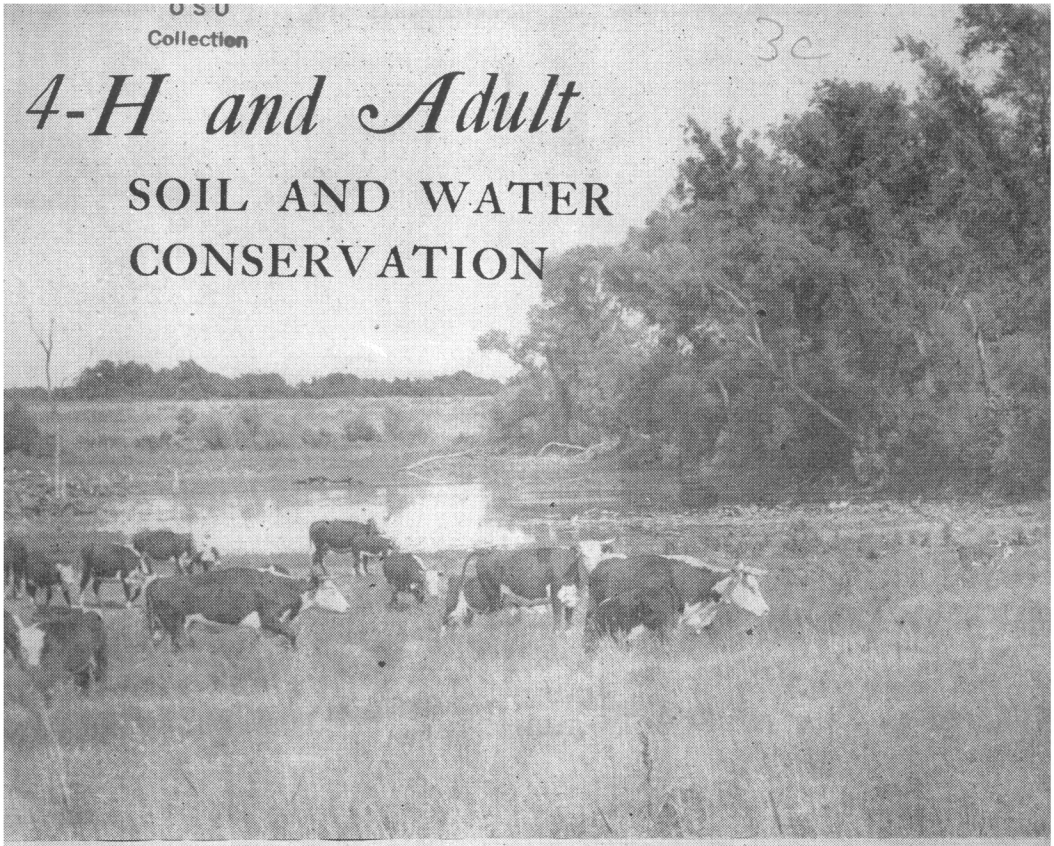
4-H and Adult

SOIL AND WATER CONSERVATION



Circular 413

EXTENSION SERVICE, OKLAHOMA A. AND M. COLLEGE
SHAWNEE BROWN, *Director*
Stillwater, Oklahoma

This publication has been prepared by Extension Service staff members. It is designed to serve as a guide for older 4-H club members and adults who are interested in the essential steps in a well-rounded program of conservation.

The conservation of our natural resources! How tremendously important this subject is to the people of this state! The welfare of every family, of every industry, of every organization is definitely associated with the progress of conservation programs. It matters not where the family may live —town or country—nor does the family occupation alter the situation. The fact remains that the welfare of every individual is directly affected by the degree to which conservation practices are established.

The wise and judicious use of our natural resources is a matter of public concern. Ours is a new state; much of the land has been put under cultivation within the memory of people still living. Forests have been cleared, farms created, and fine cities have been built. In the meantime, losses from soil erosion have been heavy. Our natural resources have been used, in some cases not too wisely, in the process of developing a great state.

However, there are many encouraging signs. Oklahoma is on the way back. Definite progress is being made. Old fields are being revegetated with improved strains of native grass; acreages of tame grass pastures are increasing; and the rolling, sloping hillsides are being treated to reduce soil losses. Tree plantings are increasing rapidly and thousands of farm ponds have been built. Limestone and phosphate are being used in large quantities to correct mineral deficiencies. All of these signs point to a stable, more profitable agriculture as more and more of these practices are included in the farm program.

A complete program of conservation and improvement is not one which can be finished within the space of a single season. Rather, it is a continuous process with one step following another. One can proceed in this work only so fast as time, finances, and equipment will permit. A satisfactory system of terraces can be built with a turning plow; they may be built more quickly with large power machinery but it is not essential that heavy equipment be available before a program of terracing is undertaken. Thousands of demonstrations stand as witnesses to the fact that much can be accomplished by man's ingenuity and the tools at hand. Lack of equipment need not prove a handicap too big to overcome in this effort to maintain and improve the farms of the state. The most important point is to *START* a definite program of improvement *NOW* using such facilities as are available.

Shawnee Brown

Director of Extension

Contents

	Page
Introduction	2
Project Requirements	3
The National 4-H Soil Conservation Contest	8
The Soil	9
The Soil Profile	9
Soil Erosion	10
Causes of Erosion	10
How to Conserve Soil and Water	11
Land Use	11
Wind Erosion Control	14
Lime and Phosphate	14
Grasses in Soil and Water Conservation	15
Grass Species	16
Identity of Grasses	17
Seeding Native Grasses	18
Grasses for Livestock Production	21
Planting Trees to Control Erosion	22
Planting Overflow Land	22
Fire Protection as a Conservation Practice	25
Mechanical Methods in Soil and Moisture Conservation	27
The Farm Level	27
Terracing	30
Outlet Control Work	36
Gully Control	37
The Farm Pond	38
Mapping	45

4-H Club Soil and Water Conservation Project

INTRODUCTION

The 4-H soil and water conservation project provides an opportunity for club members to participate in a program which has for its purpose the rebuilding and conserving of the greatest of all natural resources—the soil.

The fertility of the soil is to agriculture what money is to the banking industry. If soil losses continue, it will doubtless become more and more difficult for those who farm the land to maintain desirable standards of living. If the trend of poor soil management is not checked, those who farm the land in the future will be the greatest losers because it will be necessary for them to make a living on land that has a lower level of fertility than that which exists at the present time.

This places a direct responsibility on the shoulders of the 4-H Club boys since they are destined to be the leaders in their various communities in solving the farm problems of the future. In order to better prepare themselves to meet this challenge, every 4-H boy should gain a practical knowledge of the soil as it is at present, together with the forces and practices which have caused its depletion and those practices which will maintain or increase its present productivity.

Project Requirements

ELIGIBILITY

Any bona fide 4-H Club boy working under the supervision of the county Extension agent is eligible to participate in the 4-H Soil and Water Conservation Project.

PROJECT REQUIREMENTS

4-H Club boys who expect to participate in the 4-H soil and water conservation contest must complete the following minimum requirements of the project: (A) Draw a map of the farm "as it is"; (B) draw a map of the farm "as it should be"; (C) carry out at least three soil and water conservation practices applicable to the home farm; and (D) write a story of the conservation work done.

The following are suggestions relating to the requirements of the project:

A. Draw a Map of the Farm As It Is at the Present Time, giving the information outlined below:

1. The number of acres in each field.
2. What each field was used for this year.
3. What each field was used for during the two previous years.
4. The amount and kind of fertilizer or limestone used if any was applied during the two previous years.
5. With spade or auger determine the average amount of top soil left in each field and indicate the extent of erosion by: slight, 0-25 percent; moderate, 25-50 percent; severe, 50-75 percent; very severe, 75 percent or more of the top soil gone. The county agent can give assistance in determining this information.
6. Use arrows to show direction of main slopes and degree of slopes.
7. Show in red color the areas where serious erosion has occurred.
8. Show location of farmstead by drawing squares to represent the buildings.
9. Show the location of streams by parallel lines.
10. Use a scale and log of symbols as shown on page 46.

B. Draw a Map of Your Farm As It Should Be to conserve the soil, prevent further erosion, and improve soil fertility:

The 4-H Club member should talk with his parents and his county agent about making his soil conservation plan. Bulletins relating to soil conservation work may be obtained from the county agent. Some of the things the club member will want to keep in mind when making these plans are suggested below. There may be additional problems on the farm that are not mentioned in the suggestions.

1. Determine where a permanent pasture should be established.
2. Determine where tree plantations and wild life areas should be located and areas where livestock should be excluded.
3. Decide on which fields cultivated crops should be grown.
4. Decide what fields should be terraced, strip cropped, or farmed on the contour.
5. Determine whether there are waterways which should be kept in grass.
6. Decide on the number of livestock that may be kept on the farm without overgrazing pastures.
7. Determine if there are areas that should be cleared of trees and bushes to facilitate the growth of grass.

C. Soil and Water Conservation Practices that can be put into effect to Improve the Farm as Shown on the Map in Section B:

Required—At least three of the following soil conservation practices.

Optional—As many additional practices as the club member can complete profitably.

1. Protect woodland and grassland from fire. Establish a fireguard to prevent fire from spreading from one area to another or to prevent fire from reaching fields, pastures, buildings, or stacks of feed.

2. Practice deferred grazing on some native grassland. In other words, do not permit livestock to graze on the native grass pasture from spring until fall so that the grass will have a chance to produce seed and restock itself.

3. Plant a fall cover crop of small grains, clover, or winter legumes on at least one field to protect cultivated land from severe erosion during the winter months.

4. Establish adapted plants to provide food and cover for wildlife. Food for wildlife may also be provided by planting grain along creeks, ponds, and brushland. Woodlands, vegetation along fence rows, and vegetation on areas of rough land will furnish cover and food for wildlife.

5. Make limestone and phosphate tests as recommended by the county agent. Have at least two soil tests made from the farm—one from the home garden or truck field and the other from any area on the farm. The county agent has the equipment to test soils.

6. Establish a permanent pasture in one field, by planting or sodding grasses recommended by the county agent.

7. Treat permanent pastures to increase the production of desirable pasture plants. In areas where rainfall is sufficient the land may be reseeded with native grass or clovers; manure may be applied to the land, and if soil tests show a deficiency of lime and phosphate, these minerals may be applied to the land.

8. Mow weeds and sprouts in a pasture to eliminate the competition with the grasses and to reduce weed seed production.

9. Establish sod of Bermuda grass, native grass, or clover on a waterway such as a terrace outlet, natural drain through a field, or a drainage ditch. The sod will reduce erosion or "sloughing" off of the soil. It is wise to establish the sod on waterways a year or more in advance of turning the water into it so grass can establish a good turf.

