Brown's Ranch Part I - by Jay Fuhrer NRCS

Brown's Ranch
Home of Sustainable Ranching
www.sustainableranching.com

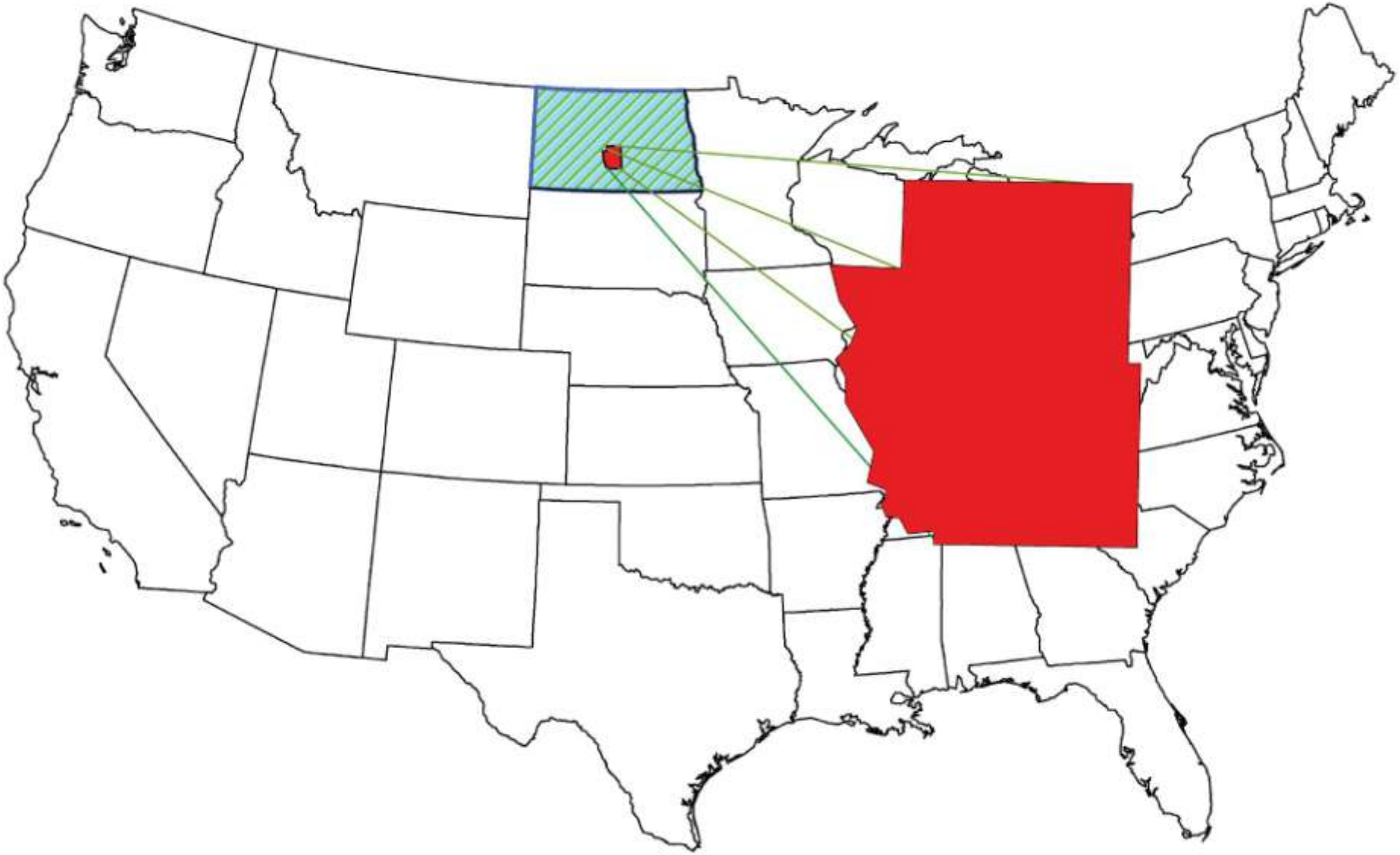
Ranch Goal

Sustainability Through Soil Health

Harvest The Sunlight, Feed The Soil

Tie the Grazing and Cropping Systems Together

Burleigh County, North Dakota

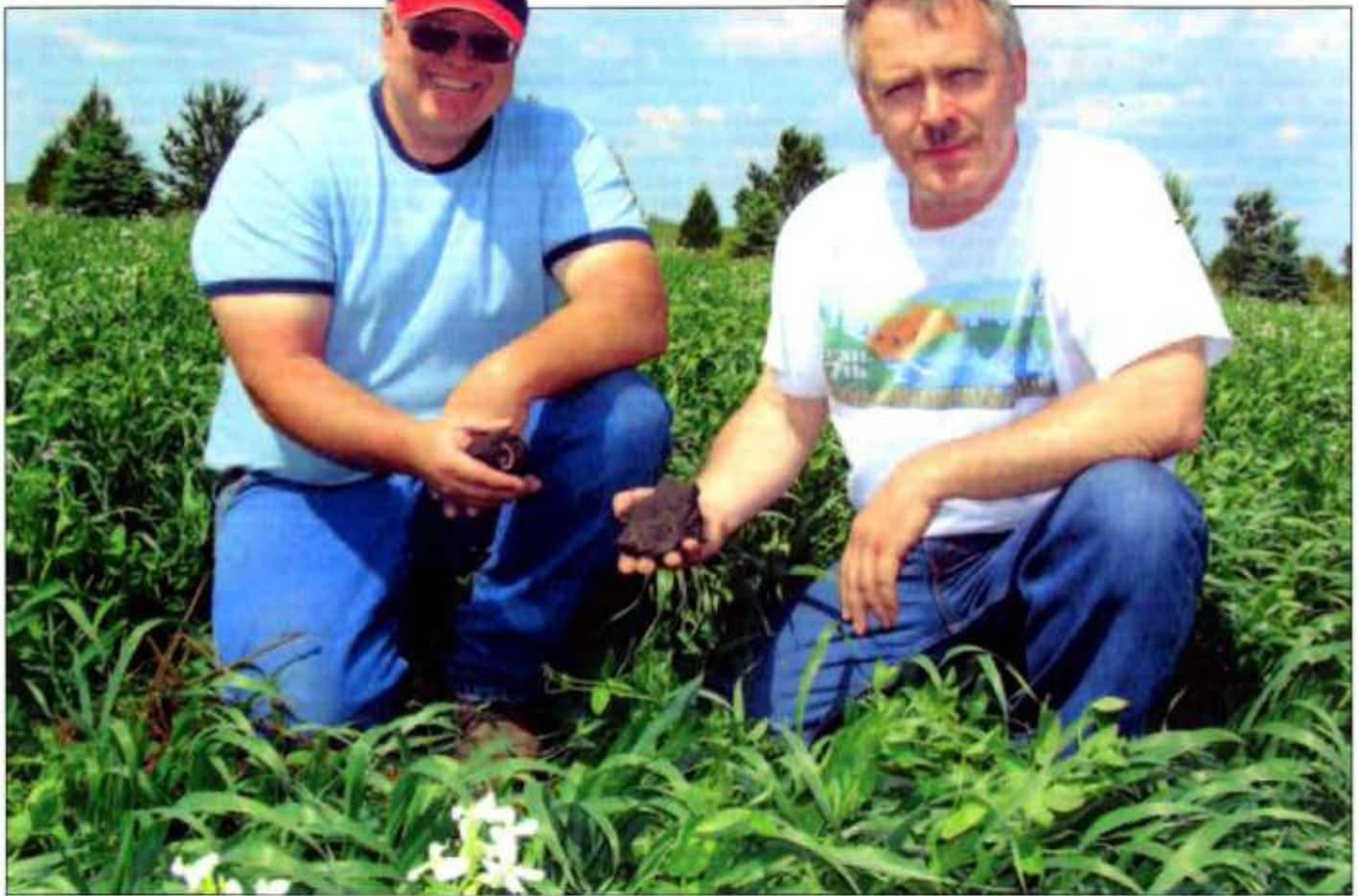


August 2009

Beef Producer

This issue

Grazing management



BISMARCK WSFO AP, NORTH DAKOTA (320819)

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

Old System

- Tillage - high inputs
- Low Infiltration 0.4 inches the 1st hour and .25 inches the 2nd hour
- Low SOM <2%
- Low Fertility
- Low Crop Diversity
- 40 year history of summer fallow, wheat and some flax
- Season long grazing on the native rangeland

Present System
4,430 Acres of Cropland, & Rangeland

- Soil Health Based
- Bought a no-till drill in 1993
- Lost the crop to hail in 95, 96 & 98 with drought in 97 “Best thing that ever happened”
- SOM upward trend
- Cropland Mimics Native Rangeland with a live root at all times
- Rangeland pastures are grazed < 5 days per year
- Cover Crops are the bridge between the rangeland & cropland
- Lower inputs over time
- Reduced herbicide by 75% - Some fields have no herbicide for 3 years
- Reduced commercial fertilizer by 90%
- 2007 cost of production for corn $1.18 per bushel
- Why can Gabe lower his cost?

No-till Seeding for 16 years

Diversity *in the Cropping System*

The Answer is to Imitate Native Rangeland

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

Diversity - Crop Types.

Cool Season Grass

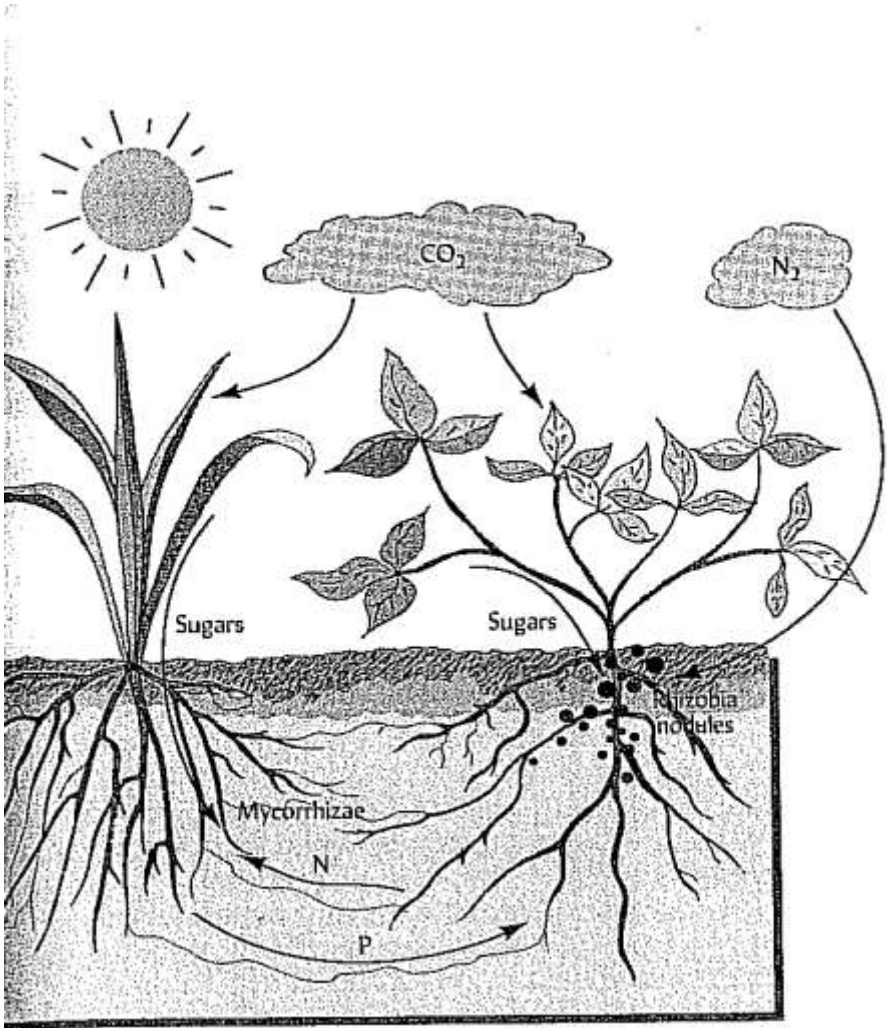
Barley
Durum Wheat
Oat
Spring Wheat
Winter Rye
Winter Triticale
Winter Wheat

