

SOIL SURVEY

Kingfisher County Oklahoma



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

HOW TO USE THE SOIL SURVEY REPORT

THIS SOIL SURVEY of Kingfisher County, Oklahoma, 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; and add to our fund of knowledge about soils.

Soil scientists studied and described the soils and made a map that shows the kind of soil everywhere in the county. Their map, at the back of this report, was made from a set of aerial photographs on which woods, roads, and many other landmarks can be seen.

Locating the soils

Use the index to map sheets to locate areas on the soil map. The index is a small map of the county that shows the location of each sheet of the soil map. When the correct sheet of the soil map is found, it will be seen that the boundaries of the soils are outlined and that there is a symbol for each soil. Suppose, for example, an area on the map has the symbol PoA. The legend for the detailed map shows that this symbol identifies Port clay loam, 0 to 1 percent slopes. This soil and all others mapped in the county are described in the section "Descriptions of Soils."

Finding information

This report has special sections for different groups of readers. The section "General Facts About the County" discusses early history, climate, markets, and other subjects of interest mainly to those not familiar with the county. The section "General Soil Areas and Soil Associations" is useful both to those who are not acquainted with the county and to those who need to plan management of large tracts of land. It tells about the principal patterns of soils, where these are located, and how they differ.

Farmers and those who work with farmers can learn about the soils in the section "Descriptions of Soils," and then turn to the section "Use and Management of Soils." In this way they first identify the soils on their farms and then learn how these soils can be managed and what yields

can be expected. The soils are grouped by capability units; that is, groups of soils that need similar management and respond in about the same way. For example, Port clay loam, 0 to 1 percent slopes, is in capability unit I-1. The management needed for this soil will be found under the heading "Capability Unit I-1," in the section "Use and Management of Soils." The "Guide to Mapping Units," just ahead of the map sheets, gives the name of each soil, the page where it is described, the symbol of the capability unit in which it has been placed, and the page where each capability unit is described.

Farmers who want information about management of native range can turn to the section "Management of Grasslands," where the soils used mainly for grazing have been placed in range sites. A table in that section lists the principal native plants on each range site and estimated yields of forage in favorable and unfavorable years. The name of the range site in which each soil has been placed and the page where it is described is shown in the "Guide to Mapping Units."

Farmers who want to protect their fields, livestock, and homesites from wind will want to read the section "Woodland and Windbreaks." Those interested in improving habitats for wildlife will find this information in the section "Wildlife."

Engineers and builders will find information that will assist them in the section "Engineering Properties of Soils."

Soil scientists and others interested in the nature of soils can learn how the soils were formed and how they are classified in the section "How the Soils Formed and Are Classified."

* * * * *

This soil survey was made as a part of the technical assistance furnished by the Soil Conservation Service to the Kingfisher Soil and Water Conservation District. Help in farm planning can be obtained from the staff of the Soil Conservation Service assisting the district. Fieldwork for this survey was completed in 1959. Unless otherwise indicated, all statements in the report refer to conditions in the county at the time fieldwork was in progress.

Cover picture.—Steers on rye-and-vetch pasture in an area formerly covered with blackjack oak.

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SOIL SURVEY OF KINGFISHER COUNTY, OKLAHOMA

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

KINGFISHER COUNTY is in the central part of Oklahoma. Distances by air from Kingfisher, the county seat, to principal cities in the State are shown in figure 1.

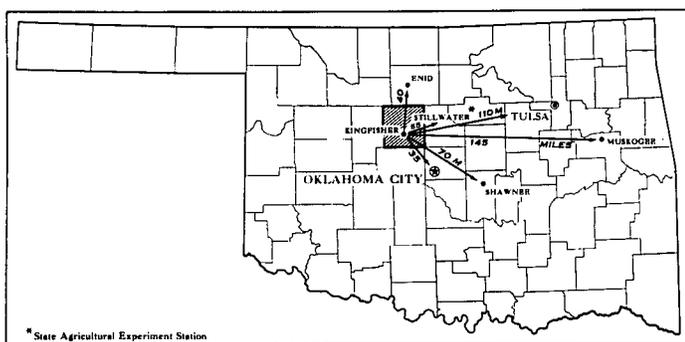


Figure 1.—Location of Kingfisher County in Oklahoma.

General Facts About the County

The land area of this county is 572,160 acres, or about 900 square miles. The county is in the eastern part of the main wheat-growing area of the State. It is in the southern part of the tall-grass prairie in the Central Lowland province of the United States.

The elevation of the county ranges from slightly more than 1,000 feet in the Cimarron River Basin at the east side to slightly less than 1,500 feet in the southwestern corner. At Kingfisher the elevation is 1,055 feet.

The county was opened for settlement by a land run in 1889. A large proportion of the homesteaders came from the Northern States. Many of the early settlers were German and Bohemian; many of the present occupants are of this original stock.

Agriculture

Agriculture is the principal source of income in Kingfisher County. The type of agriculture has changed somewhat during the years. The system of agriculture now practiced is less diversified. Cotton was once one of the principal crops. Now, wheat is the main crop, but other small grains, sorghum, and alfalfa are also grown. Farmers are producing more livestock and planting less acreage to crops than they did in years past.

General use of improved crop varieties and of modern farm machinery, and more knowledge of tillage operations, have gradually increased crop yields. This trend cannot

continue indefinitely. After nearly 70 years of continuous cultivation, the fertility of most of the soils has been lowered. Cultivation without proper practices to conserve the soils has increased erosion, reduced the content of organic matter, and somewhat changed the structure of the soils.

The farm population has steadily decreased, as it has in most areas where farming is the main enterprise. The Federal census shows a farm population of 15,960 in 1930, as compared to 12,860 in 1950, and 10,635 in 1960. The average farm was 283 acres in size in 1954.

Climate

Rainfall fluctuates widely in this county and greatly affects agriculture. The variation in yearly rainfall, in a 61-year period, is shown in figure 2.

Weather records at Kingfisher, the county seat, reveal an average annual rainfall of a fraction more than 29 inches in the period 1898 through 1958. The greatest annual rainfall in the county was recorded as 52 inches, in 1908, and the least, as slightly less than 12 inches, in 1936. May and June are the months of highest rainfall; the average is slightly more than 4 inches per month. Rainfall is least in December, January, and February, when the amount is about 1 inch per month. Much of the rain comes in a short time, usually in June and July, after small grains have been harvested and the fields plowed. Much surface runoff and erosion occurs during these storms.

The average annual temperature is 61° F. at Kingfisher. The average summer temperature is 82°, and the highest temperature recorded is 118°. In winter, the average temperature is 40°, and the record low is -20°. The average frost-free growing season is 208 days, or from April 5 to October 30. The earliest frost recorded in fall was on October 7, and the latest in spring, on May 3.

Transportation and Markets

A main line of the Chicago, Rock Island and Pacific Railroad crosses the county, north to south. U.S. Highway 81 and State Highways 3-33 and 51 carry truck and bus transportation. Most parts of the county have good farm-to-market roads.

Stockyards at Oklahoma City provide good markets for livestock. Some 20 commission firms and 2 large packing plants operate in that city. Wheat, the main market crop, can be handled in local elevators. A farmers' cooperative has elevators at Okarche, Cashion, Kingfisher, Dover, and Hennessey. Private elevators and storage are

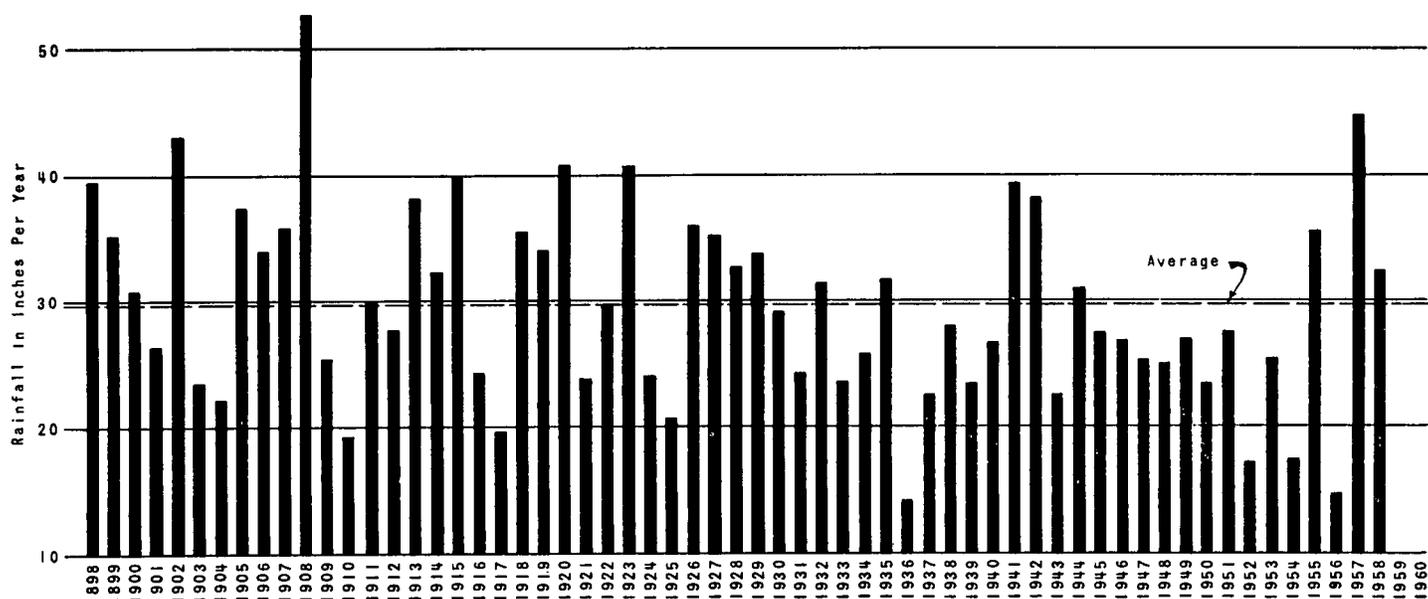


Figure 2.—Yearly precipitation, 1898 through 1958, in Kingfisher County, Oklahoma: precipitation above average in 27 years, below average in 32 years, and average for 2 years.

available at most of these population centers. Milk collection routes run into the county from Oklahoma City, Guthrie, and Enid.

How Soils Are Named, Mapped, and Classified

Soil scientists made this survey to learn what kinds of soils are in Kingfisher County, where they are located, and how they can be used.

They went into the county knowing they likely would find many soils they had already seen, and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size and flow of streams; kinds of native plants or crops; kinds of rock; and many facts about the soils. They dug or bored many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down to the rock material that has not been changed much by leaching or by deep-rooted plants or trees.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to uniform procedures. Consequently, to use this report efficiently, it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first described and mapped. Port and Yahola, for example, are the names of two soil series. All

the soils in the United States having the same series name are essentially alike in natural characteristics.

Many of the soil series contain soils that are alike except for texture of their surface layer. According to this difference in texture, separations called soil types are made. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Port silt loam and Port clay loam are two soil types in the Port series. The difference in texture of their surface layers is apparent from their names.

Some soil types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into soil phases. The name of a soil phase indicates a feature that affects management. For example, Port silt loam, 0 to 1 percent slopes, is one of two phases of Port silt loam, a soil type that in this county has a slope range of 0 to 3 percent.

After a fairly detailed guide for classifying and naming the soils had been worked out, the soil scientists drew soil boundaries on aerial photographs. They used photos for their base map because the photos show woodlands, buildings, field borders, trees, and similar details that greatly help in drawing boundaries accurately. The soil map in the back of this report was prepared from the same aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil type or a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil type or soil phase.

In preparing some detailed maps, the soil scientist has a problem of delineating areas where different kinds of soils

are so intricately mixed and so small in size that it is not practical to show them separately on the map. Therefore, he shows this mixture of soils as one mapping unit and calls it a soil complex. Ordinarily, a soil complex is named for the major soil series in it, for example, Kingfisher-Lucien complex, 5 to 8 percent slopes, eroded. Also, in most mapping, there are areas to be shown that are so rocky, so shallow, or so frequently worked by wind and water that they cannot be called soils. These areas are shown on a soil map like other mapping units, but they are given descriptive names, such as Broken alluvial land, and are called miscellaneous land types rather than soils.

Only part of the soil survey was done when the soil scientist had named and described the soil series and mapping units, and had shown the location of the mapping units on the soil map. The mass of detailed information he had recorded then needed to be presented in different ways for different groups of users, among them farmers, managers of woodlands and rangelands, and engineers.

To do this efficiently, he had to consult with persons in other fields of work and jointly prepare with them groupings that would be of practical value to different users. Such groupings are the capability classes, subclasses, and units, designed mainly for those interested in producing crops and tame pasture; range sites, for those using large tracts of native grass; and the engineering classifications, for those who build highways or structures to conserve soil and water.

General Soil Areas and Soil Associations

Kingfisher County has four general soil areas, or distinctive kinds of landscape. These are the Flood plains, Prairies, Blackjack-post oak savannas, and Sandhills. Within each of these four kinds of landscape there are one or more easily recognized patterns of soils, called soil associations. The pattern of soils is fairly uniform in each association, but the soils in any one association may be much alike or greatly different. Also, the same kind of soil may appear in more than one soil association. The soil associations of this county are shown in figure 3.

Flood Plains

The flood plains, or alluvial lands, occupy about 16 percent of the county. In this general soil area there are two soil associations, the Yahola-Lincoln, and the Port.

Yahola-Lincoln soil association

The Yahola-Lincoln soil association is on flood plains along the Cimarron River. The dominant soils, the Yahola and Lincoln, occupy about equal acreage. Together they account for about three-fifths of the association. The rest of the association consists mainly of Wet alluvial land and of Sand dunes, Lincoln material.

The Yahola soils are sandy, reddish, calcareous soils moderately productive of all crops suited to this part of the State. They are on the large, nearly level parts of the association and are often inundated. About three-fourths of their acreage is tilled, and the rest is used as range.

The Lincoln soils are sandy, grayish-brown, calcareous soils that are frequently flooded. They are in low areas, bends, and strips along the Cimarron River. About a fourth of their acreage is farmed, and the rest is used for range. Sand dunes, Lincoln material, is on ridges of stabilized sand dunes that rise 10 to 20 feet above the flood plain. It is used for range. Wet alluvial land is in frequently flooded areas, has a high water table, and is grazed or lies idle.

Port soil association

This soil association is on flood plains or alluvial bottom lands along small streams. It is named for the Port soils, which occupy about two-thirds of the total acreage. The rest of the association is occupied mainly by Clayey saline alluvial land and Broken alluvial land.

The Port soils are deep, reddish-brown, friable, and nearly level. They are well suited to crops. Clayey saline alluvial land occurs along some intermittent creeks and in areas bordering or within larger areas of Port soils. These areas are very difficult to till, moderately saline over much of their extent, and suitable as pasture or range. Broken alluvial land occurs where streams have cut deep, wide channels; it is used for pasture or as habitats for wildlife.

A cash-crop agriculture is practiced on the soils of this association. Wheat, the main crop, produces higher returns than any other crop grown. Alfalfa is well suited to the Port soils, and some farmers include it in a crop rotation to increase the yield of wheat or other nonlegume crops.

Prairies

The prairies general soil area covers about 69 percent of the county and contains four soil associations, the Kingfisher-Renfrow, Tabler-Drummond, Bethany-Norge, and Shellabarger-Pratt.

Kingfisher-Renfrow soil association

This soil association, the most extensive in the county, is mostly south of the Cimarron River and in the north-eastern part of the county. The soils are locally known as hardlands. They have good drainage and are eroded only in small areas on strong slopes. They are fertile and respond to good management. Wheat is the most important crop.

Kingfisher soils and Renfrow soils each cover about one-third of the acreage in this association. They are deep, reddish silt loams and clay loams that are nearly level to gently rolling. Kirkland and Vernon soils, used mostly for small grains, occupy about a fifth of the total area. The rest of the association is made up of Alluvial and broken land, Vernon soils and Rock outcrop, and Rough broken land, which are used for grazing. These last-named soils and land types are designated "Vernon-Renfrow" on figure 3. One such area is in the south-western corner; another, near the northwestern corner; and a third, near the northeastern corner.

Tabler-Drummond soil association

This association consists of gray or grayish-brown, droughty, claypan soils that are low in productivity. The largest areas occur intermittently in a tract beginning

5 miles southeast of Hennessey and extending southeast to the old townsite of Columbia.

The Tabler soils, which cover 15 times as much of this association as the Drummond soils, are used for small grains. Tabler soils are deep, dark-colored, clayey, and very slowly drained. The Drummond soils are not suitable for cultivation and are in native pasture. They are deep, light-colored soils marked by low mounds and intervening eroded spots.

Bethany-Norge soil association

The larger areas of this association are near Loyal, near Hennessey, and in the southwestern part of the county. Bethany and Norge soils occupy all but one-seventh of the total acreage. These are productive soils that are deep, dark, and nearly level to gently sloping. They are used mostly for small grains.

The rest of the soil association consists of Pond Creek soils, which are as desirable for farming as the Bethany and Norge soils, and of Norge-slickspot complexes, which are not well suited to cultivation and are used mainly for grazing.

Shellabarger-Pratt soil association

This soil association is composed mostly of Shellabarger and Pratt soils, in almost equal acreage, and of minor areas of Carwile soils. The larger areas of the association are north of the Cimarron River, west of U.S. Highway No. 81, and northwest of Kingfisher. Shellabarger soils are deep, brown, fine sandy loams, and the Pratt are deep, brown, loamy fine sands. These soils are suited to all crops commonly grown in this part of the State, and to vegetables and fruits.

On this soil association, growing of crops and raising of livestock is done on farms of about average size for the county. There are more operators who own and live on their farms than on the Kingfisher-Renfrow soil association. Residence is necessary because the farming is of the kind that requires close supervision. The soils need good conservation cropping systems to protect them from wind erosion and to maintain their fertility. Pasture and range on these soils respond to good management.

Blackjack-Post Oak Savannas

The blackjack-post oak savannas make up about 10 percent of the county. They consist of one soil association, Dougherty-Eufaula.

Dougherty-Eufaula soil association

The largest area of this association begins about 2 miles east of Dover and extends east to the county line. A

smaller area begins west of Hennessey, where the Drummond highway intersects Oklahoma State Highway No. 51, and extends south for about 5 miles. These areas have nearly level, undulating, or hummocky relief.

The principal soils in this association are Dougherty-Eufaula, which occupy about seven-tenths of the total acreage, and the Carwile. The Dougherty and Eufaula soils, mapped together in this county, are deep, grayish-brown and brown sandy soils that are low in fertility and productivity. The Carwile soils are unlike the Dougherty-Eufaula soils and cover a smaller acreage. About half of the soil association has a cover of blackjack oak; it has few big trees.

Crops and livestock are produced on this soil association. The soils in nearly level and undulating areas are suitable for cultivation if a cropping system is used that will control wind erosion and increase fertility. Introduced pasture grasses and native grasses will respond to good management.

Sandhills

The sandhills general soil area covers about 5 percent of the county and contains one soil association. This general area forms a band, or strip, of large hills on the valley floor that roughly parallels the north side of the Cimarron River. Isolated sandhills are on the sandy uplands.

Eufaula-Tivoli soil association

This association consists of Eufaula and Tivoli soils. On this soil association livestock is produced on ranches. Control of grazing and other good range management are needed to protect the Tivoli soils from wind erosion. The Eufaula soils occupy about three-fourths of the total acreage. They are deep, brown loamy fine sands that have a mixed cover of grasses and trees. The Tivoli are deep, grayish-brown fine sands that have a sparse cover of grasses and sagebrush.

Descriptions of Soils

This section is for those who want detailed information about the soil series and mapping units in Kingfisher County. It describes the soil series, or groups of soils, and the single soils, or mapping units. The descriptions are arranged in alphabetic order, by series name.

An important part of the description for each soil series is the soil profile. This is a record of what the soil scientist saw and learned when he dug into the ground. The profile described for each series is "typical"; that is, average, or modal, for the series. All the soils of one series have essentially the same profile. The differences, if any, are explained in the description of each soil, or are evident in the name of the soil. To illustrate, a detailed profile is described for the Port series, and the reader can assume that the Port soils mapped in Kingfisher County have essentially this kind of profile.

In describing soils, some technical terms and special methods of recording information are used simply because there seems to be no other practical way to report, accurately and briefly, what readers need to know about soils. Most of these terms are defined in the Glossary at the back of this report.

