United States Department of Agriculture

Cropland In-Field Soil Health Assessment Worksheet

Soil Health Resource Concerns

CPT = Compaction
SOM = Soil Organic Matter Depletion
AGG = Aggregate Instability
HAB = Soil Organism Habitat Loss or Degradation

Location
Field/CMU
Tract#
Client/Customer
Planner
Date
Soil Map Units
Soil Moisture
Topsoil Texture

Indicator Timing and Use Anytime | After Rain or Irrigation | With Adequate Moisture | Before a Tillage Event Primarily No-till Systems | Before Growing Season | During Growing Season | Interview	Meets Assessment Criteria (Yes/No)
Soil Cover | SOM, HAB • Surface cover from plants, residue or mulch; cover greater than 75%	❑ Y ❑ N
Residue Breakdown | SOM, HAB • Natural decomposition of crop residues is as expected with crop and conditions	❑ Y ❑ N
Surface Crusts | AGG • Crusting on no more than 5% of the field	❑ Y ❑ N
Ponding | CPT, AGG • No ponding within 24h following typical rainfall or surface irrigation event	❑ Y ❑ N
Penetration Resistance | CPT • Penetrometer rating <150 psi within top 6” depth and <300 psi in the 6-18” depth; • OR Slight or no resistance with wire flag inserted to 12”	❑ Y ❑ N
Water Stable Aggregates | HAB, AGG • Cylinder: At least 80% remains intact after 5 minutes with little cloudy water; • OR Strainer: soil remains intact with aggregates apparent; • OR Soil Quality Test Kit (SQTK): meets stability class 6	❑ Y ❑ N
Soil Structure | CPT, SOM, AGG, HAB • Granular soil structure in A horizon and no platy structure in A or B horizons	❑ Y ❑ N
Soil Color | SOM • No color difference between field and fencerow sample; • OR, Value is on the darker range using color chart and soil survey pedon description	❑ Y ❑ N
Plant Roots | CPT, SOM, HAB • Roots covered in a soil film (rhizosheaths) or are part of soil aggregates; • OR Living roots, if present, are healthy, fully branched and extend into subsoil	❑ Y ❑ N
Biological Diversity | SOM, HAB • Clearly evident; more than 3 different types of organisms observed without magnification	❑ Y ❑ N
Biopores | SOM, AGG, HAB • Presence of root or earthworm channels that extend vertically through the soil with some connecting to the surface	❑ Y ❑ N

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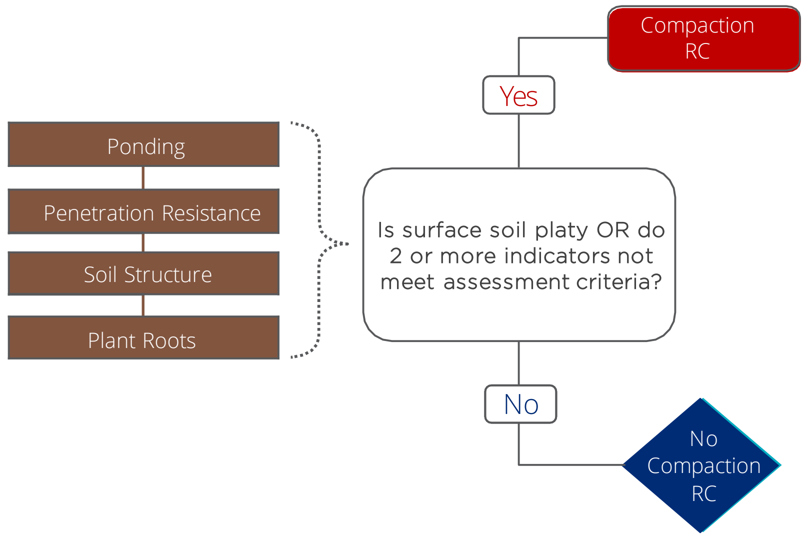
Cropland In-Field Soil Health Assessment Worksheet

