Soil, Soil Management and Soil Conservation : A Manual for Youth Groups

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Soil, Soil Management and Soil Conservation
A Manual for Youth Groups

"The strength of a nation lies very near the soil"
The cover is from an original idea by Dr. Joseph Gladden Hutton (1873-1939), head of the Soils Department at South Dakota State College until his death and father of Soil Conservation in South Dakota.

SOIL AND SOUL

The earth a bit of star-dust is,
And all of us but smaller bits
Of that celestial stuff.
In each of us, a bit of Soil
That makes us kin
To all that brethes;
In each of us, a bit of Soul
That makes us kin to God.

Forget not, O my Soul,
The sacred Soil!
The Creator through
An eon's toil
Combined these two,
And said, "It is enough.
My work is good:
In my own image — Man!
And in his mortal time,
In his own hand,
He holds his fate:
To build or ruin,
To plunder or create."

Joseph Gladden Hutton (1873-1939)

This pamphlet has been published to meet the increasing demand for informational material on soil, soil management and soil conservation. It also contains suggested demonstrations, exercises and activities for 4-H club members, vocational agriculture students and other youth groups.

Photos by Soil Conservation Service
Soil, Soil Management and Soil Conservation

LEONARD L. LADD*

Soil Composition

Soil consists of finely ground rock material, organic matter, soil air and soil water.

The rock material or mineral part of the soil forms the skeleton. This material is finely ground by processes called “weathering,” and contains the mineral elements of plant food. It occupies about 45 percent of the volume of soil.

Organic matter in the soil is the residues of plants, small animals and insects. It may be original tissues, like straw, or it may be in different stages of decomposition. Soil bacteria live on the organic matter and give life to the soil. The organic matter rots and creates acids that work on the mineral elements in the soil and change them into forms that growing plants can use. The rotted organic matter may be called “humus.” In the illustration it forms about 5 percent of the soil.

The soil air enables the soil to breathe and is composed of several gases, such as nitrogen, oxygen and carbon dioxide. The bacteria takes up the nitrogen from the soil air and changes it into a form so that growing plants can use. Oxygen is necessary for the processes that make plants grow. Carbon dioxide unites with the water and forms an important soil acid. If the soil is in good condition, about 20 percent of it should be air.

Soil water is held within the spaces between the grains of soil and around each grain. It moves through the soil and carries traces of every element present. The water occupies about 30 percent, by volume, of a soil in good physical condition.

Soil, then, is the upper few feet of the earth’s crust, which has been weathered, has accumulated organic matter and has become adapted to plant growth.

Soil Classification

Soil is classified according to the size of the grains into sand, silt and clay. However, soil usually occurs as mixtures of two or all three sizes of grains, and may be called sand, sandy loam, loam, silt loam, clay loam and clay.

Soil is divided into “topsoil” and “subsoil.” The topsoil is usually from 6 to 18 inches in depth. It is darker in color and contains most of the organic matter and a high percentage of the available plant food.

The subsoil lies beneath the topsoil, is lighter in color, contains very little humus, and is usually low in available plant food. When the topsoil has eroded away, all that is left is subsoil which is low in fertility.

*Extension Soil Conservationist
Study of Individual Soil Grains

**SAND**
2.0 to 0.05 MM.

**SILT**
0.05 to 0.005 MM.

**CLAY**
0.005 & Smaller

- **SAND GRAIN**
  0.10 MM.
  - 250
  - 1 Inch

- **SILT GRAIN**
  0.05 MM.
  - 500
  - 1 Inch

- **CLAY GRAIN**
  0.005 MM.
  - 5000
  - 1 Inch

For example, if a grain of sand is 0.10 mm (one-tenth of a millimeter) in diameter, 250 of them placed side by side, would equal one inch. If a grain of clay is 0.005 mm in diameter, 5,000 of them placed side by side, would equal one inch.

**Soil Structure**

Soil is said to have “structure.” That is, it may be in single grains, or several grains may be stuck together into groups called granules, like granulated sugar. We then call it granular structure. We say that granular soil is “mellow” and has good “tilth.”

The grains of soils are stuck together into granules with humus and other material called “colloids.”

A granular soil absorbs water faster, holds more of it and contains more organic matter than a single-grained soil. It also farms easier. So, we should farm so as to maintain the granular structure of the soil.
DEMONSTRATION NO. I
Water Absorbing Capacity of Soil

(1) Collect two samples of soil—(a) one from a field that has been farmed many years and (b) one from land that has been in grass for many years. (2) Air dry the soils. (3) Take two tall glass jars—tall pickle or olive bottles will do. Be sure they are exactly the same size and shape. (4) Mark each jar one-third (½) of the way down from the top. (5) Fill one jar up to this mark with soil from the old field. (6) Fill the other jar to the same height with soil from the grass land. (7) Settle the soil in each jar by tapping it firmly against the palm of the hand at least 25 times. (8) Add more soil to each jar to bring it up to the mark and tap at least 10 times more. Be sure to tap each jar the same number of times. (9) Fill each jar with water and observe the speed with which the water soaks into the two soils. It may be necessary to add more water. Be sure to add the same amount to each jar. (10) Which one took up the water faster? (11) Let them stand until the water has reached the bottom in both jars. (12) Pour off and measure the water left in each jar. (13) Which soil held the more moisture?

