Series 1958, No. 6. Issued July 1961

SOIL SURVEY

Texas County Oklahoma

OUR SOIL ★ OUR STRENGTH

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
OKLAHOMA AGRICULTURAL EXPERIMENT STATION

HOW TO USE THE SOIL SURVEY REPORT

THIS SURVEY of Texas County will serve several groups of readers. It will help farmers in planning the kind of management that will protect their soils and provide good yields; assist engineers in selecting sites for roads, buildings, ponds, and other structures; serve as a reference for students and teachers; help prospective farmers, land appraisers, bankers, and real estate agents to decide the worth of a particular farm; and will add to the soil scientist's fund of knowledge.

In making this survey, soil scientists walked over the county. They dug holes and examined surface soils and subsoils; measured slopes with a hand level; noticed differences in the growth of crops, weeds, and grasses; and, in fact, recorded all the things about the soils that they believed might affect their suitability for farming, engineering, and related uses.

The scientists plotted the boundaries of the soils on aerial photographs. Then, from these photographs cartographers prepared the detailed soil map in the back of this report.

This soil survey is part of the technical assistance furnished by the Soil Conservation Service to the Texas County Soil Conservation District. Work on this survey was completed in 1958. Unless otherwise indicated all statements refer to conditions at the time the survey was in progress.

Locating the soils

Use the *index to map sheets* at the back of this report to locate areas on the soil map. The index is a small map of the county on which numbered rectangles have been drawn to show where each sheet of the large map is located. When the correct sheet of the large map has been located, it will be seen that boundaries of the soils are outlined and that there is a symbol for each kind of soil. All areas marked with the same symbol are the same kind of soil wherever they appear on the map. The symbol will be inside the area if there is enough room; otherwise, it will be outside the area and a pointer will show where the symbol belongs.

Finding information

Some readers will be more interested in one part of the report than in another, for the report has special sections for different groups as well as sections that may be of value to all. Those who are not familiar with the county will be especially interested in the section, Soil Associations, which describes the broad pattern of soils in the county. They may also wish to read the section, General Nature of the Area.

Farmers and ranchers and those who work with them will be interested mainly in the section, Descriptions of the Soils, and in the section, Use and Management of Soils. Study of these sections will help them identify soils on a farm, learn ways the soils can be managed, and judge what yields can be expected. The guide to mapping units at the back of the report will simplify use of the map and the report. This guide gives the map symbol for each soil, the name of the soil, the page on which the soil is described, the capability unit and the range site in which the soil has been placed, and the page where each unit or range site is described.

Engineers will want to refer to the section, Engineering Properties of the Soils. Tables in that section show characteristics of the soils that affect engineering.

Soil scientists will find information about how the soils developed and how they are classified in the section, How the Soils Developed and are Classified.

Students, teachers, and other users will find information about soils and their management in various parts of the report, depending on their particular interest.

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SOIL SURVEY OF TEXAS COUNTY, OKLAHOMA

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UNITED STATES DEPARTMENT OF AGRICULTURE IN COOPERATION WITH THE OKLAHOMA AGRICULTURAL EXPERIMENT STATION

TEXAS COUNTY is in the central part of the Oklahoma Panhandle (fig. 1). It is bounded by the State of Kansas on the north and by the State of Texas on the south. Cimarron County, Okla., forms the western boundary and Beaver County, Okla., the eastern. Texas County has an area of 2,065 square miles, or 1,321,600 acres. It is the second largest county in the State. Guymon, the county seat, is near the center of the county.

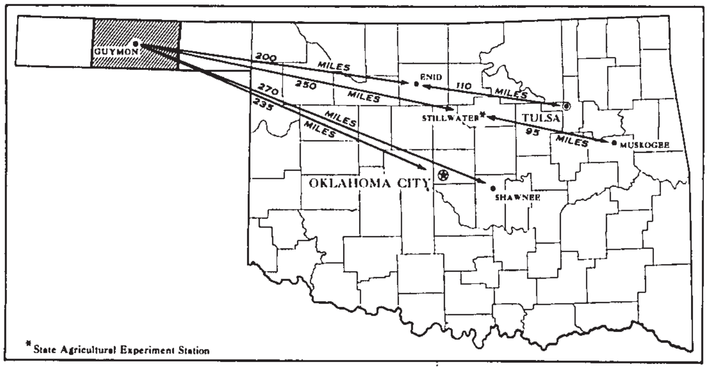

Figure 1.—Location of Texas County in Oklahoma.

Agriculture and related services are important in Texas County. Wheat, sorghum, and beef cattle are the principal sources of agricultural income, but dairy products provide a large part of the income on a few farms.

The main industry is connected with natural gas and oil. Many people are employed by companies that drill and service the oil and gas wells. Many are also employed by the natural gas and pipeline companies and by refineries producing liquid petroleum. In Guymon, employment is also provided by a company that applies an alloy to farm implements.

Soil Associations

A soil association is made up of soils that occur in a characteristic pattern. The pattern is related to the nature of the soil materials and to the lay of the land. Although several soils generally occur in an association, the association is named for the soils that are predominant.

The general pattern of the soils in Texas County is shown on the generalized soil map in the back of this report. The map is not sufficiently detailed to be useful in studying the soils of a particular farm or ranch. It is helpful, however, to point out areas that have similar economic value; that are suitable for certain crops; or that require similar practices to make the best use of the soils or to protect them from erosion. The soil associations in the county are discussed in the following pages.

Association 1

Deep, nearly level, hardland soils: Richfield-Ulysses

This soil association occupies about half of the land area in Texas County. The areas are mainly in the western and southern parts of the county. The association is made up mainly of nearly level plains, but there are a few small, gently undulating areas and some widely spaced playas. Drainage is provided by narrow, treeless draws. The typical pattern of the soils in the association is shown in figure 2. The soils are deep and clayey; locally, they are known as hardland.

About 75 percent of the acreage consists of nearly level Richfield soils. The texture of their surface soil is clay loam or loam.

The Ulysses soils make up about 20 percent of the association. In some places they occupy broad, level areas several hundred acres in size. In others they occur within broad tracts of Richfield soils in areas of irregular shape that are 5 to 80 acres in size. These areas are nearly level in some places, but in others the soils are on oval or long ridges. The ridges are 200 to 800 feet wide and 1/4 to 3/4 mile long.

Within this association are a few areas of Dalhart soils, and, near Goodwell and Guymon, there are several areas of nearly level Pullman soil. Lofton and Randall soils occur in the depressions, generally within areas of Richfield soils. In the southwestern part of the county, there are outcrops of Mansker and Potter soils within areas of Richfield soils. These occur as oval or long ridges that are 5 to 80 acres in size.

Most of this association is cultivated, and wheat is the principal crop. The hazard of wind erosion and the need to conserve moisture are the main problems. Most of the irrigated land in Texas County is in this association.

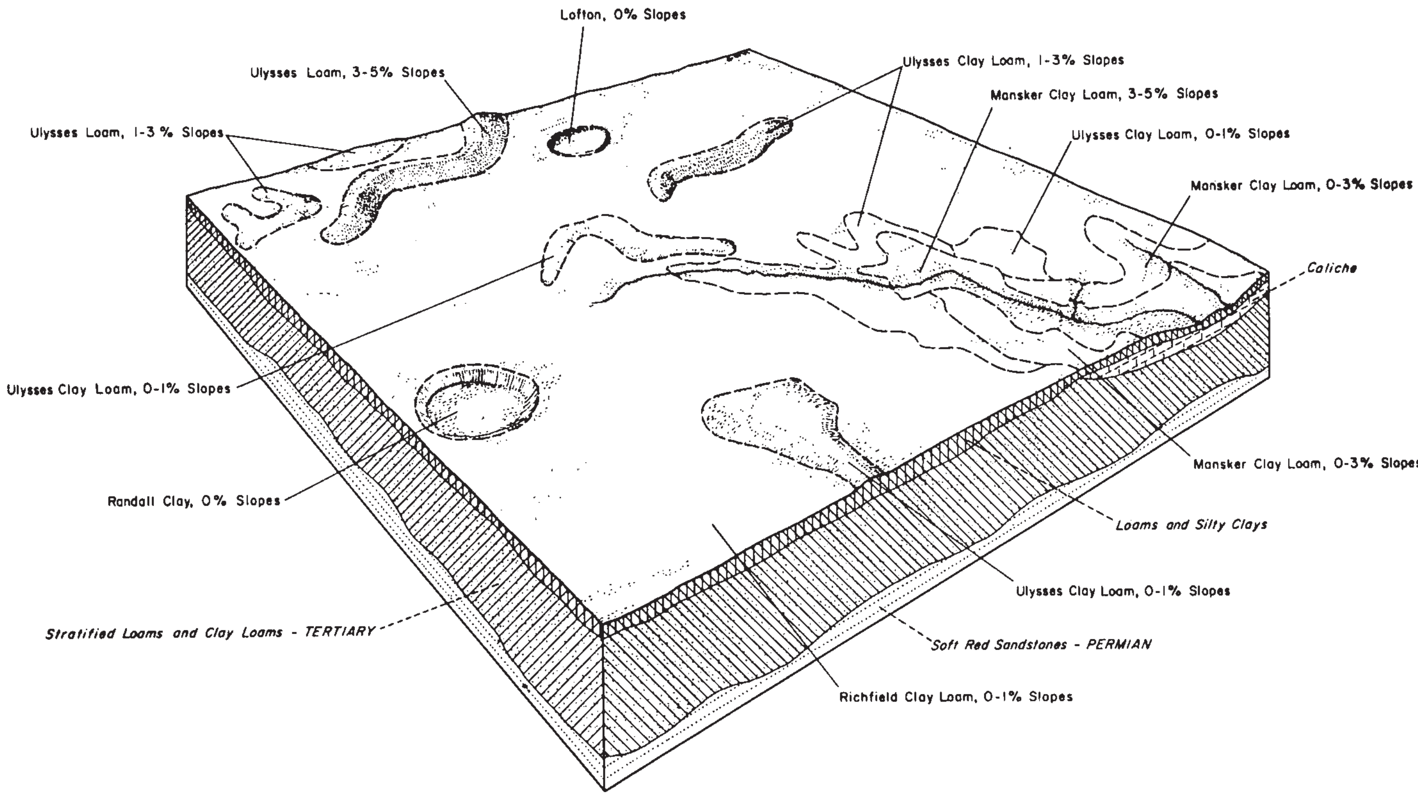

Figure 2.—**Typical pattern of the soils in association 1, Texas County, Okla.**

Association 2

Deep, nearly level, loamy soils: Richfield-Dalhart

Most of this association is in the northeastern part of the county. One smaller area is in the southwestern corner of the county, and another is in township 4 north, range 12 east. The association occupies about 230,000 acres. Most of it is nearly level, but some low hills occur within the area and make it appear gently undulating. There are no creeks within the association. Playas and low areas dot the landscape—one or more of them occur in nearly every section of land. Excess surface water drains onto them.

The soils in this association are deep loams and sandy loams. Most of Richfield loam, thick surface, is in this association; about 45 percent of the acreage consists of nearly level Richfield soils. The Richfield soils in this association have a sandier surface soil than those that are associated with the Ulysses soils. The texture of the surface soil is fine sandy loam to light clay loam.

The Dalhart soils also make up about 45 percent of this association. Areas of these soils are mainly nearly level or gently undulating, but they are crossed by low ridges, also occupied by Dalhart soils. Generally, the ridges run in a north-south or northeast-southwest direction. They are 300 to 1,000 feet wide, ¼ mile to 2 miles long, and 10 to 30 feet high. The texture of the surface soil is fine sandy loam.

The low areas within level areas of Richfield and Dalhart soils are occupied by Lofton and Randall soils. Lofton clay loam occupies the shallow depressions where water is ponded for short periods. These areas range from 1 to 20 acres in size and generally are cultivated. Randall clay occurs in the deeper depressions or playas, where water is ponded for several months. These areas range from 5 to 40 acres in size and seldom are planted to crops.

Nearly all of this association is used for crops. The Richfield soils are used to grow wheat. Sorghum is the main crop on the Dalhart soils, but some wheat is grown. Wind erosion is the main hazard, especially on the Dalhart soils. Practices to conserve moisture are needed on the Richfield soils and on the more sloping Dalhart soils.

Many farmsteads have small pastures of native grasses, and in many of these a playa occurs. The pastures provide feed for cattle and help to control wind erosion.

Association 3

Caliche breaks: Mansker-Potter-Berthoud

This soil association consists of rough, broken lands and the nearly level to moderately sloping areas that occur within them (fig. 3). It is known as the breaks. The soils are at a lower elevation than the adjacent, nearly level upland. In many places the breaks and the upland are separated by an escarpment called the caprock.

The association occurs in bands that are 1 to 8 miles wide. The bands lie along both sides of the Beaver River and along creeks in the southern half of the

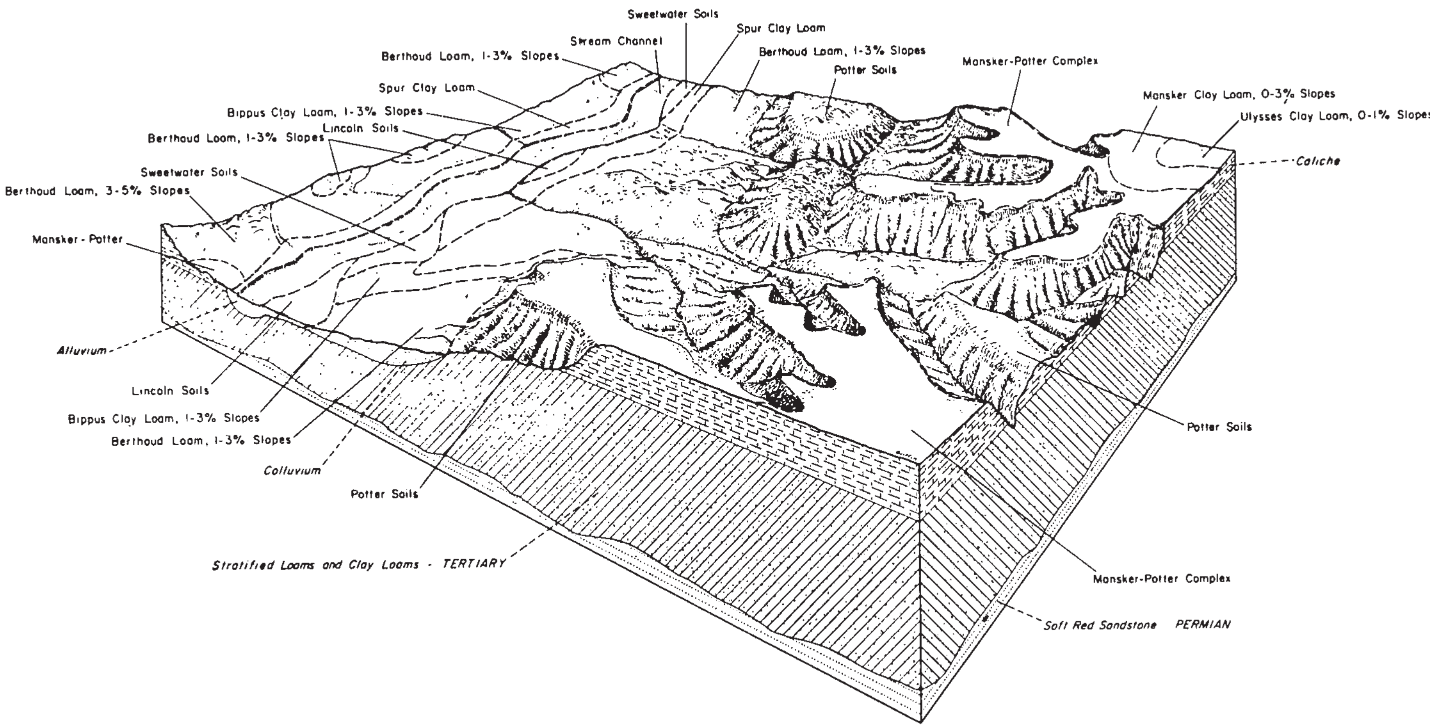

***Figure 3.*—Typical pattern of the soils in association 3, Texas County, Okla.**

county. In places the streambeds within the breaks are as much as 120 feet below the caprock. About one-fourth of the county, or 320,000 acres, is in this association. The soils developed in calcareous clay, silt, and sand of the Ogallala formation.

Nearly level to gently sloping Mansker soils make up about 15 percent of this association. They lie between the upland soils and the soils within the breaks. Many nearly level to moderately sloping areas of these soils also occur within the breaks. They consist of clay loam, 10 to 24 inches thick, that overlies caliche.

Nearly half of this association consists of Potter soils. These soils are mostly in steep, rough areas and on the escarpments within the breaks. They are shallow, loamy soils that are less than 10 inches thick over caliche. In places the soil is absent and caliche is exposed.

Areas of the Mansker-Potter complex are in this association. This complex occupies nearly level bands on top of the caprock and strongly sloping areas within the breaks.

The Berthoud soils make up about 25 percent of this association. They are on foot slopes below areas of Potter soils or soils of the Mansker-Potter complex. The Berthoud soils are deep and loamy and have gentle to moderate slopes. They occur in bands that are 500 to 3,000 feet wide and ½ mile to 2 miles long.

In some places downslope from the Berthoud, Potter, and Mansker soils, the Bippus soil occurs. This deep, dark soil is nearly level to gently sloping. Along the creeks are narrow bands of bottom-land soils.

Most of the association is used for range; the majority of the ranches in the county are within its boundaries. Only the Berthoud, Bippus, and bottom-land soils are cultivated. Vegetation is sparse on the Potter soils but grows well on the other soils.

Association 4

Deep, sandy soils and sandhills: Vona-Dalhart

This soil association consists of deep, sandy soils of the upland. Typically, the soils are on dunes that are surrounded by gently undulating to nearly level areas (fig. 4). The principal areas are southeast of Adams and along the Kansas State line north of Hooker. One small area is in the northwestern corner of the county, and another area is east of the Beaver River and north of Texhoma. About 60,000 acres, or 4 percent of the county, is in this association.

The Vona soils make up nearly 50 percent of this association. Most of the acreage occupied by Vona soils is on dunes, and here the soils are moderately sloping to steep. In the rest the soils are nearly level to gently undulating and are adjacent to dunes.

About 40 percent of the association consists of nearly level to gently undulating Dalhart soils. These soils occupy broad areas that have a few long ridges crossing them.

The dunes in the center of the two large areas of this association are made up of Tivoli soil. This soil has a surface layer of fine sand and is steep to very steep. In most places the dunes have a cover of sand sage and do not blow. Blowing is active in a few dunes, and there are a few blowouts.

The Vona and Tivoli soils are used for range, and sorghum is grown on the Dalhart soils. The ranches and farms within this association are large. Wind erosion is the chief hazard if the soils are cultivated.

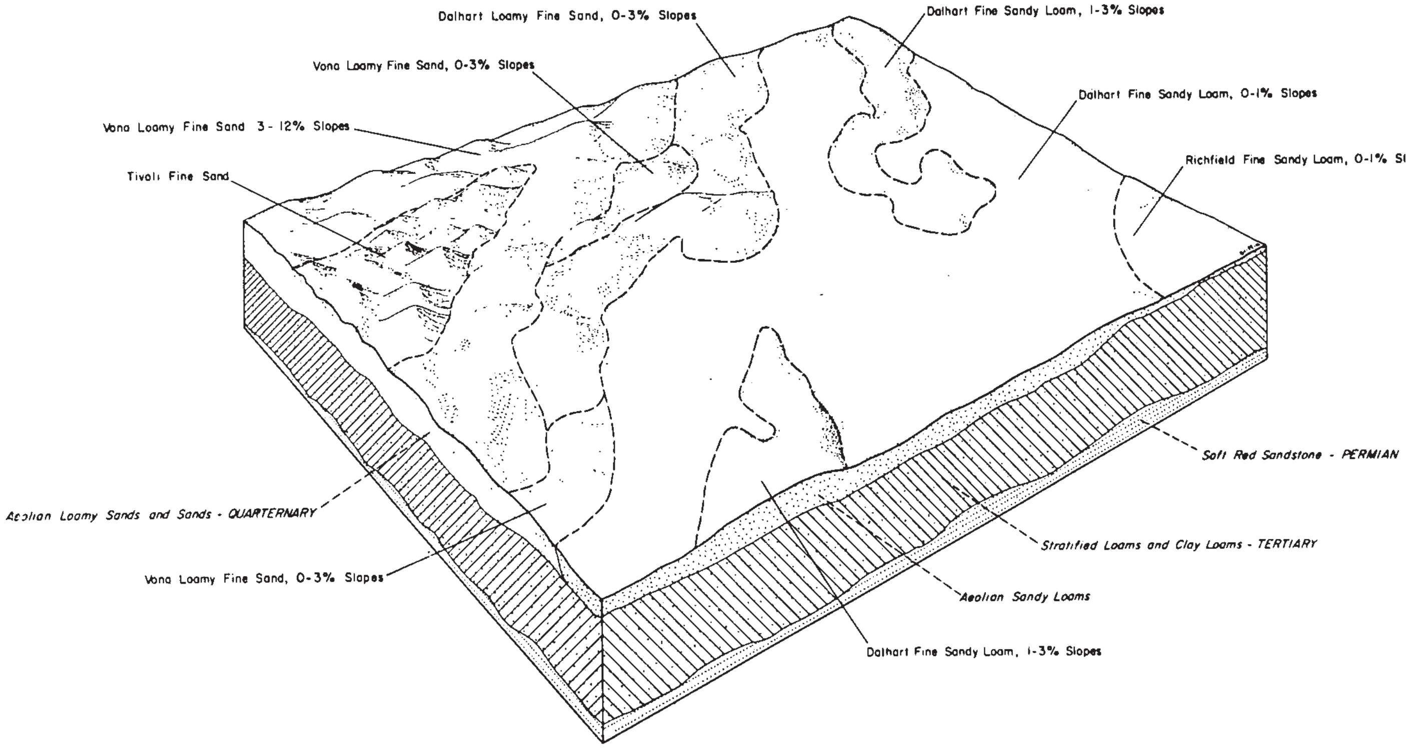

***Figure 4.*—Typical pattern of the soils in association 4, Texas County, Okla.**

Association 5

Deep and moderately deep, sandy soils: Otero-Vona

This association is made up of deep, sandy and moderately sandy soils of the upland. The areas are gently undulating to slightly duny. The association is in the extreme southeastern part of the county, mostly east of Palo Duro Creek. It occupies about 15,000 acres, or 1 percent of the county.

About 60 percent of the association is made up of Otero fine sandy loams. Most of the gently to moderately sloping areas are cultivated. The main crops are broomcorn and sorghum; most of the broomcorn produced in the county is grown here. About half of the Otero soil is strongly to steeply sloping and is used only for range.

The remaining 40 percent of this association is made up of Vona loamy fine sands. Most areas of Vona soils are nearly level to gently undulating, but there are a few dunes. The Vona soils are in native grasses and are used for range.

The smallest farms in the county are within this association, and there are a few small ranches. If the soils are cultivated, wind erosion is the main hazard.

Association 6

Steep, rough, sandy breaks: Vona-Otero-Potter

This association is made up of steep, rough, broken, sandy soils. Most of the areas lie along Goff Creek in bands that are 1 to 3 miles wide, but there are small areas along the Beaver River north of Guymon and Hardesty. Another small area is mainly along the east side of Frisco Creek south of Guymon. The association occupies about 50,000 acres.

The Vona and Otero soils developed in sand blown from adjacent streambeds. The sand overlies calcareous clay and sand of the Ogallala formation. Where the sand is deep, the Vona soils developed, and where it is thin, Otero soils developed. In places the cover of sand is absent or very thin, and here the Potter soils developed.

The Vona soils are on dunes and have a cover of sand sage and tall grasses. The Otero soils, which are gently to moderately sloping, have a cover of scattered sand sage, yucca, and blue grama. The Potter soils are generally strongly sloping to steep and have a sparse cover of side-oats grama and little bluestem. On the bottom lands is a narrow band of nearly level, sandy Lincoln soils that sometimes receive extra water from flash floods. The cover consists of sand sage and bluestem.

This association is all in range. It is occupied by a few large ranches.

Association 7

Deep, bottom-land soils: Sweetwater-Lincoln-Spur

This association consists of alluvial soils. The soils occur along the Beaver River and along Coldwater and Palo Duro Creeks, where they are likely to be flooded occasionally. The association occupies about 20,000 acres.

The Sweetwater soils make up about 55 percent of the association. They border streams, and, consequently, they are subirrigated by a high water table.

Approximately 25 percent of the association is made up of nearly level to gently undulating Lincoln soils. In these soils the water table is in gravel at a depth of more than 4 feet.

Nearly level Spur soils make up about 20 percent of the association. In these soils the water table is generally at a depth of more than 4 feet.

Most of the native trees in the county grow on soils of this association. The Sweetwater soils are used mostly for meadow, the Lincoln soils are used for range, and the Spur soils are used for cultivated crops. The ranches in this association are large.

Association 8

Rough, broken red-bed soils: Vernon-Woodward

This association consists of upland soils that developed from material of the Permian red beds. The topography is rough, broken, and scabby in appearance. The association is in the extreme southeastern corner of the county, east of Palo Duro Creek and mostly in township 1 north, range 19 east. About 8,000 acres is in the association. This is less than 1 percent of the acreage in the county.

The Vernon soils are predominant. They have moderate to steep slopes and occupy highly dissected areas. The Vernon soils are in native grasses and are used for range.

The gently sloping to moderately sloping Woodward soil is also important in the association. The gently sloping areas are cultivated, with sorghum and wheat as the principal crops. The moderately sloping areas are mostly in range.

In cultivated areas water erosion is the main hazard. Yields of the ranges are low. The farms and ranches in the association are small.

How a Soil Survey Is Made

The scientist who makes a soil survey examines the soils in the field, classifies them according to the facts that he observes, and maps their boundaries on an aerial photograph or other map.

Field Study.—The soil scientist bores or digs many holes to see what the soils are like. The holes are not spaced in a regular pattern; they are located according to the lay of the land. Most of them are not more than a quarter of a mile apart, and some are much closer. In most soils there are several distinct layers, called horizons, which collectively are known as the soil profile. Each layer is studied to see how it differs from others in the profile and to learn things about the soil that will influence its capacity to support plant growth.

Most of the terms scientists use in describing soils are familiar words and are readily understood without specialized knowledge. Some of the terms and symbols need explanation and are discussed in the following paragraphs.

In describing soils the scientist assigns letter symbols to the various layers. These symbols have special meanings that concern those who wish to make a special study of soils. Most readers will need to remember only that all letter symbols beginning with A designate surface soil; those beginning with B mark the subsoil; those beginning with C, the substratum; and those beginning with D, the deeper, underlying material. Generally, the A horizon has had some of the soluble minerals and clay removed from it by water that has soaked down through it; the B horizon is the layer in which clay and minerals from the A horizon have accumulated; the C horizon is part of the parent material; the D horizon is hard rock or layers of material that are not parent material but which may have significance to the overlying soil.

Color is expressed in words and in Munsell notations (*7*),[1] for example, grayish brown (10YR 5/2). The Munsell notations record color more precisely and uniformly than can be done in words and are primarily for the use of soil scientists. Color is normally related to the amount of organic matter. The darker the surface soil, as a rule, the more organic matter it contains. Streaks and spots of gray, yellow, and brown in the lower layers generally indicate poor drainage and poor aeration.

Depth is the thickness of soil over a limiting layer, such as a claypan, gravel, or rock. The depth of a soil determines its capacity to store moisture and the depth to which roots of plants can penetrate.

Structure is the way individual particles of soil are arranged or grouped together in larger aggregates. These soil aggregates may be granular, blocky, platelike, or have other forms. The size of the aggregates, their shape, and the pore space between them determine how water and air move through the soil and how well roots penetrate. If the pores are large, much water and air move through the soil; if the pores are small, water is stored. In soils that have granular structure, the granules fit together loosely like bread crumbs; the pores are many and are both small and large. Consequently, granular structure is generally desirable. In soils that have blocky structure, the aggregates are laid together much like stacked bricks. The blocks may be square, rectangular, or irregular in shape, and they vary in size from 1/10 inch to 3 inches in diameter. These soils are high in clay; water and roots penetrate them slowly.

Texture, or the proportion of sand, silt, and clay in the soil, is determined by the way the soil feels when rubbed between the fingers. It is later checked by laboratory analysis. Texture determines how well the soil retains moisture, plant nutrients, and fertilizer, and whether it is easy or difficult to cultivate.

Some soils have uniform texture to a depth of several feet. Others contain layers that differ greatly in texture. In many soils the surface soil contains less clay than the subsoil. Soils that are young and undeveloped are likely to have about the same texture to a depth of 3 or 4 feet or more.

The clay fraction, which consists of the finest mineral grains, is the active part of the soil. It makes the soil stick together and furnishes most of the capacity to hold moisture and nutrients. Sand and silt serve as the framework and help give the soil its physical properties.

Parent materials are variable in this county. They consist of shale, sandstone, caliche, windblown dust, water-laid material, sand, and many other materials. These materials have different physical and chemical properties.

[1] Italic numbers in parentheses refer to Literature Cited, p. 58.

Slope is expressed in percent. The steeper the slope, the faster water runs off and the greater the risk of erosion. The amount of water that soaks into the soil is likely to be less on a sloping soil than on a level one. Descriptive terms applied to slope ranges in this county are:

Nearly level—Less than 1 foot of fall in 100 feet; 0 to 1 percent slopes.
Gently sloping—1 to 3 feet of fall in 100 feet; 1 to 3 percent slopes.
Moderately sloping—3 to 5 feet of fall in 100 feet; 3 to 5 percent slopes.
Strongly sloping—5 to 8 feet of fall in 100 feet; 5 to 8 percent slopes.
Steep—8 to 12 feet of fall in 100 feet; 8 to 12 percent slopes.
Very steep—More than 12 feet of fall in 100 feet; 12 or more percent slopes.

CLASSIFICATION.—On the basis of the characteristics observed by the survey team or determined by laboratory tests, soils are classified by types, phases, and series. The soil type is the basic classification unit. A soil type may consist of several phases. Soil types that are similar in most characteristics are grouped into a soil series.

Soil type.—Soils that are similar in kind, thickness, and arrangement of soil layers and that have the same texture in the surface layers are classified as one soil type.

Soil phase.—Because of differences other than in kind, thickness, and arrangement of layers, some soil types are divided into two or more phases. Slope variations, frequency of rock outcrops, degree of erosion, depth of soil over the substratum, or natural drainage are examples of characteristics that suggest dividing a soil type into different phases.

The soil phase (or the soil type if it has not been subdivided) is the unit shown on the soil map. It is the unit that has the narrowest range of characteristics. In Texas County some mapping units have not been subdivided and, therefore, represent a soil type or a soil series.

Soil series.—Two or more soil types that differ in texture of the surface layer, but that are otherwise similar in kind, thickness, and arrangement of soil layers, are normally designated as a soil series. In a given area, however, a soil series is frequently represented by only one soil type.

Each series is named for a place near which it was first mapped. For example, the Dalhart series was named for Dalhart, Tex., and the Richfield and Ulysses series were named for towns in Kansas.

Soil complex.—If two or more different soils are so intricately associated in small areas that it is not practical to show them separately on the soil map, they are mapped together as a soil complex. The Mansker-Potter complex is a complex mapped in Texas County.

Other technical terms.—Additional terms used in describing the soils of Texas County are defined in the glossary at the back of this report.

Descriptions of the Soils

In the following pages the soils and miscellaneous land types mapped in Texas County are described in detail. A list of the soils mapped is given in the back of the report along with the capability unit and range management site of each. The approximate acreage and proportionate extent of each soil mapped are given in table 1. Terms used to describe the soils are defined in the Glossary.

TABLE 1.—*Approximate acreage and proportionate extent of soils mapped*

Soil	Acres	Percent
Bayard fine sandy loam	3, 229	0. 2
Berthoud loam, 1 to 3 percent slopes	22, 729	1. 7
Berthoud loam, 3 to 5 percent slopes	19, 597	1. 5
Bippus clay loam	6, 432	. 5
Dalhart fine sandy loam, 0 to 1 percent slopes	82, 299	6. 2
Dalhart fine sandy loam, 1 to 3 percent slopes	47, 534	3. 6
Dalhart loamy fine sand, 0 to 3 percent slopes	26, 469	2. 0
Dalhart-Ulysses loams, 0 to 1 percent slopes	8, 025	. 6
Dalhart-Ulysses loams, 1 to 3 percent slopes	42, 764	3. 2
Dalhart-Ulysses loams, 3 to 5 percent slopes	6, 894	. 5
Lincoln soils	15, 758	1. 2
Lofton clay loam	2, 731	. 2
Mansker clay loam, 0 to 3 percent slopes	68, 375	5. 2
Mansker clay loam, 3 to 5 percent slopes	11, 792	. 9
Mansker soils, severely eroded	5, 206	. 4
Mansker-Potter complex	103, 230	7. 8
Otero fine sandy loam	9, 993	. 8
Otero-Vona fine sandy loams	16, 362	1. 2
Potter soils	71, 464	5. 4
Pullman clay loam	4, 166	. 3
Randall clay	4, 713	. 4
Richfield clay loam	418, 711	31. 7
Richfield loam, thick surface	29, 839	2. 3
Richfield fine sandy loam	9, 344	. 7
Spur soils	10, 321	. 8
Sweetwater soils	10, 627	. 8
Tivoli fine sand	7, 186	. 5
Ulysses clay loam, 0 to 1 percent slopes	120, 980	9. 2
Ulysses clay loam, 1 to 3 percent slopes	34, 336	2. 6
Vernon loams	2, 544	. 2
Vona loamy fine sand, 0 to 3 percent slopes	35, 970	2. 7
Vona loamy fine sand, 3 to 8 percent slopes	19, 482	1. 5
Vona, Otero, and Potter soils	25, 619	1. 9
Woodward loam, 1 to 3 percent slopes	4, 140	. 3
Streambeds	12, 739	1. 0
Total	1, 321, 600	100. 0

Descriptions of these soils would be incomplete without mention of the effects of wind erosion. All of the soils that have been cultivated and some soils in grass show the effects of wind erosion (fig. 5), although only one soil mapping unit is named as an eroded soil.

The areas that have been cultivated are the most eroded. When the virgin sod was broken, the soil contained much organic matter and was only slightly eroded. At first, crops made good yields. Then, as plowing and cultivating were continued, they caused the organic matter to burn up or decay, just as stirring a fire makes it burn hotter. In the thirties, windstorms caught up the loose, rich surface soil in areas that were not protected. In the black blizzards that followed, losses of soil and organic matter became serious. Even in areas that are not severely eroded, the A horizon of soils that have been cultivated is slightly thinner than that of soils that have been kept under grass. This is partly the result of erosion and partly the result of compaction caused by tillage.

The clay loam soils in this county have been affected least by wind erosion. They are less susceptible to erosion than the coarser textured soils, and they can generally be roughened by tillage to make them more resistant to wind.

Some of the loamy sands were once fine sandy loams. Blowing and sifting by wind have lowered the fertility of these soils and have caused plant-soil-moisture relationships to be poor. As a result, yields of crops have become lower.

In many places wind has removed most of the organic matter, silt, and clay from the plow layer. The remaining sandy layer is low in fertility and is highly susceptible to further erosion. To offset these effects, farmers have plowed deeper and deeper to bring up more of the clayey subsoil. In some places, in spite of deep plowing, wind erosion has caused the surface soil to have a texture more sandy than its original one. In some areas, for example, the texture of the surface soil is loamy fine sand to depths of 10 to 12 inches where originally it was fine sandy loam. There is no positive way of distinguishing between the soils in these areas and in the several thousand acres of loamy fine sands that apparently always had that texture in the surface layer.

