THE
4-H SOIL CONSERVATION CLUB
I—KNOW YOUR SOIL
4-H CLUB CIRCULAR 47

COLUMBIA, MO. MAY, 1936

COOPERATIVE EXTENSION WORK IN
AGRICULTURE AND HOME ECONOMICS
UNIVERSITY OF MISSOURI COLLEGE OF AGRICULTURE AND THE UNITED
STATES DEPARTMENT OF AGRICULTURE COOPERATING
J. W. BURCH, Assistant Director, in Charge Agricultural Extension Service
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CONTENTS.

THE 4-H SOIL CONSERVATION PROJECT I - KNOW YOUR SOIL*

REQUIREMENTS.

Object.-The object of The 4-H Soil Conservation Project I - Know Your Soil - is to organize rural boys and girls into groups for the purpose of impressing them with the seriousness of soil erosion and soil fertility losses; of instructing them in some of the recommended methods which might be followed in reducing such losses in the future; of demonstrating to themselves and the community the value of these methods; and to train the members in leadership.

Work Required.-Each member is required to:

1. Determine how soil is made by observing layers of rock materials below and the soil and decaying plant materials above.

2. Identify soils from the standpoint of texture or fineness, and humus or organic matter content.

3. By observation, determine the effect of different kinds of soil upon the nature, density and size of plant growth.

4. Observe and take note of the following:

   (1). Depth of surface soil on level and rolling areas of cultivated and uncultivated fields, as compared to grass land.

   (2). The amount of soil which is lost when an average size gully is formed.

5. Observe the nature of legume growth and learn the methods by which it is made more helpful to the soil.

6. Become acquainted with a simple method of finding out whether or not a soil needs lime for the best growth of clovers and alfalfa.

7. Determine the effect of different kinds of soil on farm improvements and plant growth, and make a study of the things which will help maintain and build up soil fertility.

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*This circular was prepared by O. T. Coleman, Extension Specialist in Soils, in collaboration with T. T. Martin, State Club Agent.

Acknowledgement is hereby made for use of illustrative materials taken from the following sources:

The Soil and Its Management, by Miller, Figures 2, 4, 5, 6, 10, 12, 14.

Productive Soils, by Weir, Figures 1, 9.

Text Book of Geology, by Persson and Schuchert, Figure 3.

Records Required.-Each member is required to keep an accurate account of all operations outlined, and to write a story on a report blank provided by the Extension Service of the Missouri College of Agriculture.

Ownership Required.-The club will be required to spend only a few cents for blue litmus paper and other materials. Equipment probably can be borrowed from the county extension agent.

Time Required.-Time necessary:

For attendance at six or more club meetings.

For necessary work on the project, tours, etc.

For attendance at a public achievement program at the close of the year's work.

Organization.-Clubs may be organized at any time of the year, with preference for September and October for fall clubs; and March, April, and May for spring and summer clubs.

ORGANIZATION OF A STANDARD 4-H CLUB.

A standard 4-H club is composed of a group of five or more boys and/or girls from the same community between the ages of 10 and 21 years, who are working upon the same club project under the direction of a local club leader.

Each standard club usually is sponsored by a community organization of some kind, or by a small committee of interested persons, who are selected to speak and act for the community in cooperation with the county club leader in the conduct of 4-H club work.

If available, an interested farmer might be secured as an assistant for school clubs. Farmers or teachers who are interested will make good leaders for out-of-school clubs.

Standard 4-H clubs are required to hold at least six regular meetings during the club year. These meetings may be conducted as often as the local club leader and members desire; however, the meetings usually are conducted once each month.

Below are suggested problems for a number of club meetings. It may be necessary to devote two or more meetings to the same subject and to change the order of some of the meetings as an adjustment to the seasons of the year. Local club leaders and members are expected to adapt these subjects to local community conditions.

SUGGESTED MEETINGS FOR A 4-H SOIL CONSERVATION CLUB.

1. Organization of the Club.-The local club leader in charge. (Reference: The Club Secretary's Record Book or the Leader's Manual.)

1. Explanation of the duties and responsibilities of club officers and members.

2. Election of club officers from the membership of the club. (President, Vice-President, Secretary-Treasurer, Song Leader and Reporter.)

3. Selection of a name for the club. (So as to identify the club's community and this project.)

4. Selection of a time and place for regular club meetings.

5. Instructions.-The local club leader in charge.

(1). Distribution of the club literature and explanation of its use.

(2). Explanation of the soil conservation club project requirements and the standard 4-H club requirements.

(3). Adoption of the constitution and by-laws, as amended to suit local conditions. (The members may indicate their desire to carry out this project by signing their names as a pledge on blanks below the constitution and by-laws in the Club Secretary's Record Book.)

(4). Setting soil conservation goals, as:

a. Every member will carry out or help carry out on his or on a neighbor's farm at least one recommended practice in soil conservation or soil improvement or both.

b. Every member will teach at least one other person some approved method in soil conservation or improvement.

c. Every member will attend each club meeting.

(It is suggested that the club set up its own goals or adopt one or more of the above, and write them out on blanks provided in the Club Secretary's Record Book.)

(5). Discussion of the main club activities for the year and setting up of a local club calendar of events for the club, including community and county-wide events in which the members desire to take part. (See blanks in the Club Secretary's Record Book.)

(6). Assignment of work for the next club meetings, as:

a. Assignment of the national 4-H club pledge to be learned by all members before the next meeting. (See suggested outline of Meeting II.)

b. Bringing of report blanks for use in the club meeting.

c. Reference: What Soil Is and How It Is Made. (See Meeting II for detailed assignment.)

d. Assignment of one or more topics to be used in response to roll call at the next meeting, as:

(a). Give a standard 4-H club requirement.

(b). Give two materials from which soils are made.

(c). Name four ways in which soils are formed from rock.

e. In order to make the regular club meetings more interesting, it is suggested that the local leader encourage the members to appoint a program committee at the next club meeting to feature some special number at each club meeting, such as: a reading, dialogue, musical selection, story, debate, or talk by an invited guest, and possibly a one-act, home talent play for some program during the year.

(7). The Social Hour.-(Recreation and games.)

II. What Soil Is and How It Is Made.
(This problem can be studied any time of the year.)

1. The Business Meeting.-The club officers in charge. (Reference: The Club Secretary's Record Book.)

(1). Meeting called to order by the president, who leads the members in repeating the national 4-H club pledge, as follows:

"I pledge my head to clearer thinking, my heart to greater loyalty, my hands to larger service, and my health to better living, for my club, my community and my country."

(2). Roll call by the secretary, the members responding by reporting upon the previously assigned topics.

(3). Reading of the minutes of the last club meeting by the secretary, which should be adopted as a permanent record by the club when approved.

(4). Unfinished business:

a. Business from the last meeting.
b. Committee reports.

(5). New Business:

a. Appointment of a program committee to plan for special activities at future club meetings.

b. Appointment of a social committee.

c. Anything for the benefit of the club, such as a picnic, club tour, special meeting, club dramatics, etc.

(6). Songs, led by the song leader.

