It’s Not Just Dirt Anymore

by Jay Fuhrer

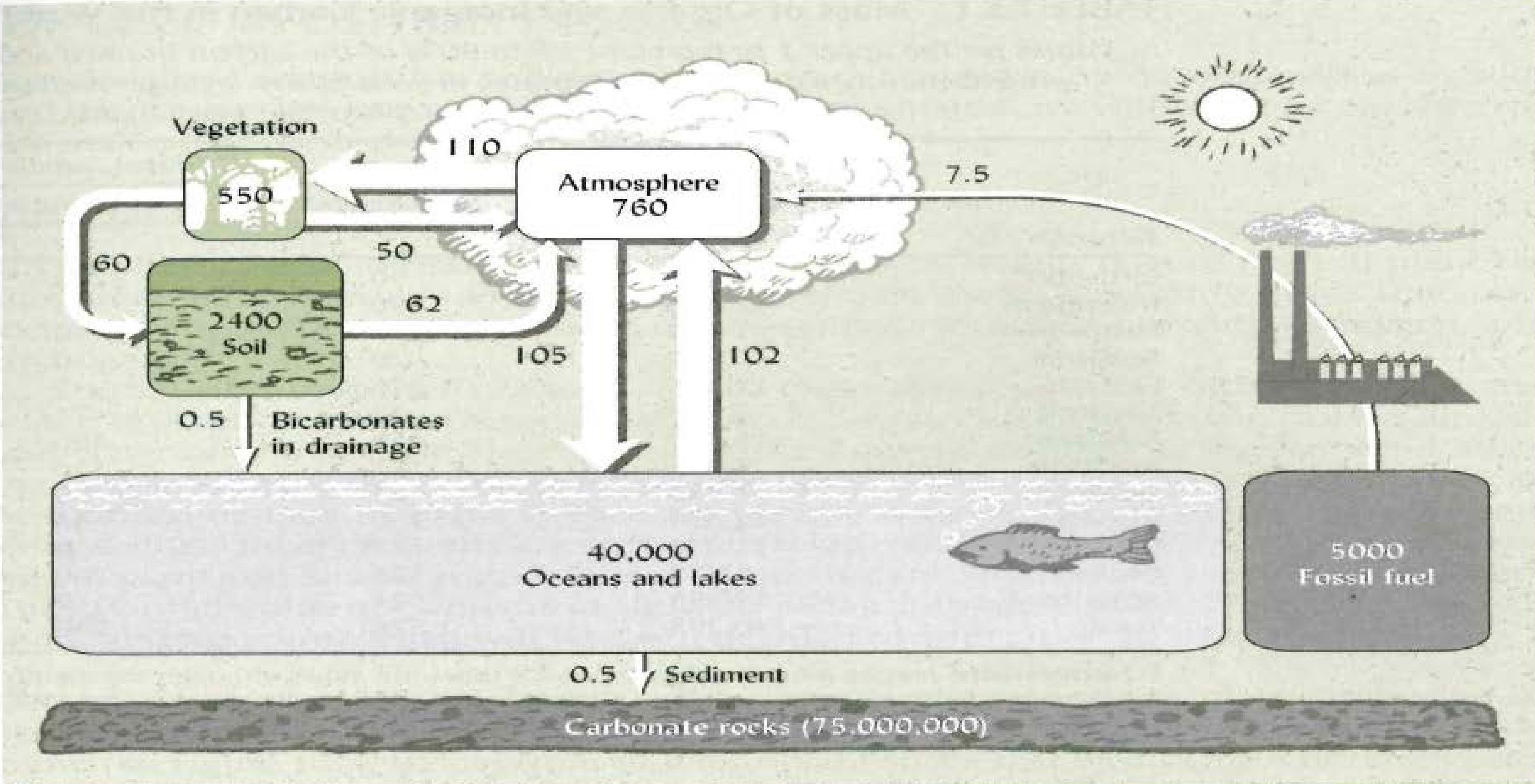


FIGURE 12.3 A simplified representation of the global carbon cycle emphasizing those pools of carbon which interact with the atmosphere. The numbers in the boxes indicate the petagrams (Pg = 10^{15} g) of carbon stored in the major pools. The numbers by the arrows show the amount of carbon annually flowing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

news | NORTH DAKOTA STATE UNIVERSITY | SEARCH
NDSU Agriculture Communication
NDSU Extension Service
ND Agricultural Experiment Station

Dust Storms Still Causing Damage in N.D.

The greatest export of phosphate is due to wind erosion.

Few people are aware that North Dakota has exported phosphate since the 1880s, according to Dave Franzen, North Dakota State University Extension Service soil science professor and soil specialist.

When settlers came to North Dakota, many wanted to farm but lacked the skills or tools to do so. Some migrated to the state from the East, where the soils and environment were very different. Those who came to North Dakota in the 1880s found an area that had few roads, no infrastructure, few neighbors and little source of income.

"Across the prairie were scattered millions of pounds of buffalo bones," Franzen says. "Some of these bones came from natural death, while many others came from the slaughter of buffalo during the earlier migration of hunters looking for hides to ship to the East."

The bones were gathered by the settlers and taken to railroad depots at Ellendale, Fort Totten and other locations.

"The bones were sold for cash of up to $15 per ton, which was big money in those days," Franzen says. "The settlers used the cash for food to survive or upgrade their sod houses. From about 1880 to 1892, when the trade all but ended, my estimate is that about 32 million pounds of bones were shipped east for fertilizer and industrial uses from North Dakota."

The nutrient content of bone is about 3-15-0, or about 15 percent phosphate (P). Using these figures, we can estimate that about two years of phosphate applications were shipped east at today's historic high rates.

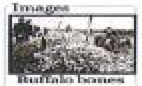
"Today, the greatest export of P is due to wind erosion," Franzen says. "North Dakota is one of the windiest regions on Earth. Settlers used farming techniques from the old country or the eastern U.S., which did not consider wind erosion. So when the soil was dry, the soil blew."

Dust storms were very common in the 1920s, '30s and even today. The dust doesn't just settle in a nearby ditch. Accounts from the 1930s by aviators describe dust clouds to 14,000 feet in elevation, so dust can travel thousands of miles.

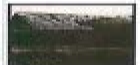
The P content of the dust that settled in East Coast states was 19 times that of what remained on the prairie, and the wind still blows today.

During the 1930s, North Dakota lost the equivalent of 40 years of P application at present rates.

Images



Buffalo bones being loaded into railroad cars in the 1880s near Krem, N.D. Photo from NDSU Germans from Russia Heritage Collection.



Soil dunes over a barn in Kidder County (1939). N.D. State Archives image.

Dust storm northern Red River Valley about 2005. Image courtesy of A.C. Cattanach,

Des Moines struggling with nitrate levels in drinking water

By DAVID PITT
Associated Press

> "What we're seeing are numbers late into the fall and into the early winter like we've never seen before."
> *Bill Stowe, Des Moines Water Works CEO*

DES MOINES, Iowa — Two rivers that supply water to 500,000 people in the Des Moines area show nitrate levels spiking to levels that make it unsafe for some to drink, a concentration experts haven't before seen in the fall that likely stems from especially wet weather in recent months.

The utility that supplies Des Moines and most of its suburbs had workers blending river water with other sources to lower the nitrate levels, but the situation may be nearing the point at which the city starts a process that costs about $7,000 a day to remove them. If that happens, the utility has threatened to sue the state.

On Friday, the nitrate level in the Des Moines River was at 12.8 parts per million and the Raccoon River was at 13.7. The U.S. Environmental Protection Agency requires officials to inform the public about safety risks at 10 parts per million.

Iowa and other states often have problems with nitrates in the spring, when rain washes unused fertilizer from farm fields. But it's unheard of to have spikes so high in November, said Des Moines Water Works CEO Bill Stowe. Scientists believe the current problem is caused by wet weather in the late summer and fall, which sent nitrogen remaining in the soil washing downstream.

"What we're seeing are numbers late into the fall and into the early winter like we've never seen before," Stowe said.

Stowe said so far workers were keeping the drinking water at just over 8 ppm. Water above 10 ppm can be deadly to children younger than 6 months because the chemical can reduce the amount of oxygen carried in their blood. Pregnant women and adults with reduced stomach acidity are advised not to drink water above the EPA limit.

In spring 2013, nitrate levels hit all-time highs on both rivers when a wet spring washed nitrogen from fields after a severe drought. Water Works mechanically cleaned the water at a cost of $900,000 until nitrate levels subsided more than two months later. If it happens again, Stowe said the utility likely will sue, alleging the state is violating the Clean Water Act by failing to reduce the nitrogen levels in rivers.

Monitors in rivers throughout the nation show no other sites with such high nitrate levels. But the issue is especially severe in parts of Iowa given the intense farming and tiling of land. More than 2 million acres in west-central Iowa drain into the Raccoon River, most of it cropland or livestock farms. An estimated 78 percent uses man-made drainage tiles to quickly move water downstream.

Although Iowa began a voluntary program in May 2013 that encourages farmers to make changes to reduce runoff, Stowe and environmental groups argue that strategy is toothless and lacks measurable benchmarks or a timeline for improvement.

For years, environmental groups have called for the state to regulate livestock farms, much as they already do for city wastewater treatment plans, which must have permits that limit release of contaminants into rivers. They're also seeking ways to measure and limit the release of nitrates from fields where tile has been laid underground.

Iowa DNR spokesman Kevin Baskins said the state acknowledges the need to improve its waterways, but that it will take time for voluntary efforts to work. He said farmers are beginning conservation practices and government grants are giving them incentives.

"This isn't something where you just get instant results," Baskins said. "We didn't get into the kind of situation we have today in terms of excess nutrients overnight and we won't get out of it overnight."

Significantly reducing nitrogen levels likely requires slowing the flow of water into rivers by setting up wetlands or planting grasses or other cover crops on harvested fields, allowing the plants to retain water and consume excess chemicals.

"We have millions of acres on which we need to implement this stuff," said Chris Jones, an environmental scientist with the Iowa Soybean Association who has studied the Raccoon River.

Bismarck Tribune 11/23/14

BISMARCK WSFO AP, NORTH DAKOTA (320819)

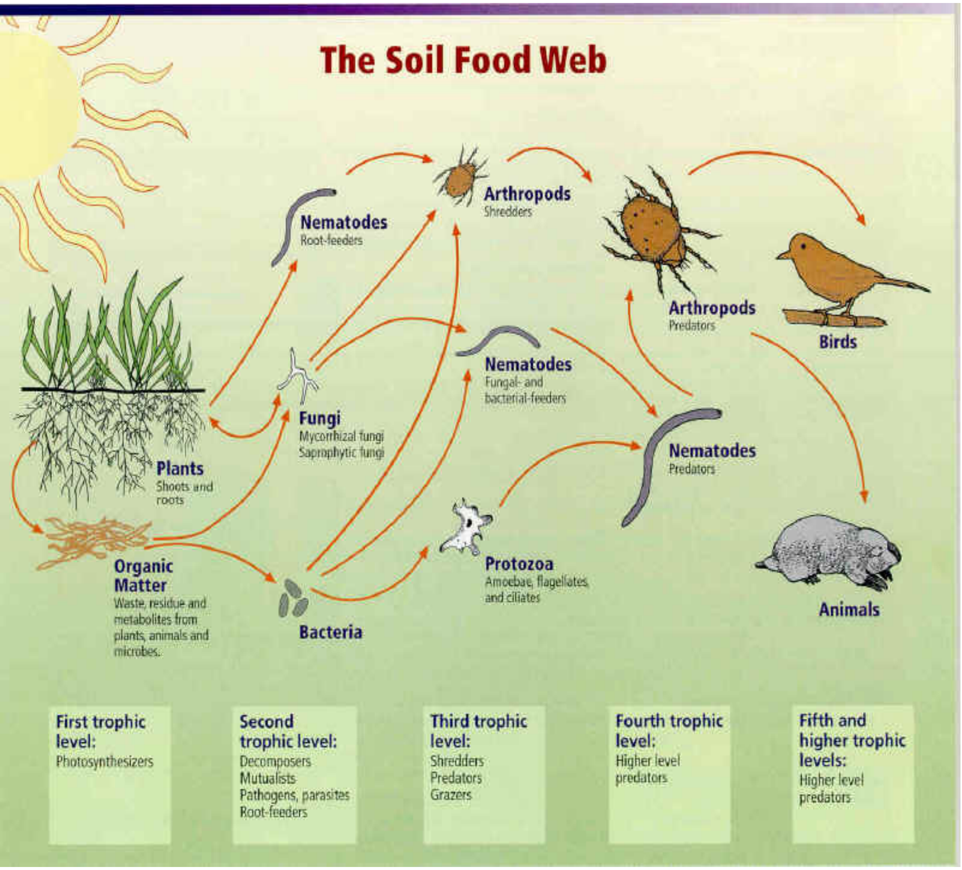
40 Centimeters
Annual Precipitation

Period of Record Monthly Climate Summary

Period of Record : 7/ 1/1948 to 12/31/2007

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	20.1	26.6	38.2	55.4	68.1	77.2	84.6	83.4	71.8	58.6	39.4	26.2	54.1
Average Min. Temperature (F)	-1.5	5.5	17.3	30.7	42.4	51.9	57.0	54.8	44.0	32.4	18.2	5.4	29.8
Average Total Precipitation (in.)	0.47	0.47	0.78	1.39	2.33	2.94	2.44	2.00	1.40	1.02	0.58	0.46	16.28
Average Total SnowFall (in.)	7.9	7.2	8.5	3.6	0.8	0.0	0.0	0.0	0.1	1.6	6.5	7.6	43.8
Average Snow Depth (in.)	4	4	2	0	0	0	0	0	0	0	1	2	1

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



- **Bacteria**-

  Decomposer of simple carbon chains (low carbon residue).

