SOIL CONSERVATION IN VOCATIONAL AGRICULTURE

by

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Organizing Subject Matter on Non-Engineering Units in Soil Conservation for Use in Teaching Classes in Vocational Agriculture.

by

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THE SITUATION

Leaders in the field of agruculture have long recognized the need for a more aggressive plan for soil conservation in Virginia. Only recently, however, have efforts been coordinated by various agencies to bring about the desired results. Teachers of agriculture are in position to make valuable contributions to this program. In order to do so they need teaching material adapted to their use. The field is so large that it seemed desirable to limit this study to those phases of soil conservation that do not involve engineering practices.

Note: A similar study is being made by G. M. Saufly on engineering practices in Soil Conservation.

OBJECTIVES

The purpose of this study is to secure and organize materials on non-engineering phases of Soil Conservation, to be used by teachers and students in Vocational Agricultural Classes.

The first part of each unit is designed for use as reference study by students of Vocational Agriculture and the second part consists of a job analysis intended primarily for the use of the teacher. (The job analysis form is that used by the U. S. Office of Education.)

PROCEDURE

Available information on Soil Conservation was secured by interviewing representatives of agencies engaged in this field of work, namely; Soil Conservation Service, Agricultural Adjustment Agency, the State Experiment Station and the Virginia Polytechnic Agronomy Department. All available literature and illustrative material were reviewed and made personal visits to farmers.

The most important phases of study in the field of non-engineering soil conservation were selected, made a job analysis of each phase, and arranged in a form suitable for use by teachers in Vocational Agriculture.

The most up-to-date practices in non-engineering soil conservation were selected and organized, and designed especially as a reference for use by boys in vocational agriculture classes.

Unit I

RECOGNIZING THE NEED FOR SOIL AND WATER CONSERVATION

Soil Losses in the United States

Why has everybody become so worried about soil erosion during the past few years? The truth is this. Man with his ax, his plow, and his cow has destroyed a very large portion of the natural plant cover that protected our land from the effects of erosion by water and by wind. When the white man first came to this country there was some erosion but it was so slight it was hardly noticed. Even when the settlers cleared the timber and plowed their first fields, there was very little erosion since the collection of decayed leaves and other plant materials on the surface soil collected the rain and held it in the soil.

Each year of cropping has removed or destroyed a part of this plant or organic matter from the soil. For many years now, the life has been going out of the land in this country. The greatest single cause of loss of fertility from our soils is water erosion. Rain and wind have been washing and blowing off our rich farm soils, making us a poorer nation of people. At present, there are about 415,000,000 acres used for crop production in the United States. Of this acreage, 73,000,000 acres are too steep, too severely eroded, or otherwise unfit for cultivation. It is estimated that only 70,000,000 acres

are suitable to be brought into production by clearing new land, draining, and irrigation. In the nation there are only 62,000,000 acres of good land that will not erode. Over two-thirds of the farms have been damaged by erosion. Erosion removes about twenty-one times as much plant food from the soil as do harvested crops. The plant food removed by harvested crops can be replaced, but the soil that is lost by erosion cannot be replaced.

It takes nature several hundred years to build one inch of soil. This same inch of soil may be lost in from one to seven years, depending upon the slope, the cropping system, and the soil-conserving practices followed. Recent estimates show that only one out of ten acres of land is being properly handled to save the soil.

Soil Losses in Virginia

The early settlers of Virginia were faced with the erosion problem just as the people of the state are today. When these early settlers began to till the land, they found that soil erosion took place on tilled land with any considerable degree of slope. By the end of the Eighteenth Century, soil erosion had made great inroads into the agricultural resources of Virginia and attempts to control it were beginning to be made. Most of the soil control practices in use at the present time, such as the use of legumes and grasses, contour plowing, and terracing, were either developed by the Virginia farmer or

were known to them during the first half of the Nineteenth Century. One of the reasons the early Virginians were unable to make more progress in soil conservation was the lack of agricultural organization.

George Washington began conducting experiments at Mount Vernon in 1769. He tried to determine whether the land could be preserved more by harrowing than by lying in furrows. Some of the other early Virginians who were interested in the conservation of soil and water were Thomas Jefferson, James Madison, Patrick Henry, and William Byrd. These leading Virginians along with many other less prominent ones overcame many of the great obstacles and hazards and made possible many opportunities that we have in agriculture today. While they erred at times in both choice and treatment of the land, they uncovered many possibilities that challenge us to meet more intelligently the problems in agriculture of today.

With the increase in population Virginia is demanding more from her soil today than ever before. This demand has made the question of conservation of the soil and water a more vital issue in the minds of the people that are helping to meet the demands of greater production from the soils of Virginia. If greater production is necessary, more care must be taken of the soil so that these goals can be met.

In 1937 the United States Soil Conservation Service made a detailed erosion survey which included eleven of its CCC Camps and one demonstration area in the Piedmont Plateau of

Virginia.

This survey included a total of 125,000 acres of land of which 25,000 acres were in woodland. From this survey the following facts were found:

0.04% of the land had no erosion,

24.40% of the land had lost less than 25% surface soil,

59.10% of the land had lost about 1/2 surface soil,

11.00% of the land had lost all or nearly all surface soil,

7.40% was alluvial and colluvial (bottom land) soil,

26.00% was affected by gullies.

It is estimated that about six inches of soil have been lost since the white settlement in the Piedmont Plateau of Virginia. If this soil would be replaced, it would take a freight train, traveling at the rate of 40 miles per hour with standard cars 42 feet long holding 50 tons each, 4.3 years to pass a given point. This train would reach sixty times around the world at the equator.

