

MARYLAND SOIL HEALTH CARD

What is Soil Health?

Soil Health is the continued capacity of a soil to function as a vital living ecosystem that sustains plants, animals, and humans. Healthy soils support plants, animals, and humans by:

- Cycling nutrients and increasing their availability
- Increasing water infiltration and availability
- Maintaining a stable porous structure that withstands natural forces (e.g., water, wind)

Healthy, fully functioning soil creates a habitat that sustains diverse soil micro- and macro-organisms.

Why is Soil Health Important?

Soils that lack organic matter, structure, and microorganisms are susceptible to erosion, hold less water, and need more chemical inputs to rebalance their productivity. Improving soil health increases soil aggregates and improves soil structure, resulting in greater water infiltration, decreased erosion, and reduced runoff and sedimentation.

Soil Health Principles to Support High Functioning Soils:

- Minimize soil disturbance
- Maximize soil cover
- Maximize the presence of living roots
- Maximize biodiversity

What is the Soil Health Card?

The Maryland Soil Health Card is a semi-quantitative tool to assist conservation planners and land managers evaluate soil health. Soil Health is evaluated as a function of select physical and biological indicators that can be assessed with minimal equipment and expertise. It can be used to identify soil health resource concerns, make suggestions on how to improve soil health, and monitor the effects of soil management practices.

The Soil Health Card is set up to evaluate a soil's ability to function within its natural capabilities and site limitations. For that reason it should not be used to compare one soil type to another. Instead, it can be used to compare soil management practices or land uses on the same soil type. Before using the Soil Health Card, review the Web Soil Survey to better understand the soils mapped in your area of interest.

Soil chemical properties (e.g., nutrients, pH, EC) can be important indicators of soil health, but are not included in this field assessment. Chemical properties are better assessed through laboratory analysis. There are also additional biological and physical properties that are better measured through laboratory analysis that can be indicative of soil health. Since the Soil Health Card is intended to be entirely field based, those potential indicators are beyond the scope of this assessment.

Using the Soil Health Card

- Step 1** Instructions for evaluating each indicator are at the end of this document. Before starting your evaluation, find out the soil series and map unit at the sample location.
- Step 2** Use the table on page 3 to identify the best times to assess each soil health indicator
- Step 3** Divide the farm and fields into separate sections for evaluation the same way you would divide them for soil fertility sampling: separate by factors such as soil type, topography, and management history (e.g., tillage, crop rotation, irrigation, and manure/fertilizer application).
If soil health is an objective of a conservation plan, an in-field assessment (such as the Maryland Soil Health Card) is recommended in each soil mapping unit that represents at least 20% or 20 acres, of the soils within a conservation management unit (CMU). A CMU is a group of fields of the same land use within an operation that are managed similarly (e.g., same tillage methods, crop rotation, pesticide use).
- Step 4** Select a representative spot in your field and evaluate each soil health indicator. Use the Descriptive Ratings and your observations to assign scoring points and a resulting rating (Excellent, Good, Fair, Poor).
- Step 5** If you identify soil health indicators that are Fair or Poor, prescribe management strategies and conservation practices (see below) to improve soil health over time.
- Step 6** Follow changes in each of the soil health indicators over time, examine current field management practices, and consider ideas for management changes in problem areas.

Using Soil Health Management Strategies and Associated NRCS Conservation Practice Standards to Improve Observed Fair and Poor Soil Health Indicators

Surface Cover, Organic Matter, Earthworm/Macroinvertebrates, and Soil Odor Indicators

Consider management strategies such as:

- Using diverse high-residue crops – see Conservation Crop Rotation (328)
- Using cover crops and cover crop mixes with grasses and legumes – see Cover Crop (340)
- Establishing perennial vegetative cover – see Conservation Cover (327) and Pasture & Hay Planting (512)
- Using no-till or reduced tillage – see Residue and Tillage Management (329 and 345)
- Manage grazing and/or browsing to maintain healthy forage stands – see Prescribed Grazing (528)
- Reducing pesticide risk to beneficial soil organisms – see Pest Management Conservation System (595)
- Applying solid manure or compost at a proper agronomic rate – see Nutrient Management (590)
- Applying plant residues or other suitable materials – see Mulching (484)

These strategies will increase organic matter, soil biological activity, water holding capacity, and nutrient availability.

