Resource Unit on SOILS for Core Curriculum

Agricultural Education Section
Department of Vocational Education
Phoenix and
Department of Agricultural Education
The University of Arizona, Tucson

Resource Unit Number Ten
Resource Unit on
SOILS
For Core Curriculum

Resource Unit Number Ten

Department of Agricultural Education
The University of Arizona, Tucson

Revised February 1982
ACKNOWLEDGEMENTS

Special recognition is given to Mr. Richard C. Sawyer, Curriculum Specialist in the Department of Agricultural Education; Mr. Fred L. Amator, Graduate Research Assistant, Department of Agricultural Education; and Dr. Donald Post, Department of Agricultural Chemistry and Soils, College of Agriculture, University of Arizona, Tucson. Acknowledgement is also given to Mr. Gordon G. Hall, Acting State Supervisor, Agricultural Education, for his critical review of material contained in this resource unit.

"The University of Arizona is an Equal Employment Opportunity/ Affirmative Action Employer. In compliance with Title IX (Educational Amendments of 1972, Title VII (Civil Rights Act of 1964), and Section 504 (Rehabilitation Act of 1973), the University does not discriminate on the basis of sex, race, creed, color, national origin, or handicapping condition in its educational programs or activities, including admissions and employment. Inquiries concerning application of Title IX, Title VII, and Section 504 may be referred to Dr. Jean Kearns, Assistant Executive Vice President, Administration 503, phone 602-626-3081."
AREA: SOIL SCIENCE

Unit: Soils

Concepts to be Taught:

1. The function of soil is to provide nutrients, support and moisture for plants.

2. The development of soil from parent material is the result of physical, chemical and biological action.

3. The ability of a soil to sustain plant growth is determined by its physical and chemical properties.

4. Organic matter improves soil structure and increases the soil's ability to retain and supply moisture and nutrients.

5. In assessing the potential of a given soil, a soil profile indicates physical properties which affect productivity.

6. In order to maintain soil fertility, essential nutrients must be replenished at the same rate at which they are removed.

7. In order to increase soil fertility, essential nutrients must be added in excess of those removed.

8. Land capability classification provides an indication of a soil's productive capability and management needs.

9. Soil testing provides information essential for making recommendations on fertilization and cultural practices.

10. Soil erosion can be minimized through the use of soil conservation practices.
Unit Objectives:

1. To list and explain the functions of soil as related to plant growth, development and maintenance.

2. To describe the formation and development of basic soils due to physical, chemical and biological reactions on parent material.

3. To list and describe the physical properties of soils.

4. To list and describe the chemical properties of soils.

5. To identify the components of a soil profile.

6. To describe the physical properties of a soil profile which are important for plant growth.

7. To identify the land capability classes.

8. To list the characteristics of the land capability classes.

9. To explain how the land capability classes aid in determining the utilization of land.

10. To list the methods of testing soils and their uses.

11. To explain how soil testing aids in determining the fertilization and cultural practices for a particular soil.

12. To list and describe the types of soil erosion.

13. To list and describe the practices used in the conservation of soil.

References:

Berger, K. C. Introductory Soils
Donahue, R. L. Soils and Introduction to Soils and Plant Growth
Foster, A. B. Approved Practices in Soil Conservation
Knuti, L., Korpí, M., and Hide, J. Profitable Soil Management
Stallings, J. H. Soil Use and Improvement
U.S.D.A. Yearbook Soils
Teaching Aids:

1. Samples of soil separates
2. Samples of common soil classes
3. Soil profile
4. Land capability maps
5. Slide series from University of Arizona Crops and Soils Club, Micro Monoliths and Overlays
6. Soil auger or core-type soil sampler
7. Soil test kit
8. Overlays
9.
10.
11.
12.

Student Activities:

1. Take a field trip to observe and compare soil properties and soil profiles. Consult with the local Soil Conservation Service Office for help in locating different kinds of soils. Collect "micro-monoliths" of each soil. "Micro-monolith" soil sampling kits may be purchased from the University of Arizona Crops and Soils Club.

2. If a microscope is available, examine sand, silt, and clay particles under the microscope. Also, look at the "micro-monolith" specimens under the microscope.

