Soil Quality Test Kit what are we missing?

Soil Quality & Soil Health

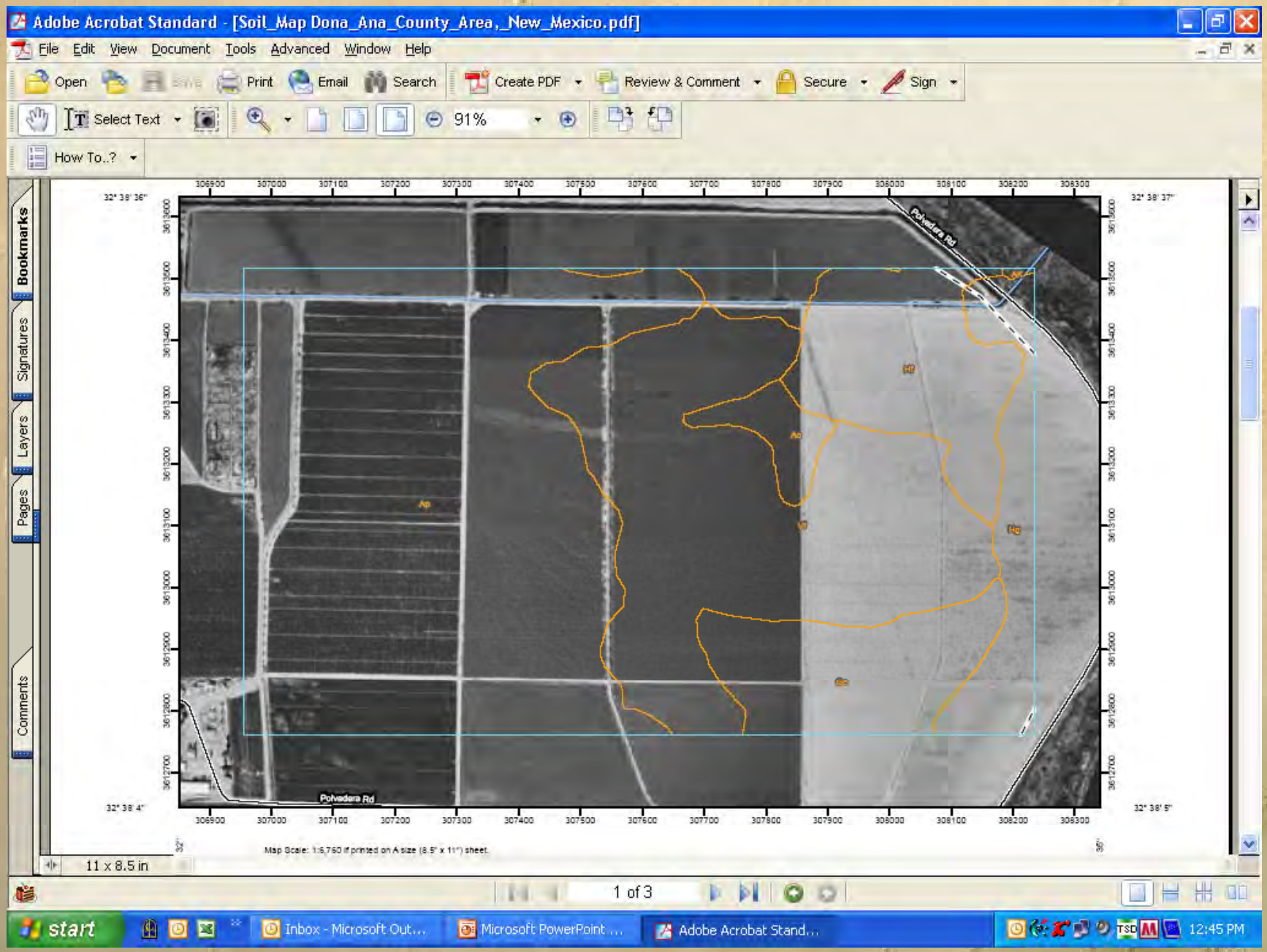
Clarence
Chavez
Soil Scientist

The Soil Survey, FOTG, your people skills, policy and programs is what gets you to the producers doorstep.

It is up to you to conduct an on-sight investigation and ask about: farming practices or rangeland practices.

We as an agency have started to teach our employees about soil quality and soil health as they relate to Water Quality, Plant Health, Air Quality, Energy Conservation, etc…!

What do we assess and where?



