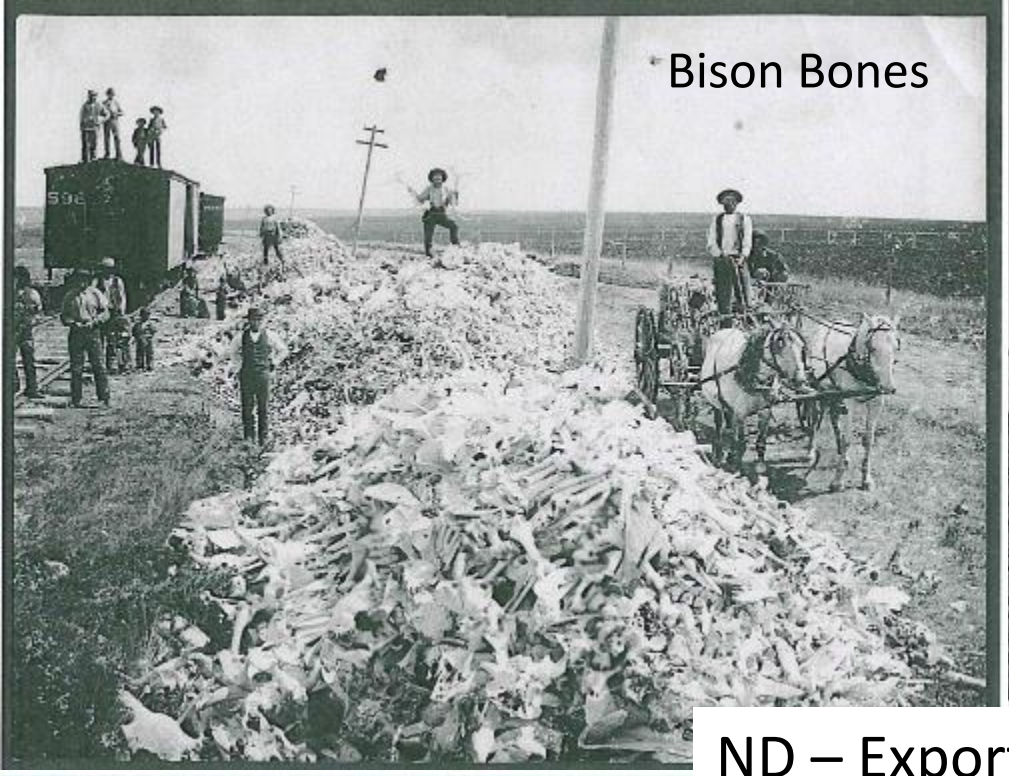
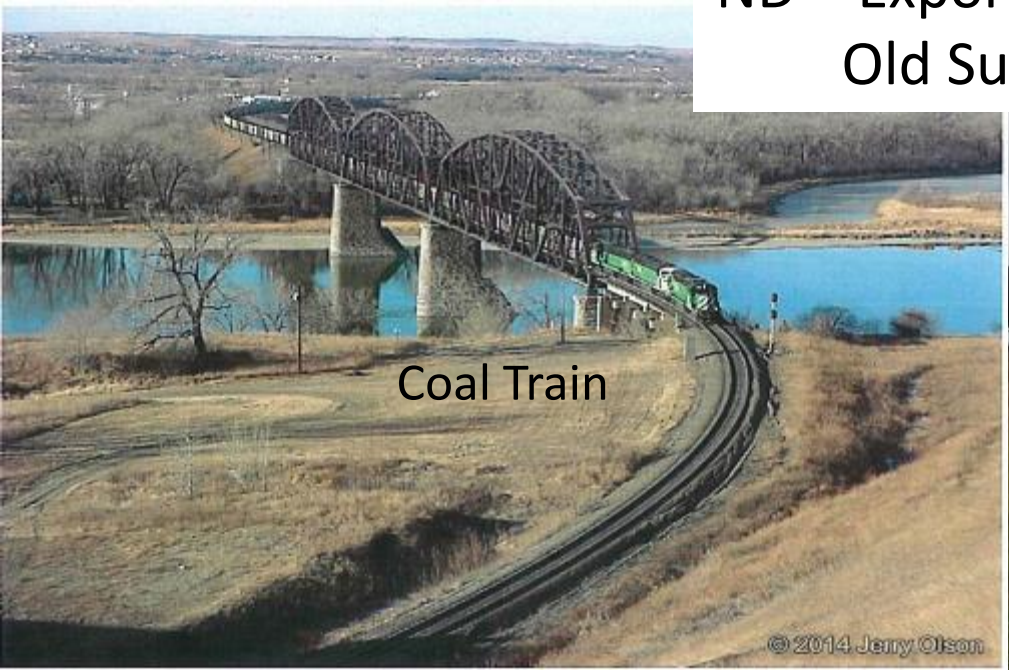
Old Sunshine Carbon vs New Sunshine Carbon

Carbon Cycle



ND – Exporting Carbon
Old Sunshine



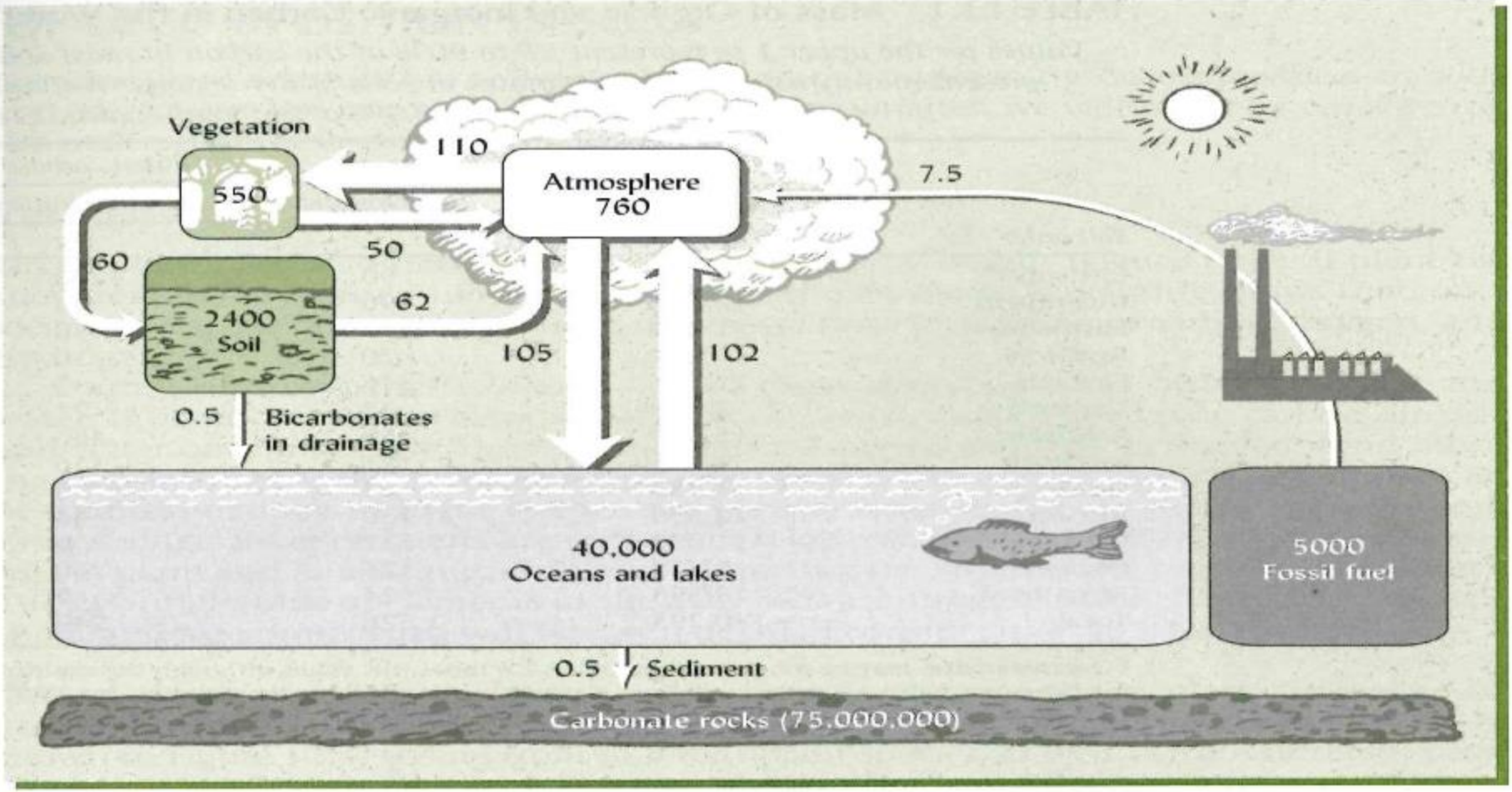


FIGURE 12.3 A simplified representation of the global carbon cycle emphasizing those pools of carbon which interact with the atmosphere. The numbers in the boxes indicate the petagrams (Pg = 10^{15} g) of carbon stored in the major pools. The numbers by the arrows show the amount of carbon annually flowing (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

