

Lesson C1–1

Determining the Nature of Soil

Unit C. Basic Principles of Agricultural/Horticultural Science

Problem Area I. Using Basic Soil Science Principles

Lesson I. Determining the Nature of Soil

New Mexico Content Standard:

Pathway Strand: Natural Resources and Environmental Systems

Standard: VII: Apply scientific principles to environmental services.

Benchmark: VII-B: Describe soil compositions and properties to demonstrate knowledge of soil science.

Performance Standard: 1. Describe soil geology. 2. Describe composition of soil. 3. Describe the biological properties of soil. 4. Identify the physical properties of soil. 5. Describe the chemical properties of soil. 6. Test soil samples to determine characteristics. 7. Explain classification of soil water. 8. Explain the relationship between soil classifications and land use.

Student Learning Objectives. Instruction in this lesson should result in students achieving the following objectives:

1. Explain how the resources soil provides help in supporting life.
2. Explain the contents of soil.
3. Describe the biological nature of soil.
4. Describe the four ways plants use soil.
5. Describe some agricultural uses of soil.
6. Describe some nonagricultural uses of soil.

List of Resources. The following resources may be useful in teaching this lesson:

Recommended Resources. One of the following resources should be selected to accompany this lesson:

Biondo, Ronald J. and Jasper S. Lee. *Introduction to Plant and Soil Science and Technology*, Second Edition. Danville, Illinois: Interstate Publishers, Inc., 2003. (Textbook and Activity Manual, Chapter 7)

Plaster, Edward J. *Soil Science & Management*. Albany, New York: Delmar Publishers, 1997. (Textbook and Lab Manual, Chapter 1)

Other Resources. The following resources will be useful to students and teachers:

Illinois Master Gardener. University of Illinois at Urbana–Champaign, Cooperative Extension Service.

Porter, Lynn, et al. *Environmental Science and Technology*, Second Edition. Danville, Illinois: Interstate Publishers, Inc., 2003. (Textbook and Activity Manual, Chapter 13)

Sager, Robert J., et al. *Modern Earth Science*. Austin, Texas: Holt, Rinehart, and Winston, Inc., 1998. (Textbook, Chapter 12)

VAS U4052a, *Understanding Soils*. Urbana, Illinois: Vocational Agriculture Service.

List of Equipment, Tools, Supplies, and Facilities

Writing surface
Overhead projector
Sample of soil
Copies of Student Lab Sheet
Magnifying glasses
Plastic or metal sieves
Transparencies from attached masters

Terms. The following terms are presented in this lesson (shown in bold italics):

Capillary water
Gravitational water
Hygroscopic water
Infiltration
Leaching
Mineral matter
Organic matter
Percolation

Permeable
Pore spaces
Soil aeration
Tilth

Interest Approach. Have students bring in soil samples or provide them with samples. Set the samples before the students and ask what is contained in each sample. Are all the samples going to be the same? Will they look the same and have similar properties? Using a writing surface, record student responses. Ask students to focus on the specific contents that are in the samples. After a consensus is reached, identify the specific objectives and possible problems for this lesson.

Summary of Content and Teaching Strategies

Objective 1: Explain how the resources soil provides help in supporting life.

Anticipated Problem: What is soil and how do its resources help in supporting life?

- I. Soil is a layer on the earth's crust that provides a combination of resources. These resources allow the growth of plants and animals. These resources include:
 - A. Oxygen—needed for adequate root growth.
 - B. Temperature—soil absorbs heat from the sun. It also loses heat to the atmosphere. This allows satisfactory temperatures for plant growth and seed germination.
 - C. Water—utilized for growth of plants.
 - D. Carbon—utilized in the form of organic matter in the soil.
 - E. Nutrients—provided as minerals. They are broken down as nitrogen and recycled through decaying material in the soil.

Ask students to identify soil resources that may be helpful in supporting life. Use notes above to supplement the answers provided by students. Chapter 1 in Soil Science and Management is recommended. Use TM: C1–1A to discuss the practical importance of soil.

Objective 2: Explain the contents of soil.

Anticipated Problem: What are the various components found in soil?

- II. Soil is composed of four primary components. They are mineral matter, organic matter, air, and water. In addition, there are numerous living organisms in the soil, such as bacteria, insect larvae, earthworms, and fungi. Soils may vary from one area to another, but most will contain these basic components.
 - A. Solid portions (50% of soil volume) represent the space occupied by mineral and organic matter.

