UNIT III - SOIL FERTILITY AND MANAGEMENT

Lesson 1: Soil Composition

Competency/Objective: Identify how the composition of soil affects fertility.

Study Questions

1. **What are the components of soil?**

2. **How does soil texture affect water-holding capacity and fertility?**

3. **How does soil pH affect nutrient utilization?**

References

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit III.

2. Minor, Paul E. *Soil Science* (Student Guide). University of Missouri-Columbia: Instructional Materials Laboratory, 1995.

3. Transparency Masters

    a) TM 1.1: Contents of Average Soil
    b) TM 1.2: Pore Spaces in Soil
    c) TM 1.3: USDA Soil Textural Triangle
    d) TM 1.4: Soil pH Governs Nutrient Release

4. Activity Sheet

    a) AS 1.1: Estimating Soil Texture by Feel

UNIT III - SOIL FERTILITY AND MANAGEMENT

Lesson 1: Soil Composition

TEACHING PROCEDURES

A. ***Introduction***

Given the fact that it takes a thousand years for a single inch of soil to form, the efforts to conserve and protect soil are vital to crop production. This unit will review key factors of soil (composition, types and limitations, testing, fertilizers, cultural and conservation practices) in relation to fertility and management for crop production.

B. ***Motivation***

1. Perform a soil test analysis by filling a tall, narrow jar half full of soil. Add a small amount of dishwashing detergent and enough water to fill the jar to within a half inch of the top. Shake the jar vigorously. Let the soil settle and observe which particles settle first. Let the jar set overnight undisturbed. Check to see if layers of sand, silt, clay, and organic matter can be observed. Measure the thickness of each layer. Calculate the percentage of sand, silt, and clay. Use TM 1.3 to determine the textural class of the soil in the jar.

2. Demonstrate water-holding capacity by relating to students that the more surface area a soil has, the more water it can hold. Use a sponge, 6 inches long x 3 ½ inches deep. (1) To relate that a clay soil can hold more water because it has more surface area, soak the sponge until it is completely full. Hold the sponge flat and tell the students that clay has the smaller of the soil particles and that each little particle adds to the total surface area. The flat side of the sponge will be the clay and it holds "X" amount of water. (2) Then by turning the sponge on its side, the surface area decreases and the sponge cannot hold the water and it will readily drip out. This would be like a silt type of soil. (3) Finally, turn the sponge on its end edge and the water will stream out. The surface area is dramatically decreased and it cannot hold the water; it drains through quickly. This is an example of typical sandy soil. (It may be more effective to use three separate sponges, or if one sponge is used, resaturate it before each step of the demonstration.)

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Soil is a living, naturally occurring system at the interface of air and rock. It is comprised of minerals, organic matter, water and air. Soil is continually changing thanks to the effects of sun, rain, and temperature fluctuations. Review soil formation by using the definition of soil and discussing the natural process by which it occurs. Discuss the four components of soil using Motivation #1. Review the particle sizes of each soil mineral, stressing the difference of the size of the pores surrounding each. Use TM 1.1 and TM 1.2.

What are the components of soil?

a) Soil components
   1) Mineral matter - 45%
   2) Organic matter - 5%
   3) Water and air - 50%
      (a) Each contribute approximately 25%, depending on how wet the soil is at the time.
      (b) When water is added to soil, the air is driven out.

(c) As soil dries out, it contains more air.

b) Mineral matter
   1) Inorganic material (rock)
   2) Consists of three particles
      (a) Sand - .05 mm to 2 mm
      (b) Silt - .002 mm to .05 mm
      (c) Clay - less than .002 mm
   3) Combination of particles determines soil's ability to hold water and nutrients

c) Organic matter
   1) Dead and decaying plant and animal material
   2) Sources
      (a) Mostly from plant leaves, roots, and stems
      (b) Biosolids (sewage sludge)
      (c) Green manure crops such as alfalfa
   3) Provides essential nutrients for plant growth

d) Water
   1) Maintains plant life
   2) Primary functions
      (a) Provide solution for plants to take up nutrients
      (b) Dissolve soil minerals
      (c) Moisten roots
   3) Types of soil water
      (a) Gravitational - percolates down through soil through pore spaces; ground water
      (b) Capillary - held above water table by adhesion of soil particles; most readily available
      (c) Hygroscopic - thin film around individual particles; exists in driest soils; unavailable for plant use

e) Air
   1) Provides carbon dioxide and oxygen for photosynthesis and respiration
   2) Moves in and out of soil providing healthy root growth
      (a) Fills pore spaces after water drains away
      (b) Occupies most of pore spaces in dry, arid, sandy soils
      (c) Is absent in water-holding clay soils or flooded fields, reduces plant growth
   3) Balance of air and water in soil best for plants

2. Explain that the texture of a soil is determined by the amounts of sand, silt, and clay it possesses. Review how soil is classified using TM 1.3: USDA Soil Textural Triangle. Illustrate how soil particles hold water on their surfaces using Motivation #2. Continue discussion on how water-holding capacity and soil fertility are affected by various soil textures. For further information on determining soil texture, refer to Chapter 4 of IML's *Soil Science Student Guide*. Have students complete AS 1.1.

How does soil texture affect water-holding capacity and fertility?

a) Soil texture
   1) Soil texture is a proportion of sand, silt, and clay in the soil.
   2) Pore space affects air and water-holding capacity and water movement.

b) Sandy or coarse-texture soils
   1) Large pore spaces
   2) Low water-holding capacity
   3) Less fertile, nutrients pass through quickly

c) Clay or fine-textured soils
   1) Small pore spaces
   2) High water-holding capacity - lack of aeration
   3) Swelling pores - water tightly held
   4) Less fertile, nutrients not easily available

d) Silty or medium-textured soils
   1) Combination large and small pore spaces
   2) Best water-holding capacity
   3) More fertile, nutrients gradually absorbed

3. Explain the pH scale and what is considered acidic or alkaline (basic). Review soil pH: its importance, how it is determined, how soils become acidic, and how they can be corrected. Refer the students to the pH scale in the Student Reference and use TM 1.4. Review cation exchange capacity of soil.

How does soil pH affect nutrient utilization?

a) Soil pH is a measure of acidity or alkalinity of the soil.
   1) Scale ranges from 0 to 14.
      (a) 7 is neutral (equal ions).
      (b) 0 - 6.9 is acidic (low pH).
      (c) 7.1 - 14 is alkaline (high pH).
   2) Missouri soils average 4.5 - 8.4 pH.
b) Soil has an ability to release important nutrients.
   1) CEC - Positive ions attracted to negative soil particles (clay) can be replaced by other positive ions in soil water such as K+, Ca+2, Mg+.
   2) CEC is determined by soil test.
c) Soil pH affects CEC.
   1) Acidic or alkaline soils unable to release nutrients have low CEC.
   2) Acidity is caused by leaching or absorption of base nutrients by plants.
   3) Soil pH should match the crops' need to maximize nutrients.
   4) Soil pH can be raised by applying lime.
d) Crops have preferred pH level.
   1) Most prefer pH range of 5.0 - 7.5.
   2) Legumes require pH of 6.8 - 7.3.
   3) Corn, small grains, and grasses prefer pH of 6.0 - 6.8.
   4) Soil tests determine the pH level needed for crops.

F. ***Other Activity***

View the video, *How Water Moves Through Soil*, available for free loan from the MRCCTE at the University of Missouri-Columbia.

G. ***Conclusion***

Knowing about the texture and pH of soil can help us in our efforts to conserve and protect this natural resource. By increasing our knowledge still further, we can likewise increase crop yields and plant survival rates.

H. ***Answers to Activity Sheet***

Answers will vary depending on the results of the experiment.

I. ***Answers to Evaluation***

1. Mineral matter, water, air, and organic matter
2. b
3. c
4. a
5. b
6. a
7. c

8. c
9. a
10. b
11. d
12. b

UNIT III - SOIL FERTILITY AND MANAGEMENT Name_____

Lesson 1: Soil Composition Date_____

EVALUATION

Complete the following short answer question.

1. What are the four components of soil?

   a.

   b.

   c.

   d.

Match the characteristic on the left with the correct soil texture on the right.

2. _____Low water-holding capacity
3. _____High water-holding capacity
4. _____Best water-holding capacity
5. _____Large pore spaces
6. _____Mixture of pore spaces
7. _____Small pore spaces
8. _____Nutrients tightly held
9. _____Nutrients absorbed gradually
10. _____Nutrients pass through quickly

a. Silty soils
b. Sandy soils
c. Clay soils

Circle the letter that corresponds to the best answer.

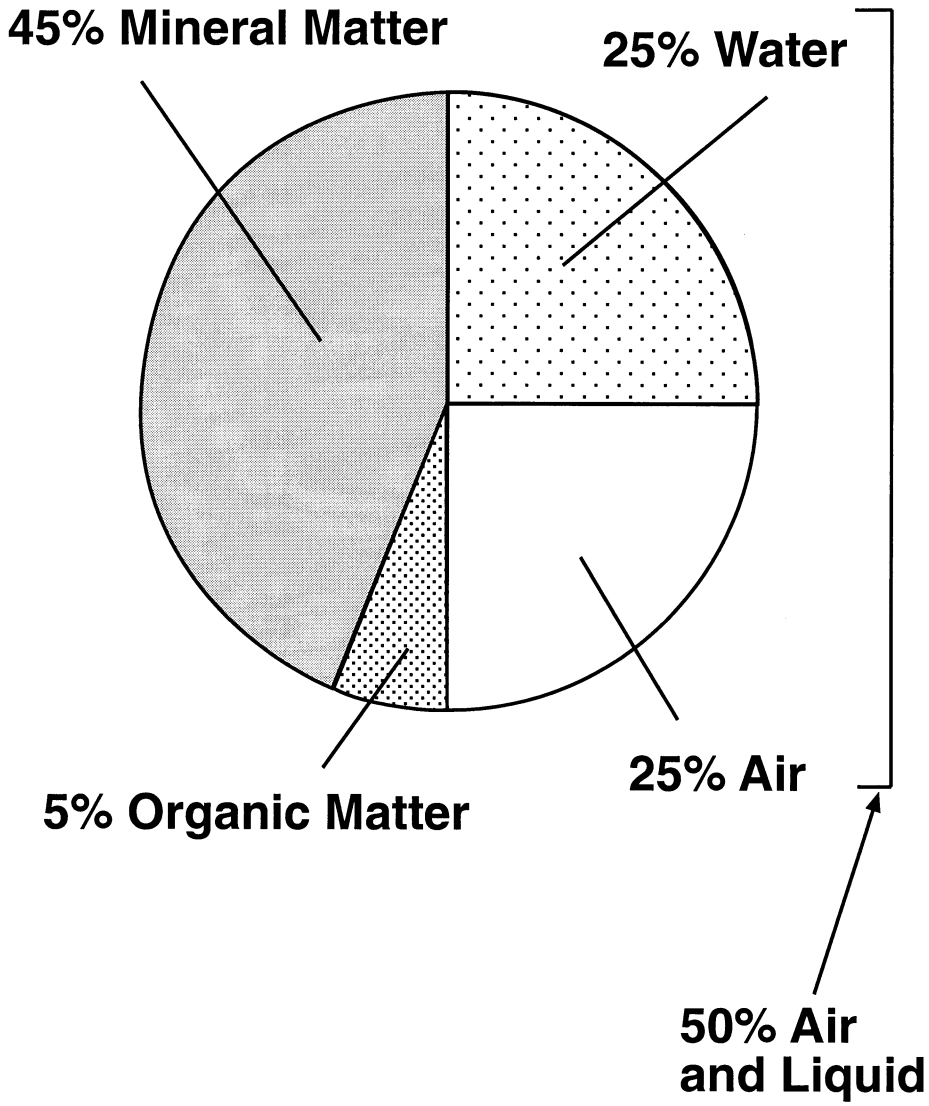
11. Which of the following pH values is considered alkaline?

    a. 3.5
    b. 6.8
    c. 7.0
    d. 8.6

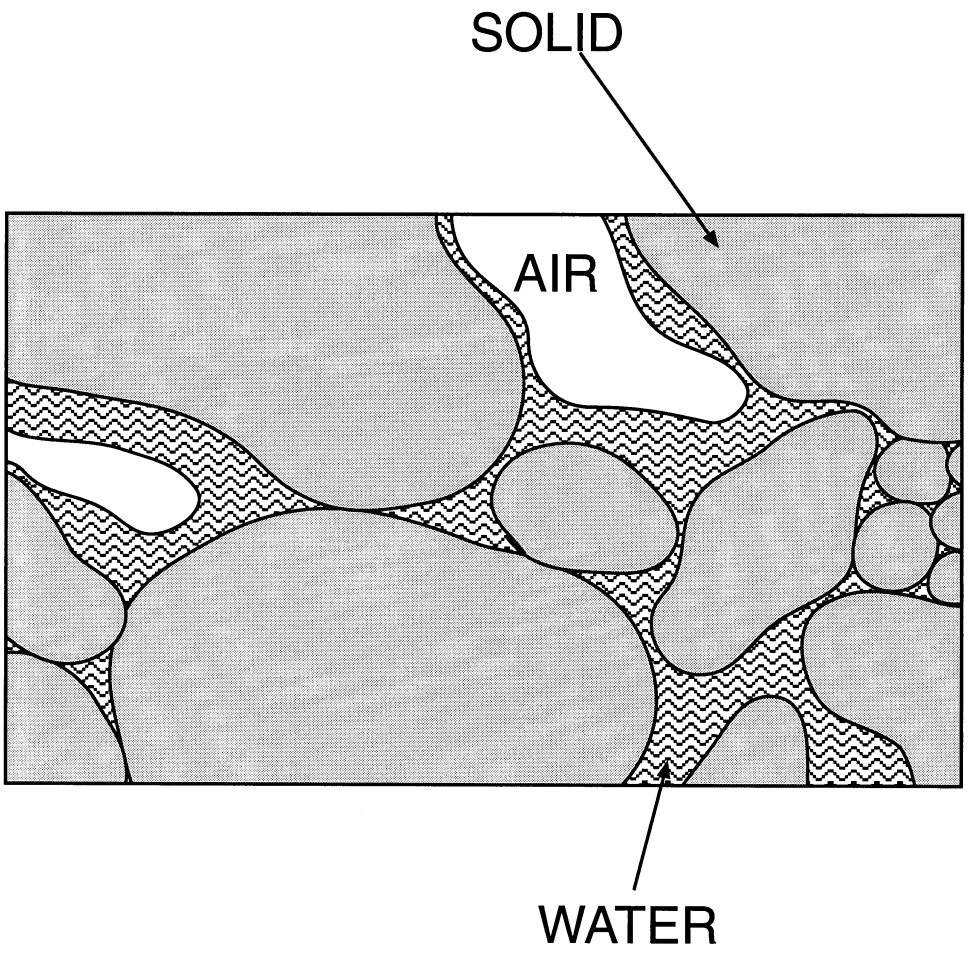
12. The depletion of which nutrient is the greatest cause for increased acidity?