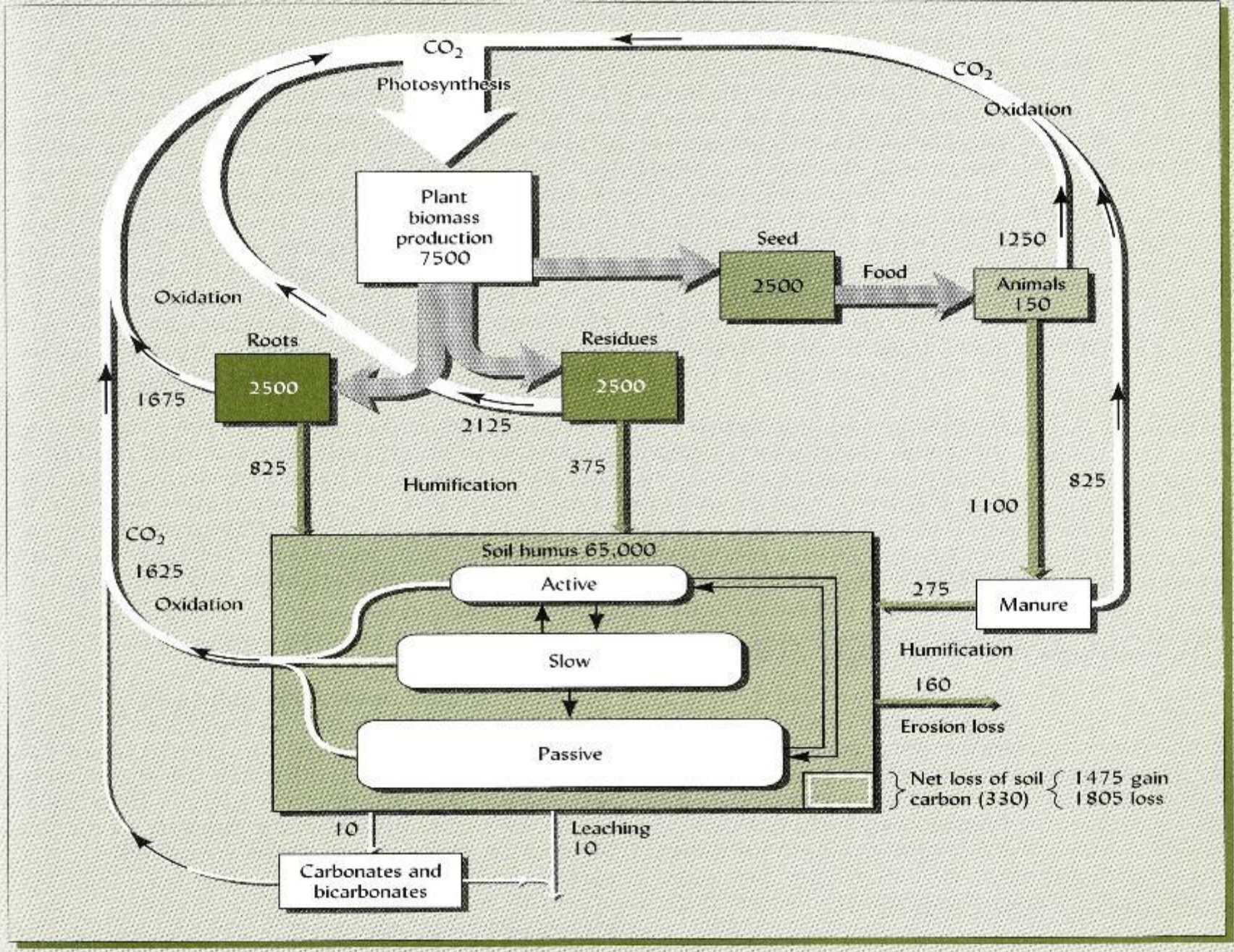


FIGURE 12.18 *Carbon cycling in an agroecosystem.*

(continued)

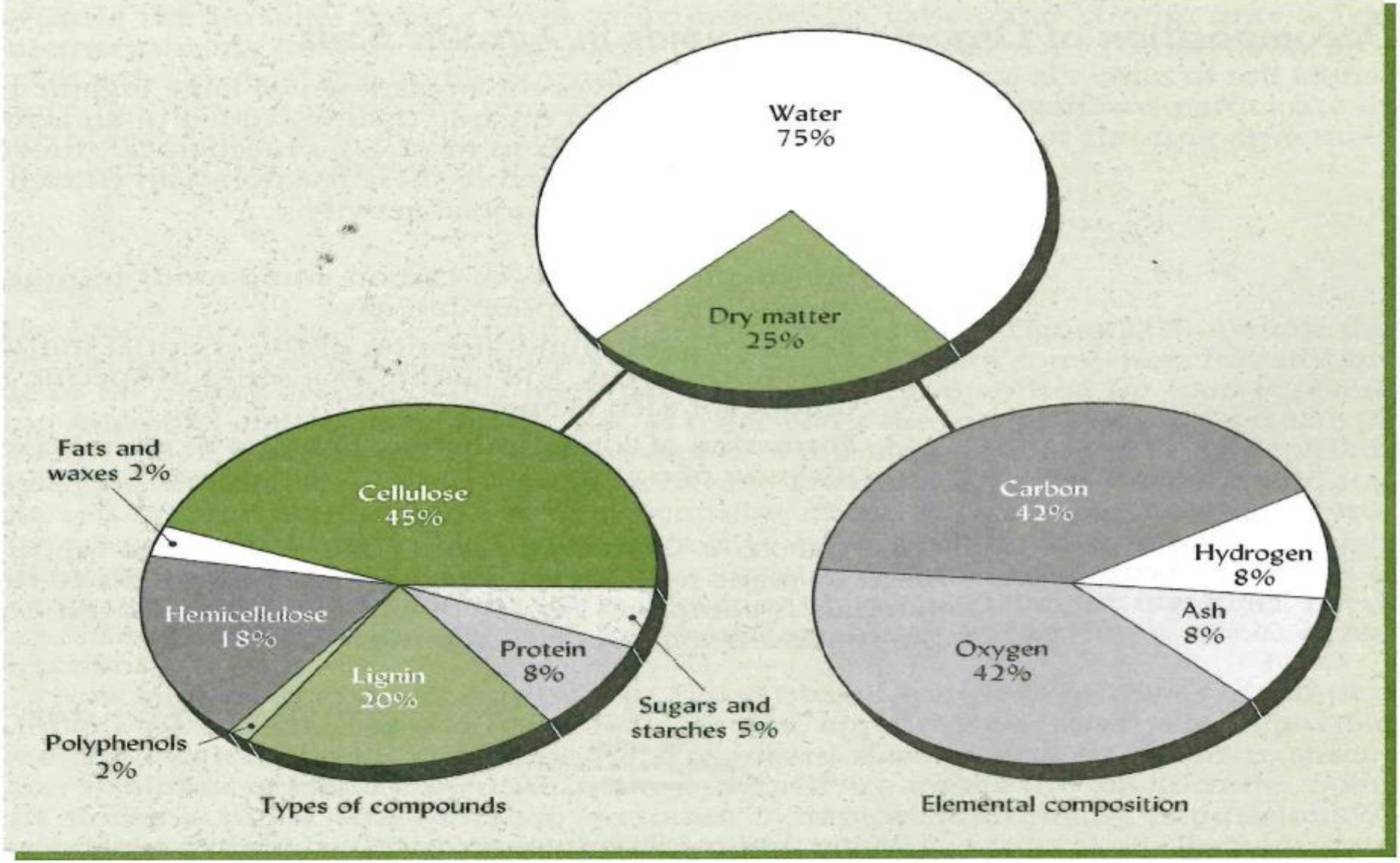


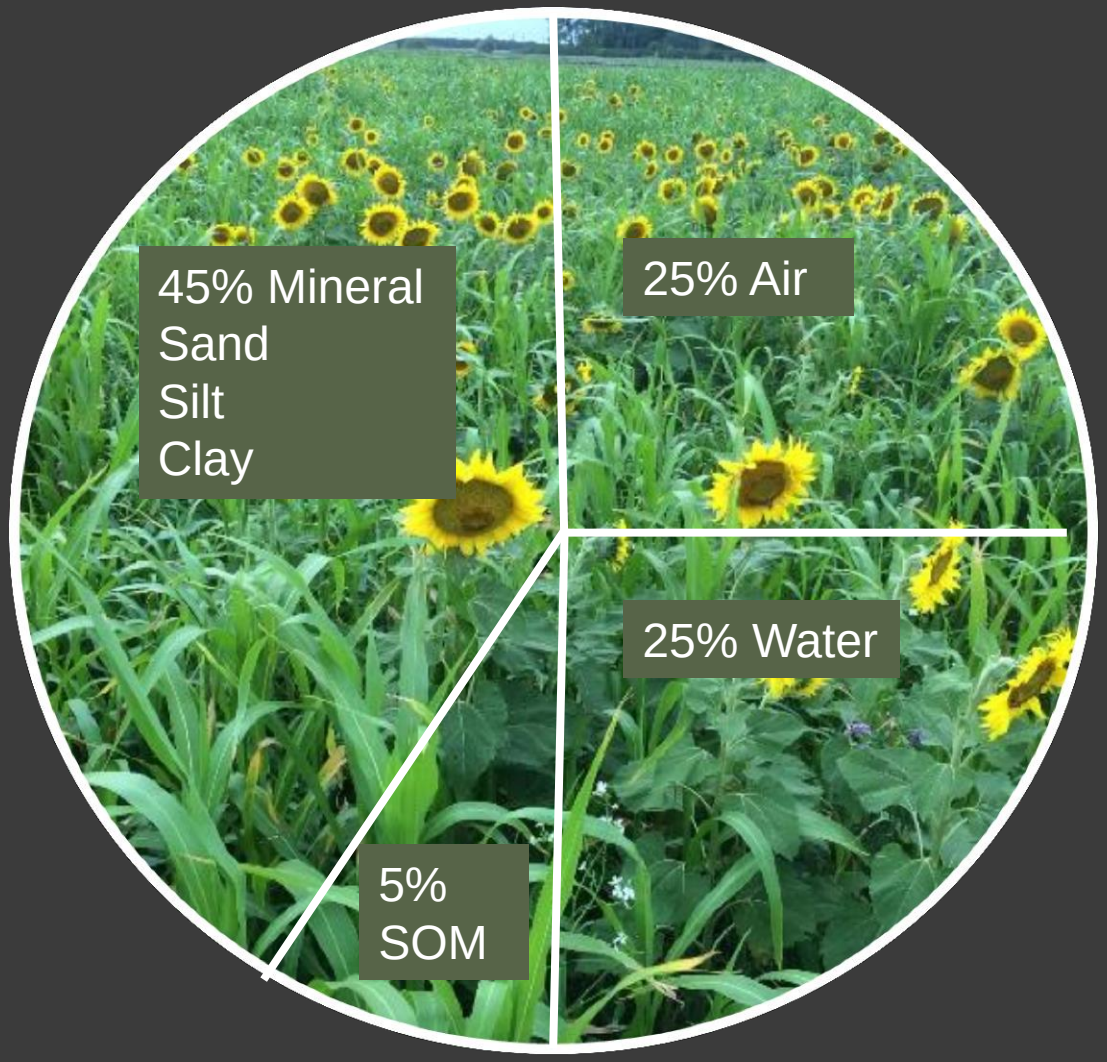
FIGURE 12.4 Typical composition of representative green-plant materials. The major types of organic compounds are indicated at left and the elemental composition at right. The *ash* is considered to include all the constituent elements other than carbon, oxygen, and hydrogen (nitrogen, sulfur, calcium,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

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


Exporting Carbon & Nutrients
The Menoken Farm


Exporting Carbon & Nutrients
Alamosa, Colorado

Soil



What Does A Soil Consist Of?