The Soil Survey is a good start

Testing for your Baseline

Tissue, Water and Soil Lab Tests - $110

Active Carbon Tests

Soil Quality Test Kits

The NRCS Active C Field Kit
Does 10 samples at a time (5 gr each)

What are the assessments

Biota Food Sources (Crop Residues, Root Exudates, Manure, Decomposing OM, Humus & Living Organisms)

Biological

2. Soil Respiration (lbs CO_2-C/ac/d)

3. Infiltration Test (in/hr)

10. Number/ft^2

(Photos: Soil Biology Primer)

Soil Temp.

Additional Assessments:

- Soil, Irrigation Water & Plant Tissue analysis
- Active Carbon Test

Large Soil Pores (Good Aeration & Infiltration)

4. Bulk Density Test (g/cm^3)

8. Aggregate Stability Test (% Water Stable Aggregates)

9. Slake Test (Stability Class: 0- 6)

Physical (Soil Texture & Structure)

5. Electrical Conductivity Test (ECe in dS/m). i.e., Salts in the Soil.

6. Soil pH Test

7. Soil Nitrate Test (ppm or mg/kg)

Chemical (Soil Solution)

NOTE: Emphasis on managing the Soil Ecosystem

(SQ – 15) Soil Quality Test Kit Guide (Assessments):

1. Discusses sampling and site characterization (Refer to Guide, pages 1 – 3)
2. Indicates the soil's biological activity
3. Measures the soil's ability to take in water through the soil surface
4. Measures the soil's compaction or pore space
5. Measures the salt concentration in the soil
6. Measures the soil's acidity or alkalinity
7. Measures the soil's nitrate levels
8. Measures the amount of water-stable aggregates
9. Estimates the stability of soil fragments in water
10. Measures the number or earthworms in the soil
11. Shows how to observe soil structure and root patterns and how to estimate topsoil depth, penetration resistance, and soil texture in the soil profile (Refer to Guide, pages 23 – 27 & 75 – 78)
12. Estimates salinity and nitrate/nitrite levels in irrigation water (Refer to Guide, pages 79-82)

rudy garcia 2009

(SQ – 16) Soil Quality Test Kit Guide - Interpretations (http://soils.usda.gov/sqi/assessment/test_kit.html)

Soil Texture (pg. 77)	% Clay (range)
Sands (S)	2 – 8
L. Sands	2 – 14
Fine Sands	2 – 8
Very F. Sands	2 – 8
L. F. Sands	2 – 14
L. V. F. Sands	2 – 14
S. Loam	2 – 18
F. S. Loam	2 – 18
V. F. S. Loam	2 – 18
Loam (L)	10 – 26
Si. Loam	2 – 26
Silt (Si)	2 – 10
S. C. Loam	22 – 36
Si. C. Loam	28 – 38
C. Loam	28 – 38
S. Clay	38 – 54
Si. Clay	42 – 58
Clay (C)	42 - 98

Infiltration Rate (inches/hr)	Infiltration Class Table 3. pg. 56
> 20	Very rapid
6 – 20	Rapid
2 – 6	Mod. rapid
0.6 – 2	Moderate
0.2 – 0.6	Mod. slow
0.06 – 0.2	Slow
0.0015 - .06	Very slow
< 0.0015	Impermeable

Aggregate Stability Table 8 (pg. 70)

Clay (%)	Water Stable Aggregates (%)	Organic Matter (%)	Water Stable Aggregates (%)
5	60	0.4	53
10	65	0.8	66
20	70	1.2	70
30	74	2	75
40	78	4	77
60	82	8	81
80	86	12	85

NRCS Active Carbon Test (0 – 4" depth)

Range (mg/kg): 100 (Low) - 1,000 (High)

Stability Class	Slake Test (Table on pg. 21)
0	Soil too unstable to sample (falls through sieve).
1	50% of structural integrity lost w/in 5 seconds of insertion in water.
2	50% of structural integrity lost w/in 5 – 30 seconds after insertion.
3	50% of structural integrity lost w/in 30 – 300 seconds after insertion.
4	10 – 25% of soil remaining on sieve after 5 dipping cycles.
5	25 – 75% of soil remaining on sieve after 5 dipping cycles.
6	75 – 100% of soil remaining on sieve after 5 dipping cycles.