This survey gives a clear picture of what is happening in regard to soil losses in the Piedmont Plateau.

A careful study of a report made in 1945 by the U. S. Department of Agriculture, Soil Conservation Service, will give a more nearly complete picture of the need for soil conservation in this state. This report gives the erosion conditions in Virginia and the percent of land area under each condition. The eight classes of land are divided into acres by land use and capability classes. These classifications are explained on pages 20, 21, and 22.

VIRGINIA

Erosion Conditions

	Percent of Land Area
Little or no erosion.....	38
Moderate to serious erosion (1/4 to 3/4 topsoil lost).....	58
Very severe erosion (3/4 topsoil and some subsoil lost).....	4

Acres of Land by Land Uses and Capability Classes:

	Cultivated	Idle	Pasture	Woodland	Other Lands Not in Farms	Total
Class I	622,578	65,401	160,224	93,474	177,414	1,119,091
Class II	821,192	74,213	284,998	299,169	449,628	1,929,200
Class III	1,540,137	315,780	904,824	1,287,060	1,287,340	5,145,141
Classes I, II, & III	2,983,907	455,394	1,350,046	1,489,703	1,914,382	8,193,432
Class IV	401,599	98,077	378,199	918,593	1,658,319	3,454,787
Class V	10,729	28,118	23,491	132,123	180,182	374,643
Class VI	148,181	68,721	495,801	2,679,715	2,618,601	6,011,019
Class VII	354,464	212,876	939,915	2,491,965	2,625,135	6,624,355
Class VIII	---	2,885	461	---	---	3,346
Miscellaneous	---	---	---	---	---	767,359
Total	3,898,880	866,071	3,187,913	7,712,099	8,996,619	25,428,941

The percentage of total acres in each class of land is given in the following summary:

4.4% in Class I; 7.6% in Class II; 20,2% in Class III; (Totals Classes I, II, and III, 32.2 percent); 13.6% in Class IV; 1.5% in Class V; 23.6% in Class VI; 26% in Class VII, and 0.1% in Class VIII.

Prepared by the U. S. Department of Agriculture, Soil Conservation Service, Region 2, Spartansburg, South Carolina

Water Run-off and Soil Erosion

Water erosion occurs chiefly on sloping land. There are three types of water erosion. One type is sheet erosion where the soil is removed from the surface and is usually unnoticed. When run-off water is muddy, there is some type of erosion taking place on the land. The second type is rill erosion or the cutting of small streamlets down the slope. The third type is gully erosion where deep gullies are formed down the hillside. The amount of erosion is affected by the steepness of the slope, the length of the slope, the soil type, the amount of rainfall, and the land use. If land is covered with growing plants, decaying organic matter, and trees, they will hold the soil on the hillside. When sloping land is plowed and planted to cultivated crops, the run-off water is much greater. Some experiments show that a heavy cover of vegetation is 300 times more effective in holding soil and 6 times more effective in holding rainfall than row crops such as corn and tobacco. Forests are considered the best defense against erosion. Not only the roots hold the soil but the forest litter such as dead leaves, twigs, limbs, and logs helps make the soil sponge-like and holds the water. The grasses and legumes provide protection to the soil in the same manner as forests.

The amount of moisture in the soil often determines crop yields. When the rainfall runs off quickly, the land is soon dry and the growing crop is soon in need of more rain. Many

pounds of water are needed to produce a pound of dry matter in plants. In corn production, 500 lbs. of water may be required to produce one pound of dry matter. Soil water also aids the dissolved plant foods to become available to the plants and transports these plant foods to all parts of the plant.

Control Measures

If we are to check the large amount of soil erosion on our land, we must study the conditions of our fields. The cause of the present condition of the lands, the best methods of improving them, and the outlook for the future are important. A long-time plan of conservation has many advantages. Some of these are as follows:

1. Makes the best use of each acre of land on the farm.
2. Helps in selecting the best practice needed to handle surplus water.
3. Assists the farmer in balancing his production of crops with the needs of the farm.
4. Insures that each acre on the farm will carry its share of the farm load.
5. Provides a more desirable distribution of farm labor.
6. Provides for the establishing of conservation practices in logical order.
7. Insures the conservation of soil fertility.

Conservation practices and the acres needing each practice

on farms in Virginia are given in the following table:

Conservation Needs, Major Practices:

Practices	Acres
Crop rotations	2,550,085
Strip cropping	1,079,579
Outlets	29,828
Terracing	281,610
Fertilizing pastures	3,562,484
Liming pastures	3,596,984
Seeding pasture	2,671,618
Field and gully planting	281,530
Harvest cutting	3,249,559
Improvement cutting	2,908,282
Wildlife borders	147,365
Perennial hay	67,671
Farm ponds, surface area	19,288
Drainage improvement	157,000

The problem of erosion rests not in saving soil for the soil's sake, but in the relationship of soil to society. With the loss of soil from the nation's fertile fields, purchasing power of farm families is severely lowered. Society must accept the loss. Schools, churches, banks, and other institutions necessarily share alike with the farm family the debt of erosion.

Unit II

THE NATURE AND PROPERTIES OF SOILS

Soil Development

What is soil? Soil is the weathered surface portion of the earth, composed of mineral and organic materials arranged by weathering in more or less definite layers. It consists largely of small particles which have been altered by the rain, wind, heat, and frost for centuries. Soils also contain air, water, and organic matter. Soil is a living thing. Eroded soil is a dying soil.