3. Set up a soil erosion experiment using flats of soil and collect all runoff and soil sediments for measurement purposes. Plant different crops in various up-down hill methods, in strip cropping fashion or construct terraces to observe differences in soil and water losses.

4. Punch holes in 2½ coffee cans and fill with various kinds of soil. Add water to the top and time in minutes the infiltration rate. Also, can measure amount of water soil can hold by carefully measuring water added minus the water leached out.

5. Take Soils of Arizona slide set and determine the capability class of these soils.

6. Grow plants in cans or pots and apply different rates of fertilizers. The response of cotton to application of nitrogen is a very good experiment. Measure the yield by weighing the plants to accurately determine the response to the fertilizer.

7. Test soils and plant tissue with testing kits sold on the market.

8. Prepare a display board with the different kinds of soil structure mounted on the board. The plastic fixative may be purchased from the University of Arizona Crops and Soils Club.
9. Cut the bottom out of several cans and push them into the soil. Add water and measure the water intake rate as a function of time.

10. Have a field trip and do some soil judging.

11. Use mechanical analysis of soil texture.

12. Use feel method to determine soil texture.

13. Correlate land capability classifications with soil maps from local areas.

14. Make a mechanical analysis of soil samples using the Mason jar method.
Questions and Problems for Discussion

1. What is soil?

   Soil is a mixture of broken and weathered fragments of rock and/or
decaying organic matter, which covers the earth in a thin layer and
serves as the medium for plant growth.

2. What are the functions of soil as related to plant growth, development,
   and maintenance?

   a. Media for the support of plants

      Roots anchored in soil enable growing plants to remain upright.
      In some soils, the second layer (B horizon) is impermeable which
      causes plants to be shallow rooted. If this happens to a tree, it
      can easily be blown over by the wind.

   b. Supplier of plant food nutrients

      The soil is a storehouse of nutrients. If nutrients are not
      stored in the soil, they are not available for plant utilization.

      Sixteen elements are currently considered necessary for plant
growth. Of these, three are obtained from the air while the other
13 elements are obtained largely from the soil.

      Most of the essential nutrients stored in the soil are largely
      insoluble and unavailable to plants. Before nutrients become
      available to plants, mineral weathering and organic matter decom-
      position must take place.

   c. Provider of moisture to plants

      Moisture for plant growth is stored in the soil. It takes about
500 pounds of water to produce one pound of dry plant material.
About five pounds or one percent of this water becomes an integral part
of the plant. The remainder is lost through the stoma of the leaves
during the course of transpiration. This water must be stored by
the soil and then provided to the plant.

   d. Media for seed germination

      The soil is used as a germination media for many seeds. As a
media for germination, it must provide the correct environment for
seed germination.

      The soil provides moisture which is absorbed by the seed as the
first step in germination. A favorable temperature is the second
requirement for seed germination. The soil must also provide a
supply of oxygen for respiration by the seed which takes place as
long as the seed is viable (capable of germination).
3. What is the composition of soil?

Soil is composed of mineral matter that has been broken down by chemical, physical, and biological action to the point where it can support life by providing the functions of soil. The soil also contains decayed plant and animal life which is called organic matter.

Many organisms are also found in the soil; these organisms include bacteria, fungi, molds, worms, insects and many other kinds of tiny plants and animals. The more living organisms there are in the soil, the more productive the soil can be. This increased productivity is due to larger amounts of nutrients being made available by the decomposition of organic matter by the soil organisms.

The soil also contains a variable percentage of water and air. The following diagram shows the general make-up of a typical Arizona soil.

4. What is parent material?

Parent material is the unweathered material from which a soil is formed.

5. In what way does the nature of the parent material affect the soil?

Soils resemble the parent material from which they come. The nature of the parent material will have a pronounced effect on the properties of young soils and will exert a lesser influence on older soils. Properties of the parent material that exert an influence on soil development include texture, mineral composition, and degree of stratification (layering).
Relative to texture the downward movement of water is largely controlled by fine-textured materials usually having a higher organic matter content than those formed from coarser-textured materials. The finer texture may enhance plant growth by providing a greater water and nutrient supply.