Explanation of figure 3

Flood plains:

Yahola-Lincoln soil association (along Cimarron River)

Port soil association (along local streams)

Prairies:

Kingfisher-Renfrow soil association

Table-Drummond soil association

Bethany-Norge soil association

Shellabarger-Pratt soil association

Blackjack-post oak savannas:

Dougherty-Eufaula soil association

Sandhills:

Eufaula-Tivoli soil association

TABLE 1.—Approximate acreage and proportionate extent of the soils

Symbol	Soil name	Acres	Percent
Ab	Alluvial and broken land.....	34, 660	6. 1
BeA	Bethany silt loam, 0 to 1 percent slopes.....	26, 700	4. 7
Br	Broken alluvial land.....	11, 000	1. 9
Ca	Carwile loamy fine sand.....	14, 700	2. 6
Cv	Clayey saline alluvial land.....	4, 900	. 9
DeB	Dougherty-Eufaula loamy fine sands, undulating.....	20, 600	3. 6
DeC	Dougherty-Eufaula loamy fine sands, hummocky.....	21, 500	3. 8
Dr	Drummond soils.....	400	. 1
Eu	Eufaula fine sand.....	21, 900	3. 8
KfB	Kingfisher silt loam, 1 to 3 percent slopes.....	23, 500	4. 1
KfC	Kingfisher silt loam, 3 to 5 percent slopes.....	27, 600	4. 8
KgD3	Kingfisher-Lucien complex, 5 to 8 percent slopes, eroded.....	6, 300	1. 1
KhB	Kingfisher-slickspot complex, 1 to 3 percent slopes.....	2, 700	. 5
KhC	Kingfisher-slickspot complex, 3 to 5 percent slopes.....	1, 200	. 2
KrA	Kirkland silt loam, 0 to 1 percent slopes.....	3, 400	. 6
Lc	Lincoln loamy fine sand.....	7, 300	1. 3
Ln	Lincoln sand.....	3, 000	. 5
NoA	Norge fine sandy loam, 0 to 1 percent slopes.....	10, 800	1. 9
NoB	Norge fine sandy loam, 1 to 3 percent slopes.....	32, 500	5. 7
NsB	Norge-slickspot complex, 1 to 3 percent slopes.....	5, 900	1. 0
NsC3	Norge-slickspot complex, 3 to 5 percent slopes, eroded.....	600	. 1
PcA	Pond Creek silt loam, 0 to 1 percent slopes.....	1, 800	. 3
PcB	Pond Creek silt loam, 1 to 3 percent slopes.....	3, 600	. 6
PfB	Pratt loamy fine sand, undulating.....	30, 500	5. 3
PfC	Pratt loamy fine sand, hummocky.....	17, 000	3. 0
PoA	Port clay loam, 0 to 1 percent slopes.....	21, 800	3. 8
PsA	Port silt loam, 0 to 1 percent slopes.....	18, 600	3. 3
PsB	Port silt loam, 1 to 3 percent slopes.....	6, 200	1. 1
RcA	Renfrow clay loam, 0 to 1 percent slopes.....	7, 300	1. 3
RcB	Renfrow clay loam, 1 to 3 percent slopes.....	51, 100	8. 9
Rg	Rough broken land.....	4, 000	. 7
Sa	Sand dunes, Lincoln material.....	4, 800	. 8
ShA	Shellabarger fine sandy loam, 0 to 1 percent slopes.....	6, 500	1. 1
ShB	Shellabarger fine sandy loam, 1 to 3 percent slopes.....	16, 000	2. 8
ShC	Shellabarger fine sandy loam, 3 to 5 percent slopes.....	18, 600	3. 3
ShD3	Shellabarger fine sandy loam, 5 to 8 percent slopes, eroded.....	4, 100	. 7
Ta	Tabler clay loam.....	3, 700	. 6
Ts	Tabler-slickspot complex.....	2, 300	. 4
Tv	Tivoli fine sand.....	4, 600	. 8
VcB	Vernon clay loam, 1 to 3 percent slopes.....	6, 400	1. 1
VcC3	Vernon clay loam, 3 to 5 percent slopes, eroded.....	31, 700	5. 5
Vr	Vernon soils and Rock outcrop.....	20, 000	3. 5
Wa	Wet alluvial land.....	2, 700	. 5
Ya	Yahola fine sandy loam.....	7, 700	1. 3
	Total ¹	572, 160	100. 0

¹ Land area; does not include 6,400 acres of water.

The letters *A*, *B*, and *C* are used to designate layers, or horizons, in a soil profile. Each letter conveys special meaning, as is explained in the Glossary. Most readers, however, need only to remember that *A* indicates the top layer, or layers, reaching to a depth of 5 to 8 inches; the letter *B*, subsoil layers; and *C*, the parent material from which the *A* and *B* layers were formed. The *A*, *B*, and *C* horizons can be divided; for example, *A*₁, *A*₂, and *A*₃.

The thickness of a soil layer varies from place to place. Hence, in the typical profile for each series, the thickness in inches that starts the description of each layer is the thickness at the location sampled. The range of thickness for this layer, considering the many other profiles of soil series that were observed, is given at the end of the description for each layer.

The boundaries between horizons are described to indicate their thickness and shape. The terms for thickness are (1) *abrupt*, if less than 1 inch thick; (2) *clear*, if about 1 to 2½ inches thick; (3) *gradual*, if 2½ to 5 inches thick; and (4) *diffuse*, if more than 5 inches thick. The shape of boundaries is described as *smooth*, *wavy*, *irregular*, or *broken*.

Colors of soil layers are given in words and in Munsell notations; for example, "dark grayish brown (10YR 4/2)." The Munsell notations describe color more precisely than can be done in words; they are used mainly by those who need to make close comparisons among soils. In this report, colors are given for the soil when dry and when moist. If the word description of color is not followed by "when moist," this means that the color is for dry soil.

Texture, or the content of sand, silt, and clay, is determined by the way the soil feels when rubbed between the fingers, and by laboratory analysis.

Structure, or the aggregates in soil layers, is described to indicate strength or grade (*weak*, *moderate*, or *strong*); size (*very fine*, *fine*, *medium*, *coarse*, or *very coarse*); and shape (*platy*, *prismatic*, *columnar*, *blocky*, *subangular blocky*, *granular*, or *crumb*). Soils without definite structure, or aggregates, are described as *single grain* (sands) or *massive* (clays).

The location and distribution of the soils are shown on the soil map at the back of this report. Within some of the mapping units delineated on this map there are areas covering less than 5 acres that are in some way different from the mapping unit in which they occur. These areas are marked with special symbols, which are explained in the legend for the soil map. The acreage and proportionate extent of the soils are shown in table 1.

Alluvial and broken land

Alluvial and broken land (Ab) is in small natural side drains in the prairie upland. These drains feed into larger creeks; they are 100 to 300 feet wide and a few feet to about 50 feet deep. They are dotted with scattered stands of trees.

Vernon-like soil material occupies most of the drainage-way, except the narrow strip on the stream floor where alluvium has been deposited. In some places the stream channel has cut through the alluvium and exposed the underlying red beds.

In many areas short, steep slopes end at benches, which, in turn, grade in steplike progression to the alluvium of the stream floor. Geologic erosion, followed by slight to

moderate accelerated erosion, keeps many of these areas raw and unproductive.

Nearly all of this mapping unit is in native vegetation and is used for pasture or range. Much rainfall runs off, and if this land were cultivated, it would be subject to moderately severe water erosion. (Capability unit VIe-1; Red Clay Prairie range site)

Bethany series

The Bethany series consists of deep, dark-colored, silty soils on nearly level uplands. They are in the north-central and west-central parts of the county. The native vegetation was a thick cover of tall grasses.

The soils are granular and permeable in the surface and subsurface layers. The surface layer is dark brown to dark grayish brown and averages about 16 inches in thickness. Beneath this is a slowly permeable dark grayish-brown layer, 18 to 28 inches thick, that grades to the lighter colored, mildly alkaline parent material.

The Bethany soils differ from the Kirkland soils mainly in having a thicker surface layer and a thicker, 2- to 3-inch, transitional layer that overlies the compact subsoil. The Bethany soils have a darker colored surface layer than the Pond Creek soils and are less red and permeable in the substratum.

Profile description: Bethany silt loam in native grass pasture on 0 to 1 percent slopes (north side of road, about 300 feet north and 800 feet west of southeast corner of sec. 13, T. 19 N., R. 7 W.).

- A₁₁ 0 to 9 inches, dark grayish-brown (10YR 4/1.5) silt loam, very dark brown (10YR 2/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; neutral; gradual boundary. 8 to 10 inches thick.
- A₁₂ 9 to 15 inches, dark grayish-brown (10YR 4/2), heavy silt loam, very dark brown (10YR 2/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; neutral; gradual boundary. 6 to 8 inches thick.
- B₁ 15 to 18 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, very fine, subangular blocky and medium granular structure; hard when dry, firm when moist; fine roots are common; neutral; gradual boundary. 3 to 7 inches thick.
- B₂ 18 to 32 inches, dark grayish-brown (10YR 4/1.5) silty clay, very dark brown (10YR 2/2) when moist; moderate, coarse, blocky structure; extremely hard when dry, very firm when moist; slowly permeable; neutral; gradual boundary. 10 to 15 inches thick.
- B₃ 32 to 54 inches, grayish-brown (2.5Y 5/2) clay loam, very dark grayish brown (2.5Y 3/2) when moist; weak, medium, blocky structure; very hard when dry, very firm when moist; contains concretions of lime; gradual boundary. 15 to 30 inches thick.
- C 54 to 75 inches +, light brownish-gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) when moist; coarsely mottled with yellowish red; this layer contains fewer lime concretions than the one above; soil mass, excluding the concretions, is noncalcareous.

Bethany soils are uniform over much of their area. The surface layer ranges from 14 to 18 inches in thickness. In places there is a weak A₂ horizon above the compact subsoil; it is 2 to 3 inches thick and shows faint to distinct gray films on the ped faces.

Bethany soils are medium in internal drainage and absorb water slowly. They contain a good supply of organic matter and no injurious salts.

Bethany silt loam, 0 to 1 percent slopes (BeA), occupies a large acreage adjoining the town of Hennessey. Other

areas are near Loyal and south of the Cimarron River, in the western half of the county.

This soil is nearly level but moderately difficult to till. Nevertheless, all of it except a few small areas in native pasture is now cultivated. Most of it lies where rainfall is near maximum for the uplands. Fair distribution of fall rain, snows in winter, and heavy rainfall late in spring make it one of the most desirable soils in the county for small grains. Winter wheat is the principal crop. (Capability unit I-2; Claypan Prairie range site)

Broken alluvial land

Broken alluvial land (Br) consists of reddish-brown, friable, loamy alluvium. It lies in rather narrow belts along streams that have cut deep, wide channels. The steep banks are up to 50 feet high but average about 20 feet. The channels range from 100 to 300 feet in width and are widest at the sharp bends. This land supports a thick stand of trees, mainly elm and cottonwood, and a mixed undergrowth that includes some shrubs and tall grasses.

This land is suitable as pasture and as a habitat for wildlife. (Capability unit Vw-1; Loamy Bottom Land range site)

Carwile series

The Carwile series is made up of deep, light-colored, nearly level, sandy soils on uplands. These soils are north of the Cimarron River and in the west-central part of the county.

The surface layer is grayish brown, very friable, and 10 to 20 inches thick. Beneath it is a very compact subsoil that is mottled with gray, brown, yellow, and red.

The parent material is mixed sands and sandy clays, 50 to 90 feet thick, that overlie the Permian red beds.

The Carwile soils differ from the Dougherty and Eufaula soils because they lack an A₂ horizon and have a heavy, mottled B₂ horizon. They are similar to the Pratt soils in their surface horizon, but they have a more distinct B horizon. They have a slightly coarser texture in their surface layer than the Shellabarger soils, and their subsoil is less reddish and less permeable.

Profile description: Carwile loamy fine sand in a cultivated field on 0 to 1 percent slopes (east side of road, about 400 feet south and 100 feet east of southwest corner of the Greenwood Cemetery, in northwest corner of SW $\frac{1}{4}$ sec. 5, T. 16 N., R. 8W.).

- A₁ 0 to 12 inches, grayish-brown (10YR 5/2) loamy fine sand, dark brown (10YR 3/3) when moist; weak, fine, granular structure; soft when dry, very friable when moist; slightly acid; clear boundary. 10 to 20 inches thick.
- A₃ 12 to 20 inches, grayish-brown (10YR 5/2) fine sandy loam, dark brown (10YR 3/3) when moist; weak, very fine, granular structure; very friable when moist; fine roots and pores are common; neutral; gradual boundary. 8 to 12 inches thick.
- B₁ 20 to 27 inches, brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 4/4) when moist; moderate, medium, granular structure; a few fine roots and pores; neutral; clear boundary. 4 to 8 inches thick.
- B₂ 27 to 40 inches, yellowish-brown (10YR 5/8) sandy clay, strong brown (7.5YR 5/8) when moist; moderate, medium, granular structure; hard when dry, friable when moist; gradual boundary. 6 to 15 inches thick.
- B_{ca} 40 to 50 inches, mottled red (2.5YR 5/8) clay, light gray (10YR 7/1) when dry; mottles are medium, prominent, and many; massive; firm when moist, hard when dry; several iron manganese concretions 5 to 15 millimeters across; moderately alkaline; grades to clay and sand.

The surface layer ranges from 10 to 20 inches in thickness but averages about 16 inches. It ranges from light grayish brown to brown (hue 10YR, value 4 to 6, chroma 2). The subsoil is mottled yellow, brown, and gray, all in hues of 10YR.

Carwile soils are in level or slightly depressed areas. In some places they are under water for several days at a time in rainy seasons. In May 1957 some of the low areas were under 4 to 6 feet of water. This ponding can be beneficial in years of drought. The soils are susceptible to wind erosion if they are clean tilled.

Carwile loamy fine sand (Ca) is in nearly level or slightly depressed areas. It is tilled for small grains, summer crops, and legumes. Wheat is the principal cash crop.

Excess water that ponds and damages crops is fairly common. Wind erosion occurs in fields where clean tillage is excessive or crop residues are lacking. (Capability unit IIw-1; Sandy Prairie range site)

Clayey saline alluvial land

Clayey saline alluvial land (Cv) is red to reddish-brown, fine-textured alluvium spotted with saline areas. It is on alluvial lands along some of the large creeks that drain out of raw, clayey red beds. Typically, it is cut by narrow and crooked, shallow, dry stream channels.

The surface layer is red to reddish-brown, calcareous clay; it grades to red, stratified silty clay and mixed sediments. The parent material is fine-textured, water-laid sediments from the nearby clayey red beds.

This land differs from the Port soils in age of parent material, texture, droughtiness, fertility, and salinity. It is more difficult to till and is overflowed more frequently.

This clayey saline land supports a thick stand of grasses, principally switchgrass, vine-mesquite, western wheatgrass, and inland saltgrass. It is poorly drained and absorbs water slowly. Crop yields are low. This land is best suited to native pasture or range, and most of it is used for those purposes. (Capability unit IVw-1; Alkali Bottom Land range site)

Dougherty series

The Dougherty soils in this county are mapped only with those of the Eufaula series. They are deep, light-colored, sandy soils on uplands north of the Cimarron River. They are loose to friable.

The surface layer is grayish brown. In undulating areas it averages about 32 inches in thickness, and in hummocky areas, about 23 inches. Beneath this is a yellowish-red layer, 24 to 44 inches thick, that grades to reddish-yellow sandy material.

The parent material is sandy, coarse-textured, and water-sorted; it has been reworked by wind and is on a deep mantle that overlies red beds. These soils formed under a thick cover of tall grasses, blackjack oak, and post oak.

The Dougherty soils are similar to the Pratt soils but have a medium acid surface layer and subsoil. The boundary between the A₂ horizon and the sandy loam subsoil is clear.

Profile description: Dougherty loamy fine sand, hummocky, with native cover of trees and tall grasses (east side of road, about 450 feet north of southwest corner of sec. 13, T. 18 N., R. 7 W.).

- | | |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A ₁ | 0 to 7 inches, grayish-brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; structureless; soft when dry, very friable when moist; medium acid; gradual boundary. 6 to 9 inches thick. |
| A ₂ | 7 to 23 inches, light-brown (7.5YR 6/4) loamy fine sand, brown (7.5YR 5/4) when moist; structureless; nearly loose; very rapidly permeable; medium acid; clear boundary. 12 to 20 inches thick. |
| B ₂ | 23 to 32 inches, yellowish-red (5YR 4/6), heavy sandy loam, yellowish red (5YR 4/8) when moist; structureless; very hard when dry, friable when moist; moderately permeable; medium acid; gradual boundary. 9 to 20 inches thick. |
| B ₃₁ | 32 to 49 inches, yellowish-red (5YR 5/8) loamy fine sand, yellowish red (5YR 4/8) when moist; structureless; hard when dry, friable when moist; porous and permeable; neutral; gradual boundary. 10 to 20 inches thick. |
| B ₃₂ | 49 to 70 inches, transition between the horizon above and below; neutral. |
| C | 70 to 100 inches +, reddish-yellow (5YR 6/8) fine sand, yellowish red (5YR 5/8) when moist; structureless; nearly loose; permeable; neutral. |

Dougherty soils intergrade with Eufaula soils (see Eufaula series for profile description). Their surface layer is brown, under native vegetation, to grayish brown where farmed (hue 10YR to 7.5YR, value 4 to 5, chroma 2).

The subsoil is strong brown to reddish yellow (hue 7.5YR to 5YR, value 5 to 6, chroma 6 to 8). It is sandy loam grading to loamy sand and fine sand.

Dougherty soils have a low supply of organic matter but contain no injurious salts. There is little surface runoff, except on the steeper, tilled slopes. The soils absorb water moderately rapidly, but after a hard rain a small amount of water accumulates in some low places.

Dougherty-Eufaula loamy fine sands, undulating (DeB), are desirable for farming. They are easily tilled and suitable for nearly all crops grown in the county.

Most of the acreage is tilled; wind erosion is the main problem after cultivation.

Eufaula soils make up about 20 to 25 percent of this mapping unit, and Dougherty soils, the rest. (Capability unit IIIe-5; Deep Sand Savannah range site)

Dougherty-Eufaula loamy fine sands, hummocky (DeC), are not very desirable soils for farming. Their surface layer is a little thinner than that of Dougherty-Eufaula loamy fine sands, undulating. It averages about 23 inches in thickness, as compared to about 32 inches for the undulating soils. About a third of the acreage is cultivated.

The Eufaula soils make up about 25 to 30 percent of this mapping unit, and the Dougherty soils, the rest. (Capability unit IVe-4; Deep Sand Savannah range site)

Drummond series

The Drummond series consists of deep, light brownish-gray, loamy and clayey soils. They are in the east-central part of the county. The areas are made up of low mounds and intervening eroded spots. The vegetation is a spotty stand of grasses.

The surface layer is loamy and granular in the mound areas and clayey and dense in the eroded spots between the mounds. The surface layer on the mounds is light brownish gray and averages about 6 inches in thickness. Beneath it is a very dark grayish-brown layer, 8 to 10 inches thick, that grades to lighter colored calcareous material.

The parent material is mostly fine textured and alkaline. It probably is of eolian origin, is 15 to 25 feet deep, and overlies the red beds.

Profile description: Drummond soil on a mound with slopes of 0 to 1 percent, in a rangeland area.

- A₁ 0 to 6 inches, light brownish-gray (10YR 6/2) silt loam, dark brown (10YR 3/3) when moist; weak, very fine, granular structure; friable when moist, soft when dry; slightly acid; abrupt boundary. 3 to 7 inches thick.
- B₂ 6 to 14 inches, very dark grayish-brown (10YR 3/2) clay, very dark brown (10YR 2/2) when moist; medium columnar structure to strong to medium, coarse, blocky structure; very hard when dry, very firm when moist; moderately alkaline; gradual boundary. 6 to 12 inches thick.
- B₃ 14 to 38 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) when moist; white (10YR 8/2) films on peds; strong, medium, subangular blocky structure; very hard when dry, very firm when moist; contains concretions of lime; moderately alkaline; gradual boundary. 20 to 30 inches thick.
- C 38 to 48 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) when moist; massive; very hard when dry, very firm when moist; calcareous; grades to moderately alkaline material.

Eroded slick spots cover 35 to 40 percent of the area; the rest consists of low, loamy mounds. In eroded spots there is a thin surface crust over brown compact clay.