Although most soil is produced from weathered rocks, the rain and the sun have changed the soil greatly. Of still more importance are those changes made by the plants and animals. It is especially the biological forces that give those characteristics to a soil that are most important to man. All life depends upon the soil. There can be no life without soil and no soil without life. All animals, including man, get their food from the soil. The plants draw chemicals out of the soil into their sap and change these chemicals into compounds that can be used by animals for building flesh, blood, and bones. But if the soil is deficient in one or more of the necessary elements, plants may be unable to get enough of it to supply the needs of the animals.

The mineral portion of the soil has been developed from underlying rock caused by weathering while the organic matter is developed from partly decayed plant and animal residues.

All soils have pore spaces of varying sizes, which are filled with air and water, the proportion depending on the character and condition of the soil. The process of soil development is very slow. It takes from three hundred to five hundred years to form one inch of topsoil, depending on the hardness of the parent material or underlying rock and climate conditions.

Many physical properties of the soil can be seen without the aid of instruments. It was early recognized, for instance, that some soils were mellow and easily tilled, that others were sandy and blew readily, and that still others turned up in clods if plowed too wet. Soils begin their history with the accumulation and exposure of finely divided, weathered rock materials. The next step is the introduction of living organisms and the beginning of the soil-forming process. As the process operates upon the rock materials, changes are slowly brought about in the surface layer which, if allowed to continue for a long time, will make those layers very different from the parent material. The changed portion, which is regarded as the true soil, may vary in thickness from a mere film to several feet. The character and thickness of the soil thus formed depend upon the intensity of the soil-forming processes, the length of time they have acted, and the resistance of the parent material to change. When a soil has developed certain characteristics, it is said to be a mature or a well-developed soil.

At any stage of its history, a soil may be affected by mechanical agencies. The surface layer may be wholly or partly removed by erosion exposing the material beneath. The soil-making processes continue even though the surface layer is removed.

Soil Layers

Soil layers are more or less defined sections of the soil, lying parallel to the soil surface. If a hole is dug in any well-drained upland soil, a series of horizontal layers of soil of varying thickness can be seen on its walls. The layers are called horizons, and they differ from one another more or less sharply in such properties as color, texture, and structure. The succession of horizons from the surface down to and including the parent material is called the soil profile. The A horizon includes the upper part of the profile in which life is most active and abundant and the most mature.

Usually the plowed layer lies within the A horizon and includes most of it. It may contain a large amount of organic matter as in grassland and normal forested soils. The B horizon is marked by deeper color and heavier texture in normal soil. The C horizon is the weathered parent material, lying below the A and B horizons and above the underlying parent material or D horizon.

The solid portions of the soil are composed of several kinds of matter that may be divided into organic and inorganic. The inorganic portion is the part that is left from the decomposition of the parent rock by the chemical and mechanical pro-

cesses of weathering. The organic portion consists of dead or living plants and animals. The inorganic portion of the solid material is variable in size, ranging from gravel and stones down to particles of clay with diameters of less than one-hundred-thousandth of an inch. The coarse and medium materials are comparatively inactive, serving mainly as a supporting framework of the rest of the soil. The fine or clay fraction serves as a bank in which plant nutrients may be placed for future use and from which they may be withdrawn when the plant needs them. The organic portion of the soil consists of both living and dead matter. Plant roots, fungi, bacteria, worms, insects, and rodents make up the bulk of the living matter; and the remains of plants and animals, together with the products of their decay, make up the dead portion. This organic matter plays an important part in holding plant nutrients and water.

The liquid portion of the soil, called the soil solution, consists of water containing varying amounts of dissolved mineral matter, carbon dioxide, and oxygen. The soil solution is the medium through which the mineral elements, nitrogen, water, and perhaps some carbon dioxide, enter the plant.

If the balance between the various parts of this liquid is not favorable, the soil is not a good medium for plant growth.

The third part, the gaseous portion of the soil, is also very important. It is well known that if a soil becomes water-logged, it sours, and normal upland plants cease to

grow in it. In this case, the water has almost completely replaced the air in the soil, depriving the plant roots of the oxygen of the air which is important to their existence. The total amount of space in a soil that is occupied by air and water together is usually referred to as pore space. If the soil is not porous enough, it is difficult or impossible for plant roots to penetrate it, to secure anchorage, and to obtain nutrients and water. If it is too porous, it will not retain enough water to support good plant growth.

Soil Texture

The proportions of coarse, fine, and medium particles determine the texture of the soil. They can be classified according to size into three principal groups, which are called sand, silt, and clay. Sand grains feel gritty to the fingers and can be distinguished by the unaided eye. Silt, barely visible to the naked eye, has the appearance and feel of flour. The individual particles of the clay fraction are not distinguishable by the eye, and a large proportion of them are too small to be seen under the ordinary microscope. It is this fraction that makes soil sticky when wet.

Varying proportions of these particles of different sizes determine the classes of soils, or what is known as soil texture. The principal classes in the order of the increasing content of silt and clay are as follows: sand, loamy sand, sandy loam, silt loam, clay loam, and clay.

Sand is loose and granular. A sandy loam is a soil con-

taining much sand and enough silt and clay to make it hold together. A loam is a soil having a fairly even mixture of sand, silt, and clay. Silt loam has a moderate amount of fine sand, a small amount of clay, over half of the particles being silt. Clay loam is a fine textured soil which breaks into clods that are hard when dry, while a clay soil forms very hard lumps or clods when dry. Texture influences plant growth through its effect on the physical condition of the soil and its influence on the supply of mineral elements.