Legend (for all RCs)
= Field indicator
= RC present
= RC not present

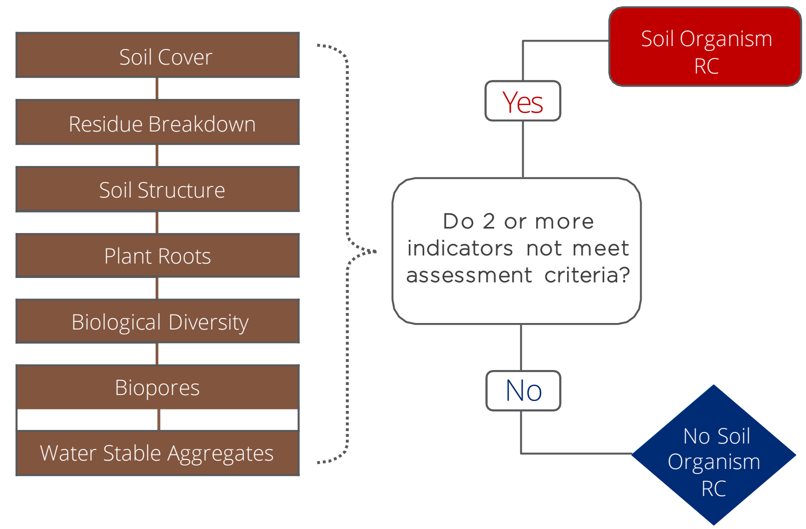
Compaction Resource Indicator Decision Tree

Circle the indicators that do not meet assessment criteria during the evaluation and follow decision tree below to determine if the given resource concern (RC) is present. Document on worksheet.



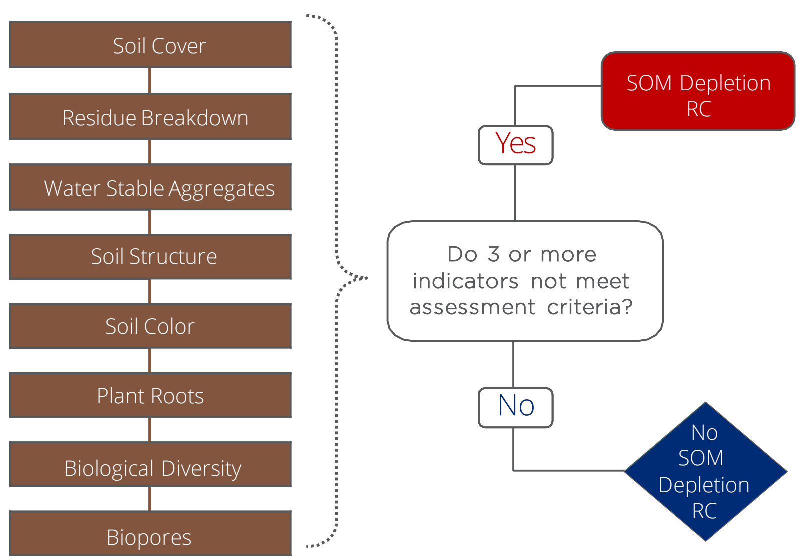
Soil Organism Habitat Loss or Degradation Resource Indicator Decision Tree

Circle the indicators that do not meet assessment criteria during the evaluation and follow decision tree below to determine if the given resource concern (RC) is present. Document on worksheet.



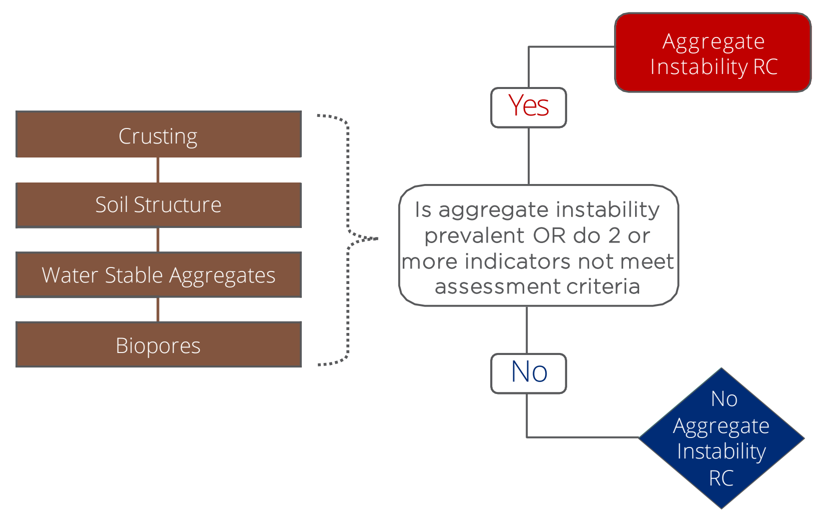
Soil Organic Matter Depletion Resource Indicator Decision Tree

Circle the indicators that do not meet assessment criteria during the evaluation and follow decision tree below to determine if the given resource concern (RC) is present. Document on worksheet.