Cool Season Broadleaf

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

Diversity Above & Below Ground
Feeding the Soil Biology a Balanced Diet

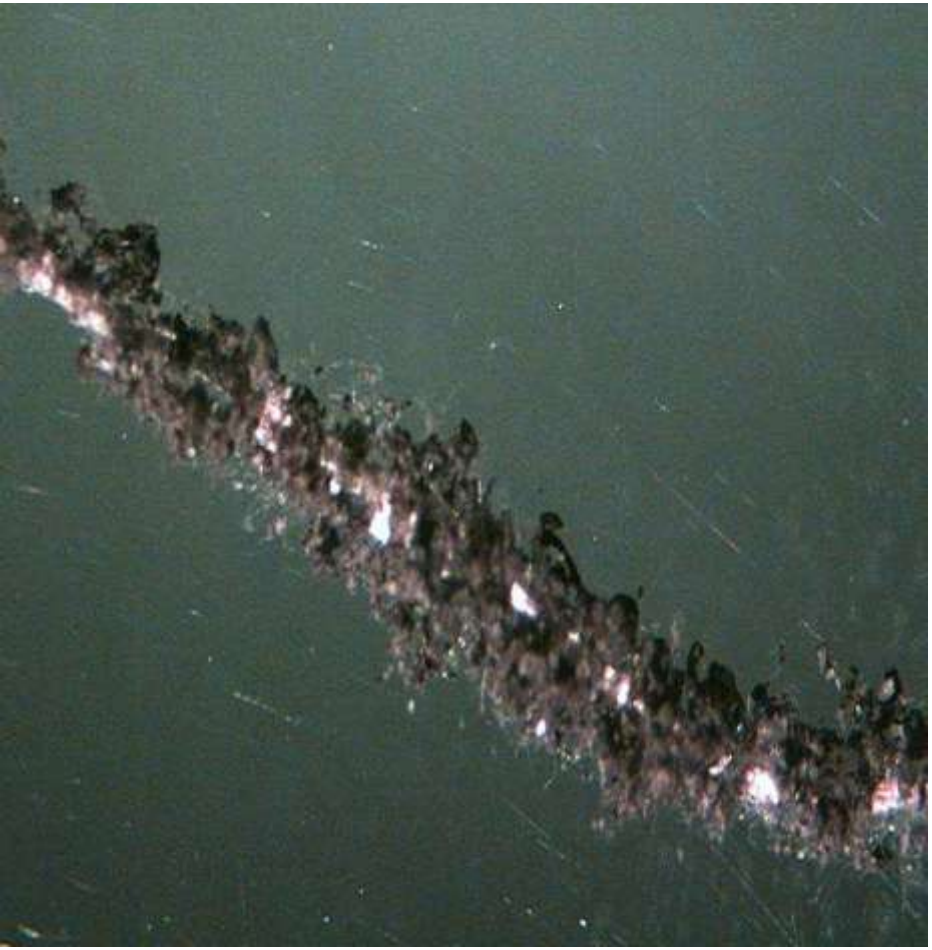
Plants Interacting with Mycorrhizal Fungi



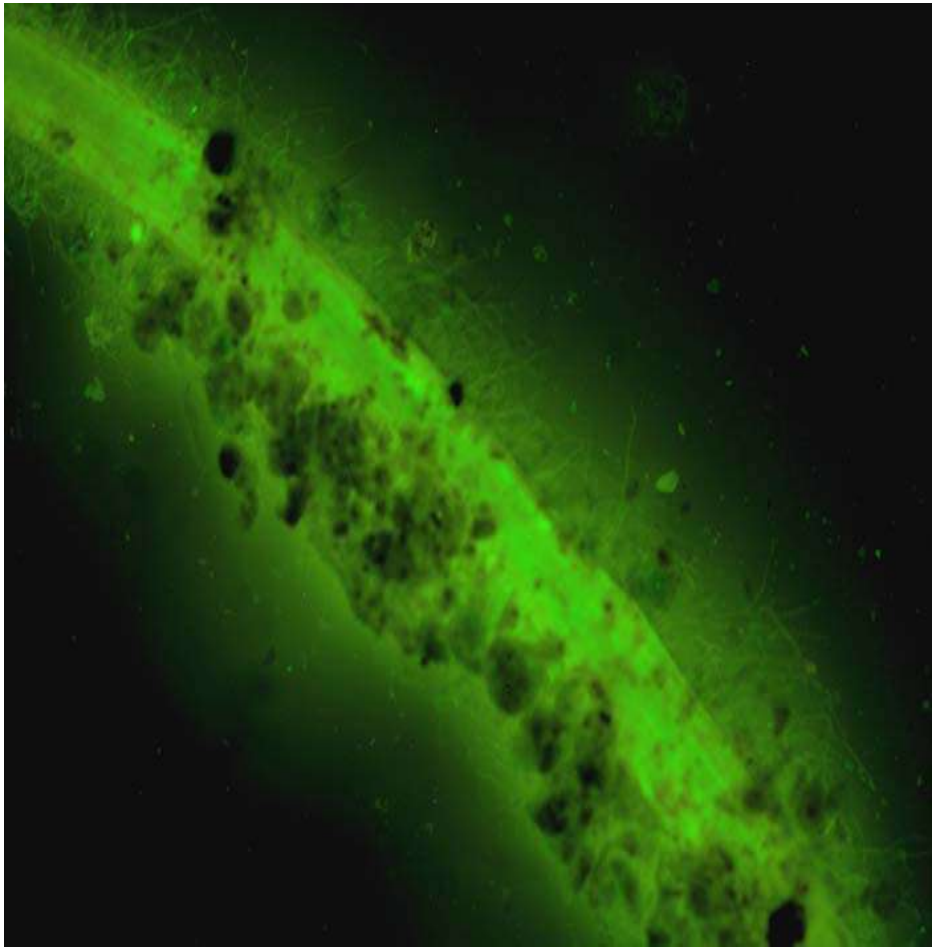
- Assists with P uptake from the soil
- Moves P from the non-legume plant to the legume plant
- Moves N from the legume plant to the non-legume plant

The Nature and Property of Soils, Brady and Weil

Soil Aggregates on a millet root. Burleigh County

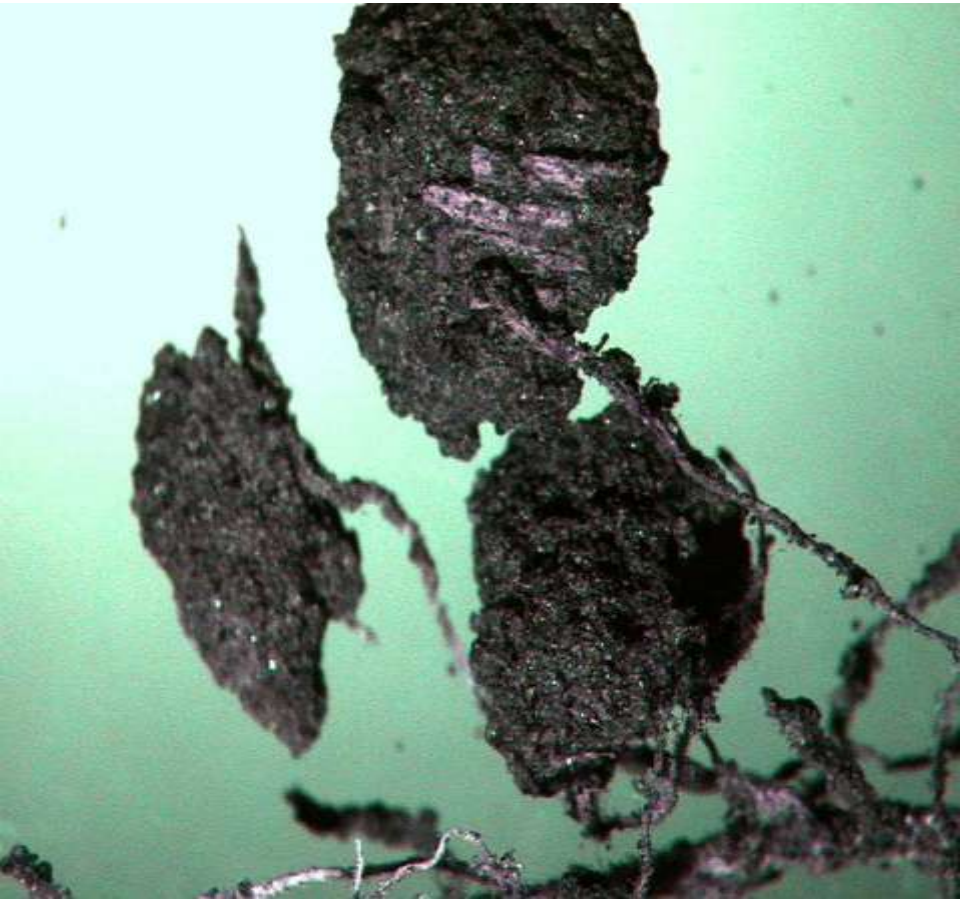


Glomalin and hyphae show well with a green color in the lab.

