

Till We or Won't We?



LEVEL: Grades 4-9

SUBJECTS: Science, Social Studies

SKILLS: Analyzing, applying, collaborating, collecting data, comparing similarities and differences, comprehending, concluding, controlling variables, cooperating, discussing, evaluating, experimenting and testing hypotheses, following directions, measuring, observing, predicting, recording, synthesizing, understanding cause and effect

MATERIALS

Several weeks before this lesson, ask students to bring in clean, clear 2-liter soda bottles. One large apple; 10 pounds of potting soil or dark topsoil; one small bag of sand or vermiculite; several handfuls of mulch (hay, grass clippings, wood shavings, and so on); one lab kit (for every four students) consisting of seven clear 2-liter soda bottles, with at least one having a cap, one or two plastic jugs for carrying water, one or two large plastic bags or plastic sheeting, sharp knife, permanent-marking pen, scissors, push pin, 1-liter measuring cup (preferably marked in milliliters [mL]), watch or clock with a second hand; and photocopies of the attached *Here's the Scoop!*, *How to Build Your Erosion Laboratory*, and *Data and Observation Journal* sheets.

VOCABULARY

contour farming, contour plowing, cover crop, crop rotation, directional hypothesis, erosion, hypothesis, minimum tillage, mulch, noncontour plowing, no-till farming, null hypothesis, row crop, sediment, soil conservation, soil erosion, subsoil, tilling, topsoil

RELATED LESSONS

Perc Through the Pores
From Apple Cores to Healthy Soil
Soil Is Not Trivial
In Harmony

SUPPORTING INFORMATION

Wherever you walk, whether it's across a farm field, baseball diamond or parking lot, beneath your feet lies one of our most important and overlooked natural resources — the soil. We all have contact with soil, but too often it is in the context of "Take off those dirty shoes!" or "Wash your dirty hands!" When we consider the role of soil in our survival, it would be more appropriate to say, "Please take off your shoes so that wonderful soil can stay outside where it's useful." This lesson is designed to increase the awareness of and respect for the ecological functions of topsoil and subsoil, their roles in agriculture, and essential functions in producing food and fiber.

Celebrate Soil!

We build our homes, plant our trees, and grow our food on soil. But even more basic, soils have a vital role in the natural processes of our environment: regulating and filtering water, decomposing organic and inorganic materials such as municipal and animal wastes, and storing and cycling nutrients such as carbon or nitrogen. Microorganisms and other animals such as earthworms make their

BRIEF DESCRIPTION

Students construct and perform experiments simulating rain on a field, investigating how soil preparation, tillage techniques, and mulches affect soil erosion and water runoff.

OBJECTIVES

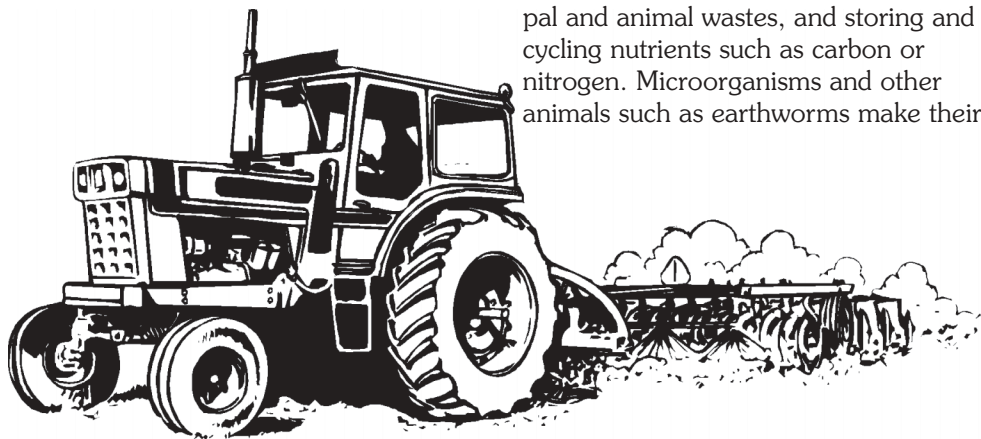
The student will work in a group to:

- discuss the importance of soil resources, especially topsoil, to food production;
- construct and conduct experiments on soil erosion;
- predict, explore and learn how different soil-preparation techniques affect soil loss by water, how soil might be preserved, and how water runoff is affected; and
- explain how farmers can conserve topsoil and reduce their costs to grow food through certain land-management practices.

ESTIMATED TEACHING TIME

Session One: 45 to 60 minutes.

Session Two: 60 to 90 minutes. (Can be taught in two sessions.)



homes in soil. They burrow through and mix the soil, opening channels for water and air that provide life-sustaining moisture and oxygen for plant roots and plant and animal life in the soil.