Infiltration, Compaction, and Soil Structure/Aggregation Indicators

Consider management strategies such as:

- Using diverse high-residue crops – see Conservation Crop Rotation (328)
- Using cover crops, cover crop mixes, and deep-rooted cover crops – see Cover Crop (340)
- Establishing perennial vegetative cover – see Conservation Cover (327) and Pasture & Hay Planting (512)



- Managing grazing and/or browsing to maintain adequate vegetative cover – see Prescribed Grazing (528)
- Managing equipment traffic, especially on wet soils
- Using no-till or reduced tillage – see Residue and Tillage Management (329 and 345)

These strategies will improve soil structure and aggregation by increasing organic matter content and porosity and will improve infiltration while minimizing compaction.

Best Times to Assess Indicators

Some indicators vary seasonally or as a result of the growth stage of the crop (e.g., surface cover). If you are monitoring soil health conditions over time, plan to make repeat measurements at a similar time of year to limit seasonal variability. For example, assessments could be done immediately after harvesting in the fall or prior to planting in the spring.

Indicator	Recommended Timing for Assessment				
	Early Spring, Before Planting	Spring	Summer	Fall	After Rainfall
Surface Cover	X	X	X	X	X
Infiltration	X	X	X	X	
Compaction	X	X		X	
Organic Matter	X	X	X	X	X
Soil Structure	X	X	X	X	X
Earthworms/ Macroinvertebrates	X	X		X	X
Soil Odor	X	X	X	X	X

Soil Health Card Instructions

Equipment needed: measuring tape, small spray bottle of water, paper towels, 1 quart water, small trowel or soil knife, stopwatch, sharp shooter shovel, wire flag, Munsell Color Chart, Soil Health Card, and Attached References

Soil Texture:

- Take sample from 2-4 inches below the surface.
- Use the Guide for Estimating Soil Texture by Feel to determine the soil texture class (Attachment A).
- Soil texture class is used when evaluating Infiltration.

Surface Cover:

- Estimate the proportion of the soil surface that is covered by living and dead plant material and residue and assign a score and rating.
- Estimates can be made visually using the NRCS surface cover photos (Attachment B) or a measuring tape.

Infiltration:

- Dig a small, 2 inch deep hole with a flat bottom with straight sides. Avoid smearing the sides and bottom of the hole. Lightly scratch the bottom and sides of the hole with the wire flag to break up smearing.
- Pour 1 inch of water into the hole and start the stopwatch. Time how long it takes for the water to completely infiltrate. Water has completely infiltrated when there is no water left in the bottom of the hole and surface is just glistening.
- Repeat two to three times in different locations to get an average time.
- Compare the infiltration time to the rates listed in the Infiltration Chart (Attachment C) using the soil texture determined.
 - The indicator rating is based on how quickly water infiltrates relative to the expected rate for its textural class. Assign a score based on the infiltration time relative to the range (e.g., a faster time within the class range should receive a higher score).

Compaction:

- Hold wire flag about 12-15" from its lower end.
- Push lower end into soil surface, wiggling if needed. The wire shouldn't bend.
- Observe how deep the wire flag penetrates the soil. Assess in several locations and compare to the narrative descriptions to assign a rating and score.
- Rock fragments can interfere with using the wire flag to test compaction. In these situations, dig a small hole and look at the root growth on the exposed side walls of the hole and in the shovel slice. Note the depth of root growth and directions of root growth. Lateral root growth or preferential root growth in one direction can be indicative of compaction and root restrictions.