The chemical and mineral composition of a soil often not only determine the effectiveness of the weathering forces, but in some instances partially control the natural vegetation. If parent material contains large amounts of organic matter, the soil will be more acidic. Soil acidity encourages mineral decomposition, translocation of very small soil particles, and the overall development of the soil profile. Soil formed from parent material high in limestone will be more basic. Where parent materials are rich in lime, development of a soil is delayed, and it remains immature for a longer period of time.

The degree of stratification or layering has an important influence on the properties and uses of a soil in that a soil is not uniform throughout its depth. A layer of soil which is high in clay can make an otherwise useless sandy soil suitable for crop growth by adding to the water and nutrient retention of the soil.

6. **What physical, chemical and biological actions take place in the development of soils?**

Rocks and minerals, which are the soil parent materials, are weathered into soil by physical disintegration, chemical decomposition and biological reactions.

Physical weathering processes include freezing and thawing, heating and cooling, wetting and drying, erosion, and the action of plants, animals, and man.

Chemical weathering includes such processes as oxidation, reduction, hydrolysis, hydration and carbonation.

Biological decomposition of parent material is closely related to both the physical and chemical decomposition. Plant and animal life greatly influence the soil-forming processes. Animals are constantly scratching rocks, and this action on soft rocks aids in their disintegration. Plants grow between rocks, splitting them apart. Also many of the microorganisms in the soil secrete gummy substances which aid in the decomposition of parent material.

7. **What are the physical properties of soil?**

a. **Texture**

Soil texture refers to the fineness or coarseness of a soil. More specifically, texture is the relative proportions of the different size particles (sand, silt, and clay) found in a
particular soil. The determination of the amount of the various separates present in the soil is called a mechanical analysis.

b. Structure

Soil structure refers to the way individual soil particles are arranged to make up the mass of soil. It is the aggregation of primary soil particles (sand, silt, clay) into compound particles. Structure modifies the influence of texture in regard to moisture and air relationships, availability of plant nutrients, action of microorganisms, and root growth. The structure of a soil is not permanent. Wetting, drying, plowing, or other disturbances of the soil can change its structure.

c. Depth

The effective rooting zone available to plants is restricted by the depth of a soil. This is very significant to soil use and management. For example, a gravel layer at two feet would restrict the roots of a plant causing it to be shallow rooted. A cotton crop growing on such a soil commonly suffers from lack of water.

d. Color

Soil color serves both the farmer and the soil scientist, provided they understand the causes of the various colors and are able to interpret them in terms of soil properties. Organic matter content, drainage conditions, and aeration are soil properties related to color which are of interest to farmers. Color is used as an aid in soil classification and the color of the different layers (horizons) relates information about conditions pertaining to and forces active during soil formation.

8. What are the soil separates?

a. Sand

Sand is coarse-grained pieces of rock. The individual grains can easily be felt and seen. Sand has a gritty feeling; it will not stick together or form clods. It may range in grade from coarse through fine to very fine (2.00mm - 0.05mm in diameter). Because it is loose and easy to work, sand is considered a "light" soil. Due to the large size of the sand particles, very little particle surface area is exposed when compared to that exposed by an equal weight of silt or clay particles; thus the part sand plays in the chemical and physical activities of a soil is almost negligible. Since the sands are inactive, their chief function in soil is to serve as a framework around which the active part of the soil is associated. The presence of sand tends to increase the size of spaces between particles, thus facilitating movement of air and water.
b. Silt

Silt is a very soft and flour-like soil separate. Its particles are so small they can be seen only with a microscope (0.05mm — 0.002mm in diameter). Silt will form clods that crumble easily when wet. Water soaks readily into silty soil, and such soil holds its moisture well. The coarser silt particles are similar to the finer sands in particle surface exposed and therefore take very little part in the chemical activities of soils. The finer silt has sufficient particle surface area to give it some slight chemical activity. Silt particles have little tendency to stick together or to adhere to other particles except when combined with clay. Soils with the largest available water-holding capacity for plant growth are characterized by being high in silt.

c. Clay

The particles of clay (less than .002mm in diameter) are even finer than particles of silt. They appear platy in shape and thin, and fit very closely together with little space in between. When wet, fine clay is almost like jelly. The particles stick together and form hard clods that are difficult to break when dry. Because a soil containing large amounts of clay is so hard to work, it is considered a "heavy" soil. Clay soils have a much larger surface area per weight than do silt or sand, due to their small size. Since a large part of the water in the soil is held as a film on the surface of the clay particles, the amount of clay in the soil has a great influence on its total water-holding capacity. In addition, certain available nutrients are held on the surface of clay particles. Therefore, clay acts as the major storage reservoir for both water and nutrients. Clay has thousands of times more surface area per gram than silt and nearly a million times more surface area than very coarse sand.