Drummond soils are poorly drained. They absorb water very slowly in the mound areas and practically not at all in the eroded spots. Injurious salts are at the surface in many places.

Drummond soils (Dr) are not suitable for cultivation. They are all in native pasture.

Under good management, switchgrass, alkali sacaton, and inland saltgrass are dominant, and there is some blue grama and buffalograss. (Capability unit Vs-1; Slickspot range site)

Eufaula series

In the Eufaula series are deep, brown, loose, sandy soils. They formed under a mixed cover of tall grasses and trees along the Cimarron River.

The surface layer averages about 15 inches in thickness and is slightly acid. Beneath it is a light-brown, slightly acid A₂ horizon that grades to reddish-yellow, neutral fine sands.

The Eufaula soils have a thick A₂ horizon that is lacking in the Tivoli soils. They support more trees than the Tivoli soils, which are dominantly grassland soils.

Two profiles are described for these soils. The first is that typical in areas where Eufaula soils were mapped separately, and the second, that where Eufaula soils were mapped in complexes with Dougherty soils.

Profile description: Eufaula fine sand with native cover of trees and tall grasses (east side of road, about 2,000 feet north of southwest corner of sec. 36, T. 18 N., R. 6 W.).

- A₁ 0 to 6 inches, brown (7.5YR 5/2) fine sand, very dark grayish brown (10YR 3/2) when moist; structureless; very friable when moist; very rapidly permeable; slightly acid; gradual boundary. 4 to 6 inches thick.
- A₂₁ 6 to 14 inches, light-brown (7.5YR 6/4) fine sand, brown (7.5YR 5/4) when moist; structureless; very friable when moist, and slightly less coherent than horizon above; contains pockets of darker material similar to that in horizon above; medium acid; gradual boundary. 8 to 14 inches thick.

- A₂₂ 14 to 29 inches, light-brown (7.5YR 6/4) fine sand, brown (7.5YR 5/4) when moist; structureless; loose; very rapidly permeable; slightly acid; gradual boundary. 15 to 30 inches thick.
- AB 29 to 36 inches, intermingled bands of materials similar to those in the A₂₂ and the B₂ horizons, all in a layer that thickens and thins from 0 to 15 inches within horizontal distances of less than 2 feet; the upper surface of this horizon is smooth, the lower surface is irregular; gradual boundary.
- B₂ 36 to 68 inches, yellowish-red (5YR 5/6) fine sand, with bands and pockets of reddish-yellow (5YR 6/6) loamy fine sand; structureless; permeable; slightly acid; gradual boundary. 6 to 32 inches thick.
- C_u 68 to 94 inches, reddish-yellow (7.5YR 6/6) sandy loam, strong brown (7.5YR 5/7) when moist; slightly hard when dry, friable when moist; permeable; slightly acid; numerous fine root channels with coatings of dark brown.

The profile varies somewhat, especially where Eufaula fine sand intergrades with Dougherty soils.

Profile description: Eufaula loamy fine sand with native cover of blackjack oaks, post oaks, and tall grasses (south side of road, about 300 feet west and 125 feet south of northeast corner of NW¼ sec. 28, T. 18 N., R. 6 W.).

- A₁ 0 to 6 inches, brown (7.5YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; structureless; very friable; very rapidly permeable; neutral; gradual boundary. 5 to 7 inches thick.
- A₂₁ 6 to 18 inches, light-brown (7.5YR 6/4) loamy fine sand, brown (7.5YR 5/4) when moist; friable and slightly less coherent than horizon above; contains pockets of darker material; slightly acid; gradual boundary. 8 to 12 inches thick.
- A₂₂ 18 to 41 inches, light-brown (7.5YR 6/4) fine sand, brown (7.5YR 5/4) when moist; structureless; loose; very rapidly permeable; neutral; gradual boundary. 15 to 24 inches thick.
- AB 41 to 56 inches, reddish-yellow (7.5YR 6/6) fine sand, strong brown (7.5YR 4/6) when moist; structureless; slightly hard when dry, very friable when moist; rapidly permeable; slightly acid; gradual boundary.
- B₂ 56 to 64 inches, yellowish-red (5YR 5/6) sandy loam, yellowish red (5YR 4/6) when moist; structureless; bands and pockets of reddish-yellow loamy fine sand; neutral; gradual boundary.
- B₃ 64 to 80 inches, mottled light-gray (5YR 7/1), reddish-brown (5YR 5/3) and yellowish-red (5YR 5/6) sandy loam; mottles are coarse; structureless; slightly hard when dry, friable when moist; permeable; slightly acid; gradual boundary.
- C_u 80 to 95 inches +, light-gray (10YR 7/2) fine sand, brown (10YR 5/3) when moist; structureless; slightly hard when dry; rapidly permeable; neutral.

Eufaula loamy fine sand is mapped only with Dougherty loamy fine sand, a profile of which is described in the Dougherty series. Eufaula loamy fine sand absorbs water rapidly; practically no runoff occurs. It is low in inherent fertility and, where tilled, the main problems are wind erosion and maintenance of fertility. It is best suited to range.

Eufaula fine sand (Eu) absorbs water rapidly, and practically no runoff occurs.

This soil is low in fertility and unsuitable for cultivation. Nearly all of it is in native wooded pasture or range. (Capability unit VI-3; Deep Sand Savannah range site)

Kingfisher series

The Kingfisher soils are deep, reddish-brown, granular silt loams. They formed under tall grasses. They are in gently rolling areas in the southern, southwestern, and northeastern parts of the county.

These soils are loamy and weakly granular after cultivation. The reddish surface layer is about 14 inches deep or, in native pasture, about 16 inches deep.

The reddish-brown subsoil contains more clay than the surface layer and grades to silty and sandstone red beds. The parent material is medium- to fine-textured, red to yellowish-red shale and sandstone of the Permian red beds; it is calcareous along the joints and bedding planes.

The Kingfisher soils differ from the Renfrow soils in having a deeper, medium-textured surface layer and in having less clay in the subsoil.

Profile description: Kingfisher silt loam in a cultivated field on 1 to 3 percent slopes (south side of road, about 1,800 feet west of northeast corner of sec. 16, T. 15 N., R. 7 W.).

- A_{1p} 0 to 6 inches, reddish-brown (5YR 4/4) silt loam, dark reddish brown (5YR 3/4) when moist; weak, fine, granular structure; soft when dry, friable when moist; permeable; slightly acid; abrupt boundary. 6 to 8 inches thick.
- A₁ 6 to 14 inches, reddish-brown (5YR 4/3) silt loam, dark reddish brown (5YR 3/3) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; porous; roots are abundant; slightly acid; clear boundary. 4 to 6 inches thick.
- B₁ 14 to 21 inches, reddish-brown (5YR 4/3), light silty clay loam, dark reddish brown (5YR 3/4) when moist; coarse, granular to moderate, medium, subangular blocky structure; slightly hard when dry, firm when moist; neutral; gradual boundary. 4 to 8 inches thick.
- B₂₁ 21 to 32 inches, reddish-brown (5YR 4/4) silty clay loam, dark reddish brown (5YR 3/4) when moist; moderate, medium, subangular blocky structure; clay films on ped faces; slowly permeable; fine roots are throughout peds; mildly alkaline; gradual boundary. 7 to 11 inches thick.
- B₂₂ 32 to 38 inches, reddish-brown (2.5YR 4/4) silty clay loam, dark reddish brown (2.5YR 3/4) when moist; moderate, medium, subangular blocky structure; clay films on ped faces; material contains few pores; moderately alkaline; gradual boundary. 6 to 11 inches thick.
- C 38 to 46 inches, red (2.5YR 5/8), partially weathered sandstone, red (2.5YR 4/8) when moist; slightly calcareous.

Kingfisher soils are fairly uniform. In some cultivated fields there are small alkali, or slick, spots, and in native pasture there are small, shallow swales.

These soils have good to excessive surface drainage. Permeability is moderately slow to slow, and runoff occurs following heavy rains. Soil erosion is slight to moderate in most places because of adequate cover, proper tillage, and other good soil conservation practices.

Kingfisher silt loam, 1 to 3 percent slopes (KfB), lies on upland areas and on the divides of watersheds. It is used mainly for wheat and other small grains. It is a desirable farming soil that is gently sloping but moderately hard to till. (Capability unit IIe-3; Loamy Prairie range site)

Kingfisher silt loam, 3 to 5 percent slopes (KfC), is on moderate slopes in gently rolling, erosional uplands. It is associated with the gently sloping Kingfisher soils. At the foot of many of the slopes it is bordered by narrow areas of prairie drainageways.

In some fields the surface layer has been thinned by erosion and is not so thick as in the profile described. Rills where surface water accumulates are in many places less than 500 feet apart. In cultivated fields 20 to 35 percent of the area has been eroded to such a degree that

part of the subsoil is mixed with the surface layer when the soil is plowed. (Capability unit IIIe-3; Loamy Prairie range site)

Kingfisher-Lucien complex, 5 to 8 percent slopes, eroded (KgD3), consists of soil on eroded uplands that formed in material weathered from sandstone and shale. About 80 percent of the acreage consists of moderately deep to deep Kingfisher soils, and the rest, of shallow Lucien soil. Most of the acreage is in narrow bands or other small, irregularly shaped, moderately steep areas parallel to streams.

The Kingfisher soil has a reddish-brown surface layer about 14 inches thick, and partially weathered sandstone is about 40 inches from the surface. The Lucien soil has a red to reddish-brown surface layer about 8 inches thick, and shale and sandstone are about 20 inches from the surface. Detailed profiles of the Kingfisher and Lucien soils are described in the appropriate soil series.

Runoff is moderate to rapid, depending on the amount of rainfall. Where the soils have been cultivated, they are subject to considerable water erosion. In tilled fields most areas of the shallow Lucien soil show mixing of the surface layer with the underlying material. In a few areas where runoff accumulates on soils of this complex, gullies form and gradually work their way up the slope. These gullies ordinarily are not more than 500 feet apart. Soil erosion can be held to a minimum under good management. Most of the acreage is farmed with the moderately sloping Kingfisher soil. (Capability unit IVe-2; Loamy Prairie range site)

Kingfisher-slickspot complex, 1 to 3 percent slopes (KhB), is made up of Kingfisher silt loam and depressed areas of salty, alkaline soil that are called slick spots. In these slick spots the surface layer is 2 to 4 inches thick and overlies compact, dark-brown clay. A profile of the Kingfisher soil is described in the Kingfisher series. The following describes a slick spot in a cultivated field with a slope of 1 to 3 percent (south side of road, about 300 feet west of northeast corner of NW¼ sec. 21, T. 15 N., R. 8 W.).

- A₀ 0 to ½ inch, very pale brown (10YR 7/4) silt loam, reddish brown (5YR 4/3) when moist; very fine, platy structure; loose when moist; noncalcareous.
- A₁ ½ to 6 inches, pale-brown (10YR 6/3) silt loam, reddish brown when moist; weak, very fine, blocky structure; noncalcareous; clear boundary. 2 to 6 inches thick.
- B₁ 6 to 14 inches, reddish brown (5YR 4/3) clay loam, dark reddish brown (5YR 3/3) when moist; moderate, medium, subangular blocky structure; contains a few fine roots and pores; noncalcareous; gradual boundary. 8 to 16 inches thick.
- B₂ 14 to 22 inches, reddish brown (2.5YR 4/4) silty clay loam, dark reddish brown (2.5YR 3/4) when moist; moderate, medium, subangular blocky structure; hard when dry; noncalcareous; gradual boundary. 8 to 14 inches thick.
- B₃ 22 to 32 inches, red (2.5YR 5/6, moist) clay loam; moderate, medium, granular structure; very hard when dry; noncalcareous; gradual boundary. 8 to 12 inches thick.
- C 32 inches +, red shale and soft sandstone of Permian red beds; weakly consolidated; calcareous along seams.

Crop yields are good on the Kingfisher soil of this complex, but they are poor on the slick spots because a crust forms on their surface. Approximately half of this complex of Kingfisher soil and slick spots is cultivated; the rest is in native vegetation and is used as pasture or range. (Capability unit IIIs-1; Slickspot range site)

Kingfisher-slickspot complex, 3 to 5 percent slopes (KhC), is much like the Kingfisher-slickspot complex on slopes of 1 to 3 percent. It has more rapid surface drainage, however, and is somewhat more susceptible to erosion because it is on stronger slopes. The proportion of Kingfisher soil and slick spots is about the same as for the complex on milder slopes.

The soil in this mapping unit is not well suited to cultivation and is used mainly as native pasture or range. (Capability unit IVE-5; Slickspot range site)

Kirkland series

The Kirkland series consists of slightly acid, moderately fertile, soils. They are on nearly level uplands in the eastern part of the county. Some areas that have a thicker surface layer have formed in a thin mantle of windblown material.

The dark-colored surface layer, about 10 inches thick, grades to a dark-brown or very dark grayish-brown claypan subsoil. Accumulations of calcium carbonate are at a depth of 30 to 34 inches. The parent material is reddish clay and shale.

Kirkland soils differ from the Bethany soils in having a thinner surface layer, a more abrupt boundary (less than 2 inches) between it and the subsoil, and less depth to accumulations of calcium carbonate. Kirkland soils differ from Tabler soils in having a darker grayish-brown surface layer, a less abrupt boundary between the surface layer and the subsoil, and a chroma of 2 or more. The darker surface layer and dark-brown claypan subsoil distinguish Kirkland soils from Renfrow soils, which have a reddish-brown surface soil and a dark reddish-brown clay subsoil.

Profile description: Kirkland silt loam in a cultivated field on 0 to 1 percent slopes (west side of road, about 1,800 feet north and 600 feet west of southeast corner of sec. 13, T. 19 N., R. 5 W.).

- A_{1p} 0 to 9 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, granular structure; slightly hard when dry, friable when moist; slightly acid; clear boundary. 6 to 12 inches thick.
- B₂ 9 to 22 inches, very dark grayish-brown (10YR 3/2) clay, very dark brown (10YR 2/2) when moist; strong, fine, blocky structure to massive; neutral; gradual boundary. 10 to 16 inches thick.
- B₃ 22 to 34 inches, dark-brown (10YR 3/3) clay, very dark brown (10YR 2/2) when moist; weak, medium, blocky structure to massive; moderately alkaline; gradual boundary. 8 to 14 inches thick.
- C_{oa} 34 to 42 inches +, reddish-brown (5YR 4/4) silty clay loam, dark reddish brown (5YR 3/4) when moist; massive; contains a few fine black concretions and many concretions of lime; moderately alkaline; grades to reddish materials.

The Kirkland surface layer ranges from 8 to 12 inches in thickness. The depth to free carbonates ranges from 30 to 34 inches.

Kirkland soils absorb water slowly, and their subsoil is very slowly permeable. In this county the thickness of the surface layer and total depth of the profile are a little less than is typical for soils of the Kirkland series.

Kirkland silt loam, 0 to 1 percent slopes (KrA), is on nearly level divides of the uplands. About 5 percent of the total acreage consists of included small areas of Tabler soils.

This soil is difficult to till. There is, however, no evidence of erosion in the plow layer, and the subsoil is not mixed with the surface layer during tillage. Most of the soil is cultivated for small grains. Wheat is the principal crop. (Capability unit IIs-1; Claypan Prairie range site)

Lincoln series

In the Lincoln series are grayish-brown to brown soils on sandy alluvium. They occupy the flood plain of the Cimarron River and support a thick cover of tall grasses and scattered stands of elm and cottonwood trees.

The surface layer is light-colored and 8 to 12 inches thick. Beneath it is a very pale brown layer, 14 to 18 inches thick, that grades to stratified sand. The parent material is sandy, water-sorted alluvium.

Lincoln soils are less reddish, somewhat coarser textured in the upper layers, and less deep over stratified alluvial sand than the Yahola soils. Both are mildy calcareous.

Profile description: Lincoln loamy fine sand in rangeland (west side of road, about 1,000 feet northwest of southeast corner of SW $\frac{1}{4}$ sec. 15, T. 19 N., R. 9 W.).

- A 0 to 8 inches, grayish-brown (10YR 5/2) loamy fine sand, dark brown (10YR 4/3) when moist; single grain to very weak granular structure; calcareous; clear boundary. 8 to 12 inches thick.
- AC 8 to 24 inches, very pale brown (10YR 7/4) loamy fine sand, light yellowish brown (10YR 6/4) when moist; structureless; calcareous; clear boundary. 15 to 30 inches thick.
- C 24 inches +, stratified sands.

Lincoln loamy fine sand (Lc) occupies nearly level areas in close association with the Sand dunes, Lincoln material, and Lincoln sand. About one-fourth of it is now cultivated; the rest is used for pasture and range.

Normally, wind erosion is the main problem where this soil is cultivated. But the severe floods in May 1957 have also contributed to a reduction in acreage of cropland and an equal increase in rangeland. The soil is suited to cultivation and well suited as rangeland. (Capability unit IIIe-5; Sandy Bottom Land range site)

Lincoln sand (Ln) is in low areas next to the bed of the Cimarron River. It was formed by floods, shifting of the braided riverbed, and the action of wind. Some areas are high enough to be used for grazing; others may be washed away by the next flood.

Most of this land is covered with a thick growth of tamarisk. Saltgrass and other salt-tolerant grasses grow in the more open spots. Generally, the water table is high, but it fluctuates somewhat with the weather. In dry seasons areas of high salt content can be seen. These small, low, clayey spots crust over, and the crust checks and curls. (Capability unit Vw-2; Sandy Bottom Land range site)

Lucien series

In this county the Lucien soils are mapped only in complex with those of the Kingfisher series.

Profile description: Lucien soil mapped with Kingfisher soil in a cultivated field on slopes of 5 to 8 percent (south side of road, about 500 feet south of northeast corner of NW $\frac{1}{4}$ sec. 18, T. 16 N., R. 6 W.).

- A 0 to 9 inches, reddish-brown (5YR 4/4) silt loam; moderate, fine, granular structure; soft when dry; calcareous; gradual boundary. 6 to 10 inches thick.

- AC 9 to 16 inches, red (2.5YR 4/6) clay loam; moderate, medium, granular structure; few insect casts and workings; calcareous; gradual boundary. 7 to 10 inches thick.
- C 16 inches +, dark-red (2.5YR 3/6), partially weathered sandstone and siltstone of Permian red beds; calcareous on and along bedding planes.

Norge series

The Norge soils are deep, brown, granular, fine sandy loams. They are on the upland areas in the central, west-central, and north-central parts of the county. They formed under a thick cover of tall grasses.

The surface layer is brown, loamy, and weakly granular. It averages about 10 inches in thickness. Beneath it is a dark-brown layer, 10 to 12 inches thick, that grades to a reddish-brown, heavy subsoil about 14 inches thick.

The parent material is mixed silty clay and sand; that is, fine- to medium-textured, water-sorted material on aprons of outwash.

The Norge soils have a slightly darker, less sandy surface layer and a thicker, redder, and somewhat heavier lower subsoil than the Shellabarger soils. The red, sandy clay substratum under Norge soils further distinguishes them from Shellabarger soils, which have a reddish-yellow sandy loam substratum.

Profile description: Norge fine sandy loam in a cultivated field on 0 to 1 percent slopes (west side of road, about 300 feet south of northeast corner of sec. 22, T. 16 N., R. 8 W.).

- A_{1p} 0 to 10 inches, brown (10YR 4/3) fine sandy loam, dark brown (10YR 3/3) when moist; weak, medium, granular structure; soft when dry, friable when moist; neutral; clear boundary. 6 to 12 inches thick.
- B₁ 10 to 22 inches, brown (7.5YR 4/2) sandy clay loam, dark brown (7.5YR 3/2) when moist; moderate, medium, subangular blocky structure; hard when dry, friable when moist; neutral; gradual boundary. 12 to 20 inches thick.
- B₂₁ 22 to 36 inches, reddish-brown (5YR 4/3), heavy sandy clay loam, dark reddish brown (5YR 3/3) when moist; strong, medium to coarse, subangular blocky and coarse, prismatic structure; clay films on peds; hard when dry, firm when moist; neutral; gradual boundary. 12 to 20 inches thick.
- B₂₂ 36 to 46 inches, dark-red (2.5YR 3/6), heavy sandy clay loam, dark reddish brown (2.5YR 3/4) when moist; strong, medium, subangular blocky structure; few thin, patchy clay films; hard when dry, firm when moist; mildly alkaline; gradual boundary. 10 to 14 inches thick.
- C_{ca} 46 to 60 inches +, red (2.5YR 4/6, moist) sandy clay; massive; hard when dry, firm when moist; many small lime concretions in pockets and streaks.