Organic Matter:

- Take soil samples from the indicated depths (0-3" and 3-8").
 - Soil health practices like cover cropping and no-till increase organic matter in the soil. Without regular disturbance from tillage, organic matter may accumulate more quickly in the upper part of the topsoil. Comparing the soil color in the upper and lower part of the topsoil can be a way to demonstrate increased organic matter storage resulting from long-term soil health practices.
- For each sample, break open a soil aggregate to reveal a fresh soil face. Moisten the soil with the spray bottle if it is dry. Do not use a smeared or crushed aggregate for evaluating soil color.
- Use the Munsell Soil Color Book (or the Globe Soil Color Book) to find the closest matching color for each of the samples. Assign the score and rating based on the soil color value and chroma.

Soil Structure/Aggregation (can be done along with the Earthworms/Macroinvertebrates indicator):

- Use the sharp shooter to remove an 8-10 inch slice of soil.
- Use the NRCS structure photos (Attachment D) to describe the soil structure in two zones, 0-3" and 3-8". Compare to the narrative descriptions to assign a score and rating for each depth zone.
 - Fields that have not been tilled for many years may have a different structure in the upper and lower parts of the topsoil. Without regular disturbance from tillage, the soil aggregates can start to form as they would in a natural, undisturbed setting. Comparing the structure in the upper and lower topsoil can be a way to identify or demonstrate this gradual recovery in the soil.

Earthworms and Macroinvertebrates (can be done along with the Soil Structure/Aggregation indicator):

- Use the sharp shooter to remove an 8-10 inch slice of soil.
- Gently separate the soil looking for earthworms and other macroinvertebrates.
- Count the number and general types of macroinvertebrates present. Look for evidence of biological activity (channels, casts, middens, etc). Compare to the narrative descriptions to assign a score and rating.
 - At certain times of year (e.g., winter, periods of drought), earthworms and macroinvertebrates may not be found in the upper part of the soil. Under these conditions it is especially important to look for evidence of earthworm and macroinvertebrate activity when assigning a score and rating.

Soil Odor:

- Take a handful of soil from just below the surface (0-3"), cup it in your hands and smell.
- Compare the smell to the narrative descriptions to assign a score and rating.
 - Healthy soils should have a sweet, earthy aroma. If the soil smells sour, metallic, stagnant, or like kitchen cleanser, this may indicate that the soil is not properly functioning.

MARYLAND SOIL HEALTH CARD

Project Name:	Location:	Assisted By:
Coordinates:		Date:
Crop Rotation and Tillage System:	Current Crop:	Air Temperature/Weather:
Inputs: <input type="checkbox"/> Synthetic Fertilizers <input type="checkbox"/> Manure <input type="checkbox"/> Herbicides <input type="checkbox"/> Pesticides <input type="checkbox"/> Irrigation <input type="checkbox"/> Other:		
Map Unit Symbol:	Soil Series:	Surface Texture:

Indicators		Descriptive Ratings and Potential Scoring Points				Score	Notes
		Excellent 9-11 points	Good 6-8 points	Fair 3-5 points	Poor 0-2 points		
Surface Cover – living and dead matter visible on surface		>80%	60-80%	30-60%	<30%		
Infiltration – Based on surface texture, refer to Infiltration Chart		Soil absorbs water quickly and easily	Soil absorbs water in a timely manner and is not susceptible to runoff or ponding	Infiltration rate is within expected range for textural class. Soil absorbs water, but more slowly and runoff or ponding may occur	Soil absorbs water very slowly and runoff or ponding will occur		
Compaction/Root Growth (Based on moist topsoil conditions)		Wire flag easily penetrates soil to 8" with no resistance. Unrestricted root growth.	Wire flag penetrates soil to 6-8" with a little resistance. Requires a little wiggling of wire flag. Little root growth restriction.	Wire flag penetrates soil to 4-6", requires a lot of wiggling of the wire flag and moderate force. Root growth is restricted.	Wire flag penetrates soil 2-4", requires force. Roots may be growing laterally.		
Organic Matter – Compare to soil color book using hues 7.5YR, 10YR, or 2.5Y	0-3" depth	Soil is black, organic matter is visible. Value ≤2 and Chroma ≤2	Soil is dark brown, organic matter is visible. Value =3 and Chroma =3	Soil is somewhat dark in color, little organic matter is visible. Any value or chroma that doesn't meet good or poor criteria.	Soil is light brown to dull colored, no organic matter visible. Value >4 and Chroma >4		
	3-8" depth	(see criteria above)	(see criteria above)	(see criteria above)	(see criteria above)		