    a. Potassium
    b. Calcium
    c. Magnesium
    d. Nitrogen

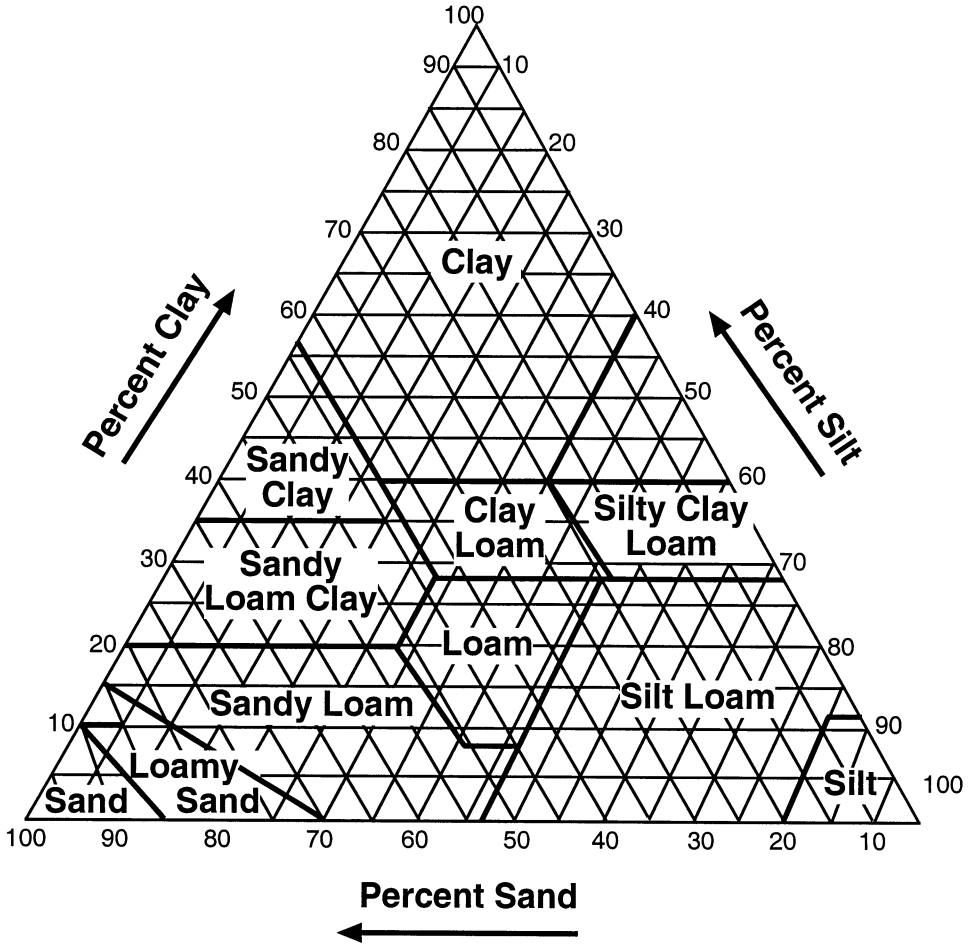
Contents of Average Soil



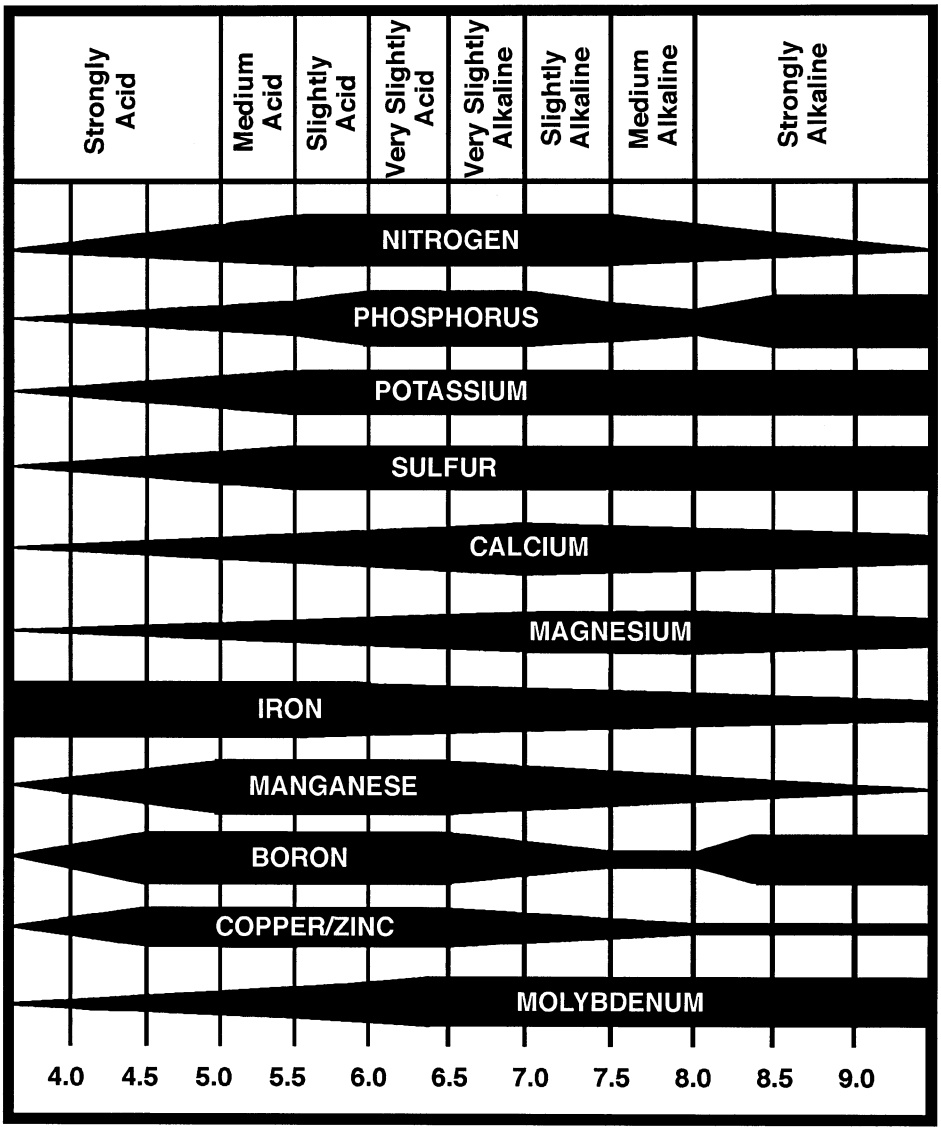
Pore Spaces in Soil



USDA Soil Textural Triangle



Soil pH Governs Nutrient Release



Soil pH Governs Nutrient Release
Acidity or alkalinity (pH) controls relative to nutrient availability.

Lesson 1: Soil Composition Name_____

Estimating Soil Texture by Feel

Objective: Students wil estimate the amount of sand, silt, and clay in a soil sample and determine the soil texture.

Procedures:

1. Fill the palm of your hand with dry soil.
2. Moisten the soil enough so that it sticks together and can be worked with the fingers. Do not saturate it to a runny mud. If the soil sticks to your fingers, it is too wet to texture. Add more dry soil.
3. Knead the soil between your thumb and fingers. Take out the pebbles and crush all the soil together. You may need to add a little more water. Continue working the soil until entirely mixed.
4. Estimate the **sand** content by the amount of textural grittiness you feel.
   a. More than 45% sand - Sand dominates. The textural name contains the word *sand* or s*andy*.
   b. 20-45% sand - Sand is noticeably present but not dominant. The texture is most likely *loam* or *clay loam*, though *silt loam* or *clay* is possible.
   c. Less than 20% sand - Silt and clay dominate. The textural name is *silt loam*, *silty clay loam*, or *clay*.
5. Estimate the **clay** content by the size of the soil ribbon formed by pushing the sample up between your thumb and index finger.
   a. Clay is less than 27%. A ribbon is not present or it is less than 1 inch long. Textural names contain the word *loam* but not the word *clay*.
   b. Clay is 27-40%. The ribbon is 1 - 2.5 inches long. Textural names contain both the words *clay* and *loam*.
   c. Clay is more than 40%. Clay dominates. The ribbon is more than 2.5 inches long. Textural name contains the word *clay* but not the word *loam*.
6. Combine your estimates of sand and clay to determine soil texture.

Answer the following questions.

1. What was your sand content estimate?
2. What was your clay content estimate?
3. Using these estimates and the table at the right, list the texture of the soil sample.

		SAND		
		>45	20-45	<20
CLAY	>40	Sandy Clay	Clay	Silty Clay
	27-40	Sandy Clay Loam	Clay Loam	Silty Clay Loan
	<27	Sandy Loam Loamy Sand Sand	Loam	Silt Loam

UNIT III - SOIL FERTILITY AND MANAGEMENT

Lesson 2: Soil Types and Limitations

Competency/Objective: Identify how soil morphology affects cropping options.

Study Questions

1. **Using a county soil survey book, how are local soil types identified?**

2. **What are the limiting factors for crop selection and growth?**

References

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit III.

2. *Soil Survey of (your county), Missouri.* U.S. Department of Agriculture Soil Conservation Service, Missouri Agricultural Experiment Station.

3. Transparency Master

    a) TM 2.1: Sample Survey Map and Soil Legend

4. Activity Sheet

    a) AS 2.1: Identify Soil Types by Using Soil Survey

UNIT III - SOIL FERTILITY AND MANAGEMENT

Lesson 2: Soil Types and Limitations

TEACHING PROCEDURES

A. ***Review***

A county soil survey book is an important guide for determining soil types and limitations. Information provided in these books can help producers make decisions on site acquisitions, cropping options, location of land and building structures, and land improvements.

B. ***Motivation***

Have students use the local county soil survey book to identify the soil type(s) of their family farm, a relative's or friend's farm, or that of another county resident's farm. Use TM 2.1 to show an example of a soil survey map and how the soil legend details the types of soils found in that particular area.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. *Explain the term soil morphology. Discuss the history and importance of using soil surveys. Soil* survey books contain important information applicable in managing farms, ranches, and woodlands. Information includes recommendations for selecting sites for roads, ponds, buildings, and other structures, as well as procedures for determining the suitability of land tracts for farming, industry, and recreation. Explain how to interpret a soil survey book. Refer to TM 2.1 for an example of a survey map and corresponding soil legend.

Using a county soil survey book, how are local soil types identified?

a) County soil survey books to classify, map, and interpret Missouri soils
   1) Chemical and physical properties of county soil types
   2) Listed by national classification system
   3) Interpreted for agricultural, engineering, recreational, and urban uses

b) Surveys to be made by soil scientists
   1) Examine aerial photographs.
      (a) Determine relationships among soil colors, native vegetation, and topography.
      (b) Characteristics of soils help predict locations of different soils.
   2) Walk the landscape to gather additional specific data.

c) Contents of survey maps
   1) Road boundaries, water features, township sections, and cultural features (schools and farmsteads)
   2) Information about each soil - interpretations for best use and management practices
   3) Free to state residents from local soil and water conservation district offices or the state NRCS office

d) Procedure to determine soil type
   1) Select a field, farm, or a homestead to research.
   2) Identify the township section number where the field, farm, or homestead is located.
      (a) Use the Index to Map Sheets found in the center of the book.
      (b) Sectioned and numbered townships correspond to soil survey sheets (aerial view of each township).
   3) Identify the soil type symbol(s) on soil survey sheet for the selected location.

(a) Symbol explanations are in the Index to Map Units found in the front of the survey book.
(b) Symbols may also be on the back of the Index to Map Sheets page.

4) Information on general soil associations for the county is in the color-coded General Soil Map adjacent to the Index to Map Sheets page.
   (a) Soil association groups have distinctive pattern of soils, drainage, and relief.
   (b) Descriptions of each group are found in General Soil Map Units section.
      (1) Provides information useful in planning the use and management of large areas
      (2) Explains soil classification of each soil type in the association group
5) Refer to Detailed Soil Map Units section for descriptions of each county soil type and to determine the suitability and potential use of a soil.
6) Tables section shows data on specific land use for each soil type.
7) Remaining information in the book reviews general and historical information on the county.

2. Limiting factors are soil properties that limit a soil from producing productive crops. Review the limiting factors found on Table 2.1 in the Student Reference for crop selection and growth. Additional limiting factors may be associated with specific soils. (For a more extensive explanation of soil erosion, see Lesson 6 of this unit.)

What are the limiting factors for crop selection and growth?

a) Slope
   1) Incline of the land
   2) Percentage of slope - vertical distance ÷ horizontal distance x 100
      (a) Less than 3% is considered an asset.
      (b) Over 3% is considered a liability.
   3) Characteristics
      (a) Gradient - steepness of the land surface (operation of farm equipment and irrigation more difficult on steeper slopes)
      (b) Length - affects erosion (Long slope allows runoff water to gather more volume as it flows over the surface increasing erosion.)
      (c) Shape - affects erosion (classified as linear, concave, or convex)
      (d) Aspect - refers to the effects of temperature and sun exposure on the soil; depends on compass direction
b) Erosion
   1) Wearing away of the land surface by water, wind, ice, or other geological agents
   2) Types of water erosion
      (a) Sheet - the detachment of soil particles by flowing water; usually caused when rain hits wet soil
         (1) Particles are detached and can float into rills and gullies.
         (2) Particles are transported into low places or off fields.
      (b) Rill - small steep-sided channels where runoff water concentrates
      (c) Gully - miniature valleys where water usually runs
         (1) Only after rainfall
         (2) An obstacle to farm machinery
c) Available water capacity (AWC)
   1) Soil's capacity to hold water
   2) Commonly expressed as inches of water per inch of soil
   3) Soils with low or very low available water-liability
d) Surface drainage
   1) Runoff, or surface flow of water from an area
   2) Needed on all poorly drained soils regardless of their classification
      (a) Soils that are nearly level in slope with depressional areas
      (b) Soils on sloping areas below seepy areas
e) Internal drainage (depth to high water table)

1) This is the rate at which internal free water leaves the soil to allow aeration.
2) Gravitational water must move out of the profile quickly so the roots can obtain adequate aeration.
3) Classified on seven levels
   (a) Excessive
   (b) Somewhat excessive
   (c) Well
   (d) Moderately well
   (e) Somewhat poorly
   (f) Poorly
   (g) Very poorly

f) Rock fragments
1) Rock or mineral fragments with a diameter of 2 mm or more such as gravel, cobbles, or boulders
2) Affect amount of irrigation water the soil can absorb

g) Stoniness
1) Soil in which rock fragments 10 to 24 inches (25 – 60 cm) in diameter are exposed at the surface
2) Evaluated according to the percentage of the soil surface covered by detached stones
3) Interferes or even inhibits tillage
4) Five general classes
   (a) Not stony
   (b) Stony
   (c) Very stony
   (d) Extremely stony
   (e) Rubbly

(Refer to IML's Soil Science Guide*, Chapter 11, for a review of these classes.)*

F. *Other Activity*

Assess the overall capability of the land in your area. Get an aerial photograph from the local U.S. Department of Agriculture office. Determine the slope, surface texture, depth, and other features of fields identified on the map. Occasionally, the office may have a soil scientist or conservationist who can help with this project. Prepare a bulletin board that shows what you have found.

G. *Conclusion*

Students with an accurate understanding and comprehension of the various soil types may find themselves competing in soil judging contests. Other than winning prizes and securing titles, however, knowing the various soil types and classifications can be useful in making land use decisions.

H. *Answers to Activity Sheet*

The answers will vary depending on the specific location of the area to be researched.