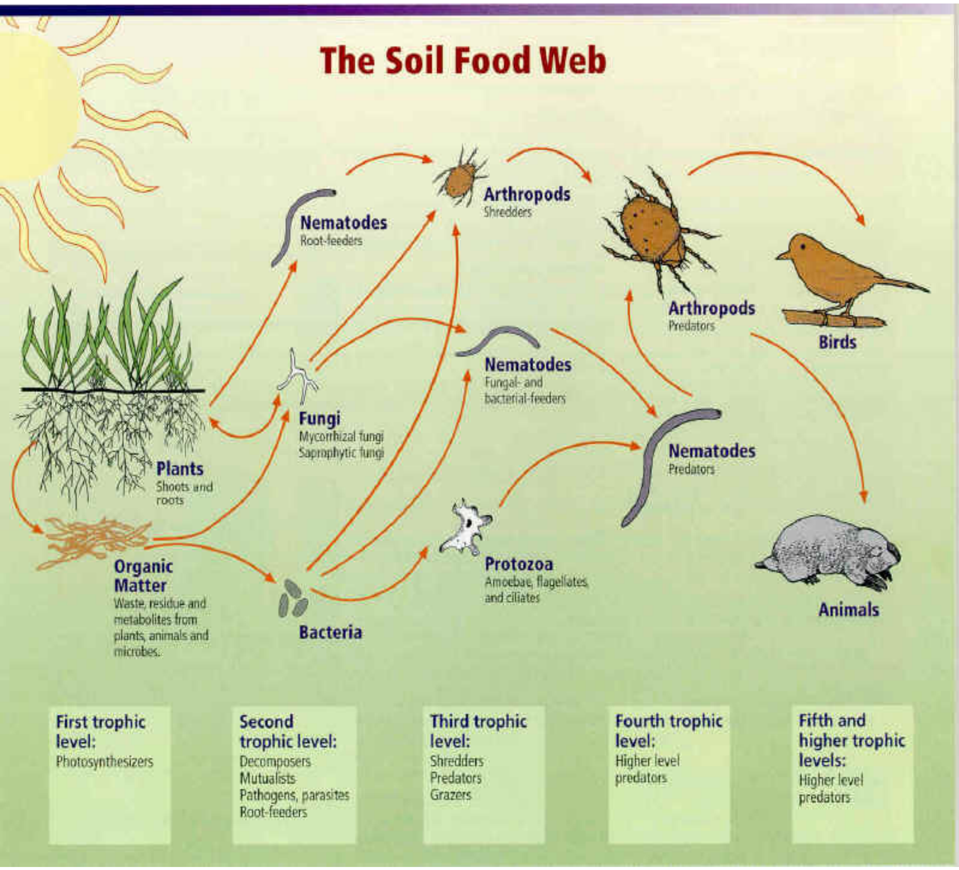
  Little bag of fertilizer.

  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…



Soil Biology Primer

- **Fungi**-

  Saprophytic-primary decomposer of complex

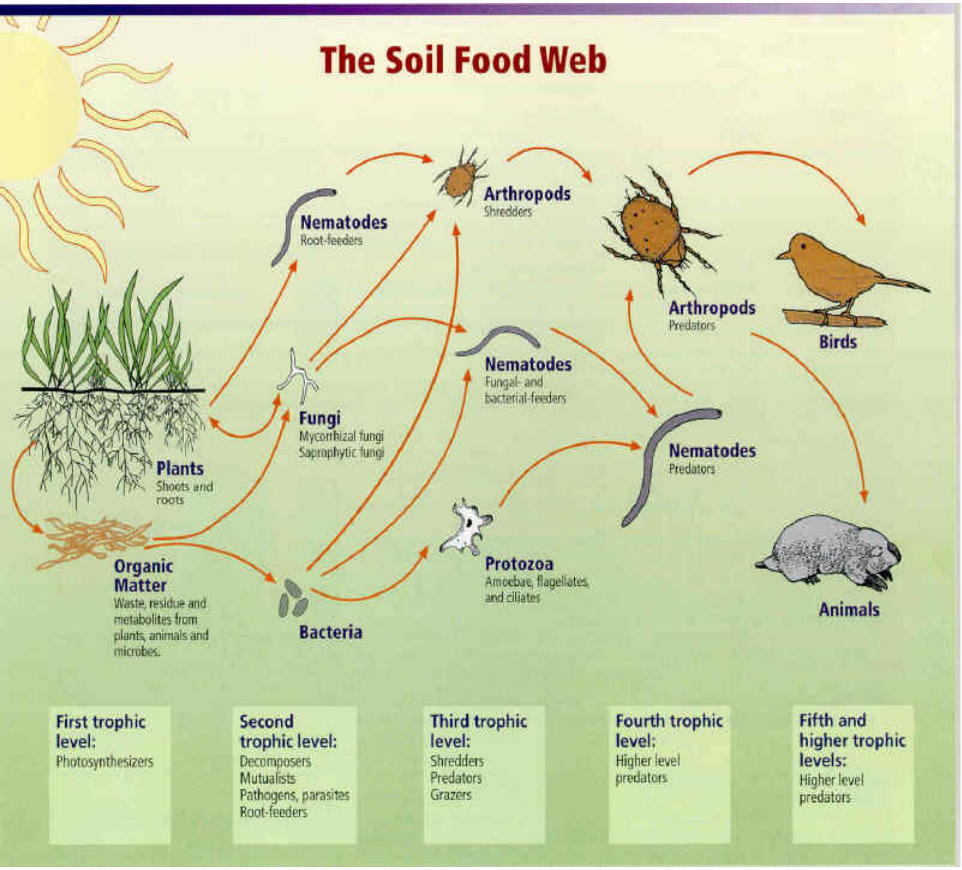
  carbon chains (high carbon chains).

  Mycorrhizal-transports nutrients.

  Little bag of fertilizer.

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

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.

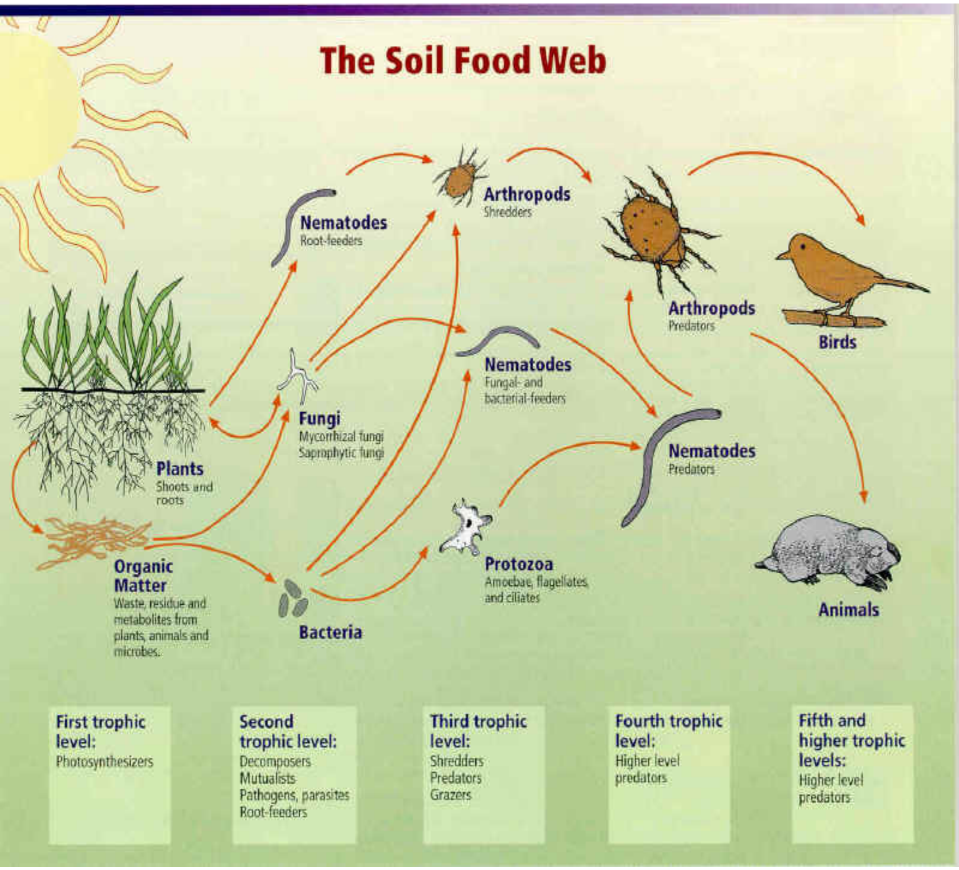
  Amoebae – large

  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.

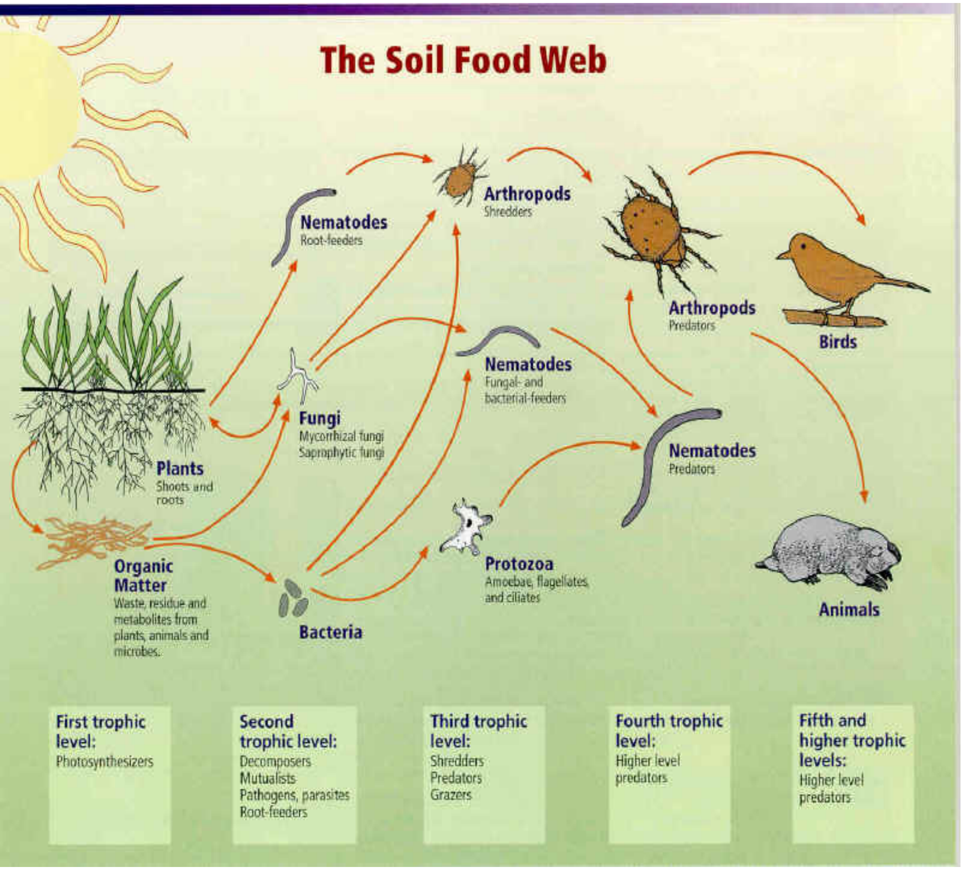
  Locate food by temperature.

  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.

The “Above Ground” Players Include the Menoken Farm plus….