In summary, the more surface area that a soil separate possesses, the more attraction these particles have for water, soil nutrients, and other soil particles.

9. How are different soils classified according to texture?

Soils are combinations of sand, silt, and clay and thus have special names and different properties. When a mechanical analysis of a soil is run, a report as to the percentage of each of the separates (sand, silt, clay) is produced. The soil triangle on the next page shows how the various separates combine to form the various classes of soils. The various classes of soil are separated from one another by a definite division, but their properties do not change abruptly at these boundary lines. One class grades into the adjoining classes of coarser or finer texture. For example, a loam gradually merges into a silt loam or clay loam as the percentage of silt and clay increase and, on the other hand, a sandy loam is produced as the percentage of sand replaces silt and clay in the loam.
GUIDE FOR
TEXTURAL CLASSIFICATION

Note to Teacher: Make a transparency of the above for use in teaching this section of the unit.
10. What are the chemical properties of soil?

a. Nutrients

A nutrient is a chemical element utilized by plants for growth. If a soil is to produce crops successfully, it must have, among other things, an adequate supply of all the essential nutrients which plants require for growth and development. These nutrients must be present in forms that plants can use and also there must be a rough balance between the nutrients in accordance with the amounts needed by plants. If any of these nutrients are lacking, or if they are present in insufficient quantities, normal plant growth will not occur. As nutrients are used, they must be replaced in order to maintain good soil fertility. The nutrients may be added in the form of organic matter or commercial fertilizers. If these nutrients are added to the soil in excess of those removed, an increase in soil fertility will result.

(Note to teacher: At this point, it may be desirable to identify essential plant nutrients (major and minor). Refer to Resource Unit No. 5 - Plant Growth and Development.

The table below gives general plant nutrient recommendations for various crops in Arizona. Variations in soils, crop varieties grown, fertilizer, crop history, irrigation water quality, insect and disease problems, and climatic factors all influence the amount and kind of plant nutrients needed. Suggested rates given here are average values.

<table>
<thead>
<tr>
<th>Crop</th>
<th>N</th>
<th>P2O5</th>
<th>K2O*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley</td>
<td>125</td>
<td>75</td>
<td>--</td>
</tr>
<tr>
<td>Citrus</td>
<td>75</td>
<td>0</td>
<td>--</td>
</tr>
<tr>
<td>Corn (silage and forage)</td>
<td>150</td>
<td>75</td>
<td>--</td>
</tr>
<tr>
<td>Cotton</td>
<td>125</td>
<td>50</td>
<td>--</td>
</tr>
<tr>
<td>Hay (alfalfa)</td>
<td>0</td>
<td>100</td>
<td>--</td>
</tr>
<tr>
<td>Hay (other)</td>
<td>50</td>
<td>50</td>
<td>--</td>
</tr>
<tr>
<td>Nursery &amp; Greenhouse</td>
<td>125</td>
<td>125</td>
<td>--</td>
</tr>
<tr>
<td>Nuts &amp; Fruits</td>
<td>75</td>
<td>30</td>
<td>--</td>
</tr>
<tr>
<td>Oats</td>
<td>100</td>
<td>75</td>
<td>--</td>
</tr>
<tr>
<td>Permanent Pasture</td>
<td>50</td>
<td>20</td>
<td>--</td>
</tr>
<tr>
<td>Potatoes</td>
<td>120</td>
<td>250</td>
<td>--</td>
</tr>
<tr>
<td>Safflower</td>
<td>100</td>
<td>0</td>
<td>--</td>
</tr>
<tr>
<td>Soil Improvement Crops</td>
<td>75</td>
<td>40</td>
<td>--</td>
</tr>
<tr>
<td>Sorghum</td>
<td>150</td>
<td>50</td>
<td>--</td>
</tr>
<tr>
<td>Sugar beets</td>
<td>100</td>
<td>100</td>
<td>--</td>
</tr>
<tr>
<td>Vegetables</td>
<td>125</td>
<td>50</td>
<td>--</td>
</tr>
<tr>
<td>Wheat</td>
<td>125</td>
<td>75</td>
<td>--</td>
</tr>
</tbody>
</table>

