Continued Study in Blacklands of Texas to Measure Differences in Soil Quality Characteristics with Three Tillage Systems and Three Cropping Rotations

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This year (2008) Orthman Manufacturing, Inc. and USDA – Natural Resources Conservation Service (USDA-NRCS) in cooperation with Texas A&M Stiles Research Center near Thrall, Texas, scientists added to the information collected in 2007. We collected specific soil quality measurements to better comprehend the soil quality changes in continued conservation tillage system applications. It is all three groups' intentions to inform folks of the changes rarely measured in adopting practices that will help growers significantly reduce erosional issues but gain soil capacity to yield better.

The major portions of the soils on the Stiles Farm and the field sized plots are Burleson clay. This is an expansive clay textured soil that can be difficult to manage in even the best of moisture conditions. Last year in May we saw incredible rains, this May the heat and dry returned and the soils were cracking deep. We were able to initiate a new test to observe dry soil surface 1 inch infiltration rates.

As stated last year the common crops of the Blacklands are; cotton, corn, grain sorghum, wheat, and hay crops. The study near Thrall is a rotation of cotton-corn-grain sorghum. This year we scientists from A&M, USDA-NRCS and Orthman measured water infiltration in the near saturated condition and in the dry surface condition, soil porosity and aggregate stability of dry peds soaked in water. All of these related studies offer one a better idea what soil changes are affected by tillage and have some measurable way to gauge those changes.

Water infiltration is a standard method of measuring intake of rain or irrigation water into the soil surface in the predominantly downward flow. In table 1, there are the results of what the scientists collected in the last week of May 2008.

As we jointly collect this data throughout this three year study, we want to provide you a better understanding of the benefits and reasoning why less tillage is profiting growers all across Texas.

Fig.1 The photo to the left shows Andy Spencer with USDA-NRCS, Weatherford, Texas is taking readings from the Cornell Sprinkle Infiltrometer in the corn on corn area of the crop and tillage rotation study on the Stiles Foundation Farm near Thrall, Tx.

Table 1. Near saturated infiltration of Burleson clay, 0 to 2 percent slopes

modified Robert Grossman, Ph.D method(USDA-NRCS) of H. van Es Method, Ph.D (Cornell Univ.)

Stiles Farm Cornell Sprinkle Infiltrometer Tests 2008

Rotation - *Cotton on Corn* Infiltration measured in Inches/hour

row type	Tillage Type	Avg.	Lo	Hi
hard row	Conv Till	0.64	0.25	1.53
	Strip-Till	0.87	0.29	1.38
	No-Till	0.47	0.05	1.38
soft row	Conv Till	1.99	0.92	3.97
	Strip-Till	0.81	0.19	2.98
	No-Till	1.31	0.14	2.62

Grain sorghum on cotton		Avg.	Lo	Hi
hard row	Conv Till	0.28	0.03	0.67
	Strip-Till	1.2	0.62	2.69
	No-Till	0.23	0.03	0.4
soft row	Conv Till	1.05	0.44	2.18
	Strip-Till	1.74	0.09	4.44
	No-Till	0.92	0.19	1.53

Corn on Corn		Avg.	Lo	Hi
hard row	Conv Till	0.57	0.06	1.53
	Strip-Till **	11.27	7.95	16.7
	No-Till	0.27	0.07	0.49
soft row	Conv Till **	5.15	3.43	6.49
	Strip-Till	0.62	0.07	0.93
	No-Till	1.45	0.75	3.37

Note: ** Soil was cracked and even after 24 hours of soaking
the surface cracks had not swollen shut, infiltration was still measured.

USDA National Soil Survey Data - this Burleson clay is determined to have
a 0.06 to 0.20 inches/hour infiltration rate

Dry Soil Surface Infiltration Tests

Table 2. Quick infiltration tests when soil surface is extremely dry, adding 1 inch of water and observing how much time it takes to soak in.