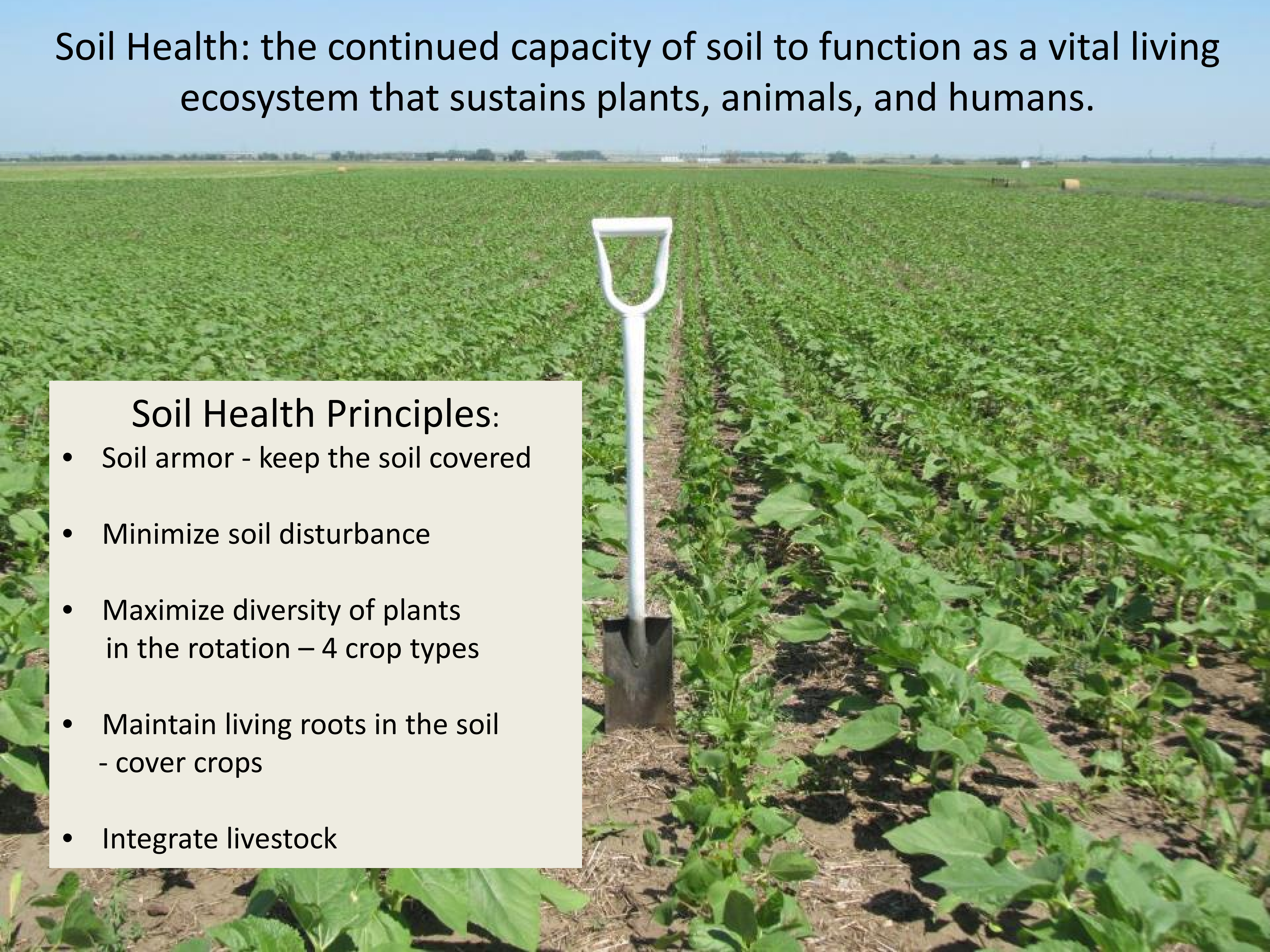
Gabe Brown
Brown’s Ranch

Glenn Bauer
Bacon Heights Farms

Marlyn Richter
Richter Farms

Jerry Doan
Black Leg Ranch

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



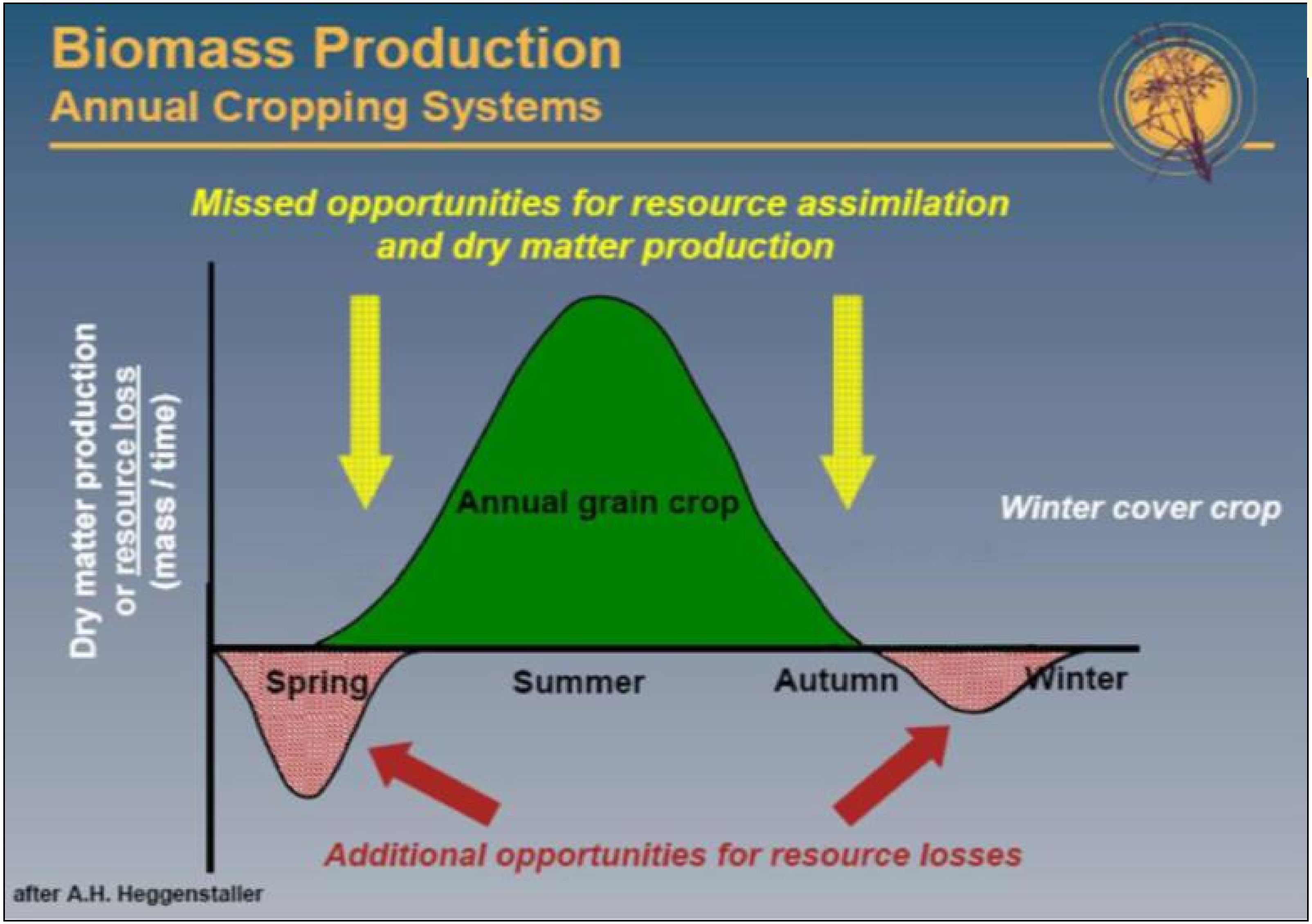
Soil Health Principles:

- Soil armor - keep the soil covered
- Minimize soil disturbance
- Maximize diversity of plants in the rotation – 4 crop types
- Maintain living roots in the soil - cover crops
- Integrate livestock

Soil Health Principle Number 1: Armor – Keep The Soil Covered

High Carbon Residue

Missed Opportunities



A. H. Heggenstaller, University of Alberta

Living Armor - Low Carbon Residue
Especially Helpful In Wet Springs


The Menoken Farm
Cover Crop Combination – Mid Carbon Residue

SOM'S Revolving Nutrient Bank Account.

- 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.
- Mineralization Rate = 2-3% from Organic N to Inorganic N, which does not stop at harvest time.

Nutrient Cycling

Carbon/Nitrogen Ratios

• Soil Microorganisms, Bacteria *	5/1
• SOM, Mollisol Ap horizon *	11/1
• Rotted barnyard manure *	20/1
• Mature Alfalfa Hay *	25/1
• Protozoa **	30/1
• Corn Stover *	57/1
• Wheat Straw *	80/1
• Newspaper *	120/1
• Deciduous Wood **	300/1

Source:

*The Nature and Properties of Soils, fourteenth Edition.
DR. Nyle C. Brady and DR. Ray R. Weil

** DR. Elaine R. Ingham, Soil Food Web

Soil Health Principle Number 2: Minimize Soil Disturbance

Compaction's Big Three

- Tillage
- No armor
- Traffic

FALL PLOWING, DALRYMPLE WHEAT FARMS, RED RIVER VALLEY, D.T., 1876. *This shot of plowing on a bonanza farm, taken on his first contract for the Northern Pacific Railroad in October 1876, carried the comment, "Heel to toe plows tear up the Red River Valley soil." The railroad hoped to show easterners the extent and productiveness of the bonanza farms by using such photographs at fairs and exhibits*


No-Till Field
No Residue!
04/28/2014

Glenn Bauer – Bacon Heights Farms
Two Tillage Compaction Layers

Using Cover Crops to address Resource Concerns

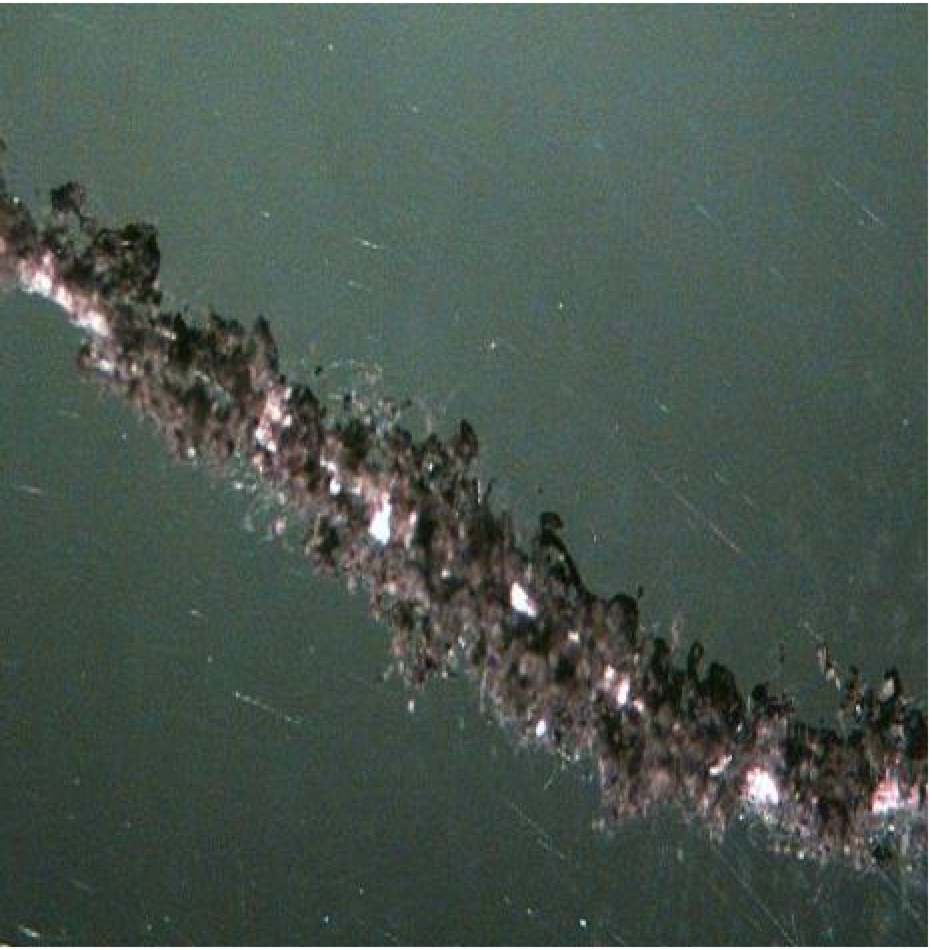
- Infiltration
- Compaction
- Surface Saturation

