

Soil Science Curriculum

Content and lab derived from the USDA-NRCS Guides for Educators. Go to www.nrcs.usda.gov/soils for the Guides and additional pictures and diagrams. This lesson plan was adapted for South Dakota from the University of Nebraska Institute of Agriculture and Natural Resources, CROPWATCH.

January 2018

Soil Organic Matter

Approximately 90 minutes

Objectives

By the end of the lesson, students will know or be able to:

- Define soil organic matter
- Explain the role of inherent factors affecting soil organic matter
- Explain the five soil organic matter management practices
- Explain how soil organic matter relates to soil function
- Estimate organic material needed to increase soil organic matter
- Measure soil organic matter

Preparatory Work

- Make necessary copies
- Obtain necessary supplies
- Prepare five flip charts

Materials

- Dry erase markers
- Soil samples high in organic matter
- Clay or Play-Doh
- Guided notes sheet – one per student
- Soil Glue Lab sheet from NRCS – one per student
- 2 wide mouthed jars
- 2 pieces of ½-inch wire mesh
- 2 clods of soil, each about the size of an egg from two different sites
- Water
- Poster making supplies
- Measuring Soil Organic Matter lab – one per student
- Soil Color Chart
- Plastic bucket
- Squirt bottle with water
- 5 sheets of poster paper or flip charts
- Markers

Soil Organic Matter

Enroll the Participants *(Approximately 3 minutes)*

Write “Soil Organic Matter” on the board. As students walk into the classroom, greet them at the door with a dry erase marker. Instruct each student to write something they know about the phrase or a question they have on the board.

After all students have written on the board, review several of the responses with the class. Explain to the class that this lesson will investigate soil organic matter.

Provide the Experience – Define Soil Organic Matter and Explain Roles of Inherent Factors Affecting Soil Organic Matter *(Approximately 15 minutes)*

Divide students into small groups and provide each group with a soil sample high in organic matter. Within their group, have the students collect observations for look, feel, and smell of the soil.

Note: Consider finding a soil sample with established vegetation that may have organic matter in various stages and visible living organisms.

After a few minutes, encourage students to share their observations with the class.

State that, in this lesson, the class will continue to explore soil organic matter.

Label the Information *(Approximately 3 minutes)*

Instruct students to capture the definition of soil organic matter in their guided notes.

Soil organic matter is the organic component of soil, consisting of three parts:

- Plant residues and small living soil organisms
- Actively decomposing matter
- Humus, a stable organic matter

Also, guide students through factors affecting organic matter. Encourage students to capture this information in their guided notes page.

Demonstrate the Relevance *(Approximately 5 minutes)*

Pass around three jars: one containing marbles, another containing small beads, and the third sugar. Use this visual to facilitate discussion on particle size and pore space. Consider using the following discussion points:

- The larger the particle sizes of a soil, the larger the pore space.
- The larger the pore space, the more water will infiltrate and move through soil.
- Most soils are a mixture of many different sized particles.
- What impacts particle size during soil formation?

Soil Organic Matter

Provide the Experience – Create Model of Seven Soil Structures, Explain Factors that Affect Aggregate Stability and Soil Structure, and Definition of Bulk Density

(Approximately 10 minutes)

Show students a picture with the seven soil structures and provide each student with clay or Play-Doh. Encourage students to select one type of soil structure and build a model, tell them not to discuss their model during construction. After a few minutes, as students complete their model, guide the class through a gallery walk of the different models. As students identify each other's model, have them discuss each type of aggregate. Keep models intact to use throughout the class today.

Label the Information *(Approximately 5 minutes)*

Encourage students to draw a diagram of each structure on their Guided Notes sheet.

Share with students the definition for soil structure, aggregates, and bulk density. Refer back to the clay models as appropriate.

- Soil structure is the naturally occurring arrangement of soil particles (sand, silt, and clay) into larger distinct units called peds through pedogenic processes.
- Soil aggregates are groups of soil particles, which bind together more strongly than to neighboring particles and can usually be separated easily along planes of weakness.
- Bulk density is the ratio of oven-dried soil (mass) to its bulk volume, which includes the volume of particles and the pore space between the particles.

Demonstrate the Relevance *(Approximately 10 minutes)*

Discuss factors that affect soil structure and aggregate stability. Students should capture this in their Guided Notes.

Aggregate stability

- Amount of clay
- Chemical elements
- Organic matter
- Biological activity
- Tillage

Soil structure

- Organic matter
- Soil organisms
- Tillage
- Freezing and thawing, wetting and drying

- Water movement
- Chemical elements

Guide a discussion differentiating between soil structure and aggregate stability. Students should highlight this discussion in their notes using the Venn diagram. Consider using the following information to help facilitate discussion.

