Lesson C7–3

Calculating Soil Loss

Unit C. Plant and Soil Science

Problem Area 7. Soil Erosion and Land Management

Lesson 3. Calculating Soil Loss

New Mexico Content Standard:

Pathway Strand: Problem Solving and Critical Thinking

Standard: **IV:** Solve problems using critical thinking skills (e.g., analyze, synthesize and evaluate) independently and in teams.

Benchmark: **IV-B.** Analyze information critically to ascertain its value to whatever discipline it is applied.

Performance Standard: **1.** Explain how to analyze, synthesize, and evaluate information and apply its implications to a variety of avenues.

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

1. Describe the soil erosion process.
2. Identify the various types of soil erosion.
3. Estimate the amount of soil loss from water erosion.
4. Discuss how to control soil erosion.

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 the lesson:

Plaster, Edward J. *Soil Science & Management.* Albany, New York: Delmar. 1997 (Chapter 18)

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

Brady, Nyle C. *The Nature and Properties of Soils*. Englewood Cliffs, New Jersey: Prentice-Hall, Inc. 1990 (Chapter 15)

Cooper, Elmer L. and L. DeVere Burton. *Agriscience: Fundamentals & Applications.* Albany, New York: Delmar, 2002 (Chapter 9)

Lee, Jasper S. and Diana L. Turner. *Introduction to World AgriScience and Technology*. Danville, Illinois: Interstate Publishers, Inc. 1997 (Textbook and Activity Manual, Chapter 17)

Parker, Rick. *Introduction to Plant Science.* Albany, New York: Delmar. 1998 (Chapter 5)

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

University of Illinois. *VAS 4054b Using the Universal Soil Loss Equation to Estimate Soil Loss.* Urbana, Illinois: Vocational Agricultural Service.

List of Equipment, Tools, Supplies, and Facilities

Writing surface
Overhead projector
Transparencies from attached masters
Copies of student lab sheets

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

Conservation tillage
Contour
Contour tillage
Fallow
Graded terraces
Grassed waterway
Gully erosion
Level terraces
Rill

Rill erosion
Sheet erosion
Splash erosion
Strip-cropping
Terraces
T value
Universal Soil Loss Equation (USLE)

Interest Approach. Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Successful police officers and detectives work for hours trying to understand how a criminal operates so they can stop him. An agricultural producer must work the same way. He or she must become a soil detective. The crime to be solved is robbery. Soil erosion is a thief that steals the precious soil that the producer needs to raise a profitable crop. In order for the producer to stop soil erosion, he or she must first understand how erosion works.

Summary of Content and Teaching Strategies

Objective 1: Describe the soil erosion process.

Anticipated Problem: How does soil erosion occur?

I. Erosion is a form of work, which requires energy. The energy for water erosion comes from the energy of a falling raindrop or running water. The energy of a falling raindrop relates to its size and especially to its speed. A 2 inch per hour rainfall has the same energy as a 1 pound object falling 47 feet onto 1 square foot of soil. The erosive energy of running water depends on its volume and speed of flow.

A. The process of soil erosion follows a simple, systematic progression each and every time. There are three basic steps to soil erosion. They are:

1. Detachment—First, the impact of raindrops shatters surface aggregates and loosens soil particles. Some of the particles float into soil voids, sealing the soil surface so water cannot readily infiltrate the soil. The scouring action of running water also detaches some soil particles.

2. Transport—In this step the detached soil grains move in flowing water and are carried down slopes.

3. Deposition—In this final stage, the soil is deposited when the water slows down.

B. There are four factors that determine how susceptible a soil is to soil erosion. The factors are:

1. Texture and Structure—Soil structure influences infiltration of water. Good soil structure allows water to enter the soil, thus reducing the amount of water runoff. Soil texture has two effects on soil erosion.
    a. Infiltration—Like soil structure, texture also affects the rate at which water can enter the soil. Less water running on the surface of the soil, means less soil can be transported.
    b. Ease of detachment—Soil particles of different sizes vary in how easily they can be detached. Silt particles are the most easily detached.
2. Slope—There are two components that determine slope. They are length and grade.
    a. Water runoff velocity will increase as slope grade increases. This causes an increase in the erosive energy of the runoff water.
    b. On a long slope, a greater surface area is collecting water, increasing flow volume. Running water can also pick up speed as it flows down a long slope.
3. Surface roughness—A rough soil surface slows the downhill flow of water. Surface roughness depends a great deal on the tillage practice used on the land. In conventional tillage, the seedbed is left smooth with very few ridges. Chisel plowing leaves the seedbed rough. Tillage across slopes, or on the ***contour***, also acts to slow water flow.
4. Soil cover—Bare soil is fully exposed to the erosive forces of raindrop impact and the scouring of running water. Soil cover reduces the energy available to cause erosion to the soil. A mulch, cover, or crop residue absorbs the energy of the falling raindrop. This reduces the amount of soil detachment.