Sweep layer

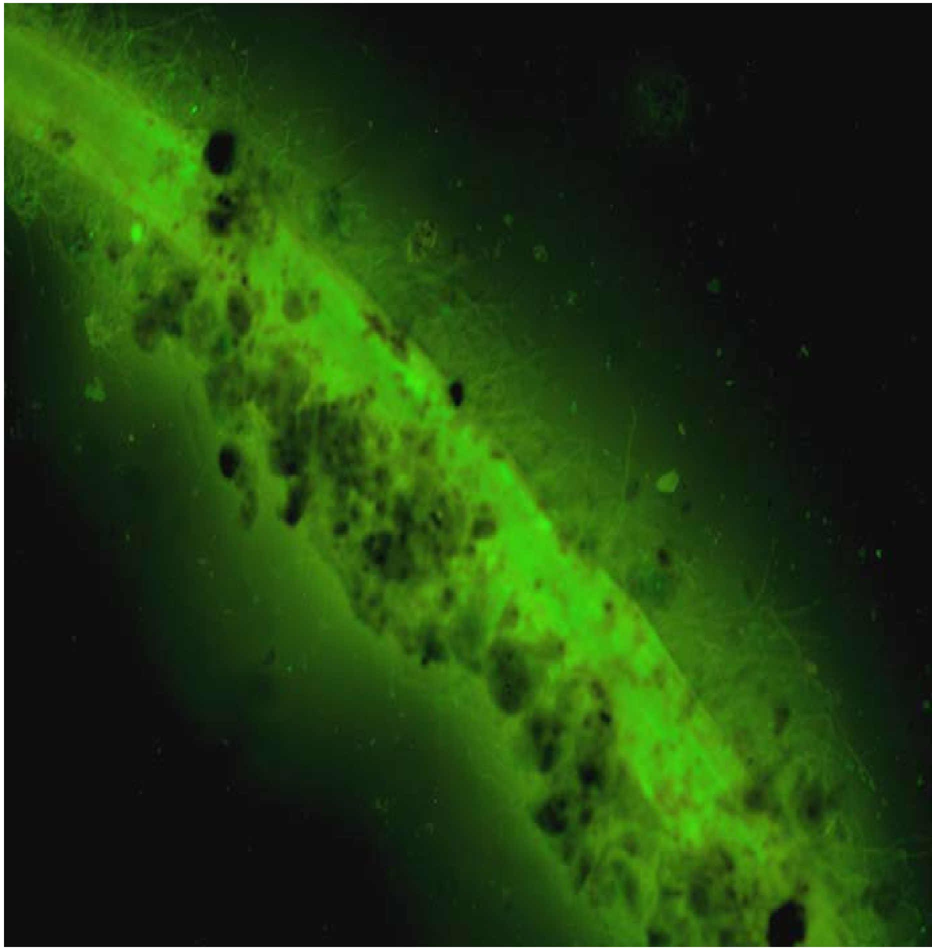
Plow layer

Root breaking compaction layer

Soil Aggregates
on a millet root.
Richter Farms



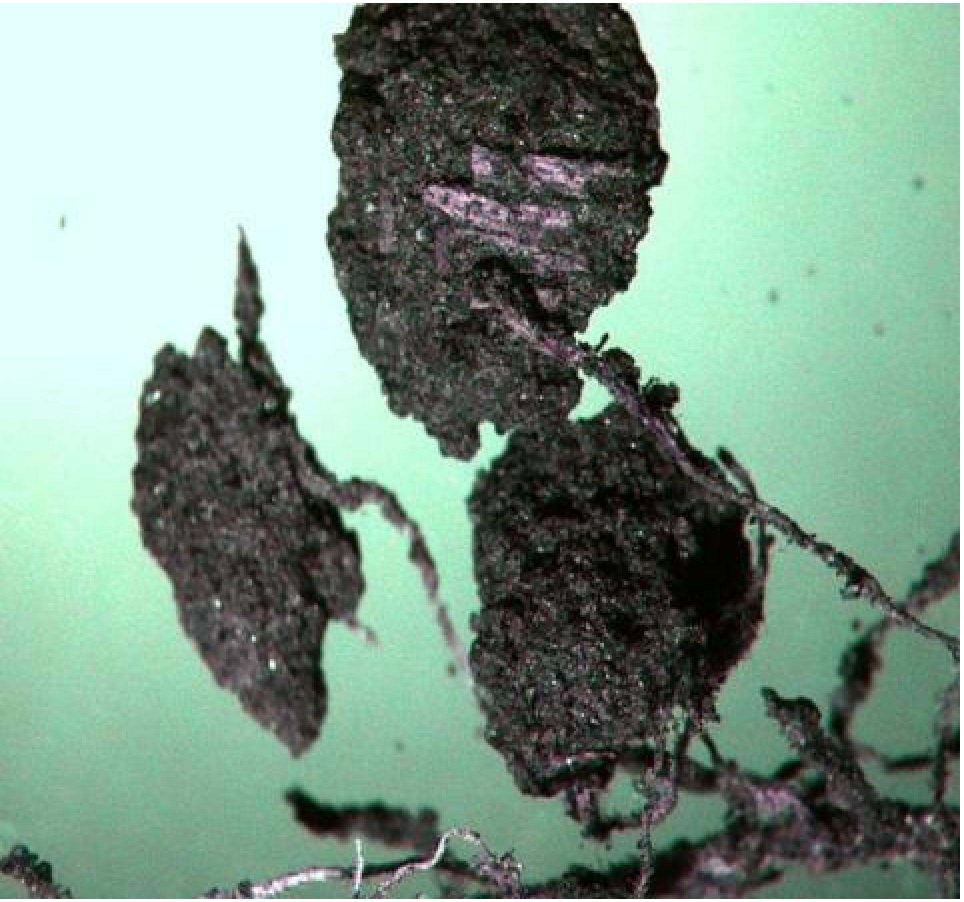
Glomalin and hyphae
show well with a green
color in the lab.

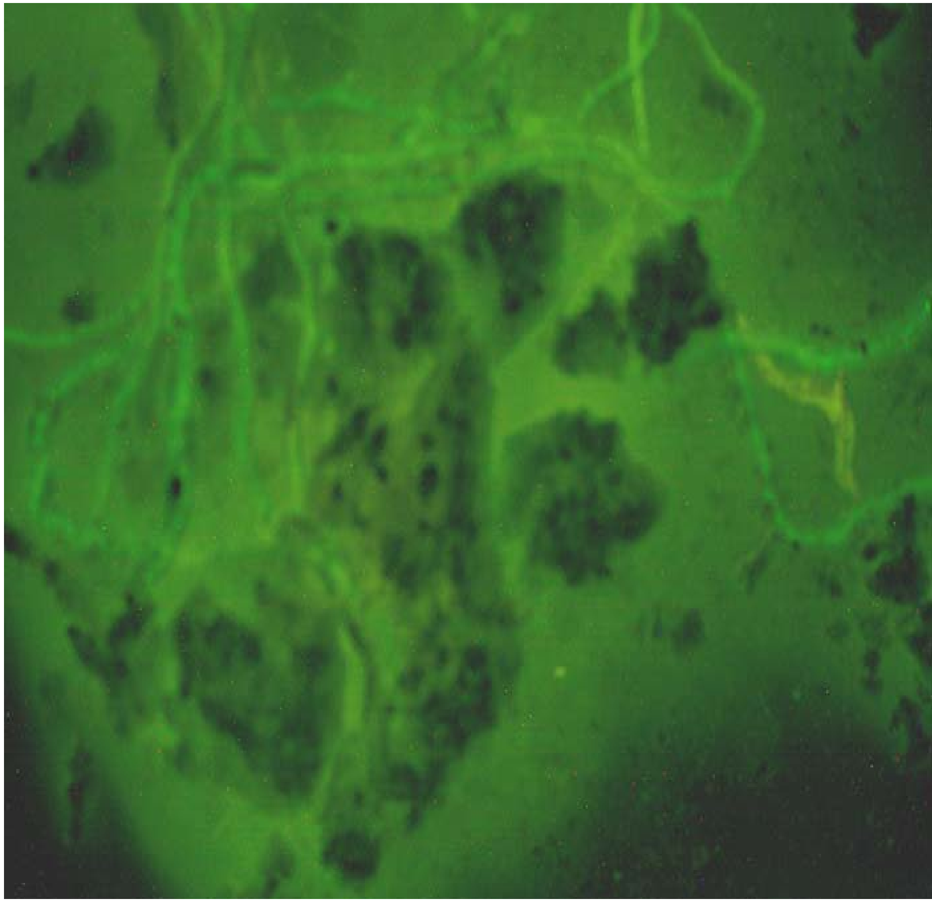


Dr. Kris Nichols, Microbiologist, ARS, Mandan, ND

Enlarged Soil Aggregates

Glomalin and hypae





Dr. Kris Nichols, Microbiologist, ARS, Mandan, ND , 2006

The Menoken Farm
Infiltration – Silt Loam Soil – 5 Years Of No-till Seeding
Minimal Disturbance Allows Soils To Rebuild

6 Inch Ring (15 Centimeters)
Stop Watch
Hammer & Block Of Wood

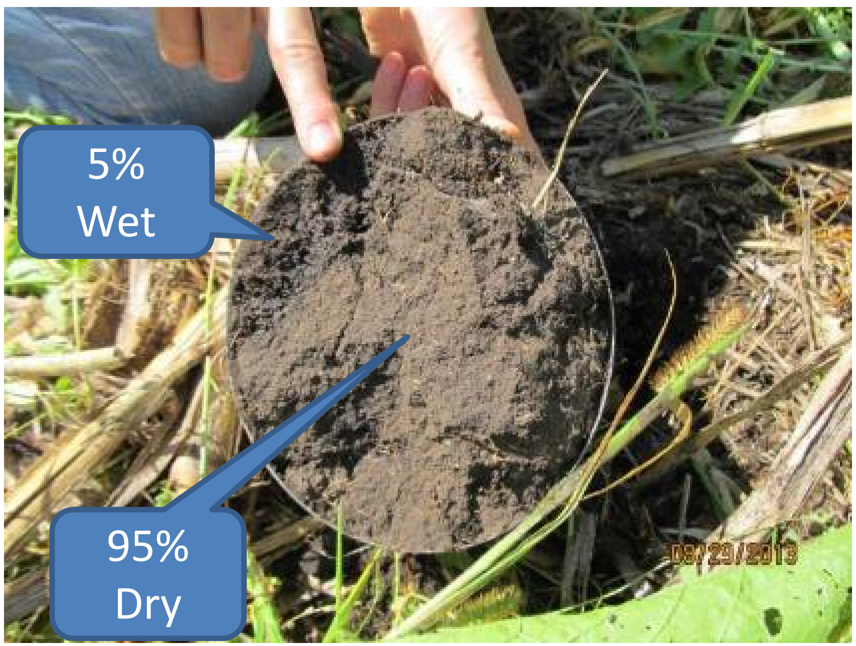
Plastic Wrap
500 ML Water
Apply and Time 500 ML's Twice

Healthy Soils With Good Soil Aggregates Have Rapid Infiltration
Degraded Soils With Poor Soil Aggregates Have Slow Infiltration

The Menoken Farm Infiltration

Poor Infiltration
Bottom Of The Ring Is Mostly Dry
Water Ponds On Top Of The Soil Profile

Good Infiltration
Bottom Of The Ring Is Wet
Water Enters The Soil Profile Rapidly



First 500 ML of Water Average Infiltration Time = 6 Minutes – 57 Seconds
Second 500 ML of Water Average Infiltration Time = 18 Minutes – 54 Seconds

The Menoken Farm
No-Till Cropping System. 2009 - 2014

Field	2009	2010	2011	2012	2013	2014	Bulk Density 2014
1	Soy/CC	Canola/CC	Triti/Vetch	Corn	Canola/Pea	Pasture	0.93
2	Pea/CC	Cover Crop	Corn	Wht/Lentil	Corn	Cover Crop	0.95
3 Fert	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat	1.26
4	Pea/CC	Corn	Pea/CC	Cover Crop	Corn	Yellow Pea	0.90
5	Pea/CC	Corn	Pea/CC	Wheat/CC	Cover Crop	Corn/CC	1.11
6	Pea/CC	Corn	Cover Crop	Corn	Cover Crop	Corn	1.06
7	Pea/CC	Corn	Pea/CC	Wheat/CC	Sunfl/CC	Cover Crop	0.90
8	Canola	Pea/CC	Wheat	Cover Crop	Corn	Sunfl/cc	0.81
9	Flax/Lentil	Cover Crop	Corn	Canola/Pea	Wheat/CC	Sunfl/cc	0.89
10	3 Sisters	3 Sisters	Triti/Vetch	Triti/Vetch	Sunfl/CC	Pasture	1.03

Soil Health Principle Number 3: Crop Diversity

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	Warm Season Grass
Alfalfa	Corn
Buckwheat	Proso Millet
Chick Pea	Pearl Millet
Amaranth	Sorghum
Cowpea	Sudan
Soybean	
Safflower	
Sunflower	

The Menoken Farm
Cover Crop Monocultures 2006
Pounds Of Production
1260 lbs To 2070 lbs Per Acre

The Menoken Farm

Cover Crop Cocktails 2006

Pounds Of Production

4350 lbs To 4785 lbs Per Acre

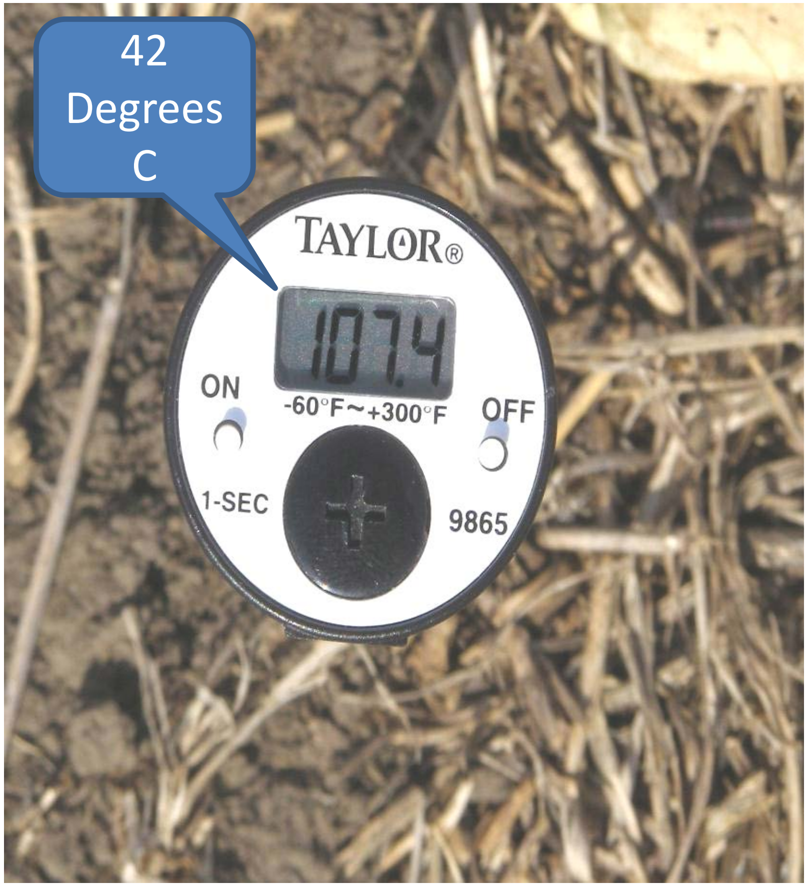
Team Work Above And Below The Soil Surface

2006: June 1 – August 15 = 1.97 Inches (5 Centimeters) Precipitation

North Dakota Agricultural Weather Network

The Menoken Farm 2006
We Manage Soil Temperatures With Armor and Crop Canopy.

Cover Crop Combination



Cover Crop Monoculture

SOLVITA®

PROFESSIONAL SOIL TEST INTERPRETATION

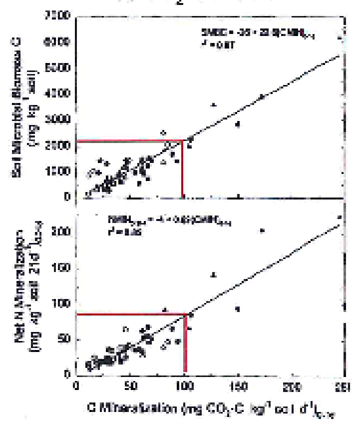
BASED ON THE DRYING-REWETTING PULSE

Test Result ppm CO_2-C	N-Mineralization Potential	Biomass
> 100	High N-Potential soil. Likely sufficient N for most crops.	Soil very well supplied with organic matter. Biomass >2,500 ppm
61 - 100	Moderately-high. This soil has limited need for supplemental N.	Ideal state of biological activity and adequate organic matter level.
31 - 60	Moderate Level. Supplemental N is most likely indicated.	Requires new applications of stable organic matter. Biomass <1,200ppm
6 - 30	Moderate-Low - will not provide sufficient N for most crops	Low in organic structure and microbial activity. Biomass < 500ppm
0 - 5	Little biological activity; requires significant fertilization.	Very inactive soil. Biomass < 100 ppm. Consider long-term care.