I. *Answers to Evaluation*

1. b
2. d
3. a
4. c
5. c
6. g
7. f
8. a
9. d

10. b
11. e
12. Gradient, length, shape, aspect
13. Sheet, rill, gully

UNIT III - SOIL FERTILITY AND MANAGEMENT Name _____

Lesson 2: Soil Types and Limitations Date _____

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which section in the soil survey book is color coded and divided into groups of soil associations in the survey area?

   a. Index to Map Sheets
   b. General Soil Map
   c. Detailed Soil Map
   d. Tables

2. Which section in the soil survey book gives data regarding specific land uses for each detailed soil map unit?

   a. Index to Map Sheets
   b. General Soil Map
   c. Detailed Soil Map
   d. Tables

3. Which section in the soil survey book shows the townships sectioned and numbered?

   a. Index to Map Sheets
   b. General Soil Map
   c. Detailed Soil Map
   d. Tables

4. Which section of the soil survey book contains soil descriptions for the soil associations and explains the soil classification of each soil type?

   a. Index to Map Sheets
   b. General Soil Map
   c. Detailed Soil Map
   d. Tables

Match the definition in the left column with the term In the right column.

5.	_____ Soils capacity to hold water	a.	Slope
6.	_____ 25 - 60 cm in diameter	b.	Erosion
7.	_____ 2 mm in diameter	c.	Available water capacity
8.	_____ Inclination of the land surface	d.	Surface drainage
9.	_____ Runoff from an area	e.	Internal drainage
10.	_____ Wearing away of land surface	f.	Rock fragments
11.	_____ Depth to high water table	g.	Stoniness

Complete the following short answer questions.

12. What are four slope characteristics?

    a.

    b.

    c.

    d.

13. What are the three main types of erosion?

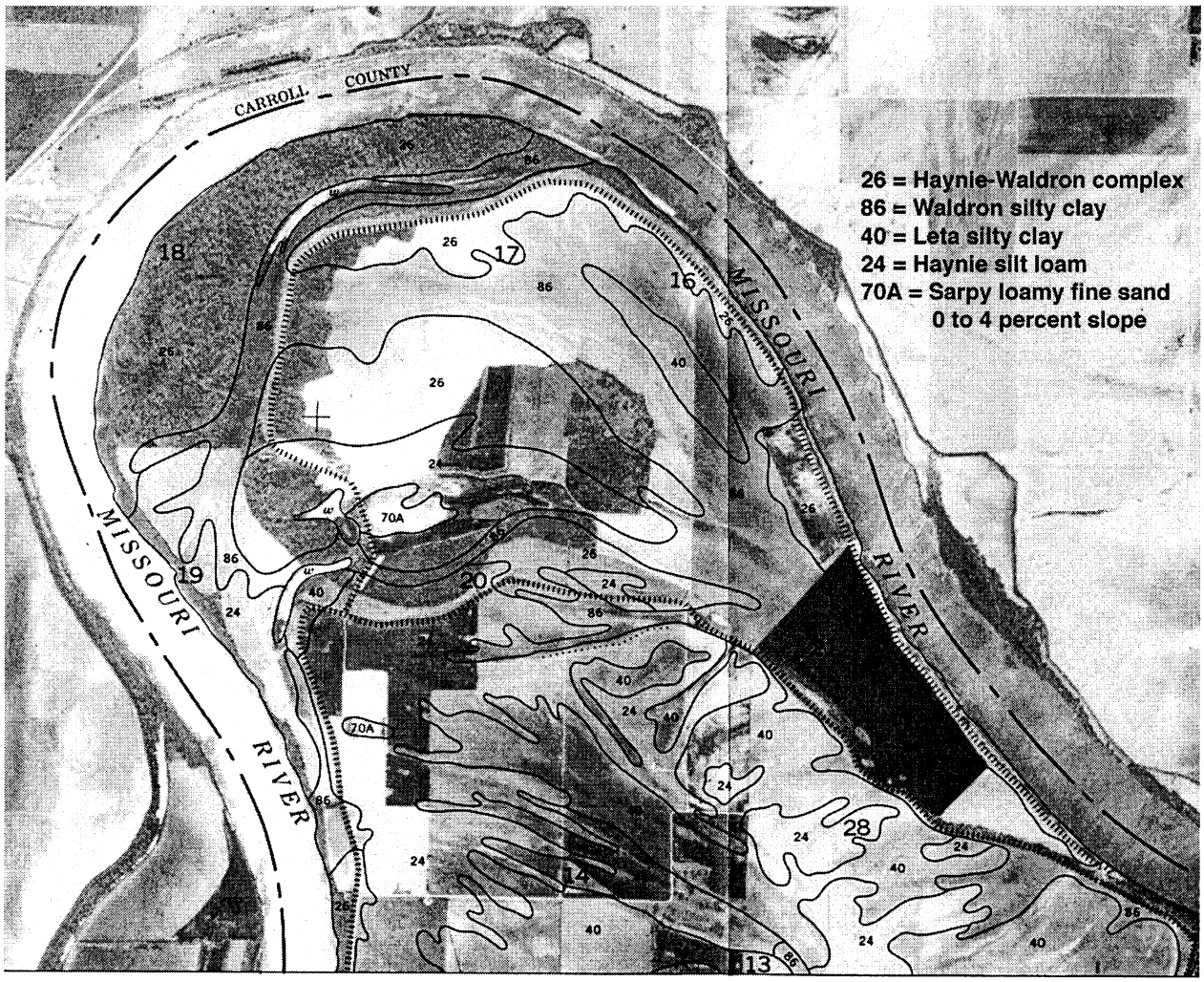
    a.

    b.

    c.

TM 2.1

Sample Survey Map and Soil Legend



Lesson 2: Soil Types and Limitations Name_____

Interpreting Soil Survey Books

Objective: Students will become familiar with understanding and interpreting soil survey maps and guides.

Directions: Using a soil survey book provided by your instructor, answer the following questions. This activity may be completed individually or as a group.

Procedures:

1. Locate the area being researched on the Index to Map Sheets page. What is the township section number for the area to be researched?

2. Find the location of the researched area on the survey map that corresponds to the township number above. Write down the symbols and codes located for this area. Refer to the *Index to Map Units* in the front of the survey book and list what each symbol or code means and on what page detailed information can be located.

3. Turn to the Detailed Soil Map Units section of the soil survey book and use this information to determine what crop or crops will be productive in this area. Summarize the information in paragraph form listing any limitations.

UNIT III - SOIL FERTILITY AND MANAGEMENT

Lesson 3: Soil Testing

Competency/Objective: Use soil test results to improve soil fertility and crop production.

Study Questions

1. **What techniques should be used to obtain a representative soil sample?**

2. **Where can soil samples be tested?**

3. **What are the key parts of a soil test report?**

4. **How are soil test results interpreted?**

References

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit III.

2. University of Missouri Outreach and Extension Publications. These are available on the Internet at <http://muextension.missouri.edu/xplor>.

   a) G9102 - *Liming Missouri Soils*
   b) G9110 - *How to Get a Good Soil Sample*
   c) G9111 - *Using Your Soil Test Results*

3. Transparency Masters

   a) TM 3.1: Field Diagram for Soil Sampling
   b) TM 3.2: Field Sampling Pattern
   c) TM 3.3: Sampling Soil for Satellite Technology
   d) TM 3.4: Results of GPS Soil Sample
   e) TM 3.5: Soil Test Report

4. Activity Sheets

   a) AS 3.1: Interpreting Soil Test Results
   b) AS 3.2: Collecting a Soil Sample

UNIT III - SOIL FERTILITY AND MANAGEMENT

Lesson 3: Soil Testing

TEACHING PROCEDURES

A. ***Review***

As discussed in the last lesson, a soil test report is important basic knowledge about a producer's field. However, a soil report is nearly useless if the producer does not know how to use it completely or does not know what it means. This lesson will further address interpreting soil reports and incorporating their information into production techniques.

B. ***Motivation***

1. Obtain soil samples from several students' farms or yards and have them tested prior to the lesson. Make multiple copies of the soil test report for all students to evaluate.

2. Arrange for students to visit a nearby soil testing laboratory.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Discuss the importance of why a soil sample should be taken from several locations in the given area to be tested. Soil properties can vary even over short distances. The size of the area to be tested will depend on the uniformity of the soil. Refer to the University of Missouri Extension Guide G9110 *How to Get a Good Soil Sample*. To do AS 3.2, a copy of the Soil Sample Information form from University Outreach and Extension will be needed. This is available from a local county extension office or on the Internet at <http://www.soiltest.psu.missouri.edu/>. Also use TMs 3.1, 3.2, 3.3, and 3.4 to show the methods of soil sampling.

   What techniques should be used to obtain a representative soil sample?

   a) Traditional soil sampling
      1) Area to be tested should be 20 acres or less.
      2) Take samples from different soil type areas.
      3) Special areas should be tested.
         (a) Where different crops have grown
         (b) Varying soil surface texture
         (c) Eroded and wet production areas
      4) Avoid taking samples from areas that are not representative of the entire field.
         (a) Driveways
         (b) Dead furrows
         (c) Road edges
         (d) Old barn lots
         (e) Severely wet or eroded areas where production is not feasible
      5) An average of 15 to 20 samples is recommended from each soil type or special area to determine average fertility of the field.
      6) Sample from top 7 inches of top soil should be prepared and taken to testing facility.
   b) Sampling soil for Global Positioning Systems (GPS)
      1) Mapping software divides the field into sectors, or grids.
      2) A typical sector is 2 1/2 acres.

3) One sample, which consists of 8 to 10 core samples 5 to 10 feet apart, is taken every 2 1/2 acres.
4) Track exact location of soil samples to correspond with location on mapping software.

c) Comparison of traditional sampling method with GPS method
1) Comparison of same 20-acre plot could vary tremendously.
2) Traditional soil sample would show same results throughout the plot.
3) GPS sample may show variances for each sector throughout the plot.

2. Discuss possible locations where soil samples can be evaluated. Stress that all recommendations should be made by the local University Extension Center or an independent laboratory to confirm validity.

Where can soil samples be tested?

a) University Extension Center soil testing laboratory
b) Fertilizer dealers
c) Private soil testing laboratories
d) Testing for acidity levels
1) Salt pH measurement - used by University of Missouri Soil Testing Service
2) Water pH measurement - 0.5 unit higher than salt pH reading

3. Discuss the importance of determining the appropriate fertilizer rates for a field, garden, or lawn. Failure to sample soils before planting could lead to over- or underfertilization, which reduces income and net returns and can have a negative impact on the environment. Discuss an actual soil test from a crop field. (Show TM 3.1.)

What are the key parts of a soil test report?

a) Field information
1) Field name
2) Sample number
3) Acres in the field
4) Last crop planted
b) Soil test information
c) Rating
d) Nutrient requirements
1) Cropping options
2) Yield goal
3) Pounds per acre
e) Limestone suggestions
f) Special notes

4. Explain each section of a soil test report in detail. Refer to the University of Missouri Extension Guides G9111 *Using Your Soil Test Results* and G9102 *Liming Missouri Soils* for more detailed information. Use TM 3.1 to interpret the results of the soil test or use soil test reports from local farms.

How are soil test results interpreted?

a) Field information section identifies which field was tested.
b) Soil test information gives suggested fertilizer and limestone treatments.
1) Salt pH
2) Phosphorus
3) Potassium
4) Calcium
5) Magnesium

6) Sulfur
7) Zinc
8) Iron, manganese, and copper
9) Organic matter
10) Cation exchange capacity

c) Rating indicates probability of a yield increase from fertilizer application.
d) Nutrient requirements provide fertility management practice answers.
1) Cropping options
2) Yield goal
3) Pounds per acre
e) Limestone suggestions indicate amount of limestone needed to raise pH level to optimal level desired.
f) Special notes aid in interpreting the test results and list additional recommendations.

F. ***Other Activity***

Organize a soil judging team. Practice judging soil near your school and at nearby schools. The local Natural Resources and Conservation Service (NRCS) office may help. In some cases, the local soil and water conservation district can help.

G. ***Conclusion***

The information available in a soil report is worth the cost of the service. By following a soil report, a producer can make intelligent decisions about the types of plants most likely to thrive in a specific field and is able to make informed decisions on the amount and types of fertilizer to add to the field.

H. ***Answers to Activity Sheet***

AS 3.1

1. Soybeans
2. 428 lb.
3. High
4. 6.3
5. Yes
6. Phosphorus, 86 lb.
7. 16.6 meq/100 g
8. Corn (grain), soybeans, and wheat
9. 60 bu./acre, 95 lb.
10. Phosphorus and potassium

(Note: These answers are from the example soil test report in the text. Answers will differ if local soil test reports are used.)

I. ***Answers to Evaluation***

1.
a) Area tested should be 20 acres or less.
b) Take samples from different soil type areas.
c) Special areas should be tested such as different crop areas, areas with varying soil surface texture, and wet and eroded production areas.
d) Avoid taking samples from areas that are not representative of the entire field such as driveways, dead furrows, road edges, old barn lots, and severely wet and eroded areas not in production.

2. Answers should include two of the following: University Extension soil laboratory, fertilizer companies, independent soil testing laboratories.

3.

a) Field information
b) Soil test information
c) Rating
d) Nutrient requirements
e) Limestone suggestions
f) Special notes

4. d
5. e
6. a
7. b
8. c

UNIT III - SOIL FERTILITY AND MANAGEMENT Name_____

Lesson 3: Soil Testing Date_____

EVALUATION

Complete the following short answer questions.

1. What factors or techniques should be considered in obtaining a representative soil sample using traditional methods?

   a.

   b.

   c.

   d.

2. List two locations where soil samples can be evaluated.

   a.

   b.

3. List the six key components of a soil test.

   a.

   b.

   c.

   d.

   e.

   f.

Match the following terms in the right column with the definition in the left column.