Irrigation Salinity (pg. 80) Classification - Table 11	EC (dS/m)	TDS (mg/l)
No effects usually noticed	0.75	500
Can have detrimental effects on sensitive crops	0.75 – 1.50	500 – 1,000
Can have adverse effects on many crops	1.50 – 3.00	1,000 – 2,000
Can be used for tolerant plants (on permeable soils)	3.00 – 7.50	2,000 – 5,000

Salts in the soil Rating (Table 6. pg. 61)	EC range for 1:1 soil:water suspension for which yield reductions occur
S = Sensitive	> 0.90 dS/m
MS = Mod. Sensitive	> 1.40 dS/m
MT = Mod. Tolerant	> 2.50 dS/m
T = Tolerant	> 4.0 dS/m

Soil Respiration (lbs CO_2-C/a/d)	Class	Soil Condition (Table 1. pg. 53) (Class ratings & soil conditions at optimum soil temp. & moisture)
0	No soil activity	Soil has no biological activity and is virtually sterile
< 9.5	Very low soil activity	Soil is very depleted of available OM and has little biological activity.
9.5 - 16	Mod. low soil activity	Soil is somewhat depleted of available OM, and biological activity is low.
16 - 32	Medium soil activity	Soil is approaching or declining from an ideal state of biological activity.
32 – 64	Ideal soil activity	Soil is in an ideal state of biological activity and has adequate OM and active populations of microorganisms.
> 64	Unusually high soil activity	Soil has a vary high level of microbial activity and has high levels of available OM, possibly from the additions of large quantities of fresh OM or manure.

Bulk Density (Soil Type Table 4. pg. 57)	Ideal Bulk Densities (g/cm^3)	Bulk Densities that restrict root growth
sands, loamy sands	< 1.6	> 1.80
sandy loams, loams	< 1.4	> 1.80
S. C. loams, loams, clay loams	< 1.4	> 1.75
silts, silt loams	< 1.3	> 1.75
silt loams, silty clay loams	< 1.4	> 1.65
S. clays, silty clays, some clay loams (35-45% clay)	< 1.10	> 1.58
clays (> 45% clay)	< 1.10	> 1.47

Kit Tests (Table of contents): 1. Measuring Soil Quality (pg. 1); 2. Soil Respiration Test (pg. 4); 3. Infiltration Test (pg. 7); 4. Bulk Density Test (pg. 9); 5. Electrical Conductivity (EC) Test (pg. 14); 6. pH Test (pg. 15); 7. Soil Nitrate Test (pg. 16); 8 Aggregate Stability Test (pg. 18); 9. Slake Test (pg. 20); 10. Earthworm Test (pg. 22); 11. Soil Physical Observations and Estimations (pg. 23); 12. Water Quality Tests (pg. 28). (Note: The NRCS Active Carbon Test is not part of this kit)

Test 1: discusses sampling and site characterization; Test 6: measures the soil's acidity or alkalinity; Test 7: measures the soil's nitrate levels; Test 10: measures the number of earthworms in the soil; Test 11: observation of soil structure/texture, root patterns, topsoil depth & penetration resistance.

Soil Respiration

Soil Infiltration

Respiration / Infiltration

Soil Respiration (lbs CO_2-C/a/d)	Class	Soil Condition (Table 1. pg. 53) (Class ratings & soil conditions at optimum soil temp. & moisture)
0	No soil activity	Soil has no biological activity and is virtually sterile
< 9.5	Very low soil activity	Soil is very depleted of available OM and has little biological activity.
9.5 - 16	Mod. low soil activity	Soil is somewhat depleted of available OM, and biological activity is low.
16 - 32	Medium soil activity	Soil is approaching or declining from an ideal state of biological activity.
32 – 64	Ideal soil activity	Soil is in an ideal state of biological Activity has adequate OM and active populations of microorganisms
> 64	Unusually high soil activity	Soil has a vary high level of microbial activity and has high levels of available OM, possibly from the additions of large quantities of fresh OM or manure.

Infiltration Rate (inches/hr)	Infiltration Class Table 3. pg. 56
> 20	Very rapid
6 – 20	Rapid
2 – 6	Mod. rapid
0.6 – 2	Moderate
0.2 – 0.6	Mod. slow
0.06 – 0.2	Slow
0.0015 - .06	Very slow
< 0.0015	Impermeable

Soil Respiration

Use of cover crops helps control erosion as well as improve:

- Soil tilth
- Increase organic matter levels
- Enhances water infiltration
- Lessens pests
- Soil organic matter levels (up or down)

Soil Infiltration

- Is sensitive to near surface conditions.
- Indicates the rate and amount of water will enter the soil.
- Indicator of compaction or soil pore clogging (degradation)

Which leads to decreased yields and increased erosion rates.