Besides these ecological functions, soil provides the place to put roots. Roots anchor plants in the soil. This is easy to see, as evidenced by the soil trapped by the root system after you dig up a plant. Clearly, people in the city are just as dependent on the soil as wildlife in the forest or families on the farm. This lesson is designed to increase the awareness of and respect for the ecological functions of topsoil and subsoil, their roles in agriculture, and essential functions in producing food and fiber.

Soil Formation and Types

It's time to appreciate that soil is more than dirt. What exactly is soil? It's a dynamic mixture of air, water, and extremely small rock particles, and plant and animal material. Soil formation starts as the accumulation of loose materials from the breakdown of parent material (weathered rock debris). Soil forms in horizons, commonly called topsoil, subsoil, parent material, and bedrock. The soil-formation process is a result of the complex and continuing interaction of the parent material, living plants and animals, climate, and topography. The interaction of these factors over time develops a unique personality for each soil type. We all know how important personality is, right? For soil, personality includes texture — determined by the amount of sand, silt, and clay particles in the soil. Sand is the largest and has a gritty feel. Silt is the medium particles and feels smooth like flour. Clay particles are the smallest and feel sticky. The soil texture helps determine the soil type as described by soil scientists. Soil type matters because all soils have varying capabilities for uses they provide, such as growing crops or trees, holding water, or providing a solid foundation for a basement or a skyscraper. (See the FLP lessons "Perc Through the Pores" and "In Harmony.")

So What's the Problem? Erosion!

The problem is that in many areas our soil is being eroded faster than nature can replace it. Erosion is the loosening and movement of soil mainly by wind and water, but also by ice and landslides. Erosion is a natural and never-ending process. While erosion is degrading one landscape, soil deposition is building another, normally over a long period of time. Eroding soils end up in rivers, streams, river deltas by the sea,

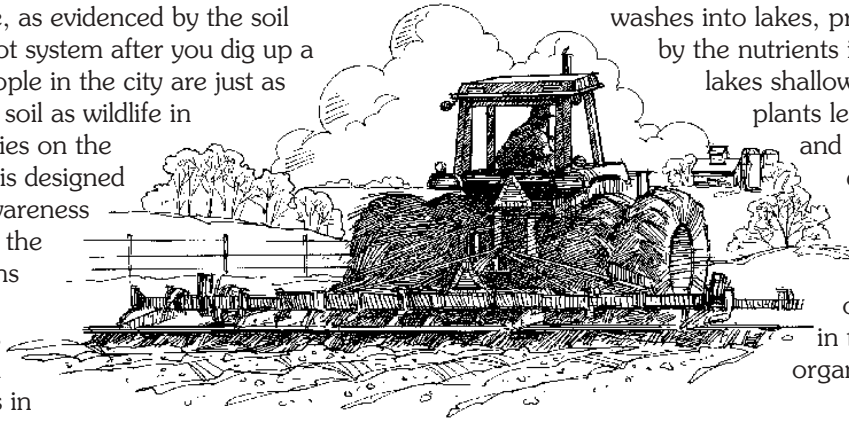
bases of hills, city street gutters, or people's windowsills. Soil washed into our waterways by erosion also causes other problems. Soil clogs rivers and changes their flow, affecting navigation. Silt and pollutants, which are carried into our drinking water, raise water-treatment costs. When soil washes off land, it also can hurt wildlife miles away. Eroding soil washes into lakes, promoting plant growth by the nutrients it carries, and making lakes shallower. The overgrowth of plants leads to shading of plants and eventually to their death. As the dead plants decompose, they reduce the amount of dissolved oxygen which can result in the death of other organisms such as fish.

You may be surprised to learn that it takes nature about 500 to 1,000 years to create one inch of topsoil. Topsoil is the richest part of the soil. Most of the growth potential of a field is in this area, where microbes and organic matter are concentrated. As the soil washes away, the land's potential for production drops. Subsoil, the layer of material beneath the topsoil, is not as fertile, so production declines.

Wind, Water, and Human Activities

Wind erosion occurs when the soil surface, generally bare of vegetative cover, is attacked by the force of the wind. The wind lifts and tumbles soil particles along the soil surface creating a scouring action and deposits the particles in another location. The Dust Bowl of the 1930s is a grim reminder of wind erosion, although it remains a problem even today, where the soil surface is left exposed and loose during the windy parts of the year. Techniques and programs implemented by farmers and ranchers in cooperation with the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) and local conservation districts have been effective in reducing the wind erosion, which caused the Dust Bowl. The rate of wind erosion declined by 33 percent or one third per acre in the United States from 1982 to 1997, according to the latest data available from the NRCS. The average annual rate of wind erosion has declined from 3.3 tons per acre on 421 million acres of total U.S. cropland in 1982 to 2.5 tons per acre on 382 million acres in 1992, with a further decline to 2.2 tons per acre on 377 million acres in 1997.