Aggregate Instability Resource Indicator Decision Tree

Circle the indicators that do not meet assessment criteria during the evaluation and follow decision tree below to determine if the given resource concern (RC) is present. Document on worksheet.



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Management History – Interview

The following questions are offered as examples to guide a conversation with the client and help the planner more thoroughly understand current conditions, the client's management and how these may contribute to existing soil health resource concerns. Answers to these and other similar questions will be helpful in assessing some of the indicators.

1. What is the crop rotation?

2. What are the types and frequency of ground disturbing operations?

3. For how many months per year is the soil surface at least 75% covered with plants, residue or mulch?

4. Are cover crops a consistent part of the cropping system?

5. If yes, for how many years has the field been continually cover cropped?

6. How are the cover crops terminated? If chemically, what herbicide is used?

7. Is the field irrigated? If yes, what type of irrigation system, and how many acre-inches are applied for each crop in the rotation described above?

8. Does water pond or run off during or immediately after typical rainfall or irrigation events? Where in the field?

9. Are there problems with crop emergence or early crop growth? Where in the field?

10. Is water management a concern (i.e., field too wet or too dry at planting)?

11. Other observations not captured in the assessment including plant condition, and recent weather and landscape characteristics that may affect assessment results.

Instructions

- Pages 1 and 2 (Worksheet) of the In-Field Assessment can be printed and taken to the field without the remainder of the Assessment document.
- When conducting the field evaluation, it is often helpful to compare the indicators in the managed field to an unmanaged similar soil in an adjacent fencerow or field edge.
- The following *Field Assessment Indicator Details* pages provide guidance for assessing each indicator, and list conservation practices that can be considered for inclusion in a soil health management plan to address the resource concerns associated with each indicator.
- The first four indicators (soil cover, residue breakdown, surface crusts, ponding) represent surface conditions that either affect or are indicative of soil health and should be assessed observing conditions across the field.
- The remaining indicators represent subsurface conditions and are checked by digging down to at least 8 inches and evaluating each indicator to determine if it meets the assessment criteria.
- The subsurface indicators are best confirmed by looking at more than one location in the field. Select three representative locations in the field to evaluate the subsurface indicators. If conditions are not consistent for at least two of the locations, an additional site should be evaluated.
- Penetration resistance should be assessed in several locations in the field when there is adequate soil moisture. It is often helpful to verify compaction by checking for platy or massive structure in the holes dug for the other subsurface indicators.
- Whenever possible, take photos to include in your assessment. These can be added to the customer folder along with field observations and notes.
- Soil moisture can be determined with a handheld soil moisture meter if available, or qualitatively as: *dry, moist, field capacity, or saturated.*
- Soil texture can be estimated by the "feel method." Soil surveys can provide an estimate but should be verified in the field.

Useful assessment materials

- Shovel
- Wire flag
- Penetrometer
- Clear plastic cups or similar
- Wire sink strainers
- Water
- Small hand lens
- Texture-by-feel guide
- Camera

Considerations for using the assessment

The Cropland In-Field Soil Health Assessment is designed to be used as a diagnostic tool to help conservation planners determine if soil health resource concerns exist. It should not be used for comparing one field to another, or as a means of monitoring changes in a field over time, nor should it be assumed that it is a comprehensive assessment of all biological, physical, and chemical processes that are critical to soil function. Fields where multiple indicators do not meet assessment criteria will likely benefit from the implementation of a management system that utilizes as many soil health building practices as practical, to maximize biodiversity, presence of living roots and soil cover, and minimize disturbance (Refer to The Basics of Addressing Resource Concerns with Conservation Practices within Integrated Soil Health Management Systems on Cropland).