(7). Adjournment of the business meeting for work.

2. Instructions.-The local club leader in charge.

(1). Discussion: What Soil Is and How It Is Made, Chapter II.

a. What soil is.

b. How soil is made.

(a). Freezing and thawing.

(b). Dissolving effect of water on rock.

(c). The breaking up of rock by plant roots.

(d). Softening effect of the organic acids upon the rock itself.

(2). Demonstration: Apply a small amount of acid to limestone rock and note results.

(3). Assignment of work for the next club meeting, as:

a. References: Kinds of Soils. (See Meeting III for detailed assignment.)

b. Bringing of report blanks for use in the club meeting.

c. Assignment of one or more topics to be used in response to roll call at the next meeting, as:

(a). Name a standard 4-H club requirement.

(b). Tell how to distinguish a sandy soil from a silt soil.

(c). Describe how to tell a silt soil from a clay soil.

(d). Describe the effects which organic matter has on soil.

3. The Social Hour.-(Recreation and games.)

III. Kinds of Soils.
(This problem can be studied any time of the year.)

1. The Business Meeting.-The club officers in charge. (Follow order of business as suggested for Meeting II.)

2. Instructions.-The local club leader in charge.

(1). Discussion: Kinds of Soils, Chapter III.

a. Classification according to fineness or texture.

b. Classification according to the organic matter content.

c. Soil identification.

(a). Explanation of terms used.

(b). Soil identification contest.

(2). Demonstration: Individual demonstration on the effect of organic matter on soil tilth.

(3). Assignment of work for the next meeting, as:

a. Reference: Relation of Soil to Plant Growth. (See Meeting IV. for detailed assignment.)

b. Bringing of report blanks for use in the club meeting.

c. Assignment of one or more topics for roll call, as:

(a). Name a standard club requirement.

(b). Where is the largest and healthiest plant growth found?

On sloping or level areas?
On poorly or well drained land?
On sandy, silty or clayey soil?
On rocky or rock-free land?

3. The Social Hour.-(Recreation and games.)

IV. Relation of Soil to Plant Growth.
(This problem should be studied during the growing season.)

1. The Business Meeting.-The club officers in charge. (Follow order of business suggested for Meeting II.)

2. Instructions.-The local club leader in charge.

(1). Discussion: Relation of Soil to Plant Growth, Chapter IV. (Fill in tables)

a. Comparison of plant growth on slopes and level areas.

b. Determination of the effect of drainage on plant growth.

c. Study of the effect of texture or the coarseness and fineness of soil particles upon plant growth.

d. Comparison of plant growth on a rocky area and on one fairly free from rocks.

(2). Assignment of work for the next club meeting, as:

a. Reference: Study of Soil Erosion. (See Meeting V for detailed assignment.)

b. Bringing of report blanks for use in the club meeting.

c. Assignment of one or more topics for roll call, as:

(a). Name a standard club requirement.

(b). Name two different kinds of soil erosion.

(c). State which of these usually is more serious.

(d). Tell why soil erosion is greater on cultivated fields than on pasture land.

3. Social Hour:-(Recreation and games.)

V. Soil Erosion.
(For summer work - June to October.)

1. The Business Meeting.-The club officers in charge. (Follow order of business suggested for Meeting II.)

2. Instructions.-The local club leader in charge.

(1). Discussion: Study of Soil Erosion, Chapter V.

a. Sheet erosion on cultivated field.

b. Comparison of sheet erosion on a field in cultivation and one in permanent pasture.

c. Determining amount of soil lost when a gully is washed in a field.

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(3). Assignment of work for the next meeting, as:

a. Reference: Testing Soil. (See Meeting VII for detailed assignment.)

b. Bringing of report blanks for use in the club meeting.

c. Assignment of one or more topics for roll call, as:

(a). Name a standard club requirement.

(b). Give two reasons why soils become acid, or need lime.

(c). Name four legume crops in the order of their needs for lime.

(d). What effect does the fineness and fertility of the soil have on the amount of lime needed?

3. The Social Hour.-(Recreation, games, etc.)

VII. Testing Soil.

(This problem can be studied at any time of the year.)

1. The Business Meeting.-The club officers in charge. (Follow order of business as suggested for Meeting II.)

2. Instructions.-The local leader in charge.

(1). Discussion: Testing Soil for Lime Needed, Chapter VII.

a. Object.

b. Why soils become acid and need lime.

c. Characteristics of acid soil.

d. Tests for an acid soil.

e. Sampling soils for test.

(2). Demonstrations: Individual demonstration on taking soil samples, and testing soil for lime need by the Comber method. (Testing material probably can be secured from the county extension agent.)

(3). Assignment of work for the next club meeting, as:

a. Reference: Building up and Maintaining Soil. (See Meeting VIII for detailed assignment.)

b. Bringing of report blanks for use in the club meeting.

c. Assignment of one or more topics for roll call, as:

(a). Give answers to two of the questions asked in Chapter VIII.

3. The Social Hour.-(Recreation, games, etc.)

VIII. Building Up and Maintaining Soil.
(This problem can be studied during any time of the year.)

1. The Business Meeting.-The club officers in charge. (Follow order of business suggested for Meeting II.)

2. Instructions.-

(1). Discussion: Building up and Maintaining Soil, Chapter VIII.

a. In view of information at hand, a general discussion should be given of the six questions submitted on this subject.

(2). Demonstrations: Individual demonstrations by all members as try-outs to be one of the club demonstration team.

(3). Assignment of work for the next club meeting, as:

a. Reference: The 4-H Club Achievement Program. (See Meeting IX for detailed assignment.)

b. Bringing of completed report blanks to give to the leader before the achievement club program is held.

c. Appointment of committees to help prepare for the achievement club program and conduct it, as:

(a). Committee on arrangements, place, equipment, etc.

(b). Committee on decorations, if desired.

(c). Courtesy committee to welcome visitors and to act as ushers, if needed.

3. The Social Hour.-(Recreation, games, etc.)

IX. Suggested 4-H Soil Conservation Club Achievement Program.
(To be held when the club work is completed.)

1. A regular 4-H club meeting. with the club officers in charge.

2. Exhibit of the different kinds of soil found in the community.

3. A team demonstration of an approved soil conservation practice.

4. A soil identification contest.

5. Talk by the local club leader, a representative of the sponsoring organization or parent, on the value of the soil club work.

6. Plans for next year.

7. Presentation of club achievement pins, if awarded, by the extension agent or a representative of the local sponsoring organization.

8. A 4-H club play or dramatic presentation of some kind.

9. Adjournment.

Suggestions.-Only club members who make a complete report or have their records up-to-date should be eligible to take part in county or state contests, club camps, etc.

II. WHAT SOIL IS AND HOW IT IS MADE.

Object.-The object of this exercise is to determine from actual observation what soil is and how soil is made or formed.

Field Trip.-Make field trip to determine:

Fig. 1. Showing soil being formed from rocks and plants.