Wind erosion moves large amounts of soil and deposits it as dirt in our homes and across the land, but water erosion carries away even larger quantities of soil that many of us never see. Surprisingly, recent research



shows that up to 90 percent of soil loss from water erosion is due to the impact of raindrop splashes. The force of the raindrops on bare soil dislodges soil particles. As the water moves across the soil, it lifts and carries the loose soil particles, either as a sheet or in small channels called rills. Sheet erosion occurs when a thin, almost invisible, uniform layer of soil erodes off the land like a sheet. If nothing is done to protect the soil surface, the runoff gains speed and volume as it moves further down the slope. Eventually the sheets of runoff and little rills come together and begin to cut small gullies. As the small gullies come together at the bottom of a hill, they grow into larger gullies or channels that are very expensive to repair. Sheet erosion is not as visible as the rills and gullies, but it often impacts a much larger area. The average rate of sheet and rill erosion also declined about one third per acre (31.7 percent) between 1982 and 1997. According to the National Resources Inventory (revised edition) conducted by NRCS, the average sheet and rill erosion rate on cropland declined from 4.1 tons per acre in 1982 to 3.1 tons per acre in 1992 and declined further to 2.8 tons per acre by 1997.



Nature usually manages to replace geologic or natural soil loss because soil formation is a continual process. But human activities speed up erosion rates beyond what nature can replace. When erosion is people-induced, avoidable problems begin. People inflict significant damage when land is denuded of vegetation by clearing and overgrazing or the soil structure is pulverized by such activities as construction development, hiking off established trails, off-road driving, and excess tillage. For an example, recall what highway or building construction sites look like. Surface mining and logging are other human activities that increase soil erosion. Off-road vehicles have accelerated wind and water erosion and scoured more soil than nature will replace in 1,000 years. These damages can become costly to repair. The answer to reducing or eliminating human-caused erosion damage is to reduce the effect of the activity and use tried-and-true conservation techniques.

Minimizing Erosion

Luckily, many farmers, builders, homeowners, and other land managers today are taking soil conservation seriously. They have a better awareness of the types and effects of various conservation-management practices in both their immediate vicinity and also the wider environment. They know that people in both rural and urban settings have a responsibility for soil

conservation practices. Urban and suburban developers can plant grass or install soil erosion fences on newly graded subdivisions to control wind and water erosion.

Farmers are on the front lines of the efforts to save our soil. They know that some farming practices contribute to erosion. Plowing, for example, turns the soil over and leaves it more vulnerable to both wind and water erosion. Since so much erosion comes from the effects of rainfall, tilling up and down hills also creates avenues for erosion. To minimize these problems, farmers have come up with conservation practices that work to save soil. Many of these practices were used 2,000 years ago.

- Contour farming moves across the natural slope of the land when tilling, planting and cultivating so that row crops are not placed up and down the slope. Cultivating on the contour creates small ridges which capture water, allowing it to be absorbed and thus minimizing runoff. (Creating ridges up and down the slope would accelerate runoff.)

- Terracing, used on steeper slopes or mountainsides, consists of larger ridges or little dams called terraces that are built on the contour. Spacing between terraces depends on the amount of slope. They look like a staircase on the hillside. The terraces and space between them hold rain water so it does not run down the slopes and create gullies.

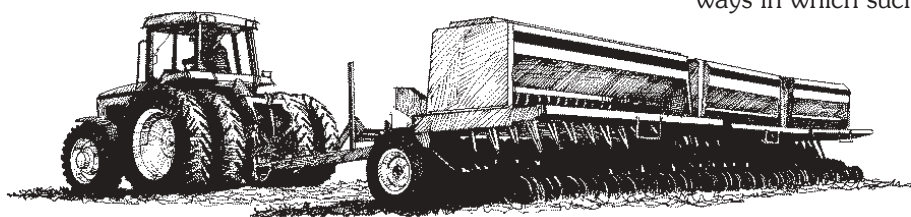
- Strip-cropping alternates close-growing perennial plants like grass and clover between strips of row crops such as corn, wheat and other annual crops. The close-growing crops hold the water (rain or irrigation) and protect the soil from erosion better than row crops. The strips of perennial plants capture wind blown soil particles, reduce scouring, and mitigate wind erosion in areas such as the plains states. Strip-cropping on the contour is often done to maximize erosion control.

- Trees planted in hedge rows reduce wind erosion and scouring action by reducing the speed of the wind and capturing airborne soil particles.

- Minimum tillage methods reduce the amount of cultivation (e.g., plowing, disking, harrowing, and so on) that disturbs the soil surface, when planting and growing crops, thereby decreasing the opportunity for erosion.