4. _____ Indicates the level of active soil acidity.
5. _____ Expressed in pounds of elemental P per acre.
6. _____ Used to calculate CEC.
7. _____ Expressed as pounds of exchangeable K per acre.
8. _____ Used to estimate potential hydrogen release.

a. Calcium

b. Potassium

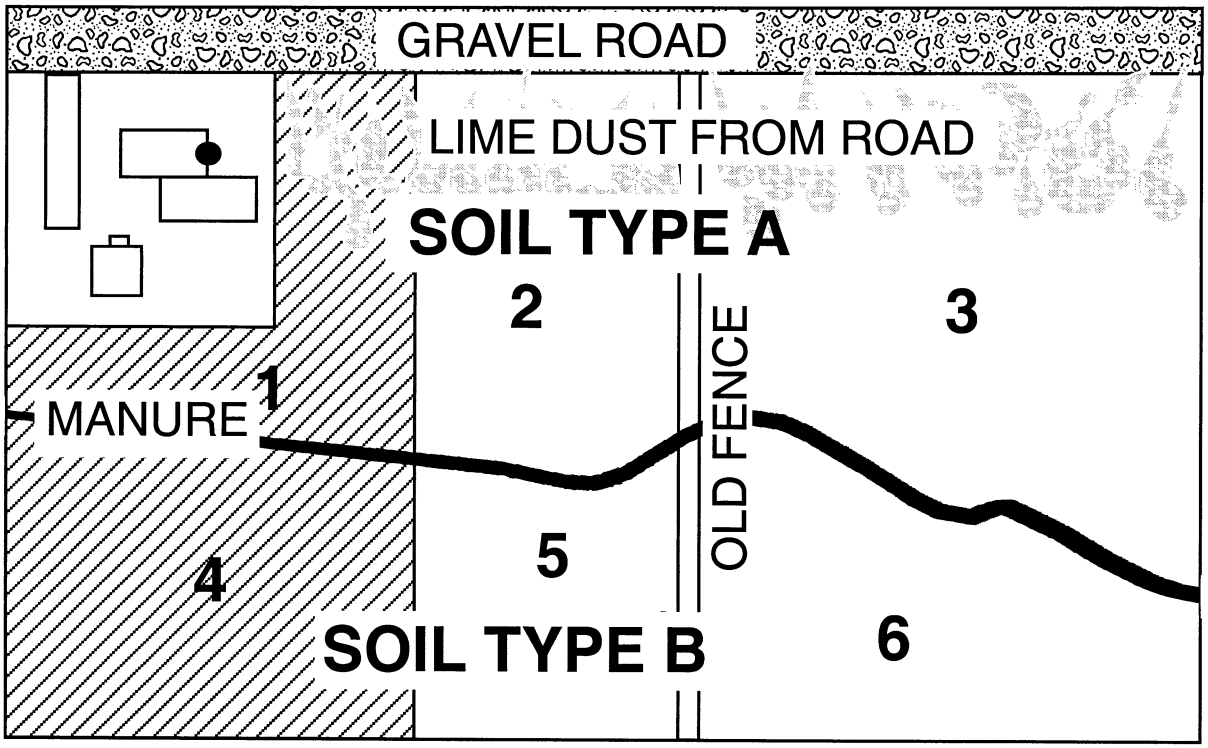
c. Organic matter

d. Salt pH

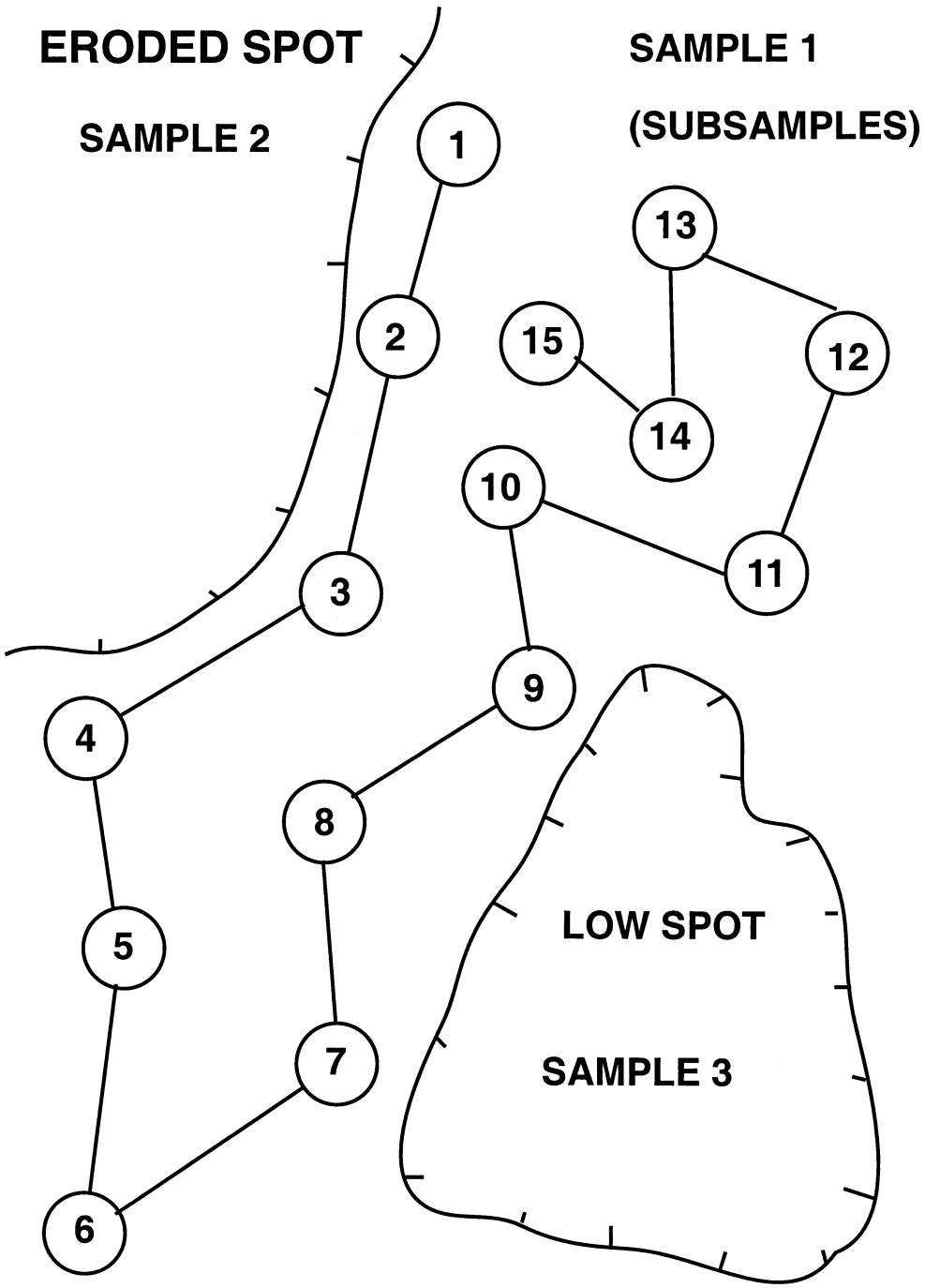
e. Phosphorus

TM 3.1

Field Diagram for Soil Sampling

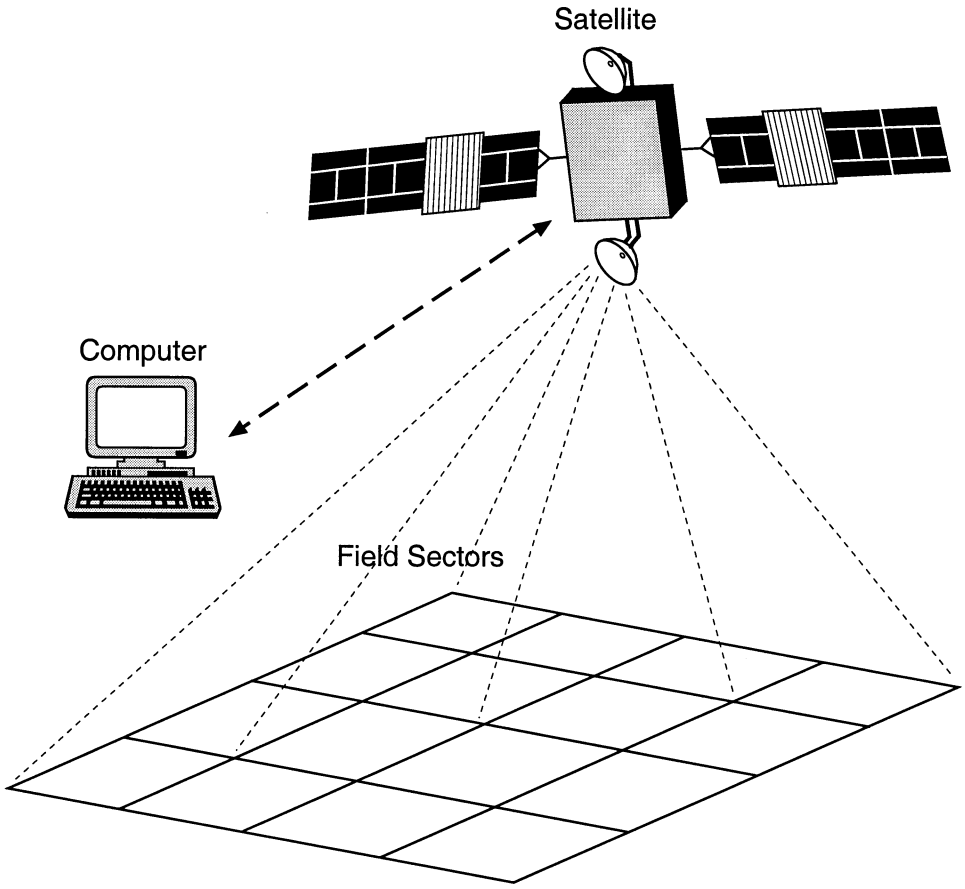


Field Sampling Pattern

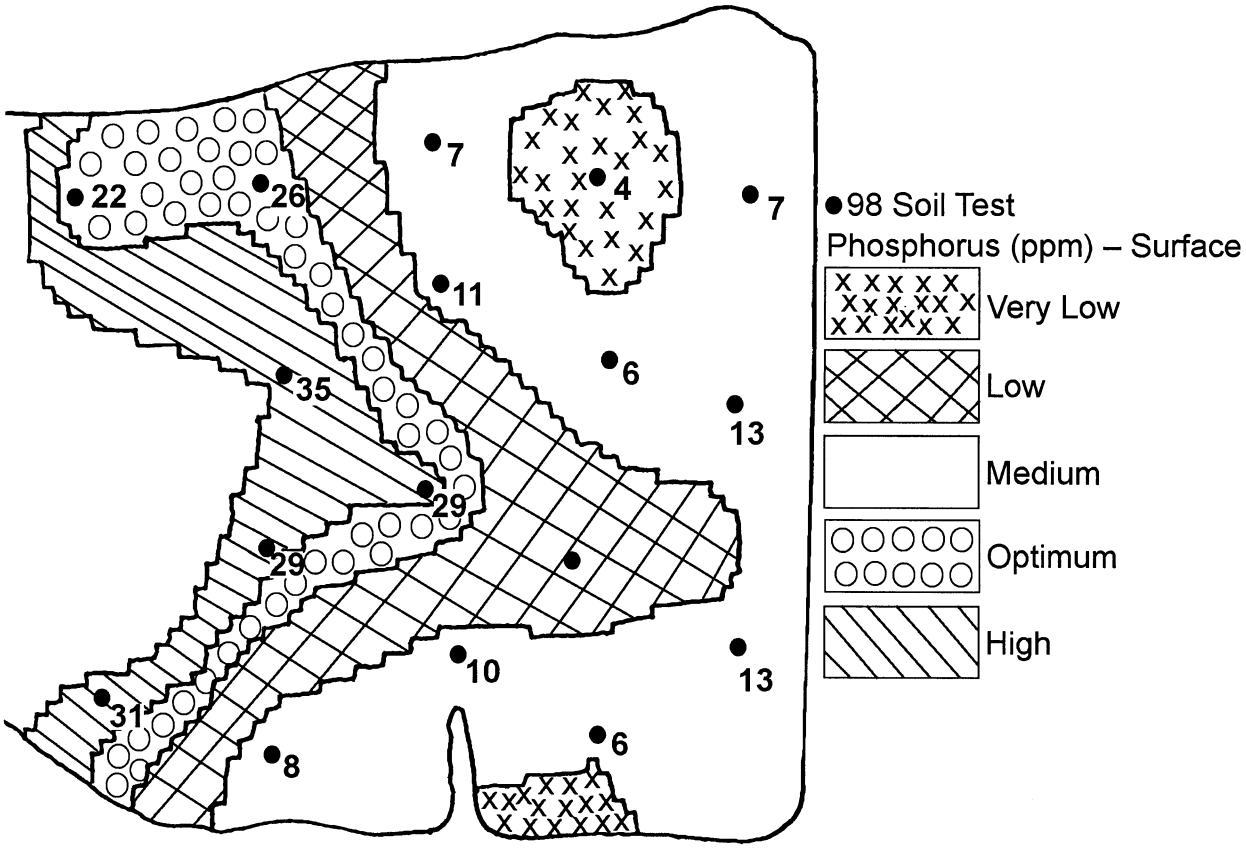


TM 3.3

Sampling Soil for Satellite Technology



Results of GPS Soil Sample



Soil Test Report

OUTREACH & EXTENSION
UNIVERSITY OF MISSOURI
LINCOLN UNIVERSITY

Soil Test Report

Soil Testing Laboratory
23 Mumford Hall, MU
Columbia, MO 65211
Phone: (573) 882-0623

or

Soil Testing Laboratory
P.O. Box 160
Portageville, MO 63873
Phone (573) 379-5431

Serial no. P9039	Lab no. 18793
Area 15	County 010 Region 3
Submitted 11/18/98	Processed 11/24/98

Soil sample submitted by:

FIELD INFORMATION		
Field ID A1 SOIL	Sample no. 1	
Acres 22	Last Limed UNKNOWN	Irrigated NO
Last crop 115 SOYBEANS		

This report is for:

JOHN DOE
RURAL ROUTE 1, BOX 1
CENTERTOWN, MO

SOIL TEST INFORMATION			RATING					
			Very Low	Low	Medium	High	Very High	Excess
pHs	(salt pH)	6.3	**********					
Phosphorus	(P)	86 lbs/a			**********			
Potassium	(K)	428 lbs/a				**********		
Calcium	(Ca)	5071 lbs/a					**********	
Magnesium	(Mg)	568 lbs/a					**********	
Sulfur	(SO_4-S)	6.0 ppm		**********				
Zinc	(Zn)	1.3 ppm			**********			
Manganese	(Mn)	ppm						
Iron	(Fe)	ppm						
Copper	(Cu)	ppm						

Organic Matter	2.9 %	Neutralizable acidity	1.0 meq/100g	Cation Exch. Capacity	16.6 meq/100g	
pH in water		Electrical Conductivity	mmho/cm	Sodium (Na)	lbs/a	
Nitrate (NO_3-N) Topsoil	ppm	Subsoil ppm	Sampling Depth Top	Inches	Subsoil	Inches

NUTRIENT REQUIREMENTS

Cropping options	Yield goal	Pounds per acre N	P_2O_5	K_2O	Zn	S
103 CORN (GRAIN)	140 BU/A	155	0	20	0	0
115 SOYBEANS	40 BU/A	0	0	20	0	0
119 WHEAT	60 BU/A	95	0	20	0	0
103 CORN (GRAIN)	140 BU/A	155	0	20	0	0

LIMESTONE SUGGESTIONS

Effective neutralizing material (ENM)	0
Effective magnesium (EMg)	0

Your sample has an estimated pH in water of 6.8.
The cation exchange capacity of this soil would suggest very low potential for sulfur response. Monitor the crop by plant analyses for potential need for sulfur.
Nitrogen requirements may be reduced by 30 pounds per acre for the first crop following soybeans. Not applicable for wheat.
Soils testing high in P or K should be retested annually to determine when maintenance fertilizer should be applied.

Lesson 3: Soil Testing Name_____

Interpreting Soil Test Results

Objective: Students will be able to identify components and interpret information on the soil test report.

Directions: Using the soil sample report from the text or results from a soil sample taken locally, answer the following questions.

1. What was the last crop planted on the field from which soil samples have been taken?

2. What is the exchangeable K per acre for potassium?

3. What is the rating for probability of yield increase for potassium?

4. What is the salt pH?

5. Is the salt pH within the favorable area for Missouri soils?

6. Which component has a very high rating and what are the pounds available per acre?

7. What is the cation exchange capacity?

8. What are the cropping options to be considered for the sample location?

9. What is the yield goal for wheat and how many pounds per acre of nitrogen are recommended?

10. Which two components should be retested annually to determine when maintenance fertilizer should be applied?

Lesson 3: Soil Testing Name_____

Collecting a Soil Sample

Objective: Students will be able to collect a soil sample and prepare it for a testing laboratory.

Materials and Equipment:

Soil probe, auger, or spade
Clean, plastic bucket
Soil sample boxes
Soil sample information form

Procedure:

1. Scrape away any surface mat of grass or litter from the chosen soil sample site. Make sure you are taking a soil sample from a relatively uniform area of a field. Before you take the sample, look at the site surroundings. Note the slope of the land, crop rotation, limestone, fertilizer, manure, and nearby farmsteads or feedlots.