*Arizona soils contain adequate amounts of K2O, therefore, consumption rates for K2O are not indicated.
b. **Soil Organic Matter**

Soil organic matter is the partially rotted remains of plants and soil organisms. The average irrigated soil in Arizona contains less than one percent organic matter. This small amount of organic matter can improve the structure, bacterial action, and plant growth relationships of a soil.

c. **Acidity and Alkalinity**

The acidity or alkalinity of a soil, usually referred to as pH, exerts a great influence on the availability of plant nutrients. When acidity or alkalinity exceeds optimum levels, the nutrients in the soil become less available to plants and in extreme cases, acidity and alkalinity can retard plant processes.

Nitrogen, phosphorus, potassium, sulfur, calcium, magnesium, and molybdenum are more available at a pH of 6.5 than at any other pH level. Iron, manganese, boron, copper, chlorine, and zinc are less available at a pH of 6.5 than at more acid reactions. In general, however, minor elements are sufficiently available so that plant growth is not limited at a pH of 6.5. A pH of 6.5 to 7.0 is considered to be the optimum range in which most nutrients are available to plants because at this pH range they can become water soluble and thus be absorbed by the plant.

Below is a chart showing the pH scale that indicates the pH range for acidic, neutral and basic soils.

```
14  13  12  11  10  9  8  7  6  5  4  3  2  1

Optimum pH for most plant growth: 7

Basic (Alkaline)

Neutrality

Acidic
```

11. **How does soil organic matter affect the properties of the soil?**

Organic matter serves many purposes in the soil that may be summarized as follows:
a. Direct nutrition for plants
   1) To supply major nutrients such as nitrogen and phosphorus;
   2) To supply minor nutrients such as boron, manganese, zinc and others.

b. Indirect effect on plant nutrition
   1) Change in rate of release of potassium and phosphorus from inorganic minerals;
   2) Mobilizing plant nutrients such as iron, phosphates, etc.

c. Food and nutrient supply for soil microorganisms, such as carbon energy supply, nitrogen and phosphorus.

d. Plays a part in determining soil structure and thereby water behavior.
   1) Prevents dispersion or running together.
   2) Aids in water penetration and aeration.
   3) Reduces soil erosion.

e. Conservation of moisture.

12. What is a soil profile?

   A soil profile is a vertical cross-section through a soil. It is made up of a succession of layers of soil material. These layers are called horizons and they differ from each other in color, texture, or structure.

13. What are the components of the soil profile?

   a. The A horizon

      It includes the upper part of the profile in which life is most active. It is the most productive horizon because of its normally high organic matter content and granular soil structure.

   b. The B horizon

      This horizon is generally called the subsoil.

   c. The C horizon

      This horizon is the parent material.
14. What are the characteristics of each of the three horizons?

a. The A horizon
   1) May be from a few inches to a foot or more deep
   2) Usually dark colored
   3) Lighter in texture than the B horizon or C horizon
   4) More likely to have a granular structure than the other horizons

b. The B horizon
   1) Usually low in organic matter
   2) Usually red or yellowish in color
   3) Structure is less desirable than that of the A horizon, it may have a blocky or prismatic structure.

c. The C horizon
   1) It is the deepest of the three major horizons
   2) Usually very low in organic matter
   3) The texture is often coarse
   4) Structure usually undesirable
5) It is commonly lighter in color than the A and B horizons

15. What is the significance of color in a soil profile?
   a. Dark color usually indicates organic matter.
   b. Gray, motley color indicates poor drainage.
   c. Yellowish or reddish color, due to the presence of iron, indicates good drainage.

16. Of what importance is a soil profile in determining crop production?
   The kind of soil profile helps determine the vertical distance plant roots, water and air penetrate freely into the soil. If a profile shows a soil to be shallow, then a shallow rooted crop should be planted. The profile will also determine the water-holding capacity of a soil. Through calculation of crop needs, a farmer can determine how much water he will need to apply and how often he will have to apply it.