Soil Management and Crop Rotations

When we farm the land we remove plant food from the soil through the crops. If the land erodes it carries the plant food away with it. When we farm the land we also remove some of the organic matter. In South Dakota we already have used up 40 percent of the original organic matter content of the soil.

As we use up the organic matter, the granular structure of the soil breaks up into single grains and the soil becomes fine and powdery. The fine and powdery soil does not absorb the water as rapidly and consequently there is more run off. As the water runs off it carries soil with it and we have erosion. These fine and powdery soils blow more readily.

When rains fall on this powdery soil it causes the fine particles to run together and form a tight mass, or sort of scaling coat that absorbs water more slowly. Consequently there is more run off and more erosion. When rain falls on granular soil, the granules do not break up so readily. The water soaks into it faster and there is less run off. That means less erosion. Refer to Demonstration No. I.
DEMONSTRATION NO. II
Value of Granular Soil

(1) Take two saucers. (2) Take some soil from the two samples used in demonstration No. I. (3) Put about one-fourth (¼) inch of one soil in one saucer and the same amount of the other soil in the other saucer. (4) Add enough water to each to just cover the soil. (5) Give each saucer about six stirs with a pencil. (6) Let the soil settle. (7) Pour off the excess water. (8) Is the soil in one run together more than the other? Which one? (9) Let them dry out. (10) Is one caked more than the other? Which one?

You can see how the fine soil has run together and crusted, while the granular soil has retained its granular structure.

To prevent erosion we need to use good soil management along with soil conservation practices. Good soil management means using:

(1) Crop rotations, (2) grasses, (3) legumes, (4) crop residues, (5) barnyard manures, (6) green manures, (7) commercial fertilizers when needed and (8) conservation practices.

A good crop rotation contains cultivated crops, grain crops, grass, legumes, or a mixture of grass and legumes, with a growth of the legume plowed under.

This kind of farming helps to maintain the organic matter supply in the soil, and to retain the granular structure so that more water soaks into the soil and less runs off. Consequently there is less erosion.

Fertilizers

Our crops are plants. Plants, like animals, need food and air and water in order to grow. Unlike animals, the crops cannot move from place to place to find food and water. They must get their food from the soil where they are growing, from the water that is in that soil and from the air. The mineral plant foods must come from the soil.

As we harvest the crops from the land we remove plant food in the parts of the plant that we harvest. After many years of farming our soils may arrive at the point where they no longer contain enough plant food to raise good crops. We must then add this plant food to the soil in some way.

Most of our South Dakota soils contain enough of all elements of plant food, except nitrogen, phosphorous and potash. These are the plant foods that we need to supply to the land after it has been farmed a long time.

We said that a good crop rotation contains legumes and that a growth of the legume is plowed under. When we do that, we add nitrogen to the soil with the legume
that is plowed under. So, the nitrogen supply can be maintained by the use of a rotation in which legumes are plowed under.

Phosphorous and potash are minerals. When the supply of them in the soil becomes low, they must be added in the form of a commercial fertilizer.

Not all soils need an application of commercial fertilizers. The best way to find out whether or not a certain field needs fertilizer is to apply some to the crops on that land and find out if the crops respond.

**DEMONSTRATION NO. III**

**Use of Fertilizers**

Put out some commercial fertilizer on different crops under the direction of the county agent.

**Grass Seeding**

Grass is one of the best soil conserving crops that we have. Soil under a good cover of adapted grass absorbs water faster, and holds more water than cultivated land. Consequently there is less run off and less erosion.

Grass produces a heavy growth of fine roots. Each year many of the old roots die and many new ones grow. The dead roots add to the organic matter in the soil. They increase the granular structure, improve the tilth and mellowness of the soil and the land is easier to work when we put it back into cultivation.

When legumes are mixed with the grass, they improve the quality of the grass for either hay or pasture and add nitrogen to the soil. Certain bacteria live in “nodules” on the roots of legumes. They have the power to take nitrogen from the soil air, store it in their bodies, and later release this nitrogen in a form that is available for growing crops.

Grass, or a grass and legume mixture should be used in every crop rotation along with small grains and cultivated crops.

When planting grass or legumes use the kinds and rates of seeding that are recommended for your area.