Dry Infiltration Tests

Corn on Cotton	Min+sec/Inch	
Tillage Type	hard row	soft row
Conv. Till	12:15	1:18
Strip-Till	45:38	1:14
No-Till	56:43	4:21
Cotton on Grain sorghum	hard row	soft row
Conv. Till	8:39	7:22
Strip-Till	0:42	1:21
No-Till	5:15	2:55
Corn on corn	hard row	soft row
Conv. Till	34:21	4:55
Strip-Till	14:10	1:09
No-Till	9:15	1:17

Fig. 2 Ring for infiltration is 9.5 inches in diameter, observing different sizes of soil pores. Dime offers reference of some of the 2 to 5mm pores pointed out by red arrows.

Porosity

Another measurement to help understand the intake rate of the Burleson soil, is pore size and space, these scientists observed three different pore sizes of a large ped of soil from the 2 to 6 inch zone in the surface horizon. The pores were counted by the use of hand lenses, using the standard pore size classes from the Field Book for Describing & Sampling Soils, National Soil Survey Center, USDA – Natural Resources Conservation Service, 1998.

Table 3. Observable soil pores in surface 2 to 6 inch zone

Porosity

observations at 2 to 6 inch level of 1 sq. decimeter

Corn on Corn		Strip-Till		No-Till		Conv.Till	
	Size	2007	2008	2007	2008	2007	2008
hard row	0-1mm	149	187	183	281	65	75
	1-2mm	0	3	2	3	2	2
	2-5mm	0	3	0	0	1	0
soft row	0-1mm		236		230		171
	1-2mm		7		5		14
	2-5mm		0		0		0

Corn on Cotton ... 2008 is the cotton year		Strip-Till		No-Till		Conv.Till	
	Size	2007	2008	2007	2008	2007	2008
hard row	0-1mm		228		208		122
	1-2mm		0		2		2
	2-5mm		0		0		0
soft row	0-1mm	196	337	101	89	43	107
	1-2mm	6	9	4	10	1	4
	2-5mm	3	2	0	2	1	0

Cotton on Grain Sorghum --- 2008 is cotton year

	Size	Strip-Till 2008	No-Till 2008	Conv.Till 2008
hard row	0-1mm	103	171	65
	1-2mm	2	3	0
	2-5mm	1	0	0
soft row	0-1mm	145	275	110
	1-2mm	11	0	0
	2-5mm	4	0	0

Note: 10x hand lenses are used to observe the different classes and sizes of pores

Discussion of 2007 & 2008 Data….

To nearly all farmers, you already know that water penetrates clayey textured soils much slower than sandy soils; i.e. sandy loams have an infiltration rate of 1.25-1.50 inches per hour (in hr^{-1}), and clays, silty clays 0.25 in hr^{-1} or less. As we look at what occurred last season and this year, we have observed that the more leftover fibrous root system of the corn and grain sorghum from 2007, we see the infiltration rates improving. As the Stiles Foundation is managed with strip-till and moving over a 5 to 10 inches from last years crop the soils gain porosity, action from worms, old root channels and vertical tillage to create an ideal seedbed. Water intake this year for the Strip-Till compared to Strip-Till in the corn-on-corn plots is 20% faster than 2007. No-till 2008 compared against No-till 2007 is 2X faster. Conventionally tilled 2008 compared to Conventional 2007 is 2.2X faster. In 2008 the corn-after-cotton a little different results; No-till compared to Conventional plots is nearly the same, and Strip-till compared to Conventional has a better intake in the hard row but somewhat slower than conventional in the soft rows.