2. Remove a soil sample using a soil probe, auger, or spade. Take a sample for fertilizer and limestone recommendations to a depth of 6 to 7 inches or to tillage depth if deeper. In long-term, no-till fields, take a separate sample of the top 2 inches of soil for soil acidity measurements.

   (Note: If you use a spade, dig a hole to the proper sampling depth. Then shave a 1-inch slice from the side of the hole to the sampling depth with the shovel. Save the vertical, 1-inch wide center portion of the soil as one subsample.)

3. Note what the soil sample looks like including color and texture.

4. If more than one sample has been taken from the sampling area, mix all of the subsamples in a clean, plastic bucket.

5. Let the sample air-dry, then place it in a small (1-pint) box or bag, and label it for analysis.

   (Note: Record sampling depth on the information form when taking depths of less than 6 inches.)

6. Properly clean and store any equipment used.

7. Complete a soil sample information sheet for each soil sample by using the form your instructor provides you.

UNIT III - SOIL FERTILITY AND MANAGEMENT

Lesson 4: Fertilizing Soils

Competency/Objective: Identify fertilizers and the applications needed to obtain optimal crop performance.

Study Questions

1. **What are the various types of fertilizers?**
2. **What are the forms of fertilizer?**
3. **Where can fertilizer formulations be obtained?**
4. **What are the different application techniques?**
5. **When should fertilizer be applied?**
6. **How are fertilizer application rates calculated?**

References

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit III.
2. Activity Sheet
    a) AS 4.1: Calculating Fertilizer Needs and Cost

UNIT III - SOIL FERTILITY AND MANAGEMENT

Lesson 4: Fertilizing Soils

TEACHING PROCEDURES

A. ***Review***

The previous lessons reviewed the composition of the soil and how important nutrients are to maintaining healthy soil. Nutrients are easily used up or lost due to cultivation, topsoil erosion, and crop harvesting. These nutrients have to be replenished through fertilization. This lesson will review forms of fertilizer and the factors involved with the application of fertilizer.

B. ***Motivation***

Present a bag of fertilizer to the class and point out the ingredients found on the bag. Determine if the bag lists application techniques and safety warnings to be observed.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Discuss the various types of fertilizers including mineral fertilizers, organic fertilizers, and chemical (inorganic) fertilizers that can be applied to soils to supply the nutrient elements needed for optimum plant growth.

   What are the various types of fertilizers?

   a) Mineral fertilizers - rocks containing nutrients that are ground up and applied to the soil
      1) Limestone
         (a) Used to neutralize soil acidity
         (b) Good source of calcium, magnesium, and sulfur
      2) Phosphorus
         (a) Commonly phosphate rock (PO_4)
         (b) Processed into soluble fertilizer sources
         (c) Used only on soils with a definite phosphorus shortage
   b) Organic fertilizers - plant or animal tissues that have become waste materials
      1) Plant residue, animal manure, bone, cottonseed, and soybean meal, and biosolids (sewage sludge)
      2) Advantages
         (a) Slow-releasing nutrients are less likely to cause root damage.
         (b) Organic wastes are long lasting.
         (c) Source of live bacteria needed to convert natural soil minerals and chemical fertilizers into useable forms for plants.
      3) Disadvantages
         (a) Low in major nutrients
         (b) Bulky material
         (c) Difficult to measure exact amount of fertilizer to apply
   c) Chemical (inorganic) fertilizers - manufactured from a nonliving source
      1) Formulations of nitrogen (N), phosphorus (P), and potassium (K)
      2) Advantages
         (a) Higher proportion of useable nutrients than mineral or organic fertilizers
         (b) More readily soluble and immediately available for plant use
         (c) Easier to measure

3) Disadvantages
   (a) They are more costly.
   (b) Errors in application can damage crops and the environment.

2. Discuss the various forms in which fertilizers can be purchased and how they are applied. Include in the discussion the placement of the fertilizer, whether they are surface applied or injected into the soil, and how this affects plant growth.

What are the forms of fertilizer?

a) Fluid
   1) Nutrients in true liquids are completely dissolved.
      (a) Sprayed or dribbled directly on soil or plant surfaces
      (b) Injected into the soil
      (c) Mixed with irrigation water
   2) Suspension fertilizers are mixtures of liquids and finely divided solids.
      (a) Solids redispersed by easily agitating to give a uniform mixture
      (b) Applied to the soil surface
b) Pressurized liquids
   1) Injected directly into the soil from tanks
   2) Adheres to the moisture in the soil
c) Dry
   1) Applied mechanically or absorbed into soil through rainfall
   2) Available in powders, granules, or prills
   3) Can be mixed with liquid and applied as a fluid fertilizer
d) Slow release
   1) Dissolve into the soil slowly
   2) Available in dry or liquid form
   3) Most commonly used in horticulture or vegetable production

3. Review how the proportions of nitrogen, phosphorus, and potassium are expressed on a fertilizer bag. Include how to figure the total pounds of each active ingredient. This information will help the student understand how bulk fertilizers are mixed. Chemical fertilizer dealers will have trained personnel who will mix and apply the fertilizer, but the producer should understand the product purchased. Complete AS 4.1 to help students understand a fertilizer bill of sale. If more detailed information is needed, obtain the *Farmland Soil Fertility Manual* available for free loan from MRCCTE.

Where can fertilizer formulations be obtained?

a) Complete commercial fertilizer mixtures contain nitrogen (N), phosphorus (P), and potassium (K).
   1) Proportions known as fertilizer grade and expressed as percentages
   2) Equation to figure total pounds of each active ingredient
      (total lb. of fertilizer X percent of macronutrient = lb. of macronutrient)
b) There are several locations where fertilizer can be purchased.
   1) Agriculture supply centers
      (a) Trained personnel mix and apply fertilizers.
      (b) Materials are hazardous and require specialized equipment to maintain safety.
      (c) License is obtained and records are maintained as determined by state law.
   2) Limestone purchased from quarries
   3) Barnyards, livestock sewage pits or lagoons, or sewage treatment facility
      (a) Special equipment is required to perform applications.
      (b) License must be obtained to transport and comply with state regulations.

4. Explain the methods of applying dry and liquid fertilizers. Include in the discussion how the application method may affect the penetration rate of the fertilizer and the growth of the plant if placed too closely to the seed or applied too heavily.

What are the different application techniques?

a) Broadcasting
   1) Spreading dry fertilizer evenly over soil prior to planting
   2) Uses mechanical equipment or aircraft
   3) Disked or mixed into the soil to increase nutrient breakdown process
b) Soil injection or knifing
   1) Used before and during planting
   2) Anhydrous ammonia injected directly into the soil - evaporates quickly
   3) Preferred option to apply liquid manure to reduce odors
c) Banding
   1) Places dry fertilizers directly into the soil about 2 inches to each side and slightly below the seed
   2) Used extensively for row crops during planting
   3) Starter applications
      (a) Fertilizer applied in a band 1 to 2 inches from one or both sides of the seed, only at planting time
      (b) Commonly used on corn and cotton to stimulate early growth
      (c) Applied as either dry or liquid materials
d) Side-dressing
   1) Placing fertilizer in bands about 6 to 8 inches from the row of plants
   2) Common in row crops such as corn, cotton, and vegetables
   3) Minimizes leaching during planting and cultivation
e) Top-dressing
   1) Dry or fluid fertilizer is broadcast lightly over close-growing plants.
   2) It is a common method for applying nitrogen to wheat, small grains, hay fields, pastures, and lawns.
   3) Rainfall dissolves dry fertilizer and soaks into soil.
f) Foliar
   1) Application of liquid fertilizer directly on foliage or leaves
   2) Broadcasted soluble nutrients on plants for rapid utilization
   3) Can cause severe burning of leaves if sprayed too heavily
   4) Not recommended for applications of nitrogen, phosphorus, or potassium
g) Fertigation
   1) Fertilizer is applied in irrigation systems.
   2) Liquid fertilizers are typically used.
   3) Dry fertilizers may be dissolved and dispersed by irrigation.
   4) Type of irrigation system dictates type of fertilizer used.

5. Determining when fertilizer should be applied depends on many factors. The soil temperature, moisture levels, crop to be grown, and the specific nutrients to be applied are all primary factors to consider when planning fertilizer application. Discuss the various factors with the students and how the four seasons affect the appropriate application time.

When should fertilizer be applied?

a) Soil temperature
   1) Rate (speed) affects chemical activity.
   2) Nitrification begins just above freezing and continues to increase up to about 85°F.
b) Moisture
   1) The amount between fertilizer application and plant utilization affects efficiency of applied material.
   2) Nitrifying bacteria remain active in very dry conditions.

3) Saturated soils do not contain enough oxygen for nitrifying bacteria.

c) Crop to be grown
   1) Single application of primary nutrients is satisfactory for most fast-growing annual crops.
   2) Split applications of nitrogen may be desirable for perennials, cool- and warm-season grasses.

d) Nutrients
   1) Mobile nutrients are more susceptible to leaching losses than phosphates or potassium.
   2) Nitrogen applied in ammonia form must be nitrified before leaching or denitrification can occur.

e) Favorable planting season
   1) Fall application
      (a) Soil texture, average temperatures, and nitrogen carrier influence possible losses from leaching.
      (b) Applying nitrogen materials to sandy soils is discouraged.
      (c) Anhydrous ammonia is recommended.
      (d) Phosphorus and potassium are relatively safe in most areas.
   2) Winter application
      (a) Plow-down applications and anhydrous ammonia application can continue until ground freezes.
      (b) In some areas, these methods continue throughout the winter.
   3) Spring application
      (a) Most popular
      (b) Broadcast applications for plow-down or disk-in on row crops
      (c) Preplant applications of anhydrous ammonia for row crops
      (d) Starter applications for spring small grains or row crops
   4) Summer application
      (a) Provide supplemental amounts of plant nutrients not applied previously.
      (b) Side-dressing with nitrogen during irrigation applications is used.

6. Discuss fertilizer application (spread) rates. The rate will be listed on the bill of sale if the fertilizer is purchased from a service center or dealer. The spread rate is necessary to calibrate application equipment.

How are fertilizer application rates calculated?

a) Dry chemical fertilizers
   1) Pounds per acre (also called spread ratio)
   2) Formula - spread rate = total lb. of fertilizer / total acres
   3) Listed on side of bill from local supply center or dealer
   4) Spread ratio needed to calibrate application equipment

b) Lime
   1) Measuring based on rating system
      (a) ENM is the ability to reduce soil acidity and is determined by material purity and fineness.
      (b) Local quarry can provide ENM per ton.
   2) Always applied - pounds of ENM per acre
      (a) Found on soil test recommendations
      (b) Formula - ENM recommendation / ENM rate or guarantee of material = amount of lime needed per acre
   3) ENM sources
      (a) Sources are not equal in rating or price.
      (b) Use least expensive source per pound of ENM.

F. ***Other Activity***

Visit a local fertilizer supply center and ask the staff to explain the procedure of mixing bulk fertilizer from a soil test report. Use the soil test report from Lesson 3 as an example for the supply center to work from.

G. ***Conclusion***

Determining fertilizer needs for a specific crop or soil is highly technical. Many factors and variables need to be considered when choosing the most appropriate fertilizer and application process. Consultation with trained professionals is important to achieve the most productive and profitable crop.

H. ***Answers to Activity Sheet***

1. a. 2250 lb.
   b. 5250 lb.
   c. 3750 lb.
2. 18,037 lb.
3. 240.5 lb. per acre
4. $2,351.35

(Note: Complete fertilizer bill of sale on next page.)

I. ***Answers to Evaluation***

1. Mineral, organic, chemical (inorganic)
2. Fluids, pressurized liquids, dry, slow-release
3. Nitrogen, phosphorus, potassium
4. Agriculture supply centers
5. Any or all of the following: quarries, barnyards, livestock waste pits or lagoons, sewage treatment facility
6. Temperature, moisture, crop to be grown, nutrient being applied
7. Fall
8. Total pounds of fertilizer material divided by the total acres to be fertilized
9. Lime
10. b
11. f
12. d
13. c
14. a
15. h
16. g
17. e

Agriculture Supply Center

Anyplace, Missouri 000-555-9999

Name _____ Delivered by _____

Address _____ Date _____

	Nitrogen	Phosphorus	Potassium
Soil Test Recommendation (lb./ac.)	30	70	50
Total Acres to Spread	75	75	75
Total Pounds of Fertilizer Needed	2250	5250	3750

MANUFACTURING INSTRUCTIONS

Use the Following:		*Percent of Materials Used*			*Pounds of Actual Plant Food Supplied*		
Fertilizer Source	Lb.	N	P	K	N	P_2O_5	K_2O
Diammonium Phosphate 18-46-0	11,413	18	46	0	2054	5250	0
Ammonium Nitrate 34-0-0	576	34	0	0	196	0	0
Potassium Chloride 0-0-60	6048	0	0	60	0	0	3750
Total Lb.	18,037		*Total Lb. Supplied*		2250	5250	3750

18,037 (Total Lb.) ÷ 75 (Acres) = 240.5 Spreading Rate (lb. per acre)

Guaranteed Analysis = 12.5 % N 29 % P_2O_5 20.8 % K_2O (lb. of nutrient/acre ÷ spread rate)

Fertilizer Source Used	*Cost per Lb.*	*Lb. Used*	*Cost per Source*
Diammonium Phosphate 18-46-0	$ 0.1385607	11,413	$ 1,581.39
Ammonium Nitrate 34-0-0	0.073614	576	42.40
Potassium Chloride 0-0-60	0.083093	6048	502.56
		Total Fertilizer Cost	$ 2,126.35
		($ 3.00 per acre) Spreading Charge	225.00
		TOTAL BILL	$ 2,351.35

UNIT III - SOIL FERTILITY AND MANAGEMENT Name_____

Lesson 4: Fertilizing Soils Date_____

EVALUATION

Complete the following questions.

1. What are the three types of fertilizer?

   a.

   b.

   c.

2. In what four forms can mineral and chemical fertilizers be purchased?

   a.

   b.

   c.

   d.

3. What are the primary soil nutrient deficiencies that most often need to be corrected?

   a.

   b.

   c.

4. What is the primary source for purchasing fertilizer products?

5. What are alternative sources for purchasing fertilizer products?

   a.

   b.

6. What four factors affect when fertilizers are applied?

   a.

   b.

   c.

   d.

7. What time of the year is best for applying anhydrous ammonia?

8. How is the application rate determined?

9. What is the only fertilizer that requires measuring on a rating system?

Match the definition on the left to the term on the right.

10.	____ Application technique for anhydrous ammonia.	a.	Broadcasting
11.	____ Method used to fertilize pastures.	b.	Soil injection
12.	____ Used when planting to stimulate seed germination.	c.	Banding
13.	____ Dry fertilizer placed to each side and below seed.	d.	Starter applications
14.	____ Spreading dry fertilizer over soil prior to planting.	e.	Side-dressing
15.	____ Application of fertilizer in irrigation systems.	f.	Top-dressing
16.	____ Fertilizer applied directly to leaves of plants.	g.	Foliar
17.	____ Fertilizer applied 6 to 8 inches from the plant row.	h.	Fertigation

Lesson 4: Fertilizing Soils Name_____

Calculating Fertilizer Needs and Cost

Objective: Students will be able to identify components of a fertilizer bill of sale and calculate fertilizer needs spreading rate, guaranteed analysis, and costs.