Soil and Plant Relationship

In all soil management, the important point is the relationship between the soil and the plants that grow in it. Good management consists (1) in selecting the right plants for a given soil, or in choosing the right soil for a given plant; (2) in maintaining the soil so that it remains suitable for the plant; or (3) in changing the soil so that it is more suitable for plant production.

If the soil is to be favorable for plant culture, it must meet six conditions which are:

1. There must be a supply of plant food sufficient for profitable yield.
2. The soil must be free of unfavorable chemical conditions such as excessive acidity or alkalinity.
3. It must be able to hold enough moisture to meet crop requirements.
4. There must be adequate aeration to permit the development

of a good root system.

5. It must offer resistance to erosion under a cropping system.
6. It must be suited to the use of efficient machinery.

The fundamental characteristic of soil is its productivity; that is, its capacity to produce green plants. A knowledge of the capabilities of the soil is necessary before the plants can be selected that are best adapted. Farming practices such as crop rotation, strip cropping, and others must be selected to prevent soil losses and get the greatest production of crops.

Unit III

PLANNING A CONSERVATION PROGRAM

Utilizing Contributing Agencies

The Soil Conservation Service assists the Soil Conservation District Supervisors by furnishing technicians. These technicians make soil surveys, do farm planning, and conduct research on conservation problems.

The State Soil Conservation Committee consists of not less than four and not more than five members. The purpose of the committee is to carry out the objectives set forth in the Soil Conservation District Law. The objectives provide for conservation of the soil and soil resources of Virginia, to preserve natural resources, control floods, prevent damage to dams, and reservoirs, preserve wild life, protect public lands, promote the health, safety, and general welfare of the people of the State.

The Soil Conservation Districts are sub-divisions of the state made up of two to six counties each. To start a district a majority of the land owners lying within the limits of the territory, which must include the majority of acres of land in the area, may file a petition with the State Soil Conservation Committee asking that a soil conservation district be organized. After the committee has decided on the need for such a district, a vote is held, all owners of land lying within the boundaries are allowed to vote on the questions

whether or not the district is desired. If the conditions are favorable, the State Committee appoints two local supervisors and three are elected by the voters within the district. These will serve as the Board of Supervisors. This Board promotes the work of conservation within the district by making available agricultural machinery and equipment and by developing plans for conservation of soil and water. They also work out plans for the proper use of lands within the district. They have the right to ask help from the Soil Conservation and other Federal and State Agencies for technical assistance such as soil experts, engineers, crop experts, and other technicians.

The State Agricultural Experiment Stations conduct experiments, surveys, and reports on problems which help the conservation program.

The Agricultural Adjustment Agency helps the conservation program by giving materials to farmers to maintain and preserve the nation's productive soil.

The State Forestry Service helps with conservation by promoting proper woodland management and fire control, and the production of seedling trees to be planted on idle or waste lands.

Classifying Land According to their Use Capabilities

Before land can be classified, it is necessary to know the type and class of soil on the farm. The amount of erosion, the slope, and the climate must also be considered when de-

ciding what the land can produce. (See Unit II - The Nature and Properties of Soil). The Soil Conservation District Board of Supervisors will furnish special help in making this study. They can furnish an aerial photograph of the farm from which a soil map may be made. By using a soil map of the farm, the conservation program can be more easily planned. The success of the crops depends partly on the conditions of the soil. Land is classified into eight classes and colored on the map according to the crops they are able to produce.

The classes are as follows:

Class I; Lands which can be cultivated without protective practices, made up mostly of level, well-drained soils. For practical purposes river and creek bottom lands which have been given enough artificial drainage come in this class.

Class II: Lands which need simple protective practices such as good rotations, fertilization, etc., when put to clean cultivated crops. These are lands of moderate slopes and soils which are not easily eroded.

Class III. Lands which need intensive practices such as terracing, contour cultivation, strip cropping, and close growing crops in rotations alternating with those that are clean tilled.

Class IV: Lands which can be cultivated occasionally but are best left in perennial forage crops for hay, pasture, or woods.

Classes V, VI, VII: Lands which should never be cultivated.

Classes VI and VII need protective measures even if in permanent grass. Liming, fertilizing, and diversion ditches may be necessary to safeguard these soils for grazing purposes.

Class VIII: Lands which have no agricultural use, made up of rock outcroppings, and other useless soils.

Determining the Needs of the Farm

The first need of the farm is to provide enough income for the farmer and his family. The type of farming should be considered such as beef cattle, dairying, poultry, tobacco, potatoes, peanuts, or fruit. Then the number or acreage needed can be decided from the land use classification.. The number of livestock will be governed by the land use capability of the farm. It may be profitable to change the type of farming after the land capabilities have been found. The money outlay that will be necessary to make the change must be considered.

Selecting Methods of Control

It is necessary to be familiar with the land classifications on the farm before methods of control can be selected to meet the needs of the farm. Some lands are level with no erosion problem and need only good cropping practice with fertilizer and lime. Other lands are steep and have lost their topsoil because of poor methods of farming and must use additional practices to reach high production. Strip

cropping may be needed to control erosion and hold the water on the field to get high production, while terraces may be needed on others. Sod waterways are used to carry off extra amounts of water and may be needed to provide more hay for the farm. It is a waste of time and money to try to grow crops on lands not suitable for cultivation. These should be planted in forest trees to be used for Christmas trees, fence posts, firewood or a haven for wildlife.