- All soil-forming factors, especially climate, influence the type of structure that develops within soil.
- Consider the definition of soil structure and aggregates.
- How are aggregates and soil structure related?
- Use models to demonstrate aggregate stability and soil structure.

Explain that there are many other differences in soil, including color.

Soil Organic Matter

Provide the Experience – Explain the Causes and Indications of Soil Color

(Approximately 5 minutes)

Gather pictures of a variety of soils in several colors from around the world.

Examples: red desert sands in Arizona, gray desert sands in Nevada, white sands of New Mexico, black soils of the mid-west, redbed soils in South Dakota, yellow soils of the Yellow River beds in China, or green sands of Hawaii.

Show the students each picture and have them guess where each soil can be found.

With a partner have the students discuss, “What causes color differences in soil?” Have a few students share highlights from their discussion.

Thank students for their thoughts and participation.

Factors affecting organic matter in soil:

- Climate
 - Organic matter decomposes more quickly in warm and humid climates than cool dry climates
- Soil Texture
 - Soil aeration: more oxygen in the soil speeds up the decomposition process
- Vegetation
 - Prairie soils have more organic material added to the soil than forest soils because of vegetation

Demonstrate the Relevance *(Approximately 5 minutes)*

Guide students through a short discussion on organic matter and its formation. Encourage students to describe the organic matter in the soil in your area. Use the following questions to guide your conversation:

- What type of vegetation creates organic matter in our area?
- Compared to the rest of the country, does organic matter decompose more quickly or slowly? Why?
- How do animals impact organic matter in our area?
- How is organic matter different in different soils, even in our town?

Conclude this conversation by having a discussion about why they believe organic matter is important to soils.

Provide the Experience - Management Practices and Organic Matter Related to Soil Function *(Approximately 20 minutes)*

Demonstrate soil organic matter’s role in surface soil stability using the “Soil Glue” demonstration and have students complete the “Soil Glue – Student Exercise” with their thoughts and observations.

Soil Organic Matter

Label the Information *(Approximately 5 minutes)*

While discussing management practices of soil organic matter, have students capture the following information in their Guided Notes.

- Use of conservation cropping systems
 - Diverse crop rotations, solid manure, high residue crops, grasses, or perennial plants properly grazed or hayed help improve organic matter
- Reducing or eliminating tillage
 - Tillage exposes the organic matter to the air and can result in the lowering of stable organic matter
- Reduce erosion
 - When soil erodes organic matter goes with it
- Soil-test and fertilize properly
 - Proper fertilization encourages root growth for more organic matter in the soil
- Use of perennial forages
 - Provides for annual die back and regrowth of plants

Instruct students to list the benefits of organic matter as it relates to soil function:

- Nutrient Supply
 - As organisms decompose, nutrients are released in a plant usable form
- Water-Holding Capacity
 - Organic matter has the ability to hold up to 90 percent of its weight in water
- Soil Aggregation
 - Improved soil aggregation improves soil structure
- Erosion Prevention
 - Erosion is reduced because water infiltration and soil stability are increased

Explain how each benefit impacts soil function. Consider using the information above to help guide your instruction.

Demonstrate the Relevance *(Approximately 20 minutes)*

Students will create an advertisement for soil organic matter. Explain to students that they have been hired by the National Soils Corporation to create a TV, radio, or magazine advertisement for the sale of organic matter. They have 10 minutes to use the materials provided to create their advertisement that will be shared with that class. Explain to students that they must include a definition or description of organic matter and at least three benefits organic matter has to soil. Divide the class in to groups of 3-4 students.

Note: Provide a variety of props for TV commercials and poster supplies for the magazine advertisement.

Allow students to present their advertisements to the class. After all groups have presented, thank the students for their engagement and willingness to share.

Soil Organic Matter

Provide the Experience – Measure Soil Organic Matter

(time varies with number and location of samples)

Measuring Soil Organic Matter

Gather necessary materials and inform students you will be giving important instructions for measuring soil organic matter. Ask students to follow along in their “Measuring Soil Organic Matter – Lab Sheet”

At the conclusion of the laboratory exercise, instruct students to clean up and return materials to designated areas.

Note: Consider reviewing the NRCS Soils Video “Soil Organic Matter” to aid in this laboratory experience.

Label the Information *(Approximately 3 minutes)*

Students will briefly describe the process of measuring soil organic matter using a soil color chart in their Guided Notes.