Indicators		Descriptive Ratings and Potential Scoring Points				Score	Notes
		Excellent 9-11 points	Good 6-8 points	Fair 3-5 points	Poor 0-2 points		
Soil Structure/ Aggregation	0-3" depth	Soil is granular, soft, and crumbly, like cottage cheese. Roots are covered in a soil film (rhizosheath) and soil is held together with many fine roots. Living roots are healthy, fully branched, and extend into the subsoil.	Soil is granular, but not soft and crumbly. Soil aggregates are held together with some fine roots.	Soil is blocky and firmer with few fine roots.	Soil is platy, single grain, or massive and hard to break apart. Few or no fine roots.		
	3-8" depth	(see criteria above)	(see criteria above)	(see criteria above)	(see criteria above)		
Earthworms and Macroinvertebrates		≥7 earthworms and macroinvertebrates per shovel slice, more than three different types of organisms observed without magnification, or many obvious middens, casts, and channels.	4-6 earthworms and macroinvertebrates per shovel slice, or obvious middens, casts, and pores. Root and earthworm channels extend vertically through the soil with some connecting to the surface.	1-3 earthworms and macroinvertebrates per shovel slice, or few middens, casts, and channels.	No earthworms or macroinvertebrates present in shovel slice. No middens, casts, or channels.		
Soil Odor		Earthy/sweet odor noticeable > 6 inches from nose.	Earthy/sweet odor noticeable when close to nose.	Little odor at all.	No odor at all, or sour, metallic, kitchen sink, rotten egg or stagnant smell.		

Assessment Indicator
 Surface Cover
 Infiltration
 Residue Breakdown
 Water Stable Aggregates
 Soil Structure
 Soil Color
 Plant Roots
 Biodiversity
 Biopores
 Surface Crusting
 Earthworm Channels