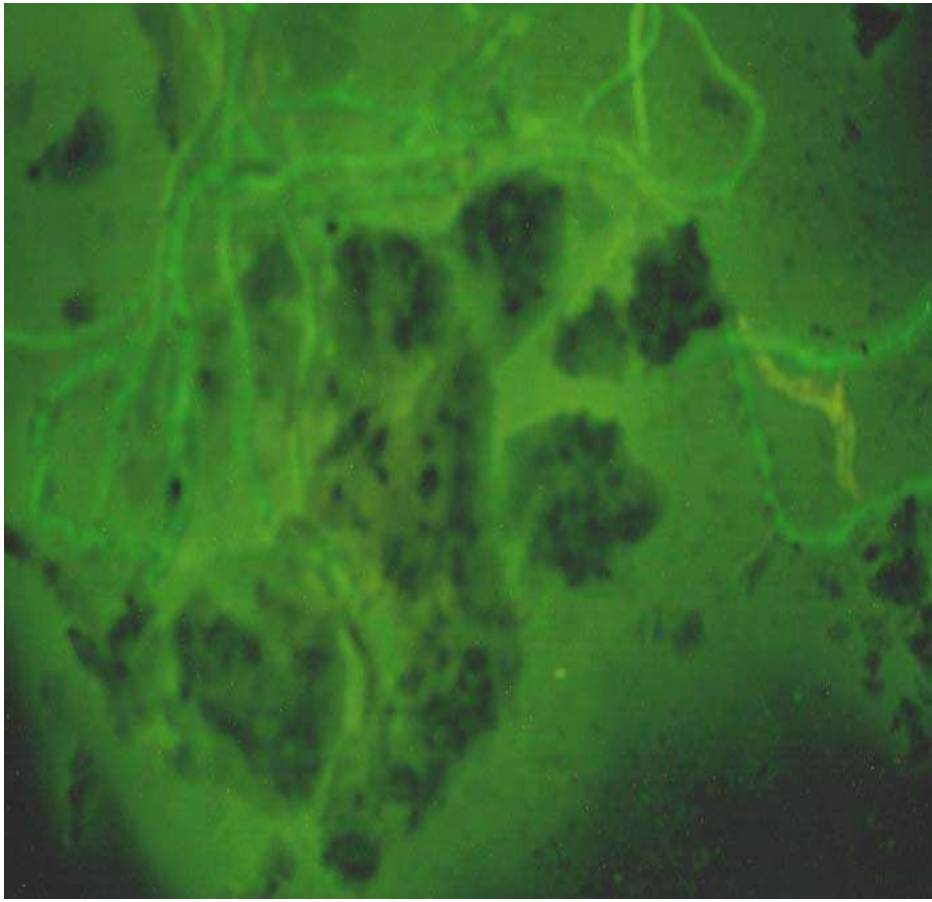


Dr. Kris Nichols, Microbiologist, ARS, Mandan, ND

Enlarged Soil Aggregates



Glomalin and hypae



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

Tracking Organic Matter…

Upward Trend

Beginning 1.7 to 2%
Present 3.7 to 4.3%

Gabe's revolving nutrient bank account.

- 1.0% OM = 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.

- Resulting in 20 to 30 lbs of useable N per acre.

Soil Organic Matter & 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

Nodules Fixing Nitrogen


Improving Organic Matter
Continual Live Root 24/7

Past Inputs…

Present - Low Input Corn Crop

Tissue Sample

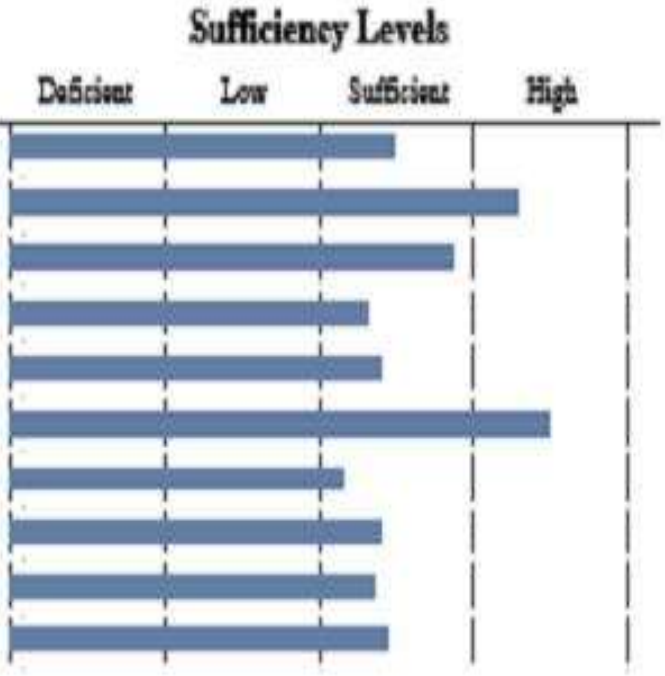
Taken from Non-Fertilized Corn

Results For : GABE BROWN
Location :
Sample ID : CORN

WARD Laboratories, Inc

Plant Type : Corn
Stage : Tassel

	Result Dry Basis
Nitrogen ,% N	3.05
Phosphorus, % P	0.42
Potassium, % K	2.52
Calcium, % Ca	0.43
Magnesium, % Mg	0.22
Sulfur, % S	0.33
Zinc, ppm Zn	25
Iron, ppm Fe	143
Manganese, ppm Mn	67
Copper, ppm Cu	11.8



2008 Yield Data

- **Fertilized Corn**
  - 100 # 46-0-0
  - 20 ton/ac manure (fall ’07)
  - 114.6 bu/ac
- **Non-fertilized Corn**
  - No commercial fertility
  - 20 ton/ac manure (fall ’07)
  - 114.8 bu/ac

No Commercial Fertilizer or Manure
Farm Average Yield is 127 Bushels/Acre
August 2009

Early Soil Health

- Thomas Jefferson in the year 1794 was using vetch, turnips, peas and clover as cover crops to improve soil health on his Virginia plantation
  - *Thomas Jefferson's Garden Book, 1776-1824*

- Why did we get away from this?