The soils that have been most affected by wind erosion are the coarse-textured loamy fine sands. In cultivated areas soil materials from areas of loamy fine sands are piled up in dunes as much as 6 feet high in many places along the fence rows. In many places farmers have had to replant sorghum because the first crop was covered by shifting sands.

Rangeland has also been affected by wind erosion (fig. 6). Some soil shifting and removal of soil material have been the direct result of wind erosion, but most of the damage has been caused by soil blown from adjoining cultivated fields. In many places several inches of soil has been blown onto the rangeland. It smothers the desirable grasses, and annual weeds and brushes start to encroach. On most of the rangeland, duststorms have deposited a thin layer of silt and clay that has formed a crust almost impervious to water. Consequently, some of the rainfall runs off, moisture is lost to plants, and water erosion is increased.

Figure 6.—**Sandy rangeland that has been severely eroded by wind.**

Figure 5.—**A cultivated field of Richfield clay loam where wind erosion has been severe. The soil has accumulated to depths 4 feet where it has been caught by Russian-thistles growing along the edges of the field.**

The immediate effects of wind erosion are dramatic and easily seen, but it is difficult to identify and map the lasting effects on the soil profile. Winnowing of the surface soil can be erased by deep plowing and by mixing the surface soil with the soil below. Low hummocks and drifts along fence rows can be leveled. The surface in blowouts can be roughened, and nearby accumulations of soil can be loosened and allowed to drift over and fill in the blowout areas.

A study of the effects of wind erosion on soil productivity was made in this area (*2*). It showed that wheat following wheat produced 0.5 bushel less per acre on a moderately eroded soil than on a slightly eroded soil; on a severely eroded soil, 2.4 bushels less of wheat was produced. Under good management, there was only a slight reduction in productivity between soils that were slightly and moderately eroded by wind. Because of the uncertainity of positive field identification, slightly eroded and moderately eroded soils were not separated in mapping.

In some areas soils are so severely eroded that it does not pay to cultivate them and they have been abandoned. More areas will have to be abandoned if accelerated wind erosion is not brought under control in Texas County.

Bayard Series

The Bayard series consists of young alluvial soils that are deep, moderately sandy, and well drained. The soils are on the flood plains of the Beaver River and its tributaries.

The surface soil is dark grayish-brown fine sandy loam; it is about 16 inches thick and overlies grayish-brown fine sandy loam.

The parent material is sandy alluvium of local origin. The soils developed under sand sage and tall grasses.

The Bayard soils are darker and less sandy than the Lincoln soils. They have developed in sandier alluvium and are less clayey than the Spur soils. The Bayard soils have less silt and clay in the surface soil than the Sweetwater soils. They are also less gray and are deeper over the water table. Only one soil of the series—Bayard fine sandy loam—is mapped in this county.

The following describes a typical profile in a cultivated field (900 feet east and 400 feet north of the southwest corner in SE¼ sec. 8, T. 1 N., R. 18 E.):

A_1 0 to 16 inches, dark grayish-brown (10YR 4/2, dry; 3/3, moist) fine sandy loam; moderate, very fine and fine, granular structure; friable when moist; a few wormcasts; calcareous; gradual boundary.

AC 16 to 31 inches, grayish-brown (10YR 4.5/2, dry; 3/3, moist) fine sandy loam; strong, very fine, granular structure; very friable when moist; wormcasts; calcareous; gradual boundary.

C 31 to 48 inches, pale-brown (10YR 6/3, dry; 5/4, moist) fine sandy loam; single grain; loose; calcareous.

The upper part of the profile is fairly uniform, but the substratum is variable. The A_1 horizon ranges from 10 to 24 inches in thickness and from brown to dark grayish brown in color. In some places it is calcareous throughout, and in others it is calcareous beginning at a depth of 12 inches. The texture of the AC horizon is commonly fine sandy loam, but in places it is loamy fine sand. The C horizon in many places contains stratified layers of loamy fine sand, sandy clay, and sandy clay loam.

Bayard fine sandy loam (Ba).—This nearly level soil is flooded occasionally. It is moderately fertile and is easy to till. The large, smooth areas are used for crops; the small, dissected areas are in native grass.

Sorghum, wheat, and alfalfa are the principal crops. Because of its sandy surface layer, this soil is susceptible to wind erosion, but, except for a few areas that lie in the way of runoff from higher areas, it is not likely to be eroded by water. (Capability unit IIIc-2; Loamy bottomland range site.)

Berthoud Series

The soils of the Berthoud series are deep and well drained. They are friable and loamy and absorb water readily. These soils are on foot slopes below escarpments and within the breaks.

The surface layer is grayish-brown to dark grayish-brown loam and is generally about 12 inches thick. It overlies light brownish-gray to pale-brown loam or light clay loam that is 10 to 24 inches thick. The layer beneath ranges in texture from sandy loam to clay loam. The Berthoud soils are calcareous and contain many small fragments of caliche.

The parent material consists of calcareous, loamy sediments and contains many fragments of caliche and rock. The sediments were washed down from the escarpments or were deposited by streams during Tertiary time. The soils developed under short grasses.

The Berthoud soils are similar to the Ulysses soils in color and structure, but the Ulysses soils do not contain fragments of caliche. Moreover, the Berthoud soils have a thicker surface soil, are more friable, and are more strongly granular. The Berthoud soils have stronger slopes, are less clayey, and are lighter in color than the Bippus soils, which are noncalcareous in the uppermost 6 to 12 inches. They have a thicker surface layer than the Mansker soils, which have a distinct C_{ca} horizon.

The following describes a typical profile of Berthoud loam (NE¼SW¼ sec. 21, T. 1 N., R. 14 E.):

A_1 0 to 12 inches, grayish-brown (10YR 5/2, dry; 4/2, moist) loam; strong, very fine and fine, granular structure; friable when moist; numerous fragments of caliche up to ½ inch in diameter; strongly calcareous; gradual boundary.

AC 12 to 24 inches, light brownish-gray (10YR 6/2, dry) loam; about 75 percent wormcasts; strong, fine and very fine, granular structure; very friable when moist; thin films of calcium carbonate; contains fragments of caliche up to ½ inch in diameter; strongly calcareous; clear boundary.

C 24 to 36 inches, pale-brown (10YR 6/3, dry; 5/3, moist) clay loam; strong, fine and very fine, granular structure; friable when moist, and soft when dry; fragments of caliche up to ½ inch in diameter; a few soft concretions of calcium carbonate; strongly calcareous; clear boundary.

C_{ca} 36 to 56 inches, very pale brown (10YR 8/3 to 7/4, dry) clay loam; strong, fine, granular structure; friable when moist; a few fragments of caliche and soft to semi-indurated concretions of calcium carbonate; very strongly calcareous.

These soils are somewhat variable. The texture of the surface layer is commonly loam, but it ranges from fine sandy loam to clay loam. The surface layer is 6 to 16 inches thick and overlies loam to clay loam. Fragments of caliche and rock occur in varying amounts throughout the profile.

The Berthoud soils absorb water readily. Because they have moderate slopes and occur below escarpments, they are likely to be eroded by water if cultivated.

Berthoud loam, 1 to 3 percent slopes (BeB).—This soil is on gentle slopes that lead into valleys and drains; the slopes are generally 500 to 3,000 feet long. In many places this soil is near Berthoud loam, 3 to 5 percent slopes, which lies on the slope above.

Much of Berthoud loam, 1 to 3 percent slopes, is used for native range, but some of the larger areas are used for crops. Sorghum is the main crop. If this soil is cultivated, there is a moderate risk of water erosion, and about half of the cultivated areas are already eroded. In a few small areas, erosion is moderately severe. (Capability unit IIIe-3; Hardland range site.)

Berthoud loam, 3 to 5 percent slopes (BeC).—This moderately sloping soil is mostly in native grass and is used for grazing. Areas that are cultivated are used to grow sorghum; these minor areas are eroded. Included with this soil in mapping are some small areas of Mansker clay loam and of Potter soils. (Capability unit IVe-1; Hardland range site.)

Bippus Series

The Bippus series is made up of deep, dark, granular and clayey soils that are well drained. The soils are on alluvial flats and fans within the breaks.

The surface soil is dark grayish-brown clay loam, about 10 inches thick. The subsoil is brown to dark grayish-brown, granular clay loam that grades to lighter colored, granular clay loam.

The parent material consists of strongly calcareous, moderately fine textured sediments washed down from nearby slopes. The soils developed under short grasses.

The Bippus soils are darker colored and more clayey than the Berthoud soils and generally have milder slopes. They are darker colored and more strongly granular than the Ulysses soils. The Bippus soils are similar to the Spur soils, which occur on the flood plains of streams, but they have concave, gentle slopes and occur above the flood plains. Only one soil of the series—Bippus clay loam—is mapped in the county.

The following describes a typical profile of Bippus clay loam in native range (NE¼SE¼ sec. 36, T. 4 N., R. 13 E.):

A_1 0 to 7 inches, dark grayish-brown (10YR 4/2, dry; 3/2, moist) clay loam; strong, fine, granular structure; friable when moist; noncalcareous; gradual boundary.

AB 7 to 16 inches, brown (10YR 5/3, dry; 4/3, moist) clay loam; moderate, fine, granular structure; hard when dry; a few wormcasts; films of calcium carbonate; strongly calcareous; gradual boundary.

B_{21} 16 to 23 inches, pale-brown (10YR 6/3, dry; 4.5/3, moist) clay loam; compound, moderate, medium, prismatic and weak, very fine, granular structure; hard when dry; films and threads of calcium carbonate; strongly calcareous; gradual boundary.

B_{22} 23 to 38 inches, light yellowish-brown (10YR 6/4, dry) clay loam; compound, strong, coarse, prismatic and weak, very fine, granular structure; slightly hard when dry; a few thin films and threads of calcium carbonate; strongly calcareous; gradual boundary.

C 38 to 45 inches, brown (7.5YR 5/4, dry), light clay loam; weak, very fine, granular structure (almost structureless, but porous); slightly hard when dry; thin films and threads of calcium carbonate; strongly calcareous.

The surface soil ranges from very dark grayish brown to brown in color, from 4 to 20 inches in thickness, and from heavy loam to clay loam in texture. Generally, this soil is noncalcareous to depths of 6 to 12 inches, but in some places it is calcareous throughout. Most slopes are from 1 to 3 percent, but some are less than 1 percent.

Bippus clay loam (Bp).—This well-drained soil absorbs water at a moderate rate. The soil is on low foot slopes, on alluvial fans at the mouths of draws, and in the bottoms of draws. As a result, larger amounts of water flow across this soil than flow across most other soils in the county. If cultivated, the soil is likely to be eroded by water. About 10 percent of the acreage is moderately eroded.

Most of this soil is in native grass, but it is suited to wheat and sorghum. (Capability unit IIIe–3; Hardland range site.)

Dalhart Series

The Dalhart series is made up of deep, friable, sandy soils that are well drained. The soils occur on uplands in all parts of the county.

The surface soil is brown to dark-brown fine sandy loam or loamy fine sand and is generally about 8 inches thick. The layer beneath is dark yellowish-brown sandy clay loam, 10 to 20 inches thick, that grades to yellowish-brown, calcareous, sandy material.

The parent material of these soils is wind-laid sand that was deposited as a mantle on the uplands. The soils developed under short grasses.

These soils have more clay in the subsoil and are deeper over free lime than the Otero and Vona soils. They have a more sandy subsoil and substratum than the Richfield and Ulysses soils.

The following describes a typical profile of Dalhart fine sandy loam in a cultivated field (on the south side of the road, about 1,300 feet west of the intersection of the road, NE¼NE¼ sec. 36, T. 1 N., R. 12 E.):

A_{1p} 0 to 5 inches, brown to dark-brown (10YR 5/3, dry; 3/3, moist) fine sandy loam; strong, fine, granular structure; very friable when moist; noncalcareous; abrupt boundary.

A_1 5 to 10 inches, dark grayish-brown (10YR 4/2, dry; 2.5/2, moist) fine sandy loam; moderate to weak, fine, granular structure; friable when moist; noncalcareous; gradual boundary.

B_2 10 to 28 inches, dark yellowish-brown (10YR 4/4, dry; 3/4, moist) sandy clay loam; compound, strong, coarse, prismatic and weak, fine, granular structure; hard when dry, and firm when moist; noncalcareous; gradual boundary.

C 28 to 70 inches, yellowish-brown (10YR 5/4, dry; 4/4, moist) sandy loam; moderate, very fine, granular structure; soft to slightly hard when dry, but very friable when moist; thin films and threads of segregated lime; calcareous; grades to loamy sand.

These soils are fairly uniform. In places, however, the lime carbonate is leached only to a depth of 10 inches and the B_2 horizon is less than 10 inches thick. In some places these soils grade to the nearby Vona and Otero soils. In others they grade to Richfield soils.

Dalhart soils absorb water readily. They have a moderately high capacity to store water. As a result, crops can be grown consistently, even in dry years. The soils are well suited to sorghum.

Dalhart fine sandy loam, 0 to 1 percent slopes (DaA).—This is one of the most desirable soils in the county for farming. It is nearly level and is easy to till. Included in mapping are some areas in which there is as much as 6 inches of winnowed loamy fine sand on the surface.

Most of Dalhart fine sandy loam, 0 to 1 percent slopes, is in crops. Grain sorghum is the principal crop, but wheat and forage sorghum are grown in many places. The soil is moderately susceptible to wind erosion. Water erosion is seldom a problem. (Capability unit IIIe–2; Sandy plains range site.)

Dalhart fine sandy loam, 1 to 3 percent slopes (DaB).—Gently sloping and irregular topography mark areas of this soil. The soil occurs near Dalhart fine sandy loam, 0 to 1 percent slopes. Most of it is on ridges or stabilized dunes that are 5 to 10 feet high and several hundred feet wide. Included in mapping are some areas in which there is as much as 6 inches of loamy fine sand on the surface.

Generally, the surface layer and subsoil of Dalhart fine sandy loam, 1 to 3 percent slopes, are thinner than those of the profile described for the series. Also, in many places lime is closer to the surface than in the typical soil and the soil is more eroded.

This soil is moderately susceptible to wind and water erosion. The west-facing slopes and the tops of the ridges are generally the most eroded by wind. Most of this soil is used to grow grain sorghum and wheat. (Capability unit IIIe–2; Sandy plains range site.)

Dalhart loamy fine sand, 0 to 3 percent slopes (DsB).—This soil is nearly level to moderately sloping and occurs in areas where there are many broad, stabilized dunes and ridges. It is near areas of the Dalhart fine sandy loams and Vona loamy fine sands.

The surface soil is sandier than that of the profile described for the series. It is highly susceptible to wind erosion. If only a sparse cover of plants is kept on this soil, the surface soil is shifted about by the wind and is piled up around the stubble of crops or around weeds.

Grain sorghum, to which this soil is well suited, is the principal crop. A lister planter is used for planting the sorghum so that the seed will be placed in the more clayey subsoil. Some wheat is grown, but yields are only moderate because of the sandy surface soil and the severe risk of blowing. (Capability unit IVe–3; Deep sand range site.)

Dalhart-Ulysses loams, 0 to 1 percent slopes (DuA).—This complex is one of three complexes of Dalhart-Ulysses soils. The soils are nearly level and are deep, medium textured, and calcareous. They occur in intricate mixtures on uplands in all parts of the county.

This complex is made up of Dalhart loam or heavy fine sandy loam and Ulysses loam, together with soils that are gradations between the two. Some areas are made up wholly of Ulysses loam; others contain 5 to 50 percent of Dalhart soils.

The Dalhart soils in this complex are calcareous at shallower depths than the typical Dalhart soils, and the B horizon is weakly developed or absent. In some places the surface soil is winnowed, grayish-brown fine sandy loam. The subsoil, which is commonly brown loam, ranges from sandy clay loam to light clay loam. The substratum is less clayey and more sandy in the sloping areas than in the nearly level areas. The parent material is light yellowish-brown sandy loam to sandy clay loam. A profile description and characteristics typical of the Dalhart and Ulysses soils are given under the respective series.

Most of this complex is cultivated. The soils are well suited to wheat and sorghum. There is a moderate hazard of wind erosion; small, eroded areas make up about 20 percent of the acreage. (Capability unit IIIe–1; Hardland range site.)

Dalhart-Ulysses loams, 1 to 3 percent slopes (DuB).—This complex is on gently sloping ridges and hills. Most of the areas are cultivated, and wheat and sorghum are the main crops. The hazard of wind and water erosion is moderate; small, eroded areas make up about 20 percent of the acreage. Erosion is the most severe on the west-facing slopes and on the crests of ridges that are exposed to wind. (Capability unit IIIe–3; Hardland range site.)

Dalhart-Ulysses loams, 3 to 5 percent slopes (DuC).—This complex is on moderately sloping hills, mainly in the northern and southwestern parts of the county. It is similar to Dalhart-Ulysses loams, 1 to 3 percent slopes.

The soils are better suited to grass than to cultivated crops, but about 75 percent of the acreage is cultivated. Sorghum is the main crop, although some wheat is grown. There is risk of wind and water erosion, and most of the areas are moderately eroded. The most eroded areas are on the crests of ridges and on west-facing slopes. Some soil materials have blown onto the east-facing slopes and have accumulated there. (Capability unit IVe–1; Hardland range site.)

Lincoln Series

The Lincoln series consists of young alluvial soils that are deep and sandy. The soils occur on the flood plains of the Beaver River and its tributaries. They are the principal soils along streams in the western half of the county.

The surface soil is brown loamy fine sand that is 8 to 15 inches thick. Beneath the loamy fine sand is fine and coarse sand. The water table generally is at depths below 10 feet.

The Lincoln soils are sandier than other bottom-land soils in the county. They developed in sandy alluvium under sand sage and tall grasses. Only one mapping unit of this series—Lincoln soils—is mapped in the county.

The following describes a typical profile of Lincoln loamy fine sand in native grass rangeland (SW¼SW¼ sec. 1, T. 2 N., R. 19 E.):

A_1 0 to 10 inches, brown (10YR 5/3, dry; 4/3, moist) loamy fine sand; weak, granular structure; soft to loose when dry, and loose when moist; noncalcareous; gradual boundary.

C 10 to 36 inches, light yellowish-brown (10YR 6/4, dry; 5/4 moist) fine sand; single grain; loose; slightly calcareous.

Lincoln soils (Ln).—This mapping unit is made up soils that have little profile development. Except in areas where floodwaters have deposited a thin layer of silt and clay, the surface soil is sandy. In many places stratified silt and sand occur at depths below 3 feet. Along Goff Creek the depth to the water table is more than 10 feet, but in places along the Beaver River and Palo Duro Creek the water table is at a depth of 4 feet. In places the soils are calcareous throughout.

Most of this mapping unit is in native range, and none of it is cultivated. In a few areas the water table is in reach of deep-rooted grasses. Meadow hay is generally harvested from these areas. (Capability unit VIs–2; Sandy bottom-land range site.)

Lofton Series

The Lofton series is made up of deep, dark-gray, clayey soils that have a tight subsoil. The soils are poorly drained. Many of the areas are in shallow depressions that are generally 5 to 20 acres in size. The depressions are within nearly level areas of the Richfield and Dalhart soils. Some areas of Lofton soils are on low benches that surround areas of Randall clay that are in lower lying positions.

The surface soil is dark-gray clay loam about 4 inches thick. The subsoil is dark-gray to gray clay and is 25 to 40 inches thick.

Silt and clay, probably wind laid, is the parent material of these soils. The soils developed under short grasses.

The Lofton soils are grayer than the Pullman soils. They are not so compact as the Randall soils, and the Randall soils are in deeper depressions. Only one soil of this series—Lofton clay loam—is mapped in this county. This soil is mostly in the northeastern part of the county.

The following describes a typical profile of Lofton clay loam in a cultivated field (NE¼SW¼ sec. 18, T. 5 N., R. 19 E., 600 feet south and 300 feet west of the center of the section):

A_{1p} 0 to 4 inches, dark-gray (10YR 4/1, dry; 3/1, moist) clay loam; moderate, thin, platy structure; slightly hard when dry, but friable when moist; noncalcareous; abrupt boundary.

B_{21} 4 to 35 inches, dark-gray (10YR 4/1, dry; 3/1, moist) clay; moderately strong, fine and very fine, blocky structure; very hard when dry, and firm when moist; noncalcareous; clear boundary.

B_{22} 35 to 44 inches, pale-brown (10YR 6/3, dry; 4/3, moist) silty clay loam; moderately strong, fine and very fine, subangular blocky structure; hard when dry, and firm when moist; thin threads and scattered, small, soft concretions of calcium carbonate; moderately calcareous; gradual boundary.

B_3 44 to 56 inches, pale-brown (10YR 6/3, dry; 4/3, moist) clay loam; weak, very fine, subangular blocky structure; slightly hard when dry, and friable when moist; slightly calcareous; gradual boundary.

C 56 to 62 inches, light yellowish-brown (10YR 6/4, dry; 4/4, moist) clay loam that contains more fine sand than horizon just above; weak, very fine, granular structure; friable when moist; slightly calcareous.

The texture of the surface soil is commonly clay loam, but in areas where the Lofton soil occurs near the Randall soil, the surface soil is silty clay loam or clay. In areas that are surrounded by Dalhart soils, the surface soil is loam to sandy loam.

The soil is high in organic matter and in minerals needed by crops. The water-holding capacity is high.

Lofton clay loam (Lo).—This soil occurs in depressions, generally less than 10 acres in size, where water from surrounding areas drains onto it. Because its subsoil is blocky clay, the soil absorbs water slowly. Consequently, it is frequently too wet to till or to harvest crops when the surrounding soils have dried out. In irrigated fields, areas of this soil require filling because of their low position.

Wheat and grain sorghum are the principal crops. (Capability unit IIIw–1; Hardland range site.)

Mansker Series

The Mansker series consists of friable, calcareous, loamy soils that are well drained. The soils are nearly level to gently sloping. They occur along the edges of the breaks or within them.

The surface soil is grayish-brown to dark grayish-brown clay loam or loam that is 5 to 12 inches thick. Beneath it is pale-brown or light brownish-gray soil material, 10 to 15 inches thick, that grades to very pale brown to white caliche. The layer of caliche is 10 to 20 inches thick.

The parent material consists of strongly calcareous, medium to moderately fine textured sediments from the Ogallala formation. The vegetation was short grasses.

The Mansker soils are more strongly granular than the Ulysses soils, which lack a distinct C_{ca} horizon. Their surface soil is not so thick as that of the Berthoud soils, and they have a more distinct, chalky C_{ca} horizon. The Mansker soils are deeper than the associated Potter soils, which are less than 12 inches thick over hard caliche.

The following describes a typical profile of Mansker clay loam in native range (300 feet north and 20 feet west of the center of SW¼ sec. 5, T. 2 N., R. 17 E.):

A_1 0 to 8 inches, grayish-brown (10YR 5/2, dry; 3/2, moist) clay loam; strong, fine and medium, granular structure; friable when moist; wormcasts; a few small, hard concretions of calcium carbonate; calcareous; gradual boundary.

AC 8 to 22 inches, pale-brown (10YR 6/3, dry; 5/3, moist) clay loam, 30 percent consisting of hard and soft concretions of calcium carbonate, the hard concretions as much as ½ inch in diameter; moderately strong, fine and very fine, granular structure; slightly hard when dry, and friable when moist; wormcasts; strongly calcareous; clear boundary.

C_{ca} 22 to 32 inches, mixed very pale brown (10YR 8/3, dry) clay loam and white (10YR 8/2, dry) calcium carbonate, the mixture about 15 percent clay loam and 85 percent calcium carbonate; approximately 50 percent of the concretions of calcium carbonate are soft, and 50 percent are hard.

C 32 to 36 inches, hard caliche.

The texture of the surface soil is commonly clay loam, but in some places it is loam or fine sandy loam. The color of the surface soil ranges from grayish brown to dark grayish brown. The solum is 12 to 36 inches thick over caliche. In some places scattered, small areas of Potter soils occur within areas of Mansker soils, but they make up less than 15 percent of an area.

The Mansker soils absorb water readily. Because of the thinness of the solum, they have a low capacity to store water. Their ashy surface soil makes them highly susceptible to wind erosion.

Mansker clay loam, 0 to 3 percent slopes (MaB).—This is the most extensive of the Mansker soils. More than half of it is in native range. The cultivated areas are mainly in wheat, but some sorghum is grown. This soil is highly susceptible to wind erosion if the cover of grass is removed by cultivation or overgrazing. (Capability unit IVe–4; Hardland range site.)

Mansker clay loam, 3 to 5 percent slopes (MaC).—This moderately sloping soil occupies areas within the breaks and extends into drainageways. Its profile is similar to the profile described for the series.

Most of this soil is in grass; it is poorly suited to cultivation. (Capability unit VIe–2; Hardland range site.)

Mansker soils, severely eroded (MnC4).—This mapping unit has gentle to moderate slopes. It is made up of soils that have been severely eroded by wind and water. The soils resemble the typical soil described for the series but lack an A_1 horizon and part or all of the AC horizon.

The surface soil is pale brown to very pale brown and contains many hard concretions of calcium carbonate. This mapping unit is not suited to cultivation. (Capability unit VIe–2; Shallow range site.)

Mansker-Potter complex (Mp).—This complex is made up of Mansker and Potter soils so intermingled that it was not practical to map them separately. The complex occurs mainly along the Beaver River and its tributaries. It occupies two distinct types of topography. In the first type are fairly smooth, nearly level to gentle slopes;

70 to 85 percent of this type is occupied by Mansker soils, and 15 to 30 percent, by Potter soils. The other type consists of rough and dissected areas where slopes are moderate to steep; 40 to 80 percent of this type consists of Mansker soils, and 15 to 60 percent, of Potter soils.

In the rough areas some tracts of Berthoud soils are mapped with these soils. In a few places in the southwestern part of the county, there are outcrops of soils of this complex within nearly level areas of the upland plains. These areas are too rocky to cultivate without damaging farm implements. Most farmers have left them in native grasses or, if the areas were once cultivated, have since ceased to cultivate them. Profile descriptions and other characteristics typical of the Mansker and Potter soils are given under the respective series.

This mapping unit is used mostly for rangeland consisting of native grasses, for which it is well suited. (Capability unit VIe–2; Mixed hardlands and shallow range site.)

Otero Series

The Otero series is made up of deep, calcareous fine sandy loams that have a sandy subsoil. The soils are well drained. They occur on the uplands and on high stream terraces.

The surface soil is brown to grayish-brown fine sandy loam that is about 7 inches thick. Beneath it is a layer of sandy loam, 10 to 24 inches thick, that grades to the parent material. The parent material is loose, calcareous loamy fine sand of local origin. The soils developed under short grasses, sand sagebrush, and yucca.

The Otero soils have less clay in the subsoil than the Dalhart soils and are calcareous at shallow depths. They are less sandy and more limy than the Vona soils.

The following describes a typical profile of Otero fine sandy loam in native range (southeast corner of SW¼ sec. 35, T. 1 N., R. 18 E.):

A_1 0 to 7 inches, brown (10YR 4/3, dry; 3/2, moist) fine sandy loam; strong, fine and very fine, granular structure; slightly hard when dry; slightly calcareous; gradual boundary.

B 7 to 21 inches, brown (10YR 5/3, dry; 4/3, moist), light sandy clay loam; compound, strong, coarse, prismatic and strong, fine, granular structure; soft when dry; a few films of calcium carbonate; calcareous; gradual boundary.

C_{ca} 21 to 42 inches, very pale brown (10YR 7/4, dry; 5/3, moist) loamy fine sand; single grain; loose; very strongly calcareous.

The surface soil ranges from 5 to 15 inches in thickness. It is brown to grayish brown in color, and in places it is not calcareous. The subsoil ranges from light sandy clay loam to sandy loam in texture and from 10 to 24 inches in thickness. In general, it has a granular structure, but in many places the structure is prismatic. The subsoil is generally the same color as the surface soil, but in places it contains small, hard concretions of lime. The parent material is loose, calcareous loamy fine sand that is pale brown, very pale brown, light yellowish brown, brown, reddish yellow, or light gray.

Otero fine sandy loam (Ot).—This gently sloping to moderately sloping soil occurs near the Vona and Dalhart soils. It absorbs water readily but is droughty. The surface soil is limy and sandy; it is highly susceptible to wind erosion. Most of this soil that has been cultivated has been damaged by wind erosion. The soil is well suited to grass, but broomcorn and sorghum are the main crops. (Capability unit IVe–2; Limy sandy plains range site.)

Otero-Vona fine sandy loam (Ov).—This complex is made up mainly of Otero and Vona soils so intermixed it was not practical to map them separately. The soils are gently undulating to strongly sloping. They occur in the southeastern part of the county and on uplands along the tributaries of Goff Creek and the Beaver River.

The Otero and Vona soils are the principal soils in this complex, but several calcareous fine sandy loams that have slopes of 3 to 12 percent are included. The proportion of the several soils making up the complex varies from place to place. Generally, about 40 percent is Otero fine sandy loam; 35 percent, Vona fine sandy loam; 15 percent, Dalhart fine sandy loam; and 10 percent, Potter, Mansker, Lincoln, and other soils.

Commonly, the Otero soil occurs in moderately sloping areas and on rounded knolls; the Vona soil, in strongly sloping areas and along the natural drains; and the Potter and Mansker soils, as outcrops, narrow bands, and escarpments. The soils have developed from sandy loam that was deposited as a mantle over the Ogallala formation. Profile descriptions and other characteristics typical of these soils are given under the particular series.

Most of this mapping unit is used for rangeland consisting of native grasses, for which it is well suited. (Capability unit VIe–1: Sandy plains range site.)

Potter Series

The Potter series consists of very shallow, strongly calcareous, loamy soils that are underlain by caliche. The soils are excessively drained. They occupy the rough, dissected areas of the breaks.

The surface soil is grayish-brown loam to clay loam and is about 8 inches thick. It overlies white to very pale brown, hard, consolidated caliche that is several feet thick.

The parent material is caliche or a mixture of earth, gravel, and caliche that contains 50 percent or more calcium carbonate.

The Potter soils are less well developed and are shallower over caliche than the Mansker soils with which they are associated. Only one mapping unit of this series—Potter soils—is mapped in this county.

The following describes a typical profile of Potter loam in native range (NE¼NE¼ sec. 19, T. 1 N., R. 17 E.):

A_1 0 to 10 inches, grayish-brown (10YR 5/2, dry; 3/2, moist) loam; strong, fine, granular structure; very friable; very strongly calcareous; abrupt boundary.

C_{ca} 10 to 20 inches +, white (10YR 8/2, dry), indurated to semi-indurated caliche.

In most places the texture is loam or clay loam, but in a few places it is gravelly loam or fine sandy loam. Depth to caliche ranges from 2 to 12 inches. Generally, the underlying caliche is hard and rocklike, but in some places it consists of lime-cemented pebbles and nodules. The caliche ranges in thickness from 6 inches to 3 feet or more. In most places the soils have slopes between 5 and 20 percent, but a few small areas are nearly level.

Potter soils (Pt).—The soils of this mapping unit have strong slopes and a strong, granular structure. They are underlain by a layer of broken caliche. As a result, drainage is excessive. The texture of the surface soil is loam to clay loam. Included in mapping are some areas of Mansker and Berthoud soils that were too small to map separately.

The soils are not suited to cultivation. They are used for native range, but the cover of grass is sparse. (Capability unit VIIs–1; Shallow range site.)

Pullman Series

The Pullman series consists of deep, dark, clayey soils that have a subsoil of blocky clay. The soils are nearly level. They are on upland flats between the Beaver River and Frisco and Coldwater Creeks.

The surface soil is dark grayish-brown to dark-brown, heavy clay loam that is about 6 inches thick. It is underlain by dark-brown clay, 15 to 25 inches thick, that grades to lighter colored, calcareous clay loam.

The parent material consists of fine-textured sediments that were deposited by wind and water. The soils developed under a dense cover of short grasses.

The Pullman soils are similar to the Richfield soils, but their subsoil consists of more compact, blocky clay. They are less gray and have better surface drainage than the Lofton soils. Only one soil of the series—Pullman clay loam—is mapped in this county.

The following describes a typical profile of Pullman clay loam in a cultivated field (on the north side of the road approximately 1,000 feet east of the southwest corner, SW¼SE¼ sec. 11, T. 2 N., R. 14 E.):

A_{1p} 0 to 5 inches, dark grayish-brown to dark-brown (10YR 4/2.5, dry; 3/2.5, moist) clay loam; weak, very fine, granular structure; slightly hard when dry; noncalcareous; abrupt boundary.

B_2 5 to 15 inches, dark-brown (10YR 4/3, dry; 3/3, moist) clay; compound, moderately strong, coarse, blocky and weak, fine, blocky structure; very hard when dry, and very firm and very compact when moist; prominent clay skins; noncalcareous; gradual boundary.

B_3 15 to 32 inches, dark-brown (10YR 4/3, dry; 3/3, moist) clay; moderate, very fine, blocky structure; very hard when dry, and very firm when moist; clay skins; calcareous; gradual boundary.

C 32 to 44 inches, brown (10YR 4.5/3, dry; 3/3, moist) clay loam; weak, very fine, subangular blocky structure; slightly hard when dry; films and streaks of lime and a few semi-indurated concretions of calcium carbonate; strongly calcareous.

The Pullman soil absorbs water very slowly, and surface drainage is slow. The soil stores large quantities of water. It is well supplied with organic matter and minerals essential for the growth of crops.

Pullman clay loam (Pm).—This soil is fairly uniform. The A horizon is 3 to 8 inches thick. The B horizon is 10 to 25 inches thick and ranges from very dark brown to brown in color.

This soil is slightly susceptible to wind and water erosion. Most of it is slightly eroded.

Most of this soil is cultivated. It is well suited to dryland wheat. Sorghum grows well only in exceptionally wet seasons or under irrigation. If irrigated, the soil needs a long watering time. (Capability unit IIIc–1; Hardland range site.)

Randall Series

The Randall series consists of deep, clayey soils that are poorly drained. The soils occur on the bottoms of deep depressions or playas in uplands throughout the county.

The surface soil is very dark gray clay that is 10 to 20 inches thick. It overlies very dark gray, massive clay that is several feet thick. The parent material consists of fine-textured sediments.

The Randall soils are more compact and clayey than the Lofton soils, which occur in many of the shallower depressions. Only one soil of the series—Randall clay—is mapped in this county.

The following describes a typical profile of Randall clay (NW ¼ sec. 11, T. 2 N., R. 15 E.):

A 0 to 14 inches, very dark gray (10YR 3/1, dry) clay; moderate, fine, blocky structure; very hard when dry; noncalcareous; gradual boundary.

AC 14 to 48 inches, very dark gray (10YR 3/1, dry) clay; weak, very fine, blocky structure (almost massive); very hard when dry, and plastic when wet; a few very small concretions of calcium carbonate and iron; noncalcareous; gradual boundary.

C 48 to 68 inches, very dark grayish-brown (10YR 3/2, dry) clay; structureless (massive); compact; a few brown mottles and a few scattered concretions of iron; calcareous.

The surface soil is very dark gray to gray clay that is 10 to 20 inches thick. Generally, the soil is noncalcareous to a depth of 4 feet, but in places, where it occurs near soils that are strongly calcareous, it is calcareous throughout.

Randall clay (Ra).—This soil receives excess water from surrounding areas. At times, following periods of heavy rainfall, it is covered by as much as 20 feet of water that sometimes remains for many months. The soil is not suited to cultivation, and most of it is not cultivated. (Capability unit Vw–1; Hardland range site.)