Unit I	Planning a Conservation Program
Operation	Accepted Practices
1. Utilizing contributing agencies	1. United States Department of Agriculture (a) Soil Conservation Service assists the Soil Conservation District Supervisors by furnishing agricultural technicians. These technicians make soil surveys, do farm planning, and conduct research on conservation problems. (b) Agricultural Adjustment Agency contributes to the conservation program by providing practice allowance or payments for carrying out certain approved practices on the farm. (c) The Farm Security Agency encourages conservation practices on the farms purchased through this agency. 2. The State Experiment Station conducts research on problems related to soil and water conservation. 3. State Forestry Service cooperates with the Soil Conservation Districts with forestry problems. 4. The State Extension Division provides

Operation	Accepted Practices
	information on livestock and crop production.
	5. The State Soil Conservation Committee and the Soil Conservation District Supervisors promote the objectives set forth in the Soil Conservation District Law.
2. Classifying land according to their use capabilities	Study the nature of the soil, degree of erosion, the slope, and the climate on the farm. With the help of the Soil Conservation District staff, make a soil map of the farm. Classify the land into one of the eight classes according to use capability.
3. Determining the needs of the farm	Determine the type of farming to be followed. Decide on the number of livestock the farm can support. Estimate the number of acres that is capable of producing row crops, small grain, fruit, hay, and pastures. Consider the capital outlay in providing these needs.

Operation	Accepted Practices
4. Selecting methods of control	Study the land classifications of the farm. Select the applicable cropping system. Use fertilizer and lime if needed. Use strip cropping to control erosion. Build terraces where needed for erosion control. Building sod waterways and proper water disposal. Providing wildlife and forest plantings.

Related Information

The Soil Conservation Service assists the Soil Conservation District Supervisors by furnishing agricultural technicians. These technicians make soil surveys, do farm planning, and conduct research on conservation problems.

The purpose of the State Soil Conservation Committee and the District Supervisors is to advance the objectives set forth in the Soil Conservation District Law. The objectives are to provide for the conservation of the soil and soil resources of Virginia, to preserve natural resources, control floods, prevent damage to dams and reservoirs, preserve wildlife, protect public lands, promote the health, safety, and general welfare of the people of Virginia. The State Soil Conservation Committee or the local district supervisors may employ technical experts and such other agents and employees as it may require to carry out the program. The State Agricultural Experiment Stations may contribute to the conservation program by making special studies, reports, or surveys as the committee may request.

The Agricultural Adjustment Agency contributes to this conservation program by giving allowance for conservation practices carried out on the farm.

The State Forestry Service helps with conservation by promoting proper woodland management and fire control; also by producing seedling trees to be planted on idle or waste land.

The study of the nature of the soil, degree of erosion, slope, and the climate on the farm will show what crops the land may produce. (See Unit II - The Nature and Properties of Soil.) By the use of a soil map of the farm the conservation program can be planned more easily since the success of the crops are based largely on the capability of the soil. The land is classified to find out its best use for production and conservation of soil.

It is important to select the type of farming before the conservation program is planned to determine the needs of the farm. The number of livestock to be kept on the farm will be determined by the amount of pasture and feed the farm is capable of producing.

The cost necessary to provide these needs must be considered because it may be too expensive to carry out this type of farming on some locations. It is necessary to be familiar with the land classifications on the farm (refer to second operation) before methods can be selected to meet its needs. A cropping system is selected that is best for the land classifications. Some land may only need adapted rotations and fertilizer and lime to give the greatest production, while other land may produce better by strip cropping, terracing, sod waterways, or forest plantings.

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Unit IV

ESTABLISHING SOIL CONSERVING CROPS

A soil conserving crop is any crop that serves as a means of holding soil and water on the land, adding organic matter to the soil, and improving its fertility. A good cover crop reduces the run-off of rain and holds the moisture. A green crop growing on the ground prevents the plant food from leaching. These crops also protect newly constructed drainage and terraces.

Selecting Crop Rotation

Except when growing bright tobacco a legume should be included once every three or four years in the rotation. The legume will provide excellent hay or pasture, hold the soil and water on the cropland, and improve the production of the following crop. The entire rotation should be built around a soil conserving crop such as alfalfa, clover, lespedeza, or one of the grasses. The best rotation for the farm is not the same over the state because of differences in soil, climate, and types of farming practiced. The turning under of a green crop before it matures, green manuring, may be followed as a part of the rotation. When planning the rotation, it is important to provide a cover of grain, grasses, or legumes on the soil the entire year. The feed requirements of the farm should also be considered, since as much of the

feed should be grown at home as possible. (See A Handbook of Agronomy, Bulletin No. 97, Virginia, Pages 29 and 30 for recommended crop rotations for Virginia.)

Providing Hay Crops

When providing for a hay crop in the rotation, it is important to follow small grain with the hay. By doing this clover and grass seed is sown with the small grain. This method saves much labor in preparing a seed bed. This also provides a cover on the soil after the grain is harvested. In order to have a large thick growth of hay, it is necessary to apply lime and fertilizer. By sowing a mixture of several grasses, the chances of getting a better stand are increased and if one of these grasses fails to grow because of the weather or other reasons, a good hay crop may still be produced. Sometimes summer or winter legumes and grasses are used for hay; these provide excellent cover on the soil and serve as a conserving crop. (See A Handbook of Agronomy, Pages 30 and 31, for recommended hay mixtures.)