**EXERCISE NO. I**

**Observe Root Growth**

1. Go into an old grass meadow and dig a hole about 1½ feet deep and a foot wide.
2. Then cut off a piece of sod about six inches square, getting all of the soil and roots for at least foot deep. This must be done carefully in order to avoid breaking off the roots. (3) Wash the soil out of the roots by running a stream of water over it. (4) Observe the tremendous amount of roots. (5) How does the amount of root growth compare with the amount of top growth?
Soil Conservation Practices

Much of our land has been farmed many years, and has been so handled that it has lost a lot of organic matter. The soils have become fine and powdery and they blow and wash easily. We have usually farmed the land up and down hill, which helps the water to run off faster. When the soil is fine and powdery the running water picks it up easier and carries more of it off the land. The result is erosion.

It then is necessary to set up a program to prevent further erosion and to repair the damage already done. This is called a “conservation program” and consists of such practices as contour farming, terracing, gully control and grassed waterways, proper tillage, proper range and pasture management, stock water dams, water spreading systems, tree plantings and many others.

Contouring and Terracing

Contour farming is “farming on the level,” rather than up and down hill. One or more level lines are marked out on the field and farming operations are done parallel to each line, both above and below the line. In this way the small furrows and ridges made by the farm implements are at right angle to the slope of the land. Hence they form thousands of little dams and dikes that catch and hold the water, so that more of it soaks into the ground and less runs off.

Two men with a farm level, a rod and some stakes can mark out contour lines.

Some lands are too steep or the slopes are too long and contours are not sufficient. Then terraces or ridges of soil with a channel above, are built either on the contour or with a slight grade. The terraces intercept the water as it flows down the slope and hold the water in the channel where it soaks into the soil, or it moves off the land slowly. Terraces must drain onto natural grassed areas or previously constructed grassed waterways.

Terraces may be built with a blade, moldboard plow, disk tiller or regular terracing machine. Many farmers build them with their own moldboard plow, with from 20 to 35 rounds. The terrace ridge should be about 18 inches higher than the bottom of the channel and the channel should be about 10 feet wide.

Gully Control and Grassed Waterways

The run-off water from cultivated fields flows down into the natural draws or waterways. If these draws are farmed, the water running through them carries away some of the soil. After a time small gullies develop. They grow longer, deeper and wider until finally they cannot be crossed with machinery. The field is cut into two or more irregular shaped pieces. Each has to be farmed as a separate field.

These gullies may be filled in with a motor patrol blade, with a disk tiller or with an ordinary moldboard plow.

After the gully has been filled in, it should be shaped into a broad or flat curve, leveled and given a dressing of manure that is cultivated into the soil. Then it should be packed and seeded with adapted grasses at about twice the normal rate of seeding. It is often necessary to protect the new waterway by first planting small grain or sudan grass. The roots will bind the soil and the top growth will give it further protection. Then the grass seed may be planted right in this trash in the fall or spring. This forms a good grassed waterway.

The grassed waterways should be further protected by contouring or terracing the joining croplands in order to reduce the amount of water and silt that comes into them from the sides.
Grassed waterways should be at least two rods wide, wider where necessary. If too narrow, they do not protect the waterway and the operator looks upon them as a nuisance. In a wide waterway the water spreads over a larger area, is shallower and flows slower. So, there is less danger of it cutting.

**Tree Planting**

Trees and shrubs may be used for wind-breaks to protect the farm buildings and feed lots, for shelter belts to protect farm land from the winds and for wildlife plantings to furnish habitat and feed for birds and other wildlife.

A tree strip to give adequate protection, should contain at least seven rows with the outside row on either side planted to shrubs or other low and close growing trees or evergreens.

**EXERCISE NO. II**

**Show Value of Trees**

Make a windbreak planting or fill in the old one.

Make a wildlife planting if there is a suitable location on the farm.
Tillage Practices

Tillage simply means plowing. Usually when we talk about plowing, we are thinking about the moldboard plow. There are many other ways of plowing. We may plow with a duck foot type shovel, a wide sweep blade similar to the duck foot only wider, a spike tooth or chisel type shovel, a "wheatland" type plow, an ordinary plow with the moldboards removed and several others. All of these implements till or plow the ground. All of them loosen the soil and they kill weeds if done at the proper time. Some of them turn the stubble under completely, some partially cover it, and some leave most of the stubble and trash on the surface of the ground.

Plowing that leaves part or all of the stubble and straw on the surface of the ground is called "trashy tillage" or "crop residue management." The trash on the surface of the ground prevents the soil from blowing and washing, it reduces run off, and encourages more water to soak into the ground where it can be used for growing crops. So, this kind of plowing has a place on land that is subject to erosion when fall plowed.
Demonstrations

Demonstration on penetration of water into soil that has been farmed many years as compared to soil from grass land. This demonstrates how granular soil absorbs water faster than single grained soil. It also demonstrates that soil high in organic matter absorbs water faster than soil low in organic matter, and that it holds more water.

Demonstration on water absorbing capacity of grass land compared to cropland.

Demonstration to show how fine and powdery soils run together when wet, while granular soils do not.

Exercises

Collect a piece of sod 6 x 6 inches showing the grass roots.

Plant a piece of sod 6 x 6 inches showing the grass roots.

Plant a grass plot containing several kinds of grass.

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