CART ASSESSMENT

Resource Concern # Criteria Met Interpretation

Compaction

Soil Organic Matter Depletion

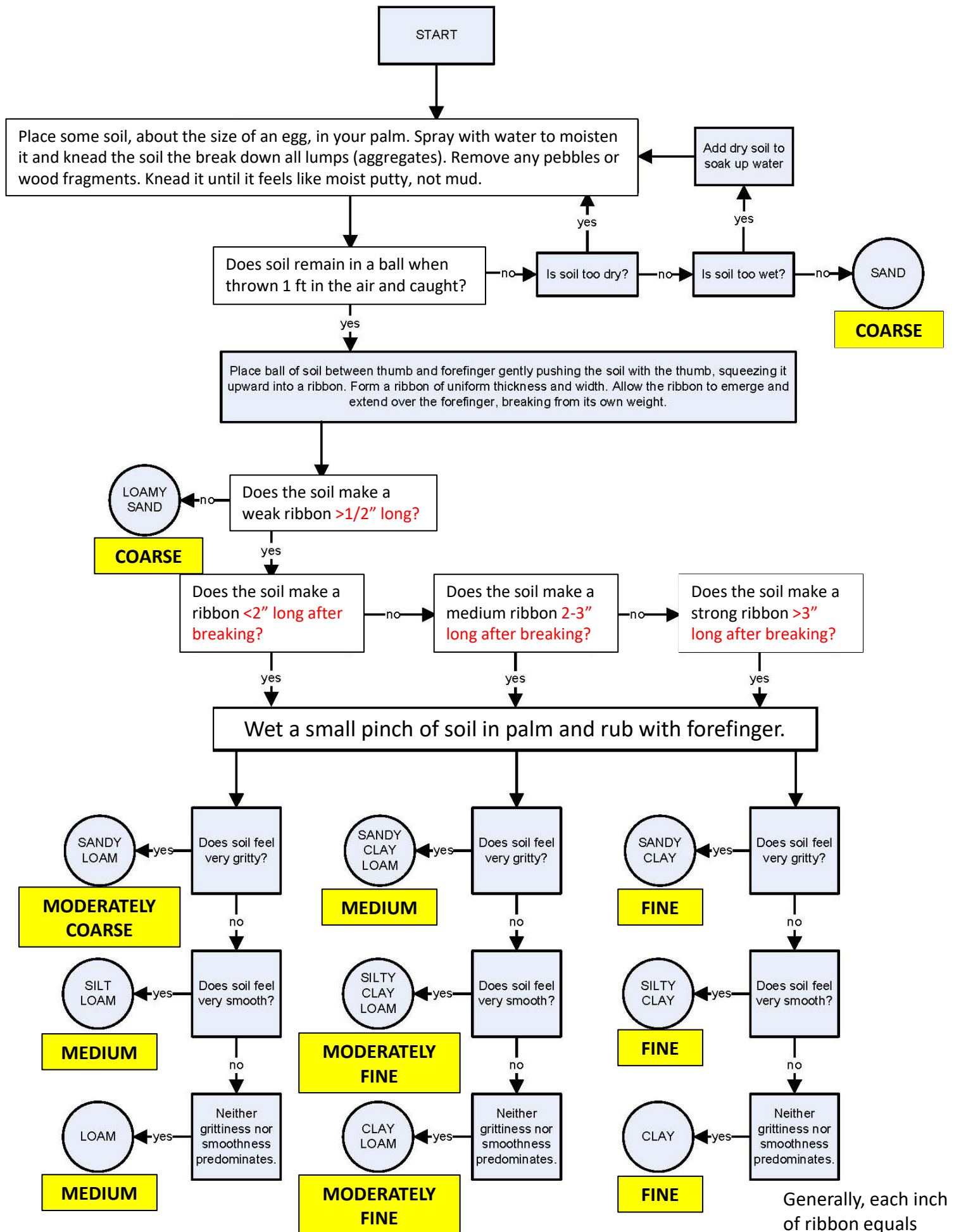
Soil Organism Habitat Loss

Aggregate Instability

Total Score =

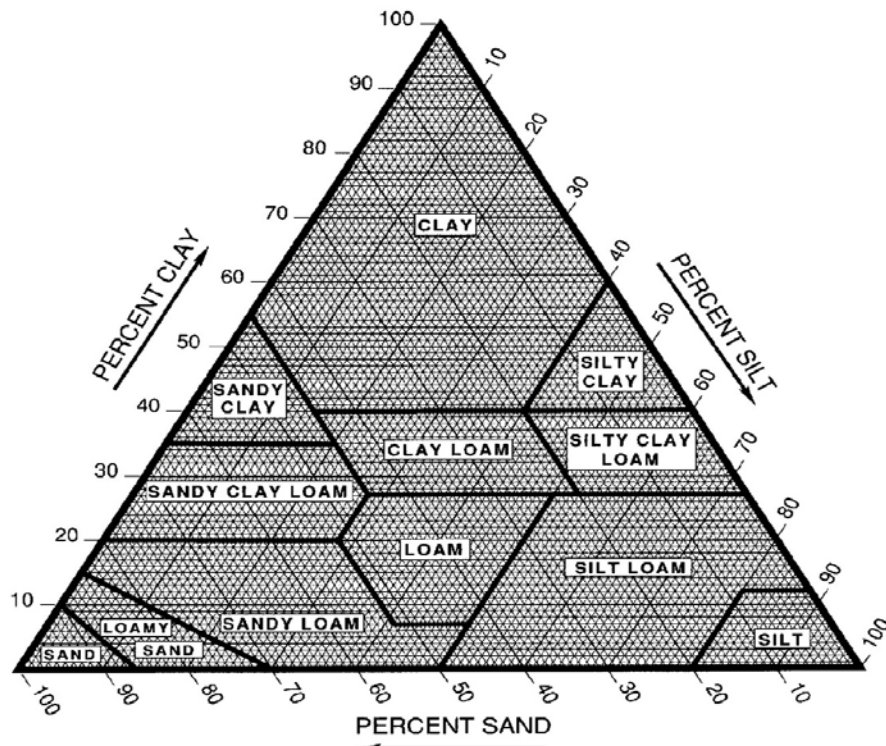
Excellent: 75-99
 Good: 50-74
 Fair: 25-49
 Poor: 0-24