Normally, it will not be necessary to evaluate all eleven indicators but only those that will enable the planner to adequately assess field soil health and develop management alternatives if soil heath resource concerns exist. Numerous variables will contribute to the indicators not being equally useful during any single field visit. It is anticipated that some indicators will be more interpretable and representative of soil health than others depending on the soil, landscape position, climate, weather, time of year, and cropping system. Different indicators will have different optimal sampling time or conditions and thus, sampling time and field conditions should be noted. The timing symbols associated with each indicator provide a quick reference for the recommended conditions and time for assessing that indicator.

It is recommended that Field Office staff work with State technical specialists responsible for soil health resource concerns related to conservation planning to determine which indicators are likely to provide useful resource concern assessment information for their climate, soils, and cropping systems. In addition, State and Area specialists may find it necessary to adjust the assessment criteria of the indicators that are used to insure they provide meaningful assessment information for local systems and conditions.

Soil chemical properties (nutrients, pH, EC, etc.) are an important component of soil health, and can impact soil function, but are not part of the in-field assessment. These are best quantified by sending samples to a reputable soil testing laboratory. Additionally, there are physical and biological properties indicative of soil health that can be assessed by laboratory methods (Refer to Soil Health Methods Technical Note). The soil organic matter depletion resource concern can also be identified by tracking trends of lab analyses of SOM through time or determining soil conditioning index (SCI) by an NRCS-approved method. Quick in-field assessments of nutrients, pH, EC, etc. can be done to demonstrate, compare, and contrast the impact of management on nutrient cycling, or differences within a field and determine whether further soil testing is needed (NRCS - Soil Health for Educators). Although soil salinity can have negative impacts on soil health and should be evaluated as a resource concern, and considered in a management plan where appropriate, it has not been included in this assessment.

Field Assessment Indicator Details

Soil Cover

A significant factor in promoting soil health is keeping the soil surface covered, particularly during fallow periods. Estimate the percent of soil surface covered with dead plant material, organic mulch or live plants (i.e., cover crop or cash crop). The crops may be different, but the percent cover will look the same. Take photographs of representative areas. Can be assessed at any time.

Conservation practices to address the resource concerns associated with the indicator: 329, 340, 345, 484, 512, 528

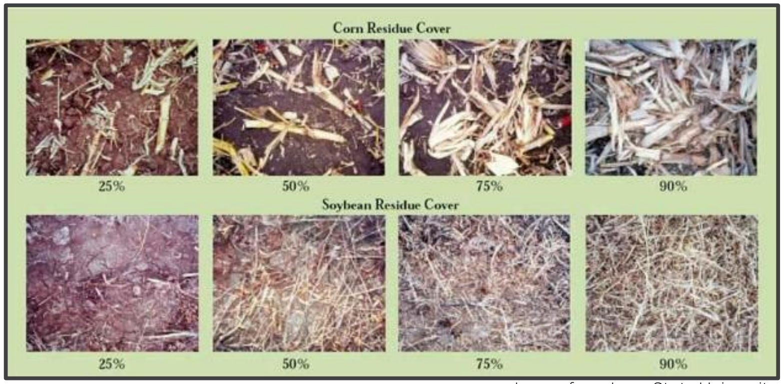


Image from Iowa State University

Residue Breakdown

Residue breakdown is the biological shredding, fragmenting, cycling, and/or incorporating of previous crop residue. The rate at which residue decomposes can be an indicator of management-influenced biological activity. Other factors that will influence the rate of residue breakdown include C:N ratio of the plant residue, crop species, residue amount and environmental conditions during residue decomposition. Breakdown is highly climate-dependent. Residue breakdown is assessed by looking at existing residue cover for signs of decomposition, shredding, and incorporation by soil organisms. Note the depth of litter and color and condition of most recent residue. The conversation with the producer will be helpful in providing information about management, residue age and plant types. Take photographs of representative areas. This indicator can be assessed at any time, but it will not be useful in full width tillage fields.