1. What Soil Is.-Examine a road cut or a more or less perpendicular embankment which shows bed rock with a natural covering of rock and soil. Make a rough sketch of a section of this embankment, showing how large pieces of rock have broken off the top of the bed rock and how the sizes of the rocks gradually become smaller farther away from this bed rock and nearer the surface of the soil. Also, note the darker layer of soil at the surface. By examining the soil at different depths and the layer of darker soil at the surface, determine from what two different kinds of material soil is made.

2. How Soil is Made.-

Fig. 2. How freezing and thawing break up rocks and help make soil.

(1). Freezing and Thawing.-Observe the effect of freezing and thawing on soil formation. Locate a rock with a comparatively level surface which the water does not drain off of readily. Note how thin pieces or flakes have chipped off or broken loose. Make a rough sketch of this and explain briefly how these pieces are chipped or broken off by freezing and thawing of the water which the rock has absorbed or soaked up.

(2). Dissolving Rock and Leaving Impurities.-Visit a cave or cavity in the bed-rock somewhere in the community and determine whether this cave was formed by the water's dissolving out the rock itself or by dissolving the cement holding rock particles together. List your reasons for these conclusions. Note the kind of soil just above solid limestone rock. What is this soil made from and where did the rock in the soil just above the limestone come from?

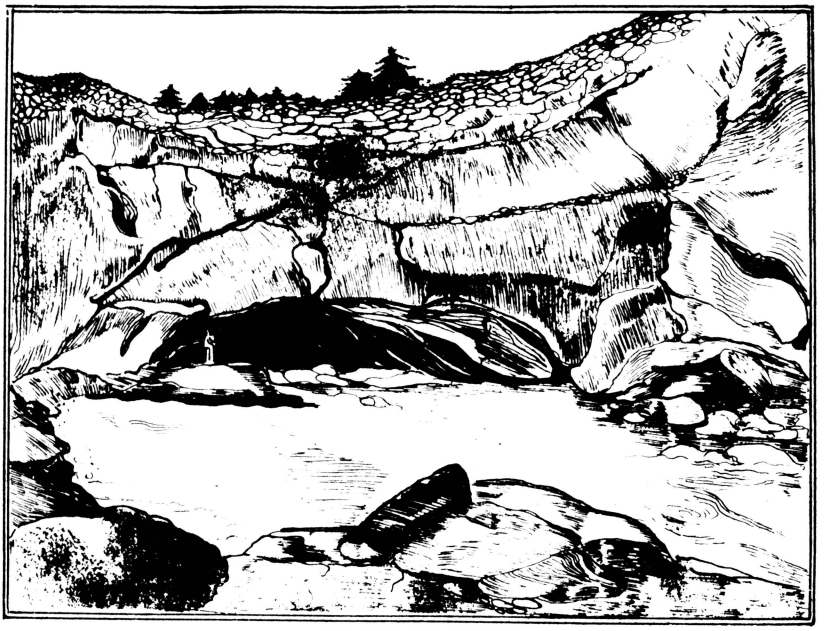

Fig. 3. Limestone cave showing how water dissolves rock.

Fig. 4. How trees and plant roots break up rocks.

(3). Breaking up Rocks by Plant Roots.-Observe a place where tree roots or the roots of some other plants grow into the crevices or cracks of rocks. Note how they break off pieces of rock or tend to widen these crevices so that water can enter and bring about more breaking down of the rocks by freezing and thawing, and by dissolving the rock itself or the cement which holds the particles of the rock together. Make a diagram of any place observed where tree or plant roots are helping in the formation of soil.

(4). Softening Effect of the Organic Acids Upon the Rock Itself. Fine pieces of rock which are in among the live roots and decaying organic matter. Compare the hardness of this rock with rocks out in the open and not surrounded by organic matter and plant roots. Determine which is the more difficult to break or crush and give your reasons for this.

III. KINDS OF SOILS.

Object.-The object of this exercise is to learn how to identify different soils from the standpoint of their fineness or textures and the amount of humus or organic matter which they contain.

Equipment and Materials Needed.-For this study one should have about one pint of each of the following kinds of soil: sand, loam and clay, a soil dark in color or high in organic matter or humus, and a light colored soil low in organic matter or humus. In addition to this, one should have a pan of water handy, two ordinary drinking glasses or jelly glasses, some paper and a pencil.

1. Classifying Soils According to Fineness or Texture.-From the standpoint of good soil maintenance or conservation, the fineness or texture of the soil is quite important. Where soil is extremely high in the amount of sand or coarse particles, there usually will be less washing because this soil is able to absorb more of the water and thereby reduce the amount that runs off and cut down the amount of soil erosion. It is harder, however, to keep up the supply of humus or organic matter in sandy soils and they also dry out much worse in the summer. For this reason, it usually is best to plant a deep rooted crop on sandy soils or one that is rather drouth resistant. Since sandy soils do dry out and warm up quickly, this may be an advantage in late wet springs because it allows one to plant crops earlier on them.

Clay soils, being fine in texture, are different from sandy soils in that they dry out rather slowly in the spring, retain their organic matter longer, are rather compact or tight, and absorb less water, thus allowing more of it to run off and cause erosion.

A loam soil is made up of a mixture of sand, silt and clay in such amounts as to be most desirable for cultivation.

Since loam soils are about mid-way between the sand and the clays in fineness or texture, their qualities rank be-

tween them. That is, they do not dry out so readily as sand but more quickly than clay; they hold humus or organic matter better than sand but not so well as the clay; they do not absorb moisture so quickly as a sand but more quickly than clay, etc. The loam soils usually are more desirable than either the sands or the clays, but are subject to serious soil erosion or soil washing. Because of this, one has to give more attention to soil erosion control methods on a rolling loam soil.

Fig. 5. A poor soil showing a thin surface layer.

Fig. 6. A good soil showing a deep, black surface layer.

The fineness or texture of soils can be most readily determined by rubbing some of the soil between the thumb and the forefinger. The sandy soil is made up of coarser particles and can be identified by the rough or gritty way it feels when rubbed between the thumb and finger. The clay soils are made up of the finer particles and can be identified by their finer, smoother feel. When moistened and rubbed between the thumb and finger, they feel rather slick and seem to hold or stick the thumb and finger together. The loam soil is made up of sand, silt and clay particles. They do not feel so coarse and rough as the sandy soil and not so fine and slick as the clay soil.

2. Classifying Soils According to Their Organic Matter Content.-In speaking of a sand or clay soil, one often is inclined to think of different colors. This is a mistaken idea, because color has nothing to do with the fineness or texture of a soil. Any of the above soils can be dark, light, reddish, brownish or yellowish and still not have its classification affected from the standpoint of fineness or texture.

The thing that most frequently will determine whether soils are dark or light in color will be the amount of humus they contain. By humus, we mean partially decayed organic matter or plant or animal remains. There are also certain substances like iron rust in the soil which cause yellowish, brownish or reddish casts, but, in general, the more humus soils contain the darker they are.

Organic matter, or humus, is valuable in the soil because it (1) increases the moisture holding capacity of soils, thus reducing the amount of water lost, which reduces the amount of erosion and enables the crops to better stand a period of dry weather, (2) increases the activity of favorable bacteria in the soil, (3) makes the plant food in the soil more available to plants, (4) improves the tilth, which makes the soil work easier, (5) decreases the possibility of the soil's becoming cloddy when it is worked slightly wet.

