AGRISCIENCE EXERCISE

LIFE/EARTH CONCEPTS

Key Concept: EARTH CYCLES "Everything on earth operates in cycles."

Sub-Concept: The Rock Cycle

Agricultural Context: Effect of organic matter on moisture-holding capacity of soils.

Exercise: **Soil Water-holding Capacity and Water Movement Rate**

Applied Principle: The size of particles and organic matter content of a soil determines how much water it holds. This has important implications for the productivity and possible uses of a soil.

Goals:

1. Discuss the relationship between soil particle size and water-holding capacity.
2. Discuss the effect of organic matter on a soil's moisture-holding capacity.

Preparation Time: You will need to collect soil samples in advance in order for them to dry (minimum of over night if dried in an oven).

Materials: (per group)

- DRIED soil samples
- 2 rubber bands
- Water
- Sharpie marker
- Data sheet
- 2 - 12" squares of cheesecloth
- 1 - gallon coffee can
- Kitchen-sized scale
- 2 - 6" squares of cheesecloth
- Ruler
- 2 - old-fashioned lamp chimneys
- 2-cup beaker/measuring cup
- Stopwatch/watch with second hand
- 2 - quart-sized, smallmouth canning jars

References:

USDA Soil Conservation Service. (1986). "Compare how much water different soils hold." Soil and Water Conservation Activities for Youth. Washington, D.C.: USDA.

South Dakota AgriScience Lab Manual. (1994).

Procedures for Conducting the Activity:

1. Before activity, the instructor should collect soil samples. One should be hard and have clods, as from an over cultivated garden or field which has lost much of its organic matter. The other sample should be from a well-managed field where grasses and legumes have been grown, or a similar location, and should be crumbly and free from clods.

   A fairly large amount of each type should be gathered, since each group will need a sample of each type of soil. Each soil should be thoroughly dried (separately) before the activity. This may be done by spreading it out on a tarp or flattened cardboard box in a heated room, or otherwise speeding up the drying process.

2. Divide the class into small groups of about 3 or 4 students each.

3. Provide each group with DRIED soil samples and other materials.

PART ONE

4. Empty ONE-HALF of one of the two soil samples onto one of the large cloth squares (save the other half for part two of this activity), pull the corners together, and secure with a rubber band.

5. Weigh this sample and record on Data Sheet.

6. Fill the coffee can about one-half full of water.

7. Saturate the bag of soil by holding it in the water.

8. Remove the sample from the water and allow the free water to drain off for two minutes. (Do NOT squeeze the bag to remove water!)

9. Weigh the sample and record on Data Sheet.

10. Calculate the difference in weights. (Weight Wet - Weight Dry)

11. Repeat steps 3 through 8 for the other soil sample.

PART TWO

12. Using the ruler and marker, mark 1/2" increments, on the side, from the bottom of each jar to about 3" up.

13. Place a small piece of cheesecloth over one end of each chimney, securing with the rubber bands used in part one.

14. Turn each chimney upside down into the canning jars (see Figure 1).

15. Carefully place the remainder of each DRY soil sample into a chimney.

16. Pour 32 oz. of water into each chimney.

17. Note on data sheets how long it takes the water to begin to drip into each jar.

18. Continue to time and record the amount of water dripping from each sample.

19. As a class, discuss the following points:

    a. From Part One of the exercise, which type of soil held the most water? What caused this? (Was there some “ingredient” present/absent in the one holding the most water?)
    b. What effect do you think the particle size composition of the soil has on its water-holding capacity?
    b. Which soil was heavier when dry? Was it still heavier when wet? Why?
    c. Did the results of Part Two match those from Part One?
    d. Is it good for soils to hold water? Why? Can they hold too much water? How much is too much?
    e. What do you think producers can do to help their soils hold more water? What if they want their soil to hold <u>less</u> water?

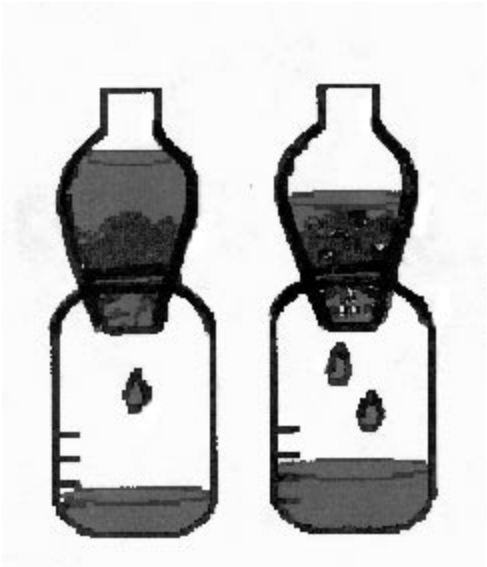

Figure 1

TEACHER BACKGROUND INFORMATION

Soil Water-holding Capacity and Water Movement Rate

When organic matter is used up, soil packs together. So, a soil with clods has fewer air spaces, its particles do not cling together in granules, and the lack of organic matter means that it weighs more than an equal volume of crumbly soil from a well-managed plot.

