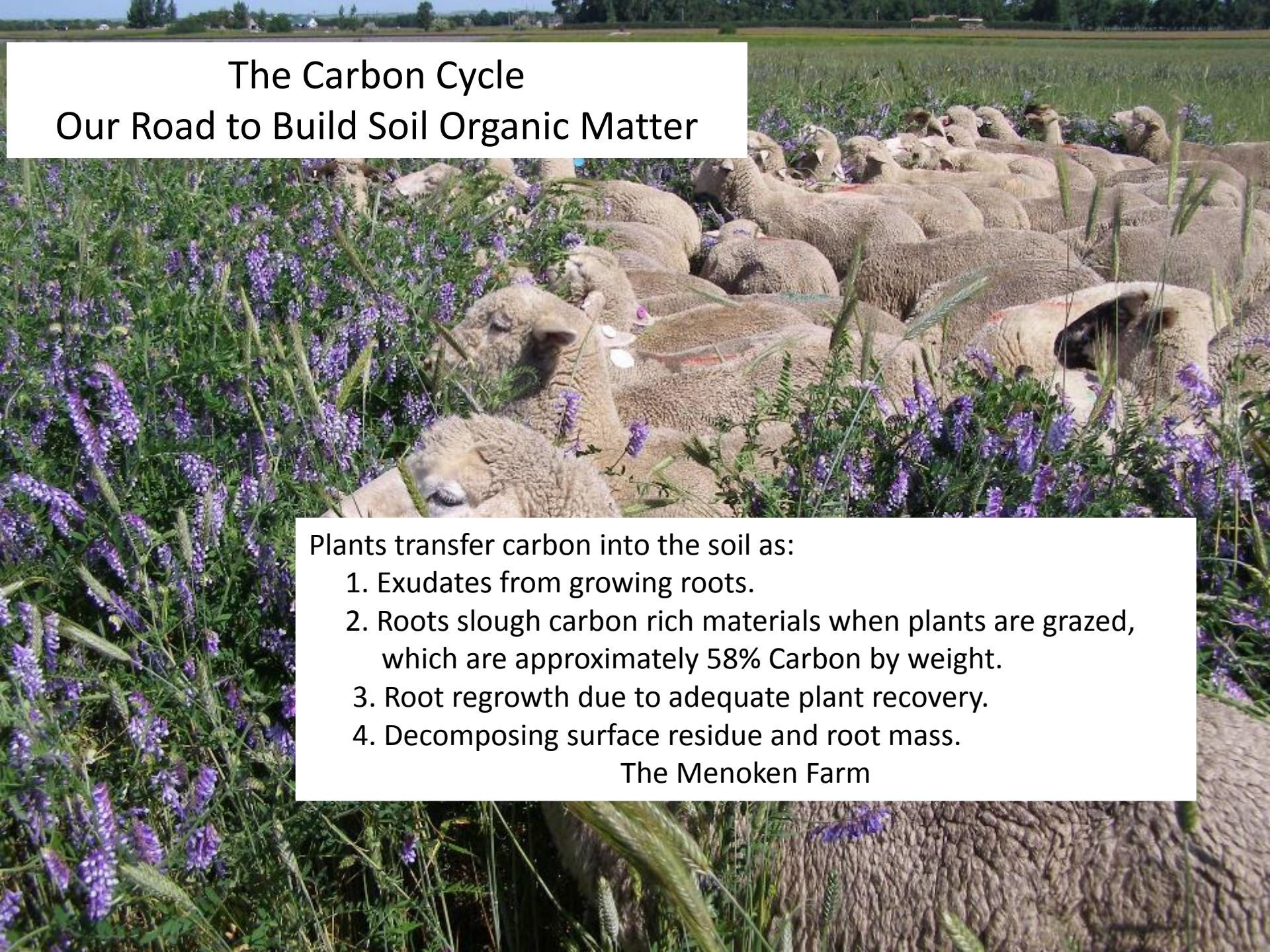
The soil releases CO_2 back into the atmosphere, primarily from the Soil Food Web respiration. Prior to civilization; the C entering and leaving the soil was in balance.

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)

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.
4. Decomposing surface residue and root mass.