Providing Seasonal Cover Crops

Seasonal cover crops may be used to protect the soil by serving as a cover during seasons when the land is not occupied by another crop in the rotation. The cover crop may also be used as a mulch in orchards, for hay, or for plowing under as a green manure crop. Some of the more

common winter cover crops are wheat, rye, hairy vetch, crimson clover, Austrian winter peas, and rye grass. These are usually seeded in the fall. If seeded early so that a good growth is produced before cold weather, the soil is well protected from erosion during the winter.

Summer cover crops are such crops as soybeans, cowpeas, lespedeza, Sudan grass, and oats. These are seeded in the spring and produce a cover during the summer. If any one of these crops is planted mainly to hold and protect the soil from erosion it should be planted fairly thick. A crop that will produce a heavy, rapid growth should be selected.

Providing Green Manure Crops

A green manure crop is one that is plowed under. It is turned under usually in the spring while the plant is young and tender and while there is plenty of moisture in the soil. The young tender plant will soon decay in the soil and improve the soil condition for the following crop. Rye planted in the fall provides good cover during the winter and is used all over the state as a green manure crop.

Providing Permanent Pastures

Permanent pastures are those fields used for pasture which are never plowed or used in a rotation. A thick heavy sod is one of the best crops that may be used to conserve the soil. To obtain a heavy sod, it is necessary to apply a

suitable amount of a complete fertilizer, usually 400 lbs. to 600 lbs. of 4-12-4 fertilizer per acre when seeding. A good pasture mixture to plant is 8 lbs. Kentucky bluegrass, 2 lbs. red top, 8 lbs. orchard grass, 8 lbs. lespedeza, and 3 lbs. of white Dutch clover per acre. The best time to plant this mixture is in late summer or early spring when the weather is usually more favorable and the growth will start quickly. Old plantings of pasture should be topdressed with 300 lbs. to 600 lbs. of superphosphate per acre in the spring for three straight years. When soils are low in potash, 0-14-7 fertilizer should be used. The soil should be tested for lime requirements and lime applied as needed. The lime and fertilizer applications are necessary to provide a good sod. This prevents erosion and gullies from starting.

Unit II	Establishing Soil Conserving Crops
Operation	Accepted Practices
1. Selecting crop rotations	Include a legume once every three or four years in the crop rotation. Select a soil-conserving crop around which to build the crop rotation. Select a rotation that is adapted to local conditions. Turn under legume crops except for bright tobacco. Rotation should be planned to provide a cover on the soil the entire year. Select the rotation that will provide the most feed to be used on the farm
2. Providing hay crops	Follow small grain with hay in a crop rotation. Plant legumes for hay whenever possible. Test soil to determine the need for lime and fertilizer. Sow a mixture of several grasses unless the grass is grown for a special market. Summer and winter annual legumes and supplementary grasses may be used for a hay crop.
3. Providing seasonal cover crops	Use a cover crop to protect the soil in orchards and other cropland, when not covered by the crop.

Operation	Accepted Practices
	Winter cover crops include wheat, rye, hairy vetch, crimson clover, Austrian winter peas, and rye grass. Summer cover crops are soybeans, cowpeas, lespedeza, Sudan grass, rape, and oats. Select a type of cover crop that will form a rapid heavy growth.
4. Providing green manure crops	Plow under crops while green for green manure. Plow under in the spring while there is plenty of moisture and before the crop matures. Use rye for green manure when doubtful what green manure crop to use.
5. Providing permanent pastures	Apply 400 lbs. to 600 lbs. of 4-12-4 fertilizer on new seedings for pasture. Plant a mixture of 8 lbs. Kentucky bluegrass, 2 lbs. of red top, 8 lbs. orchard grass, 8 lbs. lespedeza, and 3 lbs. white Dutch clover per acre. On soils of low fertility use 20 lbs. of lespedeza and 5 lbs. of red top. Plant in late summer or early spring.

Operation	Accepted Practices
5. Providing permanent pastures	Top dress the pasture with 300 lbs. to 600 lbs. of superphosphate per acre in the spring for three straight years. 0-14-7 fertilizer should be used on soils low in potash. Apply lime when needed as shown by soil test.

Related Information

A legume included in the rotation increases the yield of the following crop by adding organic matter and improving the condition of the soil. If a soil-conserving crop is included in each rotation, the soil structure is improved and erosion is better controlled. Crops turned under as green manure replace in the soil the necessary elements for plant growth and improve the soil condition. Because of the differences in soil, climate, and type of farming in different sections of the state, no one rotation is best. Plan the rotation to provide cover on the soil during the entire year to prevent erosion. The feed requirements of the farm must be considered when deciding on a rotation to provide as much home grown feed as possible.

If a hay crop follows small grain in the rotation, the cost of seed bed preparation is reduced since the grass can be sown with the small grain.

Proper liming and fertilizing are essential in producing hay efficiently. By sowing a mixture of several grasses, a better quality of hay is produced and if one of these grasses fails to grow because of freezing or drought, the ground will be covered with the others. Grasses may be seeded alone if they are sown for a special purpose such as for seed. Summer or winter annuals may be used as catch crops in case other grasses fail.

Fast growing cover crops establish a good root system, and, therefore, hold the soil, water, and plant nutrients in the soil. Any crop that provides a thick cover and stays green during the winter provides a winter cover such as small grains. Summer cover crops are usually planted in the spring following a crop that has been harvested or turned under for green manure.

If crops are turned under in the spring while they are green, the great amount of moisture in the soil helps to decay the tender green plants rapidly and this decayed matter provides plant food for the following crop.