Norge soils are fairly uniform. In places, however, they are underlain by red beds at a depth of 40 to 52 inches from the surface. In some small areas they intergrade with Shellabarger soils.

The Norge soils are well drained. Permeability is moderate to slow. Runoff is not excessive, but the soils are subject to some wind erosion.

Norge fine sandy loam, 0 to 1 percent slopes (NoA), in most respects, is one of the most desirable soils for farming. It is nearly level and easily tilled. Except for a few small areas in pasture, it is cultivated.

Nearly all crops suited to the area are grown on this soil. Winter wheat is the principal crop. (Capability unit I-2; Loamy Prairie range site)

Norge fine sandy loam, 1 to 3 percent slopes (NoB), occupies gently sloping areas in association with the nearly level Norge soil and gently to moderately sloping Kingfisher and Renfrow soils. Some of this soil is on broad, gently sloping divides and small ridges within the hardland areas.

In a few areas the surface layer has been slightly to moderately eroded by wind and water.

Nearly all crops suited to the area are grown on this soil. Wheat is the principal crop. (Capability unit IIe-3; Loamy Prairie range site)

Norge-slickspot complex, 1 to 3 percent slopes (NsB), is made up of Norge fine sandy loam and areas of saline-alkaline soil, called slick spots.

In pasture the surface layer of the slick spots is 2 to 4 inches thick over compact, dark-brown clay loam, but in cultivated areas there are thin, white-crusts spots that cover about 15 to 25 percent of the acreage. In native pasture there are many small mounds that range from 8 to 15 inches in height and from 5 to 20 feet in width at their base. Slick spots generally cover from 10 to 50 percent of the area between these mounds.

A profile of the Norge soil is described in the Norge series. The following describes a slick spot in a cultivated field with a slope of 1 to 3 percent (east side of northwest corner of SW¼ sec. 2, T. 17 N., R. 8 W.).

- A₁₁ ¼ to ½ inch, light-gray (10YR 7/2) fine sandy loam, dark brown (10YR 4/3) when moist; crusty, fine, platy structure; open and porous on under side; hard when dry; noncalcareous.
- A₁₂ ½ to 7 inches, dark grayish-brown (10YR 4/2, moist) fine sandy loam; weak, fine, granular structure; noncalcareous; clear boundary. 3 to 12 inches thick.
- B₁ 7 to 16 inches, dark-brown (7.5YR 3/2, moist) clay loam; medium, blocky structure; friable; contains many fine and a few coarse roots; slightly calcareous; gradual boundary. 10 to 12 inches thick.
- B₂ 16 to 28 inches, reddish-brown (5YR 4/4, moist), heavy sandy clay loam; coarse, prismatic structure; gray film of fine sand on column faces; contains a few fine roots and pores; slightly calcareous; gradual boundary 10 to 20 inches thick.
- B₃ 28 to 42 inches, yellowish-red (5YR 5/6, moist) sandy clay loam; moderate, medium, granular structure; hard when dry, firm when moist, sticky when wet; contains a few fine roots and pores; few, faint, medium mottles; calcareous.

Approximately half of this land is cultivated. The rest is in native vegetation and is used as pasture or range. The grasses are mostly switchgrass, alkali sacaton, and inland saltgrass. (Capability unit IIIs-1; Slickspot range site)

Norge-slickspot complex, 3 to 5 percent slopes, eroded (NsC3), is similar to the Norge-slickspot complex, 1 to 3 percent slopes. The proportions of Norge soil and slick spots is about the same as for the complex on the more gentle slopes.

Surface drainage is more rapid and the soil is more susceptible to erosion. About 60 to 80 percent of the plow layer shows mixing of the surface layer and the subsoil.

The slick spots cover from 15 to 40 percent of the acreage of this mapping unit and make it undesirable for cultivation. It is best suited to native pasture or range. (Capability unit IVe-5; Slickspot range site)

Pond Creek series

In the Pond Creek series are deep, brown, granular, silty soils. They are on the upland divide between Turkey and Skeleton Creeks. They formed under a thick cover of tall grasses.

The surface layer is brown to dark brown and ranges from 10 to 12 inches in thickness. Beneath it is a dark-brown layer, 10 to 16 inches thick, that grades to reddish-brown, mildly calcareous material.

The parent material is silty, medium to moderately fine textured old alluvium.

The Pond Creek soils differ from the Norge soils in having a higher content of silt in the surface layer and a more clayey subsoil. They are mildly alkaline in the upper part of the B₂ horizon, or at a depth of about 22 inches. The Norge soils, in contrast, are mildly alkaline in the lower part of the B₂ horizon, or at a depth of about 36 inches. The reddish-brown subsoil and yellowish-red substratum of Pond Creek soils distinguish them from the Bethany soils, which have a grayish-brown subsoil and brownish-gray substratum.

Profile description: Pond Creek silt loam in a cultivated field on 0 to 1 percent slopes (east side of road, about 400 feet north and 100 feet east of southwest corner of NW¼ sec. 13, T. 19 N., R. 7 W.).

- A_{1p} 0 to 12 inches, brown (7.5YR 4.5/4) silt loam, dark brown (7.5YR 3/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; slightly acid; abrupt boundary. 8 to 12 inches thick.
- B₁ 12 to 22 inches, dark brown (7.5YR 3.5/2), light silty clay loam, dark brown (7.5YR 3/2) when moist; strong, medium to fine, granular structure; hard when dry, friable when moist; very weak and very patchy clay films on peds; neutral; gradual boundary. 8 to 10 inches thick.
- B₂₁ 22 to 28 inches, reddish-brown (5YR 4/4), heavy silty clay loam, dark reddish brown (5YR 3/3) when moist; moderate, medium, subangular blocky and moderate, fine, blocky structure; hard when dry, firm when moist; continuous clay films on peds; mildly alkaline; gradual boundary. 5 to 8 inches thick.
- B₂₂ 28 to 36 inches, reddish-brown (5YR 5/4), heavy silty clay loam, dark reddish brown (5YR 3/4) when moist; moderate, medium, blocky structure; very hard when dry, firm when moist; clay films on peds are distinct and continuous; mildly alkaline; gradual boundary. 6 to 10 inches thick.
- C 36 to 46 inches, yellowish-red (5YR 5/6) silty clay loam, yellowish red (5YR 4/6 when moist); massive; hard when dry; mildly alkaline; gradual boundary. 8 to 12 inches thick.
- D 46 to 60 inches, brown (10YR 5/3) silty clay; mildly alkaline; gradual boundary.
- D_u 60 to 70 inches +, yellowish-brown (10YR 5/4) clay, dark yellowish brown (10YR 4.5/4) when moist; massive; hard when dry; contains concretions of calcium carbonate up to one-half inch in diameter and a few noncalcareous concretions up to one-eighth inch in diameter.

The Pond Creek soils are fairly uniform, although the subsoil may be darker and slightly heavier in some areas than in the profile described. The lower horizon may be slightly thicker, and the depth to the C horizon may be slightly greater.

Pond Creek soils are well drained and productive. Erosion is evident only near the stronger slopes.

Pond Creek silt loam, 0 to 1 percent slopes (PcA), is a desirable soil for farming. It is nearly level but moderately difficult to till.

Except for a few small areas in native pasture, this soil

is cultivated. It is used mainly for small grains; wheat is the principal crop. (Capability unit I-2; Loamy Prairie range site)

Pond Creek silt loam, 1 to 3 percent slopes (PcB), is on gentle slopes in close association with nearly level Pond Creek soils.

In some small areas the surface layer has been thinned slightly by erosion or was never quite so thick as that in the profile described.

Most of this soil is cultivated. (Capability unit IIe-3; Loamy Prairie range site)

Port series

Soils of the Port series are deep, reddish brown, and blocky to granular. They form on wide terraces in large stream valleys where floods bear sediments from upland red beds. The native vegetation is a thick cover of tall grasses.

These soils are neutral to alkaline in reaction. Their texture does not change significantly from the surface downward. In some places along channels of secondary streams there are buried layers at or near the surface.

The parent material is medium textured or moderately fine textured water-laid materials.

Port soils have a darker, finer textured, thicker surface layer than the Yahola soils, are finer textured in the substratum, and are less subject to flooding.

Port silt loams and Port clay loams are mapped in this county. Following are two profile descriptions, the first for the clay loams, and the second for the silt loams.

Profile description: Port clay loam in a cultivated field on 0 to 1 percent slopes (south side of road, about 1,000 feet west of northeast corner of sec. 11, T. 17 N., R. 9 W.).

- A₁ 0 to 17 inches, reddish-brown (5YR 4/3) clay loam, dark reddish brown (5YR 3/3) when moist; moderate, very fine, subangular blocky structure; hard when dry, friable when moist; fine roots and pores are common; neutral; gradual boundary. 10 to 20 inches thick.
- A₁₂ 17 to 24 inches, reddish-brown (2.5YR 4/4) light silty clay loam, dark reddish brown (2.5YR 3/4) when moist; moderate, fine, subangular blocky structure; hard when dry, firm when moist; contains a few fine roots and pores; neutral; gradual boundary. 8 to 12 inches thick.
- AC 24 to 48 inches, reddish-brown (2.5YR 4/4) silty clay, dark red (2.5YR 3/6) when moist; strong, medium, angular blocky structure; hard when dry, firm when moist; mildly alkaline; gradual boundary. 12 to 30 inches thick.
- C_u 48 to 60 inches +, red (2.5YR 4/6) clay, dark red (2.5YR 3/6) when moist; strong, coarse, angular blocky structure; very hard when dry, firm when moist; fine roots are common; thin clay films on peds; mildly alkaline.

The surface layer of Port clay loams ranges from 20 to 27 inches in thickness, and it averages about 23 inches. Its color ranges from reddish brown to dark brown (hue 5YR to 7.5YR, value 4, chroma 2 to 4).

Profile description: Port silt loam in a cultivated field on 0 to 1 percent slopes (west side of road in northeast part of SE¼ sec. 4, T. 19 N., R. 7 W.).

- A₁ 0 to 10 inches, brown (7.5YR 5/4) silt loam, dark brown (7.5YR 3/2) when moist; weak, fine to medium, granular structure; soft when dry, friable when moist; neutral; gradual boundary. 10 to 26 inches thick.

- AC 10 to 24 inches, dark-brown (7.5YR 4/4) silt loam, dark brown (7.5YR 3.5/2) when moist; moderate, very fine, subangular blocky structure; slightly hard when dry, friable when moist; neutral; clear boundary. 14 to 22 inches thick.
- C_u 24 to 68 inches, yellowish-red (5YR 4/6) heavy silt loam, dark reddish brown (5YR 3/4) when moist; moderate, very fine, subangular blocky structure; hard when dry, firm when moist; mildly alkaline; gradual boundary.
- C 68 to 80 inches +, reddish-brown (5YR 4/4) silty clay loam, dark reddish brown (5YR 3/4) when moist; moderate to strong, very fine, subangular blocky structure; hard when dry, firm when moist; moderately alkaline.

Port silt loams are of almost uniform texture throughout the profile. The surface layer ranges from 10 to 26 inches in thickness and averages about 12 inches. The color of this layer ranges from brown to reddish brown (hue 7.5YR to 5YR, value 3 to 5, chroma 2 to 4).

Soils of the Port series are productive, have medium internal drainage, and are suited to both winter and summer crops.

Port clay loam, 0 to 1 percent slopes (PoA), is one of the most desirable bottom-land soils for farming. It is nearly level but is hard to till. It is moderately permeable and has medium runoff and medium internal drainage. Flooding is unusual, except during times of extreme rainfall.

Except for a few small areas in native pasture, this soil is cultivated. Nearly all crops suited to the area are grown. Wheat is the principal crop. (Capability unit I-1; Loamy Bottom Land range site)

Port silt loam, 0 to 1 percent slopes (PsA), is one of the most desirable bottom-land soils for farming. It is nearly level and is easily tilled. It is moderately permeable and has medium runoff and medium internal drainage. Flooding is unusual, except in time of extreme rainfall, as in May 1957.

Except for a few small areas in native pasture, this soil is cultivated. All crops suited to the area can be grown. Wheat is the principal crop. (Capability unit I-1; Loamy Bottom Land range site)

Port silt loam, 1 to 3 percent slopes (PsB), occupies a band that extends from the foot slopes of the higher land to the nearly level areas of the Port soils. It consists mostly of material washed from upland red beds and deposited on alluvial fans. Slight erosion and accumulations of water from adjoining soils are common problems.

Most of this soil is farmed with the more nearly level Port soils. (Capability unit IIe-1; Loamy Bottom Land range site)

Pratt series

In the Pratt series are deep, brown, friable sandy soils on uplands. Most of them in this county are north of the Cimarron River and west to northwest of the city of Kingfisher. They formed under a mixed stand of tall grasses.

These soils have a brown, loamy fine sand surface layer, 10 to 16 inches deep, over a yellowish-brown sandy loam subsoil. The substratum ranges from light yellowish-brown or brownish-yellow loamy fine sand to fine sand.

The parent material is sandy, coarse-textured, water-sorted material, reworked by wind, that overlies red beds.

The Pratt soils differ from the Tivoli soils in having a darker and thicker surface soil and a finer textured subsoil.

The absence of an A₂ horizon and their neutral reaction distinguish the Pratt soils from the Dougherty and Eufaula soils, which have an A₂ horizon and are acid in reaction.

Profile description: Pratt loamy fine sand, undulating, in a cultivated field (north side of road, about 1,500 feet west and 100 feet north of southeast corner of sec. 33, T. 19 N., R. 8 W.).

- A₁ 0 to 14 inches, brown (10YR 5/3) loamy fine sand, dark brown (10YR 4/3) when moist; weak, very fine, granular structure; soft when dry, very friable when moist; contains numerous fine roots and pores; neutral; gradual boundary. 10 to 16 inches thick.
- B₂ 14 to 30 inches, light yellowish-brown (10YR 6/4) fine sandy loam, yellowish brown (10YR 5/4) when moist; weak, fine, granular structure; soft when dry, friable when moist; contains a few fine roots and pores; neutral; gradual boundary. 8 to 20 inches thick.
- C₁ 30 to 42 inches, brownish-yellow (10YR 6/8) loamy fine sand, yellowish brown (10YR 5/8) when moist; weak, fine, granular structure; slightly hard when dry, very friable when moist; contains a few fine roots; neutral; gradual boundary. 12 to 20 inches thick.
- C₂ 42 to 54 inches +, light yellowish-brown (10YR 6/4) loamy fine sand, yellowish brown (10YR 5/4) when moist; structureless; slightly hard when dry, loose when moist; neutral; grades to reddish-yellow fine sand.

The Pratt soils in this county are fairly uniform, although there are some inclusions of fine sandy loam. They have a low supply of organic matter but contain no injurious salts.

The color of the surface layer ranges from dark brown to brown (hue 10YR to 7.5YR, value 3 to 4, chroma 2 to 3). The lower horizons range from sticky loamy sand to sandy loam, and the substratum, from loamy sand to fine sand.

These soils are mostly slowly drained, except on the steeper slopes. They absorb water readily. No runoff occurs, but a small amount of water accumulates in low places after heavy rains.

Pratt loamy fine sand, undulating (PfB), is easily tilled and is suitable for many kinds of crops. Nearly all crops suited to the county are grown on it.

Wind erosion and maintenance of fertility are the main problems where this soil is cultivated. About half of the acreage is tilled and, unless a good conservation cropping system is used, it will blow and drift. The severity of wind erosion depends primarily on the amount of ground cover. In unprotected fields, winnowing and drifts are common. In some fields, drifting occurs along fence lines and roadsides. These small drifts are smoothed down by tillage. The fence-line and roadside drifts are not tilled and are usually stabilized by a cover of weeds and grasses. (Capability unit IIIe-5; Deep Sand range site)

Pratt loamy fine sand, hummocky (PfC), is not a particularly desirable soil for farming. Most of it is on small ridges or low, rounded, sandy rises within or bordering areas of the undulating Pratt loamy fine sand.

In some small areas the surface layer has been thinned by erosion or was never so thick as in the profile described for the Pratt series. About half of this soil is cultivated. (Capability unit IVe-4; Deep Sand range site)

Renfrow series

In the Renfrow series are deep, dark reddish-brown, moderately fine textured soils. They are on nearly level to gently sloping upland prairies south of the Cimarron River and in the northeastern part of the county. They formed under a cover of tall grasses.

Renfrow soils have a dark reddish-brown, granular clay loam surface layer about 8 inches thick. This grades clearly to a dark reddish-brown, blocky clay subsoil, 12 to 16 inches thick. The subsoil grades to reddish, calcareous clay and shale.

The Renfrow soils differ from the Vernon soils mainly in their greater depth, in having a clayey subsoil (B₂ horizon), and in having a lower lying horizon in which lime carbonates have accumulated. Their finer textured, blocky, compact clayey subsoil and substratum distinguish them from the Kingfisher soils.

The parent material of the Renfrow soils is fine-textured, red shale and clay of the Permian red beds.

Profile description: Renfrow clay loam in a cultivated field on 0 to 1 percent slopes (south side of road, about 350 feet east of northwest corner of NE¼ sec. 15, T. 15 N., R. 6 W.).

- A_{1p} 0 to 8 inches, dark reddish-brown (5YR 3/4) clay loam, dark reddish brown (5YR 3/2) when moist; moderate, fine, granular structure; hard when dry, friable when moist, and sticky when wet; fine roots and pores are common; slightly acid; clear boundary. 6 to 8 inches thick.
- B₂ 8 to 24 inches, dark reddish-brown (5YR 3/3) clay, dark reddish brown (5YR 2/2) when moist; strong, medium, blocky structure; very hard when dry, very firm when moist, and very sticky when wet; very slowly permeable; compact; thin, complete clay films on peds; contains few fine roots; layer is redder at about 22 inches; neutral; gradual boundary. 12 to 16 inches thick.
- B_{ca} 24 to 34 inches, reddish-brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) when moist; weak, medium, blocky structure; very hard when dry, very firm when moist; calcareous; contains a thin horizon in which lime carbonates have accumulated; gradual boundary. 8 to 14 inches thick.
- C 34 to 44 inches +, red (2.5YR 4/6) clay, dark red (2.5YR 3/6) when moist; films or coatings of lime in joints and seams of the country rock (clayey red beds).

Renfrow soils are fairly uniform over much of their area, but in some areas they intergrade to Vernon soils. They are free of carbonates to a depth of 22 to 28 inches, where a B_{ca} horizon begins.

Surface drainage is moderate to rapid, but internal drainage is very slow. These soils have a fair to good supply of plant nutrients. Except in a few small slick spots in cultivated fields, no injurious salts are present.

Renfrow clay loam, 0 to 1 percent slopes (RcA), is a desirable soil for small grains, principally wheat. The distribution of rainfall is more favorable for small grains than other crops. This soil is droughty and not well suited to row crops or alfalfa.

Except for a few small areas not easily accessible, this soil is in cultivation. It is nearly level but is difficult to till; tillage is kept to a minimum, to prevent the soil from packing. (Capability unit II_s-1; Claypan Prairie range site)

Renfrow clay loam, 1 to 3 percent slopes (RcB), is on gently rolling uplands in close association with Renfrow clay loam, 0 to 1 percent slopes. In some places the surface layer has been thinned by erosion or was never so thick as in the profile described for the series.

Most of this soil is cultivated. Winter wheat is the principal crop. Sorghum is occasionally grown. (Capability unit III_e-1; Claypan Prairie range site)

Rough broken land

Rough broken land (Rg) in this county is made up of a small area of "gyp-hills" in the southwestern corner of the

county and a narrow band of red-bed "bluffs" that are backcut by short gorges along the southern bank of the Cimarron River. The gyp hills are part of an east-facing escarpment of the Blaine gypsum formation of the Permian red beds.

This land type is very droughty and subject to severe erosion. It supports only a very thin stand of vegetation. The bluff areas, along the river bed, are nearly vertical and, in places, are cut back by short, steep canyons. The exposed rock layers are red and gray strata of sandstone, shale, and clay.

All of this land type is in native vegetation and is used for range and wildlife. (Capability unit VII_s-1; Breaks range site)

Sand dunes, Lincoln material

Sand dunes, Lincoln material (Sa), in this county occupy ridges of stabilized sand dunes. The slopes are steep, and the largest dunes rise from 10 to 20 feet above the flood plain of the Cimarron River.