In examining the soil samples for the amount of humus or organic matter, note the difference in color. Those samples which are highest in this material are darker and were likely collected either from bottom ground that has received organic matter from overflows, from prairies where large grasses originally grew, from pasture land where there has been an accumulation of humus from the decay of grass roots, or from some area where barnyard or green manure has been turned under recently. Those samples low in humus likely came from an eroded hillside, from the subsoil, or from a field that has been in cultivation rather continuously in recent years.

After the texture and organic matter samples have been examined, small amounts from each of them should be put on numbered sheets of paper and the members graded on the number they can correctly identify.

IV. RELATION OF SOIL TO PLANT GROWTH.

Object.-The object of this study is to study the effect of the different kinds of soil upon the amount, kind and size of the plants growing on the soil.

1. Comparison of Plant Growth on Slopes and Level Areas.-Examine the vegetation on a sloping area in a field and compare it with that on a more level area in the same field. Determine the approximate number of legumes, grasses, and weeds per square foot and their average height on both areas and list in the following table:

	Number of Plants Per Square Foot.			Average Height of Plants.
	Legumes	Grasses	Weeds	
On level area -				
On sloping area-				

On which area are the plants largest in diameter?

List below as many reasons for these differences as possible

2. Determination of the Effect of Drainage on Plant Growth.-Examine well drained and poorly drained areas which have not been in cultivation during the last few years. These should be places where the vegetation has naturally grown and where it has not been recently affected by seeding or cultivation. List the approximate number of legumes, grasses and weeds per square foot and the height of these plants in the following table:

	Number of Plants Per Square Foot.			Average Height of Plants
	Legumes	Grasses	Weeds	
Well drained area -				
Poorly drained area-				

On which are the plants largest in diameter?

List below as many reasons for these differences as possible

3. Study of the Effect of Texture or the Coarseness and Fineness of the Soil Particles Upon Plant Growth.-Locate a sandy area where the soil particles are comparatively large and coarse and an area as near as possible to this one where the soil particles are fine like those in a clay soil, and list the approximate number of legumes, grasses, and weeds found per square foot in the following table:

	Number of Plants Per Square Foot.			Average Height of Plants
	Legumes	Grasses	Weeds	
Sand or coarse texture soils -				
Clay or fine texture soil -				

On which area are the plants largest in diameter?_____

List below as many reasons for these differences as possible_____

_____

_____

4. Comparison of Plant Growth on a Rocky Area and on one Fairly Free from Rocks.-Observe the plant growth on a rocky or gravelly area and on an area of similar slope, as near this rocky area as possible where there are comparatively few rocks. List the approximate number of legumes, grasses, and weeds per square foot and their approximate height on both areas in table below:

	Number of Plants Per Square Foot.			Average Height of Plants.
	Legumes	Grasses	Weeds	
Rocky area -				
Area free of rocks-				

On which are the plants largest in diameter?_____

List below as many reasons as possible for these differences_____

_____

_____

On which one of the areas listed above was the plant growth best?_____

List all the reasons you can for this_____

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V. SOIL EROSION. (Field Trip)

Object.-The purpose of this study is to determine in a general way the influence of steepness of slope and method of handling land on the amount of surface soil lost by soil washing or erosion; also, to determine the tons of soil that is washed away when a gully forms in a field. In order to study these things to the best advantage, it is necessary to take a field trip to (1) a cultivated field located next to a permanent pasture, and (2) to a field having a V-shaped gully in it.

Equipment.-On this trip, one should take either an auger (between 1 and 2 inches in diameter) or a spade, a tape measure or a yard stick, and a pencil and paper.

1. Sheet Erosion on Cultivated Field.-Visit a field that has been in crops like corn, oats, soybeans and wheat for

several years and which has both a sloping area and an almost level area in it. On the more level area, either bore down with an auger or dig a hole with a spade to find out how deep the surface soil is. This surface soil is the darker upper layer, or top soil, that contains most of the organic matter and fertility.

After having found out the depth of the surface soil on the more level area, go to a sloping place in this same field and, with the use of the auger, or spade, determine the depth of the top soil there. The area which shows the shallowest surface soil is the area where the greatest amount of soil has washed away, or where the greatest amount of erosion has taken place.

We know this must be true because when the soil in this field was formed all the surface soil was likely the same depth. This kind of soil washing we call sheet erosion and it is quite serious because it takes off immense amounts of the surface soil which is the most fertile and the most valuable part of our land. Furthermore, farmers usually do not notice sheet erosion until nearly all their surface soil on the slopes is gone and the yellow subsoil begins to show.

On land having a fall of about 4 feet in each 100 feet of slope, it has been found that the top 7 inches of soil will last seven to eight times as long when a good cropping system including legumes is followed, as when it is kept continuously in a cultivated crop like corn. The proper use of soil terraces, combined with contour farming and a good cropping system - including a legume crop every three to five years - will do most to stop soil erosion losses on our cultivated land.

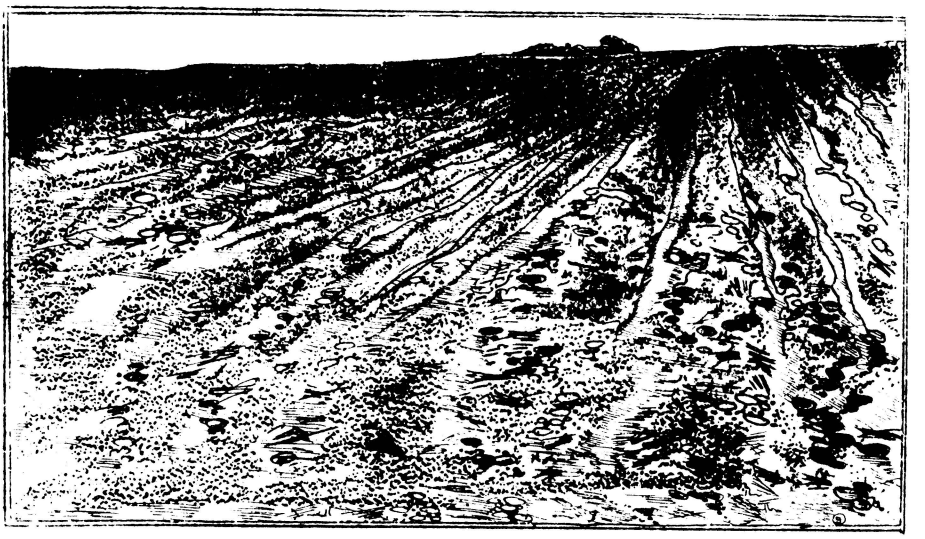

Fig. 7. Results of sheet erosion.

2. Comparison of Sheet Erosion on Field in Cultivation and One in Permanent Pasture.-Visit a portion of this cultivated field which is located next to another field that has been in grass pasture for the last five or more years. With a spade or auger, determine the depth of the surface soil in the cultivated field near the pasture. After this is done, determine the depth of the surface soil in the same way on land with a similar slope in the pasture.