N-mineralization and microbial biomass can be estimated based on the 24h soil-CO_2 burst as shown in the instance at the right. The quantity of soil microbial biomass is generally about 20-times the CO_2-C rate. The net nitrogen release varies per unit of CO_2 burst and is generally 0.7-1.0 times the indicated CO_2-C rate, and is higher with better humus quality. A conservative but reliable estimate for N-release in lb/a is to take half the CO_2-C rate as indicated by the Solvita test. This amount of N can be subtracted from fertilizer rates.

The response of soil to additions of manure or compost generally results in linear CO_2 increases so long as the C:N of the additives is below 20. The effect will decline slowly over time. Research trials show that each added 10-ton/a of stable compost increases soil respiration by about 0.1 Solvita Unit or about 2-3 ppm expressed as CO_2-C. For an acre slice of soil, weighing 1 million kg (2-million lbs) this is 2kg (4 lbs) of carbon or 7.5kg (15 lbs) of CO_2.

SMBC and N-Min Rates vs CO_2-C BURST



The Menoken Farm
2012 Wheat Yields
Field 7 = 38.3 Bu/ac

Note

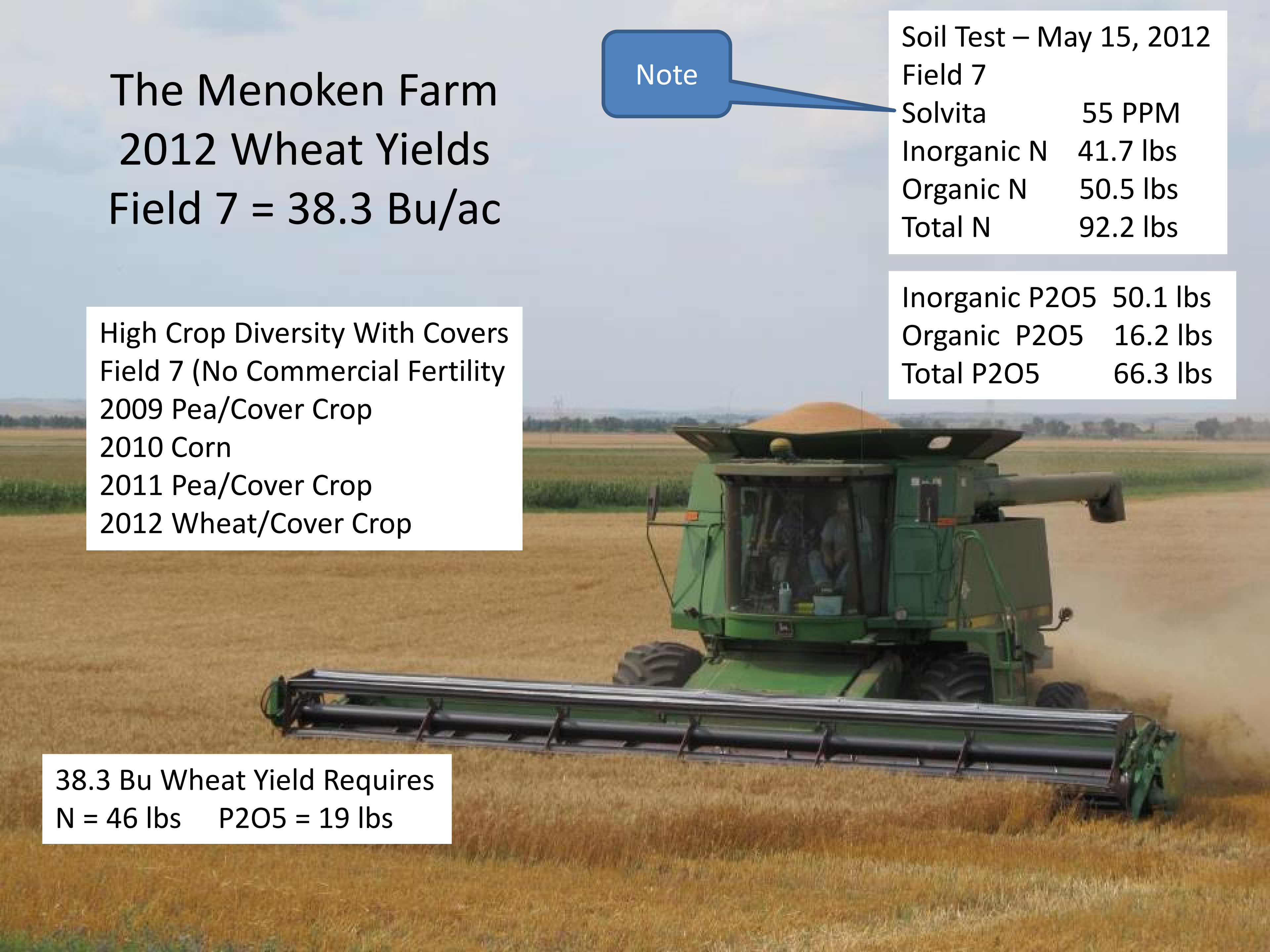
Soil Test – May 15, 2012
Field 7

Solvita	55 PPM
Inorganic N	41.7 lbs
Organic N	50.5 lbs
Total N	92.2 lbs

Inorganic P2O5	50.1 lbs
Organic P2O5	16.2 lbs
Total P2O5	66.3 lbs

High Crop Diversity With Covers
Field 7 (No Commercial Fertility
2009 Pea/Cover Crop
2010 Corn
2011 Pea/Cover Crop
2012 Wheat/Cover Crop

38.3 Bu Wheat Yield Requires
N = 46 lbs   P2O5 = 19 lbs



The Menoken Farm
2012 Wheat Yields
Field 3   45.4 Bu/Ac

Low Crop Diversity Without Covers
Field 3 Full Commercial Fertility
2009 – 2012 Wheat

Soil Test – May 15, 2012
Field 3

Solvita	43.8 PPM
Inorganic N	94.4 lbs/ac
Organic N	32.0 lbs/ac
Total N	126.4 lbs/ac

Note

Inorganic P2O5	39.6 lbs
Organic P2O5	13.3 lbs
Total P2O5	52.9 lbs

45.4 Bu Wheat Yield Requires
N = 55 lbs   P205 = 23 lbs

Seeded the Cool Season Species - November 2013
Seeded the Warm Season Species – June 2014

Side Oats Grama 1.5
Switch Grass 1.7
Blue Flax .05
Yellow Coneflower .05
Maximilian Sunflower .05
Alfalfa 1
Sweet Clover .75
Black Eyed Susan .05
Sainforn 2.25
Canada Milkvetch .05
Evening Primrose .05
Plains Coreopsis .05
Big Bluestem1.5
Indian Grass .4
Little Bluestem .25
Blue Grama .2
Meadow Brome 2
Western Wheat 2
Green Needle 2
Green Wheat 2
Intermediate Wheat 2
Total of 21 Species

Soil Health Principle Number 4: Continual Live Plant (Finding the Fit)

Nurture Nature with System Synergies

No Tillage

Minimum carbon loss

Cover Crops

Maximum carbon input

Carbon management

Sustainability

Dr. Don Reicosky
ARS – Morris, MN


BUSCH


Triticale and Hairy Vetch


Rolling the Cover


Good Kill with the Roller

Mob Grazing Sheep
90 Dry Ewes
Approximately 1/5 Acre Per Day

90 Ewes X 165 Lbs Each = 14850 Total Lbs
Divided by 0.20 Acres = 74,250 Lbs /Ac

Warm Season Cover Crop Mixture Seeded
July 11, 2011 South Half

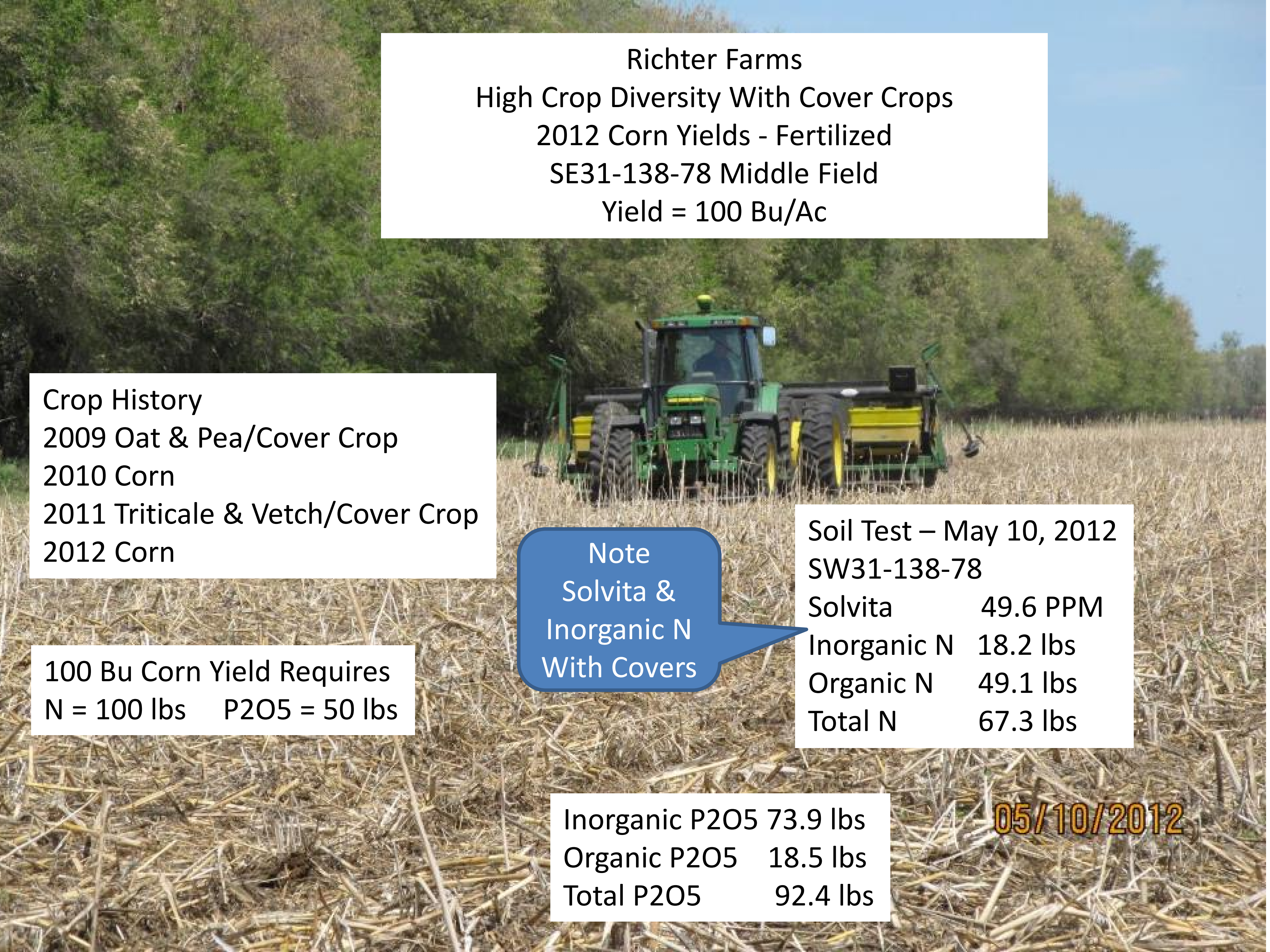

Sunflower and 10 Broadleaf Covers


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


10/18/2013

High Crop Diversity With Cover Crops	High Crop Diversity Without Cover Crops
Total Biology - 1999 ng/g soil	Total Biology - 1528 ng/g soil
Actinomycetes - 191 ng/g soil	Actinomycetes -133 ng/g soil
Bacteria - 1625 ng/g soil	Bacteria – 1251 ng/g soil
Fungi - 138 ng/g soil	Fungi – 115 ng/g soil
Ratio Bacteria:Fungi – 11.7	Ratio Bacteria:fungi – 11
Mycorrhiza – 38 ng/g soil	Mycorrhiza – 41 ng/s soil

Richter Farms 2011


Richter Farms
High Crop Diversity With Cover Crops
2012 Corn Yields - Fertilized
SE31-138-78 Middle Field
Yield = 100 Bu/Ac
Crop History
2009 Oat & Pea/Cover Crop
2010 Corn
2011 Triticale & Vetch/Cover Crop
2012 Corn
Note Solvita & Inorganic N With Covers
Soil Test – May 10, 2012
SW31-138-78
Solvita 49.6 PPM
Inorganic N 18.2 lbs
Organic N 49.1 lbs
Total N 67.3 lbs
100 Bu Corn Yield Requires
N = 100 lbs P2O5 = 50 lbs
Inorganic P2O5 73.9 lbs
Organic P2O5 18.5 lbs
Total P2O5 92.4 lbs
05/10/2012

Richter Farms
High Crop Diversity Without Cover Crops
2012 Sunflower Yields - Fertilized
SW36-138-79
Yield =2371 lbs