There are many techniques that can be used to assist students in mastering this material. Students need text material to aid in understanding the soil erosion process. Chapter 18 in Soil Science & Management is recommended.

Objective 2: Identify the various types of soil erosion.

Anticipated Problem: What are the various types of soil erosion?

II. There are two basic types of soil erosion. They are water erosion and wind erosion.

A. Water erosion—The process of soil erosion as discussed in Objective 1 of this lesson can lead to various types of water erosion.

1. ***Splash erosion*** is the direct movement of soil by splashing. A soil grain can be thrown as far as five feet by a raindrop splash. These splashed particles fill the voids between other aggregates and seal the soil surface.
2. ***Sheet erosion*** is the removal of a thin layer of soil in a sheet. On gentle slopes, or near the tops of steeper slopes, water moves in tiny streams too small to be noticed. Sheet erosion can go unnoticed until the subsoil appears.

3. ***Rill erosion*** causes a series of many small channels on a slope. Water collects in the channels, picking up energy as it runs down the slope. The small channel or ***rill*** is small enough to be filled in by common tillage.
4. ***Gully erosion*** is the most highly visible erosion. Gullies are so large the equipment cannot cross them. Gullies usually begin to form near the bottom of a slope or on steep slopes.

B. Wind erosion—The process followed in wind erosion is very similar to that of water erosion.
   1. The energy is produced by wind blowing across the soil surface instead of water running down a slope.
   2. Wind erosion accounts for about 40 percent of the soil loss in the United States.
   3. Dry areas with high winds are more likely to lose soil due to wind erosion.

There are many techniques that can be used to assist students in mastering this material. Students need text material to aid in understanding various types of soil erosion. Chapter 18 in Soil Science & Management is recommended.

Objective 3: Estimate the amount of soil loss from water erosion.

Anticipated Problem: How do I estimate the amount of soil loss from water erosion?

III. Using various soil loss factors, the ***Universal Soil Loss Equation (USLE)*** has been developed to predict the average soil loss from sheet and rill erosion on a specific site. It was developed over several years by the Natural Resources Conservation Service. Producers can use the equation to estimate the rate of soil loss on their land and compare that rate with soil's T value. ***T value*** is soil loss tolerance value. That is the amount of soil loss that can be tolerated by that soil type. Each soil type has its own T value. The formula for USLE is $A = R \times K \times LS \times C \times P$. Each letter in the formula represents a specific soil loss factor.

A. Average Annual Soil Loss (A)—"A" represents the average annual soil erosion loss in tons per acre. This factor should be less than the T value for the soil type.
B. Rainfall (R)—"R" represents the erosion potential inherent in the rainfall patterns of a particular area. The factors were developed from the U.S. Weather Service data taken over a 22 year period.
C. Soil Erodibility (K)—This factor reflects the fact that various soils erode at different rates because of different physical characteristics, such as texture, structure, organic matter content, and soil depth. Each different soil type has a specific K value.
D. Slope Length and Steepness (LS)—This factor represents the erosion potential for a particular combination of slope length and slope steepness. Slope length is not the distance from the highest point in the field to the lowest. It must be determined where the water will flow. Concentrate on natural water flow areas.
E. Cropping Factor (C)—This reflects the reduction in soil erosion when a specific cropping system is compared with continuous ***fallow*** or where the soil is tilled, but no crop is

grown. The C factor of 1.0 is assigned to continuous fallow. C factors are determined by the climatic conditions of a region, crop rotation used, tillage methods used, and crop residue on the field.

F. Conservation practice (P)—This represents the reduction of soil erosion due to the implementation of various conservation practices such as contour farming, strip cropping, and terracing.

There are many techniques that can be used to assist students in mastering this material. Students need text material to aid in understanding how to estimate the amount of soil loss from water erosion. VAS 4054b Using the Universal Soil Loss Equation to Estimate Soil Loss is recommended. Use TM: C7–3A to discuss the Universal Soil Loss Equation. Obtain the specific soil loss factors for your area and present them to students.

Objective 4: Discuss how to control soil erosion.

Anticipated Problem: How can soil erosion be controlled?