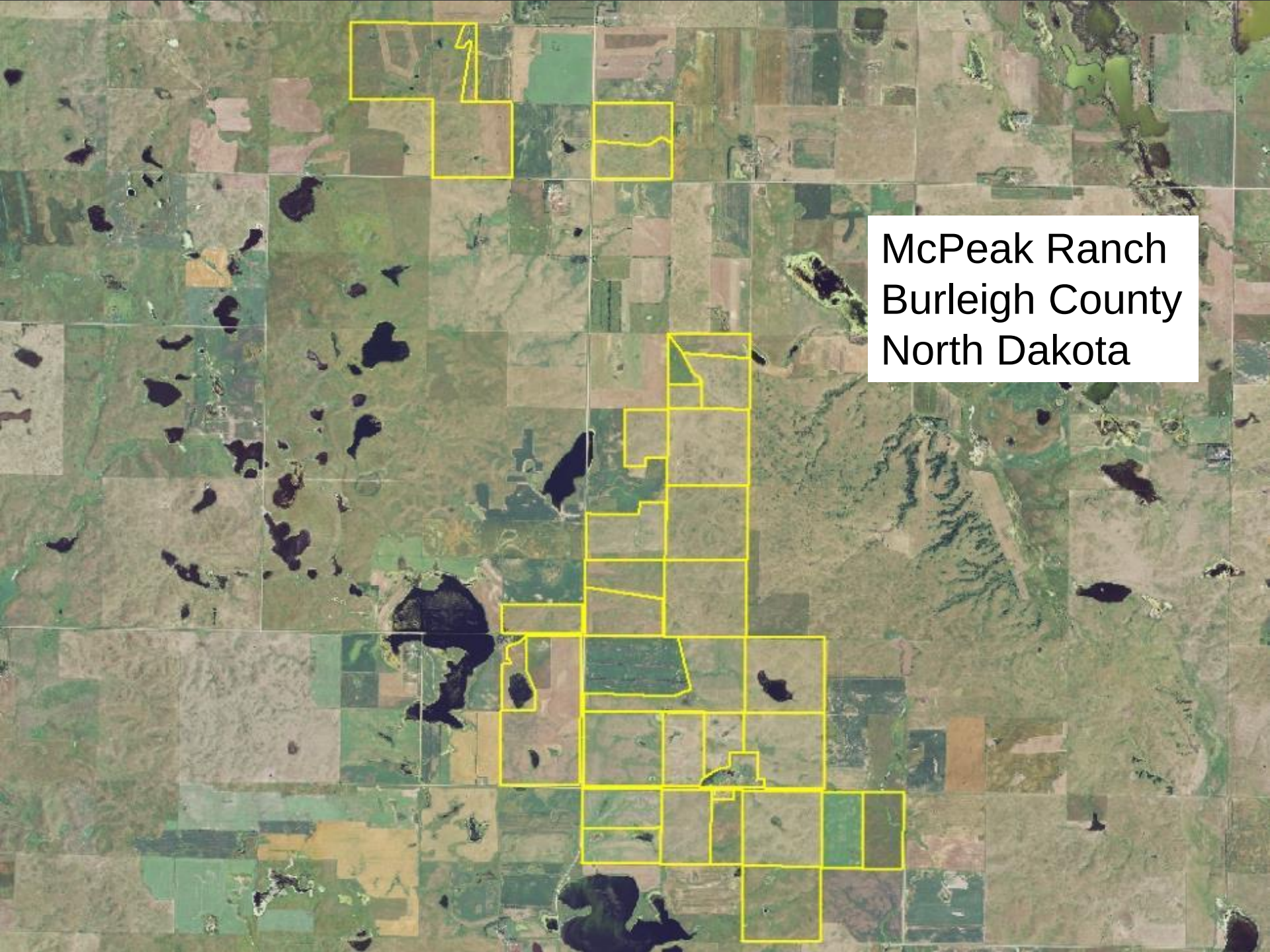
The Menoken Farm


MCPEAK
Grass & Cattle
RANCH


McPeak
Grass & Cattle
Ranch
“Everything that is alive plays a role, bees to badgers to beef.
The more life on the ranch, the better I feel I am caring for the land.”

Ranch History and the Grazing System

The Grazing System was started over 25 years ago.
After the First Drought.


McPeak Ranch
Burleigh County
North Dakota

Grazing System

- 15 pasture system
- Primarily once over with some pastures grazed twice
- Recovery Time 80 – 90 Days
- Pasture size ranges from 80 acres to 160 acres

Grazing System

- Monitoring pastures by observing the grass, not the calendar
- Season of use change.
- Exposure period 2-3 weeks/pasture.

Sometime Later the Ranch Experienced a Second Drought.
A 3 Year Dry Spell with very Little Snowfall.