- Applying good agronomic principles equals lower required inputs for the same effect

Some of Gabe's Crops

- Alfalfa
- Pea
- Corn
- Sunflower
- Barley
- Turnip
- Radish
- Lentils
- Hairy Vetch
- Wheat
- Pasja
- Red Clover
- Sweet Clover
- Sugar Beets
- Buckwheat
- Oats
- Cowpea
- Millet
- Sorghum
- Sudan
- Canola

Corn and Hairy Vetch
Maximum Sunlight Harvest


No Commercial Fertilizer

Triticale and Vetch Combination
July 16, 2009

Harvesting Triticale and Hairy Vetch. August 30, 2009

Sunflower and Hairy Vetch
2240 lbs /ac - no Fertilizer Applied

Red Millet and Red Clover
August 2009
No Chemical or Fertilizer

7 Row Interseeder

Corn and Cowpea

Seeded after the last Herbicide Application

Warm Season Grass and a Warm Season Broadleaf

Cowpea
Warm Season Broadleaf

- Fixes nitrogen
- Adds diversity
- Nectar ports attract beneficial insects

Forage Barley and Red Clover

Cool Season Grass and a Cool Season Broadleaf

Red Clover Regrowth

Cowpea & Sudan Grass

Cowpea & Millet

Pea and Hairy Vetch
Require the same Inoculant


Winter Triticale 75 lbs
Hairy Vetch 20 lbs
Sweet Clover 1 lb
Red Clover 1 lb
Fall Seeded


Winter Triticale – fibrous root
Hairy Vetch – shallow rooted legume
Red Clover – medium rooted legume
Sweet Clover – deep rooted legume

“Don’t complain about input costs – do something about it. Diversify”

Gabe Brown

Cool Season Mixture
Seeded end of April 2009
No Commercial Fertilizer Applied

- Oat 45 lbs
- Forage Pea 30 lbs
- Hairy Vetch 10 lbs
- Turnip 1 lb
- Radish 1 lb
- Red Clover 1 lb

Harvesting the Cool Season Mixture
August 2009
Chopped & Yielded 14 ton/ac

Warm Season Cocktail

- Cowpea 10 lbs
- Soybean 20 lbs
- Pearl Millet 4 lbs
- Proso Millet 4 lbs
- Radish 2 lbs
- Turnip 1 lb
- Sunflower 10 lbs
- Buckwheat 10 lbs

Foreground – Chopped Cowpea/Sudan
Background – Grazed WS Cocktail

Diversity attracts Diversity
Ringneck Pheasant, Sharptail Grouse, Hungarian Partridge, Canada Geese,
Duck, Whitetail Deer, Song Bird, Raptors, Mink, Weasel, Raccoons, Coyote, Fox and more

Left photo taken on June 16, 2009
showing Corn planted into Triticale/Vetch stubble.
12.2” rain on June 15th.
Right Photo taken on July 1, 2009.
Residue managers were not used.

Same Field
Brown’s Ranch


The Value of Soil Health
Soil Aggregates
Photo taken June 16, 2009

Left photo taken on June 16, 2009
showing Corn planted into cover crop residue.
Right photo taken on July 1, 2009.
Rapid residue decomposition.
Residue managers were not used.