Rye grows in all sections of the state, provides winter cover, grows rapidly, and becomes established easily.

Fertilizer is necessary in establishing permanent pasture to produce a quick, heavy, thick growth. Kentucky blue grass is one of the best permanent pasture grasses for areas of the state to which it is adapted, but it requires some time to become established. For this reason it should be seeded in a mixture of other grasses. After pastures are established applications of fertilizer and lime are necessary to produce good pasture that will conserve the soil and water.

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Unit V

PROVIDING WILDLIFE AND FOREST PLANTINGS

The Importance of Wildlife and Forest Plantings

Wildlife plantings are necessary to provide food and cover for birds and animals and to help control soil erosion. Birds and animals need some kind of cover in which to make their homes and in which to hide when attacked by an enemy. Cover also gives protection from bad weather. Their food supply should be near their homes to protect the birds.

Man has destroyed many of the natural hiding places of wildlife by cutting out timberland, draining swamps, and cleaning fence rows.

Insects are becoming more plentiful each year. Birds are active enemies of insects and are, therefore, very important in their control. Wildlife plantings at the proper places are important soil and water conservation practices.

Establishing Field Borders

Field borders are wildlife plantings which are planted along the edges of fields to make better use of the land. When planted across the end of cropland fields, they give room for turning when planting, cultivating, and harvesting farm crops. When the end of the field lies on a slope, much erosion takes place unless a permanent cover is provided.

At the same time these strips furnish food and cover for wildlife. The strip should be wide enough to allow for turning and wider when needed to protect the soil.

Field borders are also developed along woodlands to protect the soil from erosion and to provide a turning row. This section along the woodland is often planted to field crops with little returns because the tree roots reach into the field and use the moisture and plant food. This is an ideal location for wildlife since it is between the wooded areas and croplands.

A seed bed should be prepared before wildlife plantings are made on the strips. These are permanent strips and the only attention needed is to keep out sprouts than may crowd out the better plants.

Providing for Wildlife on Eroded Places

Many stream banks are badly eroded and are cutting back into the croplands. These banks should be planted with grasses and shrubs to hold the soil and would not interfere with cropping near the stream. All drainage ways on the farm should have a permanent cover such as legumes, grasses, or shrubs to hold the soil and provide protection for birds and animals. Steep slopes, rocky outcrops, and sinkholes provide very little income to the farm unless they help control erosion or encourage more birds to live there. When plantings are made on a badly eroded hillside sometimes it is best to get

to get them well rooted on a strip across the top of the hill first. This gives protection to the next strip when it is planted.

Selecting Location for Forest Tree Plantings

Forest tree plantings are usually made on larger areas of idle, waste, or eroded land where they will not cut down crop production near them. It may be a field located too far away from the barn and other farm buildings to be used to advantage as cropland. The trees and shrubs will hold the soil on steep land better than any other crop or pasture because of the large root systems and mulch formed by fallen leaves which ast as a sponge to hold water when it rains. Many old woodlands that have been improperly kept or where trees have been cut out should be reforested with young seedlings to produce wood and lumber needed on the farm.

Selecting the Kinds of Wildlife and Forest Plantings

A variety of plants should be grown to supply food and shelter for many different kinds of wildlife. Plantings may include legumes, grasses, shrubs, vines, fruit trees, and forest trees. The kind of each to select for planting should be determined by the use to be made of the area, the type of soil, and their suitability to that section of the state.

Legume plantings may include lespedeza, sericea, Korean, common or the shrubby species, clovers, vetches, or alfalfa,

while grass plantings may include such specimens as orchard grass, browntop millet, or Sudan grass. Some of the shrubs which may be planted are summer grape, dogwoods, hazelnut, eleagnus blackberries, bush honeysuckle, and bush lespedeza; also cyrtobotrya and bicolor lespedeza. The species or kinds of trees to plant will vary in different sections of the state, but some of the most common trees to use are the pines, locusts, and yellow popular. Apple, cultivated cherry, wild plum, black gum, mulberry, hickory, black walnut, white walnut, also are excellent. A few, at least two or three per acre, fruit and nut bearing trees should be included in each planting if the needs of wildlife are to be taken care of. Such trees as red cedar and Norway spruce should be planted to supply much needed cover for quail, rabbits, and songbirds.

Planting Trees and Shrubs

Seedlings or young trees may be secured from the State Forest Department or the Soil Conservation Service. The Forestry Department plants seeds from which these seedlings are produced. These seedlings are selected from the best varieties and are free from disease. They should be secured and planted in the spring before the buds begin to swell.

All the small tender roots of the seedlings must be kept moist while handling. If they cannot be planted as soon as they arrive, they should be "heeled in" until they can be planted. The distance between the trees planted will

vary, depending on the kind of trees, soil, and purpose for which the trees are planted. The average distance is 6 ft. to 8 ft. apart which will require about 1,000 per acre. Mark the rows and plant in a straight line. Use the grub hoe to dig the holes which should be large enough to spread the roots out evenly in all directions. The trees should be carried in a pail of water while being planted to keep the roots moist. Set the seedlings about the same depth as they were grown in the nursery to make sure all the roots will be covered well. Tramp the soil tight around the young tree to prevent air space, to hold the moisture, and to place the roots in close contact with the soil. This is very important.

Managing Woodland

The greatest enemy of woodland is fire. Forest fires are more likely to occur near highways, railroads, and broomsage fields. Fires destroy the trees, burn valuable leaves and cover on the forest floor which acts as a sponge to hold the water during rains and floods.