Conservation practices to address the resource concerns associated with the indicator: 328, 329, 340, 345, 595

Surface Crusting

Surface crusts can develop when soil is overworked and left uncovered, resulting in poor aggregate stability. Crusts inhibit seedling emergence and water infiltration. Determine if crusts are throughout the field or only in patches. Crusting can also occur in sodic (high sodium) or saline (high salts) soils. Crusts will remain intact when they are picked up. Assess for physical crusts after irrigation or rain and before next tillage.

Conservation practices to address the resource concerns associated with the indicator: 329, 340, 345, 484, 512, 528

Ponding

Standing water on the soil surface resulting from poor infiltration can be an indication of poor aggregate stability, surface crusting, lack of surface cover, poor soil structure, and/or compaction. Slow infiltration can also result from naturally occurring conditions, such as a fragipan or other slowly permeable layer close to the surface, or a clayey surface or subsurface texture. The best time to assess for ponding is within 24 hours of a typical rainfall or irrigation event. Determine if ponding occurs throughout the field or only in patches. Is ponding the result of inherent soil properties or landscape position? Producers are usually aware if this is an issue in their fields. This information is often best obtained during producer interview to determine the extent and severity of ponding.

Conservation practices to address the resource concerns associated with the indicator: 328, 329, 340, 345

Field Assessment Indicator Details

Penetration Resistance

Soil compaction in agricultural systems can result from repeated wheel or hoof traffic, or repeated tillage at the same depth. Compaction inhibits water and gas movement through the soil in addition to interfering with root growth and soil organism movement and proliferation. Management-induced compaction typically occurs at depths of 2-8 inches but may be deeper depending on soil type and management. Resistance to penetration should be checked at 8-10 randomly-selected spots in the field. Penetration resistance increases as soils dry. Therefore, assess moist to wet soil.

Use one of these methods:

1. Hold a wire flag near the flag end inserting it into the soil observing how easily it bends. Compare the resistance to a known noncompacted area, such as in a fence row or other nonimpacted field border.

2. Use a penetrometer by applying slow, steady vertical downward pressure while observing the pressure gauge reading. Record depth of restrictive layers and resistance pressure.

Conservation practices to address the resource concerns associated with the indicator: 328, 329, 340, 345

Water Stable Aggregates

The stability of soil aggregates in the presence of water is important for water infiltration and storage, gas exchange, and for plant growth and soil organism habitat. Highly degraded soils may not break apart or dissolve because high bulk density may affect how aggregates respond to water. To assess for water stable aggregates, use one of three methods:

Cylinder method: Take a soil ped about the size of a golf ball from the surface just below any residue that may be present and submerge it in water. Note the time. After 5 minutes observe the water in the container and estimate the amount of the ped (%) that remains intact. This method works best with air-dry soil.

Strainer method: Obtain a sample from the soil surface crumble any large peds (BB size or slightly larger; don't grind too fine). Place the soil in a sink strainer or small wire colander, level with top. Immerse in a bowl filled with water and allow to become fully saturated (about 1 minute). Turn strainer upside down on a flat surface. Soils with good aggregate stability will remain intact with aggregates apparent, while soils with poor aggregate stability will slump and have a pudding-like consistency. This method can be used with dry to field capacity soil moisture.

Soil Quality Test Kit method: See Chapter 9, Slake Test, in the SQTK Guide for procedure and scoring (Soil Quality Test Kit Guide). This method can be used with dry to field capacity soil moisture.

Conservation practices to address the resource concerns associated with the indicator: 328, 329, 340, 345, 528

Soil Structure

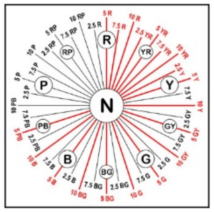
Soil structure affects water and gas movement, plant rooting, and soil organism habitat. Structure should be observed in the surface, and if possible, B horizon. Specifically look for granular or platy structure. Granular structure typically is associated with soils rich in organic matter and good aggregation. Platy structure is characterized by distinct layers that can be separated along the horizontal plane and is typically associated with a compacted layer, or often, E horizons. Sandy soils are less likely to exhibit granular structure. Other local, naturally occurring conditions will also affect structure.