Richfield Series

The Richfield series consists of deep, dark, clayey soils that are well drained. Locally, the soils are called hardland. They are nearly level and occupy large areas on uplands in all parts of the county. The soils are the most extensive of any in the county.

The surface soil is dark grayish-brown to grayish-brown silt loam or clay loam and is generally about 6 inches thick. Beneath the surface soil is dark grayish-brown, compact clay that is 6 to 20 inches thick. The clay grades to light-colored, highly calcareous parent material of wind-laid silt (loess). The soils developed under short grasses.

The Richfield soils are similar to the Pullman soils but have a less compact, clayey subsoil. They have a more compact, clayey subsoil and are deeper to free lime than the Ulysses soils with which they are associated. They are less sandy than the Dalhart soils.

The following describes a typical profile of Richfield clay loam in a cultivated field (on the west side of the road about 1,200 feet north of the intersection of the road, SE¼SE¼ sec. 28, T. 6 N., R. 12 E.):

A_{1p} 0 to 6 inches, dark grayish-brown (10YR 4/2, dry; 2/2, moist) clay loam; granular structure; friable when moist; noncalcareous; clear boundary.

B_2 6 to 15 inches, dark grayish-brown (10YR 4/2, dry; 3/2, moist) clay loam; moderate, fine, subangular blocky structure; firm when moist; prominent clay skins; noncalcareous; gradual boundary.

C_{ca} 15 to 30 inches, pale-brown (10YR 6/3, dry; 5/3, moist) clay loam; moderate, medium, granular structure; friable when moist; small, soft lime concretions; very strongly calcareous; gradual boundary.

C 30 to 68 inches, brown (7.5YR 5/4, dry; 4/4, moist) clay loam; weak, fine, granular structure (nearly massive, but porous and permeable); friable when moist; calcareous.

The surface soil ranges in texture from heavy clay loam to loam, and in thickness, from 4 to 16 inches. The subsoil is clay loam, 6 to 20 inches thick, with a subangular blocky to granular structure. Depth to calcareous material ranges from 12 to 25 inches.

Included in mapping are small areas of Ulysses soils that are calcareous throughout or that are transitional to the Mansker soils. These included soils are associated with the Richfield soils and occur in slightly convex areas. Near Hough, the Ulysses soils are on long, narrow ridges and oval hills within areas of Richfield soils.

In a few places, especially near Goodwell and Texhoma, there are outcrops of caliche soils of the Mansker and Potter series within areas of Richfield soils. In some places Lofton clay loam occurs in slight depressions, less than 5 acres in size, within areas of the Richfield soils; most of these areas are in the northeastern part of the county.

The Richfield soils in the northeastern quarter of the county are associated with Dalhart soils. Here, Richfield soils generally have less clay than the Richfield soils in other parts of the county, and they contain more sand or silt. Richfield loam, thick surface, and Richfield fine sandy loam occur mainly in this area.

The principal areas of Richfield soils are on a large plain immediately north of the Beaver River and Goff Creek. The plain, which extends into Kansas, is occupied mainly by Richfield soils, except for the northwestern corner and along the State line north of Hooker and Tyrone. Another large area is between the breaks of Goff and Sand Creeks. Still another occurs between the breaks of the Beaver River and Frisco and Coldwater Creeks.

The Richfield soils absorb water slowly and store large quantities of it. They are well supplied with organic matter and with the minerals needed by crops. The soils are well suited to dryland wheat and to all the irrigated crops that grow well in this county.

Richfield clay loam (Rc).—This nearly level soil occupies large areas and is one of the most productive soils in the county. It is, therefore, desirable for large-scale farming and commands a high price on the local land market.

The soil is slightly susceptible to erosion by wind and water, and most of it is eroded to some extent. Winter wheat is the principal crop (fig. 7). (Capability unit IIIc-1; Hardland range site.)

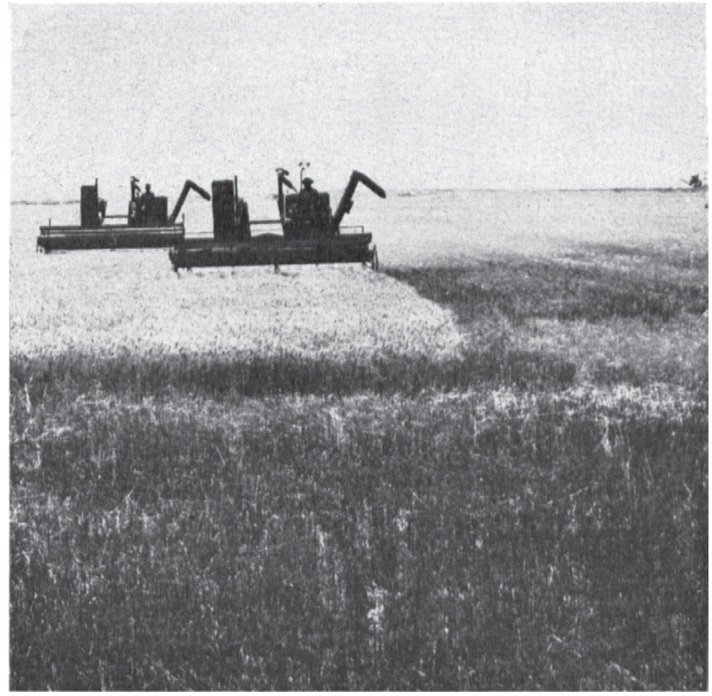

Figure 7.—**Harvesting wheat grown on Richfield clay loam.**

Richfield loam, thick surface (Rt).—This is the most productive wheat soil in the county. It is similar to the typical soil described for the series, but its surface soil has a texture of loam to silt loam and is 10 to 16 inches thick.

The soil is slightly susceptible to wind and water erosion. Much of it is slightly eroded, and about 10 percent of it is moderately eroded. Winter wheat is the main crop. (Capability unit IIIc-1; Hardland range site.)

Richfield fine sandy loam (Rf).—This soil is desirable for farming. It is similar to the typical profile described for the series, but its surface layer is sandy loam and is 6 to 12 inches thick. The subsoil is clay loam. Included in mapping are some areas that have as much as 6 inches of winnowed loamy fine sand on the surface.

This soil is easy to till, and most of it is cultivated. Grain sorghum is the principal crop, but wheat is grown in many places. The soil is moderately susceptible to wind erosion. Water erosion is seldom a problem. (Capability unit IIIe-2; Sandy plains range site.)

Spur Series

The Spur series consists of deep, dark, friable soils that are clayey and loamy. The soils occur on the flood plains of the Beaver River and its main tributaries.

The surface soil is dark grayish-brown, calcareous clay loam to loam that is about 18 inches thick. It overlies a slightly more clayey layer that is grayish brown and calcareous.

The parent material consists of calcareous, fine- and medium-textured, alluvial sediments. Most of it is of local origin.

The Spur soils are less gray in color and are less clayey than the Sweetwater soils. They also have a deeper water table. They are less sandy than the Lincoln and Bayard soils. Only one unit of this series—Spur soils—is mapped in this county.

The following describes a typical profile of Spur clay loam in native range (SW¼SW¼ sec. 6, T. 1 N., R. 16 E.):

A_1 0 to 20 inches, dark grayish-brown (10YR 4/2, dry; 2/2, moist) clay loam; moderately strong, fine and medium, granular structure; friable when moist; calcareous; gradual boundary.

AC 20 to 28 inches, grayish-brown (10YR 5/2, dry; 3/2, moist) clay loam; moderately weak, fine and medium, granular structure; hard when dry, and firm when moist; calcareous; gradual boundary.

C 28 to 42 inches, light brownish-gray (10YR 6/2, dry; 5/2, moist) clay loam; weak, granular structure; hard when dry; a few, very small mottles of olive yellow (2.5Y 6/6, dry) in the lower 2 inches; many soft spots and streaks of calcium carbonate; strongly calcareous.

The surface soil ranges from brown to dark grayish brown in color and from 12 to 24 inches in thickness. The texture is commonly clay loam but ranges to loam. In some places a sandy layer, several inches thick, has recently been deposited. The subsoil is clay loam to loam. In many places the substratum consists of stratified sand, silt, and clay. Depth to the water table is generally more than 42 inches. In some places along Palo Duro Creek, which drains an area of soils of the Permian red beds, the color of the soils is as red as hue 2.5YR.

Spur soils (Sp).—The soils of this mapping unit are desirable for farming. They are nearly level and are easy to till. The texture of the surface soil ranges from clay loam to loam, but in places sand has been deposited on the surface. Included in mapping are some areas of the associated Sweetwater, Lincoln, and Bayard soils that were too small to map separately.

These soils are well suited to dryland wheat and to all of the irrigated crops grown in the county (fig. 8). They are moderately well suited to sorghum. Most of the large areas are cultivated. The small areas and those areas that are inaccessible are in native grass. (Capability unit IIIc-1; Loamy bottom-land range site.)

Figure 8.—**Alfalfa hay grown on irrigated Spur soils; the cattle in the background are grazing on irrigated pasture.**

Sweetwater Series

The Sweetwater series consists of dark bottom-land soils that are poorly drained. The soils occur along the Beaver River and the larger creeks.

The surface soil is gray to dark grayish-brown silty clay loam that is 6 to 16 inches thick. The subsoil is sandy loam to fine sand that is wet within 3 feet of the surface.

The parent material consists of calcareous sandy alluvium recently deposited by adjacent streams.

The water table is at shallower depths in the Sweetwater soils than in such other bottom-land soils as the Bayard, Lincoln, and Spur. Also, the Sweetwater soils are more grayish than those soils. Only one unit of this series—Sweetwater soils—is mapped in this county.

The following describes a typical profile of a Sweetwater soil in native range (in the eastern half SE¼ sec. 12, T. 3 N., R. 15 E.):

A_{11} 0 to 3 inches, light brownish-gray (2.5Y 6/2, dry; 4/2, moist) silty clay loam that has a thin crust of very fine powdery salt on the surface; strong, very fine, subangular blocky structure; hard when dry, and sticky when wet; calcareous; clear boundary.

A_{12} 3 to 12 inches, gray (10YR 5/1, dry; 3/1, moist) silty clay loam; moderately strong, very fine, subangular blocky structure; hard when dry, and plastic when wet; calcareous; clear boundary.

C_1 12 to 26 inches, light-gray (2.5Y 7/2, dry; 5/2, moist) silty clay loam; moderate, very fine, subangular blocky structure; plastic when wet; calcareous; abrupt boundary.

C_2 26 to 34 inches, grayish-brown (2.5Y 5/2, moist) loamy fine sand; structureless; calcareous; permanently wet; abrupt boundary.

C_3 34 to 42 inches, black (N 2/ , moist) clay; massive; very plastic when wet; calcareous; permanently wet.

In most places the texture of the surface soil is silty clay loam to clay loam. In some small areas it is loam, and in a few areas it is loamy fine sand underlain by stratified clay and sand. Its color is gray, black, or grayish brown. The substratum is variable, but generally there is a wet, sandy layer at depths within 42 inches of the surface. In many places this sandy layer is grayish, and olive-brown to light yellowish-brown mottles are common. There is a layer of black, wet clay below the sandy layer in many places. The water table is generally within 3 feet of the surface in summer, and in places it rises to the surface in winter. In the few areas where the surface soil is loamy fine sand, the water table is at depths of 2 to 3 feet.

Sweetwater soils (Sw).—The soils of this mapping unit are nearly level, and in most places they are smooth. The large, smooth areas are used for meadows. A small acreage is cultivated, and the rest is in native range. (Capability unit Vw-2; Subirrigated range site.)

Tivoli Series

The Tivoli series is made up of deep, loose, sandy soils. The soils occupy dunes. The largest area is north of the Beaver River, southeast of Adams.

The surface soil is pale-brown fine sand that is about 8 inches thick. It overlies light yellowish-brown fine sand that ranges from 5 to 30 feet or more in thickness.

The soils are on steep dunes that are 20 to 50 feet high. They generally have slopes of more than 12 percent.

The parent material consists of fine sand that has been blown into dunes by the wind. These soils developed under a sparse cover of tall grasses and sand sage.

The Tivoli soils are sandier and less coherent throughout than the Vona soils with which they are associated. Only one soil of this series—Tivoli fine sand—is mapped in this county.

The following describes a typical profile of Tivoli fine sand in native range (SE¼NE¼ sec. 1, T. 2 N., R. 19 E.):

A_1 0 to 8 inches, pale-brown (10YR 6/3, dry; 5/3, moist) fine sand; single grain; loose; noncalcareous; clear boundary.

C 8 to 60 inches +, light yellowish-brown (10YR 6/4, dry) fine sand; single grain; loose; noncalcareous.

Except for the surface soil, which ranges from 3 to 10 inches in thickness, the soil is fairly uniform.

Tivoli fine sand (Tv).—This soil absorbs water readily; runoff is rare. It has very low water-holding capacity.

The soil is low in fertility and is suitable only for native range. None of it is cultivated. Most of it has sufficient cover of sand sage and grasses to keep it from eroding. There are only three or four active sand dunes. (Capability unit VIIe-1; Dune range site.)

Ulysses Series

The Ulysses series is made up of deep, moderately fine textured, calcareous soils. The soils are well drained and occur on uplands in all parts of the county.

The surface soil is grayish-brown to brown clay loam to loam that is about 7 inches thick. The layer underlying it has the same texture as the surface soil but is brown to pale brown. Under this is a less clayey layer of light yellowish-brown to very pale brown soil material.

The parent material consists of wind-laid silt (loess) that contains varying amounts of fine sand. The soils developed under short grasses.

The subsoil of the Ulysses soils is less clayey and more friable than that of the Richfield soils, and the Ulysses soils are calcareous at shallower depths. They are less friable and have weaker structure than the Berthoud soils and are not so strongly granular as the Mansker soils. In addition, the Mansker soils have a distinct C_{ca} horizon.

The following describes a typical profile of Ulysses clay loam in a cultivated field (1,400 feet east and 200 feet north of the southwestern corner of NW¼ sec. 13, T. 6 N., R. 11 E.):

A_{1p} 0 to 5 inches, grayish-brown (10YR 5/2, dry; 3.5/2, moist) silty clay loam; weak, very fine, granular structure; friable when moist; calcareous; clear boundary.

B_2 5 to 22 inches, pale-brown (10YR 6/3, dry; 4.5/3, moist) silty clay loam that has about 2 percent of soft to semi-indurated, whitish concretions of calcium carbonate; moderately weak, fine and very fine, subangular blocky and weak, prismatic structure; friable to slightly firm when moist; strongly calcareous; gradual boundary.

C 22 to 33 inches, light yellowish-brown (10YR 6/4, dry) silt loam; weak, very fine, granular structure; friable when moist; many fine root holes; calcareous.

The surface soil ranges from loam to clay loam in texture. It is grayish brown, brown, or dark grayish brown in color and is 4 to 15 inches thick. These soils are generally calcareous throughout, but in places they are noncalcareous in the uppermost 12 inches. The B horizon is very weakly developed or is absent. In some places the profile has alternating layers of silty and sandy soil materials; in others, the profile is silty and has a surface layer of sandy loam or vice versa. Hard concretions of calcium carbonate occur in the uppermost 6 inches in some places. The B and C horizons in places have a slightly reddish (7.5YR) hue.

These soils absorb water readily. They have a moderate capacity to store water and are moderately productive. The soils are well suited to dryland wheat and to all the irrigated crops commonly grown in the county.

Ulysses clay loam, 0 to 1 percent slopes (UcA).—This soil occurs in nearly level to slightly convex areas. Included in mapping are some areas of Richfield clay loam that were too small to map separately; in some places as much as 10 percent of an area consists of the Richfield soil.

Most of Ulysses clay loam, 0 to 1 percent slopes, is cultivated. The main crop is wheat. The soil is moderately susceptible to wind erosion. Most of it is somewhat eroded. (Capability unit IIIe-1: Hardland range site.)

Ulysses clay loam, 1 to 3 percent slopes (UcB).—Some areas of this soil occur on ridges and oval hills that are 5 to 200 acres in size. Others are on gentle slopes that lead to draws.

Most of this soil is cultivated. Wheat is the main crop. The soil is moderately susceptible to erosion by wind and water. All of it is somewhat eroded, but the severely eroded areas are too small to map separately. (Capability unit IIIe-3; Hardland range site.)

Vernon Series

The Vernon soils are shallow and reddish. They occur in rough, broken areas in the southeastern corner of the county.

The surface soil is red to yellowish-red clay loam to silt loam. It overlies shale, siltstone, or sandstone. In many places there are outcrops of unweathered shale or sandstone.

The parent material is shale, siltstone, and sandstone. In some places this material occurs in solid layers, but in others broken fragments of all three materials are mixed together. The soils developed under short and mid grasses.

The Vernon and Woodward soils developed from similar parent material, but the profile of the Vernon soils is thinner over the parent material than that of the Woodward soils. Only one unit of this series—Vernon loams—is mapped in this county.

The following describes a typical profile of Vernon clay loam in native range (500 feet west and 5 feet south of the northeastern corner of NE¼ sec. 24, T. 1 N., R. 18 E.):

A 0 to 5 inches, yellowish-red (5YR 5/6, dry and moist) silty clay loam; weak, very fine, granular structure; friable when moist; weakly calcareous; gradual boundary.

AC 5 to 9 inches, red (2.5YR 5/6, dry; 3/6, moist) clay loam; moderate, fine and very fine, granular structure;

friable when moist; weakly calcareous; clear boundary.

C 9 to 24 inches, dark reddish-brown (2.5YR 3/4, dry) unweathered shale; noncalcareous, but in places has a thin coat of lime.

The surface soil ranges from 2 to 12 inches in thickness. Its texture ranges from loam to silt loam or clay loam, and its color, from yellowish red to brown. The topography is gently undulating to smooth in some areas, but most of the areas are dissected and strongly sloping.

Vernon loams (Ve).—The surface layer of these soils is loam, silt loam, or clay loam. The soils are unsuited to cultivation. They are in native grasses and are used for range. (Capability unit VIIs–1; Shallow range site.)

Vona Series

The Vona series consists of deep, sandy soils that have a sandy subsoil. The soils occur in billowy and duny areas in the uplands. They are mainly southeast of Adams, north of Hooker, along Goff Greek, and near some of the streams in the southern part of the county.

The surface soil is brown loamy fine sand that is 6 to 8 inches thick. The subsoil is brown fine sandy loam or loamy fine sand. The soils developed in wind-laid, calcareous loamy fine sand under mid and tall grasses.

The Vona soils have a sandier, less clayey subsoil than the Dalhart soils. They contain more clay and are more coherent than the Tivoli soil.

The following describes a typical profile of Vona loamy fine sand in native range (on the south side of the road, about 1,650 feet east and 100 feet south of the northwest corner of NW¼ sec. 10, T. 4 N., R. 13 E.):

A_1 0 to 6 inches, brown (10YR 4.5/3, dry; 3.5/3, moist) loamy fine sand; single grain; loose; noncalcareous; clear boundary.

B_2 6 to 12 inches, brown (10YR 5/3, dry; 4/3, moist) loamy fine sand; moderate to weak, coarse, prismatic structure; very friable when moist; noncalcareous; gradual boundary.

B_3 12 to 36 inches, yellowish-brown (10YR 5/6, dry and moist) loamy fine sand; single grain; loose; calcareous; gradual boundary.

C 36 to 60 inches, light yellowish-brown (10YR 6/4, dry) fine sand; single grain; loose; calcareous.

In places the soils are noncalcareous to depths of 30 inches. The subsoil ranges in texture from loamy fine sand to light sandy clay loam; its structure is massive, weak granular, or weak prismatic. The soils are associated with Dalhart, Otero, and Tivoli soils.

The Vona soils absorb water readily, but they have a low water-holding capacity. They are well suited to grass. Only a small acreage is cultivated.

Vona loamy fine sand, 0 to 3 percent slopes (VoB).—This soil is nearly level to gently undulating and is hummocky. In cultivated areas and in places where the cover of plants is sparse, there are a few, small blowouts. (Capability unit VIe–1; Deep sand range site.)

Vona loamy fine sand, 3 to 8 percent slopes (VoC).—This soil occurs on dunes. Except that it has stronger slopes, it is like Vona loamy fine sand, 0 to 3 percent slopes. All of it is in native grass. Blowouts are likely to develop in areas where the cover of plants has become sparse as the result of drought or overgrazing. (Capability unit VIe–1; Deep sand range site.)

Vona, Otero, and Potter soils (Vp).—This mapping unit is made up of a mixture of sandy soils that overlie calcareous loam, clay loam, and caliche. The soils are gently undulating to steep and occur on uplands, mainly along Goff Creek. They are so intermixed and occur in such an intricate pattern that it was not practical to map them separately.

These soils were mixed as the result of sand being blown from adjacent streambeds onto soils developed in calcareous loam, clay loam, and caliche of the Ogallala formation. The sand is deep in many places near streams and in the draws draining into the streams. Vona loamy fine sands developed in this deep sand. In places where the deposit of sand was less than 2 feet thick, the Otero soils developed. The Mansker and Potter soils developed where the deposit of sand is thin or absent. The Potter soils are on the escarpments and in steeper areas.

The proportion of the several soils varies from place to place. Vona loamy fine sands are the principal soils. They generally make up about 50 percent of an area, but the proportion ranges from 30 to 80 percent. Otero loamy fine sands generally make up about 15 percent of an area, but the amount ranges from 5 to 30 percent. About 25 percent consists of Potter soils, and 10 percent, of Mansker soils. Profile descriptions and other characteristics typical of these soils are given under the particular series.

The soils of this mapping unit are used mainly for range consisting of native grasses, and they are well suited to that purpose. (Capability unit VIe–1; Limy sandy plains range site.)

Woodward Series

The Woodward series consists of moderately deep, loamy soils that are well drained. The soils are on the uplands in the southeastern corner of the county.

The surface soil is brown loam that is about 5 inches thick. It overlies reddish-brown loam, about 15 inches thick, that rests on parent material of soft, red sandstone, siltstone, or sand. The soils developed under short and mid grasses.

The solum of the Woodward soils is thinner than that of the Ulysses and Berthoud soils, but it is thicker than that of the Vernon soils. Only one soil of the series—Woodward loam, 1 to 3 percent slopes—is mapped in this county.

The following describes a typical profile of Woodward loam in a cultivated field (1,500 feet west and 100 feet north of the southeastern corner of SE¼ sec. 11, T. 1 N., R. 19 E.):

A_{1p} 0 to 5 inches, brown (7.5YR, 4/4 dry; 5YR 3/3.5 moist) loam; moderate, fine, granular structure; slightly hard when dry; calcareous; clear boundary.

AC 5 to 21 inches, reddish-brown (5YR 4/4, dry; 3.5/4, moist) silt loam; moderate, fine, granular structure; slightly hard when dry; wormcasts make up approximately 50 percent of the soil mass; calcareous; abrupt boundary.

C 21 to 42 inches, red (2.5YR 5/6, dry) very fine sand; soft; very compact; calcareous.

In native range the texture of the surface soil is mostly loam, but in cultivated areas it is generally fine sandy loam. The parent material is generally sand, but in many places it is soft sandstone or siltstone, and in some places it is shale. Depth to parent material ranges from 15 to 30 inches. The Woodward soils are associated with and grade to the Vernon soils.

Woodward loam, 1 to 3 percent slopes (WwB).—This well-drained soil absorbs water readily. It is well suited to grass. Sorghum and wheat are the main crops grown, and yields are fairly good. If cultivated, the soil is moderately susceptible to wind and water erosion. (Capability unit IIIe-3; Hardland range site.)

Use and Management of Soils

In this section the system of land capability grouping is defined and the use and management of the soils for dryland farming is discussed in terms of units of that grouping. Following this, general management practices are given; then, estimated yields of principal crops on dryland soils and on irrigated soils are listed. Yields of wheat and percentage of acreage not harvested, in relation to moisture, are discussed, as well as irrigation, range management, woodland and windbreaks, wildlife, and engineering properties of the soils.

Capability Grouping of Soils

Capability grouping is a system of classification used to show the relative suitability of soils for crops, grazing, and wildlife. It is a practical grouping based on the needs, limitations, and risks of damage to the soils and also on their response to management. There are three levels in the grouping—unit, subclass, and class.

The capability unit, sometimes called a management group, is the lowest level of grouping. A capability unit is made up of soils similar in management needs, in risk of damage, and in general suitability for use. The capability unit is represented by an Arabic number in the classification symbols, for example, IIIw-1, IIIc-2, or IIIe-3.

The next broader grouping, the subclass, is used to indicate the dominant kind of limitation. The letter symbol "e" indicates that the main limiting factor is risk of erosion if the plant cover is not maintained; "w" means excess water that retards plant growth or interferes with cultivation; "s" shows that the soils are shallow, droughty, or unusually low in fertility; and "c" shows that the soils are limited chiefly by a climate that is too cold or too dry.

The broadest grouping, the land capability class, is identified by Roman numerals. All the soils in one class have limitations and management problems of about the same degree, but of different kinds, as shown by the subclass. All the land classes, except class I, may have one or more subclasses.

In classes I, II, and III are soils that are suitable for annual or periodic cultivation of annual or short-lived crops.

Class I soils are those that have the widest range of use and the least risk of damage. They are level or nearly level, productive, well drained, and easy to work. They can be cultivated with almost no risk of erosion and will remain productive if managed with normal care.

Class II soils can be cultivated regularly but do not have quite so wide a range of suitability as class I soils. Some class II soils are gently sloping; consequently, they need moderate care to prevent erosion. Other soils in class II may be slightly droughty, slightly wet, or somewhat limited in depth.

Class III soils can be cropped regularly but have a narrower range of use than those in class II. They need even more careful management.

In class IV are soils that have greater natural limitations than those in class III, but they can be cultivated for some crops under very careful management.

In classes V, VI, and VII are soils that normally should not be cultivated for annual or short-lived crops but that can be used for pasture, or range, as woodland, or for wildlife.

Class V soils are nearly level or gently sloping but are wet, low in fertility, or otherwise unsuitable for cultivation.

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture, or range, woodland, or wildlife. Some soils in class VI can, without damage, be cultivated enough so that they can be used for some crops or seeded to pasture.

Class VII soils have very severe limitations that make them unsuited to cultivation. If used for range, they require careful management.

In class VIII are soils that have practically no agricultural use. The soils have value as parts of watersheds, and some have value as wildlife habitats or for scenery.

Capability classes, subclasses, and units

The capability classes, subclasses, and units in which the soils of Texas County are classified are defined in the following listing. Because precipitation is limited and the soils are subject to wind erosion, there are no soils in classes I or II in Texas County. The soils in class III are the best agricultural soils in the county, but they require practices to conserve moisture and control wind erosion. There are no soils in class VIII in the county.

Class III.—Soils that have severe limitations that reduce the choice of plants, or that require special conservation practices, or both.
- Subclass IIIc.—Soils that are limited for crops by insufficient effective rainfall.
  - Unit IIIc-1.—Deep, nearly level, moderately fine and medium-textured, well-drained soils that have moderately heavy subsoils.
  - Unit IIIc-2.—Deep, nearly level, moderately coarse textured, well-drained soil of the bottom lands.
- Subclass IIIe.—Soils that are well drained and that are limited chiefly by hazard of erosion when used for cultivated crops.
  - Unit IIIe-1.—Deep, nearly level, moderately fine- and medium-textured soils of the uplands.
  - Unit IIIe-2.—Deep, nearly level to gently sloping, moderately coarse textured soils of the uplands.
  - Unit IIIe-3.—Deep, gently sloping, moderately fine- and medium-textured soils of the uplands.
- Subclass IIIw.—Soils limited by excess water.
  - Unit IIIw-1.—Deep, level, moderately fine textured, poorly drained upland soil that is subject to flooding for short periods.

Class IV.—Soils that have very severe limitations that restrict the choice of plants but that can be cultivated with special management.

Subclass IVe.—Well-drained soils subject to severe erosion if not protected.

Unit IVe-1.—Deep, moderately sloping, medium-textured soils of the uplands.

Unit IVe-2.—Deep, gently sloping to moderately sloping, moderately coarse textured soil on uplands and on high stream terraces.

Unit IVe-3.—Deep, nearly level to gently sloping, coarse-textured soil on uplands.

Unit IVe-4.—Shallow, nearly level to gently sloping, moderately fine textured soil of the uplands.

Class V.—Soils too wet for cultivation but that can be used for grass.

Subclass Vw.—Soils that are likely to have excess water on the surface or that are subirrigated by a high water table.

Unit Vw-1.—Deep, level, fine-textured, poorly drained upland soil that is flooded frequently.

Unit Vw-2.—Deep, nearly level, fine- to medium-textured, bottom-land soils that are poorly drained.

Class VI.—Soils that are not suitable for cultivation, because of severe limitations, but that are suitable for grass.

Subclass VIe.—Soils subject to severe erosion.

Unit VIe-1.—Deep, nearly level to steep, coarse-textured, droughty soils of the uplands.

Unit VIe-2.—Shallow, nearly level to steep, moderately fine- and medium-textured soils within or near the breaks.

Subclass VIs.—Shallow or droughty soils.

Unit VIs-2.—Deep, coarse-textured, droughty soils of the bottom lands.

Class VII.—Soils not suited to cultivation and that have severe limitations when used for pasture.

Subclass VIIe.—Soils subject to very severe erosion.

Unit VIIe-1.—Deep, strongly sloping to very steep, coarse-textured soils of the uplands.

Unit VIIs-1.—Shallow soils.

Management by Capability Units

All the soils in one capability unit have about the same limitations and similar risks of damage. Therefore, all soils in a unit need about the same kind of management, though they may have formed from different kinds of parent materials and in different ways. In the following pages the soils in each unit are listed and management for dryland farming is suggested for the soils of the unit, or reference is made to the particular range site.

Capability unit IIIc-1

In this capability unit are deep, nearly level, moderately fine and medium-textured, well-drained soils that have subsoils of moderately fine texture. The soils are mostly on uplands. The following soils are in this unit:

Pullman clay loam.
Richfield clay loam.
Richfield loam, thick surface.
Spur soils.

These soils are the most fertile in the county. They have less runoff than most of the other soils and store large quantities of water in their subsoils. The soils are desirable for large-scale farming and irrigation. They are best suited to growing dryland wheat, but, in periods of above normal rainfall, sorghum grows well. The soils are well suited to grasses planted for grazing and for building up the soil.

The soils of this unit are slightly susceptible to wind and water erosion. Heavy rains are likely to cause sheet erosion. In areas where the slopes are long, the soils are likely to be damaged by runoff from higher areas. Intake of water is very slow in the Pullman soil, slow in Richfield clay loam, and moderately slow in the Spur soils and in Richfield loam, thick surface. The surface layer of the soils tends to crust and the structure to break down. The Pullman soil is the droughtiest of these soils; sorghum seldom grows well on it. The Spur soils occur on bottom lands along some of the streams, where some areas are flooded occasionally.

These soils need to be protected by a growing crop or a heavy stubble to help control wind erosion. Stubble mulching should be practiced if wheat or barley is grown. If sorghum fields are grazed after the grain has been harvested, the cattle should be removed after the leaves have been consumed; then, the stalks will protect the soil. Use emergency tillage to control wind erosion only if there is not enough crop residue or other cover.

Use a cropping system that fits the moisture condition, and support it by conservation practices. Fallow 1/4 to 1/3 of the field, depending upon the amount of moisture stored in the soil. Wheat is likely to fail if it is sown in soil that is moist to a depth of less than 24 inches. Delay tilling fields that have been left fallow, until the danger of soil blowing has passed in spring.

To divert runoff from higher areas and to break up long slopes, build diversion terraces where needed. Impounding terraces will help to conserve moisture. Farm all terraces on the contour. Farming on the contour without terracing will also help to conserve moisture. Stripcropping will help to reduce wind erosion, and the stubble will help conserve moisture by catching snow. Avoid excessive tillage and tillage that will leave the surface soil loose and powdery.

Capability unit IIIc-2

Only one soil—Bayard fine sandy loam—is in this capability unit. This deep, moderately sandy soil is well drained. It is nearly level and occurs on flood plains. The subsoil is sandy and takes water rapidly, but it cannot hold large quantities of water available for plants to use.

This soil is moderately fertile and is easy to till. It is well suited to sorghum, but wheat and alfalfa also grow fairly well. The soil is well suited to grasses planted for grazing, for hay, or for soil building.

Wind erosion is a hazard on the large fields. Except in a few places where there is runoff from higher areas, water erosion is generally not a hazard. The soil is flooded occasionally.

Keep a growing crop or a heavy stubble on this soil to protect it from wind erosion. Stubble mulching should be practiced. Leave sorghum stalks standing during the winter months. If the fields are grazed, the cattle should be removed after the heads and leaves of the sorghum have been consumed; then, the stalks will protect the soil.

Build diversion terraces where needed. These will protect the soil from runoff from higher areas.

Capability unit IIIe-1

This capability unit is made up of deep, moderately fine and medium-textured, calcareous soils. The soils are nearly level. They occur on uplands. The following soils are in this unit:

- Dalhart-Ulysses loams, 0 to 1 percent slopes.
- Ulysses clay loam, 0 to 1 percent slopes.

These soils are moderately productive. They have less runoff than many of the soils in the county. The subsoils store moderately large quantities of water. Therefore, the soils are well suited to growing dryland wheat, and sorghum also grows fairly well. If these soils are irrigated, crops make good yields. Grasses can be planted for grazing and for building up the soil.

These soils have an ashy surface layer that crusts over and blows easily. Chiseling or listing is not practical for controlling wind erosion. The moist clods that are turned up soon dry out, crumble, and fall apart. Except on long slopes or where there is runoff from higher areas, there is little risk of water erosion.

Keep a protective cover of heavy stubble or a growing crop on these soils to control wind erosion. Practice stubble mulching if wheat or barley is grown. Leave the sorghum stalks standing in winter. If the sorghum fields are grazed after the grain has been harvested, the cattle should be removed after they have eaten the leaves from the stalks. Then, the stalks will protect the soil from wind erosion.

Use a cropping system, supported by conservation practices, to fit the moisture conditions. Fallow 1/4 to 1/3 of the field, depending upon the amount of moisture that is stored in the soil. Wheat is likely to fail if it is planted in soil that is moist to a depth of less than 24 inches. Delay tilling the fields that have been left fallow until after the danger of soil blowing has passed in spring.

On long, nearly level slopes, build diversion terraces to divert runoff and to prevent water from accumulating. Impounding terraces will help to conserve moisture. Farm terraced areas on the contour. Farming on the contour without terracing will also help to conserve rainfall.

Stripcropping helps to reduce wind erosion, and the stubble helps to conserve moisture by catching snow. To help prevent the surface layer of these soils from becoming loose and powdery, avoid unnecessary tillage.

Capability unit IIIe-2

This capability unit consists of deep, moderately coarse textured soils. The soils are nearly level to gently sloping and are on uplands. The following soils are in this unit:

- Dalhart fine sandy loam, 0 to 1 percent slopes.
- Dalhart fine sandy loam, 1 to 3 percent slopes.
- Richfield fine sandy loam.

These soils have sandy surface layers. Water from rainfall soaks in readily, and little is lost through evaporation. Their subsoils are moderately fine textured and hold large quantities of water. Locally, the soils are called sorghum soils because sorghum has sometimes been harvested from them after a summer when little rain has fallen. Some wheat is grown, but, because sometimes the surface soil is dry when the wheat is planted, this crop is only moderately successful.

Because these soils absorb moisture readily and store it in the subsoil, the fields are seldom left fallow in summer. Sometimes, during a period of several wet years, alfalfa is grown, but yields are only moderate. The soils are well suited to grass, which can be planted for grazing or for building up the soil.

