Soil Investigation

Summary: In this lesson, students deepen their understanding of the relationship between soil and crop health by conducting a hands-on soil investigation. They start by collecting soil samples from multiple areas in the garden, and then conduct a "jar test" in which they identify and describe the soil types in their garden. This "jar test" takes a day for results to be meaningful. During this time, students learn more about how soil type impacts plant growth. This lesson forms the foundation for considering the environmental conditions that support different types of crop growth for the next lesson, Crop Planning.

This is the fourth of a 12-lesson series in which students will explore the basic ecological principle of interdependence through the lens of common organic farming practices.

Time: Two 45 minute lessons

Materials:

- Samples of soils from in and around the garden
- Tools for digging
- Water for soil test
- Two clear jars (ideally a mason jar) per group
- Gardening gloves (optional)
- Gardening books (optional

Vocabulary

- **Soil:** the upper layer of earth in which plants grow; a complex living system made up of dead and decomposing organic material (like leaves and animals), rocks, minerals, oxygen, water, decomposers (like microorganisms, insects, and fungi), and the roots of living plants.
- **Soil type:** a way of classifying soil based on its characteristics (especially its texture).
- **Control variable:** an element in an experiment that remains unaffected or unchanged by other variables. A control variable gives you a reference to compare your other results to.

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Teacher Notes:

- The "READ" sections of this lesson plan can be used as talking points or a script to introduce activities. Please note, these sections simply provide brief introductions to the topics. We recommend using your experiences to add more information and context to the topics being covered.
- If teaching asynchronously or assigning the lesson plan as homework, for the sections that instruct students to READ, consider recording you reading the sections aloud and sending the recording to students. This adaptation offers a helpful strategy for differentiating learning that supports all students, especially English Language Learners.
- The "THINK" and "DISCUSS" sections of the activities provide some great prompts for informal conversations. Consider asking your students these questions as they are gardening. You could also create a "question board" with the different questions and have students informally choose different questions to answer while they garden.
- The "DO" section of this activity involves a "jar test" that measures the comparative densities of different materials in the soil. Samples need at least 12 hours for the investigation to work because different soil particles settle at different rates. Students will collect samples on the first day of the lesson, and record their observations on the second day. You may want to fill a sample jar with soil one day ahead in order to give students an illustration for how the investigation will work.
- Optional—as an added activity you could create a public space where students can share the things they notice during each of the rotations. This could take the form of a board with chart paper or markers where students can write down their answers to the questions labeled, "NOTICE." This extra activity supports students to glean observations from their classmates and learn from one another.
- For more information on the practices of organic farming, see the Center for Agroecology and Sustainable Food Systems curriculum on Organic Farming and Gardening Skills.
- At some point during this lesson, have students return to the garden bed in which they are conducting the plant start investigation (Lesson 3). They should record their observations about the plants and soil on the Plant Start Investigation

DAY 1

READ: In the previous lesson, you learned about the farming practices of **tillage** and **cultivation** and began an investigation to explore how these practices—as well as adding **compost** to the soil—affect crops and other elements of the garden ecosystem. Today, you will deepen your investigation into the relationship between the soil and crops by analyzing the characteristics of the soil in various parts of the garden. In particular, you will focus on how **soil type** influences plant growth in our garden. **What type(s) of soil does our garden have? How does that impact plant growth in our garden?**

"**Soil type**" is a classification made based on a soil's texture. A soil's texture is determined by the size of mineral and rock particles in it. The size of the mineral and rock particles depends upon the environmental factors that impact the speed of weathering and erosion, such as precipitation, temperature, wind, and plant life. Even at its fastest, minerals and rocks take thousands of years to break down. Different types of soil are composed of different types and sizes or rocks and minerals. See page 2 of the Soil Investigation Visual to learn about some different types of soil.

Soil types are important because they determine the amount of air and oxygen in the soil. Different types of soil also have different rates of drainage, and ability to hold nutrients. Knowing what type of soil your garden has will help you better determine what plants might grow best in your soil, and what amendments your soil needs to be its most fertile.

Today we will conduct a "jar test" to determine the soil type(s) in our garden. We will also collect observations of soil characteristics and plant growth in different areas of the garden.

INVESTIGATE: A "jar test" is an investigation designed to compare the characteristics of different soil samples. In this jar test, we will compare soil samples from three areas of the garden: (1) a recently tilled or cultivated bed, (2) a bed that hasn't been tilled or cultivated in a long time, and (3) an area that has never been tilled or cultivated, such as a garden path. The soil from the "never cultivated" area will act as our **control**—it will allow us to know whether the differences we observe between the cultivated and uncultivated beds are significant.