- **25% Air**
- **25% Water**
- **45% Mineral**
- **5% SOM**

SOM

What Does Soil Organic Matter Consist Of:

- The Living – Microorganisms
- The Dead – Fresh Residues
- The Very Dead - Humus

1 % Soil Organic Matter:
10,000 units carbon
1,000 units organic nitrogen
100 units phosphorous

General Guidelines for Managing Soil Organic Matter

- A Continuous supply of plant residues (roots & tops)
- There is no “ideal” amount of soil organic matter
- Adequate nitrogen is requisite for adequate organic matter
- Tillage should be eliminated or limited
- Perennial vegetation, especially natural ecosystems, should be encouraged

- Reference: The Nature and Properties of Soils, Chapter 12

Soil organic matter (SOM or just OM) has both positive and **negative charges**, so it can hold on to both cations and anions. Both the clay particles and the organic matter have **negatively charged** sites that attract and hold positively **charged** particles.

Common soil cations + : calcium, magnesium, potassium, ammonium, hydrogen, and sodium.

Common soil anions - : chlorine, nitrate, sulfate, phosphate.

AY-238 Fundamentals of soil cation exchange – Purdue Extension.

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

Reference: The Nature and Properties of Soils, Table 12.5

Factors Promoting Gains

- Green manures or cover crops
- Conservation tillage
- Return of plant residues
- Low temperature and shading
- Controlled grazing
- High soil moisture
- Surface mulches
- Application of compost & manure
- Appropriate nitrogen level
- High plant productivity
- High plant root:shoot ratio

Factors Promoting Losses

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

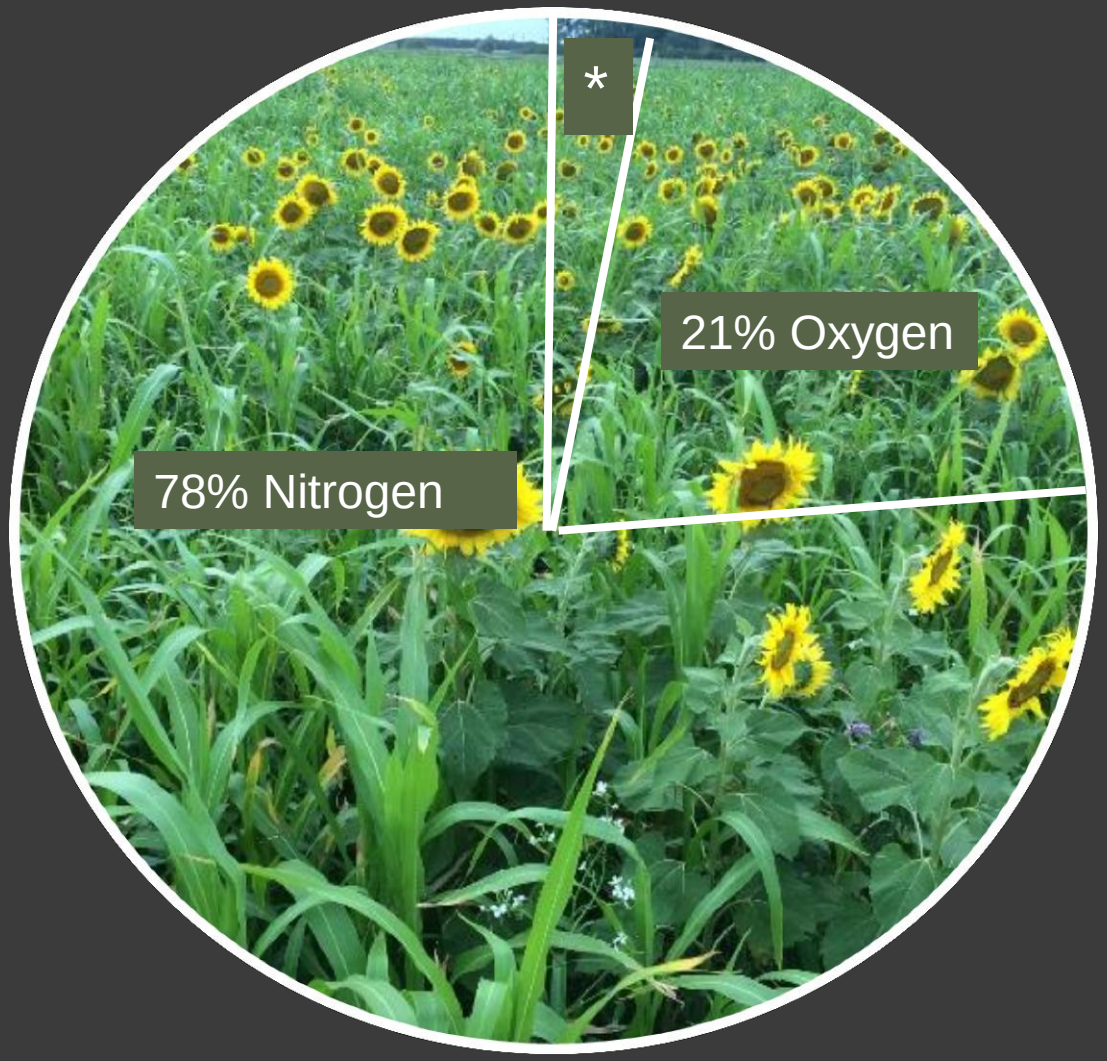
Carbon/Nitrogen Ratio

Carbon to Nitrogen Ratios in Cropping Systems
USDA/NRCS Fact Sheet

rye straw	82:1
wheat straw	80:1
oat straw	70:1
corn stover	57:1
rye cover crop (anthesis)	37:1
pea straw	29:1
rye cover crop (vegetative)	26:1
mature alfalfa hay	25:1
Ideal Microbial Diet	**24:1**
rotted barnyard manure	20:1
legume hay	17:1
beef manure	17:1
young alfalfa hay	13:1
hairy vetch cover crop	11:1
soil microbes (average)	8:1

Air

What Does Dry Air Consist Of?



- 78% Nitrogen N_2
- 21% Oxygen O_2
- 1% *
  - Argon Ar
  - Carbon Dioxide CO_2
  - Neon Ne
  - Helium He
  - Methane CH_4
  - Krypton Kr
  - Nitrogen Oxide N_2O
  - Hydrogen H_2
  - Xenon Xe
  - Ozone O_3

Source: Scifun.Chem.Wisc.edu

Soil Health Principles

Soil Health Principles

Systems Approach

Soil Health: the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans.

Eastern North Dakota

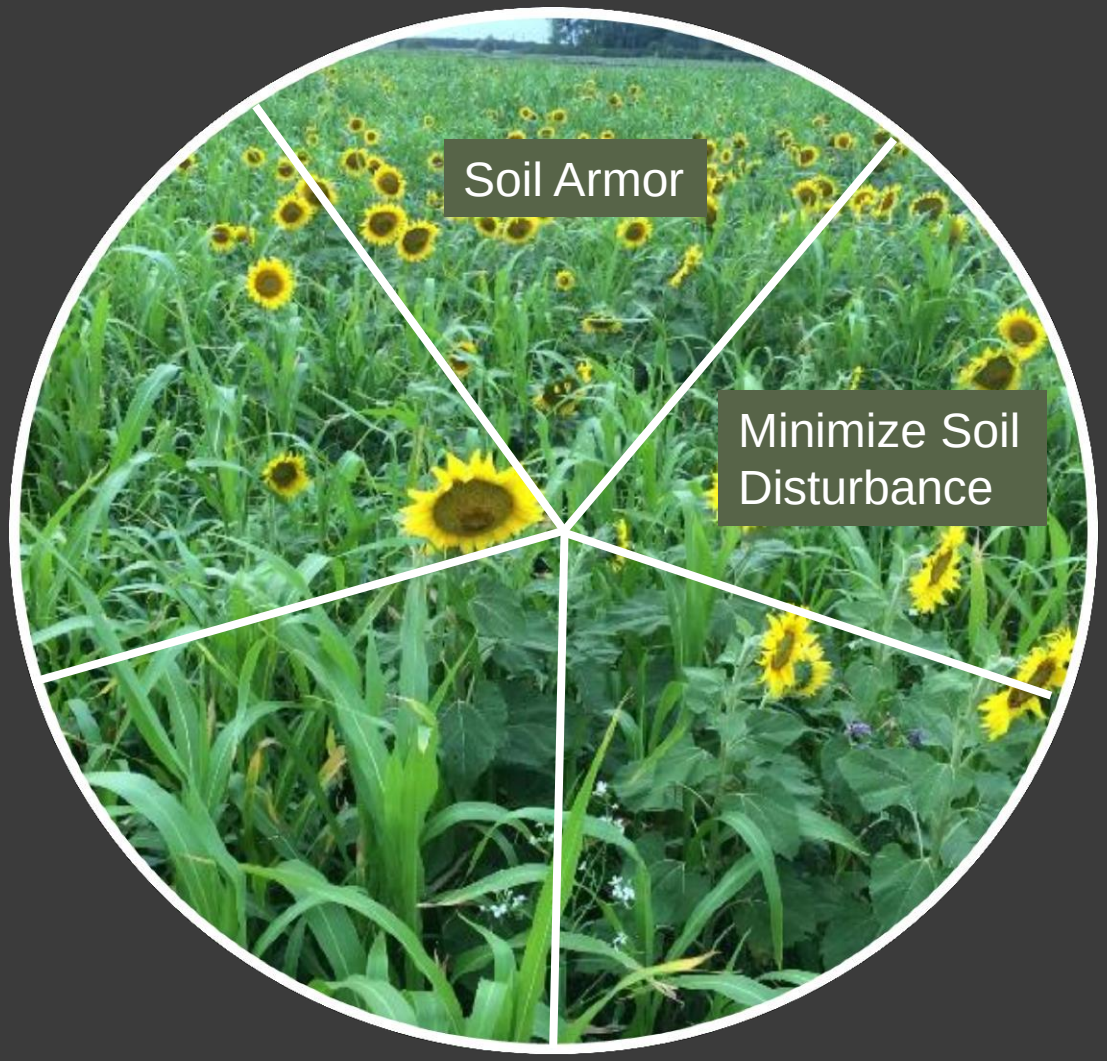
Stable Field With Armor

Erosion - Cropland Field With No Armor


No-Till Field
No Residue
No History of Carbon
04/28/2014


Fall Seeded Cover Crop
Passive Armor and Active Armor
Both are food sources
Menoken Farm


Menoken Farm
May 2015 Corn Planting
Multi Specie Cover Crop Residue



Soil Health Principles

Systems Approach

Soil Health: the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans.