Bulk Density

Bulk Density (Soil Type Table 4. pg. 57)	Ideal Bulk Densities (g/cm^3)	Bulk Densities that restrict root growth
sands, loamy sands	< 1.6	> 1.80
sandy loams, loams	< 1.4	> 1.80
S. C. loams, loams, clay loams	< 1.4	> 1.75
silts, silt loams	< 1.3	> 1.75
silt loams, silty clay loams	< 1.4	> 1.65
S. clays, silty clays, some clay loams (35-45% clay)	< 1.10	> 1.58
clays (> 45% clay)	< 1.10	> 1.47

Bulk Density / Compaction

Bulk Density

Minimize the number and weight of field operations.

- We all know that working soil too wet is detrimental. It should be avoided at all costs.

- However, soil with good structure and an extensive network of roots will be resilient to **compaction**.

Irrigation Salinity (pg. 80)	EC	TDS
Classification - Table 11	(dS/m)	(mg/l)
No effects usually noticed	0.75	500
Can have detrimental effects on sensitive crops	0.75 – 1.50	500 – 1,000
Can have adverse effects on many crops	1.50 – 3.00	1,000 – 2,000
Can be used for tolerant plants (on permeable soils)	3.00 – 7.50	2,000 – 5,000

Salts in the soil	EC range for 1:1 soil:water suspension for which yield reductions occur
Rating (Table 6. pg. 61)	
S = Sensitive	> 0.90 dS/m
MS = Mod. Sensitive	> 1.40 dS/m
MT = Mod. Tolerant	> 2.50 dS/m
T = Tolerant	> 4.0 dS/m

Electrical Conductivity

Indicates the amount of salts present in the soil. (K^+, Ca^+, Mg^+, Na^+)

Excess salts will hinder plant growth i.e. salt affected irrigation water.

Soil and Water EC

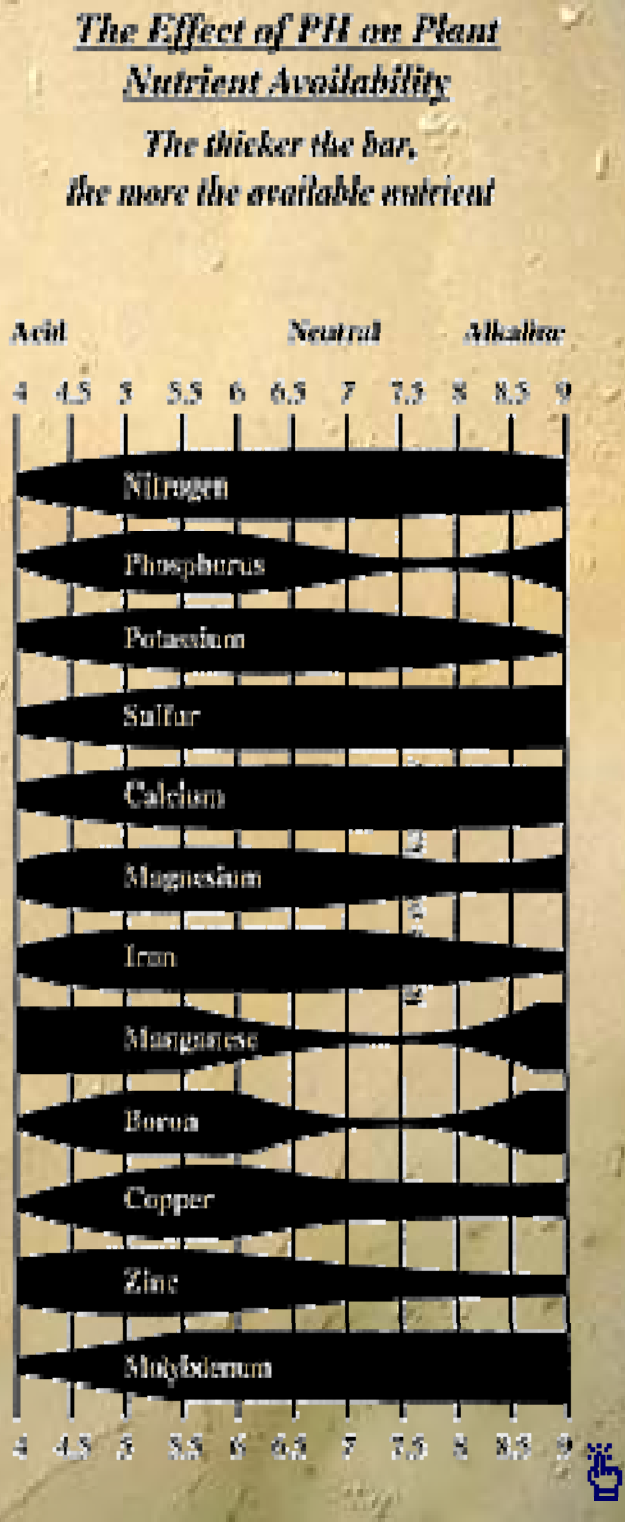
The bottom line

- Timing and amount of watering will help in the management of salts in any soil.