17. What effect does the C horizon have upon the soil?
   The C horizon is the parent material from which the soil is formed. The type of soil is therefore predetermined by this parent material. Dependent upon the weathering conditions present, the soil will be formed over short or long periods of time.

18. Why is land classification important?
   Land classification is a method of placing land into capability classes depending upon physical characteristics of the soil and significant land features. Once land has been classified into capability classes, its utilization can be determined and optimum use can be made. In the farming situation, land classification helps in determining the farming practices needed to conserve soil and water and to maintain and improve soil productivity.

19. What are the land capability classes? Briefly describe each.
   a. Class I
      Soils in this class are suited for the production of a wide range of plants and may be used safely for cultivated crops, pasture, range, woodland and wildlife. The soils are nearly level and the erosion hazard is low. They are deep, generally well drained, and easily worked. They are suited to intensive cropping.
b. **Class II**

Soils in Class II require careful soil management, including conservation practices, to prevent deterioration or to improve air and water relations when the soils are cultivated. The limitations are few and the practices are easy to apply. The soils may be used for cultivated crops, pasture, range, woodland, or wildlife feed and cover.

c. **Class III**

Soils in Class III have more restrictions than those in Class II and when used for cultivated crops, the conservation practices are usually more difficult to apply and maintain. They may be used for cultivated crops, pasture, woodland, range, or wildlife feed and cover.

d. **Class IV**

The restrictions in use for soils in Class IV are greater than those in Class III and the choice of plants to be grown is more limited. When these soils are cultivated, more careful management is required and conservation practices are more difficult to apply and maintain. Soils in this class may be used for crops, pasture, woodland, range, or wildlife feed and cover.

e. **Class V**

Soils in Class V have limitations that restrict the kind of plants that can be grown and that prevent normal tillage of cultivated crops. They are nearly level but some are wet; are frequently overflowed by streams; are stony; have climatic limitations; or have some combination of these limitations. These soils are used for pasture, range, woodland, wildlife feed and cover, or some combination.

f. **Class VI**

Physical conditions of soils placed in Class VI are such that it is practical to apply range or pasture improvements, if needed, such as seeding, fertilizing, and water control with contour furrows, drainage ditches, diversions, or water spreaders. These soils are not suited to cultivated crops but may be used for pasture, range, woodland, or wildlife feed and cover, or some combinations.

g. **Class VII**

Physical conditions of soils in Class VII are such that it is impractical to apply such pasture or range improvements as seeding, fertilizing, and water control. These soils can be used safely for grazing, woodland, wildlife, or some combination of these under proper management.
h. Class VIII

Badlands, rock outcrop, sandy beaches, river wash, mine tailings, and other nearly barren lands are included in Class VIII.

Soils and landforms in Class VIII cannot be expected to return significant on-site benefits from management for crops, grasses, or trees, although benefits from wildlife use, watershed protection, or recreation may be possible.

20. What are some of the characteristics of each of the land capability classes?

a. Slope
b. Erosion hazard
c. Past effects of erosion
d. Drainage
e. Water table
f. Flooding hazard
g. Surface texture
h. Coarse fragments
i. Available water-holding capacity
j. Permeability
k. Effective depth
l. Alkalinity and salinity
m. Climate
n. Water

(Note to Teacher: For further development of this section and breakdown of individual characteristics for specific land capability classes, contact your local Soil Conservation Service representative and get a copy of the chart on "Statewide Land Capability Classification System - Guide to Land Capability Classification".)

21. How can the land capability classifications help in determining the utilization of land?

The capability classification of land is an interpretive classification based on the effects of combinations of climate and permanent soil characteristics on risks of soil damage, limitations in use, productive capacity, and soil management requirements.
Based on this classification we find that Classes I through IV are suitable for cultivation and Classes V to VII are suitable for permanent vegetation.

Once land has been divided into capability classes, it is possible to determine the management practices needed to conserve soil and water and to maintain and improve productivity.

22. **What is soil testing?**

Soil testing is the application of various chemical tests to a soil for the purpose of determining the nutrients in a given soil. Also, soil tests are useful in predicting whether or not a profitable response will occur when fertilizers are applied to the soil. This serves as a good guide to the fertility program.