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Follow these steps to collect your three samples:

- Dig up some soil and break it up into smaller pieces before adding it to your jar. Add enough to fill your jar roughly ⅓ full. Don't pack it down.
- Label each jar with the area you gathered it from (ie. "cultivated", "uncultivated", "never cultivated")
- Add water to each jar, filling it up completely. Firmly seal the lid on the jar.
- Stir and shake the jar to make sure the soil is well dispersed.
- Set the jar down and let the mixture settle for at least 1 minute. Use a permanent marker to draw a line where the settled material and the water interface. Everything below this line is the sandy component of your soil.

OBSERVE: Now return to each area from which you collected the soil samples. Record some observations about the soil and vegetation in each area on the Jar Test Investigation Worksheet.

- What do you observe about the texture of the soil in each location?
  - What kinds of materials do you see?
  - What colors and particle sizes do you see?
- How would you describe the plant growth in each location?
  - How many plants do you see?
  - How healthy do they seem?
  - What kinds of plants are they?

HYPOTHESIZE: Compare your observations of the soils with those illustrated on the Soil Investigation Visual.

- Based on these initial observations, do you have a guess for which type(s) of soil is present in the garden?
- Do you think that you will observe a difference in soil type between the tilled and untilled areas? Why?
- How do you think the soil might impact the plant growth in each location? Explain your thinking.

INVESTIGATE: To complete the jar test, you will need to check on your samples again in 2 hours, and then again, the next day.

- Leave the jar undisturbed for two hours and, again, mark the line between the settled section and the water. The layer between your two marks is the silty segment of your soil.
- Leave the jar undisturbed for a day and, again, mark the line between the settled section and the water. This last layer is the clay segment of your soil.
- You can now approximate what percentage of your soil is sand, silt, and clay based on your jar test!

DAY 2

INVESTIGATE: Yesterday you began a jar test to investigate what soil type was present in the garden. Now that you have left the jars to sit for a full day, make the final marks on the jars.

- After you leave the jar undisturbed for a day, mark the line between the settled section and the water. This last layer is the clay segment of your soil.
- You can now approximate what percentage of your soil is sand, silt, and clay based on your jar test!

DRAW OR WRITE: Now that your jar tests have been left out for a while, come back, and take a look. Draw, write, or discuss what you see. What are the different soil types in each sample? How can you tell? Use the Soil Investigation Visual to help you determine the types of soil. Draw a diagram of each jar on the Jar Test Investigation Worksheet. Label each diagram with the different soil types.

DISCUSS: In groups or as a class, discuss your observations and reflections:

- Are the soil samples you collected the same type of soil or different types? Explain your answer.
- What did you observe about the relationships between the soil and crop growth in the different locations that you examined? What do you think could explain your observations?
- Did you see evidence for the argument that tillage and cultivation affect soil composition? Explain.
- How could what you learned in this investigation help you for your crop plan project?
- What questions do you still have about the soil in our garden, or the relationship between soil and crop health?

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READ (OPTIONAL): How does the jar test work? The jar test is designed to take advantage of the fact that different soil types have different densities. This means they settle out of water at different rates—the densest soil particles settle out the most quickly, while the least dense particles take longer to settle.

READ (OPTIONAL): Now that we have made some observations of our soil, we are going to try and identify the layers of soils in our garden. Soil is made up of different layers. See Soil Investigations visual page. 1. Each layer has its own characteristics. If you take some time to dig in your garden, can you identify each of these layers?

- The **surface layer** is the upper surface that is mostly decomposing plant material. The layer is made up of living and decomposing materials like plants, bugs, etc.
- The next layer, the **topsoil** layer, is made up of materials that are more broken down. This layer is a mixture of decomposed plant material, and decomposed minerals (rocks). This is where seeds germinate, and plant roots grow. Topsoil is considered very precious because it has the highest concentration of microorganisms and organic matter. Good topsoil takes time to build up.
- The lower layers are the **subsoil**. Subsoil is a mixture with more broken minerals and a small amount of decomposed plant material. The deepest layers of subsoil are mostly broken bedrock material. These layers can be very deep down and are not easily observable in our garden unless we dig very deep.

COMPARE (OPTIONAL): Examine images of hand-tilling vs industrial tilling/cultivation Reflect on the questions based on your observations.

- How do these practices compare?

How do you imagine their impacts on the garden ecosystem might compare? What could be the benefits and drawbacks of each? *(Draw on your own experience tilling and/or cultivating to answer this question!)*

Central Questions:

- What type(s) of soil does our garden have?
- How does soil type impact plant growth in our garden?
- Does tilling or cultivating impact soil type?