These soils are moderately susceptible to wind erosion. The heavy rains that fall occasionally cause washing in some places, and it is difficult to maintain organic matter in the soil. Plowing and listing to the same depth year after year is likely to cause a plowpan to form in these soils.

These soils should be protected by a growing crop or heavy stubble to help control wind erosion (fig. 9). Delay tillage until after the danger of soil blowing has passed in spring, and plant row crops approximately at right angles to the direction of prevailing winds. Where necessary, use terraces to control water erosion and to conserve moisture. Stripcropping will help to control wind erosion, and the stubble will help conserve the moisture from snow.

Capability unit IIIe-3

This capability unit consists of deep, gently sloping, moderately fine and medium-textured soils of the uplands. The following soils are in this unit:

- Berthoud loam, 1 to 3 percent slopes.
- Bippus clay loam.
- Dalhart-Ulysses loams, 1 to 3 percent slopes.
- Ulysses clay loam, 1 to 3 percent slopes.
- Woodward loam, 1 to 3 percent slopes.

These soils are moderately productive. They absorb water fairly well, but, because of their gentle slopes, there is some runoff. The soils store moderate quantities of water. They are best suited to wheat and grasses, but sorghum grows moderately well.

The Ulysses soils have an ashy surface layer that crusts and blows easily. On the Ulysses soils it is not practical

Figure 9.—Sorghum stubble, 8 to 12 inches high, left to help protect this Dalhart fine sandy loam from wind erosion.

to use tillage methods to control wind erosion, because clods that are turned up do not last more than a few days. In many places the Ulysses soils are on short slopes, and there is only a slight hazard of water erosion.

The other soils in this unit are moderately susceptible to water erosion. This is particularly true of the Berthoud and Bippus soils, which are on foot slopes and receive runoff from the slopes above. The structure of the surface layer of all of these soils breaks down, and a crust is likely to form on the surface when the soils are cultivated.

These soils need to be protected from wind erosion by a growing crop or heavy stubble. If small grains are grown, use stubble mulching. Leave sorghum stalks standing during the winter and in spring. If the sorghum fields are grazed after the grain has been harvested, the cattle should be removed from the field after the leaves have been consumed; then, the stalks will protect the soil.

Use a cropping system, supported by conservation practices, to fit moisture conditions. Fallow 1/4 to 1/3 of the field, depending upon the amount of moisture stored in the soil. Wheat is likely to fail if it is planted in soil that is moist to a depth of less than 24 inches. Delay tilling fields that have been left fallow, until the danger of soil blowing has passed in spring.

Use diversion terraces to prevent water, caused by runoff from higher areas, from accumulating. Construct terraces on soils that have slopes of more than 2 percent, or seed crops by sowing them or by planting in closely spaced rows. Impounding terraces can be used to help conserve moisture on soils that have slopes of less than 2 percent. Farm all terraced areas on the contour. If they are needed, construct vegetated waterways so that excess water that has accumulated back of the terraces will drain off. Much rainfall can also be conserved by farming on the contour the fields that are not terraced.

Stripcropping will help to reduce wind erosion and to conserve the moisture from snow. Avoid excessive tillage because tillage makes the surface soil powdery and loose.

Capability unit IIIw-1

Only one soil—Lofton clay loam—is in this capability unit. This soil is deep and level and is moderately fine textured. It is a poorly drained upland soil that is subject to flooding for short periods. Most of this soil occurs in shallow depressions within nearly level areas of other soils. Minor areas are on the level benches that surround some of the playas.

This soil is fairly productive. Its subsoil is fine textured and absorbs water very slowly. The soil receives water from surrounding areas, and the subsoil stores large quantities of water. Wind erosion has damaged the soil only slightly, and there has been no water erosion. The soil is well suited to grasses, and small grains can be grown successfully. Managing this soil differently than the surrounding soils, however, is not practical.

After heavy rains this soil is ponded as the result of water draining onto it. Consequently, it is likely to be too wet to plow when the rest of the field is dry enough to work. It will also be too wet to plant or harvest crops. To lessen flooding, conserve and hold the water from rainfall on the surrounding soils so it will not flow onto this soil.

Capability unit IVe-1

The soils in this capability unit are deep and calcareous. They have medium-textured surface layers and subsoils. Slopes are moderate. The following upland soils are in this unit:

Berthoud loam, 3 to 5 percent slopes.
Dalhart-Ulysses loams, 3 to 5 percent slopes.

These soils are moderately productive. They absorb water readily and store moderate quantities of it. They are best suited to grasses, but wheat and grain sorghum grow moderately well.

The surface layer of these soils crusts and blows readily. Chiseling or listing to control wind erosion is not satisfactory, because the clods that are turned up crumble and break down in a few days. If cultivated, the soils are moderately susceptible to water erosion; on the long slopes water erosion may be moderately severe. Many areas of the Berthoud soil are downslope from steeper areas and are particularly susceptible to water erosion.

These soils can be used best if they are reseeded to grasses. If they are cultivated, keep them covered by a growing crop or a heavy stubble to protect them from wind erosion. Plant crops that produce a large amount of residue. The crops should be planted by broadcasting the seed or by planting it in closely spaced rows. Practice stubble mulching if small grains are grown. Leave the sorghum stalks standing in winter and spring. In years when the sorghum has made good growth, cattle can be turned into the fields to graze. They should be removed from the fields as soon as they have stripped the heads and leaves from the sorghum stalks. Do not graze in years when the sorghum has made poor growth.

Use a cropping system that fits moisture conditions, and support it with conservation practices. Fallow 1/3 to 1/2 of the fields. Delay tilling fields that have been left fallow, until after the danger of soil blowing has passed in spring.

Use terraces to conserve moisture and to lessen water erosion. Construct the terraces so that they empty into areas covered by grass or into a vegetated waterway. Farm terraces on the contour. Construct diversion terraces, where needed, to protect the soils from runoff from higher areas. Avoid excessive tillage because it makes the surface soil loose and powdery.

Capability unit IVe-2

Only one soil—Otero fine sandy loam—is in this capability unit. This soil is deep and calcareous. It has a surface layer of sandy loam and a sandy subsoil. The soil is gently sloping to moderately sloping. It occurs on uplands and on high stream terraces.

This soil is moderately fertile. It is well drained and absorbs water readily. The soil is well suited to grasses planted for grazing and for building up the soil. If cultivated, the soil is best suited to sorghum and broomcorn.

This soil is highly susceptible to wind erosion, but it is not likely to be eroded by water. If it is cultivated, fertility declines rapidly. Consequently, the stubble of crops is often weak or short, thus making the problem of protecting the soil from wind erosion more difficult.

This soil should not be cultivated but ought to be reseeded to grasses. Areas that are cultivated need to have a growing crop or a heavy stubble on them at all times to protect them from wind erosion. Delay tillage in spring as long as feasible. Plant only those crops that leave large amounts of residue. To further reduce wind erosion, plant crops approximately at right angles to the direction of prevailing winds. Leave the sorghum stalks standing during winter and spring. An 8-inch stubble from sown crops or a 12-inch stubble from row crops will help to protect the soils from wind erosion.

In years when sorghum has made good growth, cattle can be turned into the fields to graze. They should be removed from the fields as soon as they have eaten the heads and leaves from the sorghum stalks. Do not graze in years when the sorghum has made poor growth.

Use a cropping system that fits moisture conditions, and support it with suitable conservation practices. If moisture conditions are favorable, plant grasses, legumes, or other crops that will help build up the soil. To provide an emergency cover if a crop fails, replant the field to another crop that will germinate at that time of year. Emergency tillage is of little value because the content of clay in the subsoil is so low that clods do not form.

Capability unit IVe-3

Only one soil—Dalhart loamy fine sand, 0 to 3 percent slopes—is in this capability unit. This deep, coarse-textured soil has a moderately fine textured subsoil. The soil is nearly level to gently sloping and is on uplands.

This soil has a sandy surface layer. Water from rainfall soaks in readily, and little is lost through evaporation. The subsoil holds large quantities of water. Locally, this soil is called sandy row-crop land. It is poorly suited to wheat because the sandy surface soil blows easily. It is best suited to permanent grasses, but, if cultivated, it is well suited to sorghum.

This soil is highly susceptible to wind erosion. If a protective cover is not kept on the surface, the sandy surface soil blows easily and is shifted about in the field. As a result, large amounts of organic matter and clay are lost, making a stand of crops difficult to obtain. The soil should be removed from cultivation and reseeded to grasses.

If this soil is cultivated, protect it with a growing crop or a heavy stubble to control wind erosion. Delay tillage in spring as long as feasible. Plant only those crops that produce large amounts of residue. To further reduce wind erosion, plant the crops approximately at right angles to the direction of prevailing winds. Leave the sorghum stalks standing in winter and in spring. An 8-inch stubble from sown crops or a 12-inch stubble from row crops will help to give protection from wind erosion. In years when sorghum has made good growth, cattle can be turned into the fields to graze. They should be removed from the fields as soon as they have eaten the heads and leaves from the sorghum stalks. Do not graze in years when the sorghum has made poor growth.

Use a cropping system that fits moisture conditions, and support it with good conservation practices. If moisture conditions are favorable, plant grass, a legume, or other crops to help build up the soil. If a crop has failed, the field should be planted to another crop that will germinate at that time of year, to provide emergency cover. Use emergency tillage to help control wind erosion, if there is not enough plant cover or crop residue. To be effective, the soil brought to the surface by emergency tillage must contain enough clay to form clods that are resistant to wind. Emergency tillage provides only temporary relief; it is not a substitute for maintaining a protective cover of plants.

Capability unit IVe-4

Only one soil—Mansker clay loam, 0 to 3 percent slopes—is in this capability unit. This soil is shallow and moderately fine textured. It is nearly level to gently sloping and is on uplands.

The soil absorbs water readily. It is best suited to grasses, but, if cultivated, it is best to use it for small grains. Grain sorghum grows moderately well in years when rainfall is above normal.

The surface layer of this soil is ashy. It breaks down, crusts, and blows readily. The risk of wind and water erosion is moderately severe. The soil is droughty and should not be left fallow. Chiseling or listing is not feasible for controlling wind erosion.

This soil should be removed from cultivation and seeded to grasses. If it is cultivated, use a growing crop or a heavy stubble to protect it from wind erosion. If small grains are grown, practice stubble mulching. Leave sorghum stalks standing during winter and spring. In years when sorghum has made good growth, cattle can be turned into the fields to graze. They should be removed from the field as soon as they have stripped the heads and leaves from the stalks. Do not graze in years the sorghum has made poor growth.

Use a cropping system that fits moisture conditions, and support it with suitable conservation practices. Construct terraces on slopes of 2 percent or more, or plant only crops that are sowed or crops that grow in closely spaced rows. Avoid unnecessary tillage because tillage makes the surface soil loose and powdery.

Capability unit Vw-1

Only one soil—Randall clay—is in this capability unit. This deep, level, fine-textured soil is poorly drained. It is on the uplands at the bottom of deep depressions where it is flooded frequently.

This soil is not suited to cultivation but is best suited to grass. Suggestions for managing the soil are discussed in the section, Range Management, under the Hardland range site.

Capability unit Vw-2

Only one mapping unit—Sweetwater soils—is in this capability unit. These deep, fine- to medium-textured soils are poorly drained and are permanently wet. They are nearly level and occur in the lowest part of the flood plains along some of the streams.

These soils have a water table that is within 4 feet of the surface. They are best suited to grasses and are generally used for meadow hay crops. They are not suited to cultivation. Suggestions for management are given under the section, Range Management, under the Subirrigated range site.

Capability unit VIe-1

The soils in this capability unit are deep and sandy and are droughty. They have moderately coarse textured subsoils. In some places there are outcrops of caliche within areas of these soils. The areas are nearly level to steep and are duny. In some places there are a few steep escarpments. The following soils are in this capability unit:

Otero-Vona fine sandy loams.
Vona loamy fine sand, 0 to 3 percent slopes.
Vona loamy fine sand, 3 to 8 percent slopes.
Vona, Otero, and Potter soils.

These soils are too sandy and too droughty to be cultivated without damage. They give fairly high yields of grasses if the ranges are well managed. Suggestions for managing the soils are given in the section, Range Management, under the Deep sand range site, the Limy sandy plains range site, and the Sandy plains range site.

Capability unit VIe-2

The soils in this capability unit are nearly level to steep and are shallow and calcareous. They are moderately fine textured to medium textured. Most of them are within or near the breaks. The following soils are in this unit:

Mansker clay loam, 3 to 5 percent slopes.
Mansker soils, severely eroded.
Mansker-Potter complex.

These soils are too shallow, too likely to erode, or too sloping for cultivation. They are best suited to native grasses and produce fairly high yields.

Suggestions for managing these soils are given in the section, Range Management, under the Hardland range site, the Shallow range site, and the Mixed hardlands and shallow range site.

Capability unit VIs-2

Only one mapping unit—Lincoln soils—is in this capability unit. These soils are deep and sandy and occur on bottom lands.

The soils are too sandy and droughty for cultivation but are fair for range. Suggestions for managing the soils are discussed in the section, Range Management, under the Sandy bottom-land range site.

Capability unit VIIe-1

Only one soil—Tivoli fine sand—is in this capability unit. It is a deep, loose, strongly sloping to very steep, sandy upland soil that occurs as dunes.

This soil is low in fertility. It is too sandy and droughty for cultivation. Suggestions for managing the soil are discussed in the section, Range Management, under the Dune range site.

Capability unit VIIs-1

This capability unit is made up of shallow, moderately fine and medium-textured soils of the uplands. The soils are moderately sloping to very steep. The following soils are in this unit:

Potter soils.
Vernon loams.

These soils are too shallow or too sloping for cultivation and are suited only to native grasses. Yields are fairly low.

Suggestions for management of these soils are discussed in the section, Range Management, under the Shallow range site.

General Management Practices

The use and management of the soils in Texas County hinges on the climate. Low rainfall, strong winds, high temperatures in summer, and low humidity oppose the farmer in his struggle to wrest a living from the soil.

Water is the key to successful agriculture in this semiarid region. Generally, moisture is plentiful enough so that crops can be planted, but in many years there is not enough moisture for crops to mature. Rains are likely to come late in spring—at just the right time for planting sorghum but too late for wheat to mature. In midsummer, dry periods occur and the sorghum wilts and burns. Rains late in summer provide enough moisture for planting wheat but come too late to save the sorghum crop.

Late in winter and early in spring, strong winds rip and tear at the soil. If the soil is not protected by stubble or by a growing crop, it is blown into the air in duststorms or piled up in the fence rows. Much water is lost in summer because the hot winds and low humidity cause a high rate of evaporation.

In some places water can be provided by irrigation. Few farmers, however, have access to an ample supply of water and have enough time and money to irrigate all of their land.

Farmers cannot control the weather, but they can adjust their farming methods to protect the soil from extremes of climate. In this way moisture is kept in the soil so that crops can be produced.

For crops to grow well, moisture must be stored in the soil before the crop is planted. In this county the soil is generally dry at harvesttime. From then until the next harvest, as much moisture as possible needs to be caught and held in the soil. Generally, a deep soil is needed to store enough water in advance to make production of a crop profitable. For crops to make high yields, the deep hardland soils, for example, must be moist at plantingtime to depths between 2 and 4 feet.

In most places in Texas County, the soils require protection from wind erosion. They also require practices to conserve moisture, to maintain fertility, and to control weeds and insect pests. Of primary importance are producing and managing plant residues to help control erosion and to maintain tilth. Generally, a combination of conservation practices is needed. The main practices used are discussed in the following pages. Farmers, ranchers, and landowners who wish help in managing their soils can obtain assistance from the Texas County Soil Conservation District or from the Soil Conservation Service, the Agricultural Experiment Station, or their county agent.

Crop residue use is the practice of utilizing the stubble and other plant residues left in cultivated fields by incorporating them in the soil or leaving them on the surface to protect the soil from erosion (fig. 10). This practice is used in growing both small grains and sorghum.

Figure 10.—**Wheat stubble left on the field to protect the soil from wind and water erosion.**

Using crop residue helps to maintain the organic matter and humus in the soil. It improves the tilth of the surface soil so that the surface soil takes water faster and does not crust so readily. The crop residue also protects the soil from blowing and from the impact of raindrops. In winter it helps to hold much of the snow on the field.

If the crop residue is grazed, enough must be left to protect the soil during the critical erosion period. The amount of residue depends on the kind of soil and on the type of crop.

Stubble mulching is a system of farming in which all the tilling, planting, and harvesting is done in such a way as to keep a protective cover of stubble on the soil the year round. This practice can be used in growing both small grains and sorghum, but it is particularly effective in growing dryland wheat.

Stubble mulching protects the soil from wind erosion and reduces water erosion and sealing of the surface soil caused by the impact of raindrops. It increases the intake rate of water and catches blowing snow. The stubble also provides shade, thereby lowering the temperature of the soil and reducing losses of moisture by evaporation.

Stubble mulching machines (fig. 11) are used to undercut the stubble. They leave the stubble anchored on the surface at seedingtime. To be effective, a stubble mulching machine should (1) be capable of operating at controlled and uniform depths; (2) be equipped with rolling coulters before each shank so that residues and weeds will be cut ahead of the sweeps and clogging prevented; (3) have enough weight and strength to penetrate the soil, to operate under unfavorable soil conditions, and to support strong sweeps that are 30 inches or more in width and spaced to allow 4 to 6 inches of overlap; (4) have at least 18 inches clearance between sweep and beam; and (5) effectively kill weeds and volunteer crops. The blades need to be adjustable so as to cut through the soil on a flat plane at each depth of operation. The machine must use weight to get depth rather than increasing the pitch of the sweeps.

To insure a firm seedbed, it is best to till to the greatest depth, generally 4 to 6 inches, at the time the soil is first cultivated and to till at a lesser depth in each successive operation. In addition, rodweeders and rotary hoes can be used before seeding to firm the seedbed and to help control weeds. Use only as much tillage as is necessary to prepare the seedbed.

If the crop residue remaining on the surface at seedingtime is very heavy, it may be necessary to use a shovel-type drill or other special equipment for planting.

To prevent the stubble-mulching machinery from becoming clogged, use combines that have straw spreaders that do not leave the straw in windrows. Sorghum grown in rows should be combined so that the stubble remaining in the field will be 15 to 18 inches high.

The amount of residue needed to control wind erosion depends on the speed of the wind, on the condition of the soil, on the type of residue, and on the kind of soil. For example, the amount of anchored wheat straw required per acre at seedingtime ranges from 750 pounds on clay loam soils to 1,250 pounds on fine sandy loams. About 100 pounds of straw is produced for each bushel of wheat.

The amount of sorghum residue required per acre to be left on the ground during the winter months and until the end of the blowing season is about 3,500 pounds on loamy fine sands, 2,500 pounds on fine sandy loams, and 1,500 pounds on clay loams. Adequate residue is seldom produced on the sandier soils. Roughening the surface of such soils by tillage is generally necessary in addition to leaving the stubble.

Emergency tillage consists of roughening the surface soil with chisels, shovels, or listers to check wind erosion if there is not enough cover to protect the soil. If needed, this practice can be applied quickly, but it does not provide long-term benefits. It dries the soil out and breaks down its structure.

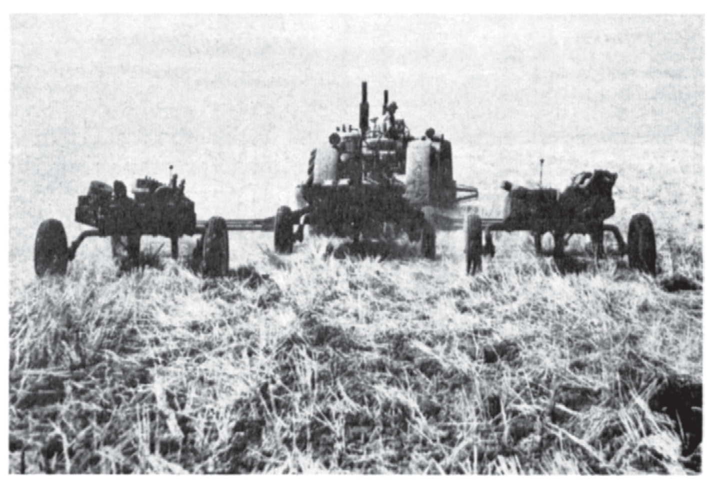

Figure 11.—**A stubble mulching machine with sweeps operating in a heavy wheat stubble on Richfield clay loam; weight has been added to the sweeps to get sufficient penetration in the dry soil.**

Emergency tillage is the most effective in fields where clods of heavy, moist soil can be turned up. Tilling loose, dry soil is likely to cause damage to the soil rather than to help conserve it. Clods formed in very sandy soils and in soils that are high in lime soon break down and crumble.

During the blowing season, chiseling is the first tillage method used to check soil blowing. Then, if another windstorm occurs, listing is used. As a final practice to stop the soil from blowing, the lister ridges are broken up.

The effectiveness of emergency tillage depends on the speed of the equipment used, on the depth of tillage, on the size of the chisel points, and on the spacing between the chisels.

In Texas County the following suggestions will help make emergency tillage effective:

1. Use intermediate speeds of 3 to 4 miles per hour to roughen the surface soil; to temporarily check blowing during a duststorm, higher speeds can be used to get sufficient roughness.
2. Till the soil deep enough to bring clods to the surface; the loose, sandy soils need to be tilled deeper than the compact hardland soils.
3. Spacing between chisels depends on the particular area being worked. Close spacing of 27 to 36 inches is more effective than wide spacing of 44 to 54 inches. However, the wide spacing may permit saving a crop of growing wheat if wind erosion is moderate.
4. The choice of chisel points depends on the texture and compactness of the soil. There is little or no difference in points if they are closely spaced; the narrow chisel is less effective if it is widely spaced. A heavy-duty, narrow chisel works best in heavy, compact soils; in moderately coarse textured soils, a shovel point is better.
5. For sandy soils that have a clayey subsoil, deep list at right angles to the direction of the prevailing winds.
6. Till the entire field, rather than tilling in strips.

Delayed fallow is the practice of leaving the stubble on fallow fields undisturbed until spring and tilling only when weeds begin to use up the moisture in the soil. It is the most effective if combined with stubble mulching. Used in this way, the weeds are destroyed without disturbing the protective cover of stubble.

Delayed fallow is more economical than early tilling of fallow land because less cultivation is required. It has little effect on the yields of crops. Because cultivation can be avoided when the soil is easily compacted, pans caused by tillage are less likely to be formed. The standing stubble also protects the soil from blowing during winter and spring.

In Texas County wheat is generally not successful if it is planted when there is less than 2 feet of moisture in the subsoil. Consequently, it is desirable to use delayed fallow on part of the acreage of a particular farm each year. The acreage can be increased or decreased depending upon moisture conditions in the soil. Start preparation of the soils for planting only if the subsoil contains sufficient moisture. If there is not enough crop residue to protect the soil from blowing, however, try to get a cover of crops growing even though there is not enough moisture for them to mature. To prevent further loss of moisture, keep tillage to a minimum. Delayed fallow is generally not used on deep, sandy soils.

Stripcropping is the practice of planting crops in alternate strips to help reduce erosion by water and wind. Wind stripcropping is the practice of planting erosion-resisting crops in strips alternating with strips of row crops or fallow, generally arranged at right angles to the direction of prevailing winds; contour stripcropping is the practice of planting the crops in a systematic arrangement of strips and bands on the contour.

Wind stripcropping lessens wind erosion by breaking up smooth areas with strips of stubble. The stubble catches snow and keeps most of it from blowing off the field. Wind stripcropping alone is not effective in stopping wind erosion, but it increases the effectiveness of stubble mulching and other conservation practices.

The width of the strips necessary to reduce soil blowing depends upon the texture of the soil. The maximum width of the strips for the various soils should be 20 rods for loams and clay loams; 8 rods for fine sandy loams; and 4 rods for loamy fine sands. The strips of clean-tilled crops and of erosion-resistant crops are the same width and are planted at right angles to the direction of prevailing winds.

Contour stripcropping increases the effectiveness of stubble mulching, terracing, and other conservation practices. The strips should be no more than 20 rods wide on slopes of less than 2 percent and less than 10 rods wide on slopes of more than 3 percent.

Terraces are used to reduce water erosion and to conserve moisture. The types of terraces commonly used are ridge, impounding, and channel.

The ridge and impounding types of terraces are built on slopes of 3 percent or less. Ridge-type terraces are built by moving soil from both the lower side and the upper side to form the terrace ridge. In constructing the impounding type of terrace, all of the soil is moved up the slope from a wide area below the terrace ridge. The terrace ends are blocked to allow maximum conservation of water. Provision is made for draining the impounded water if necessary.

Channel-type terraces are generally used on slopes of more than 3 percent. These terraces are built by moving all the soil downslope to form a channel and a ridge. Their main purpose is control of erosion.

To do the job for which they are built, terraces must have the correct layout, height, cross section, and enclosures or outlets. Terraces that have open ends need to empty onto an area that is protected by grass or other vegetation.

To help the terraces keep their original size and to keep the channels open, plow and plant crops according to the layout of the terraces. Because of irregularity of slopes, the varying widths between terraces, and the type of farming equipment available, different methods are used to maintain terraces. Help in resolving these problems can be obtained from technicians of the Soil Conservation Service or from the county agent.

Diversion terraces are used to protect cultivated fields from the water that runs off adjoining areas; to divert water from active gullies; to increase or decrease the amount of water from runoff that enters a farm pond; to break up the concentration of water on long, nearly level slopes; or to divert water from points of concentration to areas where a system of water-spreading or impounding-type terraces is installed.

A diversion terrace is like a field terrace in shape, but it is much larger. It is designed to handle large flows of water. The slope, the permeability of the soils, the type of cover, and the size of the area to be drained must be considered in designing a terrace. The outlet must be a vegetated area that has a stabilized grade capable of carrying the additional water. Each diversion terrace must be individually designed by a technician to fit the site.

Contour farming is the practice of plowing, planting, and cultivating soils across the slope. It conserves moisture and reduces loss of soil by water erosion.

In this semiarid region conservation of moisture is highly important. The difference between harvesting a crop and having a crop fail can depend on the extra water that is saved. Even in wetter years, the additional moisture makes it easier to get a uniform stand and increases the yields of crops. Also, machinery can be operated more easily and economically than in areas that are not farmed on the contour.

Farm on the contour all terraced areas and, if feasible, all cultivated areas that are not terraced. Contour farming is not applicable to fields in which the rows are generally run the same direction as the direction of prevailing winds.

Estimated Yields

In this section estimated yields are given for the soils that are suitable for dryland farming and for those soils that are suitable for irrigation farming. The estimates are based on information obtained from interviews with local farmers and with agricultural workers and others who have observed yields in the county.

Table 2 gives the estimated average acre yields of crops grown under dryland farming, and table 3 gives the estimated average acre yields of crops grown under irrigation. The estimates show the average yields that can be expected over a number of years. They also indicate the relative productivity of the soils listed.

In determining the average yields given in table 2, a zero was recorded for years when the crop failed or the soil was left fallow. In both tables the yields in columns A are those obtained under management commonly used. Yields in columns B are yields that can be expected under improved management.

Common management includes planting the seed of suitable varieties of crops, using approved methods for seeding and harvesting, and controlling weeds, insects, and plant diseases. Improved management consists, not only of using the methods listed for common management, but, in addition, using practices to conserve moisture and to protect the soil from erosion. Under irrigation, improved management also includes leveling the land, applying irrigation water properly, and rotating crops.

Dryland farming is the principal type of farming practiced in Texas County. Under this type of farming, yields obtained on the same soil vary greatly from year to year, depending upon the amount of moisture received

TABLE 2.—*Estimated average acre yields of principal crops on dryland soils*

[Yields in columns A are those obtained under common management; those in columns B are yields to be expected under improved management. Dashes indicate the crop is seldom grown on the soil indicated or that the soil is not suited to its production]

Soil	Wheat		Grain sorghum		Forage sorghum (dry)		Broomcorn	
	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Lb.*	*Lb.*	*Tons*	*Tons*	*Lb.*	*Lb.*
Bayard fine sandy loam	5	7	500	725	1. 5	2. 0	300	400
Berthoud loam, 1 to 3 percent slopes	5	8	600	800	1. 5	2. 7	375	475
Berthoud loam, 3 to 5 percent slopes	4	8	550	725	1. 2	2. 5	350	450
Bippus clay loam	6	10	----	----	----	----	----	----
Dalhart fine sandy loam, 0 to 1 percent slopes	8	10	1, 000	1, 400	2. 0	3. 5	400	500
Dalhart fine sandy loam, 1 to 3 percent slopes	7	10	850	1, 250	1. 7	3. 0	400	500
Dalhart loamy fine sand, 0 to 3 percent slopes	----	----	675	900	1. 5	2. 5	300	400
Dalhart-Ulysses loams, 0 to 1 percent slopes	8	10	850	1, 125	1. 7	3. 0	400	500
Dalhart-Ulysses loams, 1 to 3 percent slopes	7	9	725	950	1. 5	2. 7	375	500
Dalhart-Ulysses loams, 3 to 5 percent slopes	6	8	500	900	1. 2	2. 5	350	450
Lofton clay loam	8	9	----	----	----	----	----	----
Mansker clay loam, 0 to 3 percent slopes	5	7	550	725	1. 0	1. 5	200	250
Otero fine sandy loam	----	----	500	725	1. 5	2. 0	350	450
Pullman clay loam	6	10	----	----	----	----	----	----
Richfield clay loam	8	12	400	550	----	----	----	----
Richfield loam, thick surface	10	14	725	900	----	----	----	----
Richfield fine sandy loam	9	12	1, 000	1, 450	2. 0	3. 5	400	500
Spur soils	8	12	450	550	1. 5	2. 0	----	----
Ulysses clay loam, 0 to 1 percent slopes	7	10	450	550	----	----	----	----
Ulysses clay loam, 1 to 3 percent slopes	6	9	450	550	----	----	----	----
Woodward loam, 1 to 3 percent slopes	5	9	550	950	1. 2	2. 7	375	500

TABLE 3.—*Estimated average acre yields of principal crops on irrigated soils*

[Yields in columns A are those obtained under common management; those in columns B are yields to be expected under improved management. Dashes indicate the soil is not suitable for the crop indicated]

Soil	Wheat		Grain sorghum		Forage sorghum (ensilage)		Alfalfa	
	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Lb.*	*Lb.*	*Tons*	*Tons*	*Tons*	*Tons*
Dalhart fine sandy loam, 0 to 1 percent slopes	21	40	2, 800	5, 000	10	19	3. 0	5. 0
Dalhart-Ulysses loams, 0 to 1 percent slopes	20	35	2, 800	5, 000	10	19	3. 0	5. 0
Mansker clay loam, 0 to 3 percent slopes	10	18	2, 000	3, 000	7	10	----	----
Pullman clay loam	25	45	3, 300	6, 000	12	22	3. 5	6. 0
Richfield clay loam	25	45	3, 300	6, 000	12	22	3. 5	6. 0
Richfield loam, thick surface	28	50	3, 600	6, 500	14	24	4. 0	7. 0
Richfield fine sandy loam	22	40	2, 800	5, 000	10	19	3. 0	5. 0
Spur soils	25	45	3, 300	6, 000	12	22	3. 5	6. 0
Ulysses clay loam, 0 to 1 percent slopes	20	35	2, 500	4, 500	10	18	3. 0	5. 0

before planting and during the growing season. If seasonal precipitation is above normal and is timely, yields are higher than average. Crops on the moderately sandy and sandy soils produce more consistent yields; and in dry years they produce higher yields than crops on the hardland soils. In wet years, however, crops on the hardland soils produce the higher yields.

Irrigation in this county is used to supplement the natural precipitation received from rain and snow. As a rule, only part of a farm is irrigated and dryland farming is practiced on the rest of the acreage. Many farms do not have an irrigation system. The lack of marketing facilities and the high cost of labor have limited the crops grown under irrigation farming to wheat, grain sorghum, forage sorghum, and alfalfa.

Yields of Wheat and Percentage of Acreage not Harvested in Relation to Moisture [2]

The relationship between the yields of wheat obtained in Texas County and the percentage of the acreage not harvested, in relation to the amount of precipitation is shown in figures 12 and 13. In calculating the average yields, a zero was recorded for the years when crops failed or the field was left fallow.

In figure 12 the relationship between crop-year moisture and yields is shown. Crop-year moisture is the amount of precipitation recorded at Goodwell between July 1 and June 30. The records are for the period 1926–57. The yields indicated represent averages obtained in the county on the number of acres planted.

The correlation between yields and the amount of moisture is high. Variations are mostly related to the time of year when rainfall occurs. If rainfall is favorably distributed, yields are increased. If it is poorly distributed, yields are decreased.

An infestation of greenbugs, brown mites, and wireworms caused the low yields recorded in 1951. In addition, a freeze in May damaged the wheat when it was starting to head. The next year the yield was larger than normally would be expected after a period of low rainfall. This was probably caused by timely distribution of the year's rainfall and by a carryover of moisture from the preceding year.

Figure 13 shows the relationship between crop-year moisture and the percentage of acreage seeded to wheat that was abandoned before harvest.

Irrigation [3]

Nearly all of the water used for irrigation in Texas County is obtained by pumping it from underground sources. The Beaver River and its tributaries, Palo Duro, Hackberry, and Coldwater Creeks, which are all in the eastern part of the county, are all perennial streams. None of these is a dependable source of irrigation water. The other tributaries of the Beaver River flow only intermittently and, therefore, are not dependable as a source of water. Irrigation was practiced to some extent in the early days, but, until pumping of underground water was started, irrigation was not important in farming.

The first irrigation water came from shallow dug wells. These were located along the flood plains of the Beaver River and its tributaries, particularly near Sand Creek, Frisco Creek, and Palo Duro Creek. One of the earliest wells was on the flood plain of Sand Creek. This well, which was 60 feet deep, was dug in 1920 but was not used regularly for irrigation until 1932.

In 1931, a cycle of dry years began. Farmers were forced to draw upon all available water supplies. Many irrigation wells were dug in or near the flood plains of the Beaver River or its tributaries. Meanwhile, farmers on the upland plains were developing deep wells to provide water for irrigation. The earliest of these deep wells was drilled in 1936. Then, in 1937, the Panhandle A. & M. College at Goodwell developed two wells for irrigation. After this, irrigation developed fairly rapidly throughout the county, but especially near Guymon

[2] From material prepared by BILL OTT, assistant professor of agronomy, Panhandle A. & M. College and Oklahoma Agricultural Experiment Station, Goodwell, Okla.

[3] GRANT WOODWARD, civil engineer, Soil Conservation Service, prepared this section.