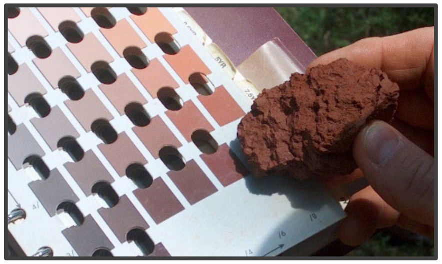
Conservation practices to address the resource concerns associated with the indicator: 328, 329, 340, 345


Soil Color

Color can be used as an indicator of loss or accumulation of organic matter. Typically, loss of SOM results in a lighter color, with accumulation resulting in darker colors. Color can be assessed in at least two ways.

1. Use a Munsell Color chart and soil survey pedon description for the field. The value is the number that reflects soil darkness. For example, a soil with color 10YR 3/6 is darker than a 10YR 5/6 soil. For the 10YR 5/6 sample, 10YR is the hue, 5 is the value, and 6 represents the chroma (brightness). A lower value number is darker than higher numbers. The assessment can be done at any soil moisture, but dry samples should be moistened prior to using the color chart.



Soil Color (cont.)

2. Compare relative color changes from field compared to fencerow or other undisturbed area at the field edge (typically darker). Exceptions to this are in semi-arid environments where irrigation and fertility in agronomically managed soils can lead to higher SOM levels compared to fencerows.

Conservation practices to address the resource concerns associated with the indicator: 328, 329, 340, 345



Plant Roots

Plant roots exude simple and complex carbohydrates that influence the microbes, which also influence soil structure by forming soil aggregates. Plant roots recycle soluble soil nutrients. Root channels can remain from season to season and function as areas of carbon concentration and biological activity (see biopores indicator). Observe growth patterns of actively growing roots within the top 0-8” or deeper depending on the crop. Healthy roots are abundant, deep, not inhibited by restrictive layers, and well-branched. Observe plant roots to see if they are covered in a soil film (rhizosheaths) or are part of soil aggregates. The presence of rhizosheaths is highly species- and environment-dependent. Best done during times of active desirable plant growth and adequate soil moisture.

Conservation practices to address the resource concerns associated with the indicator: 328, 329, 340, 345, 512, 528

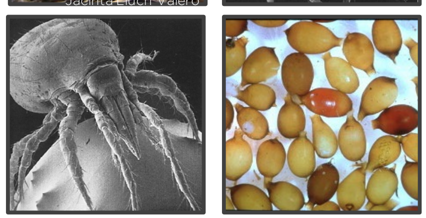


Biological Diversity

Rating based on observations of the presence of soil organisms within the residue or soil. Restrict observation to the area of the soil surface represented by the assessment hole, a shovel full of soil and the hole itself. Fungal hyphae will appear as white to light tan threads or masses. Look for active nodules if legumes are growing, meso- and macro-invertebrates such as earthworms or earthworm middens, mites, springtails, millipedes, roundworms beetles and ants. The best time to assess is during spring or fall or other times of the year when soils are moist to field capacity. Temperature will also affect the presence and activity of organisms.

Conservation practices to address the resource concerns associated with the indicator: 328, 329, 340, 345, 484, 528, 590, 595

Photo sources: NRCS, Global Soil Biodiversity Atlas, and (midden picture) lowalearningfarms.wordpress.com



Biopores

Plant roots and earthworms leave behind large pores called biopores. These biopores are important for rapid air and water exchange. In addition, earthworm channels tend to be enriched in organic matter, microbes, and nutrients. Old biopores provide excellent pathways for newly established roots. Look for continuous pores that will appear as channels, often connected to the soil surface. Biopores rich in organic matter may appear darker than the surrounding soil. Can be assessed at dry to field capacity soil moisture, but they will be easier to observe in moist to field capacity soils.

Conservation practices to address the resource concerns associated with the indicator: 328, 329, 340, 345, 528

Beare et al. 1995. Plant & Soil 170:5-22; Kuzyakov et al. 2015. Soil Biol Biochem 83:184-199

Glossary of Terms

Aggregate – A group of primary soil particles that cohere to each other more strongly than to other surrounding particles due to biological, physical, and chemical processes.

Aggregate stability – A measure of the proportion of the aggregates in a soil that do not easily slake, crumble, or disintegrate.

Biopore – Soil pores, usually of relatively large diameter, created by plant roots, earthworms, or other soil organisms.