1. **Mineral matter**, which accounts for about 45% of the soil, is partially decomposed rock material. It is the sand, silt, and clay that is found in the soil. These vary in amount depending on the type of soil. The amounts of sand, silt, and clay also determine the soil's ability to hold water and provide nutrients.
 2. **Organic matter**, which accounts for about 5% of the soil, is partially decomposed plant and animal matter. Most organic matter is from plant leaves, roots, and stems. Organic matter gives soil its dark color. Organic matter contributes to the soil's fertility as well as improved aeration and water holding capacity.
- B. **Pore spaces** (50% of soil volume) represent the space occupied by air and water.
1. Air, which accounts for about 25% of the soil, is part of the pore space in the soil. When soils are wet the amount of air will be less. When soils are dry the amount of air will be more. There is a constant fluctuation in the amount of air and water found in the soil.
 2. Water, which accounts for about 25% of the soil, is also part of the pore space in the soil. When it rains water will enter the soil or flow off of the soil's surface. The process of water soaking into the soil is known as **infiltration**. Once water is in the soil, movement downward is known as **percolation**. A quality soil allows both kinds of water movement and is said to be **permeable**. Water in the soil may be one of three types:
 - a. **Gravitational water**—water that drains through the pore spaces in the soil as a result of gravity. Gravitational water flows quickly through soil that has large pores and slowly through soil with small pores. As water moves through the soil, it carries dissolved minerals, chemicals, and salts. This movement of water is referred to as **leaching**.
 - b. **Capillary water**—water that is held between the particles of soil against the forces of gravity. It may move upward or sideways by capillary action. Clay soils hold more capillary water since they have more pore spaces.
 - c. **Hygroscopic water**—water that forms a thin film around individual soil particles. This water is unavailable to plants.

Bring in a sample of soil and use LS: C1–1A for students to identify the soil components that are present. Students may overlook the air and water in the sample. Explain the importance of these as it relates to plants being able to grow. Chapter 7 in Introduction to Plant and Soil Science and Technology or page 1 in VAS U4052a are recommended resources. Use TM: C1–1B to show the relative percentages of the components in the soil.

Objective 3: Describe the biological nature of soil.

Anticipated Problem: What living organisms are found in the soil?

- III. Abundant life can be found in soil.
 - A. Forms of life in soil include:
 1. Earthworms

2. Insects
 3. Bacteria
 4. Fungi
 5. Other organisms
- B. Bacteria and fungi have an important role in the soil. They break down organic matter and release nutrients.
- C. Earthworms, ants, crawfish, moles, and other organisms improve the soil **tilth**, the ease at which soil can be worked. These organisms create openings in the soil as they tunnel. This enhances drainage and improves air exchange.

Use a variety of techniques to help students master this objective. Students should use text materials to help understand the biological nature of soil. Chapter 7 in Introduction to Plant and Soil Science and Technology is recommended. You may also take students outdoors. Dig a hole in the soil, throwing the soil dug onto the surface so students can break it apart searching for signs of life. Ask students to identify the life they observe. Discuss the importance of these organisms in improving the soil.

Objective 4: Describe the four ways plants use soil.

Anticipated Problem: How do plants use soil?

- IV. Plants depend on soil to provide four basic needs.
- A. Anchorage—soil acts to provide a firm support as roots grow throughout the soil.
 - B. Water—soil provides nearly all of the water used by plants. Water is absorbed through the plants' roots.
 - C. Oxygen—nearly all living organisms need oxygen. Plants release oxygen during photosynthesis but consume oxygen during respiration. Plant parts above the ground have an ample supply of oxygen; however, those below the ground (roots) have less oxygen available. This increases the need for good **soil aeration**, the exchange of soil and atmospheric air in order to maintain adequate oxygen for plant roots.
 - D. Nutrients—of the 16 nutrients considered to be essential for plant growth, 13 are obtained from the soil. Root hairs absorb the nutrients dissolved in soil water.

Many techniques can be used to help students master this objective. Students need text materials to help understand how plants use soil. Chapter 1 in Soil Science & Management is recommended. Use TM: C1–1C to highlight the four basic uses. Expand on the importance of these four uses in a class discussion with students.

Objective 5: Describe some agricultural uses of soil.

Anticipated Problem: What are some uses of soil in agriculture?

- V. Agriculture depends on soil to grow food, fiber, and ornamental plants for human societies. Various uses include:
- A. Cropland—this is land on which soil is worked and crops are planted, cared for, and harvested. Most cropland is devoted to annual crops, such as corn, soybeans, cotton, vegetables, etc.
 - B. Grazing land—this is land used for grazing cattle and sheep. It is often planted to perennial forage.
 - C. Forest—this is land used for growing trees which are later harvested for building materials, paper, etc.
 - D. Water structures—ponds and other reservoirs are constructed out of soil.

A variety of techniques can be used to help students master this objective. Students need text material to help understand agricultural uses of soil. Chapter 1 in Soil Science & Management is recommended. Lead a class discussion on the various agricultural uses of soil. Ask students to identify specific local uses of soil and expand discussion to include county, state, regional, and national differences.