Materials:

- 3 jars
- Permanent marker
- Soil samples from 3 areas in the garden
- Tools for digging

Procedure:

1. Identify three areas in your garden to test the soil type:

a. A recently-tilled or cultivated bed

b. A bed that hasn't been tilled or cultivated for at least a month

c. An area that has never been tilled or cultivated (or hasn't been tilled or cultivated for at least 1 year)

2. In each location, dig up some soil, and break it up into smaller pieces before adding it to a jar. You should have 3 separate jars, one for each area. Add enough soil to each jar to fill it roughly ⅓ full. Don't pack it down.
3. Label each jar with the area you gathered it from (ie. "cultivated", "uncultivated", "never cultivated")
4. Add water to each jar, filling it up completely. Firmly seal the lid on the jar.
5. Stir and shake the jar to make sure the soil is well dispersed.
6. Set the jar down and let the mixture settle for at least 1 minute. Use a permanent marker to draw a line where the settled material and the water interface. Everything below this line is the sandy component of your soil.
7. Leave the jar undisturbed for two hours and, again, mark the line between the settled section and the water. The layer between your two marks is the silty segment of your soil.
8. Leave the jar undisturbed for a day and, again, mark the line between the settled section and the water. This last layer is the clay segment of your soil.

Jar Test Investigation Worksheet

Name: _____

OBSERVE: Record your observations about the soil and vegetation from each area.

- What do you observe about the texture of the soil in each location?
    - What kinds of materials do you see?
    - What colors and particle sizes do you see?
- How would you describe the plant growth in each location
    - How many plants do you see?
    - How healthy do they seem?

What kinds of plants are they?

Recently cultivated	**Recently cultivated**	**Never cultivated**

Jar Test Investigation Worksheet

Name: _____

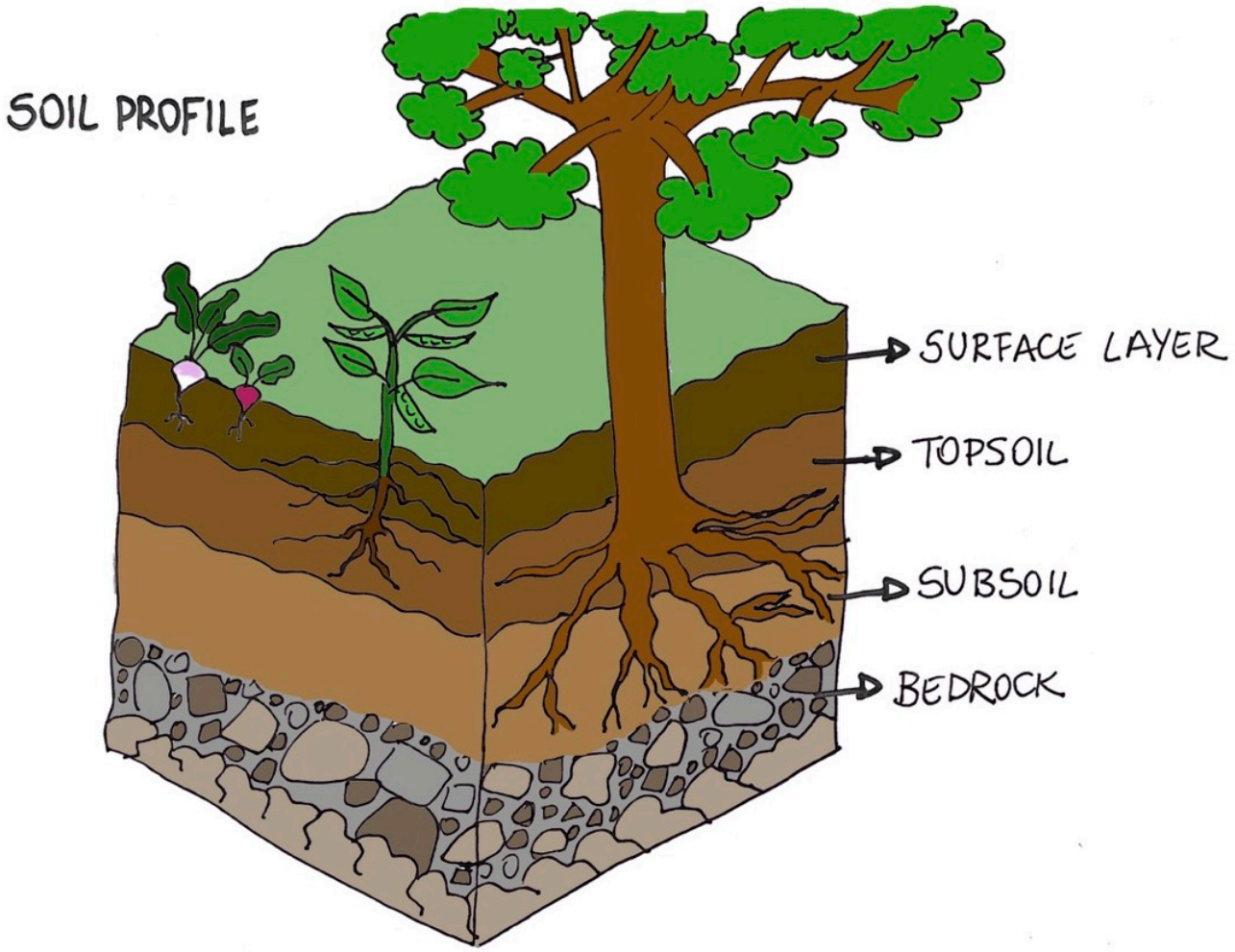
HYPOTHESIZE: Compare your observations of the soils with those illustrated on the Soil Investigation Visual.