10. Learn how to operate a farm level.

11. Draw a contour map of one field on which stakes have been set for establishing contours, strip cropping, or terraces.

12. Put contour stripping into effect on one field. Strips of close growing crops such as small grain or clovers and alternate strips of row crops may be planted on the contour to aid in checking water runoff and soil loss. The width of each strip and the recommended crops and combinations can be obtained from the county agent.

13. Put contour farming into effect in one or more fields. Plant row crops or seed small grains on the contour.

14. Select a suitable site and build a dam of proper specifications to provide water for livestock or for irrigation purposes; or to provide a place for fish and other wildlife.

15. Develop or improve a spring to furnish water for livestock or for other purposes on the farm or ranch.

16. Apply recommended fish culture methods such as restocking or fertilizing, or a combination of both to a pond or stream. The county agent can furnish recommended stocking and fertilizing methods.

17. Construct appropriate checks in one or more gullies.

18. Maintain terraces already constructed on the farm. This includes repairing breaks in terraces and plowing up or working over the terraces.

19. Plant a demonstation plot or larger area to native grasses. If applicable, plant three or more of the native grasses adapted to the locality. If a small demonstration plot is planted, save the seed.

20. Save a pound or more of seed of four or more different kinds of native grass grown in the community with the intention of planting them. Preferably, the seed should be collected on the home farm or ranch, but it may be collected anywhere in the community. Learn to identify grass seeds.

21. Use alternate strips of tall growing crops such as grain sorghum or corn with alternate strips of peanuts (rows running in a general eastern and western direction) to check wind erosion. Where it is practical after harvesting the peanuts, plant a winter cover crop on the strip where the peanuts grew.

22. Apply barnyard manure, a commercial fertilizer, or a combination, including limestone, to a field, a small demonstration plot, a few rows, or a strip of reasonable width in a field. Use fertilizer recommended by the county agent. In all cases a check plot or area which is untreated must be available to make comparisons of yields from treated and untreated land. A record should be made of comparative yields and, where it is possible, comparative photographs should be obtained.

23. Apply drainage work to any area where it is practical. Make a map of the field or area where the drainage work has been applied. Give figures and statements regarding the drainage work.

24. Establish a forest tree plantation planting under proper supervision.

25. Practice contour listing or pit cultivation on one field. The county agent can give details regarding these methods.

26. Protect summer fallowed acreage from wind and water erosion. This applies to land which is allowed to lie idle during the growing season. This practice should not be applied

on very sandy land where the absence of vegetation will create an erosion problem. The land should be kept sufficiently free of vegetation to conserve the available moisture.

27. Leave stalks or stubble of sorghum, broomcorn, or Sudan grass on the land as protection against wind erosion.

28. Grow a summer cover crop for green manure. Summer legumes adapted to the locality may be grown and plowed or disced into the soil.

29. Prepare land for seeding native grasses where the practice is applicable. A year in advance of planting the native grass, the land should be seeded to Sudan or sorghum (drilled). The crop should be cut, leaving a high stubble, before it matures seed. See the county agent for details.

30. Control undesirable shrubs or cactus in the pasture. By removing shrubs, brush, and cactus the pasture is improved. A minimum of one acre should be used in this demonstration.

31. Apply any type of practical irrigation on a suitable area.

32. Apply limestone to a field, garden, or truck area. A test to determine acidity should be made in advance to determine the amount of limestone needed.

33. Fertilize any part of the garden or truck field with manure, superphosphate, or a mixed fertilizer, as recommended by the county agent. A soil test should first be made.

D. Story of Work Done:

Write a story of not more than 300 words on the soil conservation practices put into effect.

Additional credit will be given as a part of the record book for any of the following things done:

1. Obtain information regarding the work that has been done in the county to conserve the soil and the progress that is being made from year to year and make a report of this work.

2. Have the county agent or an individual suggested by him talk at a 4-H Club meeting on soil and water conservation.

3. Make a tour with the county agent to see what is being done in the county to conserve the soil.

4. Visit a terracing demonstration or similar activity which is being held in the county.

E. Records and Reports:

A record should be kept by the club member on the soil and water conservation project. This record should show the

date, kind of work performed, and other information relating to the project. The report should be submitted to the county agent not later than September 20.

F. Demonstration:

The club member should give at least one demonstration during the current year relating to the project.

G. Exhibit:

The 4-H Club member should make an exhibit at the county fair and at one of the state fairs.

The exhibit shall consist of the following items:

1. Map of the farm "as it is."
2. Map of the farm "as it should be."
3. A story of not more than 300 words regarding the soil and water conservation practices applied on the farm.
4. A clear photograph of the club member.
5. Permanent record book, including the standard report form.

THE NATIONAL 4-H SOIL CONSERVATION CONTEST

A national 4-H soil conservation contest is sponsored through the National Committee on Boys and Girls Club Work. The requirements are the same as those outlined for the Oklahoma 4-H soil and water conservation project.

Each county will be permitted to select a county winner to compete for state honors. A county report form and other records of the county winners must be in the state office not later than October 1. A gold plated sterling silver medal of honor will be provided for each county winner in the state providing the record is received in the state not later than October 1 for competition in the state contest.

The state winner in the soil and water conservation project will be selected from the county winners, and his record will be entered for sectional and national awards.

Under the rules of the National 4-H Club Congress, the state winner must have reached his 14th birthday and must not have passed his 21st birthday on January 1 of the year in which the award is made. The state winner must have completed at least three years of 4-H Club work, including the current year.

A committee of Extension specialists will judge the records to determine the state winner and the records will be judged according to the following score card:

	Points
1. General 4-H Record (Standard report form included)	20
2. Soil Conservation Record	
a. Map of farm "as it is"	20
b. Map of farm "as it should be"	20
c. Actually carrying out three or more soil conservation practices and a 300-word story on the work done and results expected	40
TOTAL	100

THE SOIL

Soil is formed as a result of the combined action of water, cold, heat, wind, vegetation, and animal life over a very long period of time. It is this thin layer of soil that supports plant growth which makes human existence possible. To preserve the soil is to preserve our agriculture, our community life, and our civilization.

Fig. 1. Soil profile showing topsoil, subsoil, and rock from which soil is formed.

THE SOIL PROFILE

If a section downward through an undisturbed soil is examined, a well defined layering will usually be found. This section is called the soil profile. The upper layer is the surface soil or furrow slice. The surface layer generally contains considerable amounts of organic matter and is dark in color because of this accumulation. The surface soil also contains most of the available nutrients which are essential for plant growth. Below the surface soil is the layer commonly referred to as the subsoil. It contains very little organic matter and is lighter in color than the surface soil. The subsoil varies in depth and extends from the surface layer downward to the rock or parent material from which the soil was formed.

SOIL COMPONENTS

The soil is made up of four important components: namely, mineral materials, organic matter, water, and air. The mineral materials which make up the visible part of the soil are derived from the weathering of rock. The organic matter is derived from the decay of plant and animal residues. Water and air fill the pore spaces which occur between the individual particles in the soil mass.

SOIL EROSION

Erosion is the removal of soil by water or wind. Every muddy stream and every deposit of sand and silt at the bottom of a slope is evidence of erosion. This form of erosion, which is referred to as accelerated or man-made erosion, destroys soil in contrast to geological erosion which forms soil. Accelerated erosion is found on most farms in Oklahoma in two forms: sheet erosion and gully erosion.

Sheet erosion removes or washes away the topsoil in thin sheets, and the loss may not be realized until the subsoil begins to appear. The entire surface layer of soil in cultivated fields may be washed away without the appearance of a single gully. Sheet erosion actually causes more damage than gully erosion. In gully erosion the soil is carried away by the action of water flowing in distinct channels. The appearance of gullies is the last stage in the destruction of the land.

Wind erosion is the wearing away of the soil by the action of the wind. This form of erosion is common in western Oklahoma and on some soils in the central area. Sandy soils are more susceptible to blowing than fine-textured soils. Wind erosion not only injures the fields from which the soil is removed, but it may cause damage to nearby fields and farms by covering up crops, grasses, fences, and partially covering up buildings. The blowing soil or dust particles may also be disagreeable or unhealthful for people and livestock.

CAUSES OF EROSION

The virgin soils in Oklahoma were protected by a covering of grass or timber. This was Nature's way of preventing soil loss by erosion. As farming developed in the state timber was cleared, grass sod was destroyed by plowing, and the land was planted to soil-depleting crops. In many instances, steep slopes with shallow soils which are highly susceptible to erosion when not protected by grass sod or timber, were put in cultivation. Row crops were planted with the slope instead of on the contour, and much of the land was left without adequate cover or protection during periods when heavy rains were most likely to occur.

The burning of pastures and of crop residues on cultivated land has also contributed to the problem of accelerated erosion. The topsoil which is gradually being washed away by erosion contains most of the organic matter, nitrogen, and soluble minerals which are necessary for plant growth. Erosion is removing fertility on many farms more than 20 times as fast as it is being removed by crop production. More than 2,000,000 acres of cropland in Oklahoma have already been abandoned as a result of erosion, and at least 8,000,000 additional acres are subject to moderate or severe erosion.

HOW TO CONSERVE SOIL AND WATER

LAND USE

Proper use of the land is an important factor in erosion control. Each field on the farm should be used for the purpose or purposes to which it is best suited. On level or gently sloping land where erosion is not a serious problem, row crops may occupy a predominant place in the cropping system. On moderately steep slopes, erosion-resisting crops such as small grains, sweet clover, lespedeza, and grass mixtures may well occupy the land a greater portion of the time. A permanent vegetative cover, either of grasses or trees, should be established on steep slopes where erosion cannot be controlled by the use of terraces and other practices applicable to land in cultivation.

Proper soil management may be of even greater importance than land use in properly utilizing and conserving the soil on many farms. Experiments show that improved cropping systems which include erosion-resisting and soil-improvement crops such as alfalfa, sweet clover, and grasses along with terraces will greatly reduce the rate of soil loss on sloping soils. It has also been shown that soils protected by perennial grasses will not be removed faster than one inch in two or three thousand years.

The type of farming or cropping system should be suited to the conditions of the land and the physical environment. Consideration must be given to conserving the soil and also to securing a living for the operator. The aim should be to determine the most profitable utilization of the land which will also conserve the soil and maintain its fertility.