Directions: Using Table 4.2 from the Student Reference and the following information, complete the fertilizer bill of sale on the back of this page and answer the questions below.

Soil Test Recommendations:
N = 30
P = 70
K = 50

Total acres to spread is 75.

Fertilizer Sources and Costs per pound:

Ammonium Nitrate 18-46-0	$ 0.073614
Diammonium Phosphate 34-0-0	$ 0.1385607
Potassium Chloride 0-0-60	$ 0.083093

Spreading charge is $3.00 per acre.

Key Questions:

1. What are the total pounds needed of each of the following:

   a. Nitrogen -

   b. Phosphorus -

   c. Potassium -

2. How many total pounds of source fertilizer are to be used?

3. What is the spreading rate?

4. What is the amount of the total bill?

Agriculture Supply Center

Anyplace, Missouri 000-555-9999

Name _____ Delivered by _____

Address _____ Date _____

	Nitrogen	Phosphorus	Potassium
Soil Test Recommendation (lb./ac.)			
Total Acres to Spread			
Total Pounds of Fertilizer Needed			

MANUFACTURING INSTRUCTIONS

Use the Following:		*Percent of Materials Used*			*Pounds of Actual Plant Food Supplied*		
Fertilizer Source	Lb.	N	P	K	N	P_2O_5	K_2O
Total Lb.		*Total Lb. Supplied*					

_____ ÷ _____ = _____ Spreading Rate (lb. per acre)

(Total Lb.) (Acres)

Guaranteed Analysis = _____ % _____ % _____ % (lb. of nutrient/acre ÷ spread rate)

N P_2O_5 K_2O

Fertilizer Source Used	*Cost per Lb.*	*Lb. Used*	*Cost per Source*
			$
		Total Fertilizer Cost	$
		($_____ per acre) Spreading Charge	$
		TOTAL BILL	

UNIT III - SOIL FERTILITY AND MANAGEMENT

Lesson 5: Soil Management Practices

Competency/Objective: Identify how tillage and planting methods affect soil fertility.

Study Questions

1. **What are the advantages and disadvantages of different tillage practices?**
2. **What are the advantages and disadvantages of different planting methods?**
3. **What effects do tillage and planting methods have on soil structure?**
4. **How can crop rotation practices be used to enhance soil fertility?**

References

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit III.
2. Humphrey, John Kevin. *Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1995, Lesson 5.
3. Minor, Paul. *Soil Science*. (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1995, Chapter 12.
4. Transparency Master
   a) TM 5.1: Equipment Tillage Triangle
5. Activity Sheets
   a) AS 5.1: Determining Tillage Costs
   b) AS 5.2: Soil Compaction and How It Develops
   c) AS 5.3: Estimating the Percent of Residue Cover

UNIT III - SOIL FERTILITY AND MANAGEMENT

Lesson 5: Soil Management Practices

TEACHING PROCEDURES

A. ***Review***

Soil is one of our most precious natural resources. Because it renews itself so slowly (it takes approximately 1 thousand years to produce an inch of soil), it is everyone's responsibility to protect what little we have available. One of the best ways producers can protect the soil is through soil conservation. This lesson will explore the many options available in soil management so that students as future producers are aware of how they can protect this valuable resource.

B. ***Motivation***

1. Invite a local soil conservation agent to discuss tillage practices and planting methods used in your area.

2. Tour a farm utilizing both conventional and conservation tillage practices. Allow a producer to explain the advantages and disadvantages of each practice.

3. Video: *No-Till, Protecting the Heartland*, 1997, Zeneca Agricultural Products. (Available free at 1-800-759-2500.)

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. After completing one of the motivational activities, review the advantages and disadvantages of the different tillage practices. After the review, refer to AS 5.1. Have students discuss the results of their research with the class.

What are the advantages and disadvantages of different tillage practices?

a) Tillage - the act of moving soil particles or cultivating the land
   1) Used to prepare a suitable seedbed, eliminate weed competition, and improve the condition of soil
   2) Defined by level of crop residue left on soil surface
      (a) Conventional - residue levels less than 15%
      (b) Conservation - residue levels at least 30%
      (c) Reduced or minimum tillage - residue levels between 15 and 30%

b) Conventional tillage - tilling the soil using a moldboard plow, disk, or chisel plow to prepare the seedbed; inverts the soil leaving the soil surface clean and smooth; promotes organic matter oxidation
   1) Advantages
      (a) Machinery - familiar and widely available
      (b) Adaptable to a wide range of soil and crop conditions
      (c) Allows the use of cultivation for weed control throughout the growing season
      (d) Soil warms faster when soil residues are incorporated
   2) Disadvantages
      (a) Increased fuel and labor costs
      (b) High risk of erosion
      (c) Reduced organic matter

(d) Soil compaction due to increased field traffic

c) Conservation tillage - tillage system designed to reduce wind or water soil erosion and increase soil organic matter
   1) Advantages
      (a) Reduces soil erosion 50 to 90% depending on the tillage practice
      (b) Increases infiltration of water and conserves moisture
      (c) Reduces sediment from runoff that reaches streams and lakes
      (d) Reduces production and maintenance costs with fewer trips across field
   2) Disadvantages
      (a) Increased dependence on herbicides and equipment
      (b) Equipment modification needs
      (c) Fertilizers and chemicals require specific timing and sequencing
      (d) Delay in planting due to moist, cool soil conditions
   3) No-till - least disruptive conservation tillage method; undisturbed soil except for a narrow seedbed (10% or less of the surface tilled)
      (a) Advantages
         (1) Crop residue dramatically reduces soil erosion.
         (2) Expenses for equipment and fuel are reduced.
         (3) Soil moisture is conserved.
         (4) Less time is required for planting crops.
         (5) Evaporation is reduced.
      (b) Disadvantages
         (1) Weed control dependent on herbicides
         (2) Delayed planting due to slow soil warmup
         (3) Soil compaction in upper soil zone
         (4) Risk of insect, disease, and weed problems
   4) Mulch-till - the total soil surface disturbed by tillage before planting; various tillage tools required; 30% residue left; weeds controlled with herbicides or cultivation
      (a) Advantages
         (1) Sufficient crop residue maintained to reduce erosion
         (2) A percentage of crop residue incorporated into the soil
         (3) Easy transition from conventional tillage methods
         (4) Increased roughness and filtration
         (5) Allows for surface-applied fertilizer and pesticide usage
      (b) Disadvantages
         (1) Soil compaction similar to conventional methods
         (2) Increase in fuel and labor costs
         (3) Requires more field traffic with increased time and labor costs
         (4) Some buried residue, limiting erosion-reducing potential
   5) Ridge-till - soil undisturbed except for the seedbed on ridges; used primarily on flat ground to aid in water drainage; weeds controlled with herbicides or cultivation
      (a) Advantages
         (1) Significant erosion reduction is possible.
         (2) Residue is channeled away, reducing planting interference.
         (3) Ridges warm up and drain faster.
         (4) Residue supports tractors in wet spots.
         (5) Tops of ridges provide ideal seedbed.
         (6) Evaporation is reduced and increases soil moisture.
         (7) Weed pressure and soil compaction from cultivation are reduced.
         (8) Food and shelter are provided for wildlife.
      (b) Disadvantages
         (1) Requires special planters and/or attachments
         (2) Wheel and tire width adjustments required on equipment
         (3) Ridges present challenges when turning on end rows

d) Subsoiling - tillage method used to break up the subsoil; promotes root growth in crops such as potatoes

2. Explain types of planting methods as well as the advantages and disadvantages of each method. Give examples of crops planted using each method.

What are the advantages and disadvantages of different planting methods?

a) Row method - Seeds are evenly spaced in parallel rows; used with corn, grain sorghum, soybeans, cotton, and vegetables; rows vary from ultranarrow to wide; includes skip row.
   1) Advantages
      (a) Allows for cultivation and reduces herbicide costs
      (b) High seed germination rates
   2) Disadvantages
      (a) Increased days to canopy
      (b) Population counts limited due to spacing requirements

b) Drill method - Seeds are in narrow rows at high populations; used with small grains such as wheat, oats, and alfalfa; soybeans, grain sorghum, and rice are also drilled.
   1) Advantages
      (a) Fertilizer can be incorporated with planting attachments.
      (b) No mechanical cultivation is required.
      (c) Fewer trips across the field mean saved time and labor.
      (d) There are fewer days to canopy resulting in reduced weed pressure saved moisture.
      (e) Plant distribution is better.
   2) Disadvantages
      (a) Mechanical cultivation is not possible.
      (b) Herbicides used increasingly to control weeds.

c) Broadcast method - Seeds are scattered in a random pattern across the top of the soil; used with grasses, legumes, and small grains.
   1) Advantages
      (a) Cheapest method
      (b) Provides for faster canopy to prevent erosion and control weeds
      (c) Minimum tillage
   2) Disadvantages
      (a) Poor germination
      (b) Limited crop selection
      (c) Uneven plant distribution

d) Aerial method - Airplane or helicopter is used to scatter seeds randomly across the field; used when soil is too wet to till or plant by other methods, especially with rice.

3. Explain how soil structure can be affected both positively and negatively by the tillage or planting method chosen. The physical structure of the soil is affected by crop residue, soil compaction, and moisture levels. Refer to AS 5.2. This activity will help the students understand how field traffic affects soil compaction. AS 5.3 will help the students determine the amount of crop residue on a field. For more information on this process, refer to University of Nebraska Extension Publication G93-1133, available at <http://ianr.unl.edu/pubs/fieldcrops/g1133.htm>.

What effects do tillage and planting methods have on soil structure?

a) Crop residue
   1) Insulates the soil, resulting in cooler, wetter soils
   2) Shifts soil's physical properties to a more natural state
   3) Higher concentration of nutrients, pesticides, and organic matter
   4) Changes populations of beneficial and harmful insects
   5) Soil surface becomes rougher as tillage decreases

b) Soil compaction
   1) Smaller pores and fewer channels in the soil lead to reduced water infiltration
   2) Greater surface wetness, more runoff, longer drying times

c) Soil moisture

1) Soil moisture is affected by residue and compaction and turning over of soil in tillage.
2) Soil temperatures can increase considerably from opening up soil to air and sunshine.

4. Crop rotation is growing different crops in recurring succession on the same land. Soil fertility and crop productivity are maintained by good crop rotations. Discuss various crop rotation practices that enhance soil fertility.

How can crop rotation practices be used to enhance soil fertility?

a) Control weeds, insects, and diseases
b) Improve organic matter content of soil
c) Increase nitrogen by using legumes
d) Increase soil nutrient utilization
e) Increase fertilizer efficiency
f) Reduce erosion

F. ***Other Activity***

Compare the top 2 inches of a soil sample to the top 4 or 5 inches of the same sample. Note the amount of residue and the degree of compaction at these depths. Now compare and contrast samples that are taken from conventional- versus conservation-tilled soils.

G. ***Conclusion***

Producers are responsible for preserving soil resources for the next generation of producers. This can be done through a variety of intelligent, informed decisions regarding soil management practices including tillage, planting, and crop rotation.

H. ***Answers to Activity Sheet***

Answers to the activity sheets will vary depending on the results of the research. Activities 5.1 and 5.2 may be easily used with a partner or as a small group project. Activity 5.3 will probably work best as a class activity with three teams or groups working in the same field and combining data.

I. ***Answers to Evaluation***

1. No-till, mulch-till, ridge-till

2. Any four of the following answers are correct: limited competition from weeds, maintain or increase organic matter, increase nitrogen by using legumes, increase soil nutrient utilization, increase fertilizer efficiency, reduce erosion.

3. b
4. a
5. a
6. b
7. a
8. b
9. b
10. a
11. b
12. a
13. b
14. d
15. r

16. r
17. d
18. r
19. b
20. b
21. b
22. d
23. +
24. -
25. +
26. -
27. +
28. -

UNIT III - SOIL FERTILITY AND MANAGEMENT Name_____

Lesson 5: Soil Management Practices Date_____

EVALUATION

Complete the following short answer questions.

1. List three types of conservation tillage.

   a.

   b.

   c.

2. List four ways in which crop rotation practices enhance soil fertility.

   a.

   b.

   c.

   d.

Determine which type of tillage practice the following characteristics apply to. Mark "A" for conventional tillage or "B" for conservation tillage.

3. _____ Reduces soil erosion

4. _____ Provides a smooth soil surface

5. _____ Requires more traffic on a field

6. _____ Crop residue remains on the field

7. _____ Weeds are controlled by tillage

8. _____ Increases the need for herbicides

9. _____ Improves soil structure and organic matter content

10. _____ Soil surface is exposed increasing erosion

11. _____ Production costs for labor and time are reduced

12. _____ Plows or disks are used

Determine which type of planting method the following characteristics apply to. Mark "R" for the row method, "D" for the drill method, or "B" for the broadcast method.

13. _____ Scattering seeds in a random pattern

14. _____ Mechanical cultivation is not possible

15. _____ Most expensive planting methods

16. _____ Ideal for planting large seeds

17. _____ Seeds placed in narrow rows

18. _____ Reduced population counts

19. _____ Poor germination

20. _____ Most economical

21. _____ Generally used to plant grasses and legumes

22. _____ Most often used to plant small cereal grains

Determine whether the following are positive or detrimental to soil structure. Use a "+" for positive and a "-" for detrimental.

23. _____ Conservation tillage

24. _____ Tilling the soil when wet

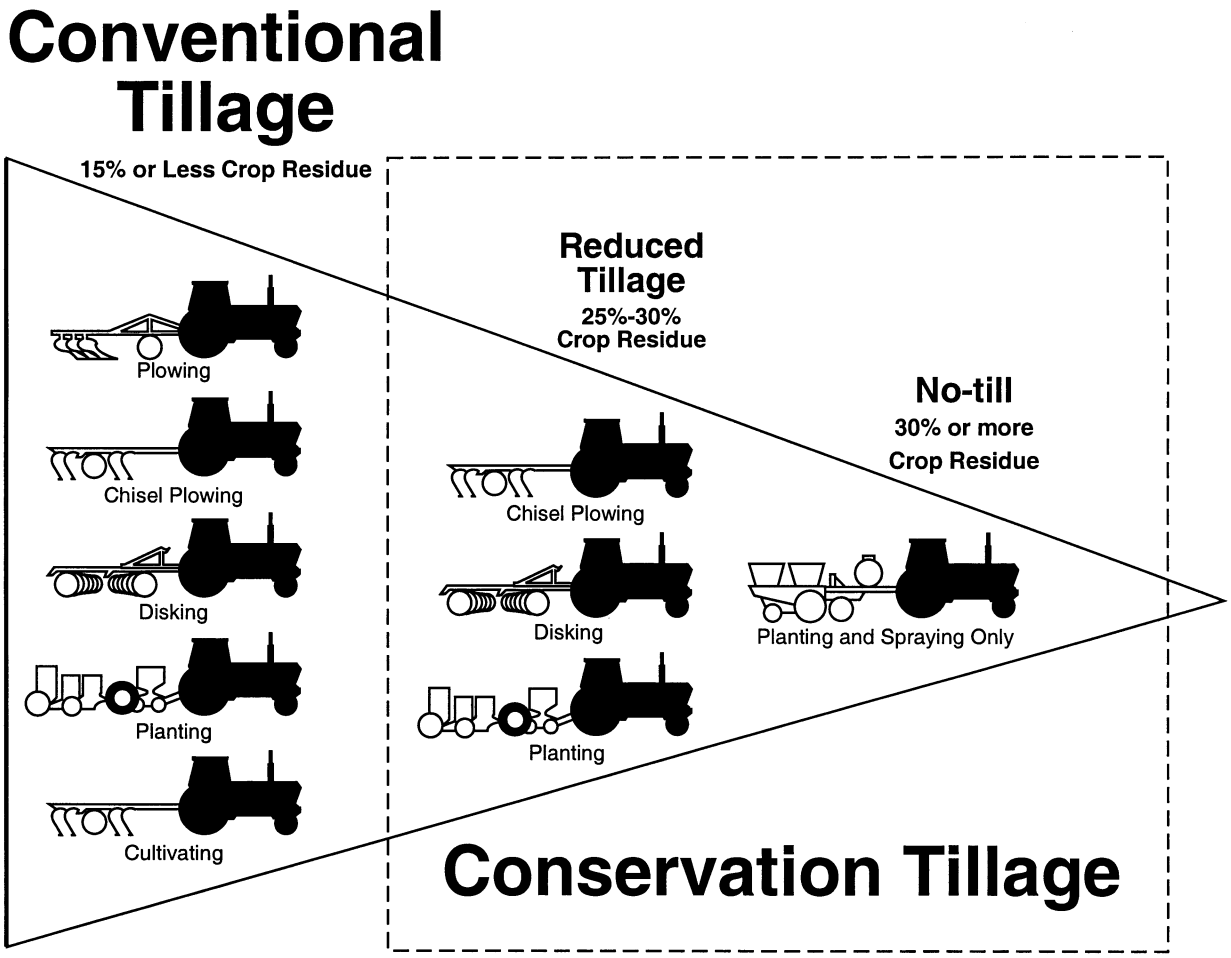
25. _____ Drill and broadcast planting

26. _____ Conventional tillage

27. _____ Maintaining crop residue

28. _____ Field traffic

Equipment Tillage Triangle



Adapted from *Fundamentals of No-Till Farming,* American Association for Vocational Instructional Materials, Athens, Georgia.