On land which has a fall of about 4 feet in each 100 feet of slope, the top 7 inches of soil has been found to last over sixty times as long when it is kept in good grass as when it is put in a cultivated crop like corn every year.

Fig. 8. Results of gully erosion.

3. Determining Amount of Soil Lost When a Gully is Washed in a Field.-Visit a field where a V-shaped gully has formed. At a place where this gully is about average in size, measure in feet the width of this gully across the top and its perpendicular depth. When one considers that 25 cubic feet of soil weighs about a ton, he can calculate rather accurately the tons of soil which have been lost from this field through the formation of this gully. Since the gully is roughly triangular in shape, to get the cubic feet of soil lost one would need to multiply the depth of the gully by the width, divide by two, and then multiply this figure by the length of the gully in feet. To get the tons of soil lost, this figure should be divided by 25. The formula for this calculation would be as follows: $\frac{\text{Width} \times \text{Depth}}{2} \times \frac{\text{Length}}{25} = \text{Tons of Soil.}$

Example: If a gully is 10 feet wide at the top and 5 feet deep in the center at an average place in the field and there are 500 feet of this gully in the field, the problem would be solved as follows: $\frac{10 \times 5}{2} \times \frac{500}{25}$ which would equal $\frac{50}{2} \times \frac{500}{25}$ or 25 x 20 = 500 tons of soil lost.

VI. LEGUMES AND INOCULATION.

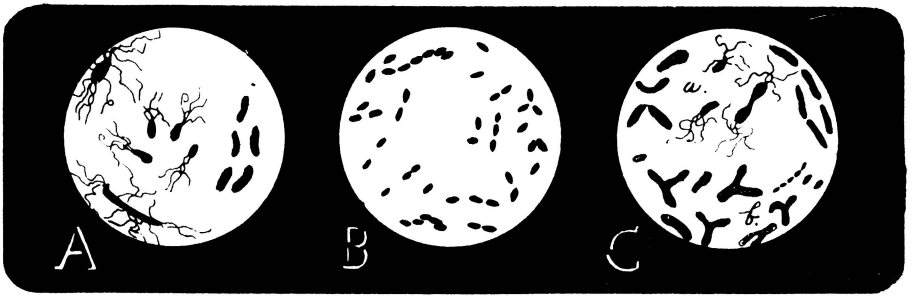

Fig. 9. How soil bacteria appear under a microscope.

Object.-The object of this study is to gain some further knowledge of the relative value of the legumes and non-legumes, and of the different kinds of legumes in conserving and maintaining the fertility and production of our better soils and the building up of our thinner soils.

Value of Legumes.-Legumes are necessary in maintaining our soil, because without them it is almost impossible to keep up soil fertility in a practical way. They differ from non-legumes in that they:

1. Are richer in nitrogen and protein.

2. Usually have nodules, containing nitrogen fixing bacteria, on their roots.

3. Increase the nitrogen supply of the soil through the action of the bacteria in the nodules on the roots.

4. Can use nitrogen from the air for their own growth and are therefore not so dependent on the nitrogen in the soil. The nitrogen they gather from the air is added to that already in the soil when legumes are used as a green manure.

Our principal non-legume crops are corn, oats, wheat, rye, barley, bluegrass, timothy and red top. Our chief legume crops are red, sweet, alsike, and crimson clover, Korean lespedeza, alfalfa, soybeans, cowpeas, peanuts and vetch.

Legumes are valuable in the maintenance and building up of our soil, because the roots of these plants furnish food for the nitrogen gathering bacteria. When these bacteria are present in the soil, either from being put there through inoculation or from being there naturally, the irritation they set up on legume roots when they feed on them causes the nodules to form. Bacteria live inside of these nodules and, in growing, store up nitrogen in their bodies. This nitrogen can be used either by the plant on which the nodules develop or it might be left in the soil for the use of plants to be grown there later.

Legume inoculation is most successful when soil conditions are as follows:

1. Good drainage.

2. Plenty of air in the soil - good aeration.

3. The supply of mineral plant foods in the soil,-chiefly calcium and phosphorus - is plentiful.

4. The soil is neutral or alkaline. This condition can best be brought about by the addition of lime in some form.

5. The soil is in good tilth, or in good working condition.

6. A fair supply of humus or organic matter is present in the soil.

Different Legumes Need Different Kinds of Inoculation.

Since nitrogen is one of the most expensive and one of the most important plant food elements, legumes occupy an important place in our cropping system. When there is sufficient nitrogen for successful growth like in a rich soil, the benefits of the nitrogen gathered by the bacteria growing on the roots of legumes may not be so noticeable. On a thinner soil, however, one may see quite a difference in the growth of those legumes which have been inoculated, as compared to those that have not been inoculated. This is because there will not be sufficient nitrogen in the thinner soil for the best growth of plants, and the added nitrogen furnished by the little bacteria will made considerable difference in the growth. It is just as important, however, to inoculate the legumes growing on the better soils as it is on the thinner soils, because if there are no bacteria growing on the roots of the plants, they will use that nitrogen already in the soil and will thus lower the fertility at a faster rate.

Inoculation of Legumes.-Tests carried on in the field and in the laboratory have shown that different legumes require different kinds of bacteria for nodule production. For instance they have found that the bacteria which will live on the roots of red clover will not live on the roots of sweet clover. They have, however, found that the same bacteria will live on the roots of both red clover and alsike clover. They have likewise found that the same bacteria will live on the roots

of both sweet clover and alfalfa. By making the test with a large number of legume plants, they are able to put them into different classes from the standpoint of the bacteria, which will live on their roots. These classes for the more common legumes are as follows:

1. Red, white, crimson, mammoth and alsike clover.
2. Alfalfa, sweet clover, and black medic or yellow trefoil.
3. Cowpeas, peanuts, Japanese and Korean lespedeza, lespedeza sericea and butter beans.
4. Soybeans.
5. Garden beans.
6. Garden peas, field peas and vetches.

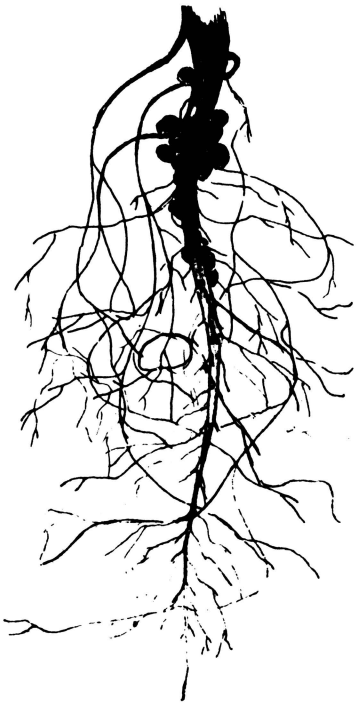

Fig. 10. Nodules on roots of soybeans.