CONTOUR TILLAGE

Contour tillage refers to plowing, planting, and cultivating with terraces or on established contour lines. The small furrows and ridges resulting from these operations retain more of the water where it falls and facilitates its entrance into the soil. This gives a more even distribution of rainfall and increases the amount of moisture available for crop use. Contour tillage is necessary to control inter-terrace erosion, which in turn, prevents the silting of terrace channels. When used in connection with terracing, contour tillage is one of the most effective methods of conserving moisture and preventing soil loss. By conserving soil and moisture, contour farming also increases crop yields.

Fig. 2. Listing and planting on the contour.

COVER CROPS

Cover crops protect the land during the periods of the year when it would otherwise be exposed to the harmful effects of wind or water erosion. They are especially valuable to plant following peanuts or other crops which leave the land

virtually bare or unprotected in the fall. Cover crops provide a convenient and effective means of supplying organic matter and nitrogen to the soil. They also take up soluble nitrogen which might otherwise be lost in drainage and conserve it for succeeding crops.

Vetch, Austrian winter peas, crimson clover, rye, rye grass, wheat, barley, and winter oats are all used to some extent as winter cover crops. Vetch is well adapted in eastern Oklahoma and on sandy soils in the central section. Austrian winter peas can be used in the central part of the state to provide winter cover crops and to increase the organic matter content of the soil. Rye and rye grass are grown extensively on sandy soils and soils which are relatively low in fertility. Rye is especially adapted on sandy soils. Wheat and barley are planted primarily for grain but the growing crops provide a protective cover for the land during the winter and spring when both wind and water erosion are most likely to occur.

CROP ROTATION

A good system of crop rotation is a fundamental principle of proper soil management. In contrast to the continued growing of one or more soil-depleting crops on the same land or to irregular cropping of the land without a definite plan, the systematic rotation has many advantages, most important

Fig. 3. Contour planting of crops on sloping soil conserves both soil and moisture.

of which is the provision for maintaining or improving the fertility of the soil. A good rotation system provides several sources of income and gives some protection against crop failure and low market prices. It also distributes labor requirements throughout the year and permits better use of farm machinery in diversified farming areas.

Crop rotation aids in the control of erosion on sloping soils. In experiments conducted at the Red Plains Conservation Experiment Station at Guthrie from 1930 to 1941 inclusive, the soil loss on land farmed to cotton continually was 4.4 times greater than from land in a three-year rotation of cotton, wheat, and sweet clover.

WIND EROSION CONTROL

The effective control of wind erosion is to prevent the soil from reaching a condition which permits soil blowing. Under normal conditions this can be accomplished by the use of proper tillage and cropping practices. Soils which are covered with well established vegetation or with crop residues such as sorghum or Sudan are in good condition to resist wind action. A protective cover of raw organic matter on the surface of the soil is especially important since it may prevent injury to young plants from drifting sand. Listing on the contour or at right angles to the direction of the prevailing winds; or, tillage with other implements which will leave a rough, uneven surface will also check soil blowing. Some sandy soils which are not suitable for small grain may be planted to sorghums if the stalks are left on the land. In areas where peanuts are grown, sorghums may be planted in alternate strips with the peanuts to reduce both wind and water erosion. In southern Oklahoma a crop such as rye or vetch may be planted following peanuts for winter cover. If peanuts are harvested too late for planting a winter cover crop, the land should be contour listed to conserve moisture and to prevent wind and water erosion during the winter.

Field shelterbelts, in conjunction with the above tillage practices, will serve an important part in wind erosion control.

LIME AND PHOSPHATE

More than 50 percent of the soils in eastern Oklahoma are deficient in lime and phosphorus. Carefully collected samples of soil from each field on the farm should be tested for lime and phosphate requirements. Sufficient amounts of finely ground agricultural limestone should be applied to neutralize

acid soils. Phosphate fertilizer should be applied on soils which are deficient in phosphorus. Legume crops such as sweet clover, alfalfa, hairy vetch, or lespedeza should be grown to add organic matter and nitrogen to the soil.

GRASSES IN SOIL AND WATER CONSERVATION

Most of the soils in Oklahoma were formed under grass. The dense growth of grasses which covered large areas of the state when the first settlers came is the best proof of the soil-holding qualities of grass. This grass cover protected the soil against erosion and the natural mulch from decaying grasses held the moisture until more of it was absorbed into the soil.

Fig. 4. Big Bluestem (Andropogon furcatus).

Fig. 5. Indian grass (Sorghastrum nutans).

GRASS SPECIES

Four native grasses are predominant in central and eastern Oklahoma. They are little bluestem, big bluestem, Indian grass, and switch grass. Certain characteristics are common to all four species. All are deep-rooted, long-lived perennials. They are called bunch grasses because they grow in bunches or clumps. The tough, fibrous roots penetrate the soil in a network extending to a depth of several feet. These grasses are known as the soft stem grasses and are about equal in palatability. They lose their plant nutrients very rapidly during late summer and fall through leaching.

The native grasses of the western section are well supplied with plant nutrients, particularly minerals, and the nutritive value of these grasses is very high throughout the year. This

is due largely to the high mineral content of the soil, the low rainfall, and the character of the grass species which are common in this area. The short grasses are deep rooted and are very drought resistant. They have the unusual characteristic of curing as hay after growth is checked by drought or cold weather. The cured or dry grass provides valuable grazing during the winter.

Buffalo grass and Bermuda grass are similar in appearance. Buffalo grass spreads by runners or stolons, and the root system extends into the soil a depth of 4 to 8 feet. Blue grama is by far the most important of the grama grasses. Hairy grama and side-oats grama are also important grasses of the grama species.

Fig. 6. Buffalo grass (Buchloe dactyloides).

IDENTITY OF GRASSES

The identity of grasses can best be learned in the field with some experienced person who is familiar with different species. A collection of the most important grasses should be made for identification and for comparative study. It will also be helpful to collect and study the seed from each of the species. In making this study of native grasses the Experiment Station Technical Bulletin No. 3, "Grasses of Oklahoma," by H. I. Featherly will be helpful.

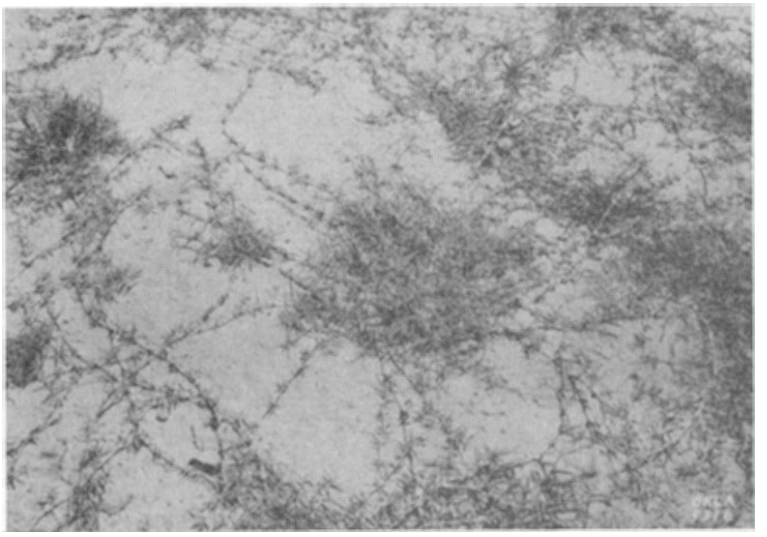


Fig. 7. Bermuda grass (Cynodon dactylon).

EFFECT OF BURNING AND OVERGRAZING ON MEADOWS AND PASTURES

Burning of meadows and pastures is highly injurious to the grasses. Fire destroys the grass seed and thus prevents new plants from replacing the old ones; it also destroys the mulch of dead grass which holds water until it is absorbed into the soil. This mulch serves as a protective cover to prevent damage to grasses from freezes during winter and from the hot sun during summer.

Overgrazing is another common practice which results in serious injury to pastures. When pastures are continuously overgrazed, the palatable and nutritious grasses are gradually destroyed and are replaced by weeds. Careful pasture management to avoid overgrazing is essential in preserving and maintaining the grasses which are most valuable for grazing purposes.

SEEDING NATIVE GRASSES

A firm seedbed with a protective cover is essential in establishing stands of native grasses. In western Oklahoma, a sorghum stubble mulch crop, such as Sudan or a sweet sorghum, grown the previous year makes an excellent seedbed for drilling grass seed the following spring, if the crop is cut and allowed to remain on the land. It should be mowed 8 to 10 inches high to provide maximum stubble protection, and mowing

should be done before the crop produces seed to prevent volunteering. The grass seed should be drilled in the stubble mulch in April. Seeding may be done with a grass seed drill or it may be broadcast and disced lightly. In central and eastern Oklahoma, the grass seed may be drilled in Sudan, sorghum, or small grain stubble. Good stands of native grasses have also been obtained by spreading mature grass hay on the land. Where this method of seeding is used, the stubble mulch is not necessary.

Fig. 8. Side-Oats Grama grass (Bouteloua curtipendula).

An adequate supply of seed is essential in establishing stands of native grasses. Grass seed can be harvested with a combine, but it is best to determine the amount of seed available before harvesting it. To do this measure off 1/100 of an acre, which is about seven steps square. Gather the seed from this small area. Dry, clean, and weigh the seed; then multiply the weight by 100 to determine the yield per acre. A combine usually gathers about one-half of the seed. Experience has shown that 30 pounds of seed to the acre is the lowest amount that is profitable to harvest.

The next step is to determine the quality and purity of the seed. To determine whether or not there is a crop of seed worth harvesting, count out 100 seed husks; put them on a glass pan and press out the seed with the point of a knife blade or pen. Ordinarily 20 to 30 grains of seed taken from 100 husks is considered satisfactory.

Fig. 9. Weeping Lovegrass (Eragrostas curvula).

GRASSES PROTECT WATERWAYS

Grass provides the most satisfactory protection for water disposal systems. Bermuda is most commonly used for this purpose. In the western part of Oklahoma where Bermuda does not thrive, buffalo grass and blue grama are used on fine-textured soils; on sandy soils, weeping lovegrass or side-

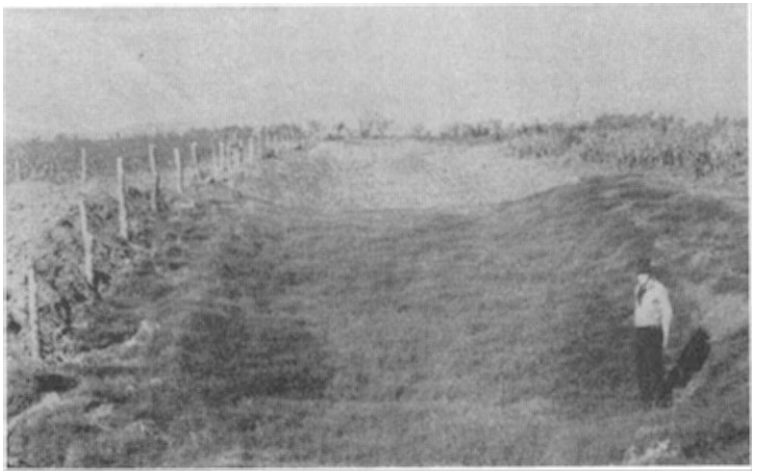


Fig. 10. Sodded outlet for outlet ditch.

oats grama may be used. Vine mesquite is sometimes used for this purpose. Bermuda and buffalo grass are also used on dams of lakes and reserviors for erosion control.