Crop History
2009 Corn
2010 Lentil
2011 Corn
2012 Sunflower

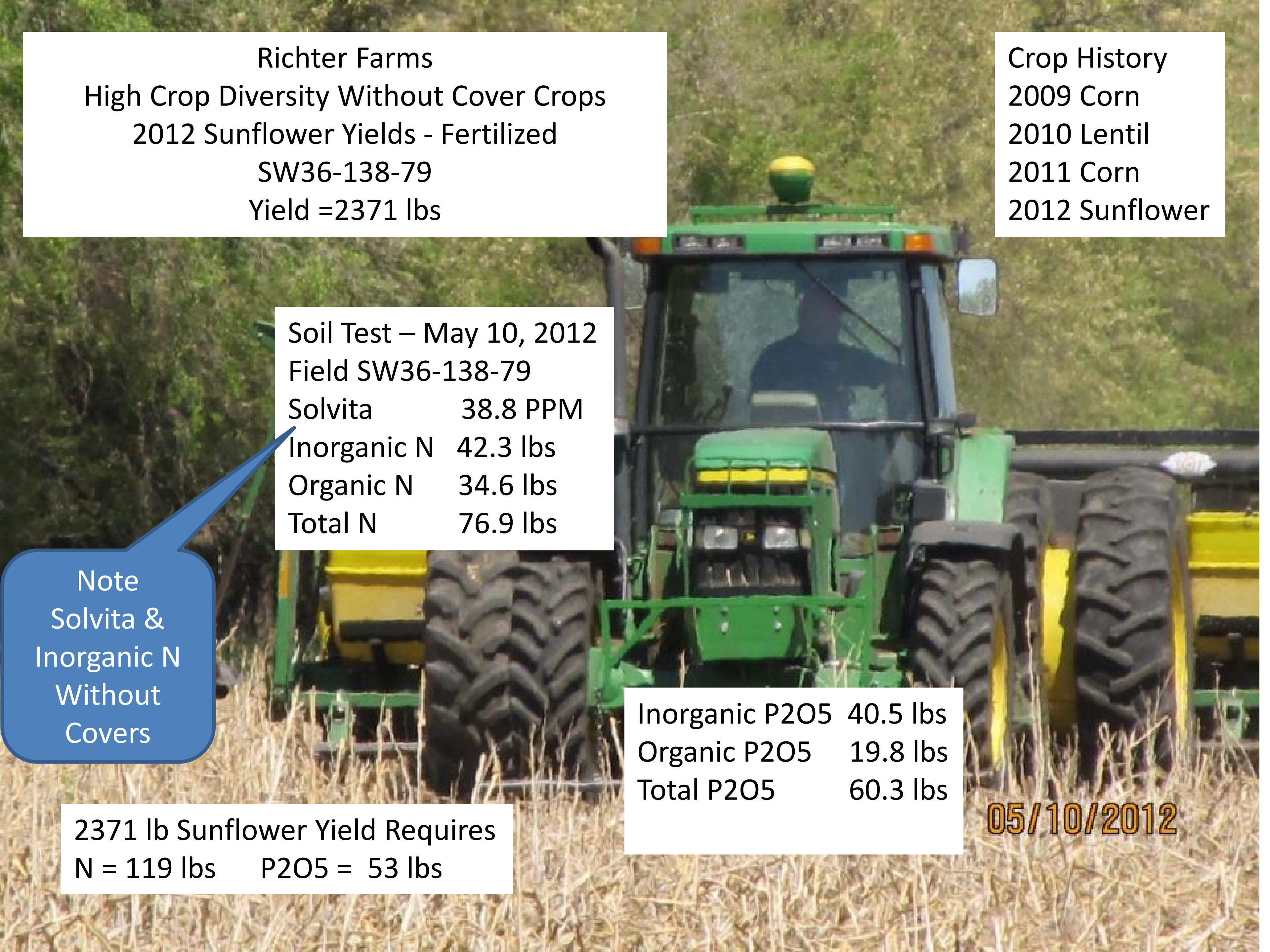
Soil Test – May 10, 2012
Field SW36-138-79

Solvita	38.8 PPM
Inorganic N	42.3 lbs
Organic N	34.6 lbs
Total N	76.9 lbs

Note
Solvita &
Inorganic N
Without
Covers

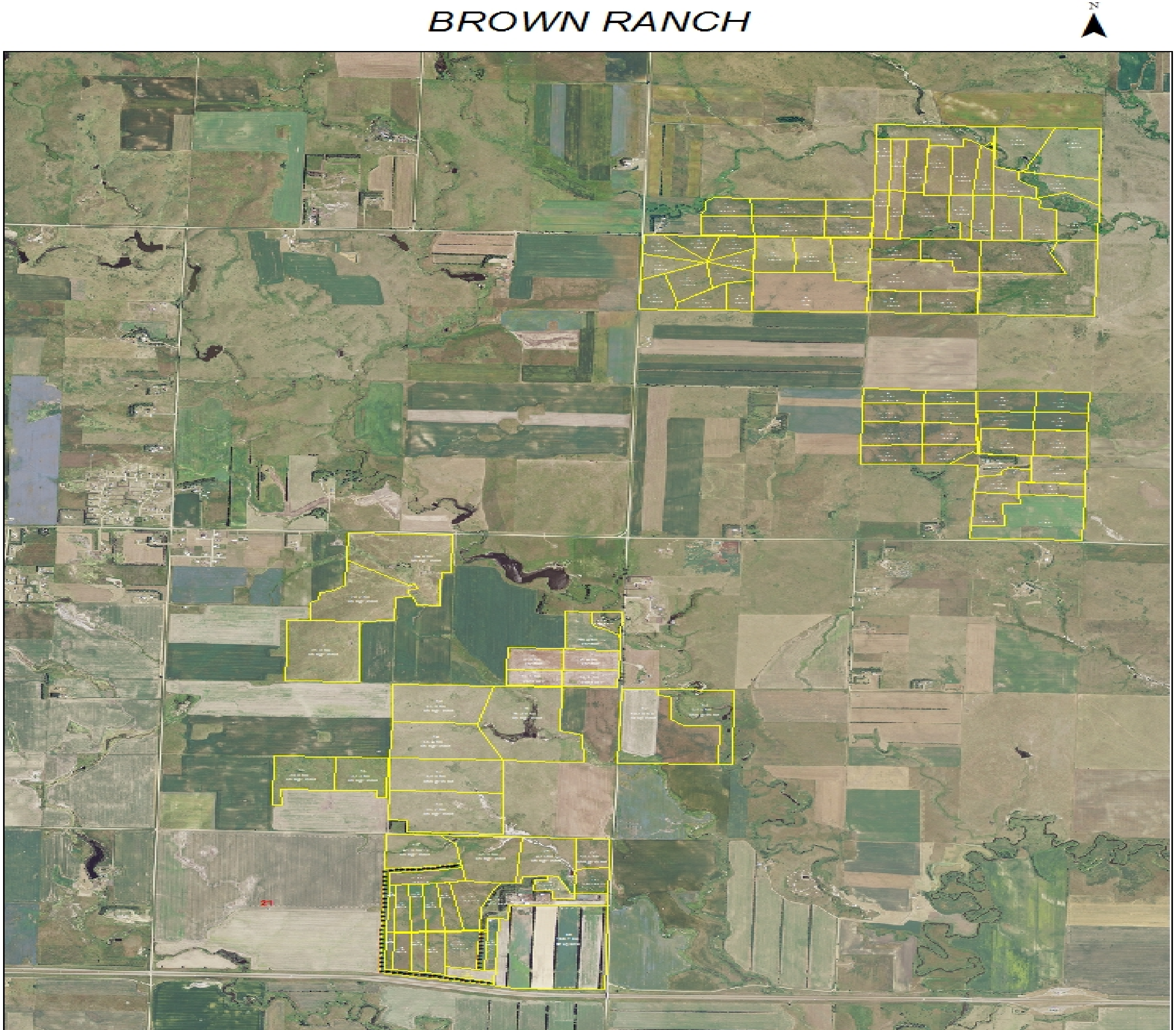
Inorganic P2O5	40.5 lbs
Organic P2O5	19.8 lbs
Total P2O5	60.3 lbs

2371 lb Sunflower Yield Requires
N = 119 lbs P2O5 = 53 lbs



Soil Health Principle Number 5: Livestock Integration

BROWN RANCH



Brown Ranch
Mob Grazing On Cropland
Gabe Brown - Before

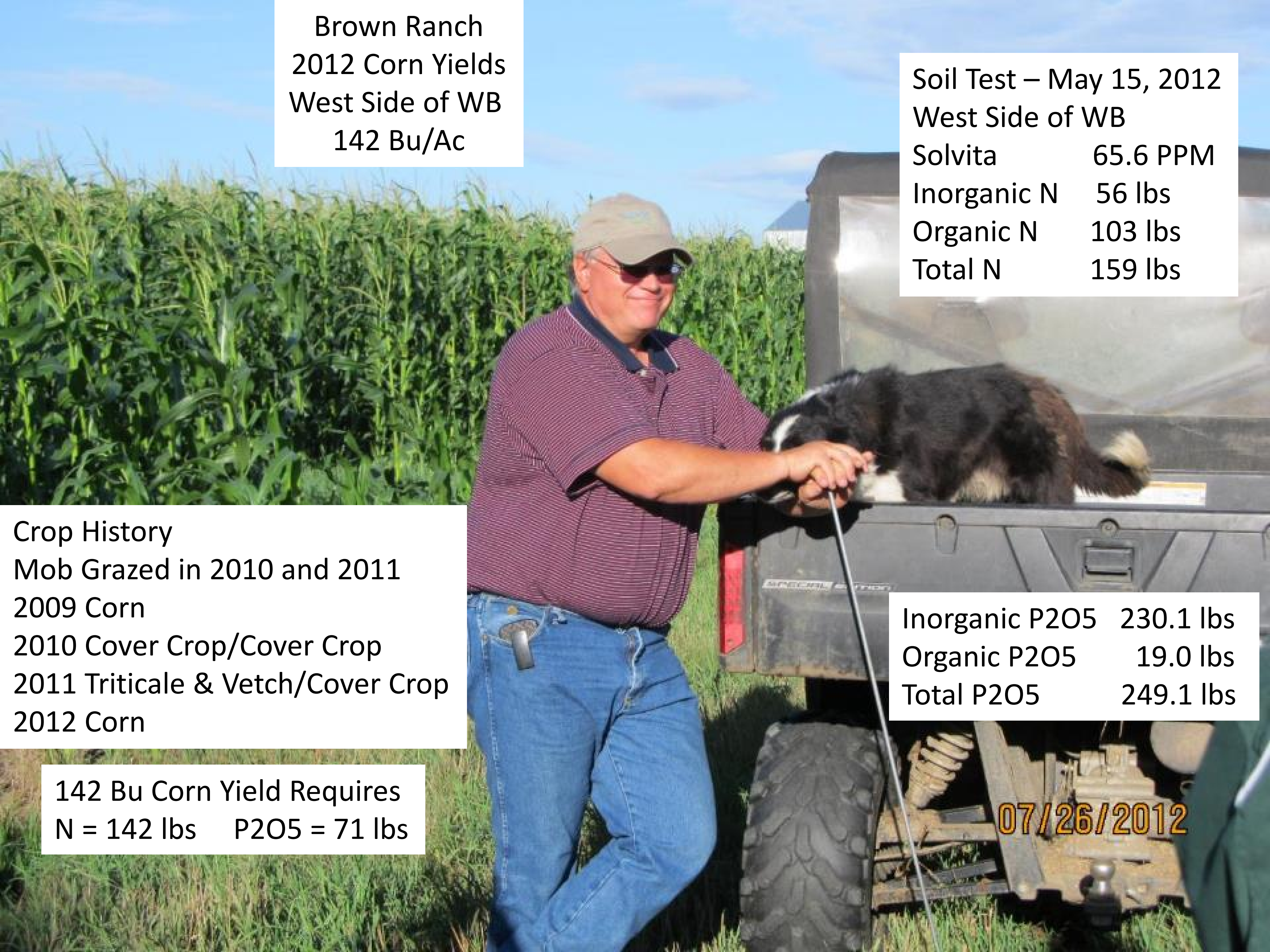

Mob Grazing On Cropland
Gabe Brown - After
Low Carbon


Mob Grazing On Cropland
Gabe Brown - Before


Mob Grazing On Cropland
Gabe Brown - After
High Carbon Material

Two Years Mob Grazing West Side of Shelterbelt	No Mob Grazing East Side of Shelterbelt
Total Biology – 6105 ng/g soil	Total Biology – 4228 ng/g soil
Actinomycetes – 213 ng/g soil	Actinomycetes – 418 ng/g soil
Bacteria – 4417 ng/g soil	Bacteria – 3349 ng/g soil
Fungi – 786 ng/g soil	Fungi – 386 ng/g soil
Ratio Bacteria : Fungi – 5.6	Ratio Bacteria : Fungi – 8.7
Mycorrhiza – 230 ng/g soil	Mycorrhiza – 145 ng/g soil

Gabe Brown



Brown Ranch
2012 Corn Yields
West Side of WB
142 Bu/Ac

Soil Test – May 15, 2012
West Side of WB

Solvita	65.6 PPM
Inorganic N	56 lbs
Organic N	103 lbs
Total N	159 lbs

Crop History
Mob Grazed in 2010 and 2011
2009 Corn
2010 Cover Crop/Cover Crop
2011 Triticale & Vetch/Cover Crop
2012 Corn

Inorganic P2O5	230.1 lbs
Organic P2O5	19.0 lbs
Total P2O5	249.1 lbs

142 Bu Corn Yield Requires
N = 142 lbs   P2O5 = 71 lbs

Season Long Cover Crops Added To High Crop Diversity Rotation

Jerry Doan – Black Leg Ranch

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 Cover Crop Mix

#/acre	Species
5	Super sweetsorg / sudan
5	BMR grazing corn
3	Soybean
1	Cowpea
1	Mong bean
2	Forage collards
1	Hunter turnips
1	Wildlife grain sorghum
1	German millet
1	Berseem Clover, Crimson Clover, Arrowleaf Clover
1	Sunflower
1	Buckwheat, Oats, Safflower
Total 23#	Cost $27.00/ acre