Clod – A compact, coherent mass of soil varying in size, usually produced by plowing, digging, etc., especially when these operations are performed on soils that are either too wet or too dry and usually formed by compression, or breaking off from a larger unit, as opposed to a building-up action as in aggregation.

Crust (soil), physical – A surface layer of soils, ranging in thickness from a few millimeters to 3 cm., that physical-chemical processes, in conjunction with the lack of biological aggregation processes, have caused to be much more compact, hard, and brittle when dry than the material immediately beneath it. *Not to be confused with a biological (microbiotic) soil crust.

Crust (soil), biological – An assemblage of cyanobacteria, algae, lichens, liverworts, and mosses that commonly forms an irregular living crust on soil surface, especially on otherwise barren, arid-region soils.

Eluviation – The removal of soil material in suspension (or in solution) from a layer or layers of a soil.

Horizon, A –The surface horizon of a mineral soil having maximum organic matter accumulations, maximum biological activity, and/or eluviation of materials such as iron and aluminum oxides and silicate clays.

Horizon, B – A soil horizon, usually beneath an A, E, or O horizon, that is characterized by one or more of the following:

1. Concentration of silicate clay, iron, aluminum, humus, carbonates, gypsum, or silica, alone or in combination
2. Blocky or prismatic structure
3. Coatings of iron and aluminum oxides that give darker, stronger, or redder color.

Horizon, soil – A layer of soil or soil material approximately parallel to the land surface and differing from adjacent genetically related layers in physical, chemical, and biological properties or characteristics such as color, structure, texture, consistency, kinds and number of organisms present, degree of acidity or alkalinity, etc.

Hyphae – Filaments of fungal cells. Many hyphae constitute a mycelium.

Ped – A unit of soil structure such as a block, column, granule, plate, or prism, formed by natural processes (in contrast with a clod, which is formed artificially).

Pedon – A three-dimensional body of soil with lateral dimensions large enough to permit the study of horizon shapes and relations.

Resource concern – An expected degradation of the soil, water, air, plant, or animal resource base to the extent that the sustainability or intended use of the resource is impaired.

Rhizosheath – Structures composed of mucilage and soil particles that form a cylinder around the root.

Soil color, chroma – Brightness.

Soil color, hue – Color or shade.

Soil color, value – The lightness or darkness of tones or colors.

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

Structure, granular – Imperfect spheres, usually sand-size.

Structure, blocky – Imperfect cubes with angular or rounded edges.

Structure, platy – A flattened or compressed appearance.

Structure, soil – The combination or arrangement of primary soil particles into secondary units or peds. The secondary units are characterized by size, shape, and grade (degree of distinctness).

Aggregate Stability
https://www.youtube.com/watch?v=7OYq6-_GW5Q
https://www.youtube.com/watch?v=z8xj5EiNNRo

Biological Activity, Fungi, etc.
http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1015&context=agronomyfacpub

Estimating Soil Moisture by Feel and Appearance -
https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_051845.pdf

Field Book for Describing and Sampling Soils Version 3.0
https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052523.pdf

Residue Cover
http://ianrpubs.unl.edu/live/g1931/build/g1931.pdf
https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs141p2_029000.pdf

Science and Technology Training Library – This webinar library houses the soil health webinar series.
http://www.conservationwebinars.net/

Soil Crusts
http://soilquality.org/indicators/soil_crusts.html
http://www.fao.org/docrep/t1696e/t1696e06.htm

Soil Health Management Systems Principles – Factsheet: Principles for High Functioning Soils.
https://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid=nrcseprd1388460&ext=pdf.

Soil Health Technical Note 450-03: Recommended Soil Health Indicators and Associated Laboratory Procedures (For quantitative assessment of soil health)
https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/soils/health/?cid=nrcseprd1315420

Soil Health Management Systems Technical Note 450-04: The Basics of Addressing Resource Concerns with Conservation Practices within Integrated Soil Health Management Systems on Cropland
https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/soils/health/?cid=nrcseprd1315420

Soil Health for Educators -
https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/health/assessment/?cid=nrcs142p2_053870

Soil Quality Test Kit Guide -
https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_050956.pdf

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