One of the best methods of establishing grasses in waterways is by planting pieces of sod approximately 24 inches apart each way over the entire area.

TEMPORARY PASTURES WILL CONSERVE SOIL

Many annual grasses and clovers are sown for the dual purpose of providing pasture and preventing surface erosion. The most important of these are Korean lespedeza, rye grass, and Sudan.

Korean lespedeza is broadcast in April at the rate of 25 pounds of seed an acre. It usually holds soil from eroding before more permanent grasses can be established.

Rye grass should be sown in September at the rate of 20 to 25 pounds of seed an acre. On fertile soil it soon forms a dense cover and protects the soil against erosion. On thin land, rye grass should be fertilized with an application of 150 to 200 pounds of superphosphate per acre. More uniform stands of rye grass are usually obtained when the seed is planted with a drill. If a drill is not available, the seed may be broadcast and disced into the soil.

Sudan is one of the most important crops that can be planted for temporary pasture during the summer and fall. Sudan is also a valuable crop to use in strip cropping systems for erosion control.

PASTURE GRASSES PREVENT WIND EROSION

Erosion on sandy areas along streams or on abandoned farm lands can be controlled by planting rye and vetch for winter growth. The growth is left on the soil to serve as mulch until gramas, sand lovegrass, sand drop seed, and other permanent western grass can be broadcast.

GRASSES FOR LIVESTOCK PRODUCTION

Pasture provides the greatest abundance of cheap feed. Native pastures in western Oklahoma which are properly managed are capable of producing 75 to 100 pounds of beef an acre during the grazing season. Good native pastures in central and eastern Oklahoma are capable of producing somewhat higher yields. Bermuda grass with lespedeza and yellow hop, White Dutch, or bur clover will often produce 300 to 350 pounds of beef an acre annually.

Where good pastures are available, a dairy herd may get more than 50 percent of the total amount of feed consumed from this source.

Fig. 11. Blue Grama grass (Bouteloua gracilis).

PLANTING TREES TO CONTROL EROSION

Trees should be grown for two purposes: first, to produce timber and wood products that will be of some value and second, to stop soil erosion.

Plantations of post lots or other timber crops will control erosion on sloping lands if proper care in planting the trees is observed. Severely eroded and very thin lands are unprofitable sites for tree plantations because a tree needs some fertility and moisture the same as any other plant. Tree plantations should be planted on the contour or approximately so. If the trees are planted on the contour, terraces will not be necessary. This type of planting will prevent the formation of gullies, but, to use trees as a means of stabilizing existing gullies, apply the procedure described for stream bank control. Plant on both banks and the bottom of gullies.

Several kinds of trees may be used in forest tree plantations. The black locust is the one most commonly used; however, other trees that may be used effectively for controlling erosion are bois d' arc, short leaf pine, red cedar, and mulberry. The black locust prefers sweet land; therefore, acid land should be limed before planting. These plantations will grow more rapidly if they are cultivated for the first four or five years. The rows should be spaced far enough apart to accommodate the implements available on the farm. Details for spacing are found on pages seven and eight of Publication

No. 6, "Planting and Care of Forest Trees," published by the Division of Forestry and State Parks, Oklahoma City. A copy of this publication may be obtained from the county agent.

PLANTING OVERFLOW LAND

Much of the bottom land of both small and large streams is subject to overflow at certain times of the year. The overflows wash silt onto the land or wash away the topsoil. Trees will thrive better than almost any other crop on land that overflows; therefore, post lots and other timber crops may be established on such land. During the first two or three years, while the trees are small, flood water may wash the trees down or bury them with trash and it may be necessary to clear off the trash after a flood. The species best adapted to this type of land are: pecan and walnut for nut production; cottonwood, sycamore, and some of the oaks for timber production; and catalpa and bois d' arc for posts.

Large blocks of timber can withstand floods, but small plantings will not provide effective erosion control in large flood areas.

STREAM AND BANK PLANTING

The planting of trees along creek banks can be a profitable venture if the trees are planted on banks that are not too steep and do not crumble. It is necessary to plant stands rather close together, about six by six feet. The stands should extend up over the line of the bank for several rows to be most effective. If a block of timber is planted so the roots are entwined, the roots will form a mat which will hold the entire creek bank. If only a few rows or individual trees are planted along the stream bank, the soil washes out from under them and they fall. Steep banks that crumble and fall into the stream when the water is high, can be held if several acres are planted. The species best adapted to stream bank planting are willow, cottonwood, catalpa, and bois d' arc.

PLANTING TREES TO CONTROL WIND EROSION

Erosion is generally thought of in terms of water erosion, but, in certain areas of Oklahoma, wind erosion is just as destructive as water erosion. The planting of farmstead windbreaks and field shelterbelts is an important means of controlling wind erosion on sandy land in the western area of the state. Some of the farmstead windbreaks will give valuable protection to the garden, orchard, poultry yard, feeding lot, and front yard.

Shelterbelts and windbreaks should be made up of several rows of trees. The farmstead windbreak should have three to

ten rows of trees and the field shelterbelt should have from five to twenty trees. The most effective windbreak or shelterbelt is made up of several kinds of trees. Details for planting trees for wind erosion control may be found on pages six and eight of Extension Circular 398, "Windbreaks and Their Relation to Agriculture."

Fig. 12. Shelterbelts protect land against wind erosion.

POST CROPS FROM EROSION PLANTINGS

Fence posts are the main product to be taken from water erosion control plantings and flood land plantations. Four-inch fence posts may be harvested from timber grown on flood land in a period of from six to eight years, while on a thin hillside, it will take from eight to fifteen years to produce the same size fence post. Under proper management, 5,000 fence posts an acre may be expected in 18 years from flood lands and 5,000 posts may be expected in 24 years from thin hillside lands. On flood lands the first cutting of timber should begin in 6 or 7 years after planting, and on hillsides, 8 to 9 years after planting.

Good post or timber production requires a small amount of pruning. Each tree should be assisted in growing a straight center leader, by taking off the minimum amount of side branches. In many cases simply cut back the tips of lateral branches instead of removing the entire branch.

HOW TO PLANT

Trees should be carefully planted if they are to succeed. Details on planting trees are found on pages 10 to 12 of Circular 398, "Windbreaks and Their Relation to Agriculture," and on pages 10 to 14 of No. 6, "Planting and Care of Forest Trees." These may be obtained from the county agent.

FIRE PROTECTION AS A CONSERVATION PRACTICE

Fire prevention is vital to any type of land management.

4-H Club members may make the fire prevention activity a worthwhile one by building fireguards and by taking necessary precautions in protecting timber, grass, and croplands from fires.

Native woodlands, meadows, and pastures should be protected by constructing fireguards completely around each unit or area. If large areas are broken up into smaller areas, the fireguards will be more effective. Roads, ditches, and streams make the best fireguard and should be used as a base line for dividing the area.

Fig. 13. Trees planted on the contour and well cultivated.

A fireguard should be approximately six feet in width, and all inflammable material should be cleared from this strip. The following methods may be used to prepare a fireguard on any type of land:

1. Plow or disc a strip of land 6 feet in width.
2. Rake all of the inflammable material off the strip down to mineral soil so fire will not cross it.
3. Burn off a strip of land. If this method is used, the following precautions should be taken: have plenty of help and equipment available so the fire will not get out of control; do the burning early in the morning or late at night when there is dew on the grass.

PLANTINGS TO PROTECT WILDLIFE

The planting of trees, shrubs, and brambles on erosive land will help hold the soil and protect wildlife. Since such an area must be left as a thicket, it is doubly important that a fireguard be established around each planting. These fireguards, if plowed or disced, should not be plowed up and down hill or they will tend to increase soil erosion.

MECHANICAL METHODS IN SOIL AND MOISTURE CONSERVATION

TERRACING

One of the important steps in a complete soil and water conservation program on cropland is the construction of terraces to control runoff water on sloping land where erosion cannot be controlled by simple tillage and cropping practices. Each terrace collects the water from its drainage area and carries it around the slope which reduces erosion to a minimum. Terraces also hold the water longer on the slope where it falls and more of it is absorbed into the soil.

One should be familiar with the correct procedure of handling a farm level before attempting to lay out terraces, contour lines, and farm ponds.

THE FARM LEVEL

SETTING UP THE LEVEL: Remove the level from the carrying case and screw or thread it onto the tripod head. Adjust the level screws in the bosses to midposition. This puts the spring under tension and allows the level screws to be either raised or lowered in leveling. Be sure that one screw is between the lugs on the bottom of the horizontal limb.

The following procedure should be followed carefully when setting up the level:

1. Set the instrument up and spread the legs of the tripod three or more feet and spike one firmly; turn the telescope over two of the legs and spike the second firmly into the ground, so the bubble in the vial is fully visible; turn the telescope over the third leg of the tripod and force the spike into the ground, shifting it sufficiently to keep the bubble fully visible in the vial. This method of keeping the bubble roughly centered in setting up the tripod makes the final adjustment with the leveling screws very brief and avoids distortion of the spring and pivot screw.

2. Tighten the wing nuts, and focus the telescope by pulling the eye piece in or out until objects beyond 50 feet are clearly visible. Do not twist.

3. Set the telescope exactly over two of the leveling screws, and center the bubble by turning the screws equal amounts in opposite directions.