23. **How are soil samples collected?**

For adequate testing, approximately one pint of soil is needed for each field to be tested. A soil auger or tube, which takes a uniform core from the surface to the desired depth and which takes a uniform volume of soil each time, is the best tool to use for taking soil samples. Quite often an auger or tube is not available and a trowel or spade is used.

The following steps should be taken into consideration in obtaining a soil sample:

a. Section off the land into fields for sampling.

b. Develop a definite pattern for sampling the field.

c. Clear away any surface trash or grass from where the core is to be taken.

d. Take at least twenty cores from each field to be tested, mix them together thoroughly in a clean container, air dry, and bag or box the required amount.

e. Take the samples from normal depth of plowing, surface to six to twelve inches deep.

f. Avoid taking samples near roadsides.

g. Avoid any small areas of unusual characteristics which are not representative of the field.
h. Sample separately those areas of the field that have a different slope, color, or texture, or those small areas that lend themselves to separate treatment.

i. Avoid sampling such areas as dead furrows or back furrows, near manure piles or under animal droppings.

j. Label all samples correctly. Included in the information on the label should be: your name, return address, field sample number, and the desired soil test.

k. A record should be kept of where the samples were taken. This can be easily done by making a map and placing on it the sampling number from the area in which it was taken.

\textbf{NOTE} Information on the cropping history and fertilization program of the field should also be made available to the soil test laboratory.

24. Where can soil be sent for testing?

All 50 states have a state—supported soil testing service. In addition, many states have county laboratories which operate as branch services for the central laboratory. Many private commercial laboratories also test soils. It is wise to have soils tested locally because local laboratories have evolved methods that are more accurate for the conditions found in the area. These local laboratories also know how the soil tests correlate with crop growth in the soils of the region.

The following agencies in the state of Arizona will do soil testing:

Educational or Research Purposes Only

County Agent (in each county)

The soil samples are sent to the U of A laboratory.

General Purposes

Continental Soils LTD
929-931 E. Indian School Rd.
Phoenix, AZ 85007

Efco Analytical Laboratories
Division of Arizona Feeds
2819 W. Ruthrauff Rd.
Tucson, AZ

IAS Laboratories
2643 E. University Dr.
Phoenix, AZ
25. What are the various methods of soil testing and their uses?

   a. Total chemical analysis

       A total chemical analysis of a soil indicates the total amount of nutrients (available and unavailable) in a given soil.

   b. Rapid laboratory test

       A rapid laboratory test of a soil measures the available nutrients in a soil. This test is an excellent guide for determining fertilizer needs of a soil but must be used in conjunction with cropping and fertilizing history.

   c. Rapid field test

       A rapid field test of a soil measures the available nutrients in a given soil but is not as reliable as a rapid laboratory test. For this test, a kit should be used that has been proven effective for the soils of the local area.

26. How does a soil test aid in determining the fertilization and cultural practices for that soil?

   Although the correlation of soil test results and fertilizer response is not perfect, it has been indicated that the lower the soil test for a particular element, the greater the plant response when this element is added as a fertilizer.

   The problem with all soil tests is in correlating laboratory results with plant response in the field situation. Many factors are taken into consideration in interpreting soil tests. Among these are the level of plant nutrients established by the tests and the fertilizer response in the area. Some types of soils are more likely to respond to certain fertilizers than other soil types. The plant nutrient needs of the crop to be grown are always given consideration.

27. What tests other than a soil test can be used for determining fertilization requirements?

   a. Plant tissue testing

       Growing plants can be chemically tested to determine the amount of nutrients they contain. Plant tests enable the grower or soil scientist to "look inside" the plant. The testing process involves a chemical analysis of a portion of the plant to determine the concentration of nutrients in such degrees as low, adequate and plentiful.

       Tissue tests (including petiole testing) have an advantage over soil tests because the plant itself is checked as a nutrient-extracting agent. The analysis reflects the condition of the plant
at the instant the sample was taken. Plant tissue tests reflect the conditions a plant is encountering better than a soil test can be expected to do.

b. Deficiency symptoms

Deficiency symptoms of plants also show what a plant needs in the way of nutrients. However, many times the symptoms occur so late in the plant's growth cycle that it is hard to correct the deficiency before non-reparable damage is done. Also, mild deficiencies may not show characteristic symptoms; yet, yields might be increased by fertilization.