Diseased trees should be removed to prevent the disease from spreading to other trees. Crooked and broken trees should be removed to make room for other trees of more value. Avoid breaking the bark on trees to prevent insect and disease injury. Sometimes undesirable species of trees should be cut out to prevent their crowding out more important trees. Vines such as ivy should be removed because they interfere with

tree growth.

The State Forestry Service should be notified when serious disease, insects, or pest trouble is discovered or when a fire is out of control. The management of the forest and wildlife plantings would depend on the purpose for which they are produced. If they are planted for timber all undesirable plants should be removed. When plantings are made for wildlife and erosion control a large variety of plants may be desirable.

Unit III	Providing Wildlife and Forest Plantings
Operation	Accepted Practices
1. Establishing field borders	Plant across ends and sides of fields and along woodland next to cropland. The width of the border may vary but should be from 25 ft. to 50 ft. in width along the woodland, depending on how far the mature tree roots reach into the cropland. Make strip as nearly uniform in width as possible. Prepare seed bed before planting. Do not plow or cultivate wildlife borders after they have been made. Cut out trees that crowd or come up in the border.
2. Providing for wildlife on eroded places	Use wildlife plantings along stream banks, drainage ways, steep slopes, rocky outcrops, sinkholes, or eroded field borders. Include both herbaceous plants and berry bearing shrubs. Plant a small strip across the top of the hill first if erosion is bad. Smooth over deep gullies. Prepare seed bed and mulch lightly,

Operation	Accepted Practices
	(about 2") with straw or litter.
	Plant legumes, grasses, or shrubs.
3. Selecting location for forest tree plantings	Make tree plantings on idle, waste, or eroded land or on land that does not fit in well with the rest of the crop and pasture land.
	Plantings may be made in an open stand of trees to increase the amount of growth.
4. Selecting the kinds of wildlife and forest plantings	Provide a variety of plants.
	Plant legumes, grasses, berry-bearing shrubs, vines, and forest trees.
	Legumes may include the lespedezas, sericea, Korean or common, cyrtobotrya, clovers, vetches, or alfalfa.
	Grass plantings include orchard grass, browntop millet or Sudan grass.
	Shrubs that may be planted are dogwood, hazelnut, blackberries, bush lespedeza, privet, eleagnus, bush honeysuckle, and summer grape.
	Species of trees from which to select are one of the pines, black locust, yellow popular, apple, mulberry, red cedar, and Norway spruce.

Operation	Accepted Practices
5. Planting trees and shrubs	Secure seedlings from State Forest Department or the Soil Conservation Service. Plant only disease-free trees and shrubs. Plant in the spring, usually before the buds begin to swell. Keep roots moist before planting, "heeled in," if necessary. Plant trees 6 ft. by 7 ft. apart, 1,000 per acre. This may vary according to kind of trees and the purpose for which they are planted. Use the grub hoe to dig the holes. Carry the trees in a pail of water. Dig the hole large enough to spread out the roots. Set the same depth they stood in the nursery. Tramp the soil tight over the roots.
6. Woodland Management	Protect plantings from fire and grazing. Remove diseased trees and trees killed by lightning when found and plant other trees to replace those removed. Avoid breaking the bark on roots and trees.

Operation	Accepted Practices
	Notify State Forester when serious disease, insects, or pest trouble is discovered.
	Cut out undesirable species of trees.
	Cut out such vines as ivy and woodbine only where over abundant or objectionable to the purpose for which the woodland is being developed.
	Plant shrubs along woodland borders.

Related Information

Field border strips are used across the ends and sides of fields to provide for a turning row when cultivating crops, also it controls erosion, and gives food and shelter for wildlife. It should be wide enough to turn on when planting, cultivating, and harvesting the crops. The field border along the woodland helps to control erosion by providing growing plants on that area where roots of trees extend into the cropland, and crop production is small. By making the strips a uniform width, cropping will be easier. If a seed bed is prepared the plantings become better rooted. If trees are cut out along the border at different times, little additional work is needed. Plantings along the stream banks, drainage ways, steep slopes, rocky outcrops, and sinkholes hold the soil and water and provide food and shelter for wildlife.

If a strip is planted across the top of a hill above badly eroded areas before the entire hillside is planted, the crops will become well rooted and make it easier to grow wildlife plantings below by holding the water and soil on top of the slope. A mixture of plants provides more of a variety of food for wildlife. A mulch is necessary to obtain best results for seeding or planting on badly eroded areas. When planting in an open stand of trees, the number of trees per acre is increased which is better land use. Sericea lespedeza

is better than Korean or common lespedeza since their roots remain in the soil from year to year. The kind of plants, trees, and shrubs should be selected according to the type of soil, climate, and other conditions which affect their growth. The State Forestry Department or the Soil Conservation Service will furnish seedling trees which are dependable.

The seedlings will grow better if they are planted before the buds begin to swell. If roots are kept moist while handling, more of the trees will grow. The planting distance will not be the same for all trees. It will vary according to the kind of tree, the soil, and the use to be made of the trees. The trees will have better root foundations if the roots are spread out when they are planted. The tramping of the soil over the roots when the trees are planted prevents they from drying. Fire kills the leaves and bark on the trees and burns the mulch, leaves, and sticks on the ground. It also kills wildlife. Grazing the woodland cleans out all young trees, tramps the soil, and injures the roots of the trees. This will start decay. Diseased trees should be removed to prevent the disease from spreading to other trees. Undesirable trees are removed to give more room for better trees to grow.

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