4. Set the telescope exactly over the third screw, and center the bubble using this screw only.

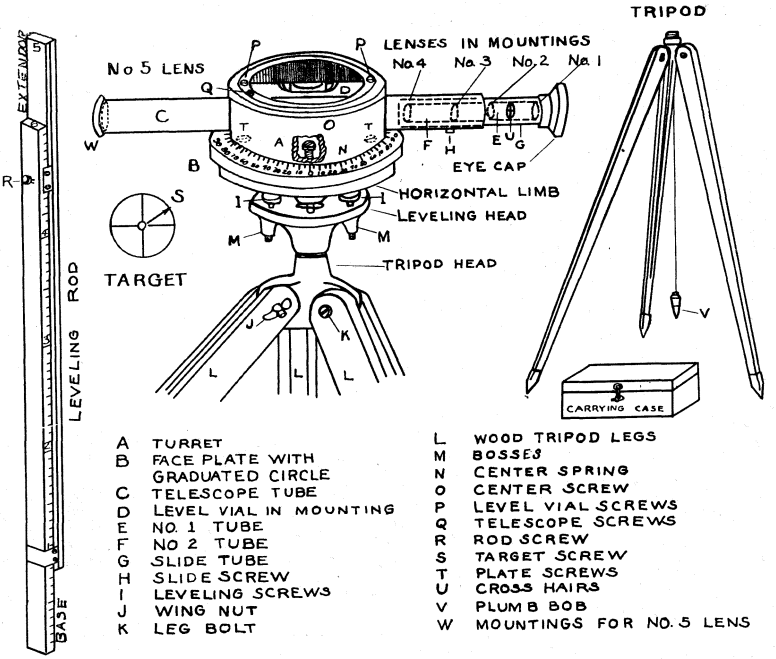


Fig. 14. Showing parts of a farm level.

5. Repeat the centering in both positions.

6. Sight over the telescope, bring it in line with the target or object to be observed by a slight pressure sideways with the tips of the forefingers on each hand. Use the tangent screw, where available, for exact setting of vertical hair.

7. Always check the bubble before and after each sight to be sure the level is still in adjustment.

TESTING THE FARM LEVEL: This discussion is limited to the type of level with a turret and three leveling screws. This method will apply to levels with or without stadia hairs. Other methods of testing a level are found in Extension Circular No. 218.

TESTING THE BUBBLE VIAL: Set the instrument on firm ground and level it. Turn the telescope over two of the leveling screws and adjust until the bubble is exactly in the center of the vial; then turn the telescope over the third leg and level. Check back from the first two legs and make any necessary adjustment. When the bubble remains centered for these two

positions, turn the telescope until it points in the opposite direction from these positions. If the bubble still remains in the center, the level is in proper adjustment. If the bubble shifts, further adjustment is necessary.

To Adjust the Bubble Vial: Level the instrument and take out the screws that hold the turret in place after noting which end of the vial the bubble has approached. Loosen one of the small screws in the turret that hold the bubble vial in place and tighten the screw on the lower side of the turret. The bubble vial will be moved toward the screw that is being tightened. Replace the turret on the horizontal limb and relevel the instrument. Check the bubble again. Repeat the operation until the bubble remains in center position at different directions of the telescope.

Testing the Telescope by Inverting the Turret: Set the instrument on firm footing and level; release the turret so it can be easily removed. Measure 100 feet from the instrument and drive a stake. With the rod on this stake, read the center horizontal hair with the turret in correct position; then invert the turret and read the center hair. Care must be taken not to disturb the tripod. The difference in the rod readings is twice the error of the instrument. To correct the

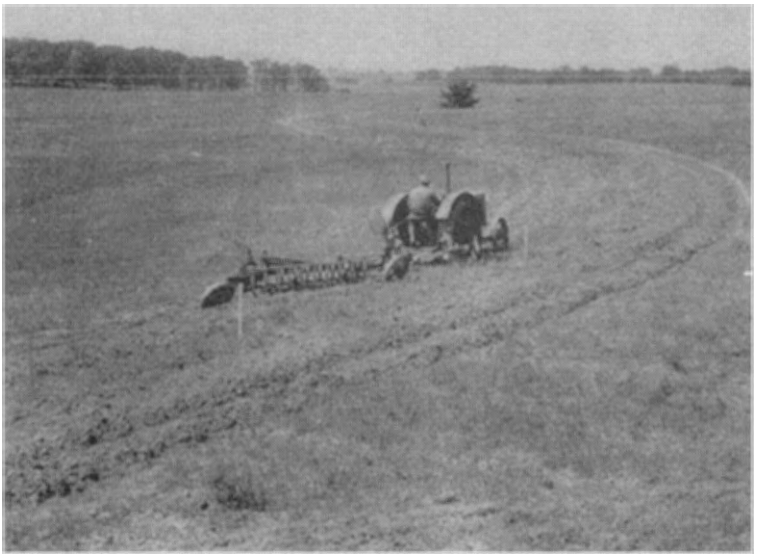


Fig. 15. Building terraces with the farm tools available.

error, remove the turret from the tripod, and adjust the small screw at the front port (where the telescope goes through the turret) to one-half the error. Take a new reading on the rod to check. Repeat the process until the rod readings are the same when taken from the turret in the correct position as when taken with the turret inverted.

CARE OF THE LEVEL

The level is a delicate piece of equipment and should be handled carefully. The following are some precautions to observe in handling the level: use a graphite pencil lead on the wearing surface where lubrication is needed; keep the level clean; do not jar or jolt the instrument; release the tension on the pivot spring because extreme tension will weaken the spring; release the wing nuts when moving the instrument; do not clean the telescope barrel with a pencil and handkerchief or similar method because the cross hairs may be broken by so doing. After the instrument has been used, it should be thoroughly dried with a wool or yarn cloth. If good judgment is used in caring for the level, it will last a long time.

TERRACING

SIZING UP THE AREA: One of the most difficult things the club member will have to master is the task of sizing up the area that is to be terraced or contoured. Since a terrace is intended to be permanent in character, it should be planned

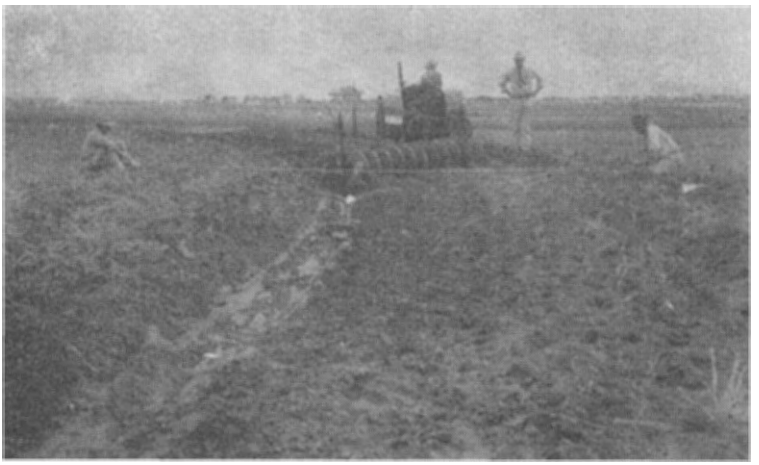


Fig. 16. Building terraces with the disc tiller.

Fig. 17. Building terraces with a moldboard plow.

with care and discretion. The entire farm and adjoining watersheds should be considered in making a plan.

The following steps should be kept in mind when planning the terrace system for the average farm:

1. Water should not be diverted into the burrow pit of the highway except as a last resort.

2. The amount of water a terrace must carry is in proportion to the length of the terrace.

3. It is a good practice to turn runoff water into a "natural drain."

4. It is not adivsable to divert more water into a "natural drain" than it will carry.

5. Plan a terrace system that will require a minimum outlet ditch with the least amount of fall and one that may be constructed at the lowest possible cost.

6. A satisfactory place to discharge water is in a pasture or on timberland if the terraces are not too long.

7. Well sodded areas may be used for disposing of water from the terrace, if the volume of water is not too great or the slope of the sodded area too great.

8. Do not discharge water from a terrace on another man's property.

MEASURING THE SLOPE OF THE LAND: The level is set up and the rodman takes the rod to the average high point where a rod reading is taken. As an illustration, we say that the top rod reading is one foot. The rodman selects what he considers to be the average of the field, takes 33 steps (approximately 100 feet) directly down the slope, places the rod on average ground and secures another rod reading. The rod may read five feet. To find the amount of fall per 100 feet of slope, subtract the top reading, which was one foot in the illustration from the bottom rod reading, which was 5 feet. The difference is 4 feet. This means that the ground is falling 4 feet vertically every 100 feet. This is a four percent slope.

The first terrace line to be laid out should be the one nearest the high side of the field. Before laying out terrace lines the club member should consult the following table on terrace spacing to determine how much vertical spacing should be given between the first terrace and the high point.

TO LOCATE THE FIRST TERRACE LINE: GO to the highest point of the field and set the level in such a manner that, after the instrument has been leveled, one can see over the high point of the field. Measure the slope of the land; consult table I to find out how much drop to give this percent of slope; add the vertical drop to the rod reading taken on the high point of the field; move the rod down hill until the

Fig. 18. A hillside ditch or diversion terrace.

TABLE I.

A Guide to the Proper Spacing of Broad Base, Channel (Nichols), or Ridge Type Terraces.

LARGE RIDGE TYPE TERRACE

Slope of Land in Feet per 100 Feet	Vertical Interval	Minimum Height Top of Terrace Above Normal Ground—Inches		Minimum Width Terrace Above Normal Ground Feet	Cross Sectional Area Above Normal Ground *Settled* Square Feet	Recommended Average Dstance Between Terraces
		New Terrace	Settled			
.5 or less	1.25	13½″	10″	19.2′	8.0′	210′
1.0	1.5	13¾	11	17.5	8.0	150
2.0	2.0	15	12	16.0	8.0	100
3.0	2.5	15	12	16.0	8.0	83
4.0	2.0	15⅔	12½	15.4	8.0	75
5.0	3.5	15⅔	12½	15.4	8.0	70
6.0	4.0	16¼	13	14.8	8.0	67
7.0	4.5	16¼	13	14.8	8.0	64
8.0 or more	5.0	17½	14	13.8	8.0	62

SMALL RIDGE TYPE

.5 or less	1.25	13½	10	12.0	5.0	210
1.0	1.2½	13¾	11	11.0	5.0	150
2.0	2.0	15	12	10.0	5.0	100
3.0	2.5	15	12	10.0	5.0	83
4.0	3.0	15⅔	12½	9.6	5.0	75
5.0	3.5	15⅔	12½	9.6	5.0	70
6.0	4.0	16¼	13	9.2	5.0	67
7.0	4.5	16¼	13	9.2	5.0	64
8.0 or more	5.0	17½	14	8.6	5.0	62

CHANNEL TYPE TERRACE

Slope of Land in Feet per 100 Feet	Vertical Interval	Minimum Height Top Terrace Above Upper Channel —Inches	Minimum Width Center of Water Channel to Top of Terrace —Feet	Minimum Effective Cross Sectional Area of Channel Square Foot	Recommended Average Distance Between Terraces
½ inches	1.25	14	10	16	210
1	1.5	14	10	16	150
2	2.0	14	10	16	100
3	2.5	15	9	14	83
4	3.0	15	9	13	75
5	3.5	16	8	12	70
6	4.0	16	8	12	67
7	4.5	17	7	10	64
8	5.0	18	7	10	62

The water channel of a channel type terrace should have a flat bottom at least four feet wide. The lower side of the terrace must be at least ⅔ as wide as the upper side.

cross on the target corresponds with the cross hair in the instrument. At this point the terrace is to be located if everything is satisfactory. Care should be taken to have enough land above the first terrace to justify its existence.