Same Field
Brown’s Ranch

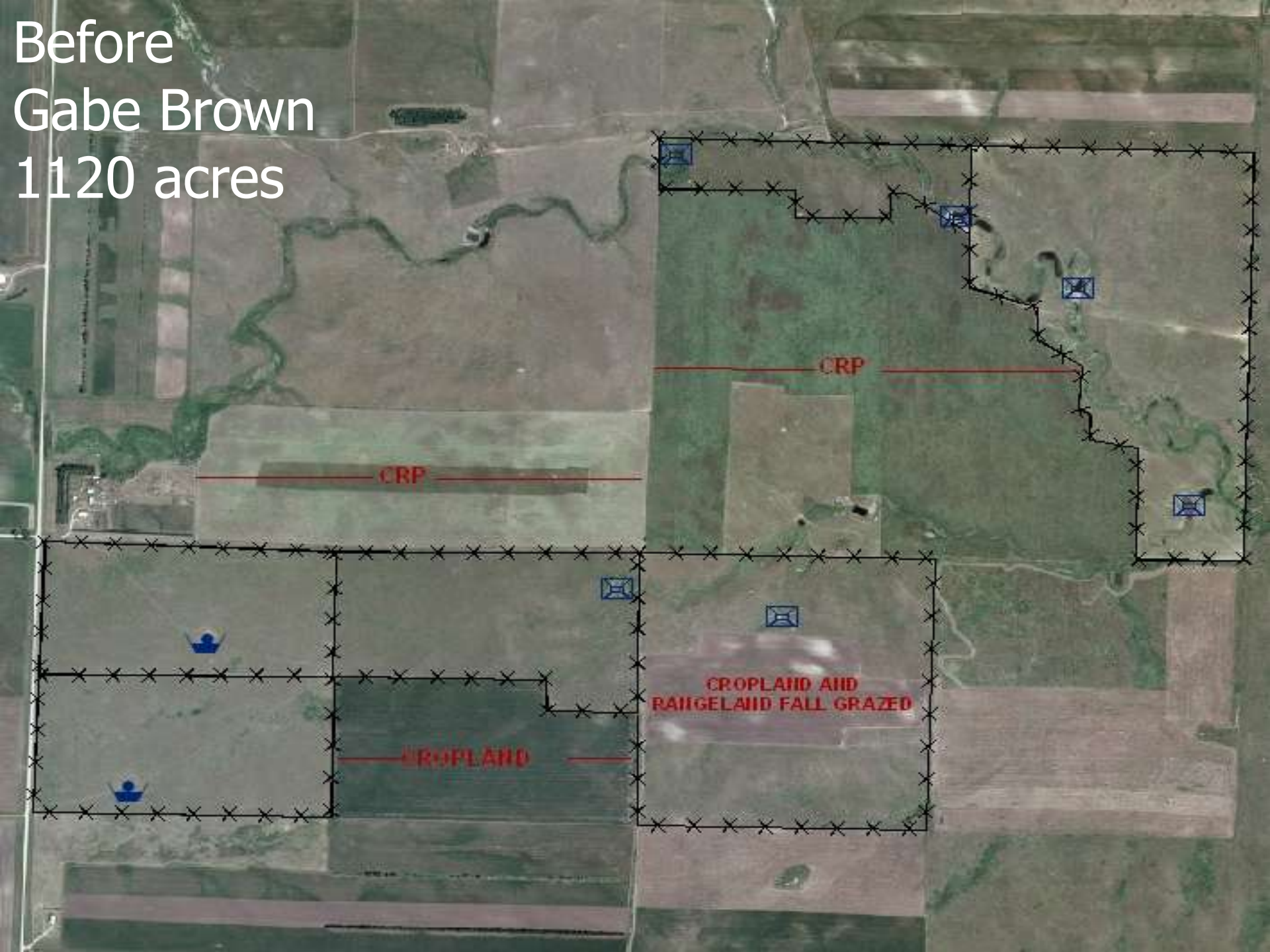
Nutrient Cycling
Carbon/Nitrogen Ratios

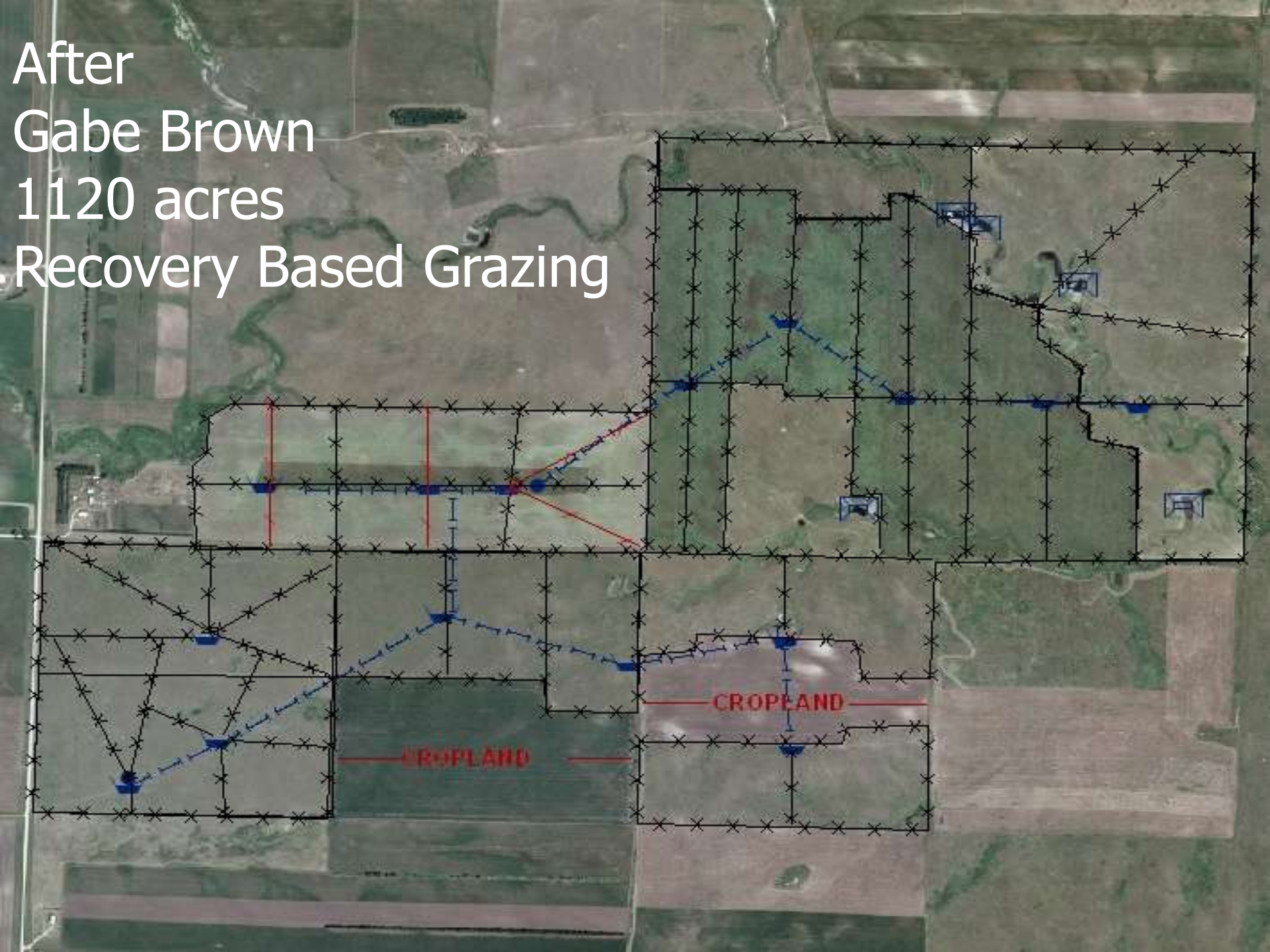
- Soil Microorganisms, Bacteria * 5/1
- SOM, Mollisol Ap horizon * 11/1
- Young Alfalfa Hay * 13/1
- Rotted barnyard manure * 20/1
- Mature Alfalfa Hay * 25/1
- Protozoa ** 30/1
- Corn Stover * 57/1