- Mulching uses crop residue or adds straw, manure or other organic matter to cover the land from fall to spring to protect soil against erosion by wind or water. As the mulch decomposes, it adds nutrients to the soil, making it richer and more productive.
- No-till farming leaves the previous crop's residue as a mulch to help reduce soil erosion from water or wind and leaves the soil undisturbed except for narrow planting strips, when new crops are planted. Weed control is done with selective herbicides.
- Crop rotation strategies alternate row crops (cotton, vegetables, corn, soybeans) with non-row crops (grasses, legumes) or row crops with different root structures, thus protecting the soil and rebuilding its fertility.
- Crop residue left on the land from fall to spring provides a cover to protect soil against erosion by water runoff.
- Cropland conversion replaces row crops on highly erodible land with pasture or trees that hold soil in place.
- Planting grassed waterways or installing plastic netting or catch basins helps slow overflow water and collect sediment before it washes into streams.
- Rotation grazing of cattle or sheep moves them among pastures and allows plants to recover between grazing periods and reduces runoff.

When choosing strategies to minimize soil erosion, farmers consider the overall cost of their management strategy. They must balance their expenditures with the money they get for their crop and the benefits from keeping the soil on the land. When they have developed a good strategy, rainfall does not erode their land or other lands below them. Their land stays productive, and the soil and any chemicals they use do not move off the land. Soil loss from wind, sheet, and rill erosion on cropland declined 39 percent from 1982 to 1997. The NRCS reports that soil loss declined from a total of 3.1 billion tons on 421 million acres in 1982 to 2.1 billion tons on 382 million acres in 1992 and to 1.9 billion tons on 377 million acres in 1997.



Good soil conservation practices benefit everyone. When we care for soil, we are more likely to have productive farmlands, healthy ecosystems, and abundant wildlife for the generations ahead. Till we or won't we? That is the question. This lesson illustrates one of the most fundamental principles of soil and water conservation — the protection that soil management gives against the loss of our soil to pounding raindrops, running water, and howling winds.

GETTING STARTED

Several weeks before this activity, ask students to bring in clean, clear 2-liter soda bottles. Obtain an apple, 10 pounds of potting soil or dark topsoil, and a small bag of sand or vermiculite. Photocopy the **Data and Observation Journal** sheet, one per student.

Each team of four students require the following:

- seven clear 2-liter soda bottles, at least one with a cap
- one or two jugs for carrying water
- one or two large plastic bags or plastic sheeting
- sharp knife
- permanent-marking pen
- scissors
- push pin
- 1-liter measuring cup (preferably marked in mL)
- "several handfuls" of finely chopped mulch (hay, grass clippings, wood shavings, and so on)
- watch or clock with second hand
- photocopies of **Here's the Scoop!** and **How to Build Your Erosion Laboratory** sheets.

For a companion lesson, see the FLP lesson "Perc Through the Pores."

PROCEDURE

SESSION ONE

1. Explain that erosion is a natural and never-ending process. While one landscape is being degraded by erosion, another is being rebuilt. The problem is that our soil is being eroded faster than nature can replace it. There are many forms of erosion, but today erosion by water accounts for the greatest loss of the topsoil essential to food production. Tell students they will be constructing and performing laboratory experiments to study the effects of water erosion on soil, as well as studying and evaluating ways in which such erosion can be reduced.
2. To show the importance of protecting soil by reducing erosion, use the following demonstration of how little of Earth's surface can be used for food production.

- Hold up the apple and tell students to imagine that it represents Earth.
 - Cut the apple into four equal slices. Describe to students that three of these represent the oceans and the fourth part is the land.
 - Slice the land section in half lengthwise, so you now have two eighths of the apple. One eighth represents land such as deserts, swamps, the antarctic and arctic, and mountains that is not suitable for farming. The other eighth represents where people live and land for farming.
 - Slice this eighth into four equal slices. Three of these slices are areas developed with cities and towns and areas where soils are not adequate for growing food or the climate is too dry or too wet.
 - Peel the remaining section. This peel represents the soil on which we all depend for growing all our food.
 - For effect, eat the peel.
3. Divide the class into teams of four students. Students from each team select one of the following roles. (Note: Students remain in their roles throughout the experiments and during the class discussions that follow each experiment.)
 - Mr. or Ms. Farmer (reads ***Here's the Scoop!***)
 - Rainmaker (makes it rain on each soil tray)
 - Hydrologist (catches and measures the runoff in the pond)
 - Timekeeper (measures and records the time between the start of rainfall and the end of the runoff period and the time it takes the water to reach the pond)
 4. Once roles are chosen, give each Mr. or Ms. Farmer one copy of ***Here's the Scoop!*** and ***How to Build Your Erosion Laboratory*** and four copies of the ***Data and Observation Journal***. Mr. or Ms. Farmer reads the Scenerio and the Get Ready from ***Here's the Scoop!*** to his or her team and sets the stage for the experiments.
 5. Students use the remaining time to work as a team to construct the erosion laboratory.

