Soil Health Assessment/Carbon Proxy Test and Analysis

Fall 2021

Manager:
Owner:
Contact Info:
Marketing:

Date of Field Test and Soil sampling: 10/7/2021
Weather: Sunny High of 72ºF
Time of day: Morning to late Afternoon

Tester: Ruben Parrilla
Report: 10/30/21
Analysis:10/7/21

Tests Performed:
Soil Surface Biology (30” Observation hoop)
Earthworm Count and Biopores
Soil Texture and Visual Aggregation Assessment
Soil Hardness
Water Infiltration
Bulk Density
Slake Test for Aggregate Stability
Active Carbon test kit from OSU/ Soil 1

Location Description

Chestnut silvopasture farm with mixed additional tree/shrub crops and pastured chickens moved down the isles. Trees foliar fed 4-6/year with rejuvenate, fish hydrolysate, EM1, AEA spectrum and trace minerals

Tests were taken from the North and South fields, each about midway between two Chestnut trees in row.

Site 1 South: Row **5a South (S1S)** 9 feet from 3rd towards 4th tree (from center isle)
Site 2 North: Row **5 North (S2N)** 18 feet from 4th tree towards 5th tree (from center isle)

Soil Temperature at 5” Depth ºF

S1S: 61ºF
S2N: 60ºF

Surface Biology

Within 30” diameter observation ring, laid on the surface of the soil, prior to digging (undisturbed).
Overall canopy view:
S1S
85% Living vegetative cover
7% Litter
8% Bare soil
Species observed: chickweed, grasses, garlic, goldenrod and sorrel
S2N
60% Living vegetative cover
35% Litter
5% Bare soil
Species observed: grasses, goldenrod, aster, dock, vetch, thistle, moss

Surface crusting observed?
No; however, some algae (<5%) was observed at each site.

Other life and signs within the ring:
S1S
Ants, caterpillar, grub, and myceliated wood chips
S2N
Ants and snails

Earthworm Count (in 12 x 12 x 12 sample hole):

S1S - 33 Earthworms
S2N - 8 Earthworms

NRCS Soil Cover Assessment Criteria:

Soil cover from plants, residue or mulch greater than 75% of field surrounding evaluation area: Yes/No:
Yes – not of test site itself, but of surrounding field
NRCS Biological Diversity Assessment Criteria, “clearly evident; more than 3 different types of organisms observed.” Yes/No: **Field level, yes**
*NRCS Surface Assessment Criteria, Crusting on no more than 5% of the field(Less/more):***None**
If rainfall or surface irrigation within 12 hrs, Ponding evident? Yes/No: **Some ponding without rainfall**

Soil Texture and Visual Aggregate Assessment in 12 x 12 x 12 sample hole

Root depth and growth pattern:
S1S Max depth 10” Most roots terminate at 5”
S2N Max depth 12” Most roots terminate at 6”
Root sheathing excellent, good, poor, none

S1S poor
S2N poor
<u>Earthworm Channels/pores observed:</u>
S1S 2
S2N 5

<u>Top soil depth and soil layering:</u>
Depth to subsoil is greater than 12” at both sites

<u>Texture</u>

S1S
Top soil slice 0-4” depth: Silt Loam. Strongly aggregated, predominantly irregular spherical, some massive chunks, plenty of pea-sized and larger spheres, mostly granular shaped fine to coarse grains.
Middle soil slice 4-8” depth: Silty Clay Loam, moderate aggregation, again, granular/spherical shape of a full range of sizes, a few massive, irregularly shaped chunks
Bottom soil slice 8-12” depth: Silt, platey, massive and weak

S2N
Top soil slice 0-4” depth: Silt Loam. Moderately aggregated, predominantly irregular spherical, some massive chunks, plenty of pea-sized and larger spheres, mostly granular shaped fine to coarse grains.
Middle soil slice 4-8” depth: Silty Clay Loam, moderate aggregation, again, granular/spherical shape of a full range of sizes, a few massive, irregularly shaped chunks
Bottom soil slice 8-12” depth: Course blocky moderate grade.