All of this material is in native vegetation and is used for range. (Capability unit VI_s-1; Sandy Bottom Land range site)

Shellabarger series

The Shellabarger series consists of deep, brown to dark-brown soils that are moderately coarse textured and friable. They are in nearly level and sloping areas in the sandy lands of this county. The native vegetation was a dense cover of tall grasses.

The surface layer is dark brown and averages about 12 inches in thickness. It grades to lighter colored, noncalcareous material. The parent material is sandy, moderately coarse textured, water-laid material partly reworked by wind.

The Shellabarger soils have a thicker, loamier surface layer and a finer textured subsoil than the Pratt soils. They have a dark reddish-brown, light sandy clay loam subsoil and a reddish-yellow to strong-brown sandy clay substratum. In contrast, the Norge soils have a dark-red, heavy sandy clay loam or sandy clay subsoil and a red sandy clay substratum.

Profile description: Shellabarger fine sandy loam in a native pasture, 0 to 3 percent slopes.

- A₁ 0 to 10 inches, dark-brown (7.5YR 4/2) fine sandy loam; dark brown (7.5YR 3/2) when moist; weak, very fine, granular structure; loose when dry, friable when moist; contains many fine roots and pores; slightly acid; clear boundary. 8 to 12 inches thick.
- B₁ 10 to 18 inches, dark reddish-brown (5YR 3/4) light sandy clay loam, dark reddish brown (5YR 3/2) when moist; medium, prismatic structure; thin, complete clay films on peds; fine roots and pores are common; contains many worm casts; slightly acid; gradual boundary. 7 to 10 inches thick.
- B₂₁ 18 to 27 inches, yellowish-red (5YR 4/6) sandy clay loam, dark reddish brown (5YR 3/4) when moist; medium, prismatic structure; a few, faint clay films on vertical faces of peds; slightly acid; gradual boundary. 6 to 10 inches thick.
- B₂₂ 27 to 36 inches, yellowish-red (5YR 4/6) fine sandy loam, dark reddish brown (5YR 3/4) when moist; moderate, medium, granular structure; friable when moist; contains many fine pores; slightly acid; clear boundary. 8 to 12 inches thick.
- C₁ 36 to 48 inches, reddish-yellow (7.5YR 6/6) loamy sand, strong brown (7.5YR 5/6) when moist; structureless; sharp and gritty when rubbed; slightly acid; gradual boundary. 10 to 15 inches thick.

- C₂ 48 to 55 inches, reddish-yellow (7.5YR 6/6) fine sandy loam, strong brown (7.5YR 5/6) when moist; structureless; hard when dry; slightly acid; gradual boundary.
- C₃ 55 to 64 inches, mottled reddish-yellow fine sandy loam with common, medium, distinct mottles; neutral; diffuse boundary.
- C₄ 64 to 78 inches +, reddish-yellow loamy fine sand; neutral.

The Shellabarger soils are fairly uniform in this county. In places, however, they have a coarser textured surface layer where they are tilled. The surface soil drifts, and winnowing occurs on the tilled land because of lack of cover or as a result of improper tillage.

These soils are susceptible to wind erosion where they are cultivated. The hazard of water erosion increases with the degree and length of slope. In the nearly level areas there is slight ponding of water for a few days after a hard rain, but water soaks in well. The soils are moderately permeable and contain no injurious salts.

Shellabarger fine sandy loam, 0 to 1 percent slopes (ShA), is a desirable soil for both winter and summer crops. It is nearly level and easily tilled but is susceptible to wind erosion. It is moderately high in fertility and responds well to good management. Most of it is cultivated, and winter wheat is the principal crop. (Capability unit IIe-2; Sandy Prairie range site)

Shellabarger fine sandy loam, 1 to 3 percent slopes (ShB), is gently sloping and subject to moderate wind and water erosion where it is cultivated. Most of it is in areas adjacent to more nearly level, sandy soils of the uplands and on slopes bordering the river valley.

Most of this soil is cultivated. It is easy to till and is suited to the crops of the area. Winter wheat is the principal crop. (Capability unit IIe-2; Sandy Prairie range site)

Shellabarger fine sandy loam, 3 to 5 percent slopes (ShC), is on gently rolling, sandy uplands. It is in close association with the gently sloping or nearly level Shellabarger soils.

Soil erosion and surface runoff are the main problems where this soil is cultivated. Many rills and small gullies are forming. In the plowed fields, 20 to 30 percent of the area shows mixing of the surface layer and subsoil. (Capability unit IIIe-4; Sandy Prairie range site)

Shellabarger fine sandy loam, 5 to 8 percent slopes, eroded (ShD3), is on steep short slopes along drains that cross the area. Most of it is farmed with the more nearly level Shellabarger soils.

Accelerated erosion is the main problem where this soil is cultivated. Erosion is moderate to severe on 65 to 80 percent of the tilled acreage; the surface layer and subsoil are mixed in the plow layer. About 40 percent of this soil is in native pasture or range. (Capability unit IVe-3; Sandy Prairie range site)

Tabler series

In the Tabler series are deep, dark, clayey soils that formed under a thick cover of prairie grasses. They are in the east-central and southwestern parts of the county.

The surface layer is moderately fine textured and granular. It is dark colored and averages 6 to 8 inches in thickness. Beneath it is a very dark gray claypan layer, 22 to 26 inches thick, that grades into lighter colored, mildly calcareous material.

The parent material is silty, fine-textured alluvium or residuum from red beds.

The Tabler soils differ from the Kirkland soils in having

a grayer surface layer, a darker subsoil, and no thin transition layer between the A and B horizons.

Profile description: Tabler clay loam in a cultivated field on slopes of 0 to 1 percent (south side of road, about 200 feet west of northeast corner of NW ¼ sec. 14, T. 15 N., R. 9 W.).

- A_{1p} 0 to 8 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; few fine pores; few, thin, gray films on peds; slightly acid; abrupt boundary. 6 to 8 inches thick.
- B₂ 8 to 18 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) when moist; thin, platy and weak, medium, blocky structure; very hard when dry, very firm when moist; thin, complete clay films on peds; slightly acid in the upper part, grading to neutral below; clear boundary. 10 to 15 inches thick.
- B₃ 18 to 36 inches, dark-gray (10YR 4/1) clay, very dark grayish brown (10YR 3/2) when moist; massive; very firm when moist; contains a few fine roots and pores; mildly alkaline; few concretions of lime below 30 inches; gradual boundary. 14 to 20 inches thick.
- C₁ 36 to 48 inches, reddish-brown (5YR 5/4) clay, reddish brown (5YR 4/4) when moist; massive; very firm when moist; mildly to moderately alkaline; few concretions of lime; gradual boundary. 10 to 15 inches thick.
- C 48 to 60 inches, same as above horizon but grades to a lighter color that has some mottling; alkaline material.

The Tabler soils are fairly uniform. In places, however, they are free of carbonates to a depth of 30 inches, and a B₃ horizon is present. In some areas they intergrade with Kirkland soils, and in cultivated fields there are many small slick spots.

Tabler soils absorb water very slowly. Runoff occurs only through shallow, open-ditch, drainage laterals. This kind of drainage is referred to locally as "turtleback" drainage.

Tabler clay loam (Ta) occupies nearly level or slightly depressed areas. Most of it is tilled but is difficult to farm. Small grains are best suited to this soil, and wheat is the principal cash crop. (Capability unit IIs-1; Claypan Prairie range site)

Tabler-slickspot complex (Ts) is made up of Tabler silt loam and clay loam and areas affected by saline salts, or white alkali, which are called slick spots.

In the slick spots the surface layer is about 4 to 6 inches deep over very dark-brown, compact clay. These slick spots are in slight depressions in the nearly level Tabler soils and cover 25 to 40 percent of the acreage. Crop failures on the slick spots are common. The spots are tilled and managed in the same way as the soil surrounding them.

The following describes a slick spot in a cultivated field on 0 to 1 percent slopes (north side of road in southwest corner of SE ¼ sec. 16, T. 18 N., R. 5 W.).

- A₁ 0 to 8 inches, very dark grayish-brown (10YR 3/2, moist) silt loam; fine, platy structure; thin surface crusting; slightly acid; gradual boundary. 6 to 12 inches thick.
- AB 8 to 12 inches, dark-brown (10YR 3/3) clay loam, pale brown (10YR 6/3) when moist; fine, platy structure; slightly acid; clear boundary. 4 to 7 inches thick.
- B₂ 12 to 30 inches, very dark brown (10YR 2/2, moist) clay; moderate, medium, blocky structure; very hard when dry; moderately alkaline; gradual boundary. 12 to 18 inches thick.
- C 30 to 48 inches +, mottled dark grayish-brown (10YR 4/2, moist), yellowish-brown (10YR 5/8, moist), and light-gray (10YR 7/2, moist) silty clay loam; yellow-

ish-brown and light-gray mottles represent about 5 percent of the soil matrix; moderate, medium, blocky structure; hard when dry; moderately alkaline.

Most of the Tabler-slickspot complex is cultivated to small grains, principally wheat. (Capability unit IIIs-1; Slickspot range site)

Tivoli series

Soils of the Tivoli series are deep, loose fine sands. They are near the Cimarron River, in the northwestern part of the county.

The surface layer is grayish-brown fine sand that averages about 6 inches in thickness. Beneath it is light yellowish-brown fine sand that continues to a depth of several feet.

Throughout their profile these soils are mildly alkaline and rapidly permeable.

Profile description: Tivoli fine sand in rangeland (south side of highway at east end of curve in Oklahoma State Highway No. 51, at northwest corner of NE ¼ sec. 22, T. 19 N., R. 9 W.).

- A 0 to 5 inches, grayish-brown (10YR 5/2) fine sand, dark brown (10YR 4/3) when moist; structureless; loose when dry; single grain; rapidly permeable; moderately alkaline; clear boundary. 4 to 8 inches thick.
- AC 5 to 60 inches, light yellowish-brown (10YR 6/4) fine sand, yellowish brown (10YR 5/6) when moist; structureless; loose when dry; single grain; rapidly permeable; moderately alkaline.
- C 60 inches +, yellowish-brown fine sand.

Tivoli fine sand (Tv) is not suited to cultivation, and all of it is used for range. It is on a high ridge of sandhills and is stabilized against wind erosion by a thin stand of tall grasses and sagebrush. A few elm and cottonwood trees grow near the base of the sandhills. (Capability unit VI s-2; Dune range site)

Vernon series

In the Vernon series are shallow, reddish-brown, granular, moderately fine textured soils. They support a mixture of tall and short grasses. They occur in the northeastern part of the county and on rolling uplands south of the Cimarron River.

The surface layer is reddish, moderately fine textured, and granular. It is about 6 inches thick in cultivated areas and approximately 8 inches deep in native pastures. Beneath the surface layer is a dark reddish-brown layer, 10 to 15 inches thick, that grades to mildly calcareous material derived from the Permian red beds.

Vernon soils are shallower than the Renfrow, do not have a B horizon, and are calcareous to the surface instead of having a zone lower in the profile in which lime has accumulated.

Profile description: Vernon clay loam in a cultivated field on 1 to 3 percent slopes (east side of road, about 300 feet north of southwest corner of NW¼ sec. 36, T. 17 N., R. 6 W.).

- A_{1p} 0 to 7 inches, reddish-brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) when moist; moderate, medium, granular structure; hard when dry, friable when moist, sticky when wet; contains a few fine roots and pores; mildly alkaline; clear boundary 6 to 10 inches thick.
- AC 7 to 14 inches, dark reddish-brown (2.5YR 3/4), heavy silty clay loam, dark reddish brown (2.5YR 2/4) when moist; strong, medium, granular structure; hard when dry, firm when moist, sticky when wet;

- C 14 to 17 inches, very similar to the above horizon except for a few fragments of unweathered shale or siltstone and claystone; moderately alkaline; gradual boundary.
- D, 17 inches +, red unweathered siltstone and claystone of Permian red beds; very hard when dry; calcareous along bedding planes, seams, or joints.

The Vernon soils are relatively uniform. In places, however, the depth to red beds is 26 inches.

These soils are well drained. They absorb water slowly to very slowly and are droughty.

Vernon clay loam, 1 to 3 percent slopes (VcB), is on gently sloping uplands. It is droughty, shallow, slowly permeable, and difficult to till. About half of it is cultivated. In some cultivated areas the surface layer has been thinned slightly by erosion. Suitable crops are small grains, principally winter wheat, and sorghum. (Capability unit IIIe-2; Red Clay Prairie range site)

Vernon clay loam, 3 to 5 percent slopes, eroded (VcC3), is on moderately sloping, erosional uplands and short slopes in the upper prairie drainageways. About half of it is in cultivation, along with the more gently sloping Vernon soils. Water erosion is the main problem where this soil is tilled.

Shallowness, droughtiness, limited crop suitability, and difficulty of tillage influence the rate of soil erosion. In tilled fields 30 to 70 percent of the plow layer of this soil shows mixing of the surface layer and part of the substratum, or C horizon. Most of this soil, 70 to 85 percent, overlies clayey red beds, and the rest, siltstone and claystone red beds. (Capability unit IVe-1; Red Clay Prairie range site)

Vernon soils and Rock outcrop (Vr) consists mostly of shallow, red, granular, fine-textured, Vernon-like soil material and areas of rock outcrop.

Soil material, where it exists, is red and ranges from 5 to 15 inches in thickness. Beneath it is dark-red, unweathered claystone and siltstone and thin beds of sandstone of Permian age.

The landscape is rough. The raw red beds are exposed; dry, narrow, shallow stream channels cut through and around clayey alluvium and colluvium; and there are small, highly granular clay mounds, or dunes, on or near the stream floor or at the foot of the short, steep breaks and slopes.

Many of the exposed red beds take the form of wavy, round-topped ridges that join the small stream channels at an oblique angle. The claystone and siltstone of the red beds is easily eroded because of jointing and fracturing. When they are dry, large blocks of this red-beds rock are easily shattered into small pieces. For this reason the rock is used extensively for surfacing county roads.

This mapping unit is not suited to cultivation; nearly all of it is used for range. (Capability unit VIe-1; Eroded Red Clay range site)

Wet alluvial land

Wet alluvial land (Wa) is mostly grayish-brown, or dark grayish-brown, friable, loamy alluvium. It is along Preacher Creek and in some areas near the Cimarron River.

This land type has various colors and textures. It is subject to frequent flooding and normally has a high water table. Seep water is at or near the surface in many places.

All of this land is in native vegetation and is used for range and pasture or lies idle. (Capability unit Vw-3; Subirrigated Bottom Land range site)

Yahola series

In the Yahola series are moderately deep, light-colored, moderately coarse textured soils. They are on the flood plain near the Cimarron River and along the major streams.

The surface layer and subsurface layer are yellowish red to brown and about 2 feet thick. They overlie the parent material, which consists of water-sorted, stratified sands.

The Yahola soils differ from the Port soils mainly in having a lighter colored, coarser, and thinner profile above the sands.

Profile description: Yahola fine sandy loam in a cultivated field on 0 to 1 percent slopes (west side of road, near northeast corner of NE¼ sec. 10, T. 17 N., R. 7 W.).

- | | |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A _{1p} | 0 to 8 inches, brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) when moist; fine, granular structure; soft when dry, friable when moist; moderately alkaline; gradual boundary. 8 to 14 inches thick. |
| AC | 8 to 22 inches, yellowish-red (5YR 5/6) silt loam; yellowish red (5YR 4/6) when moist; weak, fine, granular structure; soft when dry, moderately alkaline; gradual boundary. |
| C | 22 to 30 inches, reddish-yellow (5YR 6/6) fine sandy loam, yellowish red (5YR 5/6) when moist; weak, fine, blocky structure; slightly hard when dry; moderately alkaline; clear boundary. |
| C ₁ | 30 to 48 inches, yellowish-red (5YR 5/6) stratified fine sands, yellowish red (5YR 4/6) when moist; structureless; loose; calcareous. |

The Yahola soils have slow surface drainage and rapid internal drainage. Depth to the ground water table ranges from 5 to 20 feet.

Yahola fine sandy loam (Ya) occurs in nearly level areas in close association with the Lincoln soils.

Wind erosion is generally the main problem where this soil is cultivated. When severe floods come, as they did in May 1957, the soil is deeply scoured in some places and receives deep deposits of sandy material in others.

About three-fourths of this soil is tilled; the rest is used for pasture or range. It is suited to all crops commonly grown in the county. (Capability unit IIe-1; Sandy Bottom Land range site)

Use and Management of Soils

This section offers suggestions on the use of soils for crops, range, trees, wildlife, and engineering structures. Table 2 in this section gives estimated yields for the soils suitable for dryland farming; table 3, the plants and estimated yields of forage on the various range sites; and tables 5, 6, and 7, the characteristics of the soils significant in engineering.

Capability Groups of Soils

The capability classification is a grouping of soils that shows, in a general way, how suitable they are for most kinds of farming. It is a practical grouping based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment.

In this system all the kinds of soil are grouped at three levels, the capability class, subclass, and unit. The eight

capability classes in the broadest grouping are designated by Roman numerals I through VIII. In class I are the soils that have few limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products.

The subclasses indicate major kinds of limitations within the classes. Within most of the classes there can be up to four subclasses. The subclass is indicated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is the risk of erosion unless close-growing plant cover is maintained; *w* means that water in or on the soil will interfere with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c* is used to indicate that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only subclasses *w*, *s*, and *c*, because the soils are subject to little or no erosion but have other limitations that limit their use largely to pasture, range, woodland, or wildlife.

Within the subclasses are the capability units, groups of soils enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping of soils for making many statements about their management. Capability units are generally identified by numbers assigned locally, for example, IIe-1 or IIIe-2.

Soils are classified in capability classes, subclasses and units in accordance with the degree and kind of their permanent limitations. Not considered is major and generally expensive landforming that would change the slope, depth, or other characteristics of the soil, nor possible but unlikely major reclamation projects.

The eight classes in the capability system, and the subclasses and units in this county, are described in the list that follows.

Class I. Soils that have few limitations that restrict their use.

Capability unit I-1.—Deep silt loams and clay loams on bottom land.

Capability unit I-2.—Deep fine sandy loams and silt loams on uplands.

Class II. Soils that have some limitations that reduce the choice of plants or require moderate conservation practices.

Subclass IIe. Soils subject to moderate erosion if they are not protected.

Capability unit IIe-1.—Moderately deep to deep fine sandy loams and silt loams on bottom lands.

Capability unit IIe-2.—Deep fine sandy loams on uplands.

Capability unit IIe-3.—Deep silt loams and sandy loams with silty clay loam subsoil.

Subclass IIw. Soils that have moderate limitations because of excess water.

Capability unit IIw-1.—Deep loamy fine sands with a compact subsoil.