Recent Wind Erosion Near Fargo


Minimal Soil Disturbance
Menoken Farm

Dr. Dave Frazen – NDSU
May 26, 2016
Farm and Ranch Guide Continued

"One hundred twenty-five years ago there was black soil everywhere, and now we've gotten to the point where we have less than a foot in almost every field," he said. "We want people to know they're kind of on the tipping point. We may be farming subsoil soon, where you'll need more fertilizer and yields will be depressed because we don't have that natural organic material in there. All those things have already started to happen."

While sampling a few miles west of Gardner, N.D., this spring, Franzen said there was only 10 inches of dark topsoil left over subsoil that used to be more than two feet thick. A decade ago, along the highway from Grafton to I-29, the topsoil used to be black but now it's brown, he noted, addding while sampling in a couple fields north and south of Casselton, there is only 10 inches of topsoil left.

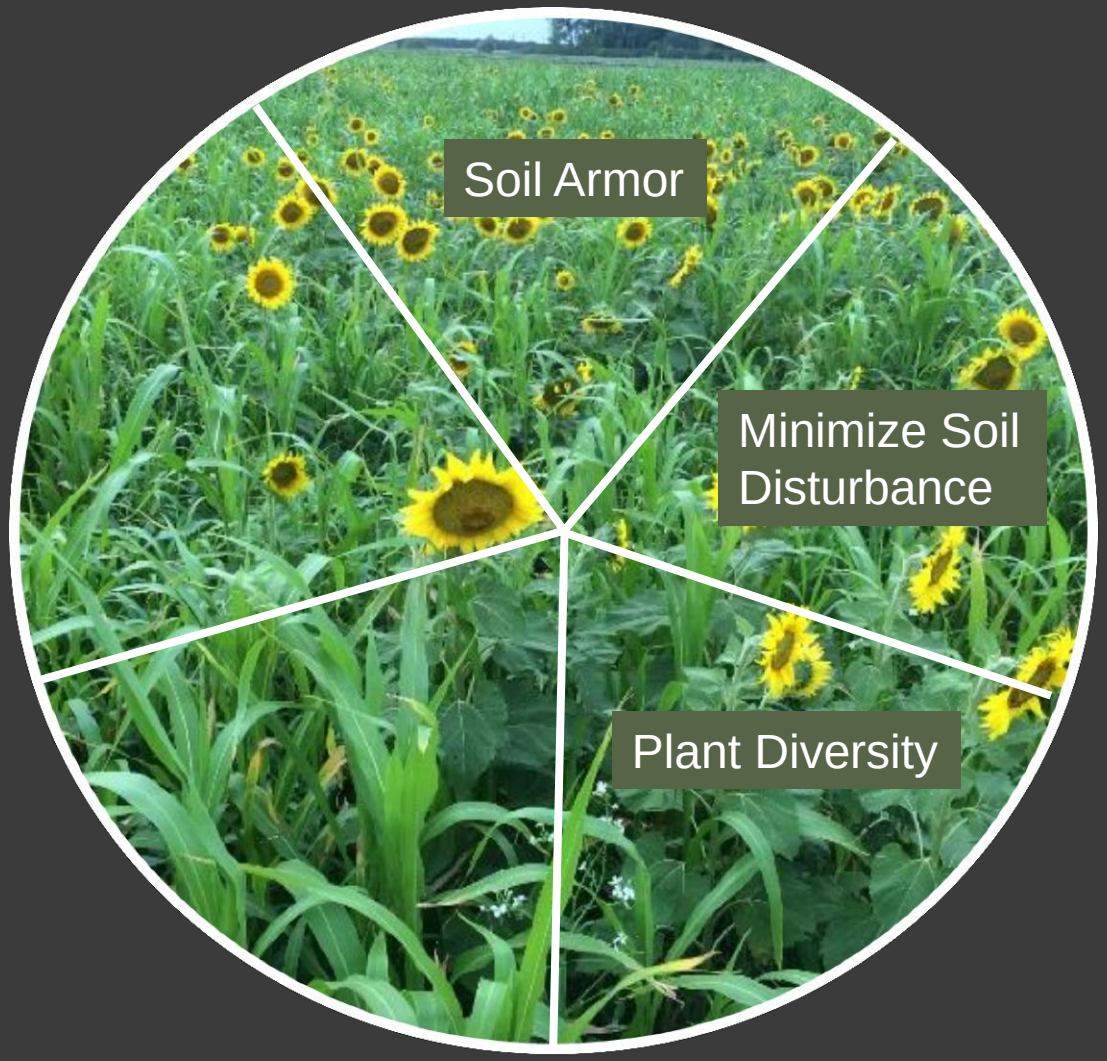
Analysis of dust in the 1930's compared to the soil that remained showed that there was 19 times more P2O5 in the dust than in what was left.

Also 10 times more organic matter.

9 times more nitrogen.

And 45 times more potassium.

Reference: Small Farms, Externalities and the Dust Bowl of the 1930's.
Hansen, 2.K., and Lidecap, G.P., 2004, Journal of Political Economy.



Soil Health Principles

Systems Approach

Soil Health: the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans.

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

Diversity - Crop Types.

Cool Season Grass

Barley
Durum Wheat
Oat
Spring Wheat
Winter Rye
Winter Triticale
Winter Wheat

Cool Season Broadleaf

Canola
Crambe
Flax
Lentils
Oilseed Radish
Mustard
Forage Canola
Red Clover
Sweet Clover
Turnip
Pasja
Pea
Lupin