To Run the Terrace Line: After the rodman has located the first terrace line, he should proceed with the survey. This is done by raising the rod to increase the amount of grade given along the terrace line per 100 feet. On average terrain in Oklahoma only 50 feet stations should be made along the survey line. However, on uniform slopes 100 feet stations can be used. For example, if the rod reading was 4 feet when the terrace was located and 50 feet stations were to be observed and the terrace grade was to be 2 inches fall per 100 feet, the rodman would raise the rod 1 inch to make the rod read 4 feet 1 inch for the next station. Then pace 17 steps around the hill, place the rod on average land, and move it up hill or down hill until the two crosses correspond. This procedure should be repeated until the outlet of the terrace is reached. A common rule is to raise the rod when going downstream to lower the grade and to lower the rod when going upstream to raise the grade.

The instrument man should not sight over a distance greater than 300 feet with the average farm level. With a little judgment the setting of the instrument can be manipulated in such a way that 600-foot distance can be surveyed from one setting. For example, set the instrument out from the end of the terrace 300 feet; then, survey 300 feet in opposite directions, thus allowing a 600-foot survey.

Grade: There are two common types of grade, the constant and the variable. The constant grade is where the amount of fall per 100 feet is the same from the beginning to the end of the survey line. The constant grade is usually used in surveying ditch line for irrigation ditches, drainage ditches, and diversion ditches. In a few cases the constant grade is used on the top line of the levee.

The variable grade is one that varies, and this is the grade used on terraces. For example, a terrace line is 900 feet long. If the first 300 feet of this terrace line were run level, the second 300 feet given a grade of 1 inch fall per 100 feet, and the last 300 feet given a grade of 2 inches fall per 100 feet, this would be a typical variable grade. There are a number of things that determine the amount of grade to give a terrace line. They are as follows: rainfall, length of terrace, type of soil, slope of land, and type of farming practiced on

the land. Terraces on fine texture soils will require more fall than terraces on sandy soils because of the limited capacity of fine textured soils for the absorption of water.

RUNNING A CONTOUR LINE: A contour line is a level line similar to a terrace line. All elevations along the line are equal or the same distance above and below sea level. Contouring alone is practiced only on medium or very gentle slopes where the land is not subject to severe erosion.

The same procedure should be used in spacing contours as in spacing terraces on land with a slope in excess of four percent; on slopes less than four percent, they may be spaced twice as far apart as terraces. The contours may be located on slopes below four percent by figuring out the vertical interval that should be given between terraces and doubling this vertical interval to locate the contour line.

The accuracy of the contour or terrace lines depends in a large measure upon the rodman. A good rodman should be alert at all times and should hold the rod as nearly vertical as possible. He should watch for the signals of the instrument man and obey them as quickly as possible. He should locate the rod on average ground trying at all times to keep stations and grade in mind.

OUTLET CONTROL WORK

Much research has been done on the problem of outlets for terraces and ditches. The native stone baffle has proved its worth where rock is plentiful. The check and spreader of concrete block is a very good method of checking the flow of water. The loose rock baffle can be used where the flow of water is not excessive, especially when vegetation is used as a binder for the rock. Many outlets can be adequately protected by sodding with grasses that are adapted to the prevailing soil type and climatic conditions.

Research work carried on at the hydraulic laboratories at Lake Carl Blackwell, Oklahoma A. and M. College, indicates that grass sod is one of the most satisfactory methods of controlling outlets, drainage ways, and spillways where the slope is not more than ten percent.

The water that is discharged from the terrace must be properly taken care of during the heaviest rains to prevent large gullies from being formed. Water flows faster through a deep gully, cutting loose more soil and carrying it away. If

Fig. 19. A waterway well protected by grass sod.

the velocity of the water is held down to about eight feet per second, little or no erosion will result.

According to a recent research at the hydraulic laboratory at the Oklahoma A. and M. College, it was found that eight feet of water per second can be held by the use of grassed ditches that have a slope as great as 10 percent. Care and judgment should be exercised to reduce the amount of water going down an outlet ditch on a slope of more than 10 percent. Pasture, timberland, and natural drains will serve in most

TABLE II.

Table for Terrace Outlet Ditches.

Drainage Area Acres	Width of Ditch Feet	Drainage Area Acres	Width of Ditch Feet
(The head of the ditch is designed on a one-foot head)			
1 to 3	6	51 to 55	30
4 to 6	10	56 to 60	32
7 to 10	12	61 to 65	34
11 to 15	14	66 to 70	36
16 to 20	16	71 to 75	38
21 to 25	18	76 to 80	40
26 to 30	20	81 to 85	42
31 to 35	22	86 to 90	44
36 to 40	24	91 to 95	46
41 to 45	26	96 to 100	48
46 to 50	28		

cases as excellent places to discharge runoff water from a terrace system; however, as a last resort an outlet ditch may be built to take care of the runoff water.

The following table will serve as an excellent guide for the 4-H Club member to follow in determining the size of ditch for any given drainage area:

GULLY CONTROL

Gully control is an important part of a complete conservation program. Gullies usually start near the bottom of the slope and erode their way up toward the top. Since average earth will stand on a ratio of three to one when exposed to wind, water, and other climatic conditions it is always advisable to slope the sides of the gully to a grade of approximately three to one before setting to grass or shrubbery. Many times the depth of the gully can be controlled by installing checks, spreaders and various types of flumes or drops. (See USDA Farmers' Bulletin No. 1813.)

Where large gullies are encountered, erosion can frequently be controlled by the use of soil-saving or spreader dams. A spreader dam is a fill of earth built across the gully to a height of approximately 2½ to 3 feet above the top of the bank and extending out over the bank on each side, thus causing the water to be diverted to flat or gently sloping areas. If an overfall is present at the end of a gully, further erosion can be prevented by installing one of the different types of structures mentioned in USDA Farmers' Bulletin No. 1813. If the gully is not carrying too much water, the overfall may be sloped back to a grade of 10 to 1 and set to Bermuda, buffalo, or some other suitable grass. It has been found that as much as 8 cubic feet of water per second can be handled on a 10 percent slope by the use of vegetative measures.

THE FARM POND

A farm pond is a body of water impounded in a natural draw by an earthen dam. The basin is usually a natural depression, gully, canyon, or small stream. The pond is generally filled by water from the watershed adjacent to the pond.

A reservoir is an excavation made for impounding water where there is no natural basin, and the excavation is usually made in a low place. The excavated dirt is placed on the lower side of the excavation to form a dam and thus increase the capacity of the reservoir.

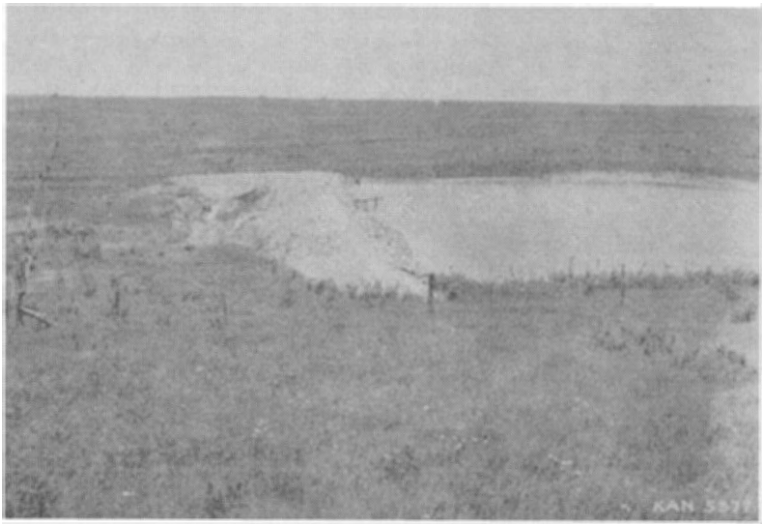


Fig. 20. Farm pond with a loose rock rip rap and a well vegetated watershed.

The farm pond is an excellent means of providing an adequate supply of water for livestock. The water from the pond may be used for irrigating small orchards and gardens. Since 1928 approximately 50,000 ponds and reservoirs have been constructed in Oklahoma to recommended specifications. With care and planning the area about the pond can be developed into a place of scenic beauty which will provide a place for recreation and wildlife.

SELECTING A SITE FOR THE FARM POND

The ideal site for a farm pond is one which will impound the largest amount of water and require the least amount of soil to be moved. Depth is more important than area. The type of soil should be considered when locating the farm pond. The soil should be impervious to moisture. The pond should not be located on an area where there is deep sand, water gravel, alkali, or large deposits of gypsum because these soils are open and pervious and will not hold the water in the pond or basin. Sandy clay and clay gravel make excellent materials from which to construct a dam.

It is well to consider the general livestock program being followed on a farm when selecting the site for a pond. Many times it is possible to provide water for livestock by locating the pond in the center of the pasture, thus reducing the distance that livestock will have to travel for water.

THE WATERSHED

A watershed covered with grass, timber, or shrubbery and with a moderate or gentle slope is ideal for the farm pond or reservoir. The watershed should be large enough to supply a sufficient amount of runoff water to fill the basin (See Table III for watershed size). In some instances it may be necessary to fill the pond basin with runoff water from cultivated fields. In such cases, the fields should be terraced and farmed on the contour. A silting device installed to prevent the basin from filling with silt is highly desirable. If a watershed is not large enough to furnish water to fill the basin, water may be diverted from an adjoining watershed by constructing a diversion ditch or terrace. Damming streams or natural draws that drain large areas should be avoided. If too much water passes over the spillway, it will be damaged and will eventually be washed out.

LOCATING THE SHORE LINE

The shore line should be established before the dam is constructed. This will give the owner a visual conception of the size of the pond when the basin is full at spillway level and will prevent the possibility of water backing up on the property of some one else.

The following procedure should be followed in establishing the shore line: determine the spillway level; take a rod reading at this point; run a level line along the draw; continue this level line until it crosses the draw and returns on the opposite side directly opposite the point where the first rod reading was taken. To determine the natural depth of the water, take a rod reading at the lowest point in the basin and subtract the rod reading taken at the shore line.