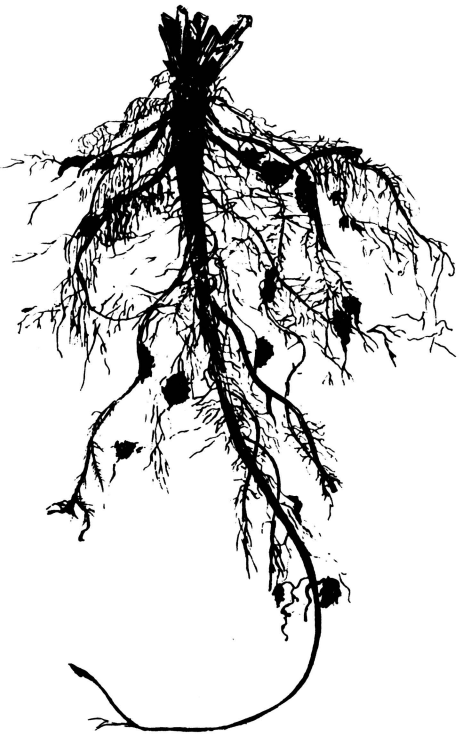

Fig. 11. Nodules on sweet clover roots.

There are two general methods of getting legumes inoculated. One is the natural method, where no bacteria are put into the soil. By this method, the plant must depend on those which are already there or which might be carried there on the seeds. It is usually the second or third year or possibly longer before one begins to get the full benefit of the legume if this method is followed.

The other method is what we call the artificial method of inoculation. By this means, proper bacteria are added to the seed from some outside source. This outside source is some other field that has grown the legume to be inoculated, or some other legume in its same class. Any of the following three methods may be used in getting this bacteria from another field and putting it on the seeds, or in the soil on the field where the plant is to be grown.

1. The soil may be hauled directly from the inoculated field and spread over the new field. This usually takes several hundred pounds per acre and it is preferable to use a smaller amount and sprinkle it directly on the seed. This usually is best done by using around one gallon of the soil for each bushel of seed to be inoculated. This soil should be thoroughly mixed with enough water to moisten the seeds. The larger particles, such as small gravel and coarse sand, are then allowed to settle out and the muddy water left above is used to sprinkle over the seed.

2. In the pure culture method, nodules are first removed from the plants in an inoculated field, taken to the laboratory where they are opened, and some of the bacteria are removed from inside them and placed on some gelatin or similar material. This gelatin-like material, called culture, is a food for them and they increase rapidly in numbers so long as this food is plentiful. The culture, together with the bacteria, is then put in a bottle. When the bacteria are wanted to put on, or inoculate, the legume seeds, they are washed off. This water, which contains the bacteria, is then sprinkled over the seed. When the seed is planted or sown, the bacteria are placed in the soil.

3. The so-called commercial method is very similar to the pure culture method, except that it is done in a commercial way and the bacteria are usually transferred to dust or soot instead of to the gelatinous or pure culture material. In using the commercial culture, the seed usually are moistened first with some sticky material, such as dilute glue solution, and the dust or soot containing the bacteria is sprinkled over them.

Field Studies.-It would be well if the members could take a field trip for the purpose of studying the root systems of legumes and non-legumes, and fill in each of the following blanks with either the word, "legumes" or "non-legumes", as they apply.

1. Most_____have a long tap root while_____ have a fibrous or sprangled root system with little or no tap root.

2. _____have a larger and deeper root system than do_____.

3. _____have a greater proportion of the total plant as roots than do_____.

4. _____do not have nodules on their roots, while they are practically always found on_____.

5. Since nitrogen gathering bacteria grow in the nodules found only on the roots of_____, these plants are called "Soil Builders".

6. Since_____have a shallower root system, they cannot stand dry weather as well as_____.

Note also the different types of nodules on the different types of legume plants and the location of these nodules on the roots. For instance, you will find the inoculated soybean has large nodules, which are distributed chiefly along the larger or main roots, while on the clovers and alfalfa roots you will find the nodules much smaller and distributed along the more fibrous or smaller roots.

In case a field trip cannot be made, it might be well if the leader could bring in to the meeting some legume and non-legume plants dug up with a spade and the dirt washed off of the roots carefully, so the nodules would be present on the legume plants. He could assign to each member the bringing in of one or more legume or non-legume plants, dug up and washed carefully, so the nodules on the legumes would show, as suggested above.

VII. TESTING SOIL.

Object.-The object of this study is to learn some of the reasons for soil acidity, how to determine its presence, something of its disadvantages and how one might correct it.

Why Soils Become Acid.-In a humid climate, such as we have here in Missouri, about the second generation of people who farm upland soil begin to have difficulty in growing such legumes as alfalfa, sweet clover and red clover on their upland soils. The chief reason for this is that these soils become acid or too low in lime for the successful growth of the above crops.

Our soils become acid, largely because the lime, which neutralizes or overcomes the effect of acid, is leached out by the water that falls on them. As this water seeps down into the sub-soil, it carries lime with it in solution. In testing soil for its acidity or lime need, one usually finds that the more level lands like those found in northeast and southwest Missouri on the level land seeps down through the soil and less of it runs off. Since more water seeps through level than rolling soil, it naturally carries more lime with it than on the more rolling land. Of course, the acid material is also taken out of the soil, but it seems the basic or limestone material is leached out and removed faster, and we gradually get

to the place where there is less of the basic or limestone material as compared to the acid materials in the soil. Also, when one cultivates the soil, he opens it up to more leaching, and when crops are harvested, there is a certain amount of lime taken off in these crops. For instance, a ton of alfalfa will remove around 100 lbs. of lime; a ton of red clover, around 85 lbs.; a ton of soybeans, about 35 lbs.; a ton of corn, counting the stalks, ears, leaves and all, will remove around 18 or 20 lbs.; and a ton of timothy, about 8 or 10 lbs.

Characteristics of an Acid Soil.-When soils become acid, it is much more difficult to maintain or build up their fertility. The reason for this is that it is difficult or almost impossible to grow our best soil-building legume crops on sour soil. Also, a sour soil will not retain or hold its humus or organic matter nearly so well as will a soil that is sweet or has plenty of lime. Recent experiments have also shown that even when one inoculates a legume crop and puts it on a sour soil, the bacteria do not develop so well. A test made with soybeans at the Missouri College of Agriculture at Columbia showed that there were nearly half again as many nodules developed on the plants grown in a soil that had received lime as on a soil that showed three tons of lime per acre were necessary in order to sweeten it. One will also find that a sweet soil can be worked sooner after a rain because it is not so clammy and hard and does not run together so badly as does sour soil. Furthermore, it takes less horse power to plow a sweet soil and it is not so difficult to work down or get in good shape for crops.

Tests for an Acid Soil.-By means of a simple test made with blue litmus paper, one can readily determine whether a soil is acid. This test, of course, will not tell how much lime one should apply in order to overcome this acidity for certain crops. If a sample of soil representing the top seven inches of each different kind of soil in the field is taken to the county extension agent, he can run a test on this sample and tell fairly definitely how much lime is needed to grow such crops as clover and alfalfa most successfully.