GUIDE FOR ESTIMATING SOIL TEXTURE BY FEEL



FIELD CRITERIA USED IN DETERMINING MAJOR TEXTURAL CLASSES

TEXTURE CLASS MAJOR (USDA)	FEEL MOIST	ABILITY TO		SOIL HANDS	STICKY	CONSISTENCY	
		FORM STABLE BALL	RIBBON OUT			MOIST	DRY
COARSE (sand)	very gritty	no	no	no	no	loose	loose
COARSE (loamy sand)	very gritty	yes	yes, very weak <1/2" long	yes slight	no	loose	loose
MOD. COARSE (sandy loam)	gritty	yes, easily deformed	yes, dull surface poorly formed	yes	no	very friable	soft
MEDIUM (loam)	slightly gritty	yes	yes, dull surface poorly formed	yes	yes, slight to moderate	friable	soft
MEDIUM (silt loam)	velvety	yes	yes, dull surface poor to well formed	yes	yes, slight to moderate	friable	soft
MOD. FINE (silty clay loam)	velvety & sticky	yes very stable	yes, shiny surface well formed	yes	yes	friable to firm	slightly hard
MOD. FINE (clay loam)	slightly gritty & sticky	yes very stable	yes, shiny surface well formed	yes	yes	firm	slightly hard to hard
MEDIUM (sandy clay loam)	very gritty & sticky	yes very stable	yes, shiny surface well formed	yes	yes	friable to firm	slightly hard to hard
FINE (sandy clay)	very gritty ext. sticky	yes very stable	yes, shiny surface well formed	yes	yes very	firm	hard to very hard
FINE (silty clay)	ext. sticky & very smooth	yes, very resistant to molding	yes, shiny surface well formed	yes	yes very	firm to ext. firm	hard to very hard
FINE (clay)	ext. sticky & very smooth	yes, very resistant to molding	yes, shiny surface well formed	yes	yes very	firm to ext. firm	hard to very hard



ESTIMATING SURFACE COVER

(Attachment B)



Farming with Crop Residues

USDA  **NRCS**
United States Department of Agriculture
Natural Resources Conservation Service
February 1992

How to use the photos

Use these photographs of residue amounts to get a good picture in your mind of what the various percentages of ground cover might look like as you look down at evenly distributed residues.



How to measure residues

- Use any line that is equally divided into 100 parts. Fifty foot cable transect lines are available for this purpose. Another tool is a 50-foot nylon rope with 100 knots, six inches apart. A 50-foot tape measure using the 6-inch and foot marks also works well.
- Stretch the line diagonally across the rows. Count the number of marks (tabs or knots) that have residue under them when sighting from directly above one end of the mark. It is important to use the same point on each mark for accuracy. Don't count residue smaller than 1/8 inch in diameter.
- Walk the entire length of the rope or wire.



The total number of marks with residue under them is the percent cover under them is the percent cover for the field. If your rope or tape has only 50 marks, multiply by 2; for 25 marks, multiply by 4.

- Repeat the procedure at least 3 times in different areas of the field and average the findings.

Helping People Help the Land.

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INFILTRATION RATING BASED ON SOIL TEXTURE CLASS AND INFILTRATION RATE (Attachment C)

[illegible]

SOIL STRUCTURES USED IN SOIL HEALTH

(Attachment D)

Granular



Blocky



Single grain



Massive



Platy