<u>NRCS Assessment Criteria</u> (Yes/No):

“Granular soil structure in A horizon and no platy structure in A and B horizons.” **No**

“*Roots covered in a soil film (rhizosheaths) and/or are part of soil aggregates; living roots, if present, are healthy, fully branched and extend into subsoil.”* **No**

“Presence of root or earthworm channels that connect to the soil surface.” **Yes**

Aggregate Stability/Slake Test

Examines the stability of aggregates, when wetted, from a sample of soil from top 6” of soil that has been briefly air-dried. This should be combined with the Soil Texture and Visual Aggregate Assessment (above) to properly assess aggregate stability.

Stable aggregates that are either larger or adhered to roots stay in the mesh while stable aggregates smaller than ⅛ in. fall through the mesh. Aggregates are considered stable if they hold together throughout the 5 minute wetting process, either in the basket or at the bottom of the jar.

After the aggregates have been immersed in the water for 5 minutes, the clarity of the water is assessed using a Secchi tube. Higher numbers mean better water clarity and indicate that soil consists of more stable aggregates and is less apt to stay in suspension and cloud the water. (If the soil is extremely sandy, non-aggregated soil may settle to the bottom more quickly and water clarity may be a less reliable indicator of aggregate stability.) Also recorded is the approximate percentage of soil that are stable aggregates bound to any roots in the sample and/or are larger than the basket mesh size (1/8 in.).

Results: Both samples (**S1S** and **S2N)** yielded 90+ cm reading on the Secchi Tube = very clear water = near 95% stable aggregates of [texture] soil.

> *<u>NRCS Assessment Criteria</u> (Yes/No): At least 80% of Sample A remains intact after 5 mins, water mostly clear:* **Yes**

Infiltration

S1S

8 Minutes 38seconds for 1"rainfall equivalent

S2N

2 Minutes 46seconds for 1"rainfall equivalent

Soil Hardness: Penetrometer PSI readings averaged over 3 separate insertion points within approximately two feet of the test pit.

S1S	**S2N**
3": 67psi	3": 75psi
6": 157psi	6": 152psi
9": 190psi	9": 217psi
12": 233psi	12": 258psi
15": 225psi	15": 250psi
250psi>24"	275psi>24"

> *<u>NRCS Assessment Criteria</u>: Penetrometer rating less than 150 psi within top 6" depth and less than 300 in 6-18" depth (Yes/No):* ***No and Yes***

Bulk Density

Taken at top layer H1 (0-4"), middle H2 (4-8") and third H3 (8-12") of the 12" deep sample slice.

S1S

H1 (0-4 inches) cm, g, Vr: cc, **bulk density = 1.22 g/cc**

H2 (4-8 inches) cm, g, Vr: cc, **bulk density = 1.47g/cc**

H3 (8-12 inches) cm, g, Vr: cc, **bulk density = 1.77 g/cc**

S2N

H1 (0-4 inches) cm, g, Vr: cc, **bulk density = .99g/cc**

H2 (4-8 inches) cm, g, Vr: cc, **bulk density = 1.23g/cc**

H3 (8-12 inches) cm, g, Vr: cc, **bulk density = 1.80g/cc**

Calculations:

Cylinder length 12.7cm, diameter 9.8cm, and area A = 75.43 cm^2

Height of soil within the cylinder h for the sample taken at each level used to determine sample volume

Table 1. General relationship of soil bulk density to root growth based on soil texture.

Soil Texture	Ideal bulk densities for plant growth (grams/cm^3)	Bulk densities that affect root growth (grams/cm^3)	Bulk densities that restrict root growth (grams/cm^3)
Sands, loamy sands	< 1.60	1.69	> 1.80
Sandy loams, loams	< 1.40	1.63	> 1.80
Sandy clay loams, clay loams	< 1.40	1.60	> 1.75
Silts, silt loams	< 1.40	1.60	> 1.75
Silt loams, silty clay loams	< 1.40	1.55	> 1.65
Sandy clays, silty clays, clay loams	< 1.10	1.49	> 1.58
Clays (> 45% clay)	< 1.10	1.39	> 1.47

Active Carbon (using Ohio State University/Soil 1 $KMnO_4$ solution test and color comparison card):

S1S
A level of **4** on a 1-4 scale indicating "**excellent soil quality**" as assessed by the presence of reactive carbon
4= active organic matter above 1600 lbs/acre and over 40lbs per acre of available N.
S2N
A level of **4** on a 1-4 scale indicating "**excellent soil quality**" as assessed by the presence of reactive carbon
4= active organic matter above 1600 lbs/acre and over 40lbs per acre of available N.