Objective 6: Describe some nonagricultural uses of soil.

Anticipated Problem: What are some nonagricultural uses of soil?

- VI. Humans require soil for many other uses besides growing plants. Such uses include:
- A. Recreation—recreational activities include playgrounds, sports fields, jogging paths, golf courses, parks, campgrounds, and many others.
 - B. Foundations—buildings depend on a solid soil base upon which to be built to remain structurally sound.
 - C. Waste disposal—soil is often used for the treatment of human sanitary wastes. Soil filters some of the material, while microorganisms break down organic portions into less dangerous compounds.
 - D. Building materials—homes and other structures are occasionally built underground, into hillsides, or even with soil piled over them. Earth-sheltered buildings help in lowering heating and cooling costs.

A variety of techniques can be used to help students master this objective. Students need text materials to help understand nonagricultural uses of plants. Chapter 1 in Soil Science & Management is recommended. Lead a discussion on various nonagricultural uses of soil. Students should be able to identify local nonagricultural uses of soil.

Review/Summary. Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used in de-

termining which objectives need to be reviewed or taught from a different angle. Questions at the end of each chapter in the recommended textbooks may also be used in the review/summary.

Application. Application can involve the following student activity using the attached lab sheet:

Soils: What Are They?—Observational Exercise—LS: C1–1A

Evaluation. Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance on the application activity. A sample written test is attached.

Answers to Sample Test:

Part One: Matching

1=c, 2=g, 3=h, 4=a, 5=b, 6=d, 7=f, 8=e

Part Two: Completion

1. Students may list any two of the following: cropland, grazing land, forest, and water structures.
2. wastes
3. Answers will vary but may include: playgrounds, sports fields, jogging paths, golf courses, parks, or campgrounds.

Part Three: Short Answer

1. Answers will vary but may include: earthworms, insects, bacteria, or fungi.
2. Students may list any three of the following: anchorage, water, oxygen, and nutrients.
3. a. 45%
b. organic matter
c. 25%
d. air
4. Use TM: C1–1A as a guide for scoring.

Test

Lesson C1–1: Determining the Nature of Soil

Part One: Matching

Instructions. Match the term with the correct response. Write the letter of the term by the definition.

- | | | |
|-------------------|----------------------|--------------------|
| a. permeable | d. infiltration | g. percolation |
| b. tilth | e. leaching | h. capillary water |
| c. organic matter | f. hygroscopic water | |

- _____ 1. Partially decayed plant and animal matter.
- _____ 2. The downward movement of water through the soil.
- _____ 3. Water that is held against the forces of gravity and may move sideways or upward.
- _____ 4. A quality of soil that allows the movement of water and air.
- _____ 5. The ease with which soil can be worked.
- _____ 6. The process of water soaking into the soil.
- _____ 7. A thin film of water around individual soil particles.
- _____ 8. The process of carrying away dissolved minerals in water.

Part Two: Completion

Instructions. Provide the word or words to complete the following statements.

- Two agricultural uses of soil include _____ and _____.
- Soil is often used for the treatment of human sanitary _____.
- Two examples of recreational uses of soil include _____ and _____.

Part Three: Short Answer

Instructions. Use the space provided to answer the following questions.

- List three examples of biological life might be found in soil.
 -
 -
 -

- c.
2. What are three needs that plants depend on soil for?
- a.