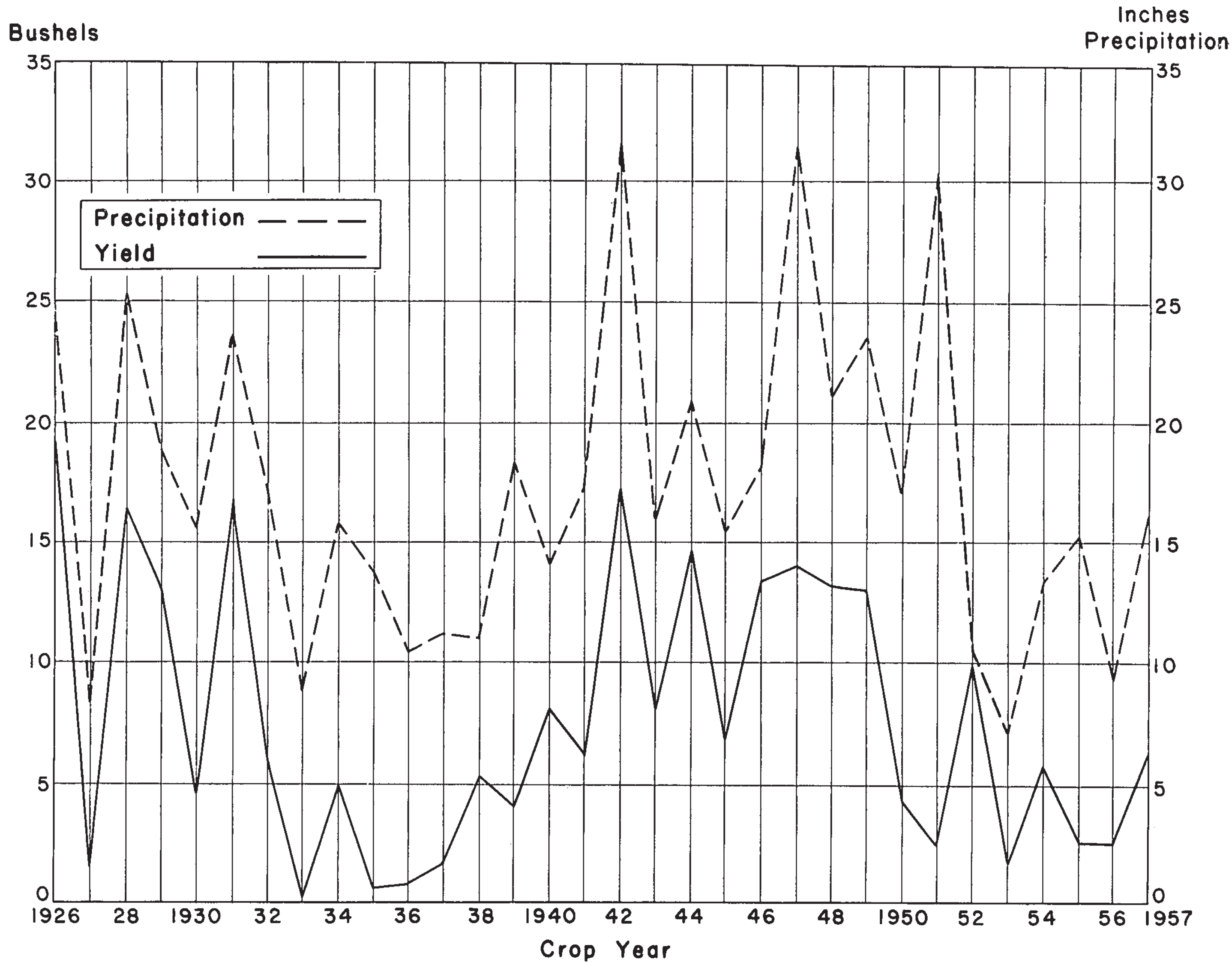

Figure 12.—**The average wheat production for Texas County given in bushels per seeded acre in relation to the crop-year moisture.**

where the aquifer consists of deep, unconsolidated deposits of sand. Underground wells now provide water for irrigation on farms occupying nearly 50,000 acres.

Water supplies

The quality of water available for irrigation ranges from good to poor, but most of the water is of good quality. Generally, water from the Ogallala formation, the major source of irrigation water, is classed as good. Water from the Cloud Chief formation is rated fair to good for irrigation use, even though it contains considerable calcium sulfate. Little irrigation water, however, is obtained from the Cloud Chief formation. Water from alluvium varies greatly in its suitability for irrigation; it should always be analyzed before it is used for that purpose.

Near streams, the underground water is at depths of only a few feet, but, in other places in the county, it is at depths of as much as 250 feet. The approximate depths to the static water level in various parts of Texas County (*4*) are shown in figure 14.

The thickness of the layer of water-bearing material varies considerably. In some parts of the Ogallala formation, the water-bearing sands are only a few feet thick, but in others they are as much as 500 feet thick.

The size of the particles in the water-bearing sands of the Ogallala formation, varies greatly, ranging from fine to moderately coarse. In many places the layers of sand are separated by layers of clay; the material is too variable to make possible an accurate estimate of yield from any given area. Instead, test wells are necessary to determine the possible yield of a well in a specific location. Sand taken from the test well should be analyzed to determine the size and uniformity of gravel needed to pack the well properly so that the formation will furnish the maximum quantity of water for irrigation. The drilled and cased well should always be developed with a

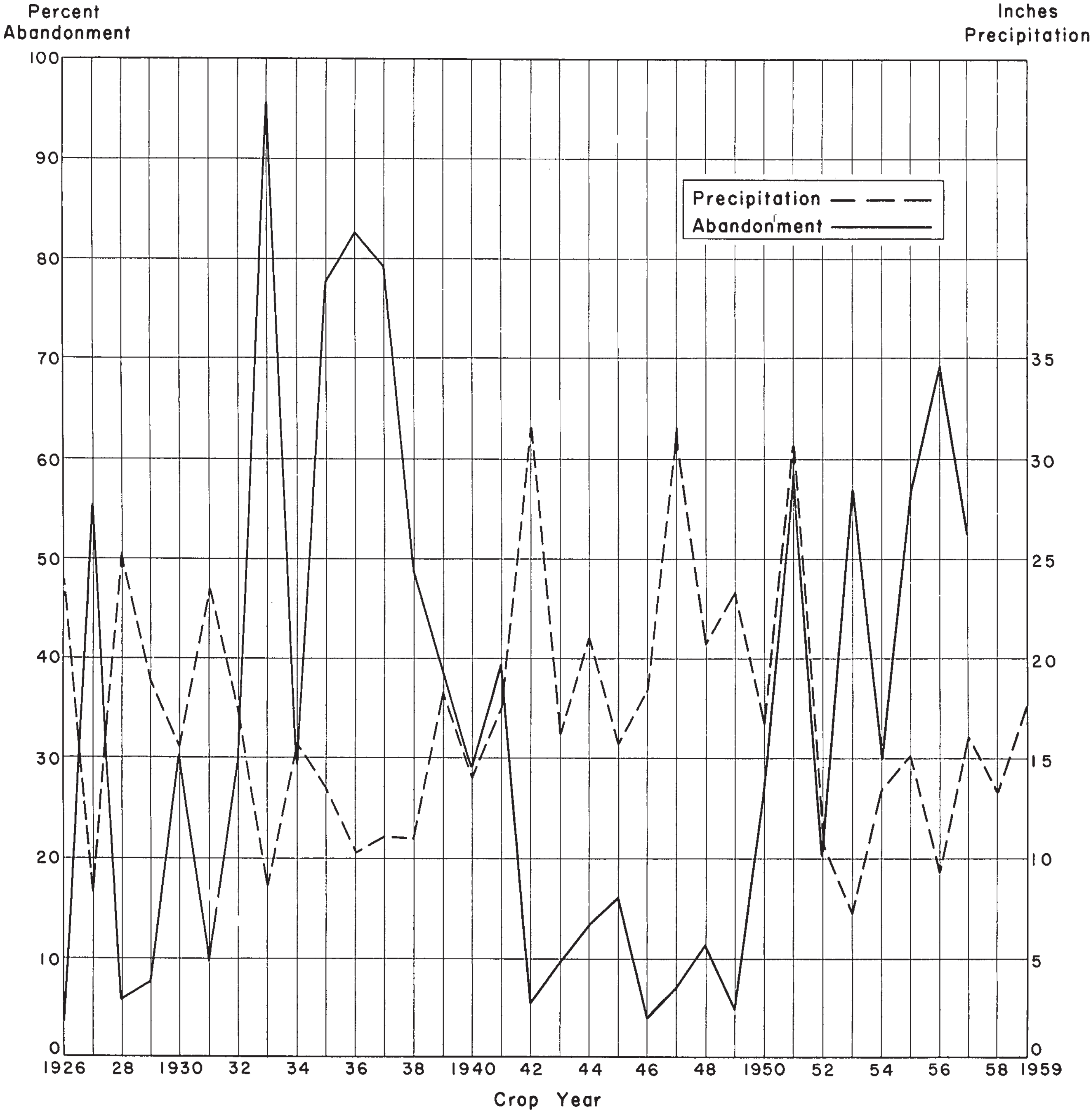

Figure 13.—The percentage of seeded acres of wheat abandoned before harvest in Texas County in relation to crop-year moisture.

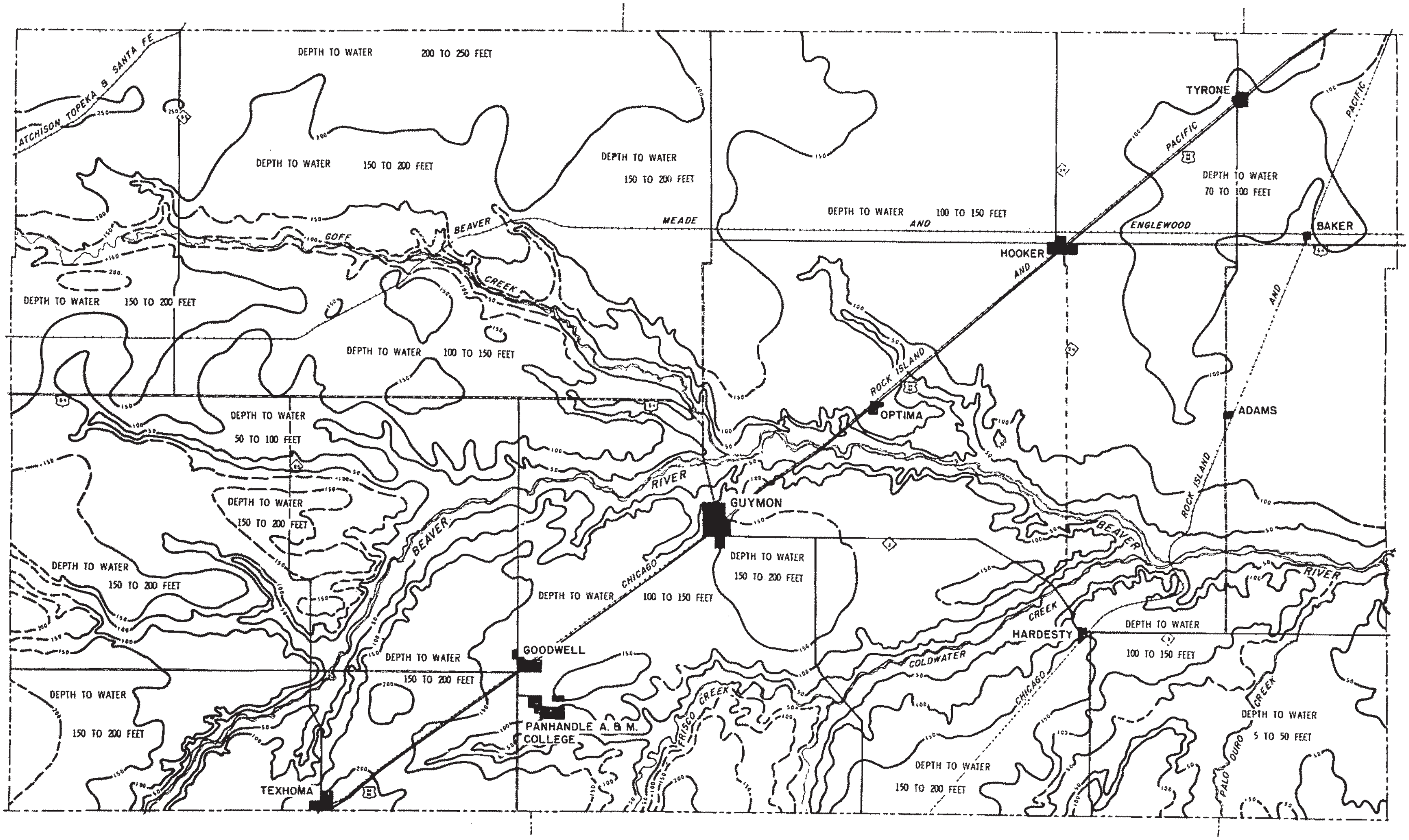

Figure 14.—The approximate depth of the static water level in Texas County; broken line with numeral shows approximately equal depths of the water level below the surface.

test pump to reduce sand wear on the impellers and bearings of the pump that is finally installed.

Planning an irrigation system

Before investing in irrigation equipment, the farmer should learn if the soils on his farm are suitable for irrigation and if he has an adequate supply of water of good quality. Also, he must decide if the crops he wishes to grow can be grown profitably under irrigation. Some soils can be irrigated more profitably than others. Generally, for profitable irrigation, a soil must (1) be productive; (2) absorb large quantities of water and store it so that it is available for plants to use; (3) have comparatively little slope; (4) be permeable enough to control accumulation of harmful salts; (5) have adequate drainage; and (6) have sufficient depth for plant roots to feed.

The soils of Texas County that are suitable for irrigation are the following:

Dalhart fine sandy loam, 0 to 1 percent slopes.
Dalhart-Ulysses loams, 0 to 1 percent slopes.
Mansker clay loam, 0 to 3 percent slopes.
Pullman clay loam.
Richfield clay loam.
Richfield loam, thick surface.
Richfield fine sandy loam.
Spur soils.
Ulysses clay loam, 0 to 1 percent slopes.

Soils that are not listed as suitable for irrigation generally do not produce enough to justify the cost of irrigating them.

The supply of water available for irrigation in this county is generally limited. Experience has shown that spreading the supply of available water over too large an acreage is not economical. Because the water varies in quality, farmers should have it tested before using it for irrigation.

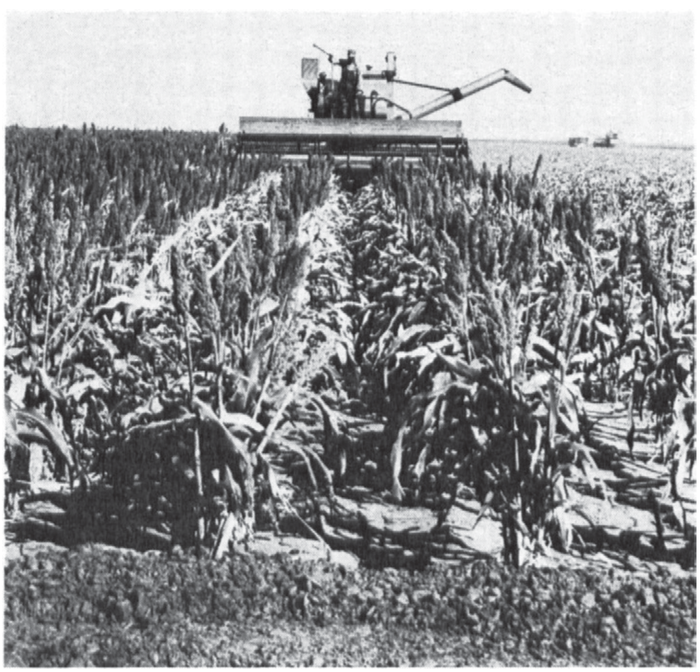

Figure 15.—**Grain sorghum being harvested from an irrigated field; the sorghum grown on this field yielded an average of 4,500 pounds of grain per acre.**

Figure 16.—**Forage sorghum being harvested from an irrigated field; the sorghum grown on this field yielded an average of 23 tons of ensilage per acre.**

In this county grain sorghum and wheat are the chief cash crops grown under irrigation. Alfalfa grows well and improves the soil. As a result, yields of crops that follow alfalfa are increased. Both grain and forage sorghums yield well if adequate moisture and fertilizer are supplied (figs. 15 and 16).

Potatoes, onions, lettuce, and spinach grow well under irrigation. These truck crops would be a good source of income if a satisfactory market were available. Native grasses can be grown profitably for seed under irrigation, especially if the seed is needed by the grower for seeding rangeland.

Irrigation methods

The method the farmer uses to distribute irrigation water is determined by the requirements of the irrigation system used. If the soil is suitable for flood irrigation and the area can be field leveled without excessive cost, the leveling generally should be done before any method of applying water is installed. Field leveling has many advantages, whether water is applied by the border, row, or corrugation method. If the land has been field leveled, the borders can be changed each year to reduce the growth of weeds. Also, farming operations can be performed more easily, for the land can be farmed in larger blocks without farming operations being hindered by the presence of permanent borders or the need to maintain a level area between border ridges. The two general methods of applying irrigation water in Texas County are the flood and furrow methods.

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The flood method of applying water consists of using level or graded parallel borders, contour borders, or contour ditches. These are described as follows:

1. Parallel border irrigation consists of applying water to a nearly level area. The direction of flow is controlled by use of small parallel borders or dikes that divide the field into areas of predetermined size. Except for the more permeable soils that require runs too short for practical farming, parallel border irrigation is suited to most soils. Fairly large streams of water are required in using this method. The water can be applied efficiently and rapidly. Also, the labor requirement is low. The two types of parallel border irrigation are level and graded.

2. Contour border irrigation is a variation of parallel border irrigation. With this system, the borders are constructed along the natural contours of the land instead of being made to run straight or parallel to each other.

3. The contour ditch method, sometimes called "wild" flooding, consists of using a nearly level ditch to carry the water to the field. A sheet of water is then permitted to flow over the field by gravity. Contour ditch flooding is used to irrigate small grains, alfalfa, or clover. It requires little field leveling. The method is suited to small heads of water and is best suited to areas that have considerable slope or irregular hillsides. If a small grain is grown, temporary ditches are constructed to provide irrigation and are filled in before harvest. The contour ditch method is inefficient and should not be used if other methods are feasible.

The furrow method of irrigation consists of applying water in furrows of various sizes and spacing the furrows so as to control the flow of water. The rows, or corrugations, are either level or graded. The spacing of the row is determined by the cropping system used, and the spacing of the furrows, by the permeability of the soil. If the maximum slope of a field exceeds 0.5 foot per 100 feet, borders should generally be installed in conjunction with the row or corrugation system.

The furrow method is suited to nearly all types of soils. On the more permeable soils, however, the length of the rows will be too short for efficient farming operations unless the water can be carried to the rows with a gated surface pipe and the rows then irrigated in segments of effective length.

Farm distribution systems

The system used to convey water should not unduly obstruct farming operations and it should not permit excessive amounts of water to be lost in transit. Underground pipes are rapidly replacing earthen ditches for conveying water. The pipes may be of plastic, concrete, transite, or steel. In this county most underground pipes are made of plastic or concrete. Eliminating surface ditches and installing underground pipes will save water and make the use of farming machinery easier. Installing underground pipes will also eliminate weed and insect infestation along the ditchbanks.

Farmers who first practiced irrigation in this area generally used canvas checks in the ditches and cut the ditchbanks so that water would run from the ditch to the field. Now, permanent structures are replacing the canvas checks. Turnout structures, gated pipes, or siphon tubes are used instead of cutting the ditchbanks.

The mechanical failure of pumping equipment during critical periods can cause serious losses of crops. If the farmer has no adequate source of parts nearby to repair his equipment, he should keep a supply of parts on hand so he can make emergency repairs. Generally, the loss of a crop would far exceed the value of stockpiled repair parts and materials.

Inspecting the system used for delivering water will help detect leaks and prevent losing water. The ditches should be filled with water and checked for cracks or holes in their banks and for possible undermining of any structures. The ditches then should be cleaned and all cracks and holes filled; the structures in ditches ought to be repaired as needed. The pipes in underground systems should be completely filled with water to determine if there is any leakage. If there are any leaks, the pipe should be repaired. If surface pipe systems have sections that are damaged, the pipe ought to be repaired or replaced. Steel pipe should be coated with asphalt as needed.

Land leveling

Land leveling is required in irrigation farming so that irrigation water can be applied uniformly. Rough grading can be used to level the land if the water is applied by the sprinkler method or through contour ditches or contour borders. It can also be used if the farmer wishes to install a temporary irrigation system until more exact leveling can be done or if mounds, knolls, gullies, or depressions make the surface uneven and require smoothing before an irrigation system can be installed. Except for contour ditch or contour border systems, conservation irrigation systems require fairly precise land leveling, which necessitates the use of detailed engineering plans.

After leveling, the soil needs to be improved so that crops will grow. The problems caused in land leveling and suggestions to solve them are discussed as follows:

1. Part of the topsoil, which contains more organic matter and is more fertile than the subsoil, has been removed from the areas where cuts were made. Consequently, a soil-improving crop should be grown the first year, and this crop should be turned under.

2. Cutting and moving the topsoil leave the surface soil slick and break down the structure of the soil. As a result, intake of irrigation water and rainfall is reduced. Chiseling immediately after leveling will help to make the soil porous.

3. Using heavy equipment packs the surface soil and thus reduces the intake of irrigation water and rainfall. Heavy machinery should not be used if the soil is wet.

4. The surface of the soil is left bare. It will seal over if there is a sudden, or flash, rain; then, the intake of water will be very slow. A crop to provide cover should be grown as soon as feasible. Also, barnyard manure or other organic matter should be added if available.

5. Soil that is moved from high areas and deposited in low areas is left loose and pulverized. It will settle later, making the land uneven. After tillage operations have been completed, the cut areas become higher. The unevenness of the areas can be eliminated by planting an

annual crop the first year after leveling and then releveling the field after the crop has been harvested.

Range Management [4]

In Texas County rangeland occupies 431,156 acres, or approximately 33 percent of the total acreage in farms and ranches. Most of this acreage is along the Beaver River and its tributaries. Generally, these rangelands are not suited to cultivation. Because of overgrazing and drought in the 1930's and 1950's, most of the rangelands are now low in productivity.

Approximately 4,000 acres of rangeland is primarily in meadows made up of native grasses. In some places these meadows provide winter grazing for cattle.

There are 60 livestock ranches, averaging about 3,500 acres in size, in the county. The number of cattle carried on rangeland in the county ranges from about 28,000 to 35,000 head. The number of stocker and feeder cattle normally equals the number of cows.

Many operators rely on anticipated yields of grain sorghum or other crops grown for supplemental feed during the current summer period to provide for the requirements of livestock and to make up for a shortage of suitable rangeland. During periods of drought, yields of dryland feed crops are generally low, as well as yields of grass. Therefore, when the current yields of dryland feed crops are low, the range is often overgrazed and the rancher loses money. Storing reserve supplies of silage or other feed will help to prevent serious damage to the range as the result of overgrazing and will aid in protecting the operator from financial loss.

Close grazing of native range removes much of the protective cover, and the surface soil becomes hard. Consequently, water from rainfall cannot penetrate the soil easily. During years of drought, operators generally keep too many cows and calves in proportion to the amount of native grass and other available reserves of feed they have on hand. They are then forced to buy additional feed at excessive cost.

Principles of range management

Improvement of the native vegetation will assure the production of range forage and the conservation of soil, water, and plants. To improve the vegetation, manage grazing to encourage and increase the best native forage plants.

Successive, although overlapping, stages in growth of grass are the growth of leaves, growth of roots, formation of flower stalks, production of seed, regrowth of forage, and storage of food in the roots. Grazing must allow for these natural processes of growth if high yields of forage and gains in weight or in numbers of animals are to be obtained.

Livestock graze selectively, and they seek out the palatable and nutritious plants. If grazing use is not carefully regulated, the better plants are weakened or eliminated. Less desirable plants can then increase. If grazing pressure is continued, even the second-choice plants are thinned out or eliminated and undesirable weeds or invaders take their places.

The experience of stockmen and studies by research workers have shown that if only about half of the yearly volume of grass produced is grazed, damage to the more desirable plants is minimized and the range can improve up to its maximum production. The forage left on the ground serves as a mulch that encourages rapid intake of water; the more water stored in the soil, the better the growth of grass for grazing. Roots grow so they can reach the deep moisture in the soil; overgrazed grass cannot reach deep moisture because not enough green shoots are left to provide the food needed for good root growth. A good growth of grass protects the soil from wind and water erosion; grass is one of the best kinds of cover for preventing erosion. If grasses are vigorous, the better grasses can crowd out weeds, which means that ranges low in productivity will improve. Plants that have plenty of tops are able to store food for quick and vigorous growth after droughts and in spring. Plenty of grass also provides a reserve of feed for the dry spells that otherwise might force the sale of livestock at a loss.

Range sites and condition classes

To make use of the best practices and improve his grassland, the range operator needs to know the range plants and the combinations in which they grow. He should be able to read the signs that show him whether his range is getting better or worse.

Important changes in the kinds of grasses often take place gradually, and they can be overlooked by an operator who is not acquainted with his range plants and soils. Sometimes the extra plant growth resulting from favorable rainfall leads to a conclusion that the range is improving, when actually the longtime trend is toward poorer grasses and lower production. On the other hand, temporary close grazing that gives areas the appearance of degraded range may provide only a temporary setback to healthy grass in the care of a capable manager.

Different kinds and amounts of grass are produced on different kinds of soils. To manage the range properly, an operator should know the different kinds of soil in his holdings and the plants each kind is capable of growing. He is then able to manage the range to favor the best forage plants on each kind of soil.

Range sites are kinds of rangeland that differ from each other in their ability to produce a significantly different kind or amount of climax, or original, vegetation. A significant difference means one large enough to require different grazing use or management.

Climax vegetation is the combination of plants that grew originally on a given site. The most productive combination of forage plants on rangelands is generally the climax type of vegetation.

Range condition is the present state of the vegetation in relation to the climax conditions for the site. Four condition classes are defined. A range in excellent condition has present from 76 to 100 percent of the vegetation that is characteristic of the climax vegetation on the same site; one in good condition, 51 to 75 percent; one in fair condition, 26 to 50 percent; and one in poor condition, less than 26 percent.

Ranchers want a range to be in excellent or good condition because such a range yields the most and has the most cover for soil and water conservation. Knowledge of the

[4] ERNEST C. SNOOK, range conservationist, Soil Conservation Service, prepared this section.

range site and range-condition class helps a rancher tell how good his range is and how much better it can become under correct use. An inventory of range site and condition gives the operator an evaluation of his range and helps him determine what can be done to maintain or improve it.

Descriptions of range sites

The soils of Texas County have been grouped into the range sites described in the following pages. The description of each range site gives the important soil characteristics, principal grasses, and other information about how to use and manage the vegetation.

SUBIRRIGATED

This site is made up of areas on the lowlands along the Beaver River and along Coldwater and Palo Duro Creeks. The soils have a substratum of clay or sandy clay that keeps the water table high and within reach of deep-rooted range plants. Only one mapping unit—Sweetwater soils—is in this site.

If this range site is in excellent condition, the dominant grasses are generally switchgrass, eastern gamagrass, and Canada wildrye. The understory is made up of alkali sacaton and inland saltgrass. This range site is not extensive, but it is the most productive one per acre in the county.

LOAMY BOTTOM LAND

This site is made up of loamy soils that are along the principal rivers and creeks. The areas are flooded occasionally or receive runoff from higher areas. The soils in this site are:

Bayard fine sandy loam.
Spur soils.

The grasses that grow on these areas are switchgrass, western wheatgrass, vine-mesquite, and little bluestem. If the range on this site is overgrazed, short grasses will encroach.

SANDY BOTTOM LAND

This site is on bottom lands along the principal streams in the county. The areas are flooded frequently, and sediments are deposited by the floodwaters. Only one mapping unit—Lincoln soils—is in this site.

In some areas the water table is within reach of deep-rooted grasses. Normally, this site will support growth of switchgrass, sand bluestem, little bluestem, and other tall grasses. If mid or short grasses increase, it is a sign that the range is being overgrazed.

DEEP SAND

This site consists of deep, sandy soils. The soils are on gently rolling to low dunes on uplands along Goff Creek and the Beaver River and in the northeastern part of the county. The soils in this site are:

Dalhart loamy fine sand, 0 to 3 percent slopes.
Vona loamy fine sand, 0 to 3 percent slopes.
Vona loamy fine sand, 3 to 8 percent slopes.

These soils are low in water-holding capacity. Because they take water rapidly, there is little runoff, and they give up water readily to plants. As a result, tall grasses and woody plants grow on these soils.

This site fluctuates more in production than any other site in the county. Therefore, the operator finds it difficult to keep a basic herd of cows and calves year after year.

In its best condition this site supports a cover of sand bluestem, little bluestem, and switchgrass. If it is overgrazed, sand sagebrush, yucca, sand dropseed, and annual plants encroach. The production of grass will then be reduced to almost nothing. Signs of heavy use are indicated by trails between the clumps of sagebrush broken open by cattle searching for grass. Using herbicides to control brush and deferring and controlling grazing will help to increase the amount of forage.

SANDY PLAINS

This site consists of deep, moderately sandy soils that are on hummocky to gently rolling uplands. The soils in this site are:

Dalhart fine sandy loam, 0 to 1 percent slopes.
Dalhart fine sandy loam, 1 to 3 percent slopes.
Otero-Vona fine sandy loams.
Richfield fine sandy loam.

The soils in this site are largely in cultivation. The deep, sandy soils encourage the growth of mid and tall grasses. This site is in excellent condition if sand bluestem and little bluestem make up much of the vegetation. Blue grama and sand dropseed commonly increase if the taller grasses are reduced by heavy grazing.

LIMY SANDY PLAINS

This mixture of sites is made up of soils that vary in depth and in texture and slope. The areas are along the Beaver River, along Goff and Frisco Creeks, and in the southeastern part of the county. The soils consist of sands of varying thickness that generally overlie caliche. The soils in this site are:

Otero fine sandy loam.
Vona, Otero, and Potter soils.

These soils are porous and can support a cover of mid and tall grasses. The cover, however, is not uniform because in places the soils are shallow and rocks outcrop. When the site is in the best condition, 60 percent of the grasses consist of sand bluestem, little bluestem, and side-oats grama. Sand sagebrush is generally present; under poor management it increases rapidly on the sandier areas.

DUNE

This site is made up of dunes of loose, coarse sand. The areas are mainly along the Beaver River in the eastern half of the county. Only one soil—Tivoli fine sand—is in this site.

Even under the best management, these duny areas are difficult to stabilize. Productivity is low, and grazing should be kept to a minimum. This helps to maintain the range in best condition and keeps enough cover on the site to check development of active dunes. If the range is in poor or fair condition, it may be necessary to keep cattle out entirely until the grasses can recover. An increase in density of big sandreed, little bluestem, and sand bluestem indicates that the condition of this site is improving.

HARDLAND

The soils in this site are nearly level to gently sloping. They are on uplands throughout the county. The soils in this site are:

Berthoud loam, 1 to 3 percent slopes.
Berthoud loam, 3 to 5 percent slopes.
Bippus clay loam.
Dalhart-Ulysses loams, 0 to 1 percent slopes.
Dalhart-Ulysses loams, 1 to 3 percent slopes.
Dalhart-Ulysses loams, 3 to 5 percent slopes.
Lofton clay loam.
Mansker clay loam, 0 to 3 percent slopes.
Mansker clay loam, 3 to 5 percent slopes.
Pullman clay loam.
Randall clay.
Richfield clay loam.
Richfield loam, thick surface.
Ulysses clay loam, 0 to 1 percent slopes.
Ulysses clay loam, 1 to 3 percent slopes.
Woodward loam, 1 to 3 percent slopes.

These soils are droughty. They absorb water fairly slowly, and much of the moisture taken in is not readily available to plants. Normally, the site supports short grasses that grow on the High Plains, mainly blue grama and buffalograss. Vine-mesquite, western wheatgrass, side-oats grama, and other tall grasses grow principally in drainageways and other areas that receive extra moisture.

If this site is overgrazed for long periods, blue grama and the taller grasses decrease and buffalograss, less desirable grasses, and weeds increase. Improvement in the condition of the range is indicated by a bunchy, vigorous stand of blue grama and taller grasses growing in areas that receive extra moisture.

SHALLOW

This site consists of shallow, gently sloping to steeply rolling soils. The areas are mainly in the southern half of the county in or near the breaks (fig. 17). Generally, the soils have a shallow, loamy surface layer with caliche exposed or close to the surface. The soils in this site are:

Mansker soils, severely eroded.
Potter soils.
Vernon loams.

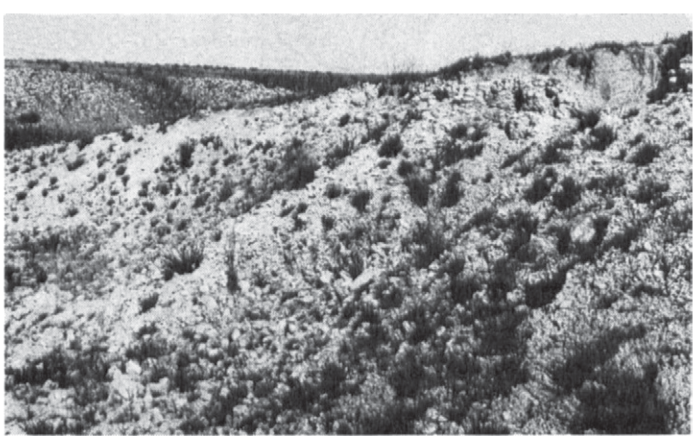

***Figure 17.*—Shallow range site occupied by Potter soils, showing the topography and typical vegetation.**

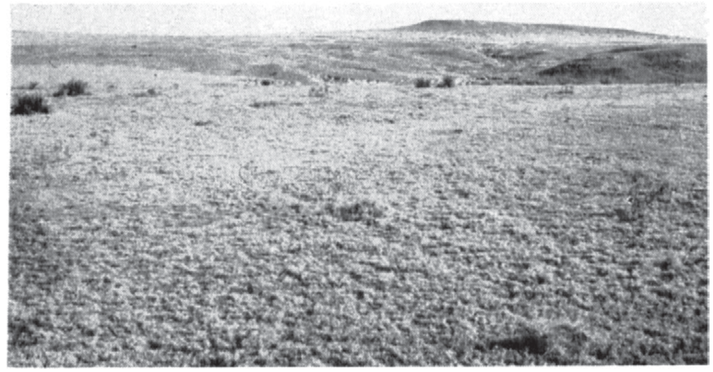

***Figure 18.*—Mixed hardlands and shallow range site showing the pattern of soils and type of topography.**

Because these soils are shallow, penetration of plant roots is restricted in much of the acreage. The stand of native vegetation is open, and many areas are bare. Deep cracks and pockets of soil collect moisture from bare areas and permit growth of such moderately tall grasses as little bluestem and side-oats grama. Hairy grama and hairy tridens grow on some of the shallower areas; they tend to increase in places where the soil is deeper as bluestem and side-oats grama decrease under overgrazing.

MIXED HARDLANDS AND SHALLOW

This site is made up of Hardland and Shallow sites that are intermixed in varying proportions; caliche outcrops in many places. The areas occur mainly along the Beaver River and its tributaries. Figure 18 shows the pattern of soils and type of topography. Only one mapping unit—Mansker-Potter complex—is in this site.

If this site is in best condition, the grasses will consist of 60 percent or more of side-oats grama and blue grama. An increase in buffalograss and three-awn grasses is a sign of overgrazing on this mixture of sites.

Practices for rangeland

Practices applicable on Texas County rangelands are proper grazing use, stocking rate for proper grazing use, range seeding, deferred grazing, and control of brush and weeds.

Proper grazing use.—Proper grazing is the most important of all range practices. Without this practice, all other practices are doomed to failure (fig. 19).

The green leaves of plants convert air, water, and nutrients into plant materials by using the energy of the sun. The food thus formed is stored within the plant tissues as starch, sugar, protein, fat, and other organic products. Because the manufacture of food takes place in the leaves, grazing or mowing needs to be limited. No more than approximately one-half of the total year's growth should be removed if the plants are to continue to thrive.

Plants that are grazed heavily are weakened because they cannot produce and store starch and other foods. Plants that are grazed least tend to grow the best because more light, water, and nutrients go to the plants that have the most leaf surface. Thus, without sound grazing management, the least palatable plants and

***Figure 19.*—Fence line marks contrast between pasture that has been overgrazed on the left and pasture that has been grazed intermittently on the right. Blue grama, buffalograss, and other short grasses are dominant on the pasture that has been overgrazed. Side-oats grama is dominant where only intermittent grazing has been allowed.**

those that best escape grazing through low or matted growth are the plants that tend to survive.