SESSION TWO

1. Upon completion of the erosion laboratory, ask each Mr. or Ms. Farmer to read the Get Set from ***Here's the Scoop!*** to his or her team.
2. Mr. or Ms. Farmer introduces you as Mr. or Ms. Journal. Your role is to explain the terms hypothesis, directional hypothesis, and null hypothesis to the class and how to complete both

pages of the ***Data and Observation Journal***. Tell students that a hypothesis is a tentative explanation about the relationship between variables. It provides guidance to an experiment about what data to collect. Scientists make hypotheses before they begin experiments because they want to test or investigate their explanation. Today we are experimenting with three soil-preparation techniques to determine which of the techniques will prevent or minimize soil erosion. Ask students to read the hypothesis on their ***Data and Observation Journal*** and circle one of the word(s) NO, SMALL, or LARGE. Be sure students understand their hypothesis may be different from the others on their team. This becomes the hypothesis that he or she tests with the three experiments.

Depending on the hypothesis, students may or may not make two predictions. Predictions are made to identify and explain observations or changes in advance of the experiment. They are based on careful observations and the inferences (why it happened) made about relationships between observed events. If students circled that there will be NO differences in erosion, that is a null hypothesis. No predictions are made with a null hypothesis. If they circled that there will be a difference, such as SMALL or LARGE, that is a directional hypothesis. If students make a directional hypothesis, they must complete both predictions.

3. Briefly review page 2 of the ***Data and Observation Journal***. Make sure students understand that they are to make individual predictions for each tray in all five columns. Again, make sure students understand that their predictions may be different from those of the other team members. Each team member also makes observations during each experiment and records the data from the timekeeper and hydrologist. Remind the hydrologists to set aside the runoff from each tray for comparison later.
4. Before teams begin the experiment, each student makes his or her predictions for all three trays and in all five columns.
5. Mr. or Ms. Farmer reads the Go from ***Here's the Scoop!*** Students assume their roles and begin the experiment using Tray 1.
6. Once each team has completed Tray 1 and students have entered the data and observations in their ***Data and Observation Journal***, repeat the experiment with Tray 2. (Historical note: During the 1930s, contour farming was promoted

heavily as a solution to widespread soil erosion in the United States. This was especially successful in the Tennessee Valley region and the Dust Bowl of Texas, Kansas, Colorado, and Oklahoma.)

7. Once each team has completed Tray 2 and entered its data and observations in their **Data and Observation Journal**, repeat the experiment with Tray 3.

Optional session break

8. Summarize the lesson by asking:
- How did your predictions compare with your observations? Were your hypothesis and/or predictions confirmed?
 - What differences are there among the three experiments? (*Mulch, time, color of water, amount of water, and so on.*) Have students draw and discuss some conclusions about the experiments.
 - What similarities are there among the three experiments?
 - Which of the three experiments produced the least erosion? (Have teams compare the amount of sediment in their three ponds.) Why?
 - Where does soil go during the process of erosion caused by water? (*Into canals and streams, clogs and changes courses of rivers, forms deltas, flows onto roads, and more.*)
 - Is it possible to get the soil back once it has been eroded? (*Not really!*)
 - Why is soil erosion a problem? (*Soil is precious. Erosion cuts down productivity of land and carries soil into waterways, where it clogs drains, fills ponds, kills fish, destroys habitat, and carries pollutants into drinking water.*)
 - Why is soil important? Why is it important to you?
 - Why is it important to control and reduce soil erosion?
 - Based on these experiments, which would appear to be the best soil-preparation technique? Why?
 - How could farmers use this demonstration to reduce soil erosion?

- How can construction companies use these experiments to reduce soil erosion at building sites? In the construction of new roads?
- What other strategies can you think of that farmers or others can use to reduce soil erosion? (Share Supporting Information.)
- How does no-till or minimum tillage help keep food production costs down? (*Farmers save time and money by cutting down tillage operations. Soil productivity increases as compaction is reduced and the decomposing crop residue adds nutrients.*)

EVALUATION OPTIONS

1. Evaluate students' **Data and Observation Journal** for understanding and completeness and have them answer these questions.
 - What is soil erosion?
 - What causes soil erosion?
 - How can soil erosion be reduced?
 - Why is it important to all of us to reduce soil erosion?
2. Students write a paragraph using the following beginning: "Soil is important to me because..."
3. Have students draw pictures of the experiment for the three fields (represented by the trays) and indicate where soil goes when it rains.
4. Have students describe possible benefits farmers can receive by maintaining a soil mulch. (*Reducing soil erosion, conserving moisture in the soil to grow new crops, saving money and time by reducing tillage operations, reducing soil compaction, saving topsoil, and so on.*)

EXTENSIONS AND VARIATIONS

1. Have students graph the results of the three experiments using bar or pie charts with legends. (See the **Pie Chart** in the Appendixes.)
2. Conduct a demonstration simulating flood conditions by pouring the same amount of water at a faster rate over two or three of the trays. Which soil tray eroded the least? The most? Why?
3. Repeat the experiment and:
 - A. alter the slope of the field.