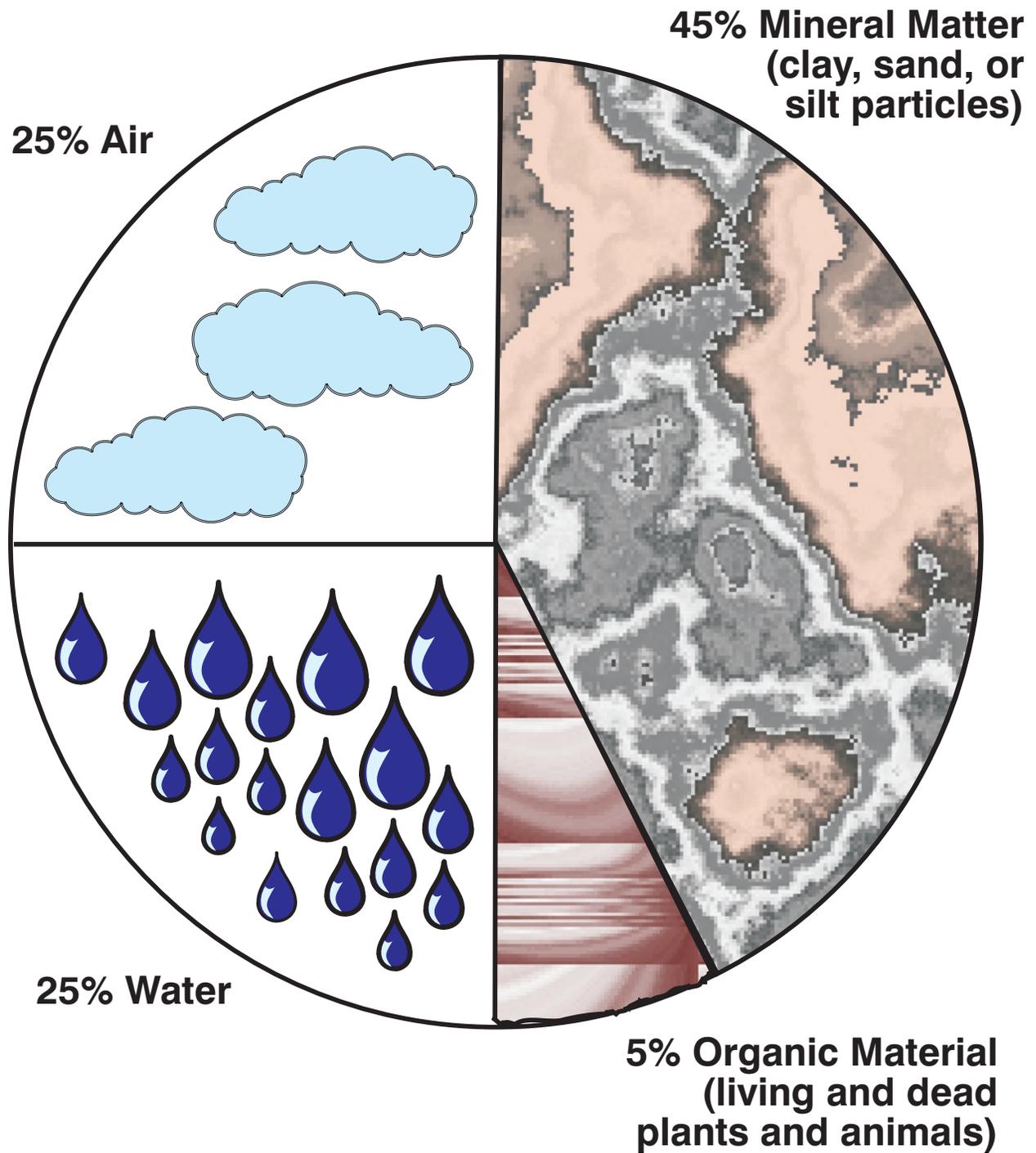
 - b.

 - c.
3. Soil is composed of the following components:
- a. ____% mineral matter
 - b. 5% _____
 - c. ____% water
 - d. 25% _____
4. Why is soil important in supporting life?

Why Soils Are Important

- 1. Plants grow in and on soil.**
- 2. Plants support animal life.**
- 3. Plants and animals support human life.**
- 4. World population is rapidly increasing, which increases the need for food.**
- 5. A large part of the world's population has inadequate nutrition.**
- 6. World supply of productive soil is limited.**

Composition of Average Soil



Four Basic Plant Uses of Soil

1. Anchorage

2. Water

3. Oxygen

4. Nutrients

Lab Sheet

Soils: What Are They?—Observational Exercise

Purpose:

Observe soil samples to determine similarities and differences in their composition.

Objectives:

1. Identify the major components of a soil sample.
2. Analyze the physical differences among soil samples.
3. Recognize differences in soil structure.

Materials:

Soil samples
Magnifying glass

Procedure:

1. Obtain a soil sample which contains enough of the top 2 inches of soil to fill a pint jar.
2. Observe the soil carefully and answer the questions below.
3. Trade samples with your lab partner. Examine the new sample, and answer the same questions again for it. How does this sample differ from the other one?

Questions:

1. Describe the location where the sample was collected.
2. Describe the color of the soil sample.
3. What does the soil sample smell like?
4. What does the soil sample feel like?

5. Does the soil sample contain any plants or animals? Describe them.

6. Use a magnifying glass to determine the structure of the soil. What structures are present? Draw a picture of each.

7. Using the magnifying glass, describe the organic matter.

8. Does the amount of water that a soil can hold change? Why?

9. Air and water make up about half of the soil sample. Where is the air and water found?

Lab Sheet Discussion Guide

Soils: What Are They?—Observational Exercise

This activity is designed to assist the students in learning to appreciate soil. Soil is naturally occurring and is a mixture of organic and mineral materials arranged to form a specific structure and composition unique to its particular location. The exercise will point to the small plants and animals within a particular sample. It will allow an opportunity to make comparisons with other samples. This comparison will facilitate in learning that samples from similar locations will have common characteristics. Samples from different locations will have different characteristics.