Summary

Your soil shows a high level of function on the following tests: active carbon, soil hardness, infiltration and bulk density from 4-12 inches; this suggests that management practices should be geared towards maintaining these conditions, as it currently indicates ideal soil functionality. It is important to note however that the latter test is prone to higher deviation from soil moisture/saturation. Similarly an overall improvement in earthworm populations was observed when compared to the Spring test again suggesting that the proper amount of moisture in the soil can help maintain higher levels of biological activity in all trophic levels.This was also observed and suggested during Fall 2020 sampling (see Fall 2020 report).

Soil hardness, infiltration rates, root and aggregate development
Penetrometer readings show slight compaction at depths greater than 6" (157psi and 152psi for samples S1S and S2N respectively) but this should be improved as the roots and aggregation move down the soil profile. Within the test plot, no clear pattern was observed of roots being forced to grow sideways, so living roots of cover crops and cash crops seem to be able to penetrate and bring water and carbohydrates deeper in the soil profile. Living roots can help foster a less-dense, more spongy soil over time, as long as management continues to minimize disturbance and encourage biodiversity.

Infiltration rate was good and slightly improved for sample S2N, a rate of 2:46 for an inch of rainfall compared to 3:39 in the Spring. Sample S1S saw a limiting infiltration rate of 8:38 compared to that of 4:01 in the Spring. (The range we've observed is 5-10 seconds (fastest) to half an hour.)

Fast infiltration and stable, well developed aggregates are important goals, affording greater resilience in the midst of the more intense storms and dry periods predicted for our area--faster infiltration of intense rains combined with more porosity/sponge-like soil keeps moisture at life-sustaining levels for longer. Biodiversity above and below the surface, living roots with good branching, and aggregate strength and diversity will all help improve infiltration and moisture holding capacity.

“Aggregate Stability is a good indicator of soil biological and physical health. Good aggregate stability helps prevent crusting, runoff, and erosion, and facilitates aeration, infiltration, and water storage, along with improving seed germination and root and microbial health. Aggregate stability is influenced by microbial activity, as aggregates are largely held together by microbial colonies and exudates, and is impacted by management practices, particularly tillage, cover cropping, and fresh organic matter additions.

Although the living roots are predominantly in the top 4 inches of the soil, they are making headway in reaching into the lower part of the profile.

Strong aggregation that is water-stable, as observed in the top 6 inches, shows that the soil life is making glues. The broad range of aggregate sizes and pore spaces indicates a trend to diversity below ground as well.

With management continuing to minimize soil disturbance, support living roots in the ground for as long as possible, and diversify plant species especially for cover crops, these trends should continue and accelerate, helping to break up the relatively dense soil profile at further depths.

Bulk density of the top two layers for both samples were within the range of ideal (see Table 1 above), but the deepest layer (8-12”) was just above criteria that restrict root growth >1.75g/cc for silts and silt loams.When compared to the values of the Spring testing the deepest layer saw a decline in ideal bulk density values.

Generally, soils with higher organic matter tend to feel more like loams the higher the organic matter goes. The size and prevalence of soil aggregates is an indicator of the presence and activity of longer-term soil biological activity. Aggregates are readily destroyed by mechanical activity on the soil, and need the presence of a mix of fungi and bacteria to form. Fungi are heavily impacted by tillage and are also less present in disturbed soils; therefore, soil disturbance destroys aggregates, releasing stabilized carbon--and repeated tillage makes it difficult for aggregates to re-form. Earthworms can help restore aggregation and soil structure by distributing bacteria through the soil, among other functions. On farms we have tested, soil structure has ranged from no aggregation present (just loose sandy soil) to strong, medium blocky aggregates (aggregates are very prevalent with almost no loose, un-aggregated soil and relatively large in size). Farms with a history of tillage and chemical inputs have tended to have the weakest, smallest aggregates (if any) while no-tilled soils have had much stronger aggregation.

Keeping living roots in the ground as much as possible, year round will help maintain a soil microbe community that is rich (in diversity and quantity) and capable of maintaining glue-based, more water-stable aggregates and pore spaces. These glues, and the underground microbial life itself, as well as the living roots, are the soil carbon that we are trying to build and keep. Soil C sequestration happens by building deeper, richer layers of well-aggregated soils.