Lesson 5: Soil Management Practices Name_____

Determining Tillage Costs

Objective: Students will become familiar with equipment needs and cost differences between tilling a field with conventional tillage methods and with conservation tillage methods.

Procedure:

1. Choose a tillage method to research. Using equipment catalogs, brochures, or the Internet, determine the equipment needs of the tillage method chosen.
2. Make a list of equipment you would use based on your selected tillage method, for example, moldboard plow, disk, chisel plow, planter, drill.
3. Include any spray equipment and cultivators that may be needed for the tillage method chosen.
4. Also, list the approximate cost of each piece of equipment.
5. Compare your list with a fellow student who chose a different tillage method and then answer the questions below.

Key Questions:

1. What are the two tillage methods you compared?

   a.

   b.

2. From equipment costs alone, which tillage method is the most economical and which is the most expensive?

   a. Most economical -

   b. Most expensive -

3. In addition to equipment costs, what variables will also have an effect on your cash flow? Write a short paragraph or create a chart to explain your results.

Lesson 5: Soil Management Practices Name_____

Soil Compaction and How It Develops

Objective: Students will analyze how soil compaction develops and determine ways to alleviate the effects.

Directions: In AS 5.1, you determined the equipment needs for different tillage methods. Using this information, determine which tillage method makes the most and the least trips across a field by completing the tables below. Include any field traffic that may occur from the application of herbicides and weed control. Be sure to write in the name of each method you are comparing.

Method No. 1		Method No. 2	
Equipment Used	No. of Trips	Equipment Used	No. of Trips
Total Trips Across Field		**Total Trips Across Field**	

Key Question:

Write a brief essay using the information above and from the lesson to explain how equipment size could affect the degree of soil compaction from each of these tillage methods. Include what steps might be taken such as adjusting tire pressure or combining operations to reduce compaction.

Lesson 5: Soil Management Practices Name_____

Estimating the Percent of Residue Cover

Objective: Students will estimate the percent of residue cover remaining after tillage/planting operations.

Directions: Accurate estimates of residue cover can only be obtained from measurements taken within the field while looking straight down at the soil and residue. The line-transect method is one of the easiest and most accurate methods of estimating residue cover. A 100-foot measuring tape is used most often, but other tape lengths, specially made cords with "beads" attached, or knotted ropes will also work. There should be 100 easily visible marks on the measuring device.

Procedure:

1. The measuring device is first stretched across a section of the field. Percent residue cover is then obtained by counting the number of marks on the measuring device that are directly over a piece of residue.

2. Select an area that is representative of the whole field. Avoid end rows or small areas of the field that have been adversely affected by flooding, drought, weed or insect infestations, compaction or other factors that have substantially reduced yields or affected residue cover.

3. Anchor one end of the tape or line and stretch it diagonally at about a 45° angle across the crop rows so it crosses more than one pass of the implements used. This avoids inaccurate readings such as those obtained if all measurements were taken in a windrow of residue left by the combine, or in an area of reduced amounts of residue. Do not take measurements parallel or perpendicular to crop rows.

4. Measure residue cover by counting the number of marks that are directly over a piece of residue. (An inexpensive click or lap counter can be useful to help keep count.) When looking at the tape and counting, follow these rules:
   - Keep both ends of the tape anchored and do not move the tape.
   - Look straight down at the tape and marks. Leaning from side to side will result in overestimation because residue may appear to be under the mark when it really is not.
   - Consistently look at the same side of the tape.
   - Consistently look at the same point at each mark.
   - Do not count if is questionable. A good way to determine this is by asking the question "If a raindrop falls at this point, will it hit residue or bare soil?"

5. When 100 points are observed, the number of marks that are directly over residue will be a direct measurement of the percent cover for that area of the field. For example, if 35 marks on a 100-foot tape were observed to be exactly over a piece of residue, then the residue cover is 35%.

6. If less than 100 points are observed, multiply the count by the appropriate conversion factor to obtain percent cover. For example, if a 50-foot tape is used, and only the foot marks are observed, multiply the count by two.

7. For increased accuracy, repeat the measuring process in three or more representative areas of the field. Average the individual measurements to obtain an estimate of percent cover for the entire field. The table on the back may be used to track the measurements.

of Marks for 100-foot tape
1.
2.
3.
Total:
Average:

# of Marks for 50-foot tape	
1.	X 2 =
2	X 2 =
3.	X 2 =
Total:	
Average:	

UNIT III - SOIL FERTILITY AND MANAGEMENT

Lesson 6: Soil Conservation Practices

Competency/Objective: Identify the conservation practices that affect crop production.

Study Questions

1. **What is soil erosion?**

2. **What factors contribute to soil loss?**

3. **What management practices are used to control soil erosion?**

4. **What conservation practices enhance wildlife habitats?**

References

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit III.

2. Activity Sheets

   a) AS 6.1: Measuring Slope
   b) AS 6.2: Contour Farming and Soil Erosion
   c) AS 6.2A: Contour Farming and Soil Erosion (Alternative Activity to AS 6.2)

UNIT III - SOIL FERTILITY AND MANAGEMENT

Lesson 6: Soil Conservation Practices

TEACHING PROCEDURES

A. ***Review***

The first five lessons of this unit explain soil composition, type and limitations, testing, fertilization, and management practices. Thorough knowledge and understanding of soil fertility and management are important when determining effective conservation methods. In an effort to conserve soil and maintain crop productivity, the producer is continually challenged to evaluate land management practices. By implementing soil conservation practices, producers can ensure the protection of our natural resources.

B. ***Motivation***

Show the 28-minute video *The Living Landscape* (VHO109) available from the Missouri Department of Conservation. The video shows how farming can function in harmony with the soil, plants, and animals. It will help the students understand the need for conservation practices.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Soil erosion is a constant concern for landowners and farmers. The land surface is worn away by water, wind, ice, and geological agents such as earthquakes, floods, and the natural wearing away of rock. Water erosion is the most prevalent in Missouri but some wind erosion can occur in the southeastern region.

   What is soil erosion?

   a) Soil erosion - wearing away of the land surface by water, wind, ice, and other geological agents
      1) No control over ice or geological erosion
      2) Wind erosion
         (a) Occurs in areas of high prevailing winds
         (b) Low annual rainfall
      3) Water erosion
         (a) Most destructive force to soil in Missouri
         (b) Caused by raindrop splash and flowing water
   b) Soil erosion by water
      1) Detaching soil particles
      2) Transporting particles
   c) Categories of water erosion
      1) Sheet - uniform removal of soil in thin layers or sheets
      2) Rill - runoff water in small, well-defined channels
      3) Gully - trenches cut to a depth of 12 inches or more
   d) Wind erosion
      1) Cannot be divided into distinct types
      2) Occurs mostly in flat, dry areas and moist sandy soils along bodies of water
      3) Removes soil and natural vegetation
      4) Causes dryness and deterioration of soil structure
      5) Detachable mucks, sands, and loamy sands

2. Soil erosion removes topsoil and causes loss of soil fertility, as well as creates environmental concerns that impair air and water quality. It is important to be aware of the factors that cause soil loss and to develop a plan that reduces the problem. Discuss the factors that make up the Universal Soil Loss Equation developed by the USDA that calculates soil loss from sheet and rill erosion. Use AS 6.1 to help students understand how slopes are measured and how they affect soil erosion.

What factors contribute to soil loss?

a) Rainfall factor (R) - measure of rainfall energy
b) Soil erodibility factor (K) - measure of soil's relative resistance to erosion
c) Slope length (L) and slope degree (S) factors - influence the amount of runoff and rate of water infiltration
d) Crop practice factor (C) - measure of the soil cover from prior crops
e) Conservation practice factor (P) - management tool that changes the flow pattern of water runoff or wind damage
f) Soil loss tolerance factor (T) - indicates the amount of soil that can be lost each year without seriously reducing productive capability

3. Discuss the major conservation practices recommended by the Natural Resources Conservation Service. Use AS 6.2 or 6.2A to demonstrate to students the conservation practice of contour farming.

What management practices are used to control soil erosion?

a) Residue management - the past year's crop residues left on the soil surface to reduce erosion
b) Contour farming - farming around a sloping cropland around the slope, rather than up and down
c) Cross slope farming - farming across the slope, nearly on the contour
    1) Provides an option for slopes that are very difficult to farm
    2) Not as effective at saving soil as contour farming
d) Contour strip cropping - growing crops on the contour with even-width strips or bands alternated with meadows or close-growing crops
e) Contour buffer strips - captures soil loss by planting bands of grass in a contoured field, similar to strip cropping
f) Field borders - stop erosion on end rows
g) Crop rotations - alternate row crop production with a high residue-producing crop to a low residue-producing crop, or a grass/legume meadow
h) Terraces - earthen embankments designed to slow down and catch runoff on moderate to steep slopes without forming erosion channels
    1) Storage terraces collect and store water until it can penetrate into the ground or release through underground outlets.
    2) Gradient terraces slow runoff water and channel it to a grassed waterway.
i) Water and sediment control basins - short earthen dams built across a slope or drainage way; used where terraces are impractical
j) Diversion - earthen embankment (similar to a terrace) that diverts runoff water from a specific area
k) Grassed waterways - grassy areas where flowing water gathers and is slowed as it is guided off the field
l) Pasture and hayland planting - builds topsoil and organic matter, making the soil better for crop growth
m) Planned grazing systems - allows resting time between two or more grazing areas in a planned sequence
n) Filter strips - bands of grass or legumes that filter runoff and other contaminants before they reach waterways

o) Cover crops - close-growing crops that temporarily protect the soil when major crops do not furnish enough cover
p) Farm ponds - control gully erosion and provide water for livestock
   1) Provide a water source for birds and animals
   2) Developed by building a dam or digging a pit
q) Windbreaks - rows of trees and shrubs that protect the soil, conserve energy, control snowdrifts, shelter livestock, and provide food and cover for wildlife

4. Discuss how the conservation management practices that reduce soil erosion also enhance wildlife habitats. Generally, any practice that provides food, cover, and water for wild birds and animals is considered a wildlife-enhancing conservation practice.

   What conservation practices enhance wildlife habitats?

   a) Cropland
      1) Use of tillage methods leave waste grain and weed seeds after harvest.
      2) Crop rotation practices provide plant diversity.
      3) Wildlife food plot is created from crops left standing after harvest.
   b) Grassland
      1) Includes all conservation methods seeded to a grass/legume mixture
      2) Should not be mowed until mid-July
   c) Idle lands
      1) Field borders, fence rows, turn-rows, or areas around farm ponds seeded with various plants that will benefit wildlife
      2) Nesting, brood-rearing, and concealment cover for wildlife

F. ***Other Activities***

1. View the 18-minute video *Farming and Wildlife* available from the Missouri Resource Center for Career and Technical Education (MRCCTE) Ag Video 14.

2. Visit various farms to observe cropland and grassland areas where conservation practices have been implemented. Include areas where improvements can be made to reduce soil erosion.

G. ***Conclusion***

Erosion is continuous and therefore must be a priority in all crop production enterprises. Students need to understand causes and prevention measures. NRCS and local soil conservation districts can assist landowners and producers with information and services on soil management conservation practices that can help control erosion and enhance wildlife habitats.

H. ***Answers to Activity Sheet***

AS 6.1

Answers will vary depending on the results of the experiment.

AS 6.2 or 6.2A

Answers will vary depending on the results of the experiment.

I. ***Answers to Evaluation***

1. a
2. d
3. c
4. b

5. a
6. c
7. b
8. Rainfall factor, soil erodibility factor, slope length factor, slope degree factor, crop practice factor, conservation practice factor

9. Answers will vary but should include conservation management practices from the areas of cropland, grassland, or idle lands.

10. b
11. a
12. d
13. c
14. a
15. c

UNIT III - SOIL FERTILITY AND MANAGEMENT Name_____

Lesson 6: Soil Conservation Practices Date_____

EVALUATION

Match the term in the left column with the definition in the right column. Terms will be used more than once.

1. _____ Uniform removal of soil by raindrop splashes
2. _____ Occurs in areas with high prevailing winds and low annual rainfall
3. _____ Forms trenches to a depth greater than 12 inches
4. _____ Runoff water forms into small, well-defined channels
5. _____ Soil is removed in thin layers
6. _____ Develops where vegetative cover has been disturbed
7. _____ Occurs primarily in recently tilled fields

a. Sheet erosion
b. Rill erosion
c. Gully erosion
d. Wind erosion

Complete the following short answer questions.

8. What are the six factors that contribute to soil loss from water erosion?

   a.

   b.

   c.

   d.

   e.

   f.

9. List and describe two conservation practices that enhance wildlife habitats.

   a.

   b.

Circle the letter that corresponds to the best answer.