- B. have students grow “crops” (e.g., grass) in the trays and then repeat the experiment to see if the results vary.
 - C. try growing “crops” in the subsoil (sand or vermiculite) and observe the results. This will clearly show the value of topsoil.
 - D. alter the composition of the soil (loam, clay, others) in the trays to determine the effects of water erosion when only that variable is altered.
 - E. place two or three coins on the bare soil to represent pebbles. Note how the soil beneath the coins tends to resist erosion.
 - F. working outside, have students use a hair dryer to simulate a wind storm. See which tray loses the most soil. (If the plowing is done deeply enough, the one in which the furrows move at a right angle to the wind direction should protect the soil better than the one where the wind blows down the furrows.)
4. Have a farmer who uses no-till farming visit your classroom to discuss the benefits of using no-till management. Or better yet, plan a field trip to a farm using no-till management.
 5. Have students draw, describe or find photographs of local examples of soil erosion around roads, construction sites, and so on. What strategies can students suggest to reduce or eliminate the erosion?
 6. Have personnel from the local conservation district, extension service, or U.S. Department of Agriculture Natural Resources Conservation Service visit your classroom to discuss soil, soil types, and soil-management practices, including no-till farming. Have students prepare questions in advance and provide them to the visitor prior to the visit. Ask the visitor to bring slides, if available.
 7. See the FLP lesson “Soil Is Not Trivial” to learn more about the history and need for soil conservation in the United States.

CREDITS

Laboratory kits adapted from “Bottle Hydrology,” Department of Soil Science, The College of Agriculture and Life Sciences, University of Wisconsin, Madison. Used with permission.

National Resources Inventory (revised edition). Natural Resources Conservation Service, United States Department of Agriculture. 2001. <http://www.nrcs.usda.gov/NRI/>

ADDITIONAL RESOURCES

America’s Private Land, A Geography of Hope. Natural Resources Conservation Service, United States Department of Agriculture. December 1996.

Conserving Soil. National Association of Conservation Districts, P.O. Box 885, League City, TX 77573. 1-800-825-5547. <http://nacdnet.org>

Lines on the Land. National Association of Conservation Districts. 408 East Main Street, League City, TX 77573. 1-800-825-5547. <http://nacdnet.org>

National Resources Inventory (revised edition). Natural Resources Conservation Service, United States Department of Agriculture. 2001. <http://www.nrcs.usda.gov/NRI/>

Soil: A Critical Environmental Resource. Fact Sheets. Resources, Soil and Water Conservation Society. 945 SW Ankeny Road, Ankeny, IA 50021. (515) 289-2331. <http://www.swcs.org>

Soil and Water Conservation Society. 945 SW Ankeny Road, Ankeny, IA 50021. (515) 289-2331. <http://www.swcs.org>

The Story of Land - Its Use and Misuse Through the Centuries. Soil and Water Conservation Society. 945 SW Ankeny Road, Ankeny, Iowa, 50021. 1-800-THE-SOIL. <http://www.swcs.org>

WEB SITES

National Resources Inventory (revised edition). Natural Resources Conservation Service, United States Department of Agriculture. 2002. <http://www.nrcs.usda.gov/NRI/>

Natural Resources Conservation Service, United States Department of Agriculture. 2002. <http://www.nrcs.usda.gov>

National Association of Conservation Districts. 2002. <http://nacdnet.org>

Soil and Water Conservation Society. 2002. <http://www.swcs.org>

United States Department of Agriculture. 2002. <http://www.usda.gov>

HERE'S THE SCOOP!

(one copy per Mr. or Ms. Farmer)

Directions: Read Scenario and Get Ready in Session One. Read Get Set and Go in Session Two.

Scenario

I'm a farmer and I love my land. My children and grandchildren love it, too. They want to own and work this farm someday. But I am concerned. Every time it rains, I can see I am losing precious topsoil. I know how important topsoil is for growing food and preserving the land for future generations. If I don't take steps to prevent soil erosion, the rain and wind will take away much of my rich topsoil. The farm produces great crops today, but unless I guard and protect the soil, there will be nothing for my children and grandchildren but poor soil and ugly gullies and trenches on my fields. I have some soil-saving ideas, but I want to see results. I've called you together because you are a group of caring experts. I know you can help me decide how to till my land to reduce soil erosion when I prepare it for planting. I am considering three different soil-preparation techniques: 1) plowing up and down the side of my hill (called noncontour plowing); 2) plowing horizontally, following the contours of my land (contour plowing); 3) or not plowing, leaving the old crop residue (no-till).