Resulting in a Livestock Pipeline System being Installed.
Converting from surface ponds to livestock tanks.

Old System: Calving January 1st
New System: Calving May/June - Last 14 Yrs

Changing the calving date resulted in several changes

- Less Disease
- Lower Vet Bill
- Less Labor
- Saves on Hay and Bedding
- No Longer Heat Barns
- No Tagging

Hayland System

When the Third Drought Occurred.

The Grazing System Had Plenty Of Grass

But The Hay Field Production Dropped To Half Or Less.

So…….Todd asked me why?

Factors Affecting the Balance between Gains and Losses of Organic Matter in Soils

Factors Promoting Gains

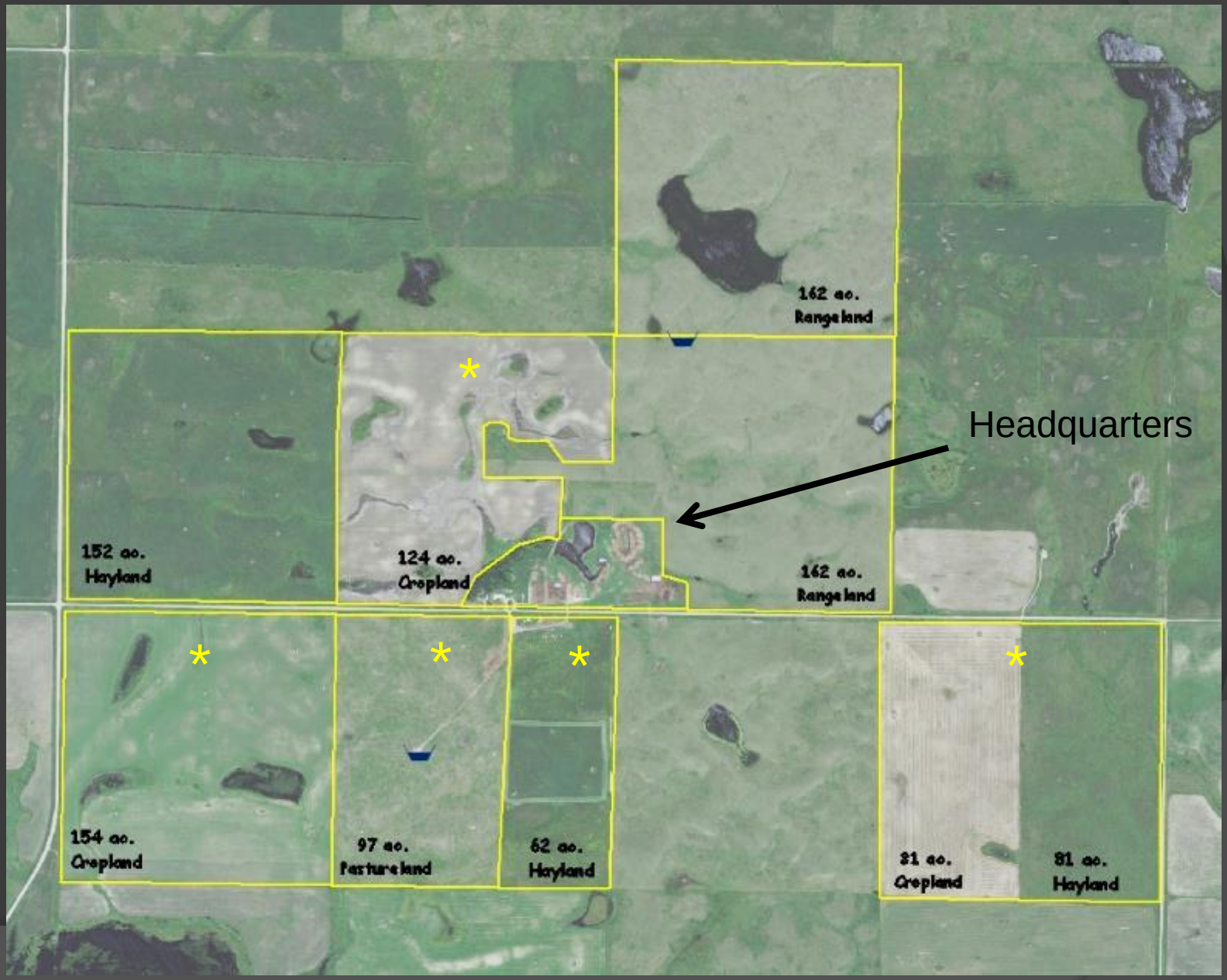
- Green manures or Covers
- Conservation tillage
- Return of plant residues
- Low temperatures & shading
- Controlled grazing
- High soil moisture
- Surface mulches
- Application of compost & manure
- Appropriate nitrogen levels
- High plant productivity
- High plant root:shoot ratio