10. _____ is growing crops on the same land in an orderly sequence.

    a. Residue management
    b. Crop rotation
    c. Diversions
    d. Cover crops

11. _____ is/are alternating contoured perennial vegetation strips with wider cultivated bands.

    a. Contour buffer strips
    b. Field borders
    c. Grassed waterways
    d. Cross slope farming

12. When two or more grazing areas are rested in a planned sequence, it is referred to as _____.

    a. Terraces
    b. Pasture and hayland planting
    c. Field borders
    d. Planned grazing system

13. When preparing the soil, planting, and cultivating crops around a slope, rather than up and down the slope, it is referred to as _____.

    a. Contour buffer strips
    b. Terraces
    c. Contour farming
    d. Crop rotation

14. A _____ is a channel or ridge that directs excess runoff from an area.

    a. Diversion
    b. Field border
    c. Filter strip
    d. Pasture and hayland planting

15. _____ should be planted on the north and west sides of the area to be protected.

    a. Field borders
    b. Filter strips
    c. Windbreaks
    d. Grassed waterways

Lesson 6: Soil Conservation Practices Name_____

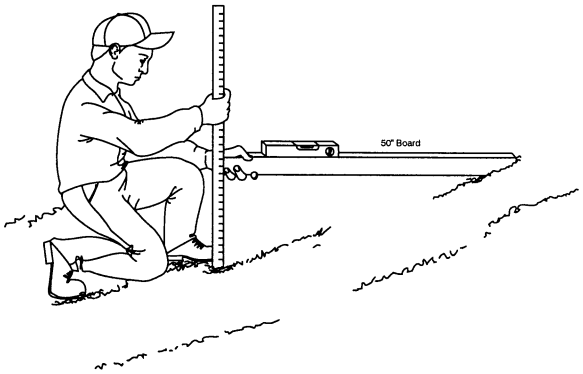
Measuring Slope

Objective: Students will identify procedure to measure the slope of a field.

Materials and Equipment:

Yardstick
1x4 board, exactly 50 inches long
Carpenter's level or bottle half full of a colored liquid

Procedure:



1. Locate an area that can be measured to determine the slope.

2. Place the 50-inch board horizontally on the ground (one end will be higher than the other because of the slope).

3. Put the level (or the bottle) on the board and move the free end of the board up or down until the bubble (or water) shows that the board is level.

4. Read on the yardstick the distance from the ground to the bottom edge of the horizontal board. Multiply this reading by 2 to get the percent of slope. (If the board used was 100 inches long, then you would not need to multiply by 2. The reading on the yardstick is the percent of slope.)

Key Questions:

1. What is the measurement reading on the yardstick?

2. What is the percent of slope?

3. Using Table 6.1, list the slope classification for the test site.

4. What erosion problems could occur from this slope classification?

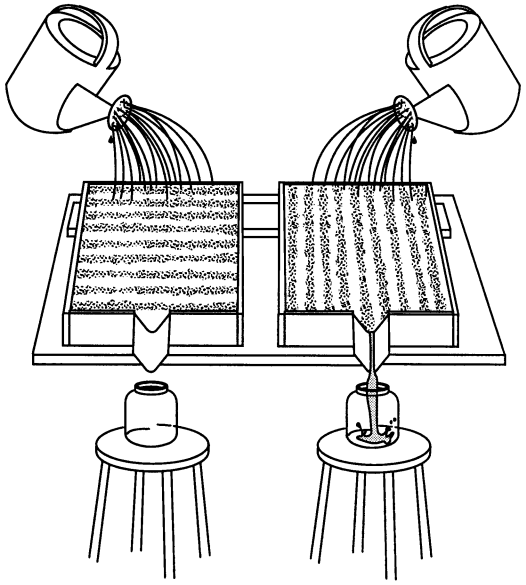
Lesson 6: Soil Conservation Practices Name_____

Contour Farming and Soil Erosion

Objective: Students will identify how contour farming affects soil erosion.

Materials and Equipment:

Two small boxes about 16 inches long, 12 inches wide, and 4 inches deep
Two watering cans with sprinkler nozzles
Two clear glass containers
One 2x4, 3 feet long
Soil (can use potting soil)



Procedure:

1. Cut a small V-notch about 1 to 1½ inches deep at the end of each box and fit with a tin spout to draw runoff water into a container.

2. Fill both boxes with the same type of soil taken from the same area. Set the boxes on a table and place the 2x4 under the unnotched end of both to make a slope.

3. Place a clear glass container below the V-notch or spout of the boxes.

4. Using your finger or a pencil, make furrows across the soil in one box and up and down the soil in the other box.

5. Fill the watering cans with water and slowly sprinkle the two boxes at the same time. Hold the sprinklers the same height above the soil and pour at the same rate.

6. Compare the rate of flow into the two containers and note the difference in the contents of the flow.

Key Questions:

1. What effect did the contouring (furrows) have on the rate of water flow through each box and into the container?

   a) Furrows running crosswise:

   b) Furrows running up and down:

2. How do the contents of the containers compare with each other? What is in each container?

3. What conclusions can you make about soil erosion and drainage for each?

   a) Furrows running crosswise:

   b) Furrows running up and down:

Lesson 6: Soil Conservation Practices Name_____

Contour Farming and Soil Erosion

Objective: Students will identify how contour farming affects soil erosion.

Materials and Equipment:

Two large, round pie pans
Watering can with sprinkler nozzle
Soil (can use potting soil)

Procedure:

1. Put two mounds of soil in the two large round pie pans.

2. With a pencil or your finger make furrows up and down one of the mounds and circles around the other mound.

3. Fill the watering can with water. Slowly sprinkle an equal amount of water on each mound and observe the water as it flows over the mounds. (Keep in mind that these example mounds probably have much steeper slopes than most cultivated land.)

Key Questions:

1. What effect did the contouring (furrows) have on the rate of water flow in each pan?

   a) Furrows running up and down:

   b) Furrows running around:

2. What conclusions can you make about soil erosion and drainage for each?

   a) Furrows running up and down:

   b) Furrows running around:

UNIT IV - IDENTIFYING AND SELECTING CROPS AND SEEDS

Lesson 1: Crop and Weed Identification

Competency/Objective: Identify crop and weed seeds and plants.

Study Questions

1. **What plant types and physical characteristics are used to identify crop and weed plants?**
2. **What are the characteristics of grass and grasslike plants?**
3. **What are the characteristics of legumes?**
4. **What are the characteristics of forbs?**
5. **What are the characteristics of woody plants?**
6. **What are the identifying characteristics of common weed plants?**
7. **What are the identifying characteristics of noxious weed plants?**
8. **What are the identifying characteristics of crop and weed seeds?**
9. **What weed seeds are included on the restricted noxious list?**
10. **What weed seeds are included on the restricted prohibited list?**

References

1. *Advanced Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2000, Unit IV.
2. *Crop Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1992.
3. *Crop and Grassland Plant Identification Manual.* University of Missouri-Columbia: Instructional Materials Laboratory, 1997.
4. *Growers Weed Identification Handbook* (Publication 4030). Cooperative Extension. University of California, Division of Agriculture and Natural Resources, 1991. (Available for free loan from MRCCTE, University of Missouri-Columbia.)
5. Transparency Masters
    a) TM 1.1: Leaf Characteristics
    b) TM 1.2: Cool- and Warm-Season Grass Growth
6. Activity Sheet
    a) AS 1.1: Identifying Weeds of Missouri

UNIT IV - IDENTIFYING AND SELECTING CROPS AND SEEDS

Lesson 1: Crop and Weed Identification

TEACHING PROCEDURES

A. ***Introduction***

This lesson will discuss the identifying characteristics of crop and weed seeds and plants. It is important for the producer to understand the differences and be able to identify, in particular, those weeds that can be harmful to the productive value of the crop. Early detection is necessary to effectively control weeds.

B. ***Motivation***

1. Have students bring in plant samples from grasslands or crop fields near their homes. Discuss what types of plants can be found locally.

2. Divide the class into groups. Give each group a package of mixed seeds (e.g., corn, sunflower, and pinto beans). Have students separate and identify them. Discuss how they identified the seeds and why identification is important. While the students are divided into groups with the seeds separated, point out to them distinguishing characteristics of specific seeds. Refer to IML's *Crop Science* Student Reference for a review of identifying characteristics of crop and weed seeds.

C. ***Assignment***

D. ***Supervised Study***

E. ***Discussion***

1. Discuss how plants can be classified other than by life cycles. Plants are also categorized according to their physical characteristics. Using the plants acquired during the Motivation, group the plants found locally into the four plant types. Leaf characteristics are the most varied. Using TM 1.1, review the characteristics of leaves.

   What plant types and physical characteristics are used to identify crop and weed plants?

   a) Plant types
      1) Grasses and grasslike plants
      2) Legumes
      3) Forbs
      4) Woody plants
   b) Physical characteristics
      1) Leaf shape
      2) Stem
      3) Flower
      4) Root

2. Separate grasses according to required temperature for growth. Point out examples of cool-season grasses, such as Kentucky bluegrass, orchardgrass, and smooth bromegrass. Compare the differences to warm-season grasses, such as indiangrass, big blue stem, and switchgrass. Discuss the characteristics of both cool-season and warm-season grasses. Show TM 1.2 of Cool- and Warm-Season Grass Growth. Also refer to the *Crop and Grassland Plant Identification Manual* for more examples of grasses.

What are the characteristics of grass and grasslike plants?

a) Characteristics
   1) Herbaceous
   2) Hollow stems
   3) Blades and stems joined directly at sheath
   4) Parallel venation on leaf blade
b) Cool-season grasses
   1) Grow when soil temperatures reach 40°F in early spring,
   2) Optimum growth with air temperatures from 59° to 77°F in spring and fall
   3) Dormant in summer
   4) Annuals or perennials
c) Warm-season grasses
   1) Grow when soil temperatures reach 60°F in spring, with optimum growth occurring when air temperatures increase from 77° to 104°F in summer
   2) Dormant in winter
   3) Annuals or perennials

3. Discuss the characteristics of legumes. Point out some examples of legumes, such as clovers, alfalfa, and birdsfoot trefoil. Refer to the *Crop and Grassland Plant Identification Manual* for details.

What are the characteristics of legumes?

a) One-chambered fruit with seeds in a single row within the pod
b) Alternating leaf arrangement - usually connected to petiole
c) Network of veins
d) May be annuals, perennials, or biennials
e) Nodules with nitrogen-fixing capacity on most rooting systems

4. Other herbaceous plants that are neither grasses nor legumes are classified as forbs. Discuss the characteristics of forbs. Examples of forbs include sunflowers, thistles, and ragweed. Refer to the *Crop and Grassland Plant Identification Manual*.

What are the characteristics of forbs?

a) Herbaceous (not woody) stems
b) Broadleaf plants
c) Commonly appear in pastures, fields, and native plant habitats
d) May be annuals, perennials, or biennials
e) Valued as wildlife food and cover
f) Prevent soil erosion
g) Some are noxious

5. Other nonherbaceous plants found in grasslands are woody plants. In crop production, most woody plants will be weedy saplings or small immature trees and shrubs. Examples of woody plants include wild rose, red cedar, and oak. Discuss the characteristics of woody plants. Refer to the *Crop and Grassland Plant Identification Manual*.

What are the characteristics of woody plants?

a) Woody (nonherbaceous) stems
b) Shrubs, vines, or trees
c) Usually immature in grasslands
d) Perennials

6. Explain that common weeds are relatively easy to control but reduce crop yields and increase production costs. Remind students that plants that are considered crops, such as corn and soybeans, are weeds if they are growing in the wrong field. Refer to the *Crop and Grassland Plant Identification Manual* to identify common weed plants. The *Growers Weed Identification Handbook* available from MRCCTE can also be used.

What are the identifying characteristics of common weed plants?

a) Easy to control
b) Annual or perennial
c) Grass or forb

7. Explain that noxious weeds are difficult to control and that the presence of noxious weed seed in agricultural crop seeds is restricted in Missouri. Refer to Table 1.1 in the Student Reference for detailed characteristics of noxious weeds.

What are the identifying characteristics of noxious weed plants?

a) Crowds out desirable crops
b) Robs crops of plant nutrients and moisture
c) Causes extra labor in cultivation
d) Annual, biennial, or perennial
e) Grass or forb
f) Growing plants considered noxious
    1) Musk thistle
    2) Scotch thistle
    3) Canada thistle
    4) Multiflora rose
    5) Bindweed
    6) Purple loosestrife
    7) Marijuana (*Cannabis sativa*)
    8) Johnsongrass

8. The Bureau of Feed and Seed administers laws and regulations to ensure that seeds are labeled consistently and accurately. Discuss with the class various characteristics of crop and weed seeds. Refer to IML's *Crop Science* curriculum for further information.

What are the identifying characteristics of crop and weed seeds?

a) Size
b) Shape
c) Color
d) Surface markings
e) Other botanical characteristics

9. Refer to the current Missouri Seed Law and Regulations for weed seeds listed as restricted noxious. Restricted noxious weed seeds are defined as highly objectional in fields, lawns, or gardens of Missouri and are difficult to control by good cultural practices. Seed companies must list these seeds, if any, on labels.

What weed seeds are included on the restricted noxious list?

a) Red sorrel
b) Curled dock
c) Dodder
d) Buckhorn plantain
e) Black nightshade

f) Giant foxtail
g) Hedge bindweed
h) Leafy spurge
i) Hoary cress
j) Purple moon flower
k) Quackgrass
l) Russian thistle
m) Slender oats
n) Wild garlic
o) Wild onion
p) Wild oats
q) Yellow star thistle

10. Discuss the weed seeds that are listed on the restricted prohibited list. Restricted prohibited weed seeds are defined by law as the seeds of weeds that when established are highly destructive and difficult to control in this state by good cultural practices. Explain that each state determines its own prohibited seed list. Seed companies must design seeds to certain state specifications.

What weed seeds are included on the restricted prohibited list?

a) Canadian thistle
b) Field bindweed
c) Johnsongrass
d) Sorghum almum
e) Musk thistle
f) Balloon vine
g) Serrated tussock

F. ***Other Activities***

1. Take a field trip to a nearby pasture or field and discuss the different types of plants found there. Have the students explain the different plant uses for producers, livestock, wildlife, and others.

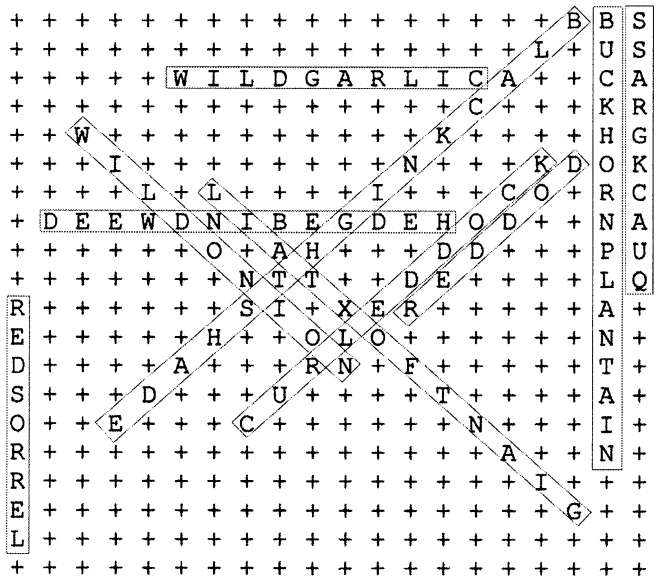
2. Have students create their own plant guide with samples collected from local grasslands and crop field areas. Guides should include 25 different plants with at least three from each classification. Plant samples should be collected, mounted, and labeled according to plant type: grass (warm- or cool-season), legume, forb, or woody.

G. ***Conclusion***

The ability to identify the differences between crops and weeds is important to the production of a profitable crop. Proper seed and plant identification plays a part in the process of reducing weeds and in turn reducing the damage to crops.

H. ***Answer to Activity Sheet***

AS 1.1



AS 1.2

Answers will vary.

I. ***Answers to Evaluation***

1. b
2. e
3. c
4. a
5. d
6. d
7. b
8. a
9. a
10. b
11. c
12. e
13. a
14. b
15. b
16. a
17. a
18. a
19. b
20. b
21. c
22. They are nonherbaceous with woody stems.
23. Common, noxious, prohibited
24. *Missouri Seed Law and Regulations*