Get Ready

1. Introduce your team members by name and their role in the experiments.
 - Rainmaker makes it rain on the soil trays
 - Hydrologist catches and measures the runoff in a pond
 - Timekeeper measures and records the time from the beginning of the rain to the end of the runoff and the time it takes the water to reach the pond
2. Your task today is to help me conduct three experiments to study ways in which erosion can be reduced on my land. Working as a team, we will:
 - gather the items for building the erosion laboratory; and
 - follow the directions on ***How to Build Your Erosion Laboratory*** so we can build the laboratory and the three soil trays

Get Set

The erosion laboratory will be used to experiment on different ways to prepare the land for planting (plow or not plow the soil). Tray 1 (hold up tray) demonstrates noncontour plowing; Tray 2 (hold up tray) demonstrates contour plowing; and Tray 3 (hold up tray) demonstrates not plowing and leaving the old crop residue on the land. One liter of rain will "fall" on each of the trays of soil. Before conducting the experiments, our teacher (Mr. or Ms. Journal) is going to talk to us about making hypotheses and predictions and using a journal to record your data and observations. Here is your ***Data and Observation Journal***. (Note: Give each student one copy and keep one copy for yourself.)

Go

- Conduct each experiment, using a different soil tray each time.
- **The rainmaker** measures exactly 1 liter of water into a jug using the measuring cup. Pour the water into the funnel so it rains on the soil trays (make sure it keeps raining by providing a constant supply to the funnel.)
- **The hydrologist** catches and measures the runoff in the pond and saves the runoff from each of the three experiments for comparison. Provide the data to team members.
- **The timekeeper** uses the clock or a watch to measure and record the time it took the water to first reach the pond (from the start of rainfall) and the length of time the water flowed (from the start of rainfall to the end of the runoff period). Provide the data to team members.

HOW TO BUILD YOUR EROSION LABORATORY

1. Turn your seven 2-liter soda bottles into one tower, three soil trays, one rainmaker, and three ponds. Here's how.

TOWER (Bottle 1)

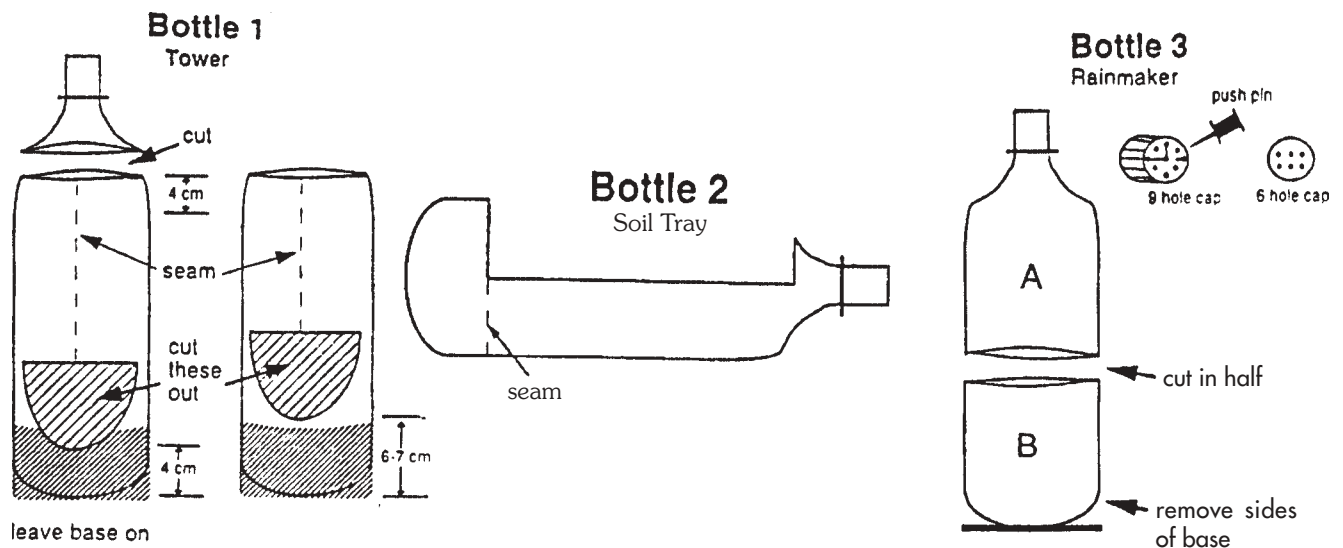
- Cut the top 1-1/2" to 2" off of one bottle.
- Cut two U-shaped holes (about 4" by 4") into the sides of the bottle opposite each other.
- Make one hole about 1 inch higher than the other.
- See the diagram at the bottom of the page.

SOIL TRAYS (Bottle 2)

- Prepare three Bottle 2s. You need one for each of the three parts of the experiment.
- Remove bases from the bottles by soaking them in hot water.
- Cut one side out of each bottle so it makes a tray when laid on its side. The neck of the bottle will channel the runoff and sediments into the pond.
- See the diagram at the bottom of the page.
- Use the permanent-marking pen to label each as Tray 1, Tray 2, and Tray 3.