In making these tests, the kind of legumes one wishes to grow on the ground and the fertility and fineness of the soil, itself, must be taken into consideration before very accurate recommendations can be made. For instance, alfalfa and sweet clover require about one ton per acre more on the same kind of soil than does red clover. On the other hand, red clover usually requires about one ton more for best results than does alsike clover or soybeans.

From the standpoint of soil fertility and fineness, land that will produce only 20 to 25 bushels of corn to the acre in an average year will require around one-half ton more limestone for best results than land which will produce 30 or 35 bushels in an average year. Also, fertile land which will produce around 40 bushels or more of corn per acre in an average year will require around one-half ton less per acre than that which produces around 30 to 35 bushels per acre. The finer textured soils, like the clays and silts, normally require a little more lime per acre than do the coarser soils like the sands and loams.

Sampling Soils for the Tests.-One of the first essentials in getting an accurate test on soil is to take a sample representing the top seven inches of each kind of soil in the field. This can be done with either an auger or a spade, according to directions contained on pages 1 and 2 of Missouri Extension Circular, #322, "How to Use Limestone on Missouri Soils".

After the soil samples are taken, they should be dried out well and each sample labeled or numbered in such a way that one can tell from which field and from what part of the field it was taken. Also, if the sample is taken to the county agent, he must know what legume crop one wishes to grow on the field and also some information as to its fertility or how much corn this land will produce per acre in an average year.

In making the blue litmus paper test, the sample of soil must first be mixed well, then a rather stiff mud ball about one inch in diameter made from part of it. This mud ball should be cut half in two, a piece of blue litmus inserted and the two halves pressed back together again on the litmus. After leaving for a few minutes, the litmus should be removed. If it has turned pinkish or red, it denotes the soil is acid.

As stated before, this litmus paper test does not tell how much lime is needed, but simply indicates whether or not the soil needs lime. In case the litmus paper does turn pink or red and shows that lime is needed, a representative sample of soil from each different kind of soil in the field should be taken to the county agent for a more definite test.

Suggestion.-It is suggested that for this meeting, each of the members bring one or more samples of soil from his farm, taken according to directions contained in Extension Circular, #322, "Using Limestone on Missouri Soils". Should the leader care to, it would be well if he could get some Comber Reagent, test tubes, directions, and color charts from the county agent and run a test for the amount of lime needed on those samples brought to the meeting. Also, he might wish to select two from the membership at this time to act as a team for a soil testing demonstration and let them do at least a part of the testing at this meeting.

VIII. BUILDING UP AND MAINTAINING SOIL.

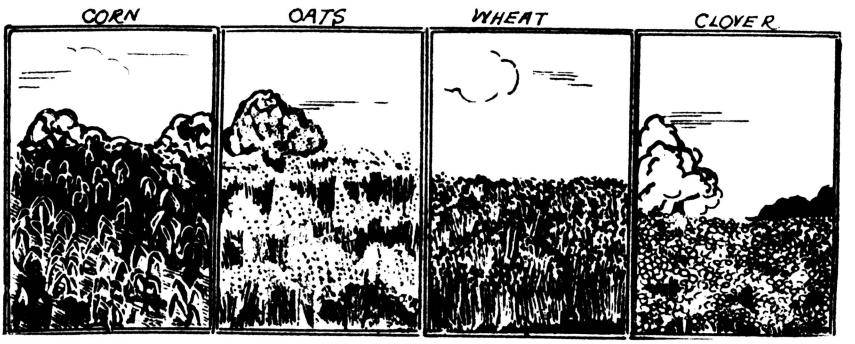

Fig. 12. Soil building rotation.

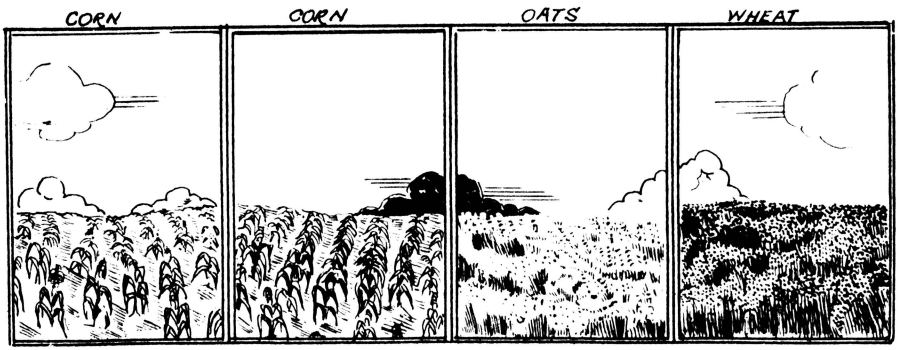

Fig. 13. Soil depleting rotation.

1. From your observations of the different farms in your community, would you say that the better buildings are located on the more fertile farms or on the farms of lower fertility? Explain.

2. In observing the tree and plant growth on your own and the other farms in your community, do you find the largest trees and plants on the more fertile soils or on the thinner soils? Explain.

3. Give a rotation or cropping system, other than the one shown in the illustration above, which you think would either maintain or build up the fertility of the soil; and one other than the one shown below, which you think would lower the fertility of the soil.

4. Which one is nearest like the one that is being followed on your own farm?

5. How do soils become low in fertility or how is plant food lost?

6. Which of the following plans takes the fertility off of the land fastest: (1) selling the products of the farm as grain and hay, (2) feeding it to meat animals like hogs, cattle, or sheep, and selling them or (3) feeding it to dairy cows and selling the milk, cream and butter? Which plan leaves most of the fertility on the farm? See illustration, Fig. 14.

THE SOIL EXHIBIT

It is suggested that the soil exhibit for the club achievement program consist of one labeled sample of as many of the following as available: Sample of (1) sand soil, (2) loam soil, (3) clay soil, (4) silt soil, (4) soil low in humus, (6) soil high in humus.

Pictures might be added, if available, which show the following:

(1). Badly eroded soil - with buildings, crops and fences where possible.

(2). Well conserved soil - with buildings, crops and fences where possible.

Fig. 14.

(3). Methods of gully control - wire checks, sod and masonry dams.

(4). Terraces.

(5). Contour farming.

(6). Strip cropping.

(7). Good crop rotations or systems.

Maps may be added, if available, as follows:*

(1). A soil type map of the county, if available; if not, one of state.

(2). An erosion map of the county or state.

(3). Phosphate, nitrogen, lime requirement and depth of surface soil maps of the state or county. (See Missouri Experiment Station Bulletin 349, "Soil Erosion in Missouri".)

DEMONSTRATIONS

In so far as possible, all club members should be instructed in regular club meetings by the demonstration method. As a usual thing, one or more members of each club can begin doing before the club useful phases of the work program soon after the processes have been demonstrated to the club by the club leader.

After two or three months of practical experience in handling real things, mature club members should be able to give public team demonstrations. The scope of the team demonstration usually should be limited to the essential processes of some practical phase of the club work of the current year on one subject. A team of two of the best demonstrators should be selected from the membership of one club, either by mutual consent, by designation of a committee, or by vote of the members, after making individual tryouts in competition. All teams should have an opportunity to demonstrate before the local club group and the people of the home community, and the championship team should represent the local club at the county achievement program or round-up, if one is held.