Diversity - Crop Types

Warm Season Broadleaf

Alfalfa
Buckwheat
Chick Pea
Amaranth
Cowpea
Soybean
Safflower
Sunflower

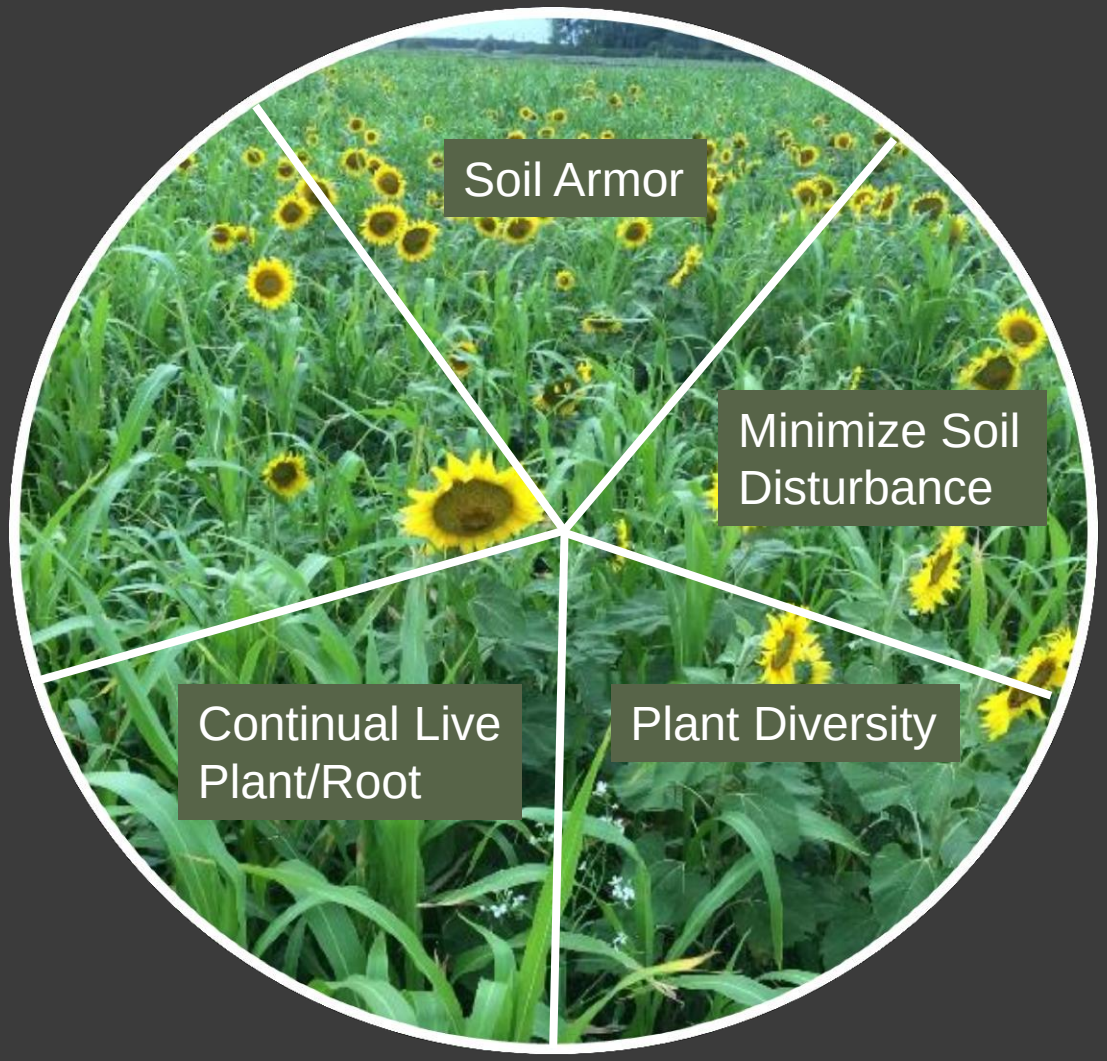
Warm Season Grass

Corn
Proso Millet
Pearl Millet
Sorghum
Sudan


10/10/2013


05/01/2012


05/10/2012

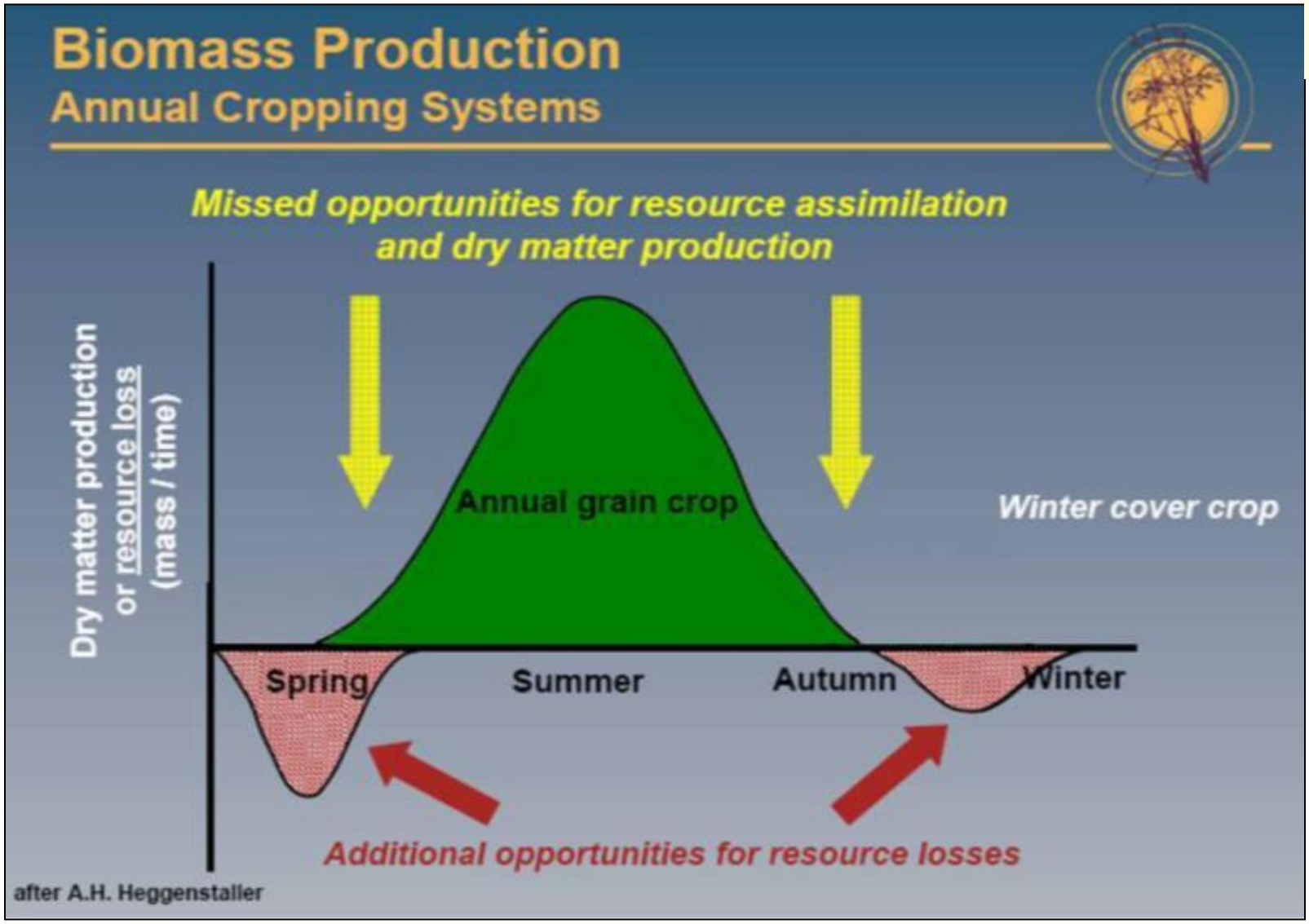


Soil Health Principles

Systems Approach

Soil Health: the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans.

Missed Opportunities



A. H. Heggenstaller, University of Alberta


Covers Seeded After Wheat Harvest
Menoken Farm

Corn/Hairy Vetch
Menoken Farm

Planting Green with Biennials in North Dakota

- Winter Hardy
- Controls Erosion
- Saline Tolerant
- Adds Crop Diversity
- Adds Carbon

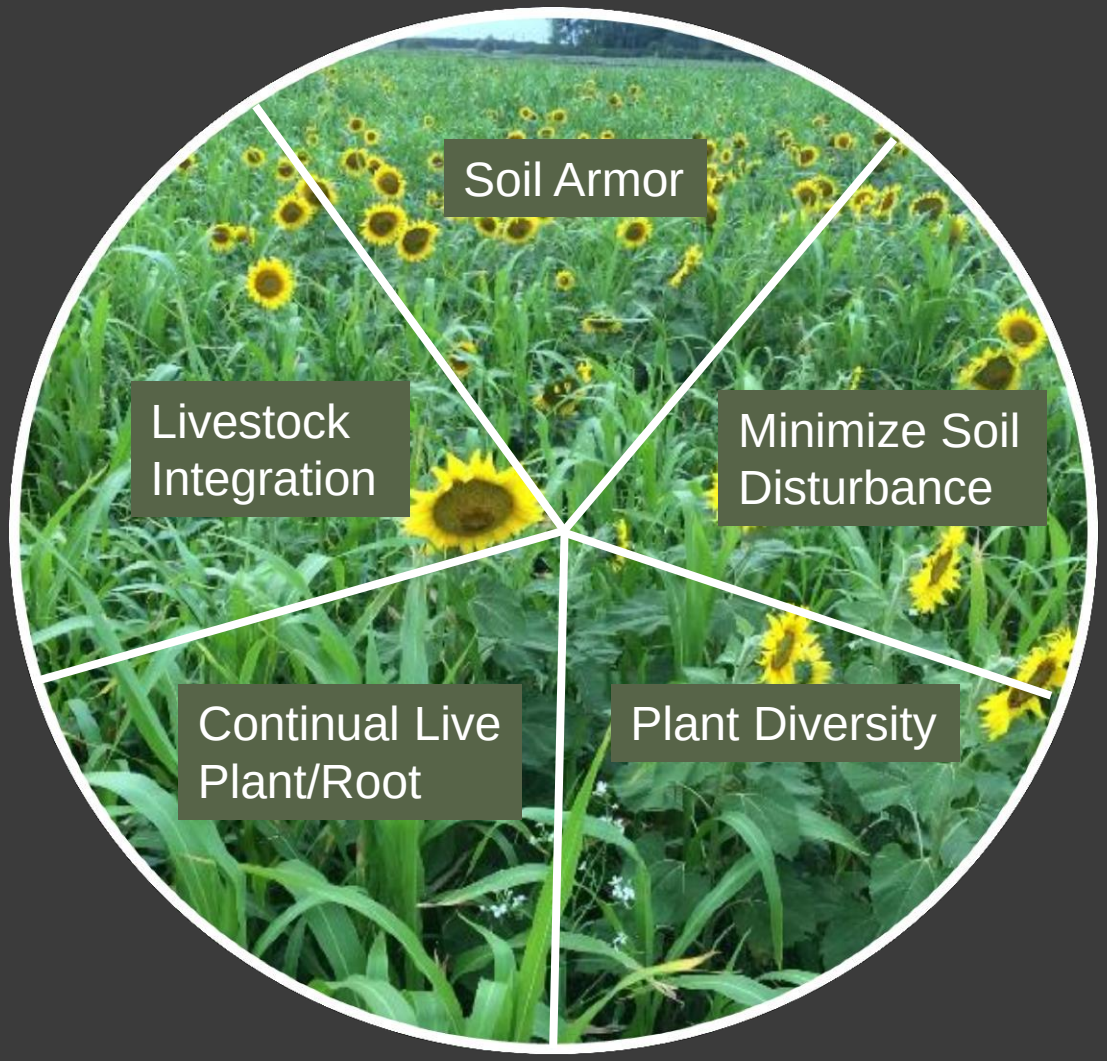

Field 3: No History of Cover Crops. Weeds: Downy Brome, Wild Oat, Tansy Mustard
Crop History 2009 Wheat 2010 Wheat 2011 Wheat
Low Diversity
The Menoken Farm
Photo Date 4/30/12
Herbicide Applied 5/1/12
Seeding Date 5/1/12
04/30/2012


Field 4 History of Cover Crops
Crop History 2009 Cover Crop 2010 Corn 2011 Pea + Cover Crop
High Diversity
The Menoken Farm
Photo Date 4/30/12
Herbicide Applied 5/1/12
Seeding Date 5/1/12
04/30/2012