Demonstrate the Relevance *(Approximately 5 minutes)*

Instruct students to complete the questions in the “Measuring Soil Organic Matter – Lab Sheet.” After a few minutes, briefly discuss these questions as a class.

Review the Content *(Approximately 10 minutes)*

Prior to class place five posters/flip charts around the room labeled with: What is Organic Matter?, Factors that Affect Organic Matter, Management of Organic Matter, Benefits of Organic Matter, and Measuring Organic Matter.

Divide the class into five groups and assign one group to each flip chart. Give them one minute to write down as much as they can about that topic on their flip chart and then have them rotate and repeat at each flip chart. When they return to their original flip chart, instruct them to summarize all of the information on the chart and review the information to the class. Allow each group two minutes to summarize their information and 30 seconds to present to the class.

Thank each group as they finish presenting for their summarization.

Celebrate Student Success *(Approximately 2 minutes)*

Thank students for their contributions and congratulate them for demonstrating their understanding of soil organic matter. Take a minute to preview the next lesson.

Soil Organic Matter

Soil Organic Matter

Guided Notes: Soil Organic Matter

Notes completed by _____

Soil Organic Matter:

Factors Affecting Soil Organic Matter

- _____
- _____
- _____

Soil Organic Matter Management

- _____
- _____
- _____
- _____
- _____

Benefits of Soil Organic Matter

- _____
- _____
- _____

The _____ chart provides an estimate of the amount of organic matter in the soil.

Steps to measure soil organic matter:

1. _____
2. _____
3. _____
4. _____

Soil Organic Matter

Measuring Soil Organic Matter – Laboratory (USDA-NRCS)

Completed by _____

Materials Needed to Measure Soil Organic Matter

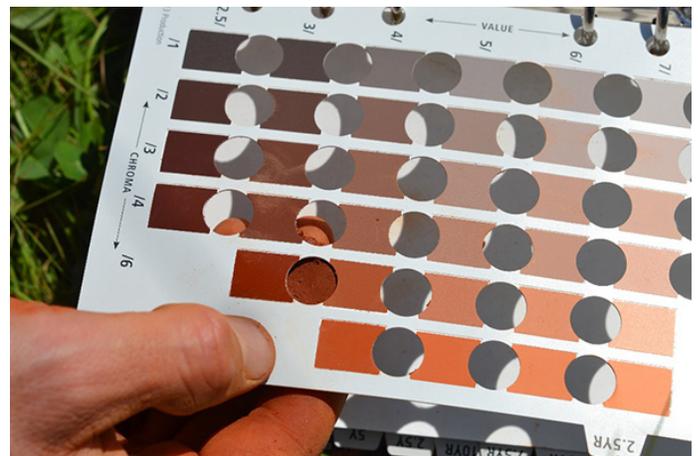
- _____ Soil color chart for estimating organic matter
- _____ Plastic bucket and probe for gathering and mixing soil samples
- _____ Squirt bottle with water (to moisten soil if dry)
- _____ Pen, field notebook, sharpie, and zip lock bags (for labeling soil samples taken back to the classroom)

Considerations – Soil organic matter typically is measured in a lab. The University of Illinois soil color chart provides an estimate of the amount of soil organic matter in mineral soils formed under grass, as many soils are in the Midwest and other natural grassland regions around the world. It can be used for other soils, but is not as accurate. Please read color chart instructions for details and other considerations. Other accepted methods to estimate organic matter such as color charts for other types of soils, lab testing, or tools can be used.

In-field Estimate for Soil Organic Matter (refer to color chart for more guidance)

1. Soil Sampling: Soil organic matter is highly variable. At least 10 small samples are gathered randomly from an area that represents the soil type and management history from the surface 0-6 inch depth and placed in the small plastic bucket and mixed. You may also estimate organic matter at each sample site and average organic matter readings for the area you are assessing. Repeat for each sampling area.
2. Use moist soil. If the sample is dry moisten it.
3. Match the soil with the color that it most closely matches (Figure 3) organic matter color chart (or other method of estimating organic matter content). Record associated organic matter content in Table 3 and complete calculations in interpretations section of this document (suggest averaging several samples).

Figure 3. Soil color chart (Munsell.com).



Soil Organic Matter

1. What is organic matter?

2. What visible types of organic matter did you observe in your samples?

3. How does color help determine soil organic matter?

4. What predictions do you have for the future organic matter of the soil in your sampled area? Why?

5. Why is organic matter important to the soil you sampled?