THE SPILLWAY

The spillway is sometimes referred to as the safety valve of the farm pond. The best spillway is the natural one. A natural spillway is a depression on one or both sides of the draw upon which it is possible to discharge the overflow from the pond in times of heavy rainfall. The native sod in a natural spillway should not be disturbed if it can be avoided.

The cross section of the spillway should equal the cross section of the stream at its high water level. The slope of the spillway should be gradual down to the level of the base of the dam. If an overfall develops at the end of the spillway, a stone or concrete structure may be installed. In some cases overfall may be avoided by carrying the overflow a greater

TABLE III.

(This Table is designed on a two-foot head)

Drainage Area Acres	Width of Spillway Feet	Drainage Area Acres	Width of Spillway Feet	Drainage Area Acres	Width of Spillway Feet
1 to 3	3	66 to 70	18	136 to 140	32
4 to 6	5	71 to 75	19	141 to 145	33
7 to 10	6	76 to 80	20	146 to 150	34
11 to 15	7	81 to 85	21	151 to 155	35
16 to 20	8	86 to 90	22	156 to 160	36
21 to 25	9	91 to 95	23	161 to 165	37
26 to 30	10	96 to 100	24	166 to 170	38
31 to 35	11	101 to 105	25	171 to 175	39
36 to 40	12	106 to 110	26	176 to 180	40
41 to 45	13	111 to 115	27	181 to 185	41
46 to 50	14	116 to 120	28	186 to 190	42
51 to 55	15	121 to 125	29	181 to 195	43
56 to 60	16	126 to 130	30	196 to 200	44
61 to 65	17	131 to 135	31	201 to 205	45

distance from the spillway. Where the overflow water passes over a rock ledge and falls on to another rock ledge, a structure is not necessary. It is a good plan to have two spillways at different elevations. (To determine the size of the spillway refer to Table III above).

WIDTH OF SPILLWAY FOR A POND OR RESERVOIR

This table gives the approximate width of the spillway in feet required of various areas drained into the pond or reservoir. The figures given check fairly closely with the rates of runoff for rolling cultivated land as found by C. E. Ramser, Senior Drainage Engineer, U. S. Department of Agriculture.

A study of the table on the width of the spillway shows an increase of one foot in the width of the spillway for every five acres of added drainage area. This increase of one foot width for every five acres continues to 400 acres. The table may be continued to 400 acres. Above 400 acres the increase is at the rate of one foot width for the spillway for each additional 10 acres. Any size spillway for any given area may be determined by the use of these rules.

STAKING OUT THE DAM

A preliminary survey of the pond dam should be made. The preliminary survey makes it possible for the surveyor to design the dam according to specifications and provides the necessary information that will be needed in construction. This survey includes the grade stakes on the upstream and downstream side, width of spillway, and height of the dam at

each break of the contour of the land upon which the dam is to be placed. If the dam is to be constructed by a contract, the length, height, and width of the dam, and number of cubic yards in the dam should be furnished the contractor. The preliminary survey will provide a means of determining whether or not the dam was built according to specifications and whether it was built to the grade stakes as outlined.

SURVEYING THE DAM

Take a rod reading on the shore line and one at the deepest part of the basin to determine the natural depth of the pond. Consult Table No. IV, Page No. 42, to determine the amount of freeboard necessary for the dam. Freeboard is that part of the dam extending above the spillway level which acts as a sideboard in times of flood to divert excess water through the spillway. Place the target at the exact point of the freeboard. For example, if the freeboard is to be three feet, place the target on a three-foot reading. Stand the rod on the spillway and move the level uphill or downhill until the cross hairs strike the horizontal cross on the target. This procedure places the level at the exact height of the top of the dam. After the level has been placed in this position, each succeeding rod reading will be the true height of the dam at the point, minus the shrinkage factor. Take a 100-foot steel tape and unwind it across the draw where the dam is to be built. Fasten one end to the tape on the spillway; stretch the tape in the direction the center of the dam is to be; with pins or stakes proceed along the center line and drive the pins or stakes at each break of the contour. If the draw has but few breaks, do not make the stations in excess of 50 feet apart.

TABLE IV.

This table shows dimensions of dam for a farm pond.

H Ft.	a Ft.	b Ft.	a+b=W Ft.	w Ft.	d Ft.	i	o
5	12	7	19	4	3	2 :1	1½:1
6	14	11	25	4	3		
7	16	12.5	28.5	4	3		
8	18	14	32	4	3		
9	20	15.5	35.5	4	4		
10	22	17	39	4	4		
11	30.5	25	55.5	6	4	2½:1	2 :1
12	33	27	60	6	4		
13	35.5	29	64.5	6	4		
14	38	31	69	6	4		
15	48	33	81	6	5	3 :1	2 :1
16	51	35	86	6	5		
17	54	37	91	6	5		
18	58	40	98	8	5		
19	61	42	103	8	5		
20	64	44	108	8	5		
21	67	46	113	8	5		

H=Height of dam.
a=Width from center to inner edge at bottom.
b=Width from center to outer edge at bottom.
a+b=W=Total width of dam at bottom.
w=Width of dam at top.
d=Distance from water level to top of dam, called the freeboard.
i=Inner slope.
o=Outer slope.

Establish a set of notes in the field notebook in the following manner:

Standard Set of Field Notes for Farm Ponds and Profile Leveling.

Station B. M.	B. S. 3 ft.	I. H.	F. S.	Elevation 100 ft.	D./S.	C. L.	U./S.
0+00		103 ft.	3 ft.	100 ft.			
0+20		103 ft.	7 ft.	96 ft.			
0+50		103 ft.	10 ft.	93 ft.			
0+75		103 ft.	12 ft.	91 ft.			
1+00		103 ft.	5 ft.	98 ft.			
1+25		103 ft.	0 ft.	103 ft.			

B. M. (Bench Mark) is a reference point of permanent nature.
B. S. (Back Sight) is a rod reading taken on a point of known or assumed elevation.
I. H. (Instrument Height) is the distance above and below sea level to the cross hairs of the level.
F. S. (Fore Sight) is a rod reading taken on a point of unknown elevation.
Elevation is the distance from sea level up to or down to a point.
D./S. (Downstream) is the distance from the center line of the dam to the outer edge of the dam.
C. L. (Center Line) is the center of the dam or structure to be constructed.
U./S. (Upstream) is the distance from the center line to the upper edge of the dam or structure.

The following equation will assist the club member in applying ease of operation to the use of the above set of notes:

B. M. + B. S. = I. H. I. H. — F. S. = Elevation.

The above is a typical set of notes to be used in staking out farm ponds, reservoirs, and dams, as well as doing profile leveling and should be adhered to very closely. The columns "F. S." and "Elevation" will probably not be used in staking out the average dam. Station is the number of feet from a given point. For example, the first station will be 0+00; if the second station is 20 feet from the first, then the second station should be entered as 0+20.

After the level has been set up to the exact height of the dam to be built and the center line established, the B. M. (a reference point of permanent nature) should be located directly opposite station 0+00 and in line with the center line of the dam. This is done because it will be necessary for the surveyor to measure from the B. M. in line with the center of the dam to find the original stations after the dam has been constructed. The B. M. is a point of known or assumed elevation; however, the true elevation of a B. M. is the distance above or below sea level.

In work on farm dams it can be assumed that the elevation of the B. M. is to be 100 feet. This takes care of any cuts or fills that have to be made. In the elevation column opposite B. M., write 100 feet, then take a rod reading on the B. M. This rod reading is known as the Back Sight and is entered in the column B. S. directly opposite B. M. Now refer to the formula B. M. + B. S. = I. H. For example 100 + 2 = 102.00 or the instrument height. No further calculations need be made unless the instrument is to be moved.

If the height of the dam is three feet at the station 0 + 00, using a 1 to 3 slope on the upstream side, multiply the height of the dam which is three times the ratio, or 3 × 3 + ½ the crown of 6 feet. The result will be 12 feet. This means the stake should be driven exactly 12 feet from the center at the station and at right angles to the center line. To determine how wide the dam will be at the downstream side and at station 0 + 00, multiply the height of the dam which is three times the ratio of the slope, or 3 × 2 + ½ of the crown and the result will be 9 feet. This should be entered in the column D. S. opposite station 0 + 00 as 3/9. The stake is driven 9 feet from station 0 + 00 and at right angles to the center line. This method or procedure is duplicated at each rod reading taken at the break of the contour on the center line, provided that

the center line rod reading does not exceed a difference of six inches from the rod reading taken at the upstream or downstream side. If the difference is greater than six inches, figure the width of the dam at that point by using the outside rod reading.

The type of machinery used in constructing the dam will determine to a large extent the width of the crown on top of the dam. For instance, if the dam is designed with a four-foot crown and built with an eight-foot bulldozer the crown would have to be eight foot, because a dozer of that size could not finish the top of the crown less than the length of the dozer blade.

UPSTREAM AND DOWNSTREAM SLOPE

Sand will stand on a ratio of 6 to 1, meaning a vertical height of one foot and a horizontal run of six feet. Average dirt, when exposed to water, will stand on a ratio of 3 to 1. Over a period of time a slope will assume a ratio of three to one through the process of wetting assisted by gravity. The downstream side of the dam is built on a ratio of two to one in order to save dirt and reduce the cost of construction.

SHRINKAGE

The amount the dam will settle or shrink is determined very largely by the type of machinery used in constructing the dam and the methods followed in applying the dirt to the earthen embankment. If a carry-all or fresno is used, a factor of 10 percent should be added. If the bulldozer is used, a factor of 15 percent should be added to the height of the dam. If a dragline is used a shrinkage factor of 20 percent should be added to overcome the extreme settling that will occur over a period of time. As an example, the dam to be built is 10 feet high when settled. Ten percent, or one foot, should be added, which would make the dam 11 feet high before shrinkage occurs. The fill or height of the dam at any particular point should be written on the downstream stake because the stake is one of the last to be destroyed by the machinery used in moving dirt to construct the dam.

CONSTRUCTION OF THE DAM

In average soils, it is necessary for the top layer of soil to be removed. Move the top soil on to the lower extremity of the dam site or next to the downstream grade stakes. Where soil is somewhat open and pervious, a ditch should be made lengthwise with the dam on or about the center line. The best clay taken from the basin should be used to fill this ditch through the center of the dam until the height of the shore line is

reached. This is called clay coring the dam. The coarser materials should be used on the downstream side of the dam; the tightest clays, in the center; and the average materials, on the upstream side of the dam.