Factors Promoting Losses

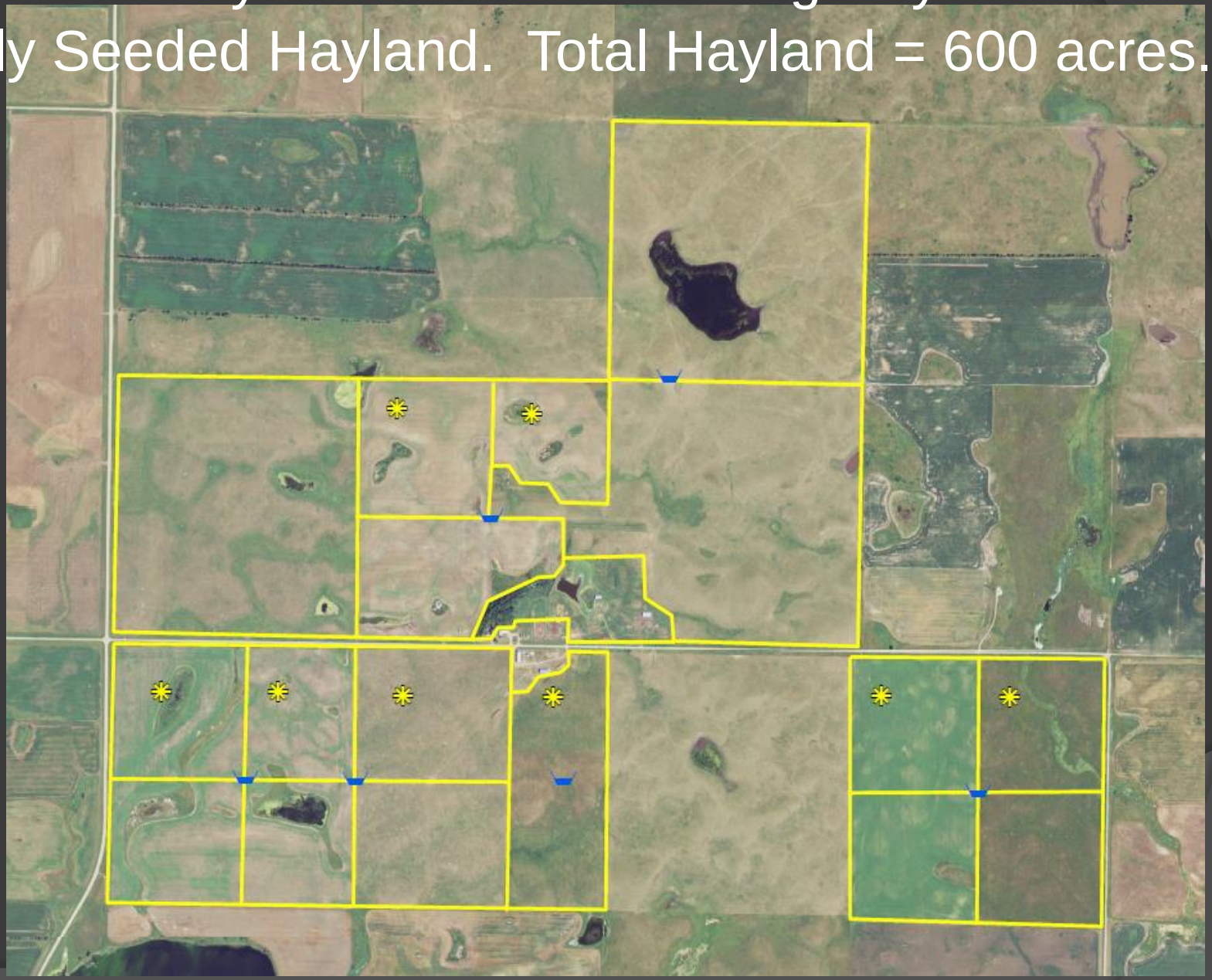
- Erosion
- Intensive tillage
- Whole plant removal
- High temperatures & exposures to sun
- Overgrazing
- Low soil moisture
- Fire
- Application of only inorganic materials
- Excessive mineral nitrogen
- Low plant productivity
- Low plant root:shoot ratio

The Nature and Properties of Soils, 14th Edition, Nyle C. Brady and Ray R. Weil

Before:


162 ac.
Rangeland
*
Headquarters
152 ac.
Hayland
124 ac.
Cropland
162 ac.
Rangeland
*
*
*
*
154 ac.
Cropland
97 ac.
Pastureland
62 ac.
Hayland
81 ac.
Cropland
81 ac.
Hayland

After: 14 Hayland Fields of Existing Hayland & Newly Seeded Hayland. Total Hayland = 600 acres.