Spring Weed Suppression
IPM BCSCD Site


Covers Seeded After Wheat Harvest
Menoken Farm


Mixed Cropping
Sunflower and Cover Crops
Livestock Integration
Menoken Farm



Soil Health Principles

Systems Approach

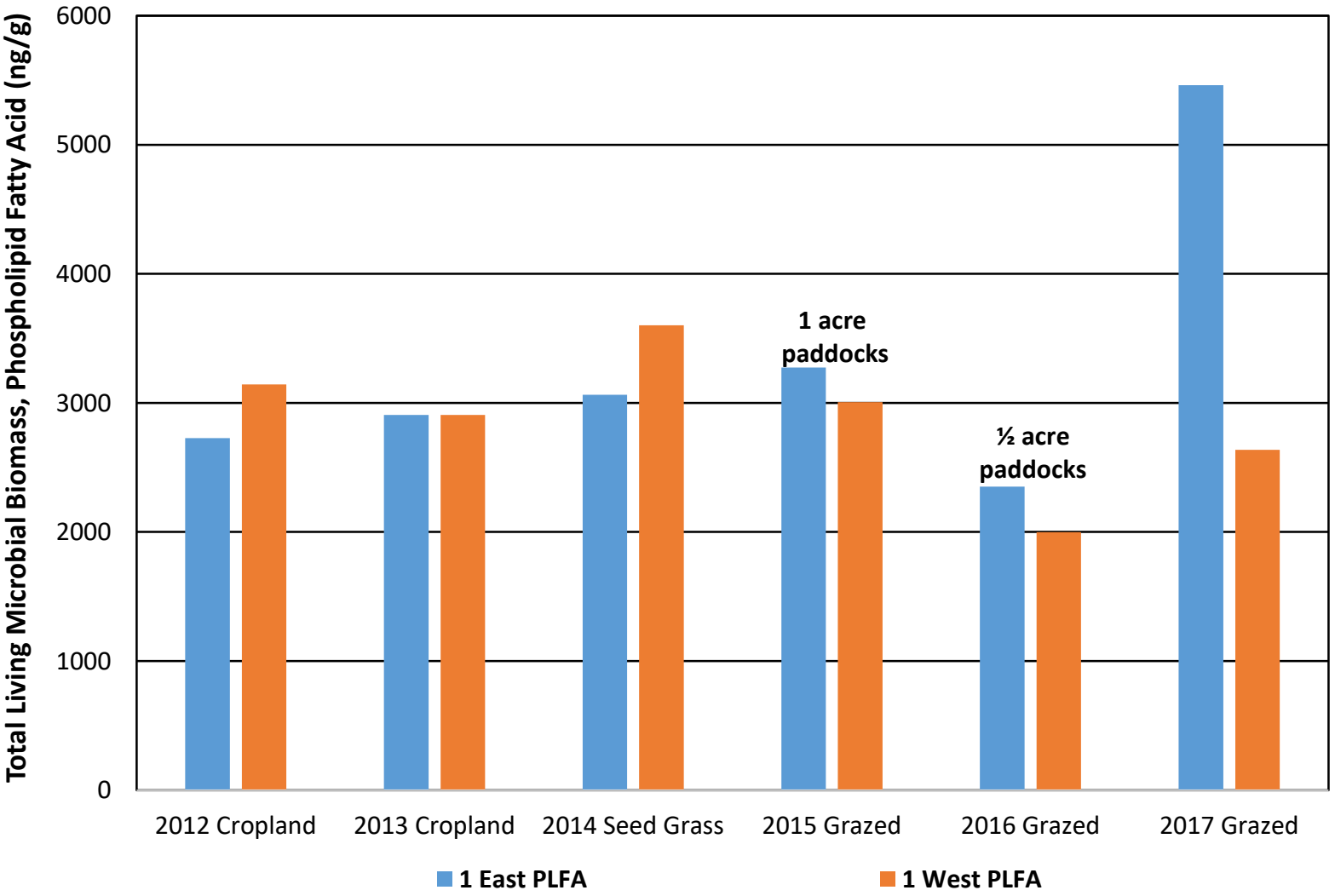
Soil Health: the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans.


Warm Season Cover Crop Mixture
Menoken Farm - 2016

Moving the open heifers to the next paddock – 17 head.

Armor After Grazing
Menoken Farm - 2016

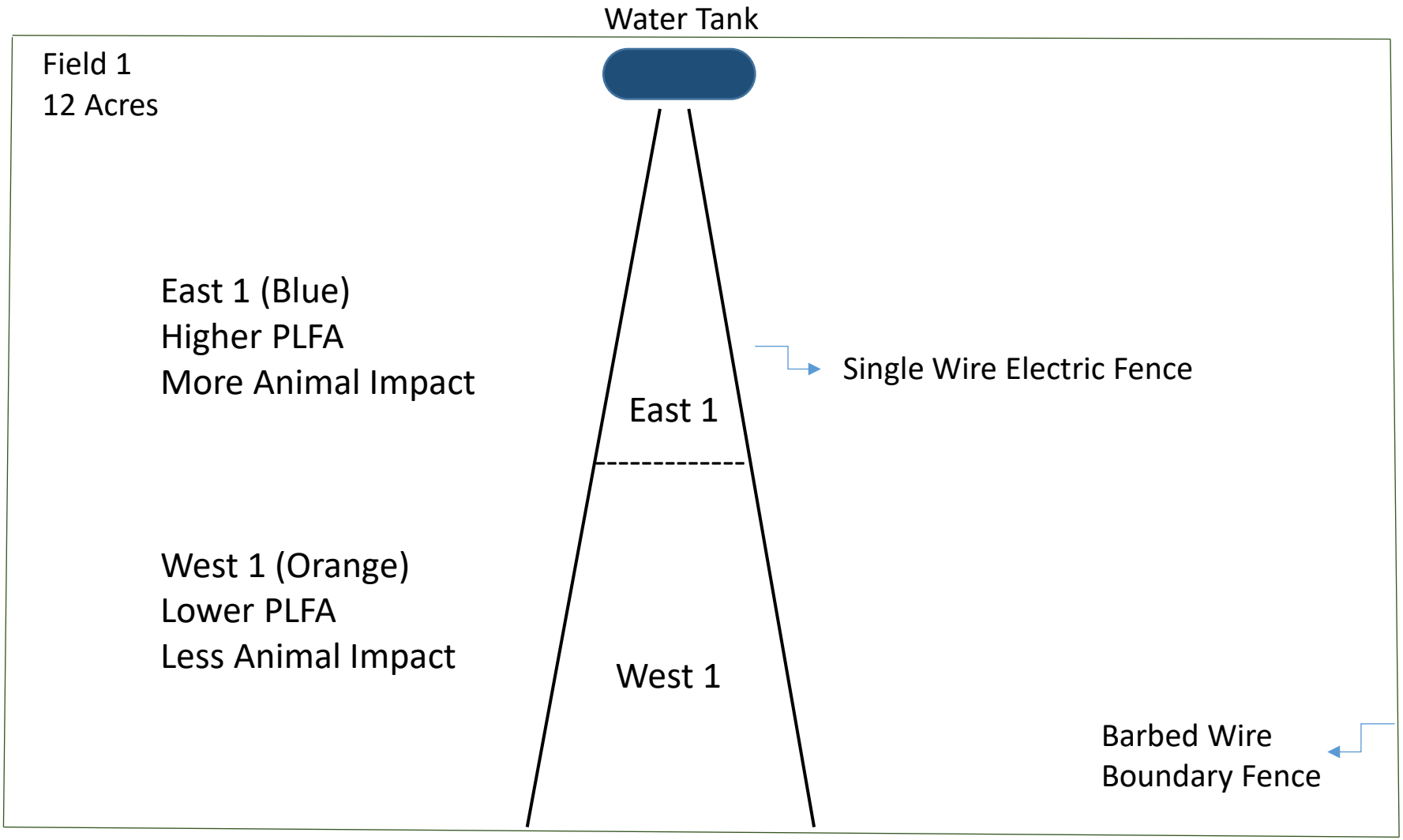
Grazing Impacts on Soil Food Web



Menoken Farm

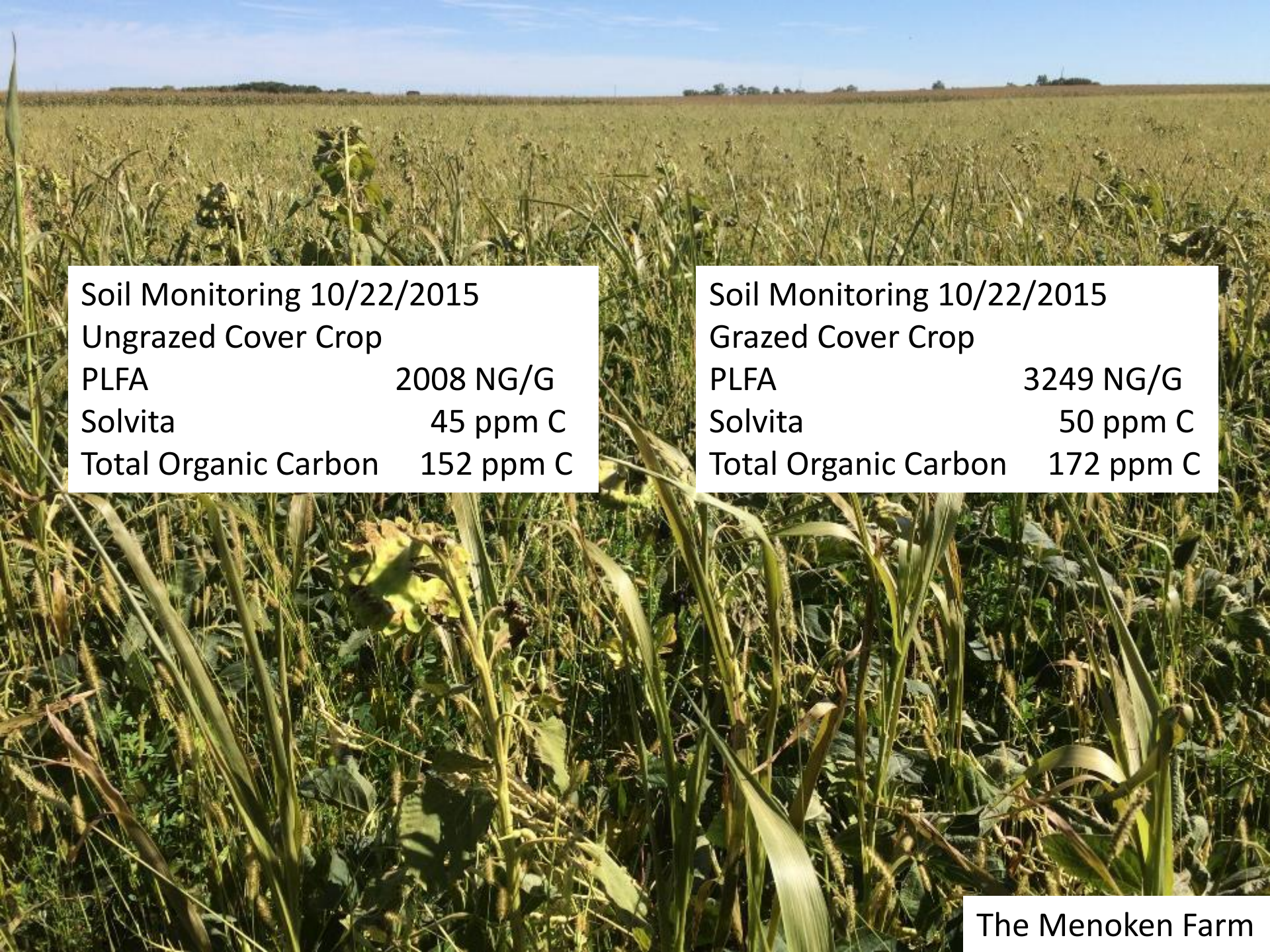
Paddock Design Influences the Soil Food Web

Note: East 1 and West 1 are Grazed as One Paddock, but Sampled Separately



Menoken Farm

Cover Crop Feed and Forage Report			
Menoken Farm			
19-Sep-16			
Specie	**Crude Protein**	**RFV**	**TDN**
Annual Ryegrass - Top/half	15.67%	110.81	61.88%
Annual Ryegrass - Bottom/half	8.02%	109.05	60.12%
Cowpea - Top/half	14.79%	218.90	69.38%
Cowpea -Bottom/half	4.35%	103.72	58.94%
Hairy Vetch - Top/half	14.75%	126.74	60.78%
Hairy Vetch - Bottom/half	6.07%	85.59	52.08%
Pearl Millet - Top/half	9.77%	83.95	59.18%
Pearl Millet - Bottom/half	1.77%	86.91	57.79%
Radish - Top/half	10.74%	105.20	56.08%
Radish - Bottom/half	6.54%	75.30	48.09%
Soybean - Top/half	17.90%	190.15	67.95%
Soybean - Bottom/half	11.76%	114.08	59.10%
Sudan - Top/half	7.83%	83.93	58.21%
Sudan - Bottom/half	7.52%	84.78	57.56%
Sunflower - Top/half	10.38%	193.66	65.57%
Sunflower - Bottom/half	6.06%	123.83	58.30%
Sweet clover - Top/half	24.53%	228.51	72.25%
Sweet clover - Bottom/half	12.62%	97.47	55.15%
Cool Season Cover Crop Mix (fall seeded)	26.79%	208.43	71.32%
Source: Dairyland Laboratories, Inc.			