- Subclass IIs. Soils that have moderate limitations of moisture capacity or tilth.
 Capability unit IIs-1.—Deep clay loams and silt loams with a compact subsoil.
- Class III. Soils that have severe limitations that reduce the choice of plants, or require special conservation practices, or both.
 Subclass IIIe. Soils subject to severe erosion if they are cultivated and not protected.
 Capability unit IIIe-1.—Deep clay loams with a compact clay subsoil.
 Capability unit IIIe-2.—Clay loams shallow to shale or siltstone.
 Capability unit IIIe-3.—Silt loams with a silty clay loam subsoil; deep over weathered sandstone.
 Capability unit IIIe-4.—Fine sandy loams with a sandy clay loam subsoil; deep over sandy materials deposited by water.
 Capability unit IIIe-5.—Loamy fine sands with a subsoil of loamy fine sand to fine sandy loam; deep over sandy water-sorted materials.
- Subclass IIIs. Soils that have severe limitations of moisture capacity or tilth.
 Capability unit IIIs-1.—Fine sandy loams, silt loams, and clay loams with slick spots; moderately affected by alkali.
- Class IV. Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both.
 Subclass IVe. Soils subject to very severe erosion if they are cultivated and not protected.
 Capability unit IVe-1.—Clay loams shallow to beds of weathered clay and shale.
 Capability unit IVe-2.—Shallow to deep silt loams that have been severely eroded.
 Capability unit IVe-3.—Deep fine sandy loams that have been moderately to severely eroded.
 Capability unit IVe-4.—Deep, hummocky, loamy fine sands.
 Capability unit IVe-5.—Silt loams with slick spots; severely affected by alkali.
- Subclass IVw. Soils that have very severe limitations for cultivation because of excess water.
 Capability unit IVw-1.—Wet, clayey alluvial land affected by alkali.
- Class V. Soils not likely to erode that have other limitations, impractical to remove without major reclamation, that limit their use largely to pasture, or range, woodland, or wildlife food and cover.
 Subclass Vw. Soils too wet for cultivation; drainage or protection not feasible.
 Capability unit Vw-1.—Loamy, broken alluvial land that is frequently flooded.
 Capability unit Vw-2.—Sands that are frequently flooded.
 Capability unit Vw-3.—Sandy alluvial land with a high water table.
- Subclass Vs. Soils generally unsuitable for cultivation because of moisture capacity, tilth, or other soil properties.
 Capability unit Vs-1.—Silt loams with clay spots; very severely affected by alkali.
- Class VI. Soils that have severe limitations that make them generally unsuitable for cultivation and that limit their use largely to pasture or range, woodland, or wildlife.
 Subclass VIe. Soils severely limited, chiefly by susceptibility to erosion, if a protective cover is not maintained.
 Capability unit VIe-1.—Shallow soils with rock outcrops, and alluvial and broken land.
- Subclass VIs. Soils generally unsuitable for cultivation and limited for other uses by their moisture capacity or other soil features.
 Capability unit VIs-1.—Sands on low, mostly stabilized dunes.
 Capability unit VIs-2.—Sands on large, mostly stabilized dunes.
 Capability unit VIs-3.—Sands on large dunes that support a mixed cover of grass, brush, and scattered trees.
- Class VII. Soils that have very severe limitations that make them unsuitable for cultivation without major reclamation, and that restrict their use largely to grazing, woodland, or wildlife.
 Subclass VIIs.—Soils very severely limited by moisture capacity or other soil features.
 Capability unit VIIs-1.—Steep, very shallow, eroded land.
- Class VIII. Soils and landforms that have limitations that preclude their use, without major reclamation, for commercial production of plants; and that restrict their use to recreation, wildlife, water supply, or esthetic purposes. (No class VIII soils in Kingfisher County.)
- In the following pages the capability units of this county are described, the soils in each are listed, and some suggestions for management are made. The management suggested for each capability unit is to be considered in relation to the basic practices of management described in the subsection "Management of Soils for Tilled Crops."

CAPABILITY UNIT I-1

In this capability unit are deep, brown or reddish-brown soils on bottom lands along the major creeks of the area. Their surface layer and underlying layers are moderately fine textured to medium textured. The soils are—

- Port clay loam, 0 to 1 percent slopes.
- Port silt loam, 0 to 1 percent slopes.

These soils are fertile, productive, and drought resistant. They are suitable for intensive farming and easy to moderately difficult to till. Both have medium internal drainage and are slightly susceptible to erosion. Runoff from adjacent uplands is a problem. During heavy floods, nearly all of the acreage is overflowed, but floods that cause severe crop damage are normally brief. Wind erosion can be a problem if the surface is not protected by crop residues or plant cover.

Soil management.—Crops suited to this climate will grow on these soils. Wheat and alfalfa are the principal crops. As a general practice, wheat is grown continuously.

In some places use of diversion terraces on foot slopes of adjacent uplands is needed to break up the concentrations of water. Otherwise, good soil management normally controls erosion.

Good yields of sown field crops, generally wheat, can be expected for a maximum of 7 consecutive years, provided the soils are kept in sweetclover, alfalfa, or some other soil-building crop for a minimum of 2 years before they are used for grain for another 7-year period. Grain

sorghum and other row crops can be grown up to 4 consecutive years if 2 years of small grains and at least 2 years of grasses, legumes, or other soil-improving crops intervene between the periods.

Wheat and other high-residue crops can be grown continuously if all residues are returned to the soils. Normally it is a good practice to apply 20 to 40 pounds of nitrogen per acre at seeding time, to aid decomposition of large amounts of straw. A winter cover crop should follow ensilage or other crops that leave little residue on the soils. Changing the depth of tillage each year helps to reduce the formation of plowpans.

CAPABILITY UNIT I-2

In this capability unit are deep, dark-brown to brown, level to nearly level soils of the uplands that have a moderately coarse textured to medium textured surface layer and a moderately fine textured subsoil. They are—

- Bethany silt loam, 0 to 1 percent slopes.
- Norge fine sandy loam, 0 to 1 percent slopes.
- Pond Creek silt loam, 0 to 1 percent slopes.

These soils are fertile, productive, medium in internal drainage, and friable. All are moderately difficult to till except the Norge, which is easily tilled. The main problems are maintenance of soil fertility and structure. Under good conservation practices the soils are suited to intensive use for all crops suited to the climate.

Soil management.—Small grains, mostly wheat, and alfalfa are the principal crops. Wheat generally follows wheat, but barley and oats are sometimes substituted.

These soils are slightly susceptible to erosion, but good management generally will control it. Stubble mulching and cover crops help control wind erosion. In some places diversion terraces on foot slopes of adjacent higher land are needed to divert water before it reaches these soils. Alfalfa or some other legume in the cropping system helps to maintain soil structure, the content of organic matter, and the intake of water. Leaving non-allotted cropland fallow generally increases the supply of moisture and results in higher crop yields the following year.

Good yields of wheat or other close-growing field crops can be expected for a maximum of 8 consecutive years if the soils are kept in sweetclover, alfalfa, or other soil-building crop for a minimum of 2 years before they are used for grains for another 8-year period. Wheat or other high-residue crops can be grown continuously if all residues are returned to the soil. Good yields of grain sorghum or other row crops can be expected for a maximum of 4 consecutive years if 2 years of small grains and a minimum of 2 years of grasses, legumes, or other soil-improving crops intervene between the periods. A winter cover crop should follow ensilage or other crops that leave little crop residue on the soils.

Generally it is a good practice to apply 20 to 40 pounds of nitrogen per acre at seeding time, to aid decomposition of large amounts of straw. Wheat responds if a small amount of phosphorus is applied at seeding time. Changing the depth of tillage each year helps to reduce the formation of plowpans.

CAPABILITY UNIT II-1

The soils in this capability unit are moderately deep to deep, brown to yellowish red, and moderately permeable. They are—

- Port silt loam, 1 to 3 percent slopes.
- Yahola fine sandy loam.

The Port soil is above the bottom lands, at the base of adjacent, higher uplands; the Yahola is on river flood plains. Both are fertile, productive, friable, easily tilled, and drought resistant. Intake of water and drainage are good, but runoff from adjacent higher land is a problem. Accelerated water erosion occurs in some cultivated fields, and wind erosion can be a problem if the surface is not protected by crop residues or a plant cover.

Soil management.—These soils are well suited to almost every crop that grows in the area. Wheat is the main crop, but some vegetables and fruits can be grown successfully.

Diversion terraces and contour farming and field terraces are needed to break up concentrations of water on long slopes. Legumes will help maintain the content of organic matter, the soil structure, and the intake of water.

Good yields of wheat or other close-growing field crops can be expected for a maximum of 7 consecutive years, provided the soils are kept in sweetclover, alfalfa, or some other soil-building crop for a minimum of 2 years before they are used for grain for another 7-year period. Good yields of grain sorghum and other row crops can be expected for a maximum of 4 consecutive years if 2 years of small grains and 2 years of grasses, legumes, or other soil-improving crops intervene between the 4-year periods.

Wheat or other crops that produce large amounts of residue can be grown continuously if all residues are returned to the soil. Normally, it is good practice to apply 20 to 40 pounds of nitrogen per acre at seeding time to aid decomposition of large amounts of straw. A winter cover crop should follow silage crops and other crops that leave little residue on the soil. Changing the depth of tillage each year helps to reduce the formation of plowpans.

CAPABILITY UNIT II-2

In this capability unit are deep, nearly level to gently sloping, sandy soils of the uplands. They have a moderately coarse textured surface layer and a moderately fine textured subsoil. They are—

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

These soils are moderately high in fertility. They are friable and easily tilled. Surface runoff is slow to moderate, depending on the slope. Both soils are moderately permeable, and their available water holding capacity is good. The common problems are controlling runoff and wind erosion and maintaining fertility and soil structure. Wind erosion, with winnowing, is a problem where cover crops are lacking or where there is not enough plant residue on the surface.

Soil management.—Under a conservation cropping system that includes stubble mulching, these soils will produce nearly all crops suited to the area. Winter wheat, however, is the principal crop.

For consistently good yields of small grains or other sown crops, a suitable cropping system allows up to 7 consecutive years in small grains, provided the soils are kept in legumes or grasses for a minimum of 2 years before starting a new period of small grains. Row crops can be grown for not more than 3 consecutive years if the soils are kept in sweetclover or other soil-improving crop for a minimum of 2 years before seeding row crops again. A winter cover crop should follow ensilage or other crops that

leave little residue on the soil. A mixture of a small grain and a legume can be grown continuously.

Legumes and crop residues help to maintain soil structure and fertility, and they increase the intake of water. Wind erosion can be controlled by stubble mulching or stripcropping crosswise to the direction of the prevailing winds. Terracing combined with contour farming helps to increase the available moisture holding capacity. If terraces are not used, natural drains should be sown to perennial vegetation. Changing the depth of tillage helps to reduce the formation of plowpans.

These soils respond to fertilization during years of adequate moisture. If legumes are inoculated, nitrogen will be added to the soils more efficiently.

CAPABILITY UNIT IIc-3

In this capability unit are deep, brown to reddish-brown soils of the uplands. They have a moderately coarse textured to medium textured surface layer and a moderately fine textured subsoil. They are—

- Kingfisher silt loam, 1 to 3 percent slopes.
- Norge fine sandy loam, 1 to 3 percent slopes.
- Pond Creek silt loam, 1 to 3 percent slopes.

These soils are about average in fertility. They are moderately difficult to till, except the Norge, which is easily tilled. They have good moisture-holding capacity, and under proper management, produce average yields of suitable crops. The common problems are control of runoff, protection from erosion, and maintenance of soil structure and fertility.

Soil management.—Suitable crops are small grains, winter and summer legumes, and sorghum. Winter wheat is the principal crop, and the general practice is to grow it continuously.

Consistently good yields of small grains or other close-growing field crops can be expected for a maximum of 7 consecutive years if the soils are kept in legumes or grasses for at least 2 years before they are used for grain for another 7-year period. Row crops can be grown for a maximum of 3 consecutive years if sweetclover or other soil-improving crop intervenes for a minimum of 2 years before row crops are planted again.

Alfalfa and sweetclover grown in the cropping system help maintain the content of organic matter and improve the soil structure and intake of water. A winter cover crop should follow silage or other crops that leave little residue on the soil. A mixture of a small grain and a legume can be grown continuously.

Stubble mulching, conserving crop residues, or planting cover crops, in combination with terracing and contour farming, will break up concentrations of water and reduce erosion to a minimum. Where moisture is adequate, crops respond to fertilizer. Changing the depth of tillage each year reduces the formation of plowpans.

CAPABILITY UNIT IIw-1

In this capability unit is a deep, grayish-brown, sandy, soil of the uplands that has a coarse textured surface layer and a mottled, moderately fine textured to fine textured subsoil. It is in nearly level areas and slight depressions. This soil is—

- Carwile loamy fine sand.

This soil is moderately fertile. It is easily tilled, but lack of cover or too much tillage results in moderate to severe wind erosion, especially during winter and

spring. Intake of water is good because the surface soil is sandy. The water-holding capacity is good. The subsoil, however, is compact, mottled clay, and during heavy rains water accumulates in the depressions. Sometimes this water damages crops.

Soil management.—Many crops are suited to this soil. Small grains, sorghum, and summer legumes are grown. Winter wheat is the principal crop. Alfalfa is grown occasionally, generally under irrigation. Weeping lovegrass and bermudagrass are introduced pasture grasses that grow well.

Tillage that leaves a rough surface, stubble mulching, and stripcropping will control wind erosion. Draining the depressions helps insure crop production. Rotations consisting of small grains and legumes, with proper use of residues from these crops, help to maintain the content of organic matter and to increase the intake of moisture.

A good cropping system for this soil is up to 5 or 6 years of high-residue crops, followed by a minimum of 1 year of a soil-improving crop. This soil responds to fertilizer if an adequate supply of moisture is available.

CAPABILITY UNIT IIc-1

The soils in this capability unit are deep, dark reddish brown to grayish brown, medium textured to moderately fine textured, and very slowly permeable. They are—

- Kirkland silt loam, 0 to 1 percent slopes.
- Renfrow clay loam, 0 to 1 percent slopes.
- Tabler clay loam.

These soils have a heavy, compact subsoil that absorbs water very slowly. This layer restricts growth of roots and limits the amount of water available to plants. Most of the time the soils are droughty. Some crusting takes place on the surface after rains and hinders movement of air into the soils.

The common problems on these soils are droughtiness, slow intake of water, and unfavorable structure. Tabler clay loam is, perhaps, more difficult to manage than the other two soils because it is nearly level or in slight depressions. In most places it has very slow surface drainage. It is difficult to till, because it is very hard when dry and is tough, or plastic, when wet. It is not subject to erosion, except in some marginal places adjacent to drainageways or slopes.

Soil management.—Most of the acreage in this capability unit is cultivated. The principal crops are small grains, generally winter wheat. These are commonly grown year after year. Crops are not systematically rotated, nor is commercial fertilizer generally applied.

Small grains can be grown for 7 years if the soils are kept in sweetclover or other soil-building crop for a minimum of 2 years before they are used for grain for another 7 years. Row crops can be grown a maximum of 3 consecutive years if followed by 3 years of small grains and then 2 years of legumes or grasses.

Sweetclover, alfalfa, and other deep-rooted legumes, grown whenever possible, help to increase the intake of water. Some crop residue should be kept on the surface to reduce crusting and check occasional wind erosion. All residue from small grains should be returned to the soils. When the production of straw is heavy, an application of nitrogen at seeding time will help decompose it. Changing the depth of tillage each year reduces the formation of plowpans. In some places simple drainage increases productivity and efficiency of farming.

CAPABILITY UNIT IIIe-1

In this capability unit is a deep, dark reddish-brown, droughty soil. It has a moderately fine textured surface layer and a fine textured subsoil. The lower part of the subsoil is red, compact, and very slowly permeable. This soil is—

Renfrow clay loam, 1 to 3 percent slopes.

The soil has moderate runoff, and erosion has removed some of its surface layer, especially where it is cultivated and poorly managed. Tillage is difficult. Maintenance of soil structure and fertility, control of runoff, and conservation of moisture are problems of management.

Soil management.—Small grains and sorghum are suitable crops. Wheat is the crop most commonly grown. Sweetclover and winter legumes are sometimes grown. The general custom is to grow wheat following wheat. Often a small amount of phosphate fertilizer is applied at seeding time.

Good yields of small grains can be expected for a maximum of 7 consecutive years if the soil is kept in legumes, grasses, or a mixture of these, for a minimum of 2 years before it is used for grain for another 7-year period. Row crops can be grown for 2 consecutive years if they are followed by 2 years of close-growing crops. A soil-building crop should be grown a minimum of 1 year in each 5. A mixture consisting of a small grain and a legume can be grown continuously if all crop residues are returned to the soil. A winter cover crop should follow ensilage or other crops that leave little residue.

Terraces and contour farming are generally used, except where close-growing field crops that produce large amounts of residue are grown continuously for 4 years and are followed by an equal number of years of soil-improving crops. Where terraces are not used, perennial vegetation should be established in natural drainageways. Using crop residues or stubble mulching and changing the depth of tillage each year to break up plowpans will help maintain soil structure and productivity.

Leaving fields fallow as long as possible normally improves the water-holding capacity of this soil for the following year. To reduce erosion and store water for crop use, special efforts should be made to hold as much rainfall on the fields as possible. Tillage soon after harvest aids moisture infiltration, controls the growth of weeds, and speeds the decay of crop residues.

CAPABILITY UNIT IIIe-2

The one soil in this capability unit is reddish brown, shallow, and droughty. It has a moderately fine textured surface layer that overlies bedrock of shale or siltstone at a depth of 17 to 24 inches. This soil is—

Vernon clay loam, 1 to 3 percent slopes.

This soil is moderately susceptible to water erosion; some occurs in most of the cultivated areas. The surface layer is slowly permeable; the subsoil, very slowly permeable. The water-holding capacity is low. Crop yields are fairly poor because of low natural fertility and droughtiness.

Soil management.—Winter wheat is the principal crop; however, other small grains, sweetclover, and winter legumes are suitable and are sometimes grown.

Grow high-residue crops each year or a soil-building crop at least 1 year in 3. A cropping system that protects the soil and provides good yields is a maximum of

3 consecutive years of close-growing crops, followed by at least 1 year of legumes, grasses, or other soil-building crop. When moisture is adequate, fertilizer increases crop yields, but in years of drought it may bring no improvement of yields. Proper fertilization helps to hasten the growth of bermudagrass in waterways.

Careful management is required to curtail losses of the soil and to store water for crop use. Fallowing generally improves the supply of moisture and the tilth of the soil. Cover crops, and crop residues plowed under, help to maintain the content of organic matter, to improve soil structure, and to increase the intake of water. Terracing and contour farming break up concentrations of water in the more sloping areas. If terraces are not used, establish perennial vegetation in drainageways.

CAPABILITY UNIT IIIe-3

In this capability unit is only one deep, reddish-brown, medium-textured, and slowly permeable soil of the uplands. It is—

Kingfisher silt loam, 3 to 5 percent slopes.

Natural fertility is moderately high. The soil is moderately difficult to till but has good moisture-holding capacity. Under good management it will produce moderate yields of suitable crops.

The main problems are control of runoff and moderate water erosion and maintenance of soil fertility and structure. In some cultivated fields 20 to 35 percent of the area is so eroded that some of the subsoil is mixed with the surface layer.

Soil management.—Wheat is the principal crop, but other small grains, sorghum, and legumes are suitable. Wheat is commonly grown year after year.

Good yields of small grains can be expected for a maximum of 6 consecutive years if the soil is kept in legumes, grasses, or mixtures of these, for a minimum of 2 years before grain is grown for another 6-year period. Row crops can be grown for a maximum of 2 consecutive years if they are followed by 2 years of close-growing field crops. A soil-building crop should be grown at least 1 year in 4.

A mixture of a small grain and a legume can be grown continuously. A winter cover crop should follow ensilage or other crops that leave little residue on the soil.

Legumes grown in the cropping system help to maintain the content of organic matter, to improve the structure of the soil, and to increase the intake of water. Terraces are generally used, except where close-growing field crops that produce large amounts of residue are grown not more than 4 consecutive years and are followed by soil-improving crops for an equal number of years. If terraces are not used, perennial vegetation is established in drainageways. Using crop residues or stubble mulching and changing the depth of tillage each year to break up plowpans help maintain soil structure and fertility.

CAPABILITY UNIT IIIe-4

In this capability unit is a deep, brown, moderately coarse textured, friable, and moderately permeable soil of the uplands. It is—

Shellabarger fine sandy loam, 3 to 5 percent slopes.

This soil is moderately fertile and easily tilled. Protection from wind erosion, control of runoff, and maintenance of fertility and soil structure are the main problems. Many rills and small gullies are forming on the more

sloping areas. About 20 to 30 percent of the plowed fields show mixing of the surface layer and the subsoil. Wind erosion occurs in excessively tilled areas or where the cover is not adequate.

Soil management.—Small grains, sorghum, and legumes are suitable crops. Wheat is generally grown year after year. Weeping lovegrass and bermudagrass are introduced pasture grasses.

Good yields of small grains or other close-growing crops can be expected for 4 consecutive years, provided the soil is kept in legumes or grasses a minimum of 2 years before grain is grown for another 4-year period. Row crops can be grown for 2 consecutive years if legumes or grasses are then grown for at least 2 years. A winter cover crop should follow ensilage or other crops that leave little residue. A mixture of a small grain and a legume can be grown continuously.

Legumes and crop residues improve the content of organic matter, help to maintain soil structure and fertility, provide cover against wind erosion, and increase the intake of water. Erosion can be controlled by terracing and contour farming, planting windbreaks, stubble mulching, stripcropping crosswise to the prevailing direction of the wind, planting cover crops, and conserving crop residues. Where terraces are not used, natural drains should be planted to perennial vegetation. Changing the depth of tillage reduces formation of plowpans. Preparation of seedbeds in the spring should be delayed until near planting time. This soil responds to fertilization when moisture is adequate. Legumes will add nitrogen to the soil more effectively if they are inoculated.