Not only does a crumbly soil take in water faster than one with clods, it holds more. The thoroughly decomposed organic matter (humus) in a crumbly soil can absorb lots of water. On a dry-weight basis, this humus has a water-holding capacity of several hundred percent and may act like a sponge. In addition to the water held by the organic matter is the water held in the pores between the soil particles and between the soil granules. Hundreds of very fine soil particles are glued together by the organic matter into soil granules.

This increased water-holding capacity of soils high in organic matter under natural conditions makes a big difference in the intake of water. These well-managed soils can absorb most of the rain and snow melt (if the soil is not frozen). This means there will be less erosion. Streams will run clear. Of course, when a soil is saturated by a long period of rainfall, any additional water then runs off. But until the soil is saturated it will store up water and let it go gradually. The result is that floods are less severe, water seeps into streams slowly and over a longer period of time, and water is stored in the soil for plants to use.

Crops use a lot of water. Vegetables use an average of 2 acre-feet, or 650,000 gallons an acre. Cotton takes 800,000 gallons per acre. An acre of alfalfa needs more than a million gallons, and to produce just one ear of corn requires over a barrel of water. Organic matter helps soil store more water, and thus helps prevent erosion and produce better crops.

Many field tests have shown the improved water-holding capacity of well-managed soils that have enough organic matter to keep them crumbly and granulated. One deep soil in Texas that was high in organic matter held 25% or 1 inch more water in the 1 foot surface layer, after the free water had drained off, than the same depth and type of soil in another field where the soil was low in organic matter. This made a difference of 27,000 gallons of water per acre in the first foot of soil.

AGRISCIENCE EXERCISE

Soil Moisture Capacity Exercise

GROUP WORK SHEET

PART ONE

1. Empty ONE-HALF of one of the two soil samples onto one of the large cloth squares (save the other half for part two of this activity), pull the corners together, and secure with a rubber band.

2. Weigh this sample and record on Data Sheet.

3. Fill the coffee can about one-half full of water.

4. Saturate the bag of soil by holding it in the water.

5. Remove the sample from the water and allow the free water to drain off for two minutes. (Do NOT squeeze the bag to remove water!)

6. Weigh the sample and record on Data Sheet.

7. Calculate the difference in weights.

8. Repeat steps 3 through 8 for the other soil sample.

PART TWO

1. Using the ruler and marker, mark 1/2" increments from the bottom of each jar to up about 3".

2. Place a small piece of cheesecloth over one end of each chimney, securing with the rubber bands used in part one.

3. Turn each chimney upside down into the fruit jars (see Figure 1).

4. Carefully place the remainder of each DRY soil sample into a chimney.

5. Pour 32 oz. of water into each chimney.

6. Note on data sheets how long it takes the water to begin to drip into each jar.

7. Continue to time and record the amount of water dripping from each sample.

AGRISCIENCE EXERCISE

Soil Moisture Capacity Activity

GROUP DATA SHEET

PART ONE:

Sample Number	Weight Dry (in grams)	Weight Wet (in grams)	Weight Wet - Weight Dry
1			
2			

PART TWO:

Sample Number	Time (in seconds) for water to Begin dripping	reach 0.5"	reach 1.0"	reach 1.5"	reach 2.0"	reach 2.5"	reach 3.0"
1							
2							

As a group, answer the following questions.

a. From Part One of the exercise, which soil sample held the most water?

What do you think caused this? (Was there some “ingredient” present/absent in the one holding the most water?)

b. What effect do you think the particle size composition of the soil has on its water-holding capacity?

c. Which soil sample was heavier when dry?

Was the same sample still heavier when wet?

Why?

d. Are the results of Part Two consistent with the results of Part One?

e. What reasons can you think of that producers might prefer soils that held moisture?

Can soils hold too much water?

How could you determine how much is too much?

f. What do you think producers can do to help their soils hold more water?

What if they want their soil to hold less water?