In some sections of Oklahoma, coring alone will not be sufficient to prevent seepage of the dam. In such a case, it will be necessary to puddle the core of the dam. This is done by using the best grade of clay in the center of the dam. Put the clay down in two-foot or three-foot layers; form a border on the side of the fill with a small blade or grader; pump six to eight inches of water on top of the newly made fill and allow it to soak into the fill six to eight hours; then drive over the fill with a tractor to pack the clay. A sheep foot roller is an excellent tool to tamp or puddle the center of the dam. The clay core of the dam should not be carried to the extreme crown of the dam because the clay will contract and crack when exposed to sunshine. The dam should be topped with a good grade of top soil to prevent cracking and provide a base on which sod or grass may be grown.

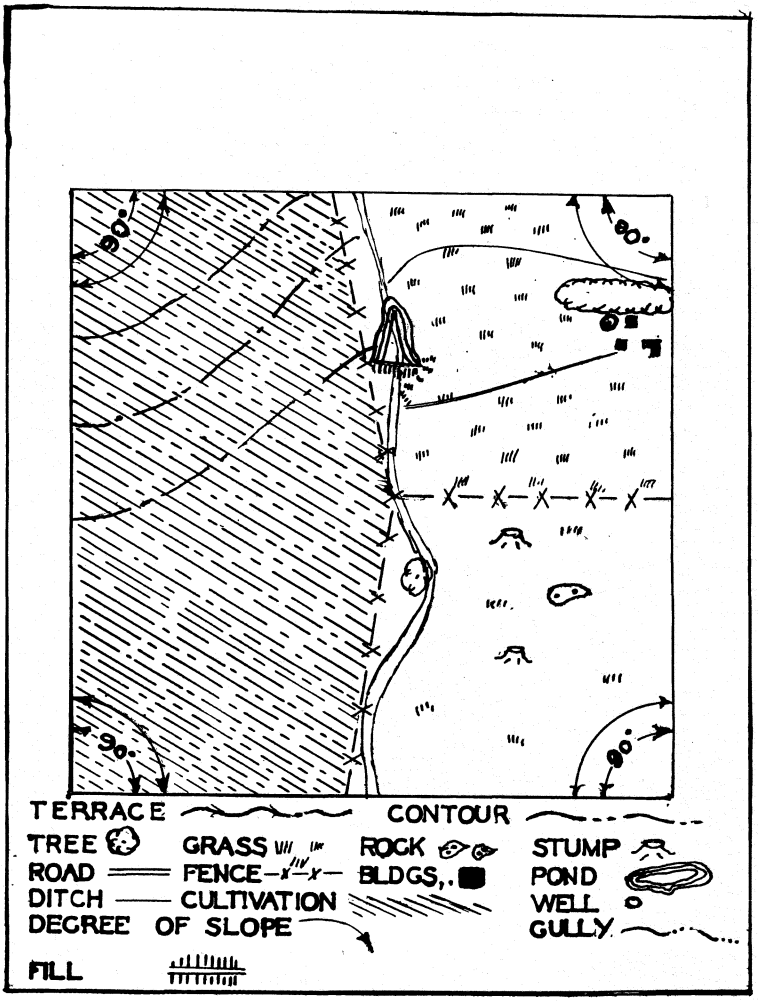
Small soil saving dams may be needed on areas where the 4-H Club member is practicing soil conservation and improvement. These should be constructed in a similar manner as the dam for a farm pond.

MAPPING

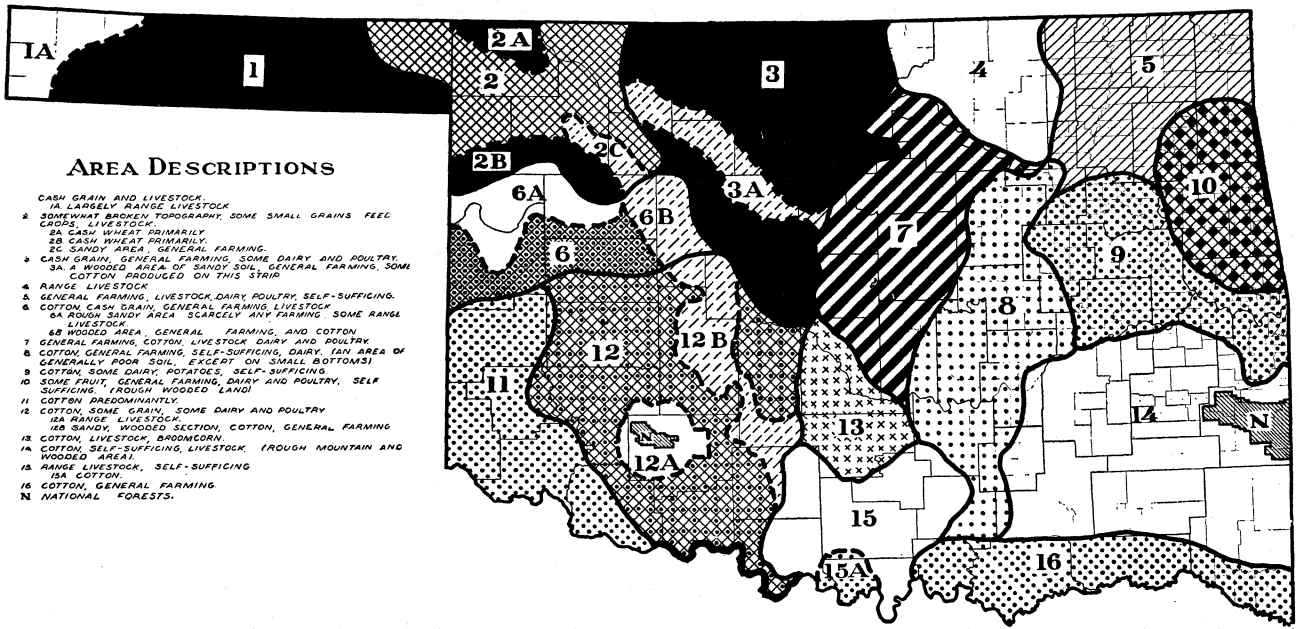
According to the rules and regulations of the soil and water conservation contest, the 4-H Club member will be required to make two maps: One map of the farm before conservation practices were applied; and the other map showing the changes made and the conservation practices applied.

The club member should know the fundamentals of mapping the farm. If possible, use a farm level, and a 100-foot tape or similar measuring device to determine the outer dimensions of the field to be mapped. With the aid of the level, find corner A and set the instrument at this point. Sight to corner B and corner D and read the angle, which in this case is 90 degrees. Move the level to corner B and set it up to check corner A. Turn the instrument to corner C and record the interior angle. Move the level to corner C and corner D and record the interior angle. The club member will now have the angles and dimensions of the field. With a calibrated protractor and a scale, the exact shape and size of the field may be plotted. A good scale to use is 300 feet equals one inch. If physical objects such as orchards, roads, meadows, draws, and farm buildings are present in the field, locate the

buildings by the use of the farm level and tape. The buildings may be placed by using about the same procedure that was used in finding the border of the field and by the use of the log at the bottom of the page to indicate what each object represents.



PRELIMINARY TYPE-OF-FARMING MAP OF OKLAHOMA



AREA DESCRIPTIONS

CASH GRAIN AND LIVESTOCK.
1A. LARGELY RANGE LIVESTOCK.
2. SOMEWHAT BROKEN TOPOGRAPHY, SOME SMALL GRAINS FEED CROPS, LIVESTOCK.
2A. CASH WHEAT PRIMARILY.
2B. CASH WHEAT PRIMARILY.
2C. SANDY AREA; GENERAL FARMING.
3. CASH GRAIN, GENERAL FARMING, SOME DAIRY AND POULTRY.
3A. A WOODED AREA OF SANDY SOIL, GENERAL FARMING, SOME COTTON PRODUCED ON THIS STRIP.
4. RANGE LIVESTOCK.
5. GENERAL FARMING, LIVESTOCK, DAIRY, POULTRY, SELF-SUFFICING.
6. COTTON, CASH GRAIN, GENERAL FARMING, LIVESTOCK.
6A. ROUGH SANDY AREA SCARCELY ANY FARMING SOME RANGE LIVESTOCK.
6B. WOODED AREA; GENERAL FARMING, AND COTTON.
7. GENERAL FARMING, COTTON, LIVESTOCK, DAIRY AND POULTRY.
8. COTTON, GENERAL FARMING, SELF-SUFFICING, DAIRY. (AN AREA OF GENERALLY POOR SOIL, EXCEPT ON SMALL BOTTOMS)
9. COTTON, SOME DAIRY, POTATOES, SELF-SUFFICING.
10. SOME FRUIT, GENERAL FARMING, DAIRY AND POULTRY, SELF SUFFICING. (ROUGH WOODED LAND)
11. COTTON PREDOMINANTLY.
12. COTTON, SOME GRAIN, SOME DAIRY AND POULTRY.
12A. RANGE LIVESTOCK.
12B. SANDY, WOODED SECTION, COTTON, GENERAL FARMING.
13. COTTON, LIVESTOCK, BROOMCORN.
14. COTTON, SELF-SUFFICING, LIVESTOCK. (ROUGH MOUNTAIN AND WOODED AREA).
15. RANGE LIVESTOCK, SELF-SUFFICING.
15A. COTTON.
16. COTTON, GENERAL FARMING.
N. NATIONAL FORESTS.

DEPARTMENT OF AGRICULTURAL ECONOMICS

OKLAHOMA A. & M. COLLEGE

SUMMARY

1. Proper land use. Land should be used as nearly as possible for the purpose or purposes for which it is best suited such as cultivated crops, grass, or timber.
2. Apply the necessary practices to conserve both soil and water. This will include terracing, pond building, contour tillage, strip cropping, winter cover crops, and other applicable practices.
3. Used mineral treatments (limestone and phosphate) where soil tests show they are needed.
4. Maintain an adequate supply of organic matter and nitrogen in the soil. This can be done by growing legumes and returning crop residues (corn, cotton, and sorghum stalks, straw, grass, etc.) and barnyard manure to the soil.
5. Use commercial fertilizers in areas where this practice is recommended.
6. Develop rotation systems suited to soil and climatic conditions. A good rotation usually includes a legume, a small grain, and a row crop.
7. Control weeds by crop rotation, use of clean seed, tillage practices, and chemicals.
8. Use tillage practices suited to crop, soil, and climatic conditions.

Cooperative Extension Work in Agriculture and Home Economics
Oklahoma Agricultural and Mechanical College and United States Department of Agriculture Cooperating

111545