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

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

NutriSolutions by WINFIELD

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

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

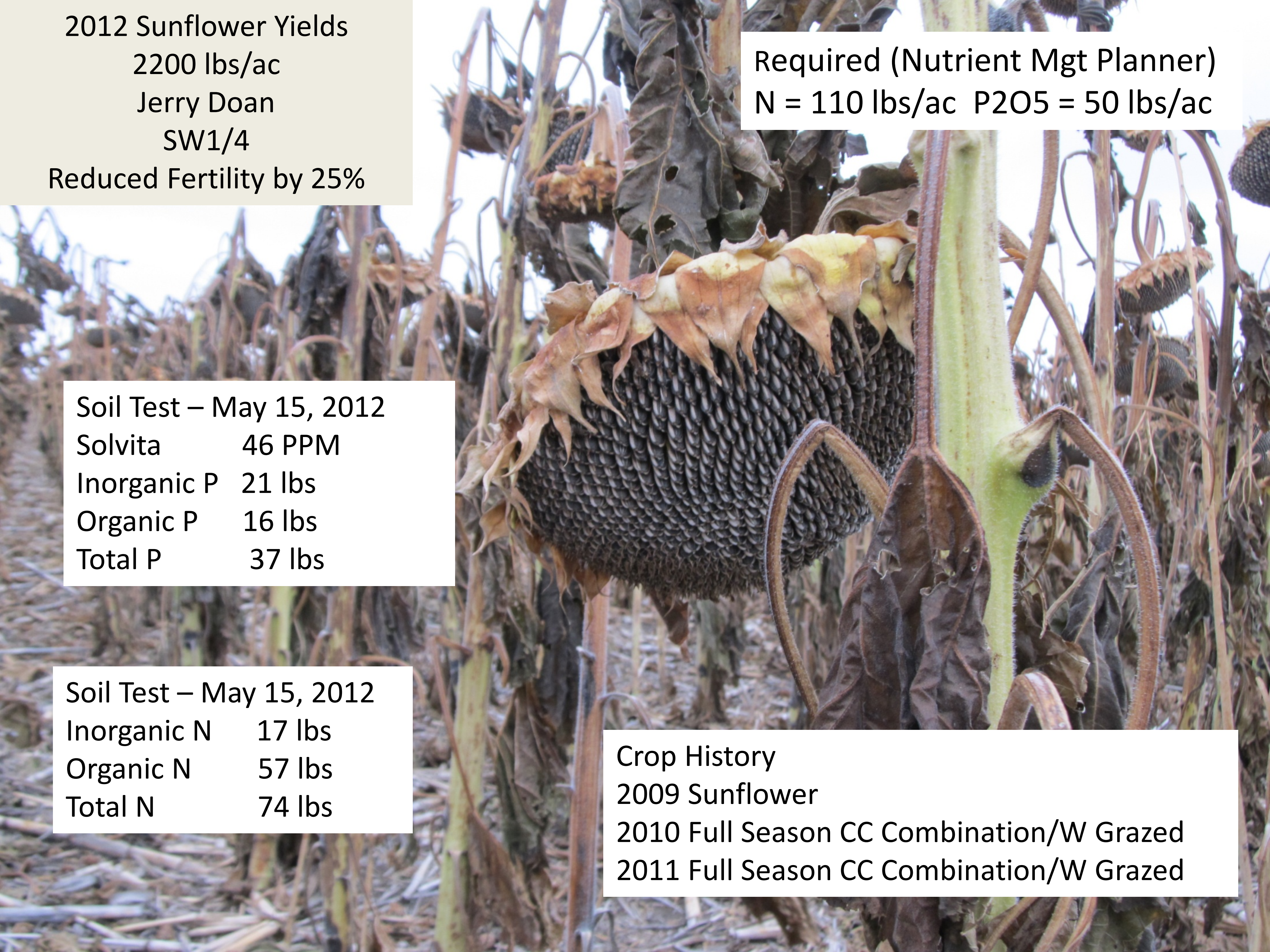
NutriSolutions by WINFIELD

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

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



2012 Sunflower Yields
2200 lbs/ac
Jerry Doan
SW1/4
Reduced Fertility by 25%

Required (Nutrient Mgt Planner)
N = 110 lbs/ac P2O5 = 50 lbs/ac

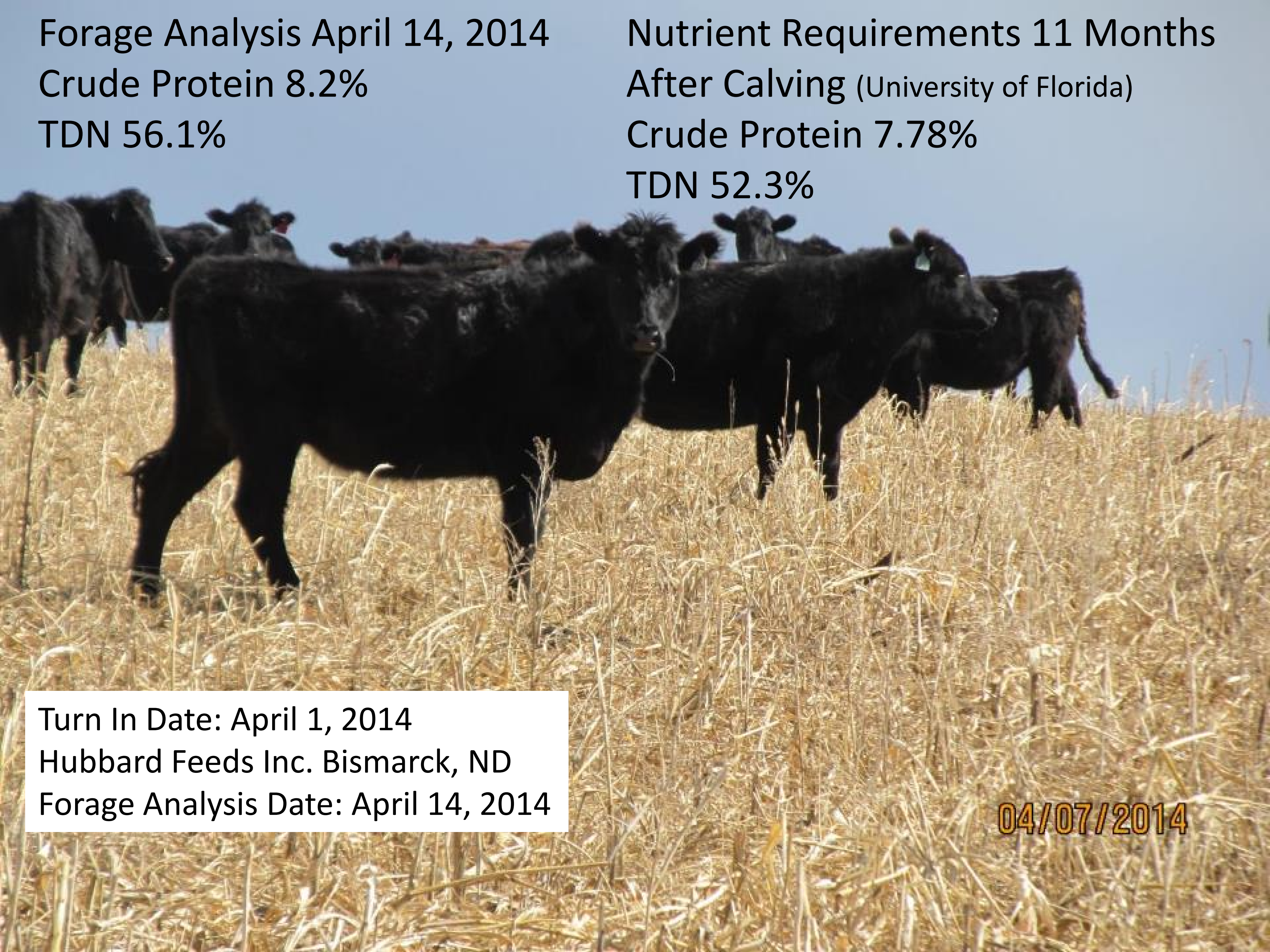
Soil Test – May 15, 2012	
Solvita	46 PPM
Inorganic P	21 lbs
Organic P	16 lbs
Total P	37 lbs

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

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

Biological Ag Waste System

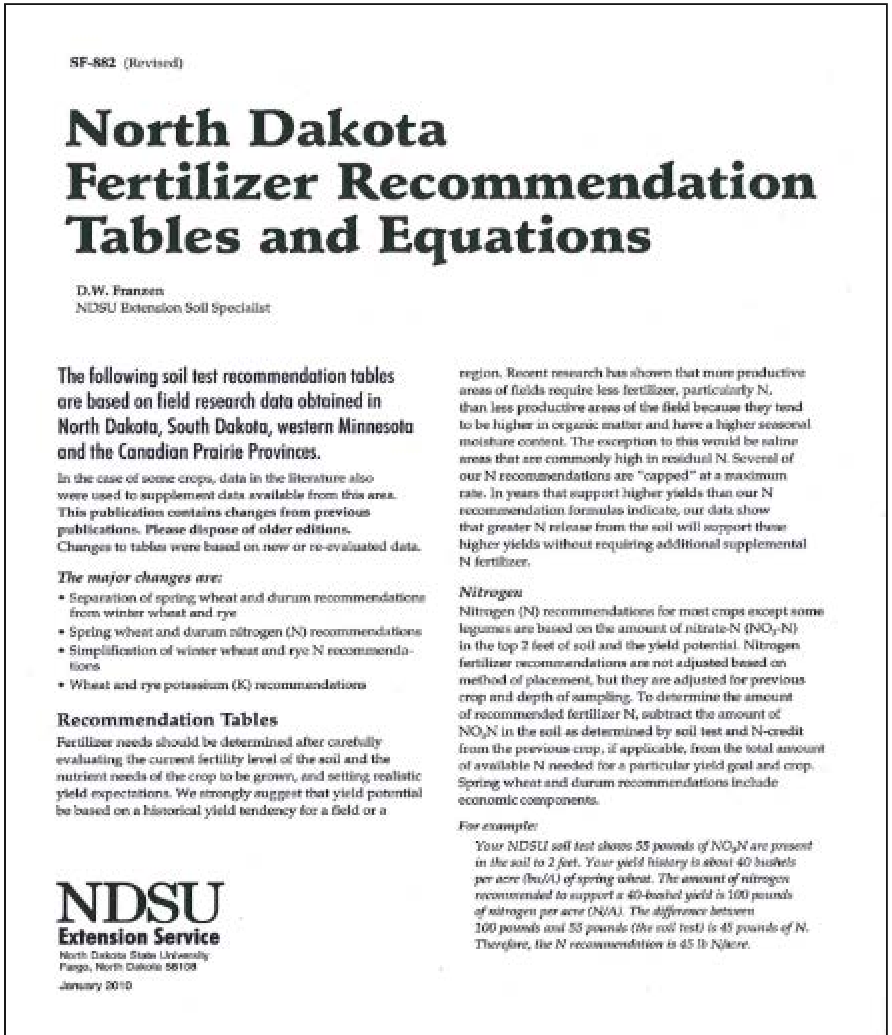
- Keep cattle on the land, out of corrals and watersheds
- Positive public perception
- Save costs

- **Quality of Life goes up/Profitability Improves**


Tying It All Together


What's Happening In ND?

NDSU Wheat Fertilizer Recommendations - January 2010



SF-882 (Revised)

North Dakota Fertilizer Recommendation Tables and Equations

D.W. Franzen
NDSU Extension Soil Specialist

The following soil test recommendation tables are based on field research data obtained in North Dakota, South Dakota, western Minnesota and the Canadian Prairie Provinces.

In the case of some crops, data in the literature also were used to supplement data available from this area. **This publication contains changes from previous publications. Please dispose of older editions.** Changes to tables were based on new or re-evaluated data.

The major changes are:

- Separation of spring wheat and durum recommendations from winter wheat and rye
- Spring wheat and durum nitrogen (N) recommendations
- Simplification of winter wheat and rye N recommendations
- Wheat and rye potassium (K) recommendations

Recommendation Tables

Fertilizer needs should be determined after carefully evaluating the current fertility level of the soil and the nutrient needs of the crop to be grown, and setting realistic yield expectations. We strongly suggest that yield potential be based on a historical yield tendency for a field or a region. Recent research has shown that more productive areas of fields require less fertilizer, particularly N, than less productive areas of the field because they tend to be higher in organic matter and have a higher seasonal moisture content. The exception to this would be saline areas that are commonly high in residual N. Several of our N recommendations are "capped" at a maximum rate. In years that support higher yields than our N recommendation formulas indicate, our data show that greater N release from the soil will support these higher yields without requiring additional supplemental N fertilizer.

Nitrogen

Nitrogen (N) recommendations for most crops except some legumes are based on the amount of nitrate-N (NO_3-N) in the top 2 feet of soil and the yield potential. Nitrogen fertilizer recommendations are not adjusted based on method of placement, but they are adjusted for previous crop and depth of sampling. To determine the amount of recommended fertilizer N, subtract the amount of NO_3N in the soil as determined by soil test and N-credit from the previous crop, if applicable, from the total amount of available N needed for a particular yield goal and crop. Spring wheat and durum recommendations include economic components.