- Wheat Straw * 80/1
- Newspaper * 120/1
- Deciduous Wood ** 300/1

Source:
*The Nature and Properties of Soils, fourteenth Edition.
Nyle C. Brady and Ray R. Weil
** Elaine R. Ingham, Soil Food Web

Recovery Based Grazing System

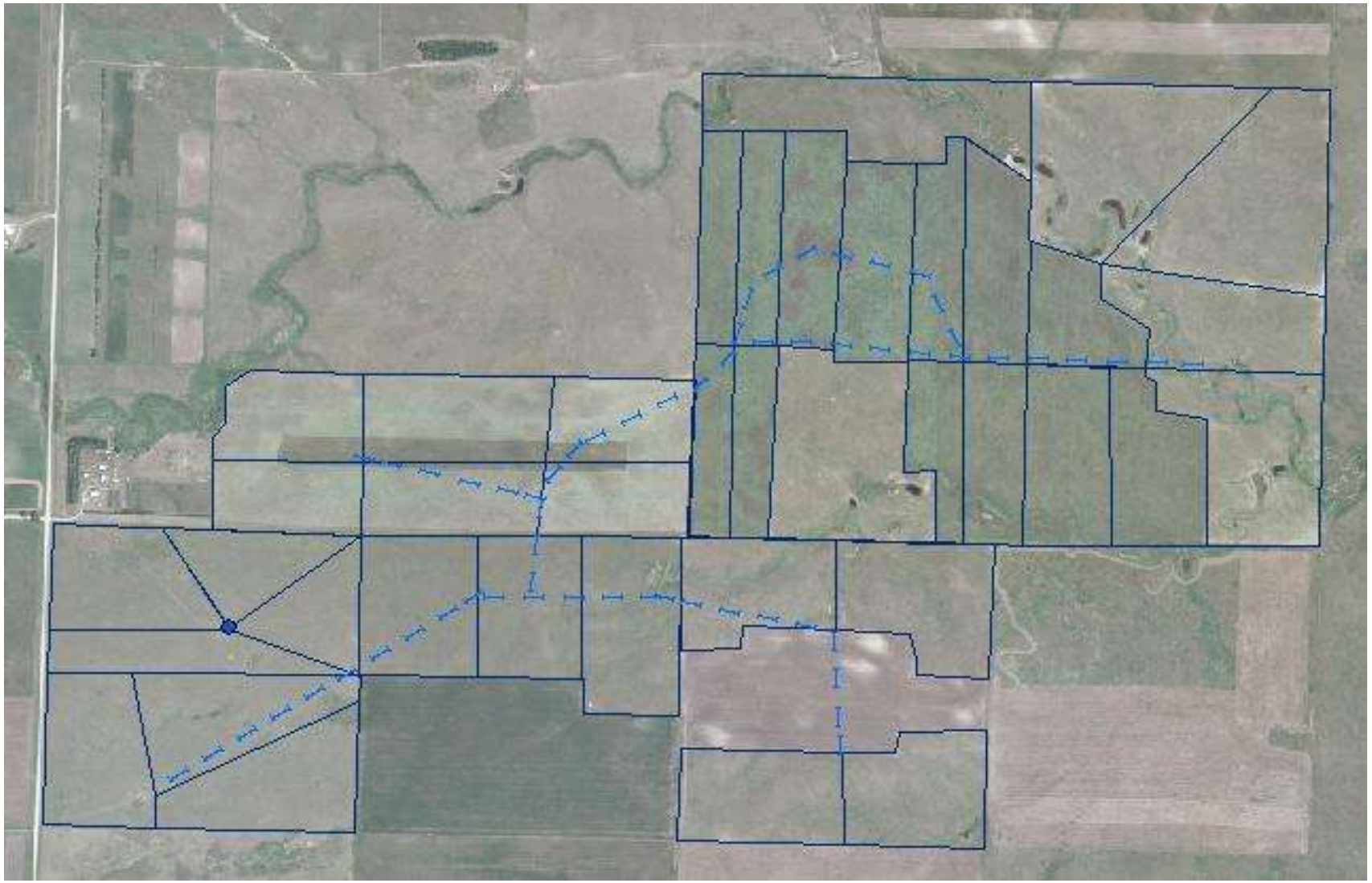
Cattle Herd Consists of 250 Gelbvieh and Angus Cows plus Yearlings