Salting is necessary to obtain proper grazing use in many pastures. Move the location of the salt from time to time to improve grazing distribution.

To avoid uneven grazing, provide watering places over the entire pasture so that the livestock will not have far to walk. The number of watering places needed varies somewhat because of differences in the range sites. Generally, on smooth, open range, such as that in the Hardland and Shallow range sites, windmills or ponds can be satisfactorily located so that livestock will not have to travel more than 1 to 1½ miles to water. On range, where the movement of livestock is impeded by areas of broken topography or by areas of sandy soils, the watering places need to be spaced more closely.

Stocking rate for other grazing use.—No specific guide for safe stocking rates can be given. The operator's pastures are likely to contain different range sites, and one part of any site may differ from another in range condition. Local agricultural agencies have qualified technical people who can help classify the range sites and condition classes in each pasture. If the rancher wishes, these people can offer suggestions on range seeding and control of brush, and help with other conservation needs.

The operator who becomes familiar with his range sites and knows the signs of improving and declining ranges can use judgment in managing his rangeland. A proverb says that the eye of the feeder fattens his cattle. To a considerable degree, the eye of the good grassland manager can improve his native pastures. A good general rule is to not remove more than half the desirable range forage.

Range seeding.—Revegetation of soils not suited to cultivation is one of the most important conservation jobs to be done in Texas County. Natural revegetation of fields that formerly were cultivated takes place very slowly. Sometimes, 40 years or more of good management has been required to obtain natural establishment of a good stand of desirable grasses. A satisfactory stand of grass can be obtained, however, in as little as 5 years by seeding the fields if there is enough moisture in the soil. To reseed a field, the operator needs to select kinds of grasses best suited to the particular range sites that compose it.

Hardlands should be seeded to a mixture that consists principally of blue grama, side-oats grama, and buffalograss. Western wheatgrass and vine-mesquite also do well in areas that receive extra moisture from runoff. Sandy sites should be seeded to a mixture made up largely of little bluestem, side-oats grama, sand bluestem, switchgrass, and blue grama. Deep sands should be seeded to a mixture of taller grasses, such as sand bluestem, switchgrass, Indian grass, little bluestem, sand lovegrass, and Canada wildrye.

It is best to leave the fence around a seeded field until the seeded area and the adjacent native range have similar plant cover. There is a tendency for cattle to concentrate grazing on the reseeded area at least for several years after a new stand is established, and better control can be maintained during that period if the field is fenced.

Deferred grazing.—It has been said that extra grass is like money in the bank. Summer rest is a good way to hasten recovery of a seriously depleted range. If grazing of a pasture is to be deferred for the entire summer, the operator must consider the effect that the extra stock will have on his other pastures. The operator is fortunate who always has a deferred pasture in reserve and keeps all his other pastures moderately stocked. Temporary pastures and feed crops will help permit summer deferment.

Control of brush and weeds.—A rancher can expect a steady shift to good range plants if he carries on a conservation grazing program on weedy pastures. As a rule, the best method of control for undesirable plants in rangeland is to allow the natural succession of native plants to crowd out the weeds. Unpalatable weeds have some value in conditioning the trampled and packed soil of a range that has been grazed too closely. They furnish protective litter for the surface of the soil and provide food and cover for wildlife. Because their presence indicates a need for better cover on the land, it is often not advisable to mow or spray them.

On ranges that have a cover of sand sage, skunkbrush, and other woody plants, the rancher can profitably assist nature in controlling these undesirable plants. Control of brush is necessary to obtain a big improvement in grass cover within a reasonable length of time. Natural succession operates slowly after brush has invaded because the woody plants have deep roots and live a long time. It is generally not safe, however, to destroy a woody plant cover on steep, choppy sand dunes. Here, any kind of cover is of great benefit to prevent active blowing of the sand.

Rest for a full growing season is needed after brush is killed. Depleted stands of grass must be allowed to develop a vigorous growth and produce seed if the pasture is to improve. Moderate grazing in the winter following deferment is ordinarily desirable because the livestock will help distribute seed and mulch, and removal of part of a dormant grass does not weaken the stand.

Estimated yields of forage

Production of forage in Texas County varies greatly because of the variable climate. As a result, the operator needs to maintain good reserves of feed. This can be done by deferring grazing, grazing pastures lightly, or by storing hay and silage.

Table 4 gives estimated yields of forage on four range sites when in good to excellent condition. The estimates represent both favorable and unfavorable climatic cycles and do not represent extremes of either cycle.

TABLE 4.—*Estimated average acre yields of forage on four range sites representative of both favorable and unfavorable climatic cycles*

Range site	Yields in years of [1]—	
	Favorable climate	Unfavorable climate
	Lbs.	*Lbs.*
Hardland	2, 000	800
Shallow	1, 600	900
Sandy plains	2, 300	1, 000
Deep sand	2, 600	1, 200

[1] Total yield of forage based on air-dry weight.

Woodland and Windbreaks [5]

Except along the Beaver River and in places along five or six creeks that drain northward into it, in the southern part of the county, few trees are native to Texas County. The trees are chiefly cottonwood, willow, elm, and hackberry. They do not furnish enough wood products to be economically important, but they have value in providing protection for livestock and wildlife. Numerous plantings of these trees have been made on bottom lands, at headquarters of ranches, and at places where livestock concentrate.

Except under irrigation, planting windbreaks around fields is not economically feasible. The average annual rainfall is only 17 or 18 inches, and much of the moisture evaporates. Therefore, the distance between tree rows and between the trees within the rows must be wide. Planting enough trees to provide a protective barrier causes a real sacrifice of cropland. Furthermore, the trees grow only to a moderate height and give limited protection to the field.

Planting trees to protect farmsteads and livestock is feasible on many soils. On upland soils a spacing of 10 feet is necessary between trees in a row, and the interval between the rows should be at least 20 feet. Here, the limited area that requires protection does not require extensive planting of trees. Even if the trees are widely spaced, the amount of land used is not great. Also, the width of spacing and the amount of land needed can often be reduced by diverting runoff water to the site or by irrigating from wells during critical dry periods.

[5] HERBERT R. WELLS, specialist in woodland and biology, Soil Conservation Service, prepared this section and the following section, Wildlife.

Soils that are suitable for farmstead windbreaks have good soil-water-plant relationships and occur in favorable positions. The following soils are suitable for windbreaks on farms; the Sweetwater soils can also be used for planting trees for fenceposts.

Bayard fine sandy loam.
Berthoud loam, 1 to 3 percent slopes.
Dalhart fine sandy loam, 0 to 1 percent slopes.
Dalhart fine sandy loam, 1 to 3 percent slopes.
Dalhart loamy fine sand, 0 to 3 percent slopes.
Dalhart-Ulysses loams, 0 to 1 percent slopes.
Dalhart-Ulysses loams, 1 to 3 percent slopes.
Otero fine sandy loam.
Otero-Vona fine sandy loams.
Richfield fine sandy loam.
Spur soils.
Sweetwater soils.
Vona loamy fine sand, 0 to 3 percent slopes.
Vona, Otero, and Potter soils.
Woodward loam, 1 to 3 percent slopes.

Some soils are suitable for farmstead windbreaks but are limited by position or texture. Others have horizons that restrict the penetration of roots. As a result, extra water and tillage are required and the spacing between the trees must be very wide. With limitations, the following soils are suitable for farm windbreaks; within the group, the Lincoln soils are suitable if the water table is at depths of 4 to 10 feet.

Berthoud loam, 3 to 5 percent slopes.
Bippus clay loam.
Dalhart-Ulysses loams, 3 to 5 percent slopes.
Lincoln soils.
Mansker clay loam, 0 to 3 percent slopes.
Mansker clay loam, 3 to 5 percent slopes.
Pullman clay loam.
Richfield clay loam.
Richfield loam, thick surface.
Ulysses clay loam, 0 to 1 percent slopes.
Ulysses clay loam, 1 to 3 percent slopes.

The following soils are not suitable for farmstead windbreaks:

Lofton clay loam.
Mansker soils, severely eroded.
Mansker-Potter complex.
Potter soils.
Randall clay.
Tivoli fine sand.
Vernon loams.
Vona loamy fine sand, 3 to 8 percent slopes.

The coniferous trees that have proved most suitable for use in windbreaks are Rocky Mountain juniper, eastern redcedar, ponderosa pine, and Austrian pine. Among the broadleaf species most suitable are Chinese elm (*Ulmus parvifolia*), Siberian elm (*U. pumila*), Russian mulberry, and Chinese pistache. Desertwillow or tamarix can be planted successfully as supporting shrubs. Lilac, privet, honeysuckle, and other ornamental shrubs thrive but require extra care. Windbreaks require cultivation so long as competitive growth of weeds persists.

Wildlife

Approximately two-thirds of Texas County consists of nearly level upland plains. The soils are used for a type of agriculture that provides little cover for wildlife other than that provided by the crops grown and their residue. The areas that are in cultivation originally had a cover of short grasses. When they were put into cultivation, antelope that were once abundant disappeared and the number of scaled quail was greatly reduced. Because the crops consist mainly of grain, however, the number of wildfowl stopping in the county during migration periods has increased. In addition, pheasants have been successfully introduced in the county.

Large areas in the uplands have no drainage. Playas are numerous; in years of favorable rainfall, they retain water and become lakes. Many wildfowl congregate in these areas, particularly where the soil is sandy and grain crops are grown. Pheasants are well distributed throughout the county. They are especially numerous along the eroded breaks and along the occasional stream courses that run through cultivated areas.

About 35,000 acres, made up of sandy soils and sandhill areas, would have a high potential for bobwhite quail if the climate were humid. The number of bobwhite quail is small, however, and climatic factors cause wide fluctuations in the population from year to year. A small, but stable, population is maintained in places along the more permanent stream courses where vegetation is good. Although they were once abundant, coveys of scaled quail are now scarce, but they are found in a variety of places. Their numbers could possibly be increased in the sandy areas and along the breaks if the habitats were improved. Restocking is not promising under present conditions, and recurring periods of scarcity would still occur.

If the habitat is favorable, doves nest in the county. They are also numerous during migration. In early times the lesser prairie chicken inhabited a few places along the Beaver River where conditions were favorable for it.

There is no big game hunting. Only two or three small bands of antelope are now in the county. Most kinds of furbearers and predators common to the plains are in this county, but the coyote is the only one that is prominent. Coyotes furnish the bulk of the fur that is marketed in the county, although a lively trade is carried on in jackrabbit skins in years of peak or near-peak population. The New Mexico cottontail is abundant in some places.

There are no permanent lakes in the county, and fish do not thrive in the intermittent and shallow streams. Farm ponds provide some fishing. The fish are mainly bass, bluegill, and catfish.

Engineering Properties of the Soils [6]

This soil survey report for Texas County, Okla., contains information that can be used by engineers to—

1. Make soil and land use studies that will aid in selecting and developing industrial, business, residential, and recreational sites.
2. Make preliminary estimates of runoff and erosion for use in designing drainage structures, in planning dams, and in planning other structures for water and soil conservation.
3. Make preliminary evaluations of soil and ground conditions that will aid in selecting locations for highways and airports and in planning more detailed investigations of the selected locations.
4. Locate probable sources of gravel, sand, and caliche for use in construction.
5. Correlate performance of engineering structures with soil mapping units and thus develop information that will be useful in designing and maintaining the structures.
6. Determine the suitability of soils identified by mapping units for cross-country movements of vehicles and construction equipment.
7. Supplement information obtained from other published maps, reports, and aerial photographs for the purpose of making soil maps and reports that can be used readily by engineers.
8. Develop other preliminary estimates pertinent to the particular area for construction purposes.

The mapping and descriptive reports are somewhat generalized and should be used only in planning more detailed field surveys to determine the in-place condition of the soil at the site of the proposed engineering construction.

Some of the terms used by the agricultural soil scientist may be unfamiliar to the engineer, and others—for example, soil, clay, silt, sand, aggregate, and granular structure—may have special meanings in soil science. These and other special terms used in soil survey reports are defined in the Glossary at the back of the report.

Engineering classification systems

The United States Department of Agriculture system of soil classification, used by agricultural scientists, is based on the texture of the soil (*7*). In some ways this system of classifying soils is comparable to the two systems used by engineers for classifying soils. The systems used by engineers are explained briefly as follows:

The American Association of State Highway Officials has developed a classification based on the field performance of soils (*1*). In this system, the groups range from A-1 (gravelly soils having high bearing capacity) to A-7 (clayey soils having low strength when wet). Most highway engineers classify soils in accordance with the AASHO system. The soils of Texas County have been classified under this system in table 5.

The Unified system of soil classification was established by the United States Army, Corps of Engineers (*5*). It is based on the identification of soils according to their texture and plasticity and on their performance as engineering construction materials. In the Unified system, the soil materials are identified as coarse grained (8 classes), fine grained (6 classes), or highly organic. Under the Unified system, the symbols GW, GP, GM, GC, SW, SP, SM, and SC are used to identify coarse-grained soils; symbols ML, CL, OL, MH, CH, and OH, fine-grained soils; and Pt, highly organic soils (see table 5).

The symbols GW, GP, and GM are used to identify gravels and gravel-sand mixtures, but because they were not applicable to the soils of this county, the symbols GP and GM have not been used, nor has GC (clayey

[6] R. L. BARTHOLIC, agricultural engineer, Soil Conservation Service, assisted in the preparation of this section.

gravel and gravel-sand-clay mixtures). Of the coarse-grained soils, the symbol SW, which is used to identify well-graded sands and gravelly sands with little or no fines, is not applicable to the soils of this county. The symbol SP is used to identify poorly graded sands and gravelly sands with little or no fines; SM is used to identify sands and sand-silt mixtures; and SC, to identify clayey sands and sand-clay mixtures.

For the fine-grained soils, the symbols ML and CL are used to identify silts and clays that have a low liquid limit, and MH and CH, to identify silts and clays that have a high liquid limit. The symbol ML, not applicable to soils of this county, stands for inorganic silts and very fine sands, rock flour, silty or clayey fine sands, and clayey silts of slight plasticity; CL, for inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, and lean clays; MH, for inorganic silts, micaceous or diatomaceous fine sandy or silty soils and elastic silts; and CH, to identify inorganic clays having high plasticity, and fat clays. The symbols OL and OH are not applicable to the soils of this county, nor is the symbol Pt (highly organic soils).

Engineering interpretations of the soils

The properties of the soils that affect their use for engineering are summarized in tables 5 and 6.

Table 5 gives a brief description of the soils, their site, and a typical profile for each site grouping. (See the section, Descriptions of the Soils, for more detailed descriptions of the mapping units). Also given are estimates of the Unified classification of the material and the classification used by the American Association of State Highway Officials. In addition, the grain size, permeability, structure, available moisture, reaction, dispersion, and shrink-swell potential are estimated.

In table 5 the column, Available moisture, gives the estimated number of inches of water available to plants in each foot of soil. The column titled, Permeability, indicates the rate at which moisture moves downward in the soil; the rate is expressed in inches per hour. The estimates in these two columns—Available moisture, and Permeability—are particularly significant in irrigation.

The ratings in the column, Dispersion, indicate the extent to which soil structure breaks down when water is applied. An easily dispersed soil seals over and resists penetration of water, roots, and air, and it is readily eroded by wind or water. The ratings in the column, Shrink-swell potential, indicate the volume change, that is, the shrinking of the soil when it dries and swelling of the soil as it takes up moisture. In general, soils classed as CH or A–7 have high or very high shrink-swell potentials and soils classed as SP or SM have low shrink-swell potentials. Soils having a high shrink-swell potential, Pullman clay loam or Randall clay, for example, are not suitable sites for building concrete structures.

Table 6 describes the suitability of the soils as a source of topping material, of sand, or of fill material. It also indicates the suitability of each soil as a site for ponds and its suitability for drainage, for irrigation, or for terraces or diversions. The data in this table are interpretations based on estimated data in table 5, on other available test data in a bulletin published by the Portland Cement Association (*3*), and on field experience and performance. For additional information about the soils, see the sections, Descriptions of the Soils, and Analyses of Soils.

Engineering needs by soil areas

The soil associations described earlier in the report are useful in making general interpretations for engineering. The associations are shown on the generalized soil map at the back of the report.

Association 1 contains chiefly deep, nearly level, hardland soils of the Richfield and Ulysses series. The slopes are long, and there is considerable sheet erosion caused by runoff from higher lying areas.

Constructing diversion terraces with open ends will help to control runoff. These should be of the channel type and run level. Impounding-type terraces that have partial blocks to increase the insoak of water can be used on these soils. If this kind of terrace is used, the channels need to be constructed so they can be drained by cutting the partial blocks, except where fills have been made. In places where it is not desirable to use terraces, diversion terraces with open ends can be used to break long slopes.

The soils in this association are well suited to irrigation. They are easily leveled, and the irrigation reservoirs hold water well. The soils are likely to crack when dry, but irrigation ditches lose little water as the result of seepage.

Most of this association is cropped, but some areas are pastured. Ample water can be obtained for livestock by digging reservoirs. Diversion terraces are needed, however, to obtain a sufficient supply of water in some of the reservoirs. In some places wells are used to provide water for livestock.

Association 2 consists mainly of Richfield and Dalhart soils. The soils are similar to those in association 1 but are sandier and have a higher rate of infiltration. Slopes are long, and there is considerable sheet erosion.

Constructing impounding-type terraces or diversion terraces with open ends will help to control erosion. The impounding-type terraces on the Dalhart soils should have closed ends. The diversion terraces should be level. If impounding-type terraces are used on the Richfield soils, they need to have partial blocks; except where fills have been made, the channels should be constructed so they can be drained by cutting the partial blocks.

The soils in this association are easily leveled for irrigation. Irrigation reservoirs on the Richfield soils hold water well, but some seepage occurs on the Dalhart soils. Irrigation ditches perform satisfactorily, except that in the Richfield soils, when the banks of the ditches become dry, some cracking occurs.

In the pastured areas ample water can be obtained for livestock by digging reservoirs. In some places, however, diversion terraces are needed to obtain enough water in the reservoirs. Wells are used in some places to provide water for livestock.

Association 3 is made up of soils in the breaks that are underlain by caliche. The Mansker, Potter, and Berthoud are the main soils. Considerable water erosion occurs in these areas. Because of steep slopes, the Mansker and Potter soils are generally not suitable for engineering structures.

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TABLE 5.—*Estimated physical*

Soil types and map symbol	Description	Depth (typical profile)	Classification		
			USDA texture	Unified	AASHO
		Inches			
Bayard fine sandy loam (Ba).	Deep, alluvial soil that is adjacent to streams and subject to occasional overflow; the subsoil is sandy.	0 to 20	Fine sandy loam.	SM-SC	A-2 or A-4
		20 to 50+	Loamy fine sand.	SM	A-2
Berthoud loam (BeB, BeC)	Deep, granular loam on foot slopes below escarpments; slopes range from 1 to 6 percent; soils developed from colluvial material washed from adjacent escarpments.	42+	Loam	CL	A-4 or A-6
Bippus clay loam (Bp)	Deep, granular clay loam on alluvial fans or foot slopes below escarpments; slopes range from 0 to 4 percent; soils developed from calcareous sediments washed from adjacent escarpments.	44+	Clay loam	CL	A-6 or A-7
Dalhart fine sandy loam (DaA, DaB).	Deep soil on nearly level to gently sloping uplands. Soil developed from windblown sand; the subsoil is sandy clay loam.	0 to 10	Fine sandy loam.	SM-SC or SC	A-4 or A-6
		10 to 30	Sandy clay loam.	SC or CL	A-6
		30 to 60	Sandy loam	SM-SC or SC	A-4 or A-6
Dalhart loamy fine sand (DsB).	Deep soil on nearly level to gently sloping uplands; it developed from windblown sand; the subsoil is sandy clay loam.	0 to 10	Loamy fine sand.	SM	A-2
		10 to 30	Sandy clay loam.	SC	A-6
Dalhart-Ulysses loams (DuA, DuB, DuC).	Deep, loamy soils on nearly level to sloping uplands; soils developed in wind-laid silts and sands.	60+	Loam	CL	A-4 or A-7
Lincoln soils (Ln)	Deep, sandy, alluvial soils that are adjacent to streams and subject to occasional overflow; the subsoil is sandy.	60+	Loamy fine sand.	SM	A-2
Lofton clay loam (Lo)	Deep soil with a clay subsoil; it occupies shallow depressions where water is ponded for short periods after heavy rains.	60+	Clay loam	CL or CH	A-7
Mansker clay loam (MaB, MaC) and Mansker soils (MnC4).	Deep, granular soils that have moderately rapid internal drainage; they occupy gently sloping areas near the breaks and strongly sloping areas within the breaks.	48+	Clay loam	CL	A-6 or A-7
Mansker-Potter complex (Mp).	This complex consists of a thin layer of loam and clay loam that is underlain by hard caliche and deep, granular clay loam; it is on uplands in rough, broken areas within the breaks and ridges.	10 to 48	Clay loam and loam.	CL	A-6
Otero fine sandy loam (Ot) and Otero-Vona fine sandy loams (Ov).	Deep soils that have a subsoil of sandy loam	42+	Fine sandy loam.	SM-SC or SC	A-4
Potter soils (Pt)	This mapping unit consists of a layer of loam and clay loam that is about 10 inches thick over hard caliche; most of it is on rough breaks, but minor areas have gentle slopes.	10	Loam and clay loam.	CL	A-6 or A-7
		10 to 24	Clay loam and loam.	GW	A-6
Pullman clay loam(Pm)	Deep, heavy, nearly level soil with a subsoil of blocky clay.	0 to 6	Clay loam	CL or CH	A-7
		6 to 30	Clay	CH or MH	A-7
Randall clay (Ra)	Deep, massive soil in depressions on the upland; it is poorly drained, and water is ponded on it for long periods after heavy rains.	60+	Clay	CH or MH	A-7
Richfield clay loam (Rc)	Deep, nearly level soil on the uplands; the subsoil is clay loam.	72+	Clay loam and loam.	CL	A-6 or A-7
Richfield fine sandy loam (Rf).	Deep, nearly level, upland soil that has a surface layer of sandy loam and a subsoil of clay loam.	5 to 10	Fine sandy loam.	SM-SC	A-4
		10 to 30	Clay loam	CL	A-6 or A-7
Richfield loam, thick surface (Rt).	Deep, upland soil that has a layer of more than 10 inches of loam overlying a clay loam subsoil; it developed in fine-textured, calcareous loess.	10 to 18	Loam and silt loam.	CL	A-4 or A-6
		18 to 30	Clay loam	CL	A-6 or A-7
Spur soils (Sp)	Deep, alluvial loams or clay loams that are adjacent to streams and subject to occasional overflow.	36+	Clay loam and loam.	CL	A-6 or A-7

See footnotes at end of table.

properties of the soils

Estimated percentage passing—			Permeability	Structure	Available moisture	Reaction	Dispersion	Shrink-swell potential
No. 200 sieve	No. 10 sieve	No. 4 sieve						
			Inches per hour		*Inches per foot of soil*			
25–35	95–100	100	2.0 – 3.0	Granular	1.4	Calcareous	High	Low.
15–20	95–100	100	3.0 – 4.0	Single grain	.8	Calcareous	High	Low.
60	90	95	1.7	Granular	1.7	Calcareous	Moderately high.	Moderate.
60–75	95–100	100	.3 – 0.7	Granular	2.0	Noncalcareous to a depth of 10 inches.	Moderate	Moderate.
35–45	100	100	2.0 – 3.0	Granular	1.4	Noncalcareous	Moderately high.	Low.
45–55	100	100	1.0 – 2.0	Prismatic	1.7	Noncalcareous	Moderate	Moderate.
35–45	100	100	------------	Granular	1.4	Calcareous	High	Low.
15	95–100	100	3.0 – 4.0	Granular	.8	Noncalcareous	High	Low.
45–55	100	100	1.0 – 2.0	Prismatic	1.4	Noncalcareous	Moderate	Moderate.
70–80	95–100	100	1.6 – 2.0	Granular	1.7	Calcareous	Moderate	Moderate.
15	90	95–100	5.0 –10.0	Single grain	.4	Calcareous	High	Low.
80–90	100	100	.05– 0.2	Subangular blocky.	2.0	Noncalcareous	Low	High.
55–65	85–95	95–100	1.4 – 1.9	Granular	1.7	Calcareous	Moderate	High.
55–65	75–85	100	2.5	Granular	1.2–1.7	Calcareous	Moderate	Moderate.
30–40	95–100	100	3.0	Granular	1.2	Calcareous	High	Low.
60–70	80–90	90–100	1.4 – 2.0	Granular	1.2	Calcareous	Moderate	Moderate.
15–25	25–35	60–70	2.0 – 3.0	----------------	.5	Calcareous	Low	Low.
80	100	100	.05– 0.2	Granular	2.0	Noncalcareous	Low	High.
95–100	100	100	.05– 0.15	Blocky	2.0	Noncalcareous	Low	Very high.
95–100	100	100	(1)	Massive	2.0	Noncalcareous	Low	Very high.
80	100	100	.2 – 0.8	Subangular blocky.	2.0	Noncalcareous	Low	High.
30–45	95–100	100	2.0 – 3.0	Granular	1.4	Noncalcareous	Moderately high.	Low.
75–80	100	100	.2 – 0.8	Subangular blocky.	2.0	Noncalcareous	Low	High.
70–80	100	100	.8 – 1.5	Granular	1.4	Noncalcareous	Moderate	Moderate.
80	100	100	.2 – 0.8	Subangular blocky.	1.7	Noncalcareous	Low	High.
75–80	100	100	.3 – 0.8	Granular	2.0	Calcareous	Moderate	High to moderate.

TABLE 5.—*Estimated physical*

Soil types and map symbol	Description	Depth (typical profile)	Classification		
			USDA texture	Unified	AASHO
		Inches			
Sweetwater soils (Sw)	Wet, alluvial clay soils that have a sandy substratum and are adjacent to streams; the water table is usually within 36 inches of the surface, but its depth ranges from 0 to 48 inches.	0 to 18	Silty clay loam	CL	A–7
		18 to 36	Loamy sand	SM	A–2
Tivoli fine sand (Tv)	Stabilized sand dunes	108+	Fine sand	SP–SM	A–2 or A–3
Ulysses clay loam, (UcA, UcB).	Deep, nearly level to gently sloping upland soil developed in loess.	48+	Clay loam	CL	A–6 or A–7
Vernon loams (Ve)	Shallow clay loams and loams over shale or siltstone; the topography is undulating, dissected, and rough.	0 to 10	Clay loam	CL	A–6 or A–7
		10+	Shale		
Vona loamy fine sand (VoB, VoC).	Deep loamy sand with a subsoil that is slightly cohesive; developed in wind-laid sand.	60+	Loamy fine sand.	SM	A–2
Vona, Otero, and Potter soils (Vp).	Deep, loamy sands that overlie calcareous loam, clay loam, and caliche; slopes are gently undulating to steep.	10 to 60+	Loamy fine sand.	SM	A–2
Woodward loam (WwB)	Moderately deep, gently sloping upland soil developed from sandstone, siltstone, or sand.	15 to 30	Loam	CL	A–4 or A–6

[1] Less than 0.05. [2] Unlimited.

TABLE 6.—*Estimated soil*

Soil series	Suitability for—		Suitability as source of—		Soil features affecting farm ponds—		Probable success of drainage
	Road subgrade	Road fill	Topsoil	Sand, gravel, or caliche	Permeability of reservoir	Stability of embankment	
Bayard	Good	Good	Good to depths of 6 to 18 inches.	Fair source of sand	Pervious	Unstable	(1)
Berthoud	Fair to good.	Fair to good.	Good to depths of 6 to 8 inches.	Good in places	Nearly impervious.	Fairly stable	Good
Bippus	Poor to fair.	Poor	Good to depths of 8 to 12 inches.	Not suitable; none	Impervious	Fairly stable	Good
Dalhart	Good	Good	Good to depths of 6 to 12 inches.	Not suitable; none	Nearly impervious.	Stable	Good
Lincoln	Poor to fair.	Poor	Poor	Good	Highly pervious	Unstable	(1)
Lofton	Poor	Poor	Poor	Not suitable; none	Impervious	Fairly stable	Fair
Mansker	Good	Good	Fair to depths of 4 to 6 inches.	Good source of caliche.	Pervious	Stable, but pervious.	Good
Otero	Good	Good	Good to depths of 6 to 10 inches.	Good	Pervious	Unstable	Good
Potter	Good	Fair to good.	Poor	Excellent source of caliche.	Pervious	Stable, but pervious.	Good
Pullman	Poor	Poor	Good to depths of 4 to 6 inches.	Not suitable; none	Impervious	Fairly stable	Poor
Randall	Poor	Poor	Poor	Not suitable; none	Impervious	Unstable	Poor
Richfield	Poor to fair.	Poor	Good to depths of 4 to 15 inches.	Not suitable; none	Impervious	Fairly stable	Fair
Spur	Poor to fair.	Poor	Good to depths of 10 to 15 inches.	Not suitable; none	Impervious	Fairly stable	Good
Sweetwater	Good	Fair	Good to depths of 4 to 6 inches.	Poor	Pervious	Unstable	High water table.
Tivoli	Poor	Very poor.	Poor	Excellent	(1)	(1)	(1)
Ulysses	Good	Good	Good to depths of 6 inches.	Not suitable; none	Impervious	Stable	Good
Vernon	Good	Fair	Poor	Poor	Nearly impervious.	Stable	(1)
Vona	Fair	Poor	Poor	Good	Highly pervious	Unstable	Good
Woodward	Good	Good	Fair	Not suitable; none	Pervious	Stable	Good

[1] Not applicable.

properties of the soils—Continued

Estimated percentage passing—			Permeability	Structure	Available moisture	Reaction	Dispersion	Shrink-swell potential
No. 200 sieve	No. 10 sieve	No. 4 sieve						
			Inches per hour		*Inches per foot of soil*			
80–100	100	100	0. 5 – 0. 2	Granular	2. 0	Calcareous	Low	High.
10–20	80–100	100	[1]	Single grain	[2]	Calcareous	High	Low.
3–10	95–100	100	5. 0 –10. 0	Single grain	. 05	Noncalcareous	High	Low.
75–80	95–100	100	. 8 – 1. 2	Granular	2. 0	Calcareous	Moderate	Moderate.
70–80	95–100	100	. 3 – 0. 6	Granular	1. 8	Calcareous	Moderate	Low.
15	95–100	100	3. 0 – 4. 0	Granular	. 8	Calcareous	High	Low.
15	90–95	95–100	2. 5 – 4. 0	Granular	. 5–1. 2	Calcareous	High	Low.
65–75	95–100	100	1. 6 – 2. 0	Granular	1. 4	Calcareous	Moderately high.	Moderate.

properties that affect engineering

Irrigation				Suitability for—		Remarks
Land leveling; features affecting or suggestions	Suitability for ditches	Suitability for borders	Suitability for holdover reservoirs	Terraces and diversions	Waterways	
6 to 8 inches allowable cut.	Poor; high loss of water.	Fair	Poor	[1]	[1].	
Excessive slope	Good	Good	Good; nearly impervious.	Good	Good	Pockets of sand and gravel occur in places under 6 to 8 feet of overburden.
6 to 10 inches allowable cut.	Good; impervious, but tends to crack.	Fair; tends to to crack.	Good	Good	Good.	
6 to 8 inches allowable cut.	Poor; high loss of water.	Poor; subject to wind erosion.	Poor; high loss of water.	Fair to good.	Good.	
[1]	Very poor	Very poor	Very poor	Very poor	[1].	
Requires fill	Good; impervious, but tends to crack.	Fair; tends to crack.	Good	[1]	Good.	
4 to 5 inches allowable cut.	Poor; high loss of water.	Good	Poor	Fair to good.	Good.	
4 to 6 inches allowable cut.	Poor; high loss of water.	Very poor	Very poor	Very poor	Fair.	
[1]	Very poor	Very poor	Very poor	Very poor	Poor.	
Cut as needed	Good; impervious, but tends to crack.	Fair; tends to crack.	Good	Good	Good.	
Requires fill	[1]	[1]	[1]	[1]	[1]	Beds of intermittent lakes.
6 to 8 inches allowable cut.	Very good; impervious.	Good	Good	Good	Good	Richfield clay loam is a poor source of topsoil.
Cut as needed	Very good; impervious.	Good	Good	Good	Good.	
[1]	Poor	[1]	Very poor	[1]	Good.	
[1]	[1]	[1]	[1]	[1]	[1].	
4 to 6 inches allowable cut.	Good	Good	Fair	Good	Good.	
[1]	[1]	[1]	[1]	[1]	[1].	
[1]	[1]	[1]	[1]	[1]	Fair	
4 inches allowable cut.	Good	Good	Good	Good	Good.	

Drop-inlet or pipe-drop structures can be used to control some of the headcuts that are likely to cause damage to grassland valleys or to fields above that produce crops of high value. In a few places the drainage area is large; cultivated areas above a headcut or below a severely eroded gully are endangered, and it may be necessary to construct an erosion control dam. Dams that are constructed to control a headcut should use a pipe spillway. Dams that are constructed to prevent silt and water from damaging soils below the structure require a diversion-terrace spillway or should be spilled into an adjoining water course.

Diversion terraces that have open ends can be used to divert runoff from higher lying areas away from the Berthoud soils. To increase water insoak and to improve grazing, water-spreading systems can be used on the Berthoud soils that are in grassland. Berthoud soils that have slopes of 2½ percent or less need impounding-type terraces that have closed ends. If slopes are more than 2½ percent, channel-type terraces that have partially closed ends should be used. If a diversion terrace is not used at the top of the field, the topmost terrace should have open ends.

Where sufficient depth can be obtained, ample water for livestock can be provided by building dams across the drains. Drainage areas should be selected carefully to prevent silt from accumulating in them from eroded gullies and slopes. Because of the caliche in these soils, there is generally much seepage from ponds for 1 or 2 years. The seepage gradually subsides as thin layers of silt and clay are deposited and seal the basin. In the Berthoud soils, wells generally provide a satisfactory supply of water for livestock.

Associations 4, 5, and 6 consist mainly of soils of the Vona, Dalhart, Otero, and Potter series. Of these, the Vona and Otero are deep and sandy. They are generally not suitable for engineering structures because of excessive infiltration of water and susceptibility to wind erosion. The Dalhart soils are suitable for irrigation in some places. They are easily leveled. The irrigation runs are short. The soils need to be irrigated frequently. Because of the topography, the small amount of runoff, and susceptibility to wind erosion, terraces are generally unsatisfactory on these soils.

In most places wells are needed to provide water for livestock. Reservoirs may be satisfactory in the Dalhart soils that border on the Richfield soils and in the Otero soils that border on Potter soils. In most of the Vona and Otero soils, seepage is excessive. In the Potter soils ponds are satisfactory if silting is controlled. Generally, considerable seepage occurs at first, but, after 1 or 2 years, thin deposits of silt and clay seal the basin.

Association 7 is made up mainly of soils of the Sweetwater, Lincoln, and Spur series. Most areas of this association are used as range or meadow and do not require engineering structures. The runoff from higher areas that spreads over these soils generally does not cause damage but provides needed moisture. In most places the Spur soils can be irrigated, but in few places overflow is a hazard.

Adjacent streams generally provide ample water for livestock. Reservoirs can be constructed by digging below the water table. In most places driven sandpoints will produce enough water for livestock.

Association 8 is made up mainly of soils of the Vernon and Woodward series. These rough, red soils are used as grassland. Water erosion has been very severe on these soils.