Some of the Hayland was Existing and some was Seeded in 2013

	lbs/ac:
Alfalfa	2.20
Meadow Bromegrass	2.03
Green Wheatgrass	1.00
Cicer Milkvetch	0.80
Western Wheatgrass	0.80
Intermediate Wheatgrass	0.43
Green Needlegrass	0.60
Maximillian Sunflower	0.25
Canada Milkvetch	0.25

More Diversity In Future Plantings
Flowering Forbs and Warm Season Plants

Cover Crops were used to Prepare a Seedbed for the new Seeding's.

No Exporting on Hayland Policy

- The Cattle are no longer wintered at the Headquarters.
- All Hay is Stacked and Fed on the Hayland Fields.
- Before: Zero Animal Impact Days vs After: 7 Months of Animal Impact.
- Serves as the Drought Plan for the Grazing System too.

Hay is stacked in a new location each year avoiding excess manure and urine.


Panels Protect the Hay Supply


Winter Tank
Summer Tank


Winter Feeding on Hayland
Feeding Cattle and Soil

Bio-Windbreak

Closest Hayland to the Headquarters

Lowers The Manure Hauling/Spreading Bill.
Captures More Urine and Manure Where We Want It…In The Field

-15 degrees
20 mph winds

Feeding A Different Location Everyday For Even Distribution Of Urine, Manure, and Armor


Snow windbreaks help draw cattle away from the primary windbreak.

Results after feeding on hayland for three winters

Hayland Production after three winters.
80 Acre Field
2011 = 155 bales (very little grass heading out)
2012 = 211 bales
2013 = 218 bales (1/3 field hailed out)
2014 = 265 bales

+ 110 bale increase in three years.

Fall Dormant Grazing in October and November
14 Hayland Fields x 3-5 Grazing Days in Each.

Hayland On The Left Was Hayed One Week Before The Hayland On The Right. Received No Rain for 6 Weeks Prior to Haying.

Traditional Hayland

Exporting All Hay. The Soil Is Tired. 10 Year Stand

Hay Fed On The Field.

The Soil is Healthy Again With Soil Armor and Carbon. 20 Year Stand

Summary

Beef Cow – Manure & Urine Produced Daily, (ASAE 1999)
62 lbs Manure (0.4% N ; 0.2% P)
20 lbs Urine (1.1% N; 0.01% P)

Calculated Nitrogen
Manure 100 cows/120 days @ 0.23 lbs N/Hd/Day = 2760 lbs N
Urine 100 cows/120 days @ 0.22 lbs N/Hd/Day = 2640 lbs N
Total N = 5400 lbs

50 % Retention = 2700 lbs N divided by 40 acres = 68 lbs N/ac
100 % Retention = 5400 lbs N divided by 40 acres = 135 lbs N/ac

Western Beef Development Centre, Lanigan, SK
University of Saskatchewan, Saskatoon SD
P Jungnitsch, H A Lardner, & J J Schoenau

October 23, 2014

- Total Biology 1671 ng/g
- Solvita 50 ppm
- Organic Carbon 186 ppm
- Inorganic N 3.0 lbs
- Organic N 26.2 lbs
- pH 7.2

No Winter Feeding.

- Total Biology 2502 ng/g
- Solvita 134 ppm
- Organic Carbon 257 ppm
- Inorganic N 3.6 lbs
- Organic N 47.9 lbs
- pH 6.9

3 Years Winter Feeding

Carbon is Food for the Soil Biology


Everything that is alive plays a role

Factors Affecting the Balance between Gains and Losses of Organic Matter in Soils

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The Nature and Properties of Soils, 14th Edition, Nyle C. Brady and Ray R. Weil

Take Care Of Your Soil Like You Do Your Cow Herd. They Both Need To Be Fed.

Summary

Connecting The Carbon Dots

- Calving With Nature
- Native Grazing System
- Wintering on Hayland
- Animal Impact On Hayland

Thank You

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