Suggested Problems for Team Demonstration.-

1. Taking a sample of soil for testing.

2. Testing a sample of soil for acidity by the use of litmus paper.

3. Testing a sample of soil for amount of lime needed for successful production of alfalfa and clovers by the Comber test.

*(The county agent can either furnish or assist in getting pictures and maps.)

4. Inoculation of legume seed.

(Typical Outline of a Problem for a Team Demonstration)

Two Methods of Taking Samples of Soil for Testing.-

Reference: Missouri Extension Circular No. 322, "Using Limestone on Missouri Soils".

Equipment and Materials: One block of soil, at least one foot square and eight inches deep; a spade; an ordinary auger (1, 1½, 2 or 2½ inch); some clean paper, paper sacks, pencil and paper.

Time: Fifteen to twenty minutes.

Procedure

"A" speaks and demonstrates.	"B" assists.
"A" leads in giving a spirited club song or in repeating the national 4-H club pledge; gives a brief history of the club; and then introduces his teammate and himself, and explains importance of the problem.	"B" joins in giving the club songs or pledge. Stands at attention.
1. Preparation of Materials.	
(1). Gives reason why it is essential to get soil sample, 7 inches deep from each different kind of soil in the field in order to determine the amount of lime needed for the successful production of certain legumes.	
(2). Methods - Auger and spade	
a. Explain why auger is preferable.	Hand auger or spade to "A" as needed.
b. Spade is satisfactory.	
2. Procedure with auger.	
Explains and demonstrates the following points:	
(1). Depth to take sample.	
(2). Care in removing auger.	
(3). Number and location of borings.	

(4). Removal of dirt from auger to paper.	Assists "A" by spreading paper and helping remove dirt from auger or spade.
(5). Mixing samples on clean paper.	
(6). Taking final samples from mixture and placing in paper sack.	Assists "A" by holding sack to receive final sample.
(7). Same procedure on each kind of soil.	
"_____ will continue the demonstration by showing how to take soil samples by use of a spade."	

"A" assists.	"B" speaks and demonstrates.
	3. Explains and demonstrates how to proceed with spade.
Assists "B" in cleaning dirt from V-shaped hole.	(1). Dig V-shaped hole, 7 inches deep.
	(2). Clean out dirt and rocks.
	(3). Cut one-half inch slice from one side.
Spreads out paper and assists in removing dirt from spade.	(4). Remove slice of soil to clean paper and mix thoroughly.
	(5). Take handful of soil and discard remainder.
Mixes soil and spreads out another clean paper and removes sample to it, as needed by "B".	(6). Put handful of soil on separate paper.
	(7). Explain that:
	(a). This should be on each <u>different</u> kind of soil <u>in field.</u>
	(b). All samples from each kind of soil in field should be mixed together thoroughly.
Holds sack while "B" puts handful of soil in it.	(c). A handful should be taken from each separate mixture, and put in a separate paper bag.
	(d). Same process should be repeated on each different kind of soil in field.

Assists "B" in marking samples.	(e). Samples should be marked to indicate field samples. (f). All samples must be dried for the most accurate test. (g). Different soils and legumes require different amounts of lime. "_____ will summarize the demmonstration.
"A" speaks.	"B" assists.
Summarizes, by explaining points demonstrated, about as follows: 1. Importance of having a representative sample of soil for accurate test. 2. Why each different kind of soil from each field should be sampled, properly labeled, showing location in field, and dried before being tested. 3. Explains that it is necessary to state kind of legume to be grown and fertility of the soil, so that more accurate recommendations can be made by those who test the sample.	Quietly cleans up the floor, collects tools, cleans and puts them in place, etc.
Asks for questions. Answers questions. Concludes by thanking the audience for its attention.	Stands at attention; answers questions referred to him.

Outline of a Team Demonstration on How to Test Soil for Acidity with Litmus Paper.

Team: Two members from one club, designated in this outline as "A" and "B".

References: Testing for Soil Acidity, in this Circular, and 4-H Club Leader's Manual.

Equipment:
Needed: Four pieces of blue litmus paper, one piece of glass (4" by 4" will do), a handful of ordinary field soil from a cultivated upland field that has not been limed and a small pan of water.

Time: Fifteen to twenty minutes.

Procedure.

"A" speaks.	"B" assists.
"A" leads in repeating the national 4-H club pledge; gives a brief history of the club: then introduces his teammate and himself and states the problem.	"B" joins in giving the club pledge and stands at attention.
I. How to Test Soil for Acidity.	
1. Explains the importance of the problem. 2. Makes two mud balls from sample of soil and explains operations as he does them. "_____will continue the demonstration by testing this soil sample with litmus paper."	Assists "A" as needed.
"A" assists.	**"B" speaks.**
Assists "B" by providing equipment and materials as needed, and in taking it away after being used.	3. Tests the sample with blue litmus paper and explains operations as he does it. (1). Cuts one of the mud balls into halves, places blue litmus paper between them, presses halves together and leaves ball there for a few minutes. (2). Places another piece of blue litmus paper on glass and presses the other mud ball down on it. (3). Reads test. a. Pulls mud ball apart which was cut in halves and observe whether red color has developed. b. Turns glass over with mud ball and litmus paper on it and observe whether red color has developed.

	c. If any color has developed, explain that it means the soil is acid and needs lime for the best growth of clover and alfalfa. "_____ will complete the demonstration by giving a summary."
"A" speaks.	"B" assists.
1. This demonstration has shown how to test soil for acid with blue litmus paper.	"B" collects equipment, cleans up table, stores materials in an orderly way.
2. The red color developed on the blue litmus paper denotes an acid soil and that it needs lime for the best growth of such high type legumes, i.e. red clover, sweet clover and alfalfa.	
3. Explains that samples of soil on fields where above crops are to be grown should be taken to the county extension agent, so that a more definite test can be made and the actual amount of lime needed can be determined.	
Asks for questions. Answers questions or refers them to teammate.	Stands at attention. Answers questions referred to him.
"This completes our demonstration." Thanks audience for its attention. Cleans up table.	

GENERAL REFERENCES.

Leaders and members can secure one or more of the following publications, as available for distribution, from their county extension agent:

Experiment Station Bulletins, Missouri College of Agriculture.-

Number 271 - Controlling Gully Erosion.
Number 317 - Terracing to Prevent Erosion.
Number 322 - Inoculation of Legumes.
Number 324 - Soil Fertility Losses under Missouri Conditions.
Number 349 - Soil Erosion in Missouri.
Number 362 - Soil Conservation in an Improved Agriculture.

Extension Service Circulars, Missouri College of Agriculture.-

Number 280 - The Use of Green Manures in Soil Improvement.
Number 132 - Soil Improvements by the Missouri Plan.
Number 322 - Using Limestone on Missouri Soils.
Number 315 - Commercial Fertilizers for General Field Crops.
Number 339 - Testing Soils for Acidity.