Before
Gabe Brown
1120 acres
CRP
CRP
CROPLAND AND
RANGELAND FALL GRAZED
CROPLAND


After
Gabe Brown
1120 acres
Recovery Based Grazing
CROPLAND
CROPLAND

Ultra-High Stock Density

Strip Grazing for Soil Health



Grazing Tall
- Improving Soil Health
by adding Carbon

Extending the Grazing Season with Cover Crops

Mechanical Harvest

Livestock Integration


Livestock Harvest
Bare Ground?

Spring 2008
Planting into grazed Cowpea/Millet
Invisible Planting


No-Till Planting Through Heavy Residue

Trash Whippers Lifted


Uniform emergence through heavy residue

Does harvest method affect crop response?

Animal vs. Mechanical

Harvesting Cover Crops

Grazing 2007

- 91 bu/ac Corn (’08)
- 1 Herbicide Application
- Value of additional nutrients from manure?

Chopping 2007

- 68 bu/ac Corn (’08)
- 2 Herbicide Applications
- Value of nutrients hauled away?

A 4 Week Supply Based on 3% of Body Weight

Winter of 08-09


May 2009

Bale Grazing Results
Tame Pastures

Pasture With Bale Grazing

8573 lbs/ac
11.95% Crude Protein
59.43% TDN

Pasture Without Bale Grazing

2559 lbs/ac
7.96% Crude Protein
60.70% TDN

Where Do We Go Next…

Brown's Ranch Part II - by Jay Fuhrer NRCS

Cropping System Overview

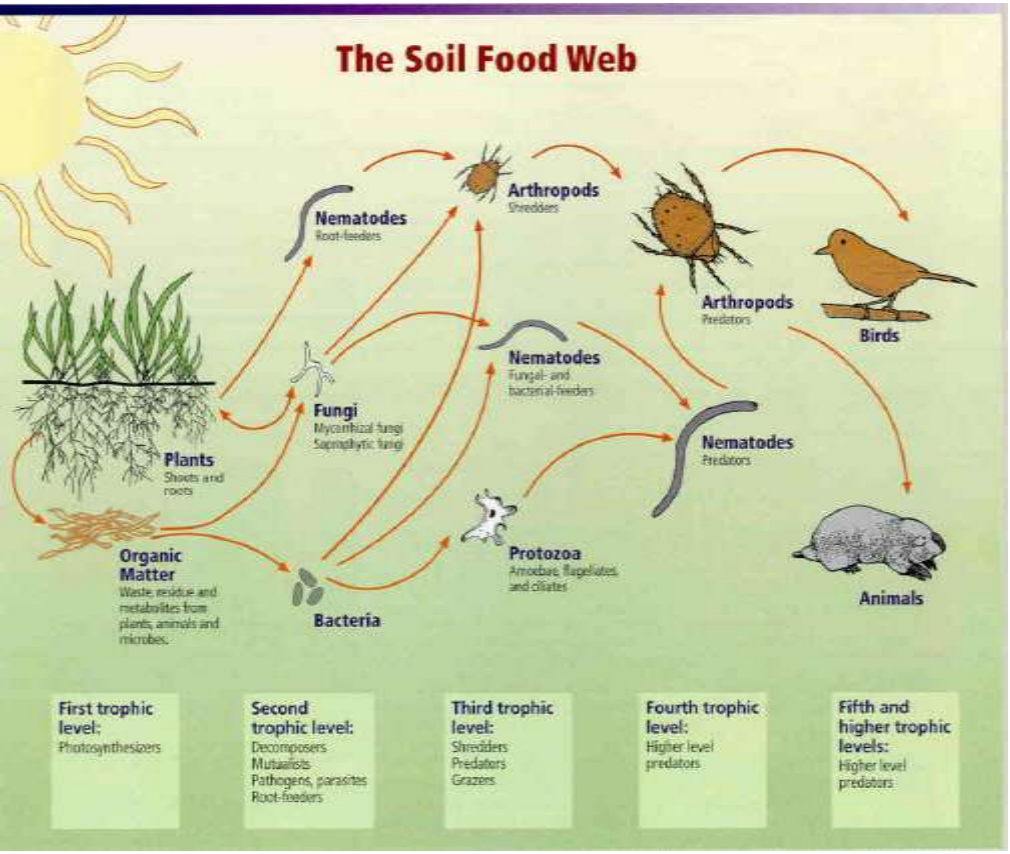
- **Phase One:** Start No-till Cropping Systems and Grazing Systems. Enhancing the home and food supply for the soil biology.

- **Phase Two:** Add Cover Crops to integrate the Cropping and Grazing Systems together. Further strengthening the crop diversity, habitat and available food supply.

- **Phase Three:** begin to reduce pesticides and commercial fertilizer in the long term systems.

- **Phase Four:** Complete two years of Soil Food Web soil tests. Evaluate and apply the Soil Food Web technology to further reduce and/or eliminate pesticides and commercial fertilizer.