If silt is controlled, ponds are satisfactory on these soils. Reservoirs are also satisfactory if suitable sites can be located. In some places the Woodward soils can be cultivated, but runoff from higher areas generally is a hazard. Diversion terraces and erosion-control dams can be used to control runoff. If slopes are less than 2½ percent, impounding-type terraces that have closed ends should be used. If slopes are more than 2½ percent, channel-type terraces that have partially closed ends should be constructed. The Woodward soils that are in grassland respond well if water-spreading systems are used to increase the insoak of water and to improve grazing.

How the Soils Developed and are Classified

In this section the factors that have affected the development and composition of the soils of Texas County are discussed. Also discussed is the classification of the soils by higher categories.

How the Soils Have Developed

Soils are developed by the action of several soil-forming processes on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given place are determined by (1) the physical and mineralogical composition of the parent materials; (2) the climate under which the soil material has accumulated and has existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil development have acted on the soil material (*6*).

Climate and vegetation are the active factors of soil formation. They act on the parent material accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effects of climate and vegetation are conditioned by relief. The kind of parent material also affects the kind of profile that can be formed and, in extreme cases, dominates it entirely. Finally, time is needed to change the parent material into a soil profile. It may be much or little, but generally a long time is required for distinct horizons to develop.

The individual factors of soil formation are discussed separately in the paragraphs that follow. It is the interaction of all of these factors, however, that determines the nature of the soil profile. The interrelationship among the five factors is complex; the effects of any one factor are difficult to isolate. In some areas the effects of four of the factors are constant, or nearly so, and the effects of the fifth factor can be partially evaluated. Even in these areas, however, the appraisal of the effects is only an approximation.

Parent materials

The soils of Texas County developed from parent materials deposited during three geological ages—the Permian, the Tertiary, and the Quaternary.

The Cloud Chief formation of the Permian age is the oldest parent material exposed. It occurs in a small area in the southeastern part of the county along Palo Duro and Chiquita Creeks. This formation consists mainly of red shale but contains some sandstone and sand. It supplied the parent material from which the Vernon soils developed.

The Ogallala formation, of Tertiary age, occurs throughout the county. It is either exposed or is covered by a thin mantle of material of Quaternary age. The Ogallala formation is made up of calcareous sand, gravel, silt, and clay and is generally capped by a layer of caliche. This mixture of rock debris was washed from the Rocky Mountains. It was deposited by debris-filled streams that shifted widely across the desert plain. The formation ranges in thickness from a few feet to about 300 feet. The parent material of the Mansker and Potter soils was derived from this formation.

During the Early Quaternary age (Pleistocene epoch), a thin mantle of silt and fine sand (loess) was deposited over the Ogallala formation by wind. This mantle is generally 2 to 12 feet thick. Most of it is in the northern half of the county, but several large areas occur in the south-central and southwestern parts of the county. The loess is fine textured. It was carried long distances by wind from its point of origin. In some places, especially near Hough, this silty material occurs as oval or long hills and ridges that rise as much as 30 feet above the surrounding level areas. The Richfield and Ulysses soils developed from loess.

Later in the Pleistocene epoch, a mantle of strongly calcareous, moderately sandy material was deposited by wind. This material was of local origin. The areas on which it was deposited are nearly level, billowy to gently sloping, or undulating. The Dalhart and Vona soils developed from this material.

During the Late Quaternary period (Recent epoch), alluvium was deposited on the flood plains along streams. In this alluvial material the Spur, Lincoln, Bayard, and Sweetwater soils developed. The sand dunes, in which the Tivoli soils developed, are also of this age.

Climate

Texas County has a semiarid climate. Although the average annual precipitation is low, most of it comes in warm weather during the growing season. Seldom does more than 2 inches of rain fall during a single rainstorm. As a result, the natural vegetation consists mainly of shallow-rooted, short grasses. Because of the strong winds and low humidity, the rate of evaporation is high. Water seldom infiltrates more than 4 feet into the soil. The basic elements are not leached out, and in most of the soils there is a lime zone within a few feet of the surface.

Climatic forces acting on the soil material cause some of the variations in plant and animal life. Thus, climate influences changes in the soil that have been brought about by differences in the plant and animal population.

Living organisms

Plants, micro-organisms, earthworms, and other forms of life that live on or in the soil are active in soil-forming processes. They help to decompose plant residues; they also affect the chemistry of the soil and hasten soil development. Living organisms also help to convert plant nutrients to a form that is more readily available to higher plants.

Vegetation provides shade and thus reduces losses of water from runoff, wind, and heat. It adds organic matter to the soil, thereby influencing the structure and physical condition of the soil. The plant roots help to keep the soil supplied with minerals by bringing elements from the parent material to the surface soil in a form more usable to plants.

Generally, the type of soil in an area varies according to the type of vegetation. In this county the nearly level to moderately sloping, fine- and medium-textured soils developed under a dense cover of short grasses. Shallow, steeply sloping, fine- and medium-textured soils developed under a sparse cover of short and mid grasses. Most of the sandy soils developed where sand sage and mid and tall grasses were dominant. The alluvial soils developed under vegetation made up mainly of tall and mid grasses but that included some cottonwood, willow, and hackberry trees.

Relief

Relief, or the elevations or inequalities of the land surface, considered collectively, affects the development of soils by its effect on runoff and drainage. Other soil-forming factors being equal, the degree of development in the soil profile depends on the average amount of moisture in the soil. Thus, the profile of a nearly level soil that has little runoff shows more development than the profile of a sloping soil, where the soil-forming processes have been retarded by the continuing loss of soil material by erosion and runoff.

Time

Considerable time is required for the development of a mature soil from the parent material. The length of time necessary for a soil to reach a state of equilibrium with its environment, or to mature, depends on the combined action of the soil-forming factors and on the intensity of their action.

Soils develop slowly in a dry climate under sparse vegetation, but they develop much more rapidly in a moist climate under dense vegetation. In Texas County the soils develop slowly. Many of the nearly level soils are mature.

Classification of Soils

Soils are classified in various categories to show their relationship to one another. The lowest units of classification—the series and type—are defined in the section, How a Soil Survey is Made.

Soils series are classified into the next higher category, the great soil group. Each great soil group is made up of soils that have the same general kind of profile but that differ in kind of parent material, in relief, or in

Table 7.—*Classification of soil series into higher categories and some factors that have influenced soil formation*

Great soil group and series	Parent material	Relief	Native vegetation
Zonal			
Chestnut:			
Bippus	Calcareous, clayey colluvium	Gently sloping	Short grasses.
Dalhart	Calcareous loamy sand and sandy loam deposited by wind.	Nearly level to gently sloping	Short and mid grasses.
Lofton	Calcareous clay loam sediments	Slightly depressed or level	Short grasses.
Pullman	Calcareous, fine-textured sediments deposited by wind and water.	Level to nearly level	Short grasses.
Richfield	Calcareous, fine-textured sediments deposited by wind and water.	Nearly level	Short grasses.
Ulysses [1]	Calcareous, fine-textured sediments deposited by wind and water.	Nearly level to moderately sloping	Short grasses.
Brown:			
Berthoud	Colluvium from caliche and sediments deposited by water; calcareous.	Gently sloping to moderately sloping; mostly foot slopes.	Short grasses and yucca.
Vona	Calcareous loamy fine sand deposited by wind	Nearly level to steeply sloping	Mid and tall grasses and sand sagebrush.
Intrazonal			
Calcisol:			
Mansker	Strongly calcareous clay loam and caliche	Nearly level to moderately sloping	Short grasses.
Grumusol:			
Randall [2]	Calcareous clay and clay loam	Deep depressions or level	Short and tall grasses.
Azonal			
Alluvial:			
Bayard	Calcareous, loamy sand alluvium	Nearly level	Tall grasses.
Lincoln	Calcareous, loamy sand alluvium	Nearly level	Tall grasses and sand sagebrush.
Spur	Calcareous, fine-textured alluvium	Nearly level	Short and tall grasses.
Sweetwater [3]	Calcareous, coarse-textured alluvium	Nearly level	Tall grasses.
Regosol:			
Otero	Strongly calcareous loamy sand and sandy loam	Gently sloping to moderately sloping	Short and tall grasses, sand sagebrush, and yucca.
Tivoli	Siliceous sand deposited by wind	Dunes	Tall grasses and sand sagebrush.
Woodward [4]	Sandstone and sand of the Permian red beds	Gently sloping	Short grasses.
Lithosol:			
Potter	Caliche	Moderately sloping to steeply sloping	Short and mid grasses.
Vernon	Shale and sandstone of the Permian red beds	Moderately sloping to steeply sloping	Short and mid grasses.

[1] Intergrading to Regosols.
[2] Not typical; sometimes ponded.
[3] High water table, but generally not ponded.
[4] Intergrading to Reddish Chestnut.

degree of development. The broadest categories of soil classification are the three soil orders—zonal, intrazonal, and azonal (*6*). All three orders are represented in this county. Table 7 classifies the soil series of Texas County by soil orders and great soil groups and gives some of the factors that have influenced soil formation.

Zonal soils have well-developed characteristics that reflect the influence of the active factors of soil formation —climate and living organisms. They have developed from parent materials of mixed mineralogy that have been in place a long time and that have not been subject to extreme conditions of relief.

The zonal soils of Texas County are those of the Bippus, Dalhart, Lofton, Pullman, Richfield, Ulysses, Berthoud, and Vona series. These soils occupy most of the level to gently undulating areas where the parent materials have been in place for a comparatively long time. The sandy soils are leached free of calcium carbonate to a depth of 36 inches, and the clay loams, to depths between 6 and 24 inches. Because there is not enough moisture to leach the calcium carbonate completely out of the soils, carbonate has collected within a certain layer in the profile. The carbonate accumulations vary from indistinct threads and films of lime and streaks and spots of soft lime to layers of chalky and hard concretions of lime.

The zonal great soil groups tend to have certain geographic ranges or to occur in zones, a tendency reflected in use of the term, zonal. At the margins of the geographic range for each zonal great soil group, however, there is interfingering with other zonal groups, depending upon features, such as topography, microclimate, and parent materials.

Texas County is part of a region dominated by Chestnut soils, with the major zonal soils of the county members of that one great soil group. The Richfield series is near the southern end of its geographic range in the county. The Ulysses series, though a member of the Chestnut group, is an intergrade to Regosols. The interfingering of Chestnut soils with other zonal groups is illustrated in Texas County by the presence of the Vona series, comprising Brown soils near the southeastern limit of the range for that soil group.

Intrazonal soils have well-developed characteristics that reflect the dominant influence of some local factor of relief or parent material rather than climate and living organisms. Because the controlling factors in their formation tend to be local in character, intrazonal soils tend less to occur over broad geographic zones but are instead scattered about in the form of small bodies. Moreover, the soils of a single intrazonal group may occur in association with the soils of several zonal great soil groups.

The intrazonal order is represented in Texas County by the Mansker and Randall series. The Mansker soils, which are Calcisols, are formed from parent materials especially high in lime. As a result of the high content of lime, leaching has removed carbonates only from the upper part of the profile and has concentrated them in the lower part. Organic matter has accumulated to some extent, giving rise to an A horizon, but no B horizon has been formed.

The Randall soils are Grumusols formed in shallow depressions underlain by clay. Water from immediately surrounding uplands drains into such depressions and remains there until it evaporates. Little or no leaching occurs, and the soil remains largely saturated with bases, as is common to Grumusols in all parts of the world.

Azonal soils lack well-defined characteristics because of horizon differentiation. They are in the early stages of development from recently deposited sediments, are derived from highly resistant materials, or occur on steep slopes where runoff and removal of soil materials are rapid. Topography ranges from level to steep, and the parent materials also have a wider range than those of other soils.

For the most part, the azonal soils in Texas County have A_1 horizons that are somewhat darker in color but similar in texture to the parent materials. Some of the soils have thin, moderately dark A_1 horizons with moderate amounts of organic matter. In a number of the soils, however, there is little difference in color between the A_1 horizon and parent material. None of the soils of the azonal order has a B horizon. Hence, they are sometimes designated as AC soils.

In Texas County the azonal order is represented by the Alluvial, Regosol, and Lithosol groups. The first of these occurs on floods plains, whereas the other two are on uplands. All of the azonal soils, except those of the Tivoli series, are calcareous throughout their profiles, but none has a distinct horizon of carbonate accumulation.

The Bayard, Lincoln, Spur, and Sweetwater series are members of the Alluvial group. All of these soils occur in stream valleys and drainageways. Formed from recent alluvium, these soils may have darkened surface layers but show no further horizonation.

The Otero, Tivoli, and Woodward series are Regosols. The soils have been formed from deep, unconsolidated deposits or from very weakly consolidated rocks and lack distinct horizons.

The Potter and Vernon series are Lithosols. Lithosols are formed in shallow regoliths over hard rocks, and the regoliths themselves may be stony or very stony. Like the Alluvial soils and Regosols, the Lithosols may have faint A horizons but otherwise lack profile development.

Analyses of Soils

Tables 8 and 9 give data obtained by laboratory analyses of samples taken from nine profiles of some of the important soils mapped in Cimarron County, Okla., and in Hansford County, Tex. Soils like these or soils very similar to them occur in Texas County, and the samples were taken within 30 miles of this county. The soils in tables 8 and 9 are the same; consequently, the location of each soil is given in detail only in table 8. Table 10 gives data obtained by mechanical analyses of the surface 7 inches of samples taken from four profiles of Ulysses clay loam. The samples were taken in Texas County in four widely spaced areas and represent the range of variations of Ulysses clay loam within the county. The analyses in these three tables were made by the Soil Survey Laboratory, Lincoln, Nebr.

TABLE 8.—*Chemical properties*

[Dashed lines indicate analyses were not

Soil name, sample number, location, and horizon	Depth	pH			Organic matter			Estimated percent of salt
		Saturated paste	1:5 ratio	1:10 ratio	Organic carbon	Nitrogen	C/N ratio	
Dalhart fine sandy loam (Sample No. 55–OK–13–7): Location.—1,840 ft. N. and 100 ft. E. of highway junction in SW¼ sec. 31, T. 1 N., R. 8 E., Cimarron County, Okla.	*Inches*				*Percent*	*Percent*		*Bureau cup*
A_1	0–8	7.8	8.2	8.3	0.44	0.059	7.5	0.03
B_{21}	8–20	7.3	7.8	7.8	.42	.061	6.9	.037
B_{22}	20–30	7.8	8.3	8.4	.22	.041	5.4	.035
C_{ca}	30–44	8.1	8.6	8.7	.23	.026	8.8	.03
C	44–70	8.4	8.9	9.0	.10	.015	6.7	.03
Dalhart loamy fine sand (Sample No. 55–OK–13–12): Location.—About 100 ft. E. of highway, near W¼ corner of sec. 15, T. 1 N., R. 7 E., Cimarron County, Okla.								
A_1	0–15	7.5	7.0	7.1	.20	.028	7.1	.02
B_{21}	15–26	7.4	7.7	7.8	.31	.051	6.1	.02
B_{22}	26–38	6.7	7.7	7.8	.36	.051	7.1	.03
A_{1bca}	38–57	7.3	8.1	8.2	.19	.043	4.4	.048
B_{1b}	57–66	7.4	8.0	8.2	.22	.046	4.8	.05
B_{2b}	66–75	7.5	7.8	7.9	.22	.044	5.0	.045
C_b	75–85	7.5	8.1	8.2	.22	.041	5.4	.047
Mansker loam (Sample No. 55–OK–13–5): Location.—850 ft. W. and 50 ft. N. of the SW¼ sec. 10, T. 4 N., R. 5 E., Cimarron County, Okla.								
A_1	0–7	7.6	8.1	8.1	1.32	.180	7.3	.039
C_{ca} and A_1	7–16	7.5	8.0	7.9	1.16	.174	6.7	.03
C_{ca}	16–38	7.7	8.3	8.5	.35	.051	6.8	.03
Mansker clay loam (Sample No. S–57–Tex–98–3): Location.—500 yds. S. and 230 yds. W. of the NE. corner of sec. 1, block 4T, T. and N. O. RR. survey, Hansford County, Tex.								
A_1	0–5	8.0	8.4	8.6	1.17	.109	10.7	.20
A_3	5–13	8.1	8.5	8.6	.86	.092	9.3	.20
C_{ca1}	13–23	8.4	8.9	9.0	.37	.042	8.8	.20
C_{ca2}	23–30	8.6	9.0	9.2	.11	.019	5.8	.20
B_{2b}	30–50	8.5	9.0	9.2	.06	--------	--------	--------
Mansker clay loam (Sample No. S–57–Tex–98–7): Location.—350 yds. S. and 270 yds. W. of the NE. corner of sec. 6, block 5T, T. and N. O. RR. survey, Hansford County, Tex.								
A_{11}	0–4	8.0	8.5	8.8	1.75	.151	11.6	.20
A_{12}	4–9	7.9	8.6	8.8	1.24	.132	9.4	.20
AC_{ca}	9–15	8.1	8.7	8.8	.98	.103	9.5	.20
C_{ca}	15–20	8.3	8.7	8.9	.53	.055	9.6	.20
B_{21b}	20–30	8.4	8.9	9.2	.13	.019	6.8	.20
B_{22b}	30–48	8.4	9.1	9.3	.05	--------	--------	.20
Pullman silty clay loam (Sample No. S–57–Tex–98–1): Location.—700 yds. S. and 50 yds. E. of the NW. corner of sec. 41, block 4T, T. and N. O. RR. survey, Hansford County, Tex.								
A_p	0–5	6.2	6.6	6.6	1.21	.114	10.6	.20
B_{21}	5–9	6.2	6.7	6.8	1.02	.099	10.3	.20
B_{22}	9–17	7.2	7.7	7.8	.71	.073	9.7	.20
B_{23}	17–28	8.1	8.6	8.8	.41	.045	9.1	.20
B_{ca}	28–39	8.0	8.6	8.8	.35	--------	--------	.20
B_{2b1}	39–50	8.1	8.7	8.9	.33	--------	--------	.20
B_{2b2}	50–59	8.0	8.5	8.7	.28	--------	--------	.20
B_{2b3}	59–75	7.9	8.3	8.5	.22	--------	--------	.20
C_{cab}	75–85	7.9	8.5	8.7	.14	--------	--------	.20
C_b	85–115	8.0	8.5	8.8	.06	--------	--------	.20
Pullman silty clay loam (Sample No. S–57–Tex–98–2): Location.—280 yds. N. and 300 yds. E. of the SW. corner of sec. 115, block 4T, T. and N. O. RR. survey, Hansford County, Tex.								
A_p	0–5	6.5	6.9	7.0	1.26	.114	11.0	.20
B_{21}	5–9	6.9	7.4	7.4	.94	.089	10.6	.20
B_{22}	9–18	7.4	7.9	8.1	.67	.065	10.3	.20
B_{23}	18–29	8.0	8.6	8.8	.42	.045	9.3	.20
B_{ca1}	29–40	8.3	8.7	8.9	.34	--------	--------	.20
B_{ca2}	40–47	8.1	8.6	8.8	.26	--------	--------	.20
B_{2b}	47–66	7.8	8.4	8.5	.17	--------	--------	.20

of important soils

made or figures were not computed]

Electrical conductivity (Ec×10³)	Calcium carbonate equivalent	Cation exchange capacity (NH_4Ac)	Extractable cations: Ca	Extractable cations: Mg	Extractable cations: Na	Extractable cations: K	Exchangeable sodium percentage	Saturation extract soluble: Na	Saturation extract soluble: K	Saturation extract soluble: Ca	Saturation extract soluble: Mg	Moisture at saturation
Mmho. per cm. at 25° C.	*Percent*	*Me./100 gm. of soil*	*Me./100 gm. of soil*	*Me./100 gm. of soil*	*Me./100 gm. of soil*	*Me./100 gm. of soil*		*Me./100 gm. of soil*	*Me./100 gm. of soil*	*Me./100 gm. of soil*	*Me./100 gm. of soil*	*Percent*
0.393	0	6.62	7.38	1.31	0.07	0.51	1.06	0.008	0.016	0.076	0.021	27.8
.602	0	10.29	9.15	1.50	.09	.39	.87	.015	.013	.175	.057	39.5
.440	4.06	8.67	33.12	1.73	.12	.30	1.38	.017	.010	.194	.061	57.3
.417	35.32	6.51	31.31	5.08	.16	.29	2.46	.021	.012	.081	.101	48.8
.509	24.01	10.91	32.79	10.34	.66	.45	6.05	.191	.013	.019	.098	51.7
.347	0	2.89	2.48	.80	.05	.13	1.73	.015	.015	.057	.025	28.7
.347	0	9.76	7.91	1.76	.10	.24	1.02	.016	.015	.093	.032	32.7
.324	0	15.76	12.75	2.56	.14	.40	.89	.022	.013	.107	.038	46.5
.417	1.93	19.27	33.77	3.85	.46	.72	2.39	.053	.010	.075	.041	45.3
.463	.65	22.76	24.60	4.82	.66	.75	2.90	.087	.013	.118	.061	47.7
.393	0	22.90	20.91	4.61	.69	.76	3.01	.108	.013	.052	.045	52.0
.370	0	21.86	20.92	4.40	.71	.76	3.25	.113	.013	.065	.045	52.3
.417	14.08	14.45	40.06	1.74	.17	.94	1.18	.010	.023	.173	.014	46.6
.509	33.93	10.98	38.66	1.73	.17	.53	1.55	.016	.017	.225	.035	52.1
.671	63.73	5.21	33.08	2.32	.14	.25	2.69	.028	.007	.224	.064	40.8
.6	2.0	18.5	--------	--------	--------	.8	--------	.02	.02	--------	--------	44.1
.7	9.0	18.6	--------	--------	.1	.6	--------	.04	.01	--------	--------	54.8
.6	35.0	11.1	--------	--------	.1	.4	1.0	.12	.02	--------	--------	43.4
.7	33.0	11.9	--------	--------	.4	.5	2.0	.28	.02	--------	--------	51.4
.9	25.0	18.2	--------	--------	1.1	.8	4.0	.49	.02	--------	--------	64.7
.6	8.0	14.5	--------	--------	--------	.8	--------	.02	.04	--------	--------	47.8
.7	23.0	13.0	--------	--------	--------	.5	--------	.03	.02	--------	--------	49.2
.6	42.0	11.8	--------	--------	--------	.3	--------	.03	.01	--------	--------	47.2
.6	48.0	9.9	--------	--------	.1	.3	1.0	.05	.01	--------	--------	48.8
.7	39.0	11.0	--------	--------	.2	.4	1.0	.12	.01	--------	--------	52.0
.7	30.0	13.4	--------	--------	1.0	.5	6.0	.39	.01	--------	--------	57.0
.8	--------	19.2	12.4	3.4	--------	1.7	--------	.03	.11	--------	--------	42.8
.5	--------	25.5	17.9	5.1	.1	1.3	--------	.04	.03	--------	--------	58.1
.8	1.0	30.6	23.2	6.8	.3	1.2	1.0	.10	.03	--------	--------	76.1
.9	4.0	26.4	--------	--------	.6	1.2	2.0	.23	.03	--------	--------	72.4
.9	3.0	26.6	--------	--------	1.0	1.3	3.0	.35	.03	--------	--------	64.8
.9	2.0	26.1	--------	--------	1.3	1.2	4.0	.44	.02	--------	--------	66.2
1.5	3.0	22.2	--------	--------	1.2	1.1	4.0	.60	.03	--------	--------	58.8
1.7	2.0	22.8	--------	--------	1.2	1.1	4.0	.60	.03	--------	--------	67.3
2.6	45.0	11.6	--------	--------	.7	.5	2.0	.72	.04	--------	--------	49.3
1.8	26.0	15.8	--------	--------	.6	.7	2.0	.50	.03	--------	--------	56.4
.5	--------	22.5	15.2	4.3	.1	1.7	--------	.03	.06	--------	--------	52.1
.5	--------	29.5	21.5	6.2	.2	1.3	1.0	.05	.03	--------	--------	66.0
.7	1.0	29.5	21.9	7.3	.4	1.1	1.0	.13	.02	--------	--------	75.7
.8	2.0	26.6	--------	--------	.8	1.1	2.0	.27	.02	--------	--------	67.1
1.0	4.0	24.3	--------	--------	1.2	1.1	4.0	.47	.02	--------	--------	58.9
1.5	3.0	22.7	--------	--------	1.5	1.0	5.0	.71	.02	--------	--------	62.8
2.6	2.0	24.2	--------	--------	1.6	.9	4.0	1.02	.03	--------	--------	60.4

TABLE 8.—*Chemical properties*

[Dashed lines indicate analyses were not

Soil name, sample number, location, and horizon	Depth	pH			Organic matter			Estimated percent of salt
		Saturated paste	1:5 ratio	1:10 ratio	Organic carbon	Nitrogen	C/N ratio	
Richfield clay loam (Sample No. 55-OK-13-2):								
Location.—102 ft. W. and 960 ft. S. of the NE. corner of sec. 27, T. 4 N., R. 6 E., Cimarron County, Okla.	*Inches*				*Percent*	*Percent*		*Bureau cup*
A_{1p}	0-5	7.4	7.6	7.7	0.78	0.086	9.1	0.045
B_2	5-17	7.2	7.7	8.0	.37	.068	5.4	.055
BC	17-22	7.7	8.2	8.4	.25	.058	4.3	.051
C_{ca1}	22-38	7.8	8.2	8.5	.23	.039	5.9	.040
C_{ca2}	38-60	7.9	8.6	8.7	.10	.030	3.3	.070
C	60-88	7.9	8.6	8.7	.07	.014	5.0	.030
Vona loamy fine sand (Sample No. 55-OK-13-11):								
Location.—300 ft. S. of the NE. corner of sec. 14, T. 6 N., R. 9 E., Cimarron County, Okla.								
A_1	0-7	7.6	8.0	8.1	.19	.036	5.3	.02
A_{12}	7-19	6.4	7.9	8.0	.18	.032	5.6	.02
C_1	19-29	6.6	7.1	7.1	.10	.018	5.6	.02
C_{12}	29-73	6.7	7.1	7.2	.06	.014	4.3	.02

of important soils—Continued

made or figures were not computed]

Electrical conductivity (Ec × 10³)	Calcium carbonate equivalent	Cation exchange capacity (NH_4Ac)	Extractable cations				Exchangeable sodium percentage	Saturation extract soluble				Moisture at saturation
			Ca	Mg	Na	K		Na	K	Ca	Mg	
Mmho. per cm. at 25° C.	*Percent*	*Me./100 gm. of soil*	*Me./100 gm. of soil*	*Me./100 gm. of soil*	*Me./100 gm. of soil*	*Me./100 gm. of soil*		*Me./100 gm. of soil*	*Me./100 gm. of soil*	*Me./100 gm. of soil*	*Me./100 gm. of soil*	*Percent*
0. 463	0	27. 14	17. 70	5. 80	0. 09	1. 41	0. 33	0. 015	0. 034	0. 177	0. 101	57. 4
. 440	0	28. 36	18. 90	7. 98	. 18	1. 09	. 63	. 027	. 024	. 158	. 123	61. 3
. 417	8. 88	23. 57	39. 16	8. 78	. 27	1. 06	1. 15	. 035	. 019	. 197	. 122	57. 7
. 393	10. 94	18. 41	37. 77	7. 70	. 36	. 79	1. 96	. 050	. 018	. 084	. 089	50. 3
. 440	2. 21	16. 66	34. 19	6. 70	. 89	. 79	5. 34	. 153	. 013	. 030	. 033	44. 7
. 440	0	12. 24	13. 14	5. 30	. 70	. 57	5. 72	. 122	. 007	. 018	. 025	34. 8
. 463	0	3. 82	3. 00	1. 10	. 06	. 23	1. 57	. 017	. 014	. 072	. 034	24. 6
. 393	0	4. 67	3. 42	. 91	. 08	. 22	1. 71	. 013	. 008	. 094	. 032	25. 1
. 231	0	3. 70	2. 38	1. 11	. 07	. 17	1. 89	. 008	. 006	. 024	. 020	23. 9
. 278	0	2. 25	1. 76	. 60	. 07	. 12	3. 11	. 007	. 008	. 052	. 021	23. 5

TABLE 9.—*Mechanical*

[Dashed lines indicate analyses were not

Soil name and sample number	Horizon	Depth	Particle size distribution in millimeters			
			Very coarse sand 2.0 to 1.0	Coarse sand 1.0 to 0.5	Medium sand 0.5 to 0.25	Fine sand 0.25 to 0.10
		Inches	*Percent*	*Percent*	*Percent*	*Percent*
Dalhart fine sandy loam (No. 55-OK-13-7)	A_1	0-8	0. 2	5. 3	15. 3	36. 7
	B_{21}	8-20	. 3	8. 6	16. 7	30. 5
	B_{22}	20-30	. 2	7. 5	18. 0	27. 8
	C_{ca}	30-44	. 7	4. 0	7. 1	15. 2
	C	44-70	. 9	4. 3	5. 3	15. 2
Dalhart loamy fine sand (No. 55-OK-13-12)	A_1	0-15	0	4. 4	19. 2	54. 9
	B_{21}	15-26	0	5. 9	18. 4	37. 5
	B_{22}	26-38	0	3. 1	10. 5	25. 2
	A_{1bca}	38-57	. 3	1. 0	2. 0	5. 7
	B_{1b}	57-66	. 2	. 7	2. 0	6. 7
	B_{2b}	66-75	. 2	. 8	2. 2	7. 9
	C_b	75-85	. 5	. 6	2. 2	8. 2
Mansker loam (No. 55-OK-13-5)	A_1	0-7	. 7	3. 0	4. 8	9. 5
	C_{ca} and A_1	7-16	1. 4	3. 1	4. 6	8. 7
	C_{ca}	16-38	3. 1	5. 0	5. 3	9. 7
Mansker clay loam (No. S-57-Tex-98-3)	A_1	0-5	. 5	3. 0	3. 6	12. 7
	A_3	5-13	. 8	2. 0	2. 3	11. 6
	C_{ca1}	13-23	. 2	1. 4	1. 6	8. 6
	C_{ca2}	23-30	1. 2	2. 4	2. 1	7. 8
	B_{2b}	30-50	. 9	1. 7	1. 6	4. 9
Mansker clay loam (No. S-57-Tex-98-7)	A_{11}	0-4	. 9	2. 0	3. 8	11. 7
	A_{12}	4-9	1. 2	2. 1	4. 4	11. 3
	AC_{ca}	9-15	. 4	1. 2	2. 4	7. 1
	C_{ca}	15-20	. 2	. 7	1. 6	5. 1
	B_{21b}	20-30	. 3	. 7	1. 8	6. 3
	B_{22b}	30-48	. 5	1. 2	2. 7	8. 4
Pullman silty clay loam (No. S-57-Tex-98-1).	A_p	0-5	----------	. 2	. 5	3. 1
	B_{21}	5-9	----------	. 1	. 4	2. 7
	B_{22}	9-17	----------	. 1	. 4	1. 9
	B_{23}	17-28	----------	. 1	. 3	1. 4
	B_{ca}	28-39	----------	. 3	. 2	1. 2
	B_{2b1}	39-50	. 1	. 4	. 2	1. 1
	B_{2b2}	50-59	. 4	. 3	. 3	1. 6
	B_{2b3}	59-75	. 3	. 2	. 3	1. 7
	C_{cab}	75-85	. 7	. 6	. 6	3. 0
	C_b	85-115	. 4	. 3	. 3	2. 6
Pullman silty clay loam (No. S-57-Tex-98-2).	A_p	0-5	----------	. 1	. 1	1. 2
	B_{21}	5-9	----------	. 1	. 1	1. 3
	B_{22}	9-18	----------	. 1	. 2	1. 3
	B_{23}	18-29	----------	. 1	. 2	1. 3
	B_{ca1}	29-40	. 5	. 3	. 3	1. 9
	B_{ca2}	40-47	. 5	. 3	. 3	2. 6
	B_{2b}	47-66	. 2	. 3	. 3	3. 1
Richfield clay loam (No. 55-OK-13-2)	A_{1p}	0-5	. 1	1. 6	3. 6	8. 0
	B_2	5-17	0	1. 2	3. 3	7. 3
	BC	17-22	. 1	1. 2	3. 6	7. 0
	C_{ca1}	22-38	. 1	1. 8	5. 7	11. 2
	C_{ca2}	38-60	. 3	1. 9	6. 5	14. 1
	C	60-88	. 1	1. 5	10. 0	27. 4
Vona loamy fine sand (No. 55-OK-13-11)	A_1	0-7	1. 8	12. 9	19. 0	46. 9
	A_{12}	7-19	1. 2	10. 6	18. 0	47. 8
	C_1	19-29	. 7	8. 6	16. 6	53. 3
	C_{12}	29-73	. 4	11. 4	19. 5	50. 2

analyses of important soils

made or figures were not computed]

Particle size distribution in millimeters—Continued						Textural class
Very fino sand 0.10 to 0.05	Total sand	Silt 0.05 to 0.002	Clay <0.002	International silt 0.2 to 0.02	Fine silt 0.02 to 0.002	
Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	
19. 5	76. 9	13. 3	9. 8	52. 4	2. 1	Sandy loam.
12. 6	68. 6	14. 4	17. 0	40. 6	3. 5	Sandy loam.
12. 0	65. 4	15. 7	18. 9	36. 4	6. 4	Sandy loam.
11. 0	37. 9	24. 3	37. 8	30. 1	14. 4	Clay loam.
11. 2	36. 9	31. 8	31. 4	35. 2	17. 4	Clay loam.
14. 5	93. 0	2. 7	4. 3	48. 5	. 3	Sand.
11. 0	72. 8	10. 1	17. 1	38. 8	2. 7	Sandy loam.
10. 8	49. 5	23. 7	26. 8	38. 4	10. 3	Sandy clay loam.
4. 7	13. 8	52. 8	33. 4	29. 0	32. 2	Silty clay loam.
5. 4	15. 0	46. 6	38. 4	30. 1	26. 2	Silty clay loam.
6. 3	17. 3	44. 2	38. 5	32. 3	23. 5	Silty clay loam.
7. 1	18. 1	44. 5	37. 4	34. 3	22. 7	Silty clay loam.
12. 5	30. 4	43. 6	26. 0	45. 9	15. 8	Loam.
8. 8	26. 7	35. 3	38. 0	34. 1	15. 0	Clay loam.
9. 4	32. 5	35. 2	32. 3	27. 7	22. 5	Clay loam.
19. 1	38. 9	37. 4	23. 7	55. 3	10. 0	Loam.
18. 7	35. 4	34. 4	30. 2	49. 9	11. 0	Clay loam.
15. 6	27. 4	36. 7	35. 9	39. 5	18. 8	Clay loam.
14. 8	28. 3	37. 2	34. 5	36. 9	20. 2	Clay loam.
7. 7	16. 8	40. 2	43. 0	29. 3	21. 5	Silty clay.
14. 4	32. 8	44. 6	22. 6	53. 2	12. 5	Loam.
13. 3	32. 3	36. 5	31. 2	44. 1	12. 8	Clay loam.
9. 7	20. 8	34. 8	44. 4	31. 0	18. 2	Clay.
8. 6	16. 2	35. 2	40. 6	24. 2	23. 1	Clay.
12. 8	21. 9	34. 2	43. 9	31. 2	20. 4	Clay.
14. 3	27. 1	35. 3	37. 6	36. 9	18. 4	Clay loam.
12. 8	16. 6	56. 0	27. 4	52. 6	18. 7	Silty clay loam.
9. 7	12. 9	48. 5	38. 6	42. 6	17. 7	Silty clay loam.
7. 9	10. 3	37. 2	52. 5	36. 0	10. 6	Clay.
6. 4	8. 2	50. 4	41. 4	35. 6	22. 2	Silty clay.
6. 0	7. 7	52. 2	40. 1	35. 6	23. 5	Silty clay.
6. 2	8. 0	52. 6	39. 4	35. 6	24. 0	Silty clay loam.
8. 2	10. 8	51. 3	37. 9	38. 7	22. 0	Silty clay loam.
10. 1	12. 6	47. 9	39. 5	40. 5	18. 8	Clay loam.
10. 1	15. 0	43. 4	41. 6	29. 9	25. 8	Silty clay.
13. 1	16. 7	44. 8	38. 5	38. 2	21. 8	Silty clay loam.
8. 7	10. 1	57. 7	32. 2	46. 1	21. 3	Silty clay loam.
7. 4	8. 9	48. 7	42. 4	38. 3	18. 9	Silty clay.
7. 0	8. 6	48. 5	42. 9	36. 5	20. 1	Silty clay.
7. 2	8. 8	49. 5	41. 7	39. 0	18. 8	Silty clay.
8. 6	11. 6	49. 7	38. 7	38. 9	21. 0	Silty clay loam.
10. 7	14. 4	48. 1	37. 5	41. 9	19. 1	Silty clay loam.
14. 0	17. 9	43. 8	38. 3	43. 8	16. 7	Silty clay loam.
9. 4	22. 8	40. 2	37. 0	38. 9	15. 2	Clay loam.
7. 0	18. 7	39. 8	41. 5	34. 3	16. 5	Clay.
4. 4	16. 2	44. 0	39. 8	30. 8	21. 0	Silty clay loam.
5. 5	24. 2	43. 8	32. 0	32. 9	21. 9	Clay loam.
9. 2	32. 0	40. 2	27. 8	41. 4	15. 0	Clay loam.
14. 7	53. 8	26. 0	20. 2	47. 8	7. 1	Sandy clay loam.
10. 6	91. 2	4. 1	4. 7	42. 0	. 3	Sand.
11. 4	89. 0	2. 3	8. 7	42. 7	0	Sand.
11. 0	90. 3	3. 2	6. 5	46. 2	. 5	Sand.
10. 0	91. 5	4. 7	3. 8	43. 4	1. 2	Sand.