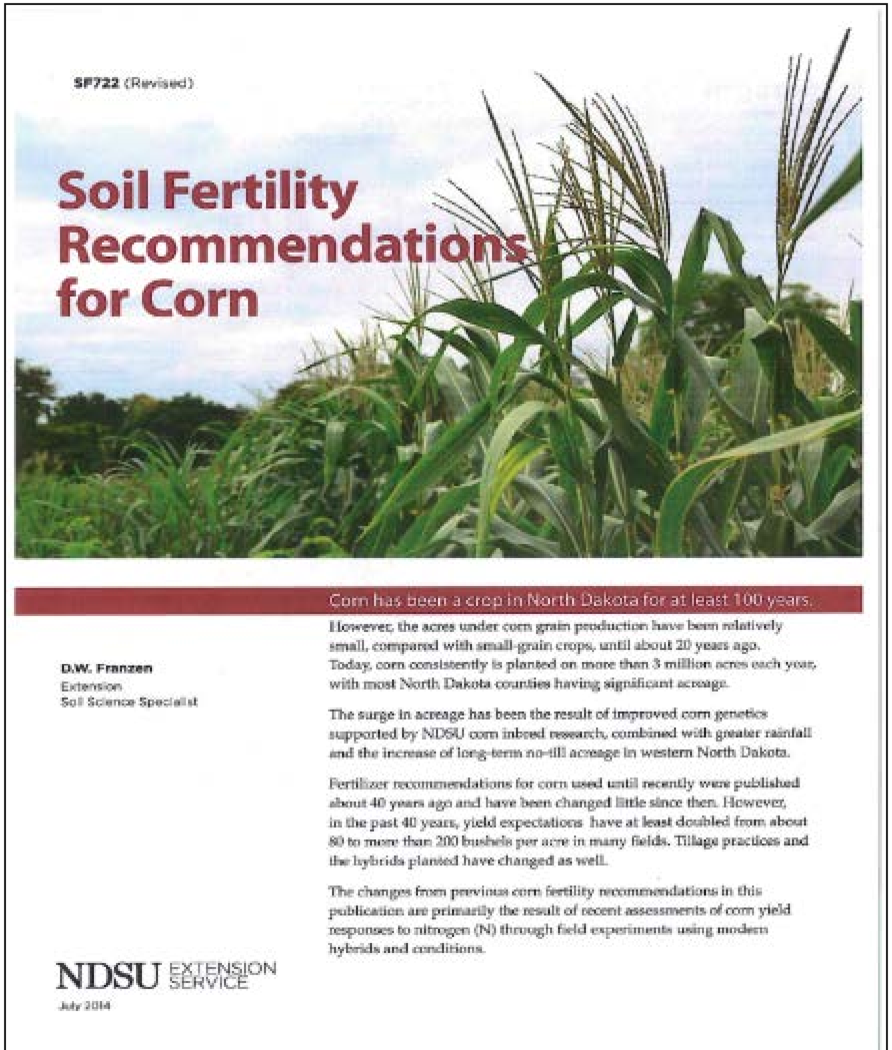
For example:

Your NDSU soil test shows 55 pounds of NO_3N are present in the soil to 2 feet. Your yield history is about 40 bushels per acre (bu/A) of spring wheat. The amount of nitrogen recommended to support a 40-bushel yield is 100 pounds of nitrogen per acre (N/A). The difference between 100 pounds and 55 pounds (the soil test) is 45 pounds of N. Therefore, the N recommendation is 45 lb N/acre.

NDSU
Extension Service
North Dakota State University
Fargo, North Dakota 58108
January 2010

- “If the field has been in no-till five or more continuous years, subtract 50 lbs N/acre.”

NDSU Corn Fertilizer Recommendations - July 2014



SF722 (Revised)

Soil Fertility Recommendations for Corn

Corn has been a crop in North Dakota for at least 100 years.

However, the acres under corn grain production have been relatively small, compared with small-grain crops, until about 20 years ago. Today, corn consistently is planted on more than 3 million acres each year, with most North Dakota counties having significant acreage.

D.W. Franzen
Extension
Soil Science Specialist

The surge in acreage has been the result of improved corn genetics supported by NDSU corn inbred research, combined with greater rainfall and the increase of long-term no-till acreage in western North Dakota.

Fertilizer recommendations for corn used until recently were published about 40 years ago and have been changed little since then. However, in the past 40 years, yield expectations have at least doubled from about 80 to more than 200 bushels per acre in many fields. Tillage practices and the hybrids planted have changed as well.

The changes from previous corn fertility recommendations in this publication are primarily the result of recent assessments of corn yield responses to nitrogen (N) through field experiments using modern hybrids and conditions.

NDSU EXTENSION SERVICE
July 2014

- “the difference in N recommendations between long-term no-till and conventional-till soils was between 40 and 50 pounds less N per acre for long term no-till soils”

North Dakota Declares Soil Health Week

State of
North Dakota
Office of the Governor

Jack Dalrymple
Governor

PROCLAMATION
SOIL HEALTH WEEK
JANUARY 6-12, 2013

WHEREAS, soil health and function is of vital importance to the health, well-being and sustainability of the people of North Dakota and their quality of life; and

WHEREAS, it is important for the citizens and civic leaders of this state to gain knowledge of and to maintain a progressive interest in the valuable role that soil health plays in plant and animal health and therefore food quality; and

WHEREAS, farmers, ranchers, land managers, conservationists and supporting organizations are responsible for studying, managing, protecting and regenerating our soil resources to ensure that future generations have the same opportunities essential for communities and landscapes across the state; and

WHEREAS, North Dakota's farmers, ranchers, land managers, conservationists and supporting organizations should be recognized for their dedication and contributions to the growth, development and knowledge of our state's foundational resource.

NOW, THEREFORE, as Governor of the State of North Dakota, I do hereby proclaim January 6-12, 2013, **SOIL HEALTH WEEK** in the state of North Dakota.

Jack Dalrymple
Governor

ATTEST:

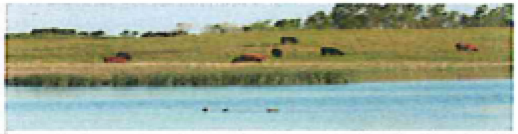
Alvin A. Jaeger
Secretary of State

600 E Boulevard Ave. • Bismarck, ND 58505-0001 • Phone: 701.328.2200 • Fax: 701.328.2205 • www.governor.nd.gov

- Governor Jack Dalrymple signs a proclamation declaring January 6-12, 2013 as Soil Health Week.

North Dakota landowners, Chevrolet make nation's first carbon deal

November 17, 2014 1:00 am • By Brian Gehring



Although the carbon credit transaction program requires landowners to sign perpetual easements, the program is designed for working lands where grazing and haying are permitted.

About 11,000 acres of North Dakota grasslands in six counties are at the center of a first-of-its-kind transaction to conserve grasslands while reducing carbon releases into the atmosphere.

In this groundbreaking deal, Chevrolet has purchased nearly 40,000 carbon credit reduction tons on working grasslands in the Prairie Pothole region of the state known as the Missouri Coteau, according to an announcement made today by the U.S. Department of Agriculture.

Robert Bonnie, USDA's undersecretary for natural resources and environment, said it's hoped the public-private partnership will open the door for additional grassland conservation in the future.

"Our hope is it serves as a model," Bonnie said.

Innovative deal

The program allows private companies to buy carbon credits while private landowners are compensated for agreeing to not till grasslands.

When ground is tilled, underground carbon reserves are released into the atmosphere.

The land involved in the deal is located in Sheridan, Burleigh, Kidder, Emmons, McHenry and McIntosh counties, according to Billy Gascoigne, a Colorado economist and market specialist with Ducks Unlimited, which launched the project with the help of a $161,000 grant from USDA's Natural Resources Conservation Service.

A total of 23 landowners are involved in the project, according to the NRCS.

Gascoigne said avoiding the conversion of grasslands to croplands benefits farmers and ranchers as well as the environment.

A new market

Carbon credits — a generic term for a tradeable certificate or permit as part of the American Carbon Registry — and carbon markets are part of national and international attempts to mitigate the growth of greenhouse gases thought to be linked to climate change.

The carbon storage potential of land can be scientifically measured, and the carbon credits are available to companies interested in purchasing carbon offsets.

New Soil Health positions for ND

- NDSU added 5 new Soil Health positions on April - 2012.
- NRCS added a new Soil Health position on August - 2014.

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

Nature and Properties of Soils, 14th Edition, Brady and Weil

SOM'S Revolving Nutrient Bank Account.

- 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.
- Mineralization Rate = 2-3% from Organic N to Inorganic N, which does not stop at harvest time.

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

Cover Crop Energy Conservation – 1800 Lb Yield Goal

Fertilizer *	Applied Per Acre Actual Pounds	Diesel Fuel EQ Gal/Lb N	Diesel Fuel EQ Gal/Ac
Urea	90	0.129	11.6
Phosphorous P205	40.5	0.042	2.2

Insecticide **	Applied Per Acre Pounds AI	Diesel Fuel EQ Gal/Lb Insect.	Diesel Fuel EQ Gal/Ac
Warrior	0.01125	0.881	0.01

Fungicide ***	Applied Per Acre Pounds AI	Diesel Fuel EQ Gal/Lb Fung.	Diesel Fuel EQ Gal/ac
Headline – 2 Aps	0.1463	2.172	0.6

Total Diesel Fuel EQ Gal Per Acre = 14.4

- * Energy Efficiency in Corn Nitrogen Fertilization, 2010, John Sawyer, Depart of Agronomy, Iowa State U.
- ** T.O. West and G.Marland; Agriculture, Ecosystems and Environment 91(2002): 217-232
- *** E. Audsley, et al. 2009, Cranfield University, Bedford, England. Estimation of the Greenhouse Gas Emissions from Agricultural Manufacture and Use

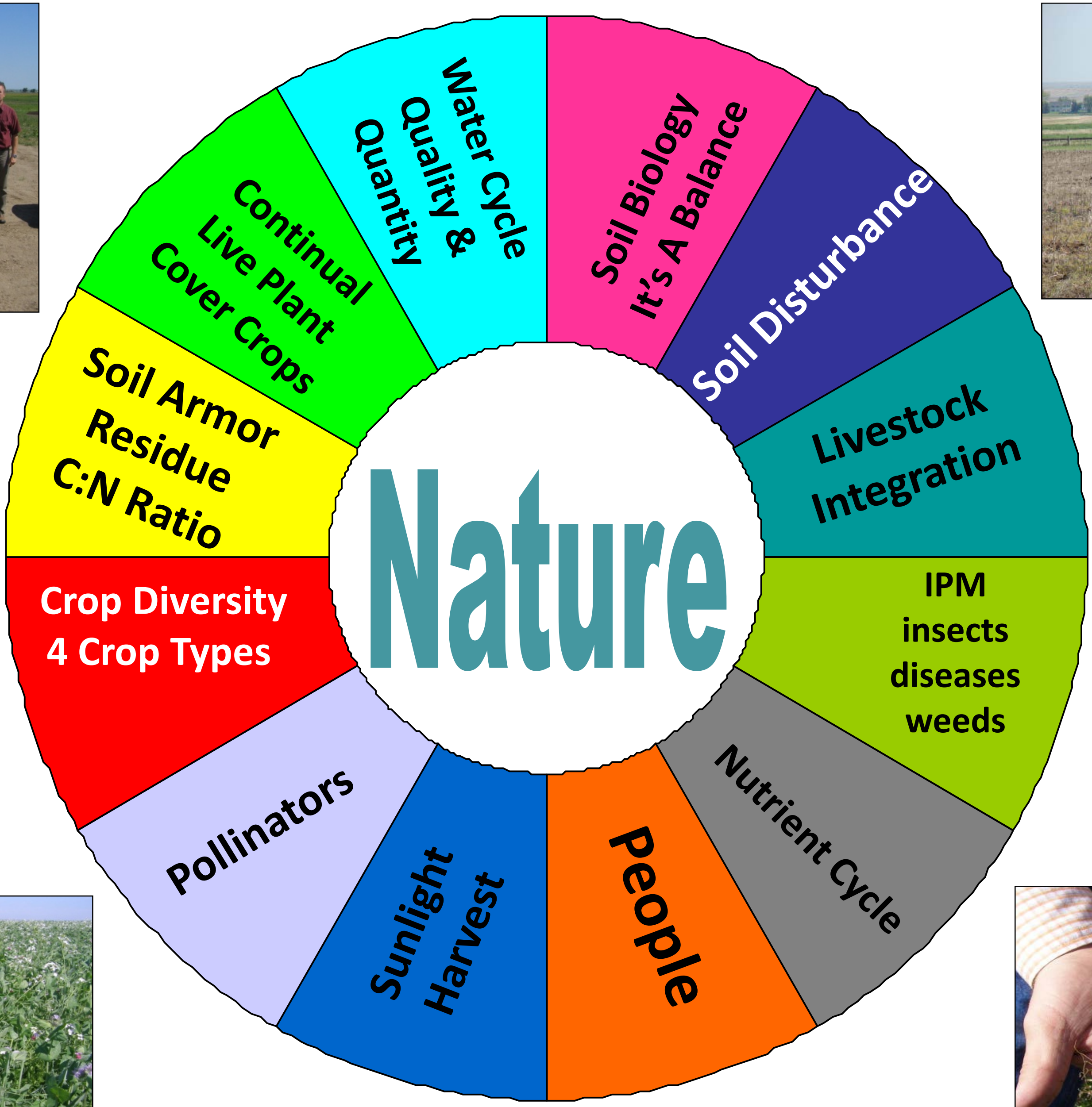
Burleigh County Today
November 19, 2014

- 10% Never Changed
- 70% No-till Systems

  Increased SOM a minimum of 1%.
- 60% Grazing Systems

  Leave more grass at the end of the year than they used to produce.
- 25% Use Cover Crops

  As a bridge to connect the cropping and grazing system together with livestock.


Nature
Water Cycle
Quality &
Quantity
Soil Biology
It's A Balance
Soil Disturbance
Livestock
Integration
IPM
insects
diseases
weeds
Nutrient Cycle
People
Sunlight
Harvest
Pollinators
Crop Diversity
4 Crop Types
Soil Armor
Residue
C:N Ratio
Continual
Live Plant
Cover Crops

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
- Guns, Germs, and Steel: by Jared Diamond
- Soil Biology Primer: by Elaine Ingham
- Life in the Soil: by James Nardi

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Beneficial Insect Habitat Planning – The Xerces Society
Attracting Native Pollinators – Mader, Shepherd, Vaughan, Black, & LeBuhn
Life in the Soil – James Nardi
Undaunted Courage – Stephen Ambrose
Dirt – David Montgomery