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.
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
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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.


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. -
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

Conventional Tillage

- 15% or Less Crop Residue
  - Flrowing
  - Chisel Plowing
  - Disking
  - Planting
  - Cultivating

Reduced Tillage
- 20% - 30% Crop Residue
- Chisel Flowing
- Disking
- Planting

No-till
- 30% or more Crop Residue
- Planting and Spreading Only

Conservation Tillage

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

<table>
<thead>
<tr>
<th>Method No. 1</th>
<th>Method No. 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment Used</td>
<td>No. of Trips</td>
</tr>
</tbody>
</table>

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.
**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:
   - **C** Keep both ends of the tape anchored and do not move the tape.
   - **C** 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.
   - **C** Consistently look at the same side of the tape.
   - **C** Consistently look at the same point at each mark.
   - **C** 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.
<table>
<thead>
<tr>
<th># of Marks for 100-foot tape</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
</tr>
<tr>
<td>Total:</td>
</tr>
<tr>
<td>Average:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th># of Marks for 50-foot tape</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. X 2 =</td>
</tr>
<tr>
<td>2 X 2 =</td>
</tr>
<tr>
<td>3. X 2 =</td>
</tr>
<tr>
<td>Total: X 2 =</td>
</tr>
<tr>
<td>Average:</td>
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</table>