TABLE 10.—*Mechanical analyses of the surface 7 inches of four samples of Ulysses clay loam in Texas County, Okla.*

Sample number and location	pH (1:1 ratio)	Organic carbon	Particle size distribution (in millimeters): Very coarse sand (2.0–1.0)	Coarse sand (1.0–0.5)	Medium sand (0.5–0.25)	Fine sand (0.25–0.10)	Very fine sand (0.10–0.05)	Total sand	Silt (0.05–0.002)	Clay (less than 0.002)	International silt (0.2–0.02)	Fine silt (0.02–0.002)	Textural class
		Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	
Sample No. 59–OK–70–MA–1. Location: 250 ft. E. and 150 ft. N. of the SW. corner of the NW¼, sec. 24, T. 2 N., R. 15 E.	8.0	1.12	0.4	2.9	4.1	7.7	14.1	29.2	40.6	30.2	45.6	13.3	Clay loam.
Sample No. 59–OK–70–MA–2. Location: 1,200 ft. E. and 100 ft. N. of the SW. corner of the SW¼, sec. 2, T. 2 N., R. 10 E.	7.9	.87	.3	3.9	5.4	9.5	13.7	32.8	37.0	30.2	43.5	12.2	Clay loam.
Sample No. 59–OK–70–MA–3. Location: 1,400 ft. E. and 200 ft. N. of the SW. corner of the NW¼, sec. 13, T. 6 N., R. 11 E.	8.0	.91	.1	.4	.5	6.5	11.7	19.2	51.2	29.6	50.9	17.1	Silty clay loam.
Sample No. 59–OK–70–MA–4. Location: 800 ft. E. and 100 ft. S. of the NW. corner of the NE¼, sec. 6, T. 5 N., R. 13 E.	8.1	.81	.3	1.3	1.1	5.2	11.7	19.6	49.9	30.5	47.2	18.1	Silty clay loam.

General Nature of the Area

In this section the physiography and climate of the county are discussed. Information is also given about the natural resources and settlement of the county, as well as facts about the growth and present status of agriculture and community facilities.

Physiography, Relief, and Drainage

Texas County is in the High Plains section of the Great Plains province. About two-thirds of the county consists of upland plains that are nearly level. The rest is made up mainly of eroded, rough breaks and narrow flood plains along streams. There are three separate areas of sandhills. The general slope of the county is toward the east, with an average fall of about 16 feet per mile. The elevation is about 3,800 feet in the western part of the county but drops to 2,600 feet in the eastern part.

The upland plains are gently undulating. They consist of broad, low hills that are separated by wide, shallow depressions. In places the hills are 15 to 20 feet high, but the distance between crests is 1 to several miles. Consequently, the slope is very gradual.

The breaks are made up of steeply sloping areas along streams. The breaks and the upland are generally separated by a steep escarpment. Most of the areas adjacent to the younger streams consist of breaks. Generally, the valley floors are narrow, but where the stream valley is wide, the breaks are narrow and the foot slopes that extend down to the valley floor are long. Along the Beaver River, Palo Duro Creek, and Coldwater Creek, the valley floors are mostly about one-half mile wide, but in places they are as much as 1 mile in width.

The largest area of sandhills consists of about 30,000 acres north of Hooker. Other such areas are in the northwestern corner of the county and north of the Beaver River, southeast of Adams.

The Beaver River is the principal stream in the county. It enters the southwestern corner of the county, flows northeast to about the center, and then flows eastward into Beaver County. Its main tributaries are Goff Creek, which drains the northwestern part of the county; Coldwater and Frisco Creeks, which drain the southern part; and Palo Duro Creek, which drains the southeastern corner. There are several small creeks, but these provide limited drainage.

Large areas of the upland have no drainage into stream channels. In the northeastern quarter of the county, all drainage is into circular, depressed areas known as playas. After heavy rains the playas are filled with water. Sometimes, they do not become dry for months or years.

Climate

Texas County has a semiarid climate. Years of drought are followed by several years of greater than normal rainfall. As a result, agriculture in the county is uncertain. The average humidity is low, and the rate of evaporation is high. Strong winds sweep the county in winter and spring. Table 11, compiled from records of the United States Weather Bureau at Goodwell, give temperature and precipitation data typical of the county.

TABLE 11.—*Temperature and precipitation at Goodwell Station, Texas County, Okla.*

[Elevation, 3,300 feet]

Month	Temperature [1]			Precipitation [2]			
	Average	Absolute maximum	Absolute minimum	Average	Driest year (1952)	Wettest year (1942)	Average snowfall
	° F.	° F.	° F.	Inches	Inches	Inches	Inches
December	35. 5	85	−19	0. 58	0. 29	0. 51	4. 0
January	34. 3	83	−17	. 32	(3)	. 30	2. 6
February	38. 7	86	−17	. 54	. 06	. 20	3. 4
Winter	36. 2	86	−19	1. 44	. 35	1. 01	10. 0
March	45. 7	93	−9	. 79	1. 08	1. 40	2. 6
April	56. 9	98	8	1. 44	1. 94	4. 49	. 8
May	64. 6	104	28	2. 57	1. 04	. 95	. 1
Spring	55. 7	104	−9	4. 80	4. 06	6. 84	3. 5
June	72. 4	109	38	2. 33	. 05	8. 86	(3)
July	79. 6	108	41	2. 35	1. 91	1. 42	(3)
August	77. 8	109	41	2. 17	2. 30	2. 32	0
Summer	76. 6	109	38	6. 85	4. 26	12. 60	(3)
September	70. 6	104	30	1. 83	. 22	2. 38	(3)
October	58. 3	100	11	1. 36	. 00	4. 15	. 2
November	45. 2	89	−1	. 66	. 27	. 02	1. 6
Fall	58. 0	104	−1	3. 85	. 49	6. 55	1. 8
Year	56. 6	109	−19	16. 94	9. 16	27. 00	15. 3

[1] Average temperature based on a 45-year record, through 1955; highest temperature on a 40-year record and lowest temperature on a 41-year record, through 1952.
[2] Average precipitation based on a 45-year record, through 1955; wettest and driest years based on a 41-year record, in the period 1911–1955; snowfall based on a 40-year record, through 1952.
[3] Trace.

Although summers are hot, gentle breezes and the low humidity keep them from being uncomfortable. In winter, temperatures sometimes drop to below zero, but these cold spells last only a few days. The daily variation in temperature is generally great; the highest and lowest daily temperatures in Oklahoma are often recorded at Guymon.

The average annual rainfall in the county (fig. 20) is about 17 inches, but it ranged from 27 inches in 1942 to about 9 inches in 1952. During the 10 years from 1931 through 1940, rainfall was below normal, but in 8 of the next 10 years, rainfall was above normal. More than half of the rainfall comes late in spring and in summer. Such distribution is favorable for growing small grains and sorghum.

About two-thirds of the annual snowfall occurs in winter, but heavy snows are not uncommon in March and April. Sometimes blinding, wind-driven snow reduces visibility to zero. During some blizzards, many cattle are lost.

From April through September the average rate of evaporation from an open tank of water is more than 50 inches. The wind velocity in spring is sometimes as much as 35 miles per hour for as long as 12 hours. Wind velocities of more than 27 miles per hour over a period of 24 hours have been recorded at the Goodwell Station. Gusts of wind of much higher velocity have been reported. In dry years winds frequently cause duststorms. Many areas are severely eroded in these storms, particularly if the cover of vegetation is sparse.

According to the Yearbook of Agriculture, 1941, Climate and Man, the length of the average growing season at Goodwell is 191 days. A growing season of only 157 days has been recorded. The average date of the last frost in spring is April 17, and the average date of the first in fall is October 25. The latest killing frost at Goodwell was recorded on May 13, and the earliest, on September 26. At Hooker, the average growing season is only 186 days. Occasionally, late-maturing sorghum is damaged by frost. Wheat has been damaged by frost after it has headed, but such damage is rare.

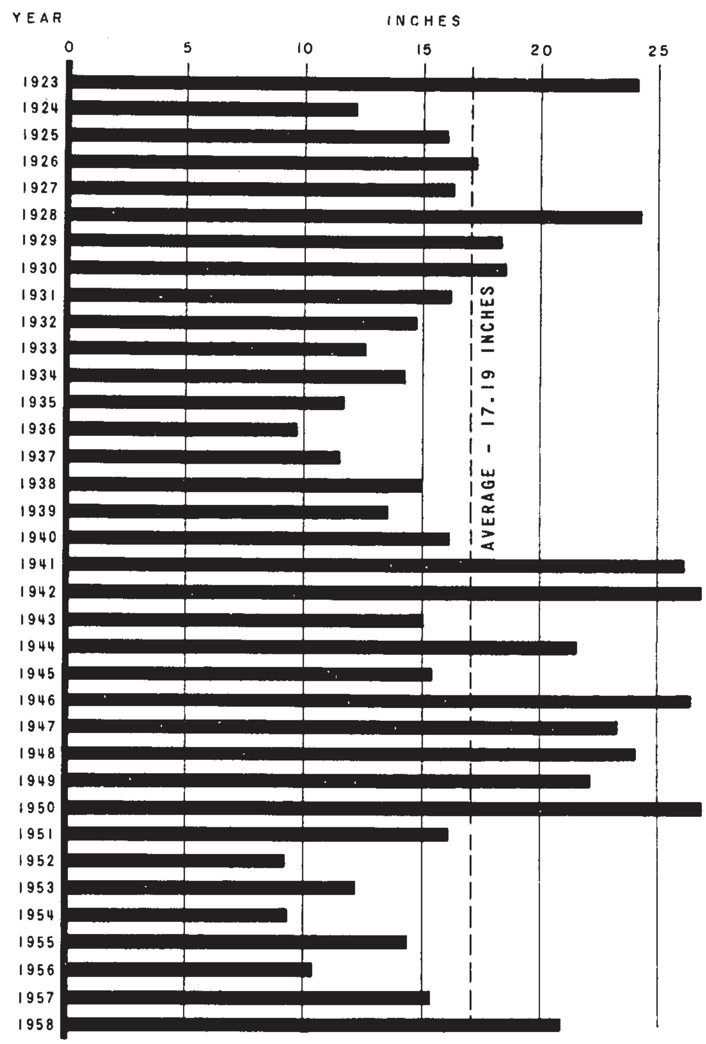

***Figure 20.*—Bar chart, showing average annual rainfall for Texas County, Okla., based on a 36-year record of rainfall at Goodwell.**

Natural Resources

The water supply in Texas County comes mainly from wells and ponds. The wells are drilled deep into the Tertiary gravel that underlies most of the county. Most of the wells in the uplands are 100 to 250 feet deep. They supply 1 to 2 gallons of water per minute if pumped by windmill, and as much as 1,200 gallons per minute if pumped by gas or electric power. The water is of good quality. It is low in sulfates and chlorides but is somewhat hard—200 to 350 parts per million of total hardness—caused mostly by calcium bicarbonate. All water for irrigation, municipal, and domestic use comes from wells. Windmills are commonly used for pumping water on farms and ranches.

More than 500 farm ponds provide water for livestock. A few springs along the Beaver River and some of the creeks—principally Palo Duro and Coldwater—also provide water for such use.

Texas County is in the center of the Guymon-Hugoton gasfield, the largest producing gasfield in the world. The first gas well in the county was drilled in the SW¼ sec. 4, T. 1 N., R. 12 E., in December 1923. There are now 1,373 gas wells producing an average of 180,682,300 M c.f. (thousands of cubic feet) annually.

Two oilfields are in the county—one in the northwestern corner and one in the southeastern corner. The 169 oil wells produce an average of 3,012 barrels daily.

There are a few gravel pits from which gravel of high quality is excavated. The gravel is used for surfacing roads.

Settlement

Texas County, as part of the Oklahoma Panhandle, has been under the jurisdiction of two monarchies, three republics, and two States. The panhandle was part of the Louisiana Purchase acquired by the United States from France in 1803. Its first boundary was established in 1819 by the Florida Treaty between the United States and Spain. Under the terms of this treaty, it came under Spanish rule along with other areas west of the 100th meridian.

In 1821, when Mexico declared herself independent of Spain, this area became a part of Mexico. The empresario land system was used by Mexico to settle the area north of the Rio Grande. By this system an individual, the empresario, was granted hundreds of thousands of acres of land to colonize. Most of Texas County was part of the Chamber's grant, but it was not settled.

In 1836, the Republic of Texas won its independence from Mexico and the panhandle became a part of Texas. It was admitted to the Union along with Texas in 1845. By agreement between the United States and Texas in 1850, the northern boundary of Texas was set at latitude 36° 30′ N., and the western boundary, at the 103d meridian; thereby, the southern and western boundaries of the panhandle were set. Later, when Kansas and Colorado became territories, the northern boundary was set at the 37th parallel. As a result, a narrow strip 166 miles long and 34½ miles wide was left—a No Man's Land.

For many years, herds of buffalo roamed over the vast plains of No Man's Land. The grass was green and lush; the streams were clear and cool. The Kiowa and Comanche Indians made hunting trips into the area every summer. Here, they killed enough buffalo to provide food, covering for their lodges, bowstrings, clothing, and robes. Some of the hides they traded.

As long as the buffalo were plentiful, the Indians kept the whitemen from occupying the plains. After the Civil War, however, hunting parties made up of whitemen came into the area and slaughtered buffalo by the millions. By 1880, most of the buffalo had been killed. The Indians no longer had reason to hunt on the plains, and the way was open for whitemen to move in.

Huge ranches were soon established. Where once the buffalo roamed and the Indian hunted, large herds of cattle grazed, watched over by cowboys. A drift fence of barbed wire was stretched from the eastern boundary of New Mexico Territory to the western boundary of Indian Territory. It consisted of nearly 170 miles of jagged wire that extended along the southern edge of No Man's Land. The fence was to keep cattle in the strip from becoming mixed with cattle on the large ranches in Texas.

In the 1880's, there were several severe blizzards. During one blizzard thousands of cattle moved south to the drift fence. Here, they piled up and trampled each other to death. Others died from starvation and thirst. A few broke through the fence, but many herds were wiped out. The loss was so great that most of the cattlemen left the area, broke and discouraged.

In 1886, after a few settlers had come into No Man's Land and established homes, a post office was opened in Optima. The following year the Provincial Territory of Cimarron was organized in Beaver City. A representative was sent to Washington, D. C., to seek admission of the territory to the United States. Congress heard the representative but did not recognize him officially. In 1890, the area became a part of the Oklahoma Territory and was officially named Beaver County. Now, the area could be legally settled and farmed. As part of Oklahoma, the area joined the United States for the second time in 1907, and Beaver County was divided into three counties—Cimarron, Texas, and Beaver.

Except for a few ranches with headquarters along the Beaver River and Palo Duro and Coldwater Creeks, there were few settlers in the county before 1900. In that year the Rock Island Railroad built its main line across the county. By 1907, the population was 16,448, the largest it has ever been. Drought that lasted for 3 or 4 consecutive years, coupled with the depression of the 1930's, reduced the population to 9,896 in 1940. Ten years of favorable moisture, high wartime prices of wheat, and development of the gasfields swelled the population to 14,235 by 1950.

Agriculture

Use of the land in Texas County for agriculture began in the 1880's when ranchers from Texas came into the area to graze cattle. About 1900, settlers began to break the sod and started farming. The main crops were wheat, grain sorghum, and broomcorn. Until 1914, when yields of wheat were abundant and prices were high, the frequent droughts were discouraging, particularly for those who grew wheat.

During World War I and in the twenties, wheat yields and prices of wheat remained high; thousands of acres were taken out of grass and put into wheat. In 1924 and in 1926, wheat in some fields yielded as high as 75 bushels an acre. Tractors and other machinery soon replaced horses as a source of power on the farms.

Yields of wheat continued high until 1932 when drought came and there were 5 consecutive years when crops failed. Nearly all of the cropland and much of the grassland were bare. Winds swept the loose topsoil away in duststorms so black that even during the day electric lights could not penetrate the darkness. In 1933, more than 95 percent of the areas that had been seeded to wheat was abandoned. About 100,000 bushels of wheat was harvested in the county in comparison to more than 9 million bushels harvested 2 years previously.

In 1941, Texas County farmers and ranchers organized the Texas County Soil Conservation District. The district was organized under State laws to help provide a solution to conservation problems in the area. The activities of the district members are supervised by a board made up of representatives elected by local farmers and ranchers.

Upon the request of the board of supervisors, the Soil Conservation Service of the U. S. Department of Agriculture assigns technical workers to help individual farmers and ranchers in the district. These trained workers assist those who request help in solving their conservation problems. More than 700 farmers and ranchers, farming about half of the acreage in the county, are now receiving such assistance. The district also owns 15 drills for seeding grass. These are used to assist in the revegetation program of the county (fig. 21).

Most agriculture in the county is practiced on a large scale. About two-thirds of the acreage is cultivated, and the rest is in grass. In size, the 1,156 farms average 1,061 acres per farm according to the 1954 Census of Agriculture. Few farms are smaller than 320 acres.

Crops and livestock

Wheat and grain sorghum are the principal crops in the county, but some forage sorghum, broomcorn, and barley are grown. Wheat is grown on the heavy soils. Except in years of above-normal rainfall, sorghum is grown mostly on the sandy soils. Broomcorn occupies 3 to 4 thousand acres and is grown mainly in the southeastern part of the county.

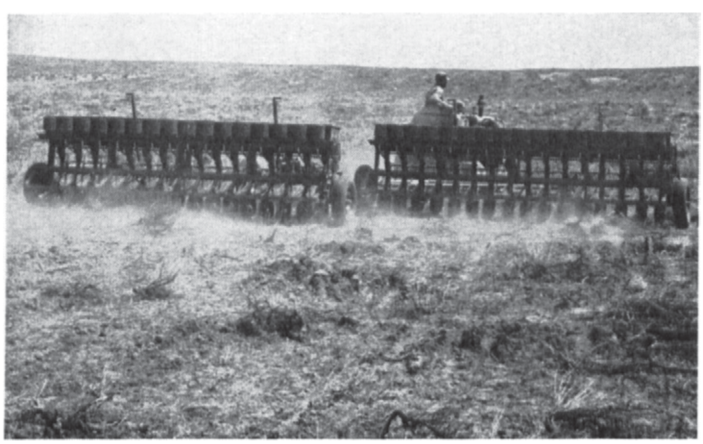

***Figure 21.*—Texas County rancher using two of the district's grass seed drills to overseed rangeland that was in poor condition.**

Water to irrigate crops on the uplands is supplied by deep wells. Grain sorghum and wheat are the main crops irrigated, but some alfalfa is grown and also forage sorghum for ensilage. Meadow hay is cut on about 3,000 acres of subirrigated bottom land along the Beaver River and along Coldwater and Palo Duro Creeks.

The grassland is used for grazing beef cattle. Generally, there are about 30,000 head of cattle on the farms and ranches.

Markets

Each week, cattle sales are held in Guymon and Texhoma, Okla. The volume of sales at Texhoma is among the largest in the Great Plains area.

Nineteen grain elevators, which have a total capacity of 5,861,500 bushels, are located in the county, and 4 elevators that have a total capacity of 3,102,000 bushels are located in Texhoma. At nearby Elkhart and Liberal, Kans., there are also elevators where 4,484,000 bushels of grain can be stored.

Transportation

A total of 239 miles of hard-surfaced State and Federal highways are in the county and 122 miles of hard-surfaced county roads. Each community is served by at least one hard-surfaced road. U. S. Highway 54, which crosses the county diagonally from the northeast to the southwest, serves the largest towns. U.S. Highway 64 and State Highway 3 cross the county from east to west and connect the county with Oklahoma City and Tulsa. Two motor freight lines provide service in the county.

Every community in the county is served by a railroad, and there are 165 miles of railroad track in the county. The main line of the Chicago, Rock Island and Pacific Railroad between Chicago and Los Angeles crosses the county. It runs parallel to U.S. Highway 54.

Airline service connects Guymon with Oklahoma City; Denver, Colo.; Wichita, Kans.; and Amarillo, Tex.

Community facilities

Texas County has 12 school districts, 9 of which offer 12 years of schooling. There is one country school. The school system in Guymon is one of the best in the State. The county also has a senior college—Panhandle A. & M. College at Goodwell. A branch of the Oklahoma Agricultural Experiment Station is connected with the college. A farm that occupies 955 acres is maintained at the Station. In addition, 1,320 acres of rangeland is used for experimental research concerning agriculture on the High Plains.

Churches of many denominations are located in all the towns. There are also several rural churches. Guymon has two hospitals.

Telephones connect all of the towns. According to the 1954 census, there were 1,156 farms in the county. Of these, 468 farm dwellings had telephones, and 1,016 farms had electricity. Piped running water was reported on 838 farms. Nearly all of the farms have natural gas piped from a well on the farm.

In Goodwell, a variety of historical items are displayed in No-Man's-Land Historical Museum. From time to time, an art gallery in the museum displays the works of local artists.

Shultz Lake in the southeastern part of the county and Sunset Lake on the western edge of Guymon provide recreation. A 9-hole golf course and a wildlife park are located at Guymon. Pheasant hunting is good throughout the county. Duck hunting is fair along the Beaver River and around farm ponds.

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Glossary

Aggregate, soil. A single mass or cluster of many soil particles held together, such as a granule, clod, block, or prism.

Alluvium. Sediments deposited on land by streams.

Aquifer. A porous soil or geological formation that yields ground water to wells and springs.

Blowout. An area from which most, or all, of the fine soil material has been removed by wind. Such an area appears as a shallow depression with a flat or irregular floor. The soil is usually barren. Blowouts commonly occur in sandy soils.

Border (irrigation). A small levee or ridge used to divide an irrigated field into narrow strips over which water flows.

Calcareous soil. A soil containing enough calcium carbonate, often mixed with magnesium carbonate, to effervesce (fizz) when treated with dilute hydrochloric acid.

Caliche. A broad term for more or less strongly cemented deposits of calcium carbonate in many soils of warm-temperate areas. When near the surface or exposed by erosion, the material hardens.

Chisel. A tillage machine that has one or more soil-penetrating points that can be drawn through the soil to loosen or shatter the subsoil to a depth of 12 to 18 inches.

Clay. (1) As a soil separate, the mineral soil particles less than 0.002 millimeter (0.000079 inch) in diameter. (2) As a soil textural class, soil material that contains 40 percent or more clay, as defined under (1), less than 45 percent sand, and less than 40 percent silt. (3) In engineering, fine-grained soil particles that are smaller than 0.005 millimeter.

Closed-end terrace channel. An embankment, or ridge, constructed at the end of a terrace across the channel. It is designed to hold the channel two-thirds full of water.

Colluvium. Mixed deposits of soil material and rock fragments near the bases of rather steep slopes. The deposits have accumulated as the result of soil creep, slides, and local wash.

Complex, soil. An intricate mixture of areas of different kinds of soil that are too small to be shown separately on maps of the scale used and are, therefore, mapped as a unit.

Concretions. Rounded and hardened concentrations of chemical compounds, such as calcium carbonate or iron oxides, often formed as concentric rings about a central particle, in the form of hard grains, pellets, or nodules of various sizes, shapes, and colors.

Consistence, soil. The combination of properties of soil material that determine its resistance to crushing and its ability to be molded or changed in shape. Consistence varies with differences in moisture content; thus, a soil aggregate or clod may be hard when dry and plastic when wet. Terms used to describe consistence are:

Friable. When moist, crushes easily under moderate pressure between thumb and forefinger and coheres when pressed together. Friable soils are easily tilled.

Firm. When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable. Firm soils are likely to be difficult to till.

Hard. When dry, is moderately resistant to pressure; can be broken in the hands without difficulty but is barely breakable between thumb and forefinger.

Indurated. Hard and brittle and little affected by moistening.

Loose. Noncoherent when moist or dry. Loose soils are generally coarse textured and are easily tilled.

Plastic. When wet, retains an impressed shape but is readily deformed by moderate pressure; wire formable. Plastic soils are high in clay and are difficult to till.

Sticky. When wet, adheres to thumb and forefinger when pressed; usually, very cohesive when dry.

Soft. Weakly coherent and fragile; when dry, breaks to powder or individual grains under slight pressure.

Diversion. A channel with a supporting ridge on the lower side, constructed across the slope to intercept runoff and minimize erosion, or to prevent excess runoff from flowing onto lower lying areas. In some areas a series of diversions are constructed across the slope similar to terraces, but with greater horizontal and vertical spacing. Also known as Diversion terrace.

Drop-inlet dam. A dam with provision for carrying off overflow through a gently sloping pipe under the dam, connected to an open-topped vertical pipe, or riser, at the pond side of the dam. The length of the vertical riser, or "drop inlet," is most often 5 to 15 feet but may be more.

Erosion-control dam. An embankment constructed across a drain with a pipe spillway or a diversion spillway depending on the purpose of the structure.

Gravel. (engineering definition). A coarse-grained soil of which more than 50 percent is retained on a No. 4 screen.

Head cut. An overfall at the head of a gully.

High bearing soil. A soil that will hold its position and shape under heavy loads.

Impounding-type terrace. A terrace built entirely from the downslope side.

Liquid limit. The moisture content at which a soil changes from a plastic to a liquid state. Sandy soils have low liquid limits, clay soils, high.

Loam. The textural class name for soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand.

Loess. Geological deposit of fairly uniform fine material, mostly silt, presumably transported by wind.

Low-strength soil. A soil unable to stand up under heavy loads without breaking apart.

Mottling. Irregular spots or blotches differing in color from the soil mass and usually associated with poor drainage.

Noncalcareous. Approximately neutral in reaction; neither acid nor alkaline.

Parent material. The unconsolidated mass of rock material (or peat) from which the soil profile develops.

Partial block. A ridge of soil at the end of a terrace and across the channel, designed to hold the channel one-half full of water.

Pipe drop. A small embankment above an overfall with a large pipe through the embankment allowing water to drop to base grade from the end of the pipe.

Pipe spillway. A hooded pipe inlet or a drop inlet used as a principal spillway through an earthen fill.

Plasticity. The degree of cohesiveness of a soil at low moisture content.

Playa. A flat-bottomed, undrained basin that contains water for varying periods following rains. May be dry for long periods.

Poorly graded soils. Coarse-grained soils with soil particles of fairly uniform size.

Profile, soil. A vertical section of the soil through all of its horizons and extending into the parent material.

Reaction. The degree of acidity of the soil mass expressed in pH values or in words as follows:

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline	9.1 and higher.
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

Runoff. Surface drainage of rain or melted snow.

Sand. (1) Individual rock or mineral fragments having diameters ranging between 0.05 millimeter (0.002 inch) and 2.0 millimeters (0.079 inch). Sand grains consist chiefly of quartz, but they may be of any mineral composition. (2) The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay. (3) In engineering, a coarse-grained soil of which more than 50 percent will pass through a No. 4 screen.

Silt. (1) Individual mineral particles that range in diameter from the upper size of clay, 0.002 millimeter, to the lower size of very fine sand, 0.05 millimeter. (2) Soil of the textural class called silt contains 80 percent or more of silt and less than 12 percent of clay. (3) In engineering, fine-grained soil particles that are larger than 0.005 millimeter in diameter.

Soil. The natural medium for the growth of plants on the surface of the earth; composed of organic and mineral materials.

Solum. The upper part of the soil profile above the unweathered parent material. In mature soils the solum includes the A and B horizons (surface soil and subsoil).

Spillway. A passage for draining excess water from behind a dam or other water-retarding structure.

Structure, engineering. An engineering construction consisting of earth, masonry, or a combination of both.

Structure, soil. The arrangement of individual soil particles into aggregates with definite shape or pattern. Structure is described in terms of *class, grade,* and *type.*

Class. Refers to the size of soil aggregates (*fine, medium,* and *coarse*).

Grade. The degree of distinctness and durability of soil aggregates. Grade is expressed as *weak, moderate,* or *strong.* Soil that has no visible structure is termed *massive* if coherent, or *single grain* if noncoherent.

Type. Shape and arrangement of the aggregates.

Blocky, angular. Aggregates are block shaped; they have flat or rounded surfaces that join at sharp angles.

Subangular blocky. Aggregates have some rounded and some plane surfaces; vertices are rounded.

Crumb. Generally, soft, small, porous aggregates, irregular, but tending toward a spherical shape, as in the A_1 horizons of many soils. Crumb structure is closely related to granular structure.

Columnar. Aggregates are prismatic, and the upper end is rounded.

Granular. Roughly spherical, firm, small aggregates that may be either hard or soft but that are generally firmer than crumb and without the distinct faces of blocky structure.

Platy. Thin, flat aggregates arranged normally in a horizontal position.

Prismatic. Soil particles arranged around a vertical line; aggregates have fairly flat, vertical surfaces.

Texture, soil. The relative proportions of sand, silt, and clay in the soil. (See Sand; Silt; Clay.)

Coarse-textured soil. Contains a large proportion of sand and is loose and noncoherent when dry.

Moderately coarse textured soil. Contains a large amount of sand but has enough silt and clay to form fragile clods; individual sand grains easily seen, and soil mass feels gritty.

Medium-textured soil. Contains about equal proportions of sand, silt, and clay; generally friable, but forms stable clods.

Moderately fine textured soil. Contains a large amount of clay; generally hard when dry and firm when moist.

Fine-textured soil. Contains a large proportion of clay; normally, very hard when dry and very firm when moist.

Topography. The elevations or inequalities of the land surface, such as hills, mountains, or plains.

Topsoil (engineering). Soil material containing organic matter and suitable as a surfacing for shoulders or slopes.

Water-spreading system. A series of dams, dikes, or ditches that divert runoff from natural channels or gullies and spread it across the slope over areas of range or meadow. Each diversion impounds a maximum of water, allowing only the excess to flow to the diversion below.

Well-graded soils. Coarse-grained soils that vary widely in size of particles.

Windbreak. A barrier of living trees or shrubs planted to protect fields and buildings from wind.

Winnow. The removal of clay and silt particles from the soil by strong winds; coarser textured particles are left so that the soil becomes sandier and highly erodible.

GUIDE TO MAPPING UNITS [1]

Soil symbol	Soil	Page	Capability unit	Page	Range site	Page
Ba	Bayard fine sandy loam	8	IIIc-2	19	Loamy bottom land	34
BeB	Berthoud loam, 1 to 3 percent slopes	8	IIIe-3	20	Hardland	35
BeC	Berthoud loam, 3 to 5 percent slopes	8	IVe-1	21	Hardland	35
Bp	Bippus clay loam	9	IIIe-3	20	Hardland	35
DaA	Dalhart fine sandy loam, 0 to 1 percent slopes	9	IIIe-2	20	Sandy plains	34
DaB	Dalhart fine sandy loam, 1 to 3 percent slopes	9	IIIe-2	20	Sandy plains	34
DsB	Dalhart loamy fine sand, 0 to 3 percent slopes	10	IVe-3	22	Deep sand	34
DuA	Dalhart-Ulysses loams, 0 to 1 percent slopes	10	IIIe-1	20	Hardland	35
DuB	Dalhart-Ulysses loams, 1 to 3 percent slopes	10	IIIe-3	20	Hardland	35
DuC	Dalhart-Ulysses loams, 3 to 5 percent slopes	10	IVe-1	21	Hardland	35
Ln	Lincoln soils	10	VIs-2	23	Sandy bottom land	34
Lo	Lofton clay loam	11	IIIw-1	21	Hardland	35
MaB	Mansker clay loam, 0 to 3 percent slopes	11	IVe-4	22	Hardland	35
MaC	Mansker clay loam, 3 to 5 percent slopes	11	VIe-2	23	Hardland	35
MnC4	Mansker soils, severely eroded	11	VIe-2	23	Shallow	35
Mp	Mansker-Potter complex	11	VIe-2	23	Mixed hardlands and shallow	35
Ot	Otero fine sandy loam	12	IVe-2	21	Limy sandy plains	34
Ov	Otero-Vona fine sandy loams	12	VIe-1	22	Sandy plains	34
Pt	Potter soils	13	VIIs-1	23	Shallow	35
Pm	Pullman clay loam	13	IIIc-1	19	Hardland	35
Ra	Randall clay	13	Vw-1	22	Hardland	35
Rc	Richfield clay loam	14	IIIc-1	19	Hardland	35
Rf	Richfield fine sandy loam	14	IIIe-2	20	Sandy plains	34
Rt	Richfield loam, thick surface	14	IIIc-1	19	Hardland	35
Sp	Spur soils	15	IIIc-1	19	Loamy bottom land	34
Sw	Sweetwater soils	15	Vw-2	22	Subirrigated	34
Tv	Tivoli fine sand	16	VIIe-1	23	Dune	34
UcA	Ulysses clay loam, 0 to 1 percent slopes	16	IIIe-1	20	Hardland	35
UcB	Ulysses clay loam, 1 to 3 percent slopes	16	IIIe-3	20	Hardland	35
Ve	Vernon loams	17	VIIs-1	23	Shallow	35
VoB	Vona loamy fine sand, 0 to 3 percent slopes	17	VIe-1	22	Deep sand	34
Voc	Vona loamy fine sand, 3 to 8 percent slopes	17	VIe-1	22	Deep sand	34
Vp	Vona, Otero, and Potter soils	17	VIe-1	22	Limy sandy plains	34
WwB	Woodward loam, 1 to 3 percent slopes	18	IIIe-3	20	Hardland	35

[1] Table 1, p. 6, shows the acreage and proportionate extent of the soils, and tables 2 and 3, p. 26 and p. 27, respectively, give estimated yields of crops. For information about the engineering properties of the soils, see the section, Engineering Properties of the Soils, beginning on p. 38.

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