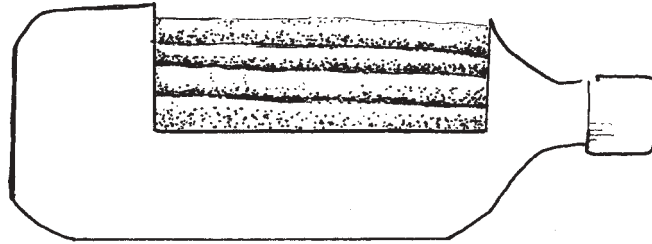
RAINMAKER AND PONDS (Bottle 3)

- Cut the remaining three bottles in half (see the diagram at the bottom of the page).
- For one top half, remove the cap and punch six holes through it with a push pin. Wiggle the push pin in a circle to enlarge the holes. Twist the cap tightly onto the top half. Now it's a rainmaker. Put some water in and test to make sure the water flows freely through the holes.
- Working with one bottle bottom at a time, measure 50 mL increments of water into the bottom half of the bottle and mark each increment with a marking pen. The bottle bottom serves as the pond; each experiment needs its own pond so the runoff from each experiment can be saved for comparisons. Label each pond as Pond 1, Pond 2, and Pond 3.

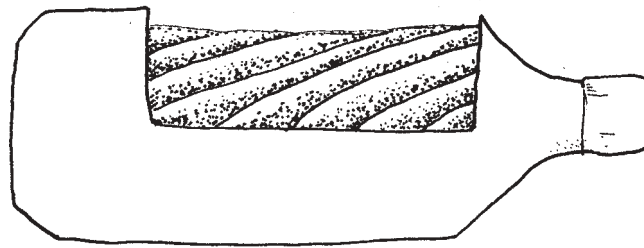


2. Fill each of the three soil trays you made with about 1/2 inch (about 1.2 centimeters [cm]) of sand or vermiculite as subsoil. Then cover with 1 inch (2.5 cm) of moist potting mix as topsoil.

- Label and prepare Tray 1 as a field prepared with noncontour plowing. Make furrows in the topsoil the length of the tray.



- Label and prepare Tray 2 as a field prepared with contour plowing. Make furrows crossways.



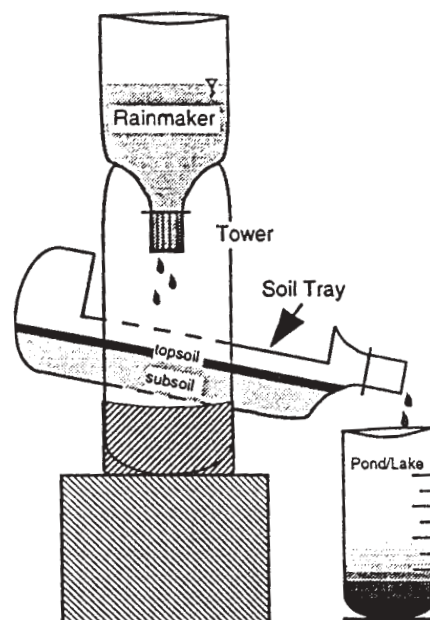
- Label and prepare Tray 3 as a mulched (not plowed) field. This also simulates a no-till field between harvest and planting. Mix several handfuls of the mulch (hay, grass clippings, or wood shavings) into the topsoil and cover the surface with more mulch.

3. Slide the soil tray (Bottle 2) in through the holes in Bottle 1. The soil tray should be at an angle with the neck positioned downward (as shown in the illustration at the bottom of the page).

4. Place the rainmaker, cap side down, into the top hole in Bottle 1.

5. Set the pond - the bottom of Bottle 3 - on the table to catch the runoff.

6. Set up the equipment to look like the illustration below.



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Consider the three soil trays and the soil-preparation techniques they represent (Tray 1 - noncontour plowing; Tray 2 - contour plowing; Tray 3 - mulched, not plowed [no-till]), then complete the hypothesis and predictions.

Hypothesis: There will be (circle one) NO SMALL LARGE differences in soil erosion among the soil-preparation techniques used.

Predictions

1. The greatest amount of soil will erode from tray _____.

2. This is because

3. The largest volume of water will run off from tray _____.

4. This is because

Questions

1. What happened when water ran across the surface of the bare ground in Tray 1?

2. How might some or all of the erosion you observed be stopped?

3. What differences did you observe between Trays 1 and 2? Trays 1 and 3? Trays 2 and 3?

4. What did you learn about contour plowing as a soil-preparation technique?

5. What did you learn about no-till farming as a soil-preparation technique?

6. Why would farmers and others want to minimize soil erosion?

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Tray and soil-preparation technique	Time for water to reach the pond	Length of time the water flowed	Describe the color of the runoff	Total milliliters of runoff in the pond	Effect of water flow on the soil
TRAY 1 Noncontour plowing Predictions					
Observations					
TRAY 2 Contour plowing Predictions					
Observations					
TRAY 3 Mulched, not plowed (no-till) Predictions					
Observations					