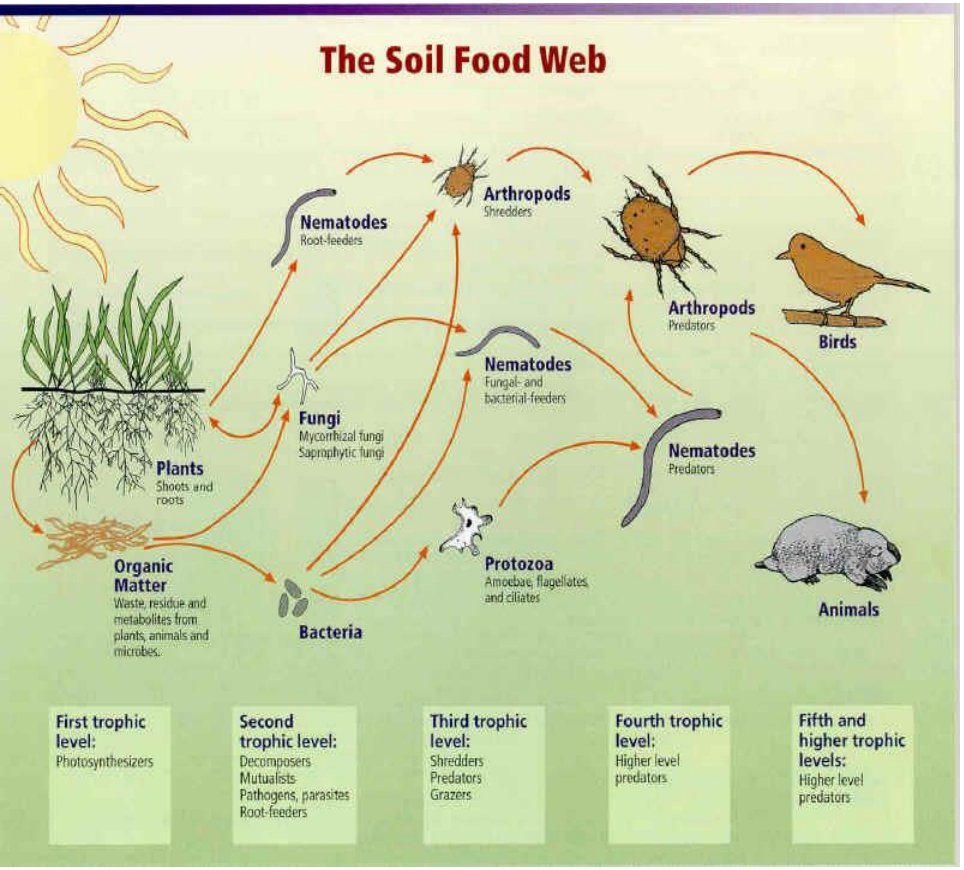


Soil Monitoring 10/22/2015	
Ungrazed Cover Crop	
PLFA	2008 NG/G
Solvita	45 ppm C
Total Organic Carbon	152 ppm C

Soil Monitoring 10/22/2015	
Grazed Cover Crop	
PLFA	3249 NG/G
Solvita	50 ppm C
Total Organic Carbon	172 ppm C

The Menoken Farm

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



- **Bacteria**-

  Decomposer of simple carbon chains (low carbon residue).

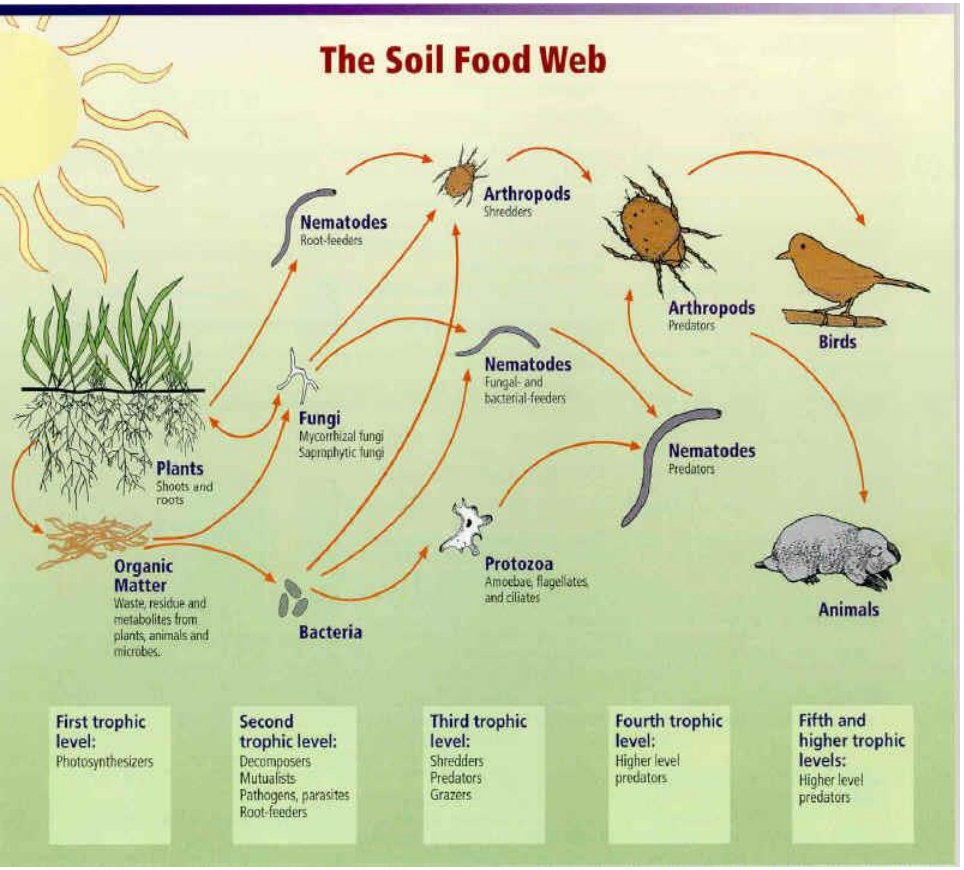
  Little bag of fertilizer.

  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).

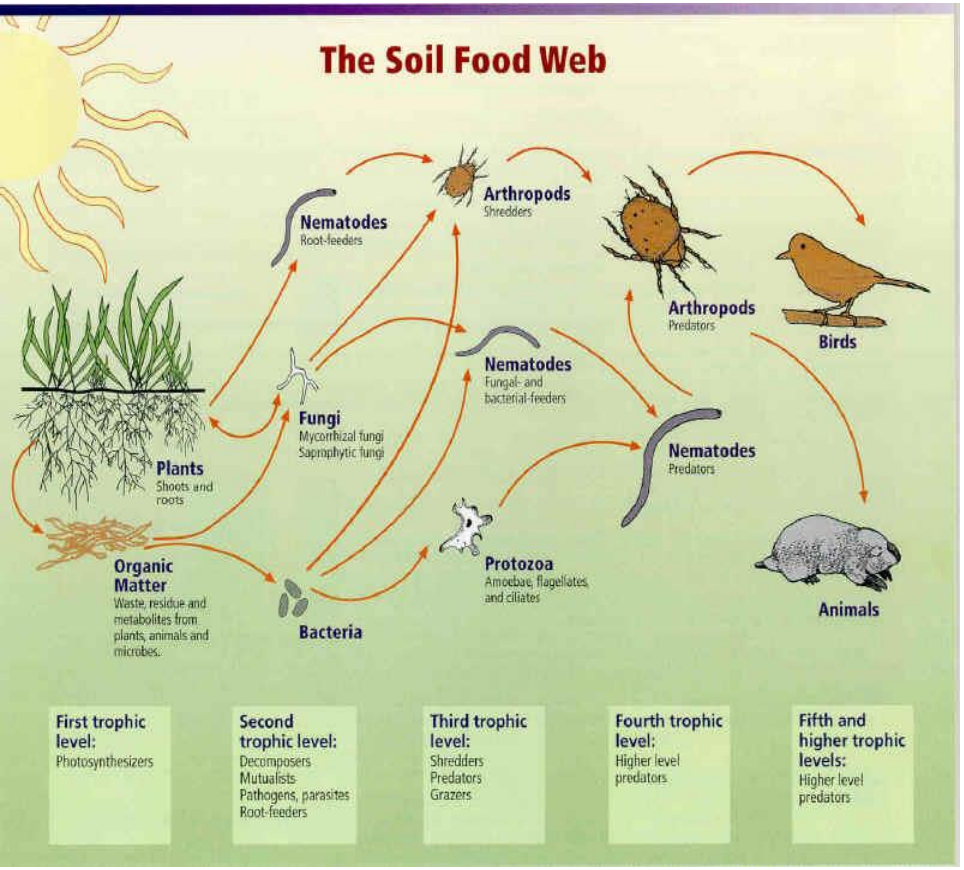
  Mycorrhizal-transports nutrients.

  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.