The Soil Food Web
Restoring Degraded Soils



- The soil is alive and requires a home and food. How do we….
- have less disturbance
- have more diversity
- keep living roots in the soil as much as possible
- keep the soil covered

1st Year No-Till

Soil Foodweb Analysis

Report prepared for:
Burleigh Co. Soil Conservation
Vicki Bailey
1511 E. Interstate Avenue
Bismarck, ND 58503-0560 US
(701) 250-4363
vicki.bailey@nd.nacdnet.net

Report Sent: 07/29/2005
Sample#: 01-100980
Unique ID: [redacted]
Plant: Wheat
Invoice Number: 8357
Sample Received: 07/14/2005

For interpretation of this report please contact:
Local Advisor: or regional lab
Soil Foodweb, Inc
info@soilfoodweb.com
(541) 752-5066
Consulting fees may apply

Organism Biomass Data		Dry Weight	Active Bacterial (µg/g)	Total Bacterial (µg/g)	Active Fungal (µg/g)	Total Fungal (µg/g)	Hyphal Diameter (µm)
Results		0.850	44.2	2243	**7.02**	205	2.5
Comments		In Good Range	Excellent	Excellent	Low	Good	
Expected Range	Low	0.45	15	100	15	100	
	High	0.85	25	300	25	300	

		Protozoa Numbers/g			Total Nematodes #/g	Percent Mycorrhizal Colonization	
		Flagellates	Amoebae	Ciliates		ENDO	ECTO
Results		**5020**	**2520**	**32**	**1.98**	**2%**	**0%**
Comments		Low	Low	Low	Low	Low	Low
Expected Range	Low	10000	10000	50	20	40%	40%
	High			100	30	80%	80%

Organism Biomass Ratios		Total Fungal to Total Bacterial	Active to Total Fungal	Active to Total Bacterial	Active Fungal to Active Bacterial	Plant Available N Supply
Results		**0.09**	**0.03**	**0.02**	**0.16**	25-50
Comments		Low	Low	Low	Low	
Expected Range	Low	0.8	0.25	0.25	0.75	
	High	1.5	0.95	0.95	1.5	

Nematodes per Gram of Soil
Identification to genus

Bacterial Feeders		
Acrobeles		0.13
Acrobeloides		0.04
Cephalobus		0.18
Eucephalobus		0.04
Panagrolaimus		0.04
Rhabditidae		0.27
Fungal Feeders		
Eudorylaimus		0.04
Mesodorylaimus		0.13
Microdorylaimus		0.04
Fungal/Root Feeders		
Aphelenchoides	Foliar nematode	0.04
Aphelenchus		0.27
Ditylenchus	Stem & Bulb nematode	0.18
Filenchus		0.04
Root Feeders		
Helicotylenchus	Spiral nematode	0.04
Meloidogyne	Root-Knot nematode	0.09
Paratylenchus	Pin nematode	0.09

Long Term No-Till

Soil Foodweb Analysis

Report prepared for:
Burleigh Co. Soil Conservation
Vicki Bailey
1511 E. Interstate Avenue
Bismarck, ND 58503-0560 US
(701) 250-4363
vicki.bailey@nd.nacdnet.net

Report Sent: 07/29/2005
Sample#: 01-100984
Unique ID: GB1
Plant: Corn
Invoice Number: 8357
Sample Received: 07/14/2005

For interpretation of this report please contact:
Local Advisor: or regional lab
Soil Foodweb, Inc
info@soilfoodweb.com
(541) 752-5066
Consulting fees may apply

Organism Biomass Data	Dry Weight	Active Bacterial (µg/g)	Total Bacterial (µg/g)	Active Fungal (µg/g)	Total Fungal (µg/g)	Hyphal Diameter (µm)
Results	**0.850**	46.3	405	**5.24**	274	2.5
Comments	To Wet	Excellent	Excellent	Low	Good	
Expected Range Low	0.45	15	100	15	100	
Expected Range High	0.85	25	300	25	300	

	Protozoa Numbers/g			Total Nematodes #/g	Percent Mycorrhizal Colonization	
	Flagellates	Amoebae	Ciliates		ENDO	ECTO
Results	178500	**9736**	331	**4.45**	**31%**	**0%**
Comments	High	Low	High	Low	Low	Low
Expected Range Low	10000	10000	50	20	40%	40%
Expected Range High			100	30	80%	80%

Organism Biomass Ratios	Total Fungal to Total Bacterial	Active to Total Fungal	Active to Total Bacterial	Active Fungal to Active Bacterial	Plant Available N Supply
Results	**0.68**	**0.02**	**0.11**	**0.11**	200+
Comments	Low	Low	Low	Low	
Expected Range Low	0.8	0.25	0.25	0.75	
Expected Range High	1.5	0.95	0.95	1.5	

Nematodes per Gram of Soil
Identification to genus

Bacterial Feeders		
Acrobeles		0.81
Acrobeloides		0.18
Cephalobus		0.45
Cervidellus		0.18
Rhabditidae		0.45
Fungal Feeders		
Eudorylaimus		0.09
Fungal/Root Feeders		
Aphelenchoides	Foliar nematode	0.54
Aphelenchus		0.45
Ditylenchus	Stem & Bulb nematode	0.54
Filenchus		0.09

Cover Crops and Compost

Designing for what you don't have!

- Cover Crops can be designed to achieve specific C/N Ratios, legume & nonlegume, taproot & fibrous root and more…

- Compost can be designed to be bacterial or fungal dominate and more…

Fungal Starting Material
What We Used

- 25% High Nitrogen
  Manure, Alfalfa, Bean, Pea
- 30% Green
  Grass Clipping, Silage
- 45% Woody
  Wood Chips, News Paper
- Water

- Actual Nitrogen: 7 ton Manure
- Actual Green: 1 hay bale, 2 pickup loads of fresh lawn clippings
- Actual Woody: 5 ton Wood Chips, 5 bags shredded paper
- Water

"The more diversity in the recipe, the greater the biological diversity in the compost"

Wood Chips

Hay Bale

Shredded Paper and Manure

Added water as each layer was applied

Finished Product

October 10, 2008

- The compost reached 150 degrees F in 52 hours. Turned for the first time on October 10, 2008
- Temperatures kept below 160 degrees F by turning as needed

How To Apply

- As a live biology compost to the soil

How To Apply

- As an extract to the soil

How To Apply…

- As a foliar tea to the plant.

The Sieve Bag is Filled ¾ Full of Compost

The Compost Tea Cooks for 24 Hours

Food Amendments for the Live Biology

Microbial Food Sources
- Molasses
- Kelp Powder
- Fish Powder

Microbial Catalysts
- Humic Acid
- Yucca Extract
- Rock Dust

Viewing the Quality and Quanity of Soil Biology before Applying

Applying a Compost Tea on Brown's Ranch 2009
20 Gallons per Acre with a Boomless Sprayer

Soil Foodweb

- Disease Suppression – applied as a foliar.
- Nutrient Enhancement – protozoa & nematodes consuming bacteria & fungi (who eats who).
- Soil Structure Improvement – micro paths and macro paths.
- Weed Suppression – F:B = 1:1
- Preventing leaching and erosion – bacteria & fungi hold nutrients and soil particles

Where Can Gabe Go In The Great Plains Agricultural System?

- Supplying the soil biology with food and a home
- Using Cropping Systems, Grazing Systems, Cover Crops, and the Soil Food Web
- Sustainability