CAPABILITY UNIT IIIe-5

In this capability unit are deep, brown to grayish-brown, coarse textured soils on uplands. They have a moderately coarse textured to coarse textured subsoil. These soils are—

- Dougherty-Eufaula loamy fine sands, undulating.
- Lincoln loamy fine sand.
- Pratt loamy fine sand, undulating.

These soils are loose, friable, and easily tilled. They are subject to moderate or severe wind erosion, especially during winter and early in spring. In unprotected fields the soils blow and drift during high winds. The natural fertility and content of organic matter are low. The intake of water is moderate to moderately rapid, but the water-holding capacity is low. Some rainfall is lost through runoff, because of the relief, but water erosion is not severe.

Soil management.—These soils are suited to many crops. Small grains, sorghum, and legumes are the principal crops. Vegetables and fruits can be grown successfully, and alfalfa is sometimes grown, generally under irrigation.

Good yields of small grains or similar close-growing field crops can be expected for a maximum of 4 consecutive years, provided the soils are kept in legumes or grasses for a minimum of 2 years before grain is grown for another 4-year period. Row crops can be grown for 2 consecutive years if they are followed by 2 years of small grains and then at least 2 years of legumes or grasses. A winter cover crop should follow ensilage or other crops that leave little residue on the fields. A mixture consisting of a small grain and a legume can be grown continuously.

Legumes and crop residue help to maintain soil structure and fertility and to increase the intake of water. Wind erosion can be controlled by planting windbreaks, stubble

mulching, or stripcropping crosswise to the direction of the prevailing wind. Seedbed preparation in the spring should be delayed until near planting time. Perennial vegetation should be established in drains.

CAPABILITY UNIT IIIs-1

In this capability unit are complexes of slick spots and deep soils that have a medium textured to moderately coarse textured surface layer and a moderately fine to fine textured subsoil. They are—

- Kingfisher-slickspot complex, 1 to 3 percent slopes.
- Norge-slickspot complex, 1 to 3 percent slopes.
- Tabler-slickspot complex.

Slick spots cover 10 to 15 percent of the areas of Kingfisher-slickspot complex, 1 to 3 percent slopes; 15 to 25 percent of the areas of Norge-slickspot complex, 1 to 3 percent slopes; and 25 to 40 percent of the areas of Tabler-slickspot complex. The spots are most noticeable in cultivated fields. They are cultivated and otherwise managed in the same manner as the soils around them.

Soil management.—Small grains are the most common crops grown on the soil complexes of this capability unit. Near crop failures are common on the slick spots, mainly because they contain white alkali, crust at the surface, and take water slowly. The soils around the slick spots are not affected by alkali and require the management discussed in capability units IIe-3 and IIs-1. The management in unit IIs-1 applies to the Tabler soil of the Tabler-slickspot complex, and that of IIe-3, to the Kingfisher and the Norge soils of those respective complexes.

For satisfactory yields of close-growing field crops, generally small grains, a suitable cropping system is not more than 4 consecutive years of small grains, followed by a minimum of 2 years of legumes or grasses.

Growing legumes and stubble mulching or using crop residues will help to maintain soil structure and fertility and to increase the intake of water. If cultivation of the slick spots is to become profitable, they must have special treatment, which includes application of gypsum or similar amendment to improve soil structure. Changing the depth of tillage each year helps to reduce the formation of plowpans.

CAPABILITY UNIT IVe-1

The one soil in this capability unit is shallow, reddish brown, and moderately fine textured. It is—

- Vernon clay loam, 3 to 5 percent slopes, eroded.

Unweathered clay and shale beds are 18 to 26 inches below the surface. From 30 to 70 percent of the acreage in cultivated fields has been eroded to such extent that the plow layer is a mixture of the original surface layer and underlying material.

The limitations of this soil are excessive surface drainage, slow permeability, shallowness, moderate susceptibility to water erosion, and difficulty of tillage.

Soil management.—This soil is not well suited to cultivation. Most of the acreage cultivated is used for small grains. Wheat is the principal crop, but small grains, sorghums, and legumes are suitable. Wheat generally is grown year after year. The grasses in native pasture are mostly buffalograss and side-oats grama. These grasses better withstand heavy grazing and dry weather than other grasses that could be used.

A cropping system with terraces and contour farming that will conserve the soil and provide satisfactory yields

allows a minimum of 1 year of a soil-improving crop in each 4-year period or continuous high-residue crops. The use of legumes, particularly sweetclover, in the cropping system helps to improve soil fertility and the supply of moisture available to plants.

Careful management is required to prevent further loss of soil. Special effort should be made to hold as much rainfall as possible, for the purpose of controlling erosion and storing extra moisture for crops. Perennial vegetation should be established in drains. Changing the depth of tillage each year reduces the formation of plowpans.

CAPABILITY UNIT IVe-2

In this capability unit is a soil complex that consists of a deep, reddish-brown, medium-textured, slowly permeable, eroded soil of the uplands and a shallow soil that occurs in areas of irregular size and shape on long, moderately steep slopes, near ridgetops, and along drainageways. This mapping unit is—

Kingfisher-Lucien complex, 5 to 8 percent slopes, eroded.

The soils of this complex are medium textured and moderately to slowly permeable, and they are moderate in natural fertility. Seventy percent of the acreage of this complex is estimated to be Kingfisher soil. Where Kingfisher soil is cultivated, from 20 to 35 percent of its area has eroded, and, in plowing, part of the subsoil is brought to the surface. The other 30 percent of the complex is estimated to be Lucien soil, which is also eroded. When the Lucien soil is plowed, part of its subsoil is exposed. A substratum of soft sandstone is 10 to 20 inches from the surface of the Lucien soil of this complex.

The problems of management, related to the moderately strong slopes, are protection from moderate to severe erosion, control of rapid runoff, and maintenance of soil structure and fertility.

Soil management.—Small grains and sorghum are the best suited crops. Wheat is the principal crop grown.

Terraces are generally used except where small grains or similar close-growing crops are produced and the residue is left on the soils. If crop residues are carefully managed, small grains can be grown 3 years in succession and followed by 3 years of legumes or grasses. If terraces are not used, perennial vegetation is established in natural drainageways. If a suitable cropping system is combined with terracing and contour farming, good yields of small grains can be expected for a maximum of 4 consecutive years, provided the soils are kept in legumes or grasses for a minimum of 2 years in the intervening periods. It is good management to grow a mixture of a small grain and a legume continuously if all crop residues are returned to the soils.

Growing legumes and stubble mulching or using crop residues will help to maintain soil structure and fertility and to increase the intake of water. Changing the depth of tillage each year will reduce the formation of plowpans.

CAPABILITY UNIT IVe-3

In this capability unit is a deep, brown, moderately coarse textured soil that has a moderately fine textured subsoil. It is—

Shellabarger fine sandy loam, 5 to 8 percent slopes, eroded.

This sandy soil of the uplands is low in fertility. It is friable and easily tilled, and wind erosion increases where

it lacks cover or is improperly tilled. Plowing has brought part of the subsoil into the plow layer. Water erosion has affected from 65 to 80 percent of the cultivated acreage.

Where this soil is farmed, the main problems are protection from moderately severe water and wind erosion, control of runoff, and increasing the supply of organic matter.

Soil management.—This soil is used mostly for wheat and other small grains, but it is also suitable for sorghum and legumes. If it is kept in cultivation, it needs more intensive treatment than the soil of capability unit IIIe-4.

A suitable cropping system allows up to 3 consecutive years of small grains or other close-growing field crops, followed by a minimum of 2 years of grasses or legumes before grain is grown for another 3-year period. Perennial vegetation should be established in natural drainageways. Wind erosion can be controlled by stubble mulching or, where practical, stripcropping crosswise to the direction of the prevailing wind. Preparation of seedbeds in spring should be delayed until near planting time.

Growing legumes and stubble mulching or using crop residues help to maintain soil structure and fertility and to increase the intake of water. Changing the depth of tillage each year helps to reduce the formation of plowpans.

CAPABILITY UNIT IVe-4

In this capability unit are deep, brown to grayish-brown, coarse-textured soils of the uplands. They have a moderately coarse textured subsoil. They are—

Dougherty-Eufaula loamy fine sands, hummocky.
Pratt loamy fine sand, hummocky.

The soils are low in natural fertility. Their intake of water is moderate to moderately rapid, and their water-holding capacity is low. They are friable and easily tilled, but they are susceptible to moderate to severe water and wind erosion, especially during spring.

Soil management.—Small grains, sorghums, legumes, truck crops, and some fruits are crops suitable for these soils. Weeping lovegrass and bermudagrass are suitable introduced grasses. Rye and vetch provide good grazing and excellent cover during winter and early in spring.

A cropping system that will provide satisfactory yields and protect the soils is not more than 3 consecutive years of the small grains, followed by a minimum of 2 years of grasses or legumes. Perennial vegetation should be established in natural drainageways. A mixture of a small grain and a legume can be grown continuously.

Legumes and crop residues help to maintain structure and fertility and to increase the intake of water. Erosion can be controlled by stubble mulching or by stripcropping crosswise to the direction of the prevailing wind. Crops respond well to fertilizer if other management is good and the supply of moisture is normal or above normal. The most benefit is obtained from fertilizer if small amounts are applied several times during the growing season. Seedbeds should be prepared late in spring, near planting time. Changing the depth of tillage each year will help to reduce the formation of plowpans.

CAPABILITY UNIT IVe-5

The two soil complexes in this capability unit are made up of moderately deep to deep soils. These soils have a moderately coarse textured to medium textured surface layer and a moderately fine textured subsoil. Many small

spots affected by white alkali are on moderately strong slopes in cultivated fields. The mapping units are—

Kingfisher-slickspot complex, 3 to 5 percent slopes.
Norge-slickspot complex, 3 to 5 percent slopes, eroded.

In areas of the Kingfisher-slickspot complex, 3 to 5 percent slopes, the spots affected by alkali cover 10 to 15 percent of the acreage, and erosion affects 25 to 60 percent of it. The surface layer and part of the subsoil are mixed in plowed fields. In areas of the Norge-slickspot complex, 3 to 5 percent slopes, eroded, the spots affected by alkali cover 15 to 40 percent of the acreage, and erosion affects about 60 to 80 percent of the entire complex in plowed fields.

The Kingfisher and Norge soils in these soil complexes are similar to soils in capability unit IIIs-1, but more of their acreage is on the stronger slopes, which cause more runoff and increase susceptibility to erosion. These two problems, together with the very slow or slow intake of water, droughtiness, unfavorable structure, and the slick spots, make careful management a necessity if the soils are to remain in cultivation.

Soil management.—A cropping system that will provide satisfactory yields and protect the soils is not more than 3 consecutive years of high-residue, sown crops followed by a minimum of 2 years of grasses or legumes.

CAPABILITY UNIT IVw-1

The land in this capability unit is deep, red to reddish-brown, clayey alluvium. It is fine textured, compact, very slowly permeable, and saline in spots. It is—

Clayey saline alluvial land.

This land is difficult to farm, and crop yields are low. The main problems are droughtiness, high content of clay, very slow permeability, wetness, and moderate salinity. Normally, erosion is not a hazard, but there is danger of damage from flooding in some places.

Soil management.—The main crops are wheat and other small grains. Most of the acreage is in range.

A suitable cropping system consists of small grains or other crops that produce large amounts of residue for 3 consecutive years, followed by annual legumes or perennial grasses for a minimum of 2 years before grain is again grown.

Growing legumes and stubble mulching or using crop residues will help to maintain structure and fertility and to increase the intake of water. Changing the depth of tillage each year will help to prevent the formation of plowpans.

Soil management.—The principal crop grown is winter wheat. This land is cultivated and otherwise managed in the same manner as the soils surrounding it. Normally, this kind of management is not intensive enough to improve the land or to offset its limitations.

A cropping system that will protect the land is up to 3 consecutive years of small grains or other crops that produce large amounts of residue, followed by legumes or grasses for a minimum of 2 years before grain is again grown. Perennial vegetation should be established in natural drainageways.

Growing legumes and stubble mulching or returning crop residues to the land will help to maintain structure and fertility and to increase the intake of water. Special treatment with gypsum or similar amendments will improve tilth in the slick spots. Changing the depth of

tillage each year will help to prevent the formation of plowpans.

CAPABILITY UNIT Vw-1

In this capability unit is a land type that consists of reddish-brown to dark reddish-brown alluvium. It is—

Broken alluvial land.

Broken alluvial land occurs in stream channels and on streambanks. It is loamy and fertile but is of limited agricultural value because it is very steep and is frequently flooded.

Soil management.—The present vegetation consists of trees and shade-tolerant shrubs, weeds, and grasses. Cottonwood, elm, chinaberry, and willow trees dominate, and there are a few walnut trees. Where the trees are dense, grass does not grow well. In the more open areas, the principal grasses are big bluestem, switchgrass, little bluestem, western wheatgrass, and Canada wildrye.

The areas of this land type are best used for grazing, wildlife, and recreation. Squirrels are particularly numerous on Turkey Creek; fishing is fair to good on most of the large creeks; and there is ample cover, food, and water for quail. Some of the higher areas are ideally suited to summer gardens.

The native pastures can be improved under proper management, particularly if some of the less sloping areas are cleared and sodded to bermudagrass.

CAPABILITY UNIT Vw-2

In this capability unit there is one land type that occurs in very low areas next to the bed of the Cimarron River. It is—

Lincoln sand.

This land type was formed by the flooding and shifting of the braided river channel and by action of the wind. Some areas have been built up enough to be of some importance for grazing. During floods, other areas may be washed down and become all or part of the riverbed. In dry seasons the very salty, small, clayey spots crust, check, and curl. The water table is generally high, but it fluctuates according to the weather.

Soil management.—Areas of this land type are covered with a dense growth of tamarisk. Saltgrass and other salt-tolerant grasses grow in the more open spots and clearings.

CAPABILITY UNIT Vw-3

This capability unit contains one land type that occurs along Preacher Creek and the Cimarron River. This land type is—

Wet alluvial land.

This land is frequently flooded. The water table is normally high, and seepage water is at or near the surface.

Soil management.—All the areas are used for native pasture or range. Production of forage is good. Pit ponds are dug to supply stock with water.

CAPABILITY UNIT Vg-1

This capability unit contains deep, grayish-brown Drummond soils of the uplands. These soils are shown as one unit on the soil map. This unit is—

Drummond soils.

Drummond soils have a loamy surface layer and fine-textured subsoil. There are many, small, loamy mounds

and intervening clayey spots. These slick spots, or alkali spots, cover about 35 to 40 percent of the area.

Soil management.—Drummond soils are not suitable for cultivation. They are all in native pasture. Under good management switchgrass, alkali sacaton, and inland saltgrass are dominant, and there is some blue grama and buffalograss.

CAPABILITY UNIT VIe-1

In this capability unit are mostly shallow, red to reddish-brown miscellaneous land types that have exposed red beds of variable texture on steep, broken slopes and along small drains. Narrow strips of alluvium on the stream floor are cut up in odd patterns by shallow, dry streambeds. The land types in this unit are—

Alluvial and broken land.
Vernon soils and Rock outcrop.

These soils are prominent in the landscape and break sharply from associated soils. About 35 percent of this capability unit consists of Vernon soils and Rock outcrop. The other 65 percent is Alluvial and broken land.

Protection from both wind and water erosion, control of rapid runoff, and improvement of the very low intake and storage of water are problems. Wind erosion is not noticeable in areas of the Vernon soils and Rock outcrop, but clay dunes are common in the lower places. These clayey areas are small, very rough, and free of vegetation.

Soil management.—Nearly all of the acreage of this capability unit is rangeland; a few small areas are in cultivated fields. Good range management that includes control of grazing is needed to reduce erosion. Little bluestem, side-oats grama, buffalograss, and blue grama are native grasses.

CAPABILITY UNIT VIe-1

In this capability unit is a deep, sandy miscellaneous land type of the bottom lands. It is in a low ridge of hills on the valley floor of the Cimarron River. The land type is—

Sand dunes, Lincoln material.

Most of this land type is well stabilized. Its moisture-holding capacity is low, and it is very susceptible to wind erosion.

Soil management.—Use of this land is limited to range. Good range management that includes control of grazing is needed to prevent erosion. Sand bluestem, little bluestem, and sand lovegrass are native.

CAPABILITY UNIT VIe-2

The soil in this capability unit is a deep, grayish-brown fine sand that forms a long, narrow, high ridge of hills along the north side of and parallel to the Cimarron River. These sand hills start in the northwestern corner of the county and extend about 12 miles in a southeasterly direction. The soil is—

Tivoli fine sand.

This soil is rapidly permeable. The principal problems are protection from wind erosion and maintenance of an adequate cover of native plants.

Soil management.—All of this soil is in rangeland. Good range management that includes control of grazing is needed to prevent wind erosion. A few elm and cottonwood trees dot the area. This soil is stabilized by a stand of coarse grasses and sagebrush. Sand bluestem, little bluestem, and tall dropseed are native grasses.

CAPABILITY UNIT VIe-3

The soil in this capability unit is a deep, grayish-brown fine sand that is rapidly permeable. Most of it is in a narrow range of high sand hills along the north side of the Cimarron River; other small isolated areas are in the sandy uplands. This soil is—

Eufaula fine sand.

About 20 to 25 percent of Eufaula fine sand has a thin loamy subsoil; the rest is sand throughout the profile.

Soil management.—In a few areas some of this soil has been farmed, but it is subject to severe wind erosion. The native vegetation is a mixture of blackjack and elm trees, some brush, and tall grasses. When properly managed, this soil will support a thick stand of tall grasses, including big bluestem, little bluestem, Indian-grass, switchgrass, and sand lovegrass.

CAPABILITY UNIT VIIe-1

In this capability unit is a land type that is mostly on gypsum hills in the extreme southwestern corner of the county. Another area is on steep bluffs, backcut by steep, V-shaped ravines, that form part of the south bank of the Cimarron River. This land type is—

Rough broken land.

The problems are protection from severe erosion and maintenance of range plants.

Soil management.—All of this land is in a very thin stand of native vegetation and is used for range and as a wildlife habitat. Grazing should be limited where this land is in range or pasture.

Estimated Yields

In table 2 are estimated acre yields of important crops grown on those soils of Kingfisher County suitable for cultivation; that is, the soils in capability classes I, II, III, and IV. The yield figures given in table 2 are estimated long-time averages, not yields for any particular year. Crop failures (zero yield) were included in computing the averages. The yields serve two purposes: (1) to report, according to best information available, yields that can be expected from these soils under customary management; and (2) to indicate the response of the various soils to improved management.

In columns A of table 2 are yields expected under customary management, which is that practiced by most farmers in the county. Under this management, crop varieties suited to the region are seeded at the proper time and rate, are harvested efficiently, and, so far as practical, are protected from weeds, insects, and diseases. Fertilizer, however, is used only when necessary to establish legumes; and cover crops are used to protect only the most sandy soils.