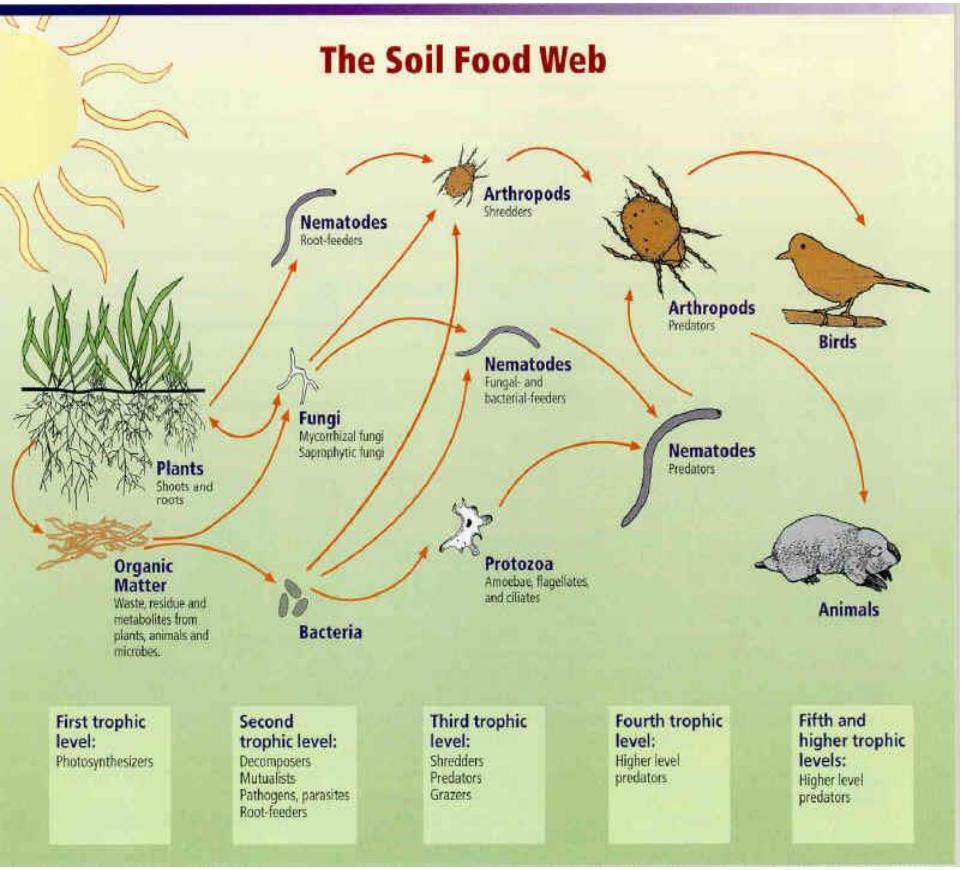
  Amoebae – large

  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.

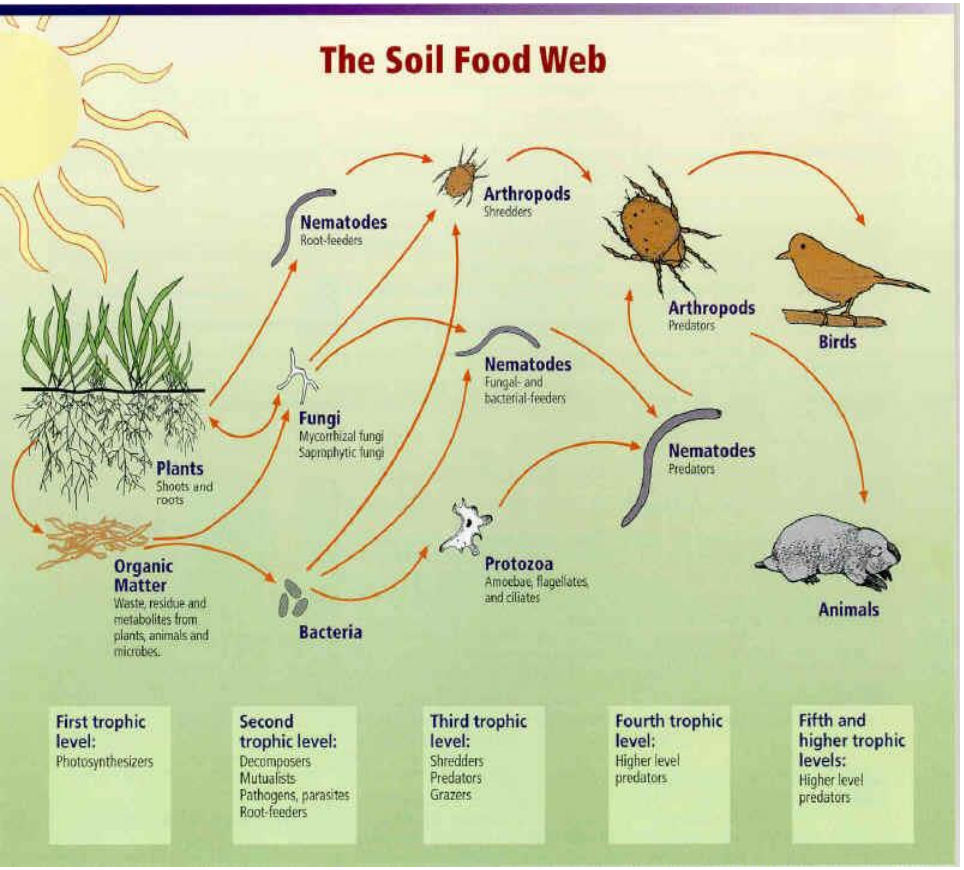
  Locate food by temperature.

  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.


Returning Cover Crops
and Livestock to the Landscape
North Dakota, USA
Thank You

Self Education

- The Nature and Properties of Soils – 14th Edition : by Brady and Weil
- Journals of Lewis and Clark
- Buffalo Bird Women's Garden : by Gilbert Wilson
- The One Straw Revolution: by Masanobu Fukuoka
- Managing Cover Crops Profitably 3rd Edition
- A Sand County Almanac: by Aldo Leopold
- Soil Biology Primer: by Elaine Ingham
- Life in the Soil: by James Nardi
- An Agricultural Testament: by Sir Albert Howard
- Dirt – The Erosion of Civilizations: by David Montgomery
- Early Settlement of North Dakota: by Clement Lounsberry
- 1491: by Charles Mann

www.menokenfarm.com

www.dakotalakes.com

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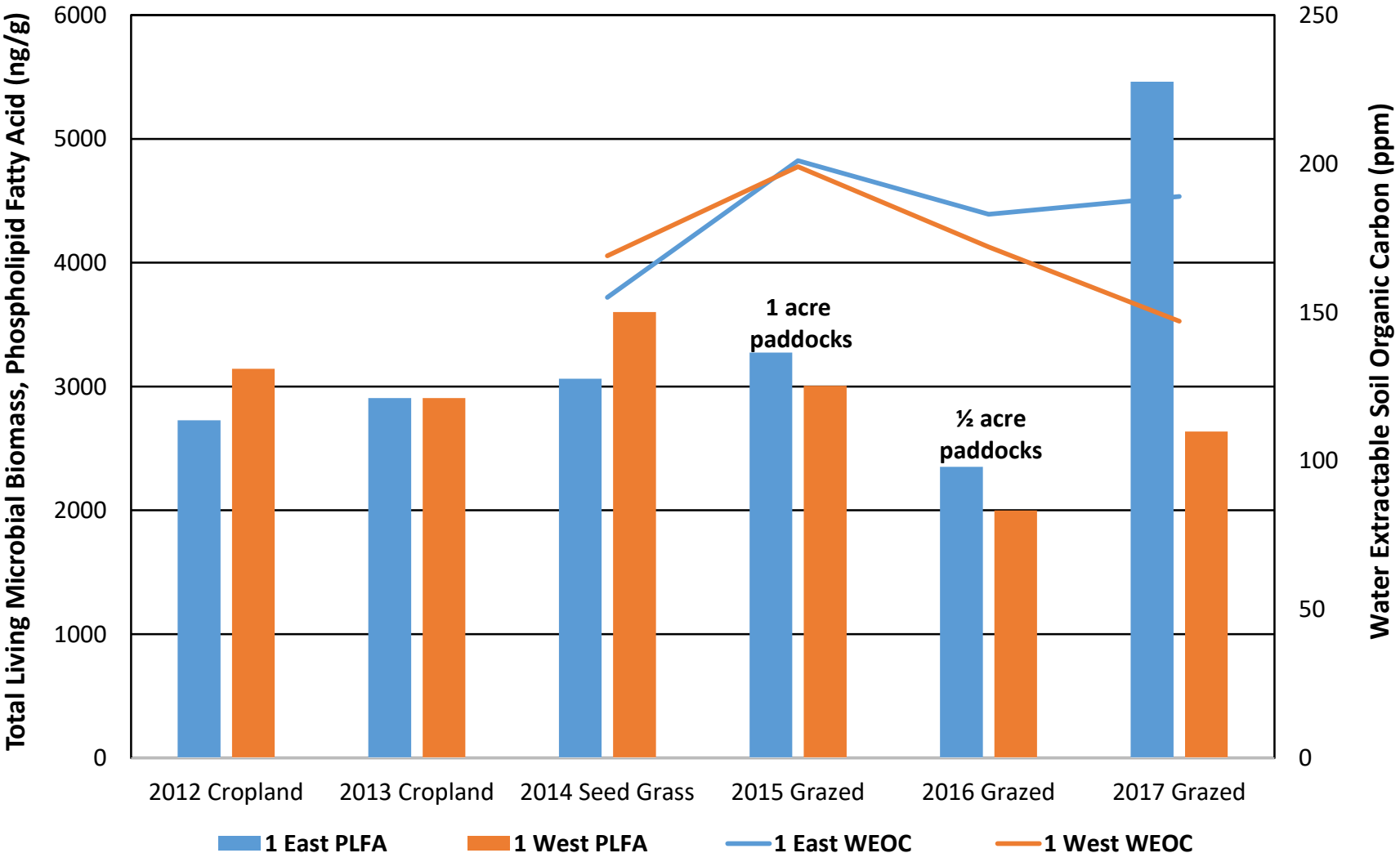
1-701-426-8611 (C)

Websites:
NRCS/USDA
https://www.nrcs.usda.gov/wps/portal/nrcs/site/nd/home/

Menoken Farm
http://menokenfarm.com/

Grazing Impacts on Soil Food Web



Menoken Farm