Sometimes deficiency symptoms are complicated by both disease and insect damage; consequently, absolute identification of deficiencies may be difficult.

28. What is soil erosion?

Soil erosion is the movement of soil particles from one place to another under the influence of water or wind.

29. What are the types of soil erosion?

a. Water erosion

Erosion by water is caused by raindrops, surface flow and gully flow. Water erosion is a selective process in which the organic matter and finer soil particles are removed first. This selective feature of soil erosion rapidly destroys productivity of cultivated lands.

Splashing of raindrops on bare loams, sands and sandy soils separate organic matter, silt, and clay from sand. These materials are then washed away by surface flow, and the heavy sand is left on the field. This sand is turned under at the next plowing of the field or is mixed with the surface layer of the soil at the next cultivation. In either case, a fresh supply of topsoil is brought to the surface for further action. Repeating this procedure over the years produces a sandier, less productive soil, particularly in the case of severe erosion.

b. Wind erosion

Erosion by wind is common in dry areas where soils are often bare of vegetation and high wind velocities are common. The wind sorts out the organic matter and lightweight silt and clay particles and blows them away. The first duststorms are the most damaging since the soil blown away contains the largest amounts of plant-food-bearing silt, clay and organic matter. More of these materials are removed with each succeeding duststorm, but the sand and other
coarse materials are left behind. The organic matter, silt and clay are the most important parts of the soil, because they supply the nutrients needed by the plants. As the food supply is reduced, crop production declines.

30. **What cultural practices contribute to soil erosion?**

a. Plowing land which is unsuitable for cultivated crops.

b. Plowing soil in areas with too little rainfall to support continuous crop production.

c. Breaking up large blocks of land susceptible to erosion.

d. Failure to maintain crop residues on the surface while the soil is not protected by growing crops.

e. Exposing soil on slopes.

f. Removing natural vegetation from forest lands.

g. Reducing and weakening plant growth by overgrazing.

31. **What are the results of erosion?**

a. Loss of the most essential part of the soil—the topsoil, with its finer soil particles, better tilth, superior water-retention capacity, more plentiful mineral and organic elements, and helpful bacteria.

b. Reduction of crop yields.

c. Need for greater use of plant and commercial fertilizers.

d. Production of less-nutritious crops.

e. Formation of gullies by which erosion is speeded and farmland is made impossible to cultivate.

f. Covering of rich bottomlands by soils from poorer highlands.

g. Destruction of roadbanks and removal of bridges.

h. Erosion by stream banks of valuable bottomlands.

i. Silting of ditches, streams, dams, lakes and reservoirs.

j. Increase in flood hazard.

k. Waste of water that could be used for farming and other purposes.
32. **How can soil loss from erosion be prevented?**

Soil erosion can be minimized through the use of soil conservation practices.

33. **What are some soil conservation practices for the control of soil erosion? Describe each briefly.**

a. **Use of thick-growing sod crops**

Crops which cover the ground surface and fill the surface soil with fibrous roots tend to hold the soil in place and reduce erosion.

b. **Cultivation on the contour**

Cultivation on the contour is the practice of planting and cultivating of crops following the contours of the land. Effective water erosion control can seldom be obtained from contour cultivation alone. The capacity of the furrows normally made by contour tillage is small. Best results are obtained when contouring is used either with strip cropping or terracing.

c. **Use of strip cropping**

Strip cropping is the practice of planting of two crops in alternating strips or alternately planting a strip and leaving a strip fallow on land that is easily erodible. Usually a cultivated crop is alternated with non-cultivated crop. The strips should be planted on the contour as nearly as possible.

d. **Terraces to remove runoff safely**

Terracing is the practice of constructing embankments or ridges across sloping soils. The main reason for terracing in wet areas is to construct a ridge across a slope to guide surplus water safely off a field. In dryland areas, terraces are constructed to increase water penetration.

e. **Use of crop rotation**

Crop rotation is the growing of a selected number of different kinds of crops in regular order on any particular field. The principle objectives of a good rotation are to secure more economical and more certain production of crops over a period of years, and to control soil erosion.

f. **Building farm ponds and dams**

Artificial ponds hold or impound water which otherwise would be lost as runoff, and which in the process of runoff, would carry soil with it.