- Based on these initial observations, do you have a guess for which type(s) of soil is present in the garden?

- Do you think that you will observe a difference in soil type between the tilled and untilled areas? Why?

- How do you think the soil might impact the plant growth in each location? Explain your thinking.

Soil Investigations



SURFACE LAYER: THE UPPER SURFACE THAT IS MOSTLY DECOMPOSING PLANT MATERIAL.

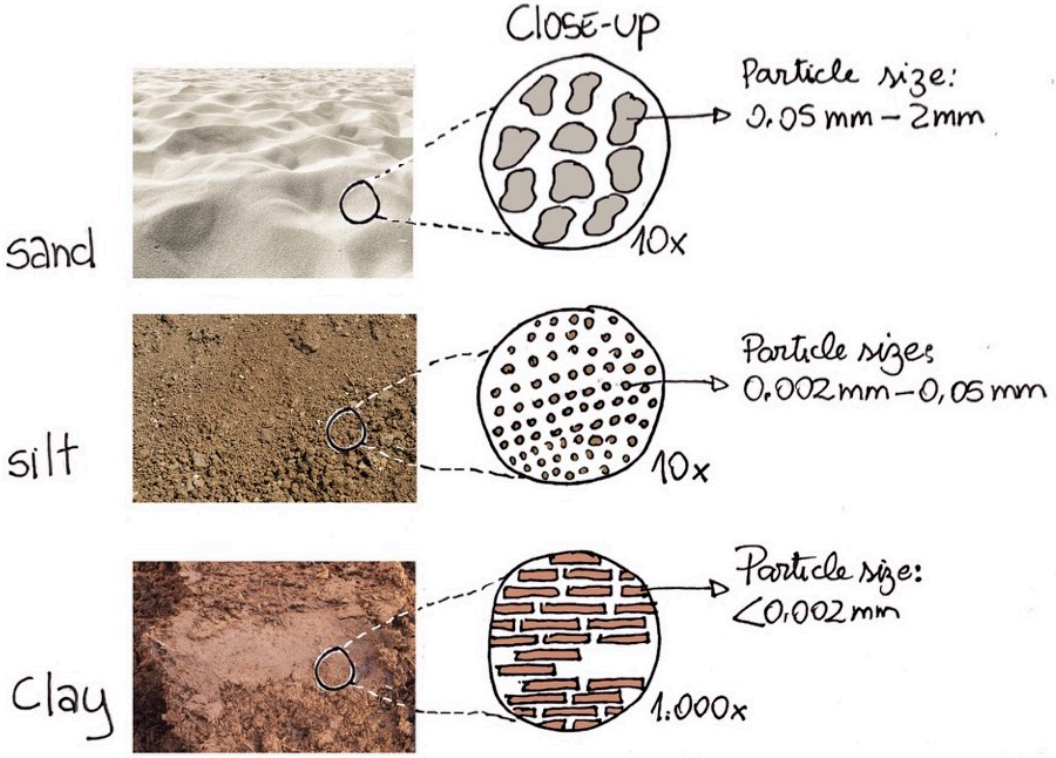
TOPSOIL: A MIXTURE OF DECOMPOSED PLANT MATERIAL AND DECOMPOSED MINERALS (ROCKS). THIS IS WHERE SEEDS GERMINATE AND PLANTS ROOTS GROW.

SUBSOIL: A LOWER LAYER OF SOIL WITHOUT MUCH PLANT MATERIAL OR LIFE.

BEDROCK: THE ABOVE SOIL TYPES REST UPON THE BEDROCK WHICH IS LARGELY COMPOSED OF UNBROKEN, HARD ROCK.

Components of soil

Sand, Silt, and Clay



*0,005mm is the width of a human hair.

Soils are categorized by their various percentages of sand, silt, and clay. When they are in roughly equal proportions is it called loam. If a soil has a majority of one type but still has the other two it may be called a _____ loam, where the blank is filled in with the majority type. For example, a soil with lots of sand but some silt and clay would be called sandy loam.