- Soil Quality and Soil Health is very important – Infiltration, Leaching, Structure.

pH -- is the measure of the acidity or alkalinity

of a soil or Water, which affects the availability of plant nutrients, activity of microorganisms, and the solubility of soil minerals



Soil and Water pH

The bottom line

- Soil pH also affects the activity of beneficial microorganisms, which affects nutrient availability, uptake and stability.

- pH values between 6 and 7.5 are optimum for general crop growth

Nitrogen requirements from fertilizers, irrigation water and the decompositions of crop residue by microbes must be checked for excess

Soil Nitrate/Nitrite

Nitrate (NO_3) / Nitrite (NO_2)

Proper fertilizer use.

- Fertilizers (in crop residue, manure, etc…) that enhance the soil. The best approach is to feed the soil biota, rather than feed the plant.

- A good soil will grow healthy crops. Don't over do it with fertility amendments (follow a nutrient management plan) as that is a waste and can be a pollutant.

Aggregate Stability / Soil Slaking

Aggregate Stability / Soil Slaking - Classes

- ✓ Class 0 to 3 are relatively unstable.
- ✓ Class 4 indicates some stability, but very little strength.
- ✓ Classes 5 and 6 represent relatively stable soil fragments or aggregates.

strength relates to the ability of the soil to resist loss of its structure

Aggregate Stability

- Table 8:

Organic Matter (%)	Water Stable Aggregates (%)	Clay (%)	Water Stable Aggregates (%)
0.4	53	5	60
0.8	66	10	65
1.2	70	20	70
2	75	30	74
4	77	40	78
8	81	60	82
12	85	80	86

- For example: for a soil with 2% organic matter and 10% clay, the suitable aggregate stability range (taken from Table 8) would be 65 to 75% water stable aggregates.

Aggregate Stability

- **Assist in Water Holding Capacity / increase Soil Organic Matter.**
- **Protects organic matter from rapid breakdown from soil biota.**
- **Minimize tillage. Plow – Disk – Floating etc…**

Note: Tillage systems that maximize surface residues are preferred.
Use tillage sparingly to solve specific soil problems.

Major practices – cover crops,
no till,
crop rotation,
mulching,
composting, etc.

fungal hyphae - produce humic compounds and organic "glues"
(extra-cellular polysaccharides, Proteins, lipids, etc.)

the Glues bind soils particals into aggregates and improves soil porosity.

Mycorrhizal fungi and other members of the fungi family are
-- soil structure builders

Increasing the availability of nutrients. “Available plant nutrients (N, P, & K) tend to be higher in fresh earthworm casts than in the bulk soil.” [Edwards et al., 1995]

10 Earthworms per cubic food is a good indicator of soil quality/ soil health

65 -90 Degrees F

Environment for soil biota and crop roots (i.e., increased nutrient cycling and water use efficiency)

Soil Temperatures

- 140 degrees, soil bacteria die.
- 130 degrees, 100% moisture lost through evaporation and transpiration.
- 100 degrees, 15% moisture used for growth, 85% moisture lost through evaporation and transpiration.
- 70 degrees, 100% moisture used for growth.

Soil Temperatures

- 140 degrees, soil bacteria die.
- 101-130 degrees, 100% moisture lost through evaporation and transpiration. Some species of bacteria, arthropods, start dying
- 95 -100 degrees, 15% moisture used for growth, 85% moisture lost through evaporation and transpiration.
- 65 - 95 degrees, 100% moisture used for growth. Soil Biota is active and doing their job.

Soil physical observations and estimations of: depth, roots, structure, texture, and aggregate stability

- Measuring the depth of topsoil
- Observe plant roots
- Examine soil structure, texture, color, fragments, pore space, resistance depth etc...

Soil Management Strategies

Mulching,

No-Till, or Minimum Till

Cover Crops

Crop Rotations, Root Diversity,

Green Manure,

Fewer Fertilizers and Pesticides,

Etc…

For more information Please Contact Your Local Office of the:

Natural Resources Conservation Service

or

Soil and Water Conservation District

Sustainability is our future!!!!!

Questions?

Non-Discrimination Statement

- "The U.S. Department of Agriculture (USDA) prohibits discrimination in all of its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex (including gender identity and expression), marital status, familial status, parental status, religion, sexual orientation, political beliefs, genetic information, reprisal, or because all or part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD)."

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service