Looking at the number of pores in Table 3; Strip-till in both rotation plots fluctuated in the number of 1 to 2mm pores compared to No-till and the Conventional. From your observations of Table 1, the larger the pore size, water is absorbed into the soil surface both in the soft and hard rows, especially in the strip-tillage plots. The larger sized pores are very important for downward flow of water when in the observed near saturated condition and this is where strip-till can shine. Now mind you, this is a one time peek below ground. Yet we are seeing in strip-till the number of larger pores increased over the other two tillage types. Strip-till in 2008 in was better in the cotton on corn compared to No-Till and Conventional in the soft rows by a long ways. In 2008 was our first good look at the visual porosity in the grain sorghum plots with cotton. Strip-till lagged behind the No-Till but had more of the larger pores.

We ran out of time during our full week to run bulk density soil samples. We will run those again in 2009 to compare what we accomplished in 2007.

With this being the second year of a three year study/research project, we do see a bit of a trend in what and how the soils respond to less tillage. The porosity continues to improve in the No-Till and Strip-Till compared to the full width tillage system named conventional. Soils drink the water and provide it deeper in the root zone for the crops. It bears watching but it is true clayey soils respond more slowly to less tillage type systems, but the farm is improving it's organic matter. Visually we saw more leaf chewing insects, red and brown wiggler worms that usually have burrowed deep to escape the coming heat. These critters provide us indication that the soil fauna is improving because there is more food/fiber for them to exist on. It is not all being burned up due to oxidation and loss.

Dry soil infiltration

Looking at Table 2 and specifically the soft row portion of data – here we can see what the potential is for water intake due to pores remain open from the subsurface to the surface in the two conservation tillage systems. It is interesting to note that when heavy and sudden rain showers dump 1 to 4 inches of water which soils will take it in or runoff. This test we ran in 2008 indicates how many minutes and seconds go by when 1 inch is dumped quickly into the infiltration rings.

Under the hard rows even when soils are extremely dry the intake is slowed considerably unless cracked as we observed in the cotton/grain sorghum cropping system. We will continue to run this test next year.

Inferences

In this 3 year study, we are seeing bulk density values remain high, we stabbed the ground with a Dickey-John hand penetrometer in many locations giving us all good indication that the compaction issue has not gone away. Soil compaction in the 6 to 9 inch zone is prevalent and is a limiting issue for water movement, root development and less than stellar air/gas exchange for roots.

Water absorption is slow in these clayey soils due to the low resident organic matter and with warmer soil temperatures (thermic soil temperature regime), and with open winters the crop aftermath/residue oxidizes readily. Soil organic matter (SOM) is a great component to helping soils absorb water since it acts like a sponge. SOM is the food source for microbes and other soil borne insects which help soils breathe, digest the crop residues, and release to the roots macro and micro nutrients. The Stiles Farm will continue to reap benefits from this rotation to leave residues on the soil surface and add to the low resident organic matter of the Burleson-type soils.

Limiting the tillage passes and cultivation during the growing season as with No-Till and Strip-Till does help considerably. Our measurements bear that out. However habits and old grandparent tales of need to oxygenate by soil stirring fade very slowly. By being students of the underground and soils, we can see that improper use of wide spread tillage has been hurtful to the soil life and response to water. In very heavy soils, wise vertical-type tillage has its place and we are carrying observations to gain the why and how much benefit it offers. No doubt, Direct Seeding has a lot of merit.   In Black Cotton soils of Texas it remains to be seen if it will always be best. We do watch the economic side of things with these studies also, and that is what others report on with the yields and input costs. This day and age economics are a priority in making farming/management decisions for the grower. Better methods to fertilize enter the management picture also and strip-till really offers that.

We do urge you all to carry out a good soil testing/sampling program with any tillage system you use. But moisture via rainfall or irrigation is so important, and getting that water into the soil to feed the roots is of prime importance. Roots absorb over 98% of all the plants needed water to grow and produce grain, fiber, or fruit. With a poor or insufficient rooting profile, well – yields suffer. A better rooting system will give you the steward/farmer the chance to reap more come harvest time.

Keep watching how this study progresses. We appreciate your interest and how the Stiles Farm is there to offer you the best management systems for agriculture of Central Texas.