IV. Preventing or stopping soil erosion is a major goal of every producer. Once a producer understands the causes of soil erosion and has estimated the amount of soil loss on his farm, a plan of action must be developed.

A. All methods of controlling water erosion are based on one of the following three actions:

1. Reducing raindrop impact to lessen detachment.
2. Reducing or slowing water runoff. This lessens detachment by scouring and reduces the amount of soil that can be transported.
3. Carrying excess water off the field safely.

B. There are several management practices and tools that a land owner can use to reduce and prevent soil erosion on property.

1. Conservation tillage—***Conservation tillage*** are tillage practices that leave crop residues on a rough soil surface to reduce erosion. These practices dramatically reduce sheet and rill erosion. It is also the lowest cost conservation method per ton of soil saved.
2. Soil cover—Whenever soil is worked or exposed, covering the surface with mulch or vegetation reduces erosion.
3. Crop rotation—This practice reduces erosion if a close-growing crop like small grains or forages are included. These close-growing crops reduce the detachment and transport energy of water. They also improve the physical properties of the soil so that water seeps into the soil better.
4. Grassed waterways—A ***grassed waterway*** is a shallow, sodded, wide ditch that runs down a slope. It is designed to carry excess water off the field safely.
5. Contour tillage—***Contour tillage*** is tillage following the contours of a slope, rather than up and down a slope. This practice works best on permeable soils in areas of low intensity rainfall.

6. Strip-cropping—***Strip-cropping*** is planting different types of crops in alternating strips to prevent wind or water erosion. Strips are usually planted on a slope contour or across the direction of the prevailing wind.
7. Improving organic matter—Improving the organic matter content of a soil can greatly reduce erosion because moisture will enter the soil more quickly.
8. Terraces—***Terraces*** are a series of low ridges and shallow channels running across a slope or on the contour to capture water so it can soak into the soil. ***Level terraces*** parallel the slope and do not empty into a waterway. This is used where soil is permeable enough that water can seep in once it is captured in a terrace. ***Graded terraces*** are needed where water cannot soak in enough. These terraces slope gently towards a waterway or an underground tile outlet.

There are many techniques that can be used to assist students in mastering this material. Students need text material to aid in understanding how to estimate the amount of soil loss from water erosion. Chapter 18 in Soil Science & Management is recommended.

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 determining which objectives need to be reviewed or taught from a different angle. Questions at the end of the textbook chapters may also be used in the review/summary.

Evaluation. Focus the evaluation of student achievement on mastery of the objectives stated in the lesson. Measure student performance on classroom participation, laboratory assignments, and written tests or quizzes.

Answers to Sample Test:

Part One: Matching

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

Part Two: Completion

1. Soil Erodibility (K)
2. Cropping Factor (C)
3. Rainfall (R)
4. Conservation practice (P)

Sample Test Name_____

Test

Lesson C7–3: Calculating Soil Loss

Part One: Matching

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

a. Rill erosion	b. Terraces	c. Conservation tillage
d. Grassed waterway	e. Universal Soil Loss Equation (USLE)	f. Fallow
g. Gully erosion	h. Sheet erosion	

_____ 1. Tillage practices that leave crop residues on a rough soil surface to reduce erosion.

_____ 2. Where the soil is tilled, but no crop is grown.

_____ 3. The most highly visible erosion.

_____ 4. Developed to predict the average soil loss from sheet and rill erosion on a specific site.

_____ 5. A series of low ridges and shallow channels running across a slope or on the contour to capture water so it can soak into the soil.

_____ 6. The removal of a thin layer of soil in a sheet.

_____ 7. A shallow, sodded, wide ditch that runs down a slope.

_____ 8. Causes a series of many small channels on a slope.

Part Two: Completion

Instructions. Provide the letter (or words) to complete the following statements.

1. _____ (_____) factor reflects the fact that various soils erode at different rates because of different physical characteristics, such as texture, structure, organic matter, content, and soil depth.
2. _____ (_____) factor reflects the reduction in soil erosion when a specific cropping system is compared with continuous fallow.
3. _____ (_____) factor represents the erosion potential inherent in the rainfall patterns of a particular area.
4. _____ (_____) factor represents the reduction of soil erosion due to the implementation of various conservation practices

TM: C7–3A

THE UNIVERSAL SOIL LOSS EQUATION

$$A = R \times K \times LS \times C \times P$$

A = the average annual soil loss in tons per acre estimated by the equation.

R = rainfall factor

K = soil erodibility factor

LS = length and steepness of slope factor

C = crop cover and management factor

P = conservation practice factor