TABLE 2.—Estimated average acre yields of principal crops on soils suited to cultivation

[Yields in columns A are those obtained under customary management; those in columns B are obtained under improved management (see text for explanation of these two levels of management); absence of yield indicates crop is not commonly grown on the soil at the level of management specified; soils and miscellaneous land types not listed in table are normally not suitable for cultivation]

Map symbol	Capability unit	Soil	Wheat		Oats		Barley		Grain sorghum		Forage ¹ sorghum		Alfalfa		Mungbeans	
			A	B	A	B	A	B	A	B	A	B	A	B	A	B
BeA	I-2-----	Bethany silt loam, 0 to 1 percent slopes.	Bu. 17	Bu. 24	Bu. 35	Bu. 55	Bu. 30	Bu. 40	Bu. 20	Bu. 30	Tons. 2.2	Tons. 3.0	Tons. 1.3	Tons. 2.3	-----	-----
Ca	IIw-1-----	Carwile loamy fine sand-----	12	19	24	44	19	29	16	24	1.8	2.2	1.5	2.8	300	600
Cv	IVw-1-----	Clayey saline alluvial land-----	11	14	18	22	15	20	14	18	1.2	1.7	-----	-----	-----	-----
DeB	IIIe-5-----	Dougherty-Eufaula loamy fine sands, undulating.	10	18	18	32	16	25	18	26	1.6	2.3	1.1	2.3	200	500
DeC	IVe-4-----	Dougherty-Eufaula loamy fine sands, hummocky.	9	16	16	30	14	22	17	23	1.5	2.0	-----	-----	-----	-----
KfB	IIe-3-----	Kingfisher silt loam, 1 to 3 percent slopes.	15	22	28	42	20	30	23	34	2.0	2.5	-----	-----	-----	-----
KfC	IIIe-3-----	Kingfisher silt loam, 3 to 5 percent slopes.	13	20	26	40	18	28	22	32	1.8	2.2	-----	-----	-----	-----
KgD3	IVe-2-----	Kingfisher-Lucien complex, 5 to 8 percent slopes, eroded.	8	12	18	28	13	20	15	19	1.6	2.0	-----	-----	-----	-----
KhB	IIIs-1-----	Kingfisher-slickspot complex, 1 to 3 percent slopes.	10	16	20	30	16	24	16	20	1.6	2.0	-----	-----	-----	-----
KhC	IVe-5-----	Kingfisher-slickspot complex, 3 to 5 percent slopes.	8	12	18	26	14	20	14	18	1.4	1.8	-----	-----	-----	-----
KrA	IIIs-1-----	Kirkland silt loam, 0 to 1 percent slopes.	14	20	30	50	22	35	18	26	2.0	2.8	-----	-----	-----	-----
Lc	IIIe-5-----	Lincoln loamy fine sand-----	9	16	20	34	18	27	20	28	2.2	2.8	-----	-----	-----	-----
NoA	I-2-----	Norge fine sandy loam, 0 to 1 percent slopes.	16	21	27	45	22	32	24	38	2.5	3.0	1.4	2.6	-----	-----
NoB	IIe-3-----	Norge fine sandy loam, 1 to 3 percent slopes.	15	20	25	42	20	30	22	35	2.0	2.8	1.0	2.0	-----	-----
NsB	IIIs-1-----	Norge-slickspot complex, 1 to 3 percent slopes.	12	16	22	35	18	25	20	30	1.8	2.2	-----	-----	-----	-----
NsC3	IVe-5-----	Norge-slickspot complex, 3 to 5 percent slopes, eroded.	10	14	20	32	16	22	18	28	1.6	2.0	-----	-----	-----	-----
PcA	I-2-----	Pond Creek silt loam, 0 to 1 percent slopes.	17	22	30	50	24	36	22	34	2.4	3.0	1.4	2.5	-----	-----
PcB	IIe-3-----	Pond Creek silt loam, 1 to 3 percent slopes.	16	20	26	44	21	31	23	36	2.4	3.0	1.2	2.5	-----	-----
PoA	I-1-----	Port clay loam, 0 to 1 percent slopes.	23	32	42	56	34	42	29	40	2.8	3.6	2.6	3.5	-----	-----
PsA	I-1-----	Port silt loam, 0 to 1 percent slopes.	22	32	40	55	30	38	30	42	2.8	3.6	2.5	3.4	-----	-----
PsB	IIe-1-----	Port silt loam, 1 to 3 percent slopes.	20	30	36	50	27	35	28	40	2.8	3.6	2.4	3.2	-----	-----
PfB	IIIe-5-----	Pratt loamy fine sand, undulating.	12	20	22	38	18	28	21	31	2.0	2.5	1.3	2.6	200	500
PfC	IVe-4-----	Pratt loamy fine sand, hummocky.	10	18	18	34	16	26	20	30	1.8	2.3	-----	-----	-----	-----
RcA	IIIs-1-----	Renfrow clay loam, 0 to 1 percent slopes.	15	20	27	44	21	32	14	20	1.6	2.4	1.0	2.0	-----	-----
RcB	IIIe-1-----	Renfrow clay loam, 1 to 3 percent slopes.	14	18	25	40	20	30	12	17	1.4	2.0	-----	-----	-----	-----
ShA	IIe-2-----	Shellabarger fine sandy loam, 0 to 1 percent slopes.	15	22	28	46	22	32	22	32	2.1	2.8	1.5	3.0	300	600
ShB	IIe-2-----	Shellabarger fine sandy loam, 1 to 3 percent slopes.	14	20	25	40	18	28	20	30	1.8	2.5	1.3	2.7	300	600
ShC	IIIe-4-----	Shellabarger fine sandy loam, 3 to 5 percent slopes.	12	15	22	35	15	25	17	26	1.6	2.2	-----	-----	-----	-----
ShD3	IVe-3-----	Shellabarger fine sandy loam, 5 to 8 percent slopes, eroded.	8	12	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Ta	IIIs-1-----	Tabler clay loam-----	12	19	24	44	19	29	-----	-----	-----	-----	-----	-----	-----	-----
Ts	IIIs-1-----	Tabler-slickspot complex-----	9	16	20	35	17	26	-----	-----	-----	-----	-----	-----	-----	-----
VcB	IIIe-2-----	Vernon clay loam, 1 to 3 percent slopes.	10	13	16	20	13	17	10	16	1.0	1.5	-----	-----	-----	-----
VcC3	IVe-1-----	Vernon clay loam, 3 to 5 percent slopes, eroded.	7	10	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Ya	IIe-1-----	Yahola fine sandy loam-----	15	22	26	40	20	30	24	35	2.5	3.0	2.2	3.0	300	600

¹ Reported as dry weight.

The specific factors that limit use of the different soils are mentioned in the subsection "Capability Groups of Soils." The practices generally used in the county to minimize these limitations are explained in the subsection "Management of Soils for Tilled Crops."

The estimates in table 2 are based on data obtained from the Agronomy Department of Oklahoma State University, on information furnished by farmers in the county, and on observations made by the soil survey party during the survey. Where available, records of actual yields were used. The source of much yield information was a study initiated in 1956 by the soil survey staff of the Agronomy Department, Oklahoma State University. In this study, research data were compiled by soil types. The records of the Oklahoma Agricultural Experiment Station on studies of soil fertility, on tests of crop varieties, and on field trials for different methods of tillage and crop rotation were assembled and evaluated. Such studies, conducted on plots on the experiment station or on the land of cooperating farmers, were the source of long-time yield records for some soil types.

Soils men obtained additional information from farmers. They selected fields that consist dominantly of one kind of soil and then contacted the farmers managing these fields. The information they gave on management and yield was recorded. Thus, a random selection of soil types and kinds of management was obtained. Through this process, 10- to 20-year yield records were obtained for several soil types.

Where yield data on a certain type of soil were lacking, estimates were made for it by comparing it with a similar type of soil for which several years of records were available. Estimates in published soil surveys in neighboring counties were also taken into consideration.

The yields in columns B are those to be expected under improved management, which normally includes all those practices listed under customary management and additional practices to conserve the soils and improve their productivity. Fertilizer is added to achieve maximum practical yield; contour tillage and terracing are practiced where appropriate; crop residues are managed in such a way as to control erosion, increase infiltration of water, and encourage emergence of seedlings; and a cropping system is followed that is designed to meet both the goal of the operator and the needs of the individual soils.

Improved management takes into account the limiting factors that apply to all soils in the county, such as weeds, insects, and lack of sufficient moisture, and, in addition, those limitations that apply to individual soils. For example, yields can be increased greatly on some soils by applying fertilizer, lime, or both, but on others increased yield and soil conservation can be achieved by carefully managing crop residues. On yet other soils, an appropriate cropping system or conservation practices will suffice.

Management of Soils for Tilled Crops ¹

Discussed in this section are the major problems encountered in growing tilled crops on the soils of Kingfisher County and the general practices of management that will conserve the soils and provide good long-term yields.

The main problems of management in Kingfisher County

are (1) protection of the soils from erosion caused by wind and water and (2) maintaining the tilth necessary for high-level production. Among the practices used to achieve these goals are minimum tillage, rotating soil-depleting crops with legumes or other soil-building crops, planting cover crops, returning crop residues to the soils, applying fertilizer, stubble mulching, strip cropping, deep plowing, terracing, and planting grass in waterways.

The efficient farmer applies these various practices with judgement based on knowledge of the soils on his farm or ranch. He knows that soils differ in the kind of management they need and that a practice essential on one kind of soil may not be needed on another.

This section, used with the one on management by capability units, will aid farmers in selecting the practices appropriate for the soils on their farms. Here, the practices generally needed in the county are explained, and, in the subsection on capability units, you may learn how these practices apply to groups of soils that require similar management. The yields to be expected under customary management and improved management (table 2) are additional guides in selecting a system of management for an individual farm.

Minimum tillage

Minimum tillage is most essential in this county but rather difficult to achieve. If soils are to be cropped, they must be worked to (1) prepare a seedbed, (2) control weeds or other competitive vegetation, and (3) provide a favorable place for growth of crop roots. But tillage breaks down soil structure, and, if it is excessive, the natural aggregates are greatly reduced in size. The soil then tends to puddle and to crust at the surface, takes in less water and air, and stores less moisture for plant growth.

Decrease in supply of moisture means less crop growth and greater damage in dry periods. The amount of runoff increases, since there is less plant growth, and the greater runoff encourages more erosion. Also, excessive tillage reduces the supply of organic matter in the soil, and soil fertility is lost with the organic matter.

Compaction is another problem that results if tillage is not kept to a minimum. If implements are used often and set at the same depth, a tillage pan, or plowpan, forms, particularly in the loam, silt loam, and clayey soils. This pan, just below plow depth, reduces aeration and the ability of the soil to store moisture at lower levels. The plowpan ordinarily restricts normal growth of roots, and, in some instances, plants can use only the moisture and nutrients available above the pan, or to the depth of normal tillage.

If tillage is not kept to a minimum, danger of wind erosion greatly increases because clods at the surface are broken and much of the crop residue is buried.

Dust mulching, once considered an appropriate way of conserving moisture, is actually excessive tillage. The belief was that the dust mulch would reduce evaporation of moisture. For this reason, the soil was cultivated after each rain, or more often, to maintain the soil mulch. But evaporation of moisture is rapid after a rain, and for all practical purposes, has ceased, before the soil is dry enough to cultivate. Thus, the tillage designed to create a mulch that will conserve moisture accomplishes little but control of weeds. Also, a dust mulch tends to puddle, and this increases runoff and makes it difficult to maintain a good seedbed.

¹ By M. D. GAMBLE, agronomist, Soil Conservation Service.

Tillage costs money. The average cost of a man's time, tractor, and equipment can be considered conservatively at a dollar an acre for each operation. By eliminating a few trips over the land, the farmer can reduce costs and, likewise, improve management of his soils.

Control of erosion

Control of wind and water erosion is needed in this county. The degree of control required depends on the soil, the topography, and the type of farming. Generally, some combination of practices is the most efficient way of achieving the control necessary. Among those that can be used are rotation of crops, planting of cover crops, contour farming, stubble mulching, minimum tillage, deep plowing, building terraces and diversions, grassing waterways, and applying fertilizer. Of prime importance, whatever the combination of practices selected, is production and conservation of the crop residues needed to control erosion and to improve the tilth of the soils.

In selecting practices, the farmer considers the need for control of erosion, the cost of applying the practices required, and the production that can be achieved. Many combinations of practices are possible, one of which will be appropriate for a particular farm. Farmers, ranchers, and landowners of this county can obtain assistance in selecting a suitable combination of practices from local representatives of the Soil Conservation Service or the County Extension Agent.

Cropping sequences and soil-building crops

Where small grains or row crops are grown, the fertility of soils declines if clover, alfalfa, or some other soil-building crop is not included in the cropping sequence. The kind of soil-building crop used, and the frequency of its use in the cropping sequence, varies according to the kind of soil and the kind of soil-depleting crop grown. Wheat and other small grains that provide a close-growing cover deplete soils less rapidly than sorghum, cotton, or other row crops. Small grains or other crops may deplete the soil little if they produce a large amount of crop residue that is left on the soil.

On soils used mainly for small grains, the soil-improving crop most often used is a legume. Since it is uncertain that a legume seeding will produce a stand on these soils, a nurse crop is needed. The nurse crop is a small grain. It may be seeded with the legume, or it may be a volunteer stand in which the legume is seeded. The entire growth of the legume would be plowed down in spring, about May 15, and the soil summer fallowed until small grain is seeded in fall.

If alfalfa or sweetclover is used in a cropping sequence and is left on the land for 2 years or longer, some crop that requires a large amount of nitrogen should follow the legume.

On sandy soils subject to wind erosion, cowpeas and vetch are the most dependable annual legumes for use in a cropping sequence. The entire growth should be turned under or disked into the surface in July or August, and a mixture of rye and vetch should be seeded to provide winter cover.

Crops other than legumes that produce a large amount of residue can be used in a cropping sequence instead of legumes. Residues from these crops should be returned to the soil and properly managed.

Following are the legumes, grasses, and other crops used to improve soils in this county:

LEGUMES.—Alfalfa, sweetclover, cowpeas, mungbeans, Austrian winter peas, hairy vetch, and guar are suitable soil-improving legumes. Alfalfa is best suited to the conditions that prevail in the county; sweetclover and cowpeas are the next choices. If rainfall is average or above, mungbeans, Austrian winter peas, and vetch do well.

GRASSES.—A mixture of native grasses or introduced grasses, for example, blue panic and weeping lovegrass, can be grown for pasture and then turned under to improve the soils. Under dryland conditions, however, native grasses will need 2 to 4 years to establish a stand, and, therefore, are suitable only in a long-term cropping system.

OTHER CROPS.—Small grains and other crops that produce a large amount of residue are soil improving, provided only the grain is removed and the residue remains on the soils. When the yield of straw or other residue is large, it is normally beneficial to apply 20 to 40 pounds of nitrogen to speed its decomposition.

Cover crops

Cover crops are used in a cropping system mainly to provide summer or winter protection from erosion. Close-growing grasses, legumes, or small grains are used, and they normally are on the land for 1 year or less.

Cover crops are now grown extensively on the sandy soils of this county, as they are susceptible to wind and water erosion during winter and early in spring. Practical experience of farmers in the county shows that the benefits of cover crops, especially on sandy soils, more than offset the fact that they use moisture needed for the crop that follows. The use of rye and vetch as cover crops has increased yields of other crops grown in the cropping sequence. Rye is the main cover crop used in this county, but other small grains are also used. Small grains can be seeded in row crops early in September by using a specially constructed drill.

Contour farming

Plowing, planting, and tilling soils on the contour, instead of up and down the slope, has many advantages. Less water erosion occurs, more water soaks into the soil where it falls, and crops grow better because there is more moisture. Stands are more even, and the plants tend to be more uniform in size. Farm equipment is easier and more economical to operate.

Contour farming is a must if land is terraced. It is also effective on land that has not been terraced, provided the rows need not be run east to west to combat wind erosion.

Stripcropping

Stripcropping is a practice suitable for controlling wind erosion on sandy soils. Crops of various kinds are grown in alternate strips with small grains. If sorghum is grown in the strips, a high stubble is left to provide protection from wind during winter and early in spring.

The width of the strips planted to crops that permit wind erosion depends on the erodibility of the soil. Soil flow with the wind should not exceed 0.25 ton per rod, per hour. Many factors affect soil flow, but the rate of movement is closely associated with the texture of the soil.

This is a general guide to width of strips: On fine sands, strips can be 1.5 rods wide; on fine loamy sands, 4 rods; on fine sandy loams and highly granulated clays, 8 rods; on loams, silt loams, and clay loams, 20 rods.

Strips of erosion resistant crops and erosion susceptible crops should be of the same width, and all strips should be as near at a right angle to the direction of the prevailing wind as practical.

Stripcropping is used in this county exclusively to provide protection from the wind. Contour stripcropping, a practice used to control water erosion, has not proven practical in this county.

Most operators in this county who have sandy land prefer cover crops of rye or crop residues, instead of stripcropping, as a means of controlling wind erosion.

Conserving crop residues

Leaving crop residues on the surface, or working them partly into the surface soil, is a desirable practice on all the soils that do not require stubble mulching. Conservation of residues is especially important on the sandy soils, as it provides the protection from wind erosion that is needed in winter and early in spring.

Crop residues contain the nutrients the plants took from the soil when they were growing. If these residues are returned to the soil, micro-organisms break them down to humus and, in the process, restore to the soil a large part of the nutrients once removed. Furthermore, the humus improves the tilth of the surface layer, and thus increases infiltration of water, improves storage of moisture, and reduces crusting of the surface.

Farmers that overgraze or burn over fields from which a crop has been harvested are encouraging erosion.

Stubble mulching

Stubble mulching is a year-round system of farming designed to keep a protective cover of crop residues on the surface until the next crop is seeded. This system requires use of sweeps, rod weeders, and blades that undercut the soil and leave residues on the surface. The seeding equipment must be capable of drilling through the trashy cover.

Stubble mulching is beneficial on all soils, and especially those where small grains are seeded. It increases infiltration of water, improves tilth, tends to check decline in supply of organic matter, reduces extremes in temperature at the surface of the soil, protects the surface soil from wind erosion, and reduces loss of moisture.

How much residue is needed at the surface to control wind erosion? This can be answered only in a general way because speed of the wind, kind of soil, physical condition (or tilth) of the soil, and other factors must be considered. Ordinarily, 750 to 2,000 pounds of residue, the actual amount depending on the soil type, will do an adequate job if it is evenly distributed and is anchored in the surface layer. Generally, about 100 pounds of straw is produced per acre for each bushel of wheat harvested.

Though stubble mulching is not widely used in this county, the practice is gaining acceptance. Many farmers now go over their harvested wheatfields with chisels or sweeps to control weeds and prepare a seedbed. These implements leave most of the stubble on the surface at seeding time. Some farmers, however, have worked the stubble into the surface soil by seeding time, and in this way almost eliminate the advantage of using sweeps or chisels. Wind erosion is usually most dangerous after a

small grain is seeded in fall and before it has grown enough to protect the soil.

Perhaps stubble mulching would be used more widely if its benefits were understood and it were realized that the job can be done with any of several machines. Generally, however, sweeps about 2 feet wide, or wider, manage surface residues most efficiently. At times, it may be necessary to use secondary tillage tools—the rotary hoe or shrewtreader, chisels, or the oneway plow. If a crop has been heavy and a lot of stubble is present, the oneway can be used first to reduce residue at the surface to a manageable amount. Each time over the field, a oneway reduces the amount of residue at the surface by about 50 percent. Large sweeps, in contrast, reduce the residue at the surface by about 10 percent.

Deep plowing

Deep plowing is used as an aid in controlling wind erosion on soils that have a moderately coarse or coarse textured surface layer and a sandy clay subsoil not more than 24 inches from the surface. The depth of plowing ranges from 16 to 24 inches, as the purpose is to bring heavier subsoil material up into the surface layer.

If deep plowing is properly done, crop yields increase and there is less soil blowing. To obtain good results, one-fourth to one-third of the furrow slice must be in the heavier subsoil material. Then, the soil must be managed carefully. After plowing, a high-residue crop should be sown on the soil and properly fertilized.

Deep plowing without proper soil management is just another way of mining the soil. The practice is expensive. Furthermore, it can be useless, or even harmful, if a soil has, alone or in combination, (1) a coarse texture but little depth; (2) a dispersed or infertile subsoil; (3) slopes of more than 4 percent, which will make it susceptible to erosion; (4) a high content of clay in the subsoil; (5) a subsoil or other layers containing little or no clay; (6) a medium or fine texture; or (7) a sandy surface layer 4 to 7 inches, or less, in thickness.

A local representative of the Soil Conservation Service can advise whether soils are suitable for deep plowing.

Field terraces and diversion terraces

A terrace is a ridge, or a combination of a ridge and channel, built across the slope to divert or to stop the flow of water. Terraces are used to reduce erosion and to conserve moisture, and they serve as guidelines for contour farming. The differences between field terraces and diversion terraces are mainly those of size and purpose. A field terrace is designed mainly to slow or stop movement of water in a field, and the diversion terrace, to protect a cultivated field from runoff from adjoining land.

Field terraces, by increasing intake of water, appreciably improve crop yields in this county, where limited moisture is one of the chief obstacles to good yields. At times, they improve crop growth to such extent that need for other conservation practices is minimized.

The wide-based, channel type of terrace suits this county very well, since large equipment is used extensively.

Emergency tillage

Emergency tillage, as the name implies, is to be used only when there is not enough vegetation on the soil. The purpose of this tillage is to create a rough, cloddy surface that will resist the force of the wind.

Emergency tillage can be done rapidly, and will control wind erosion for a time, but is undesirable because one of the main objectives of management in this county is to keep tillage to a minimum.

The effectiveness of emergency tillage depends on speed at which the equipment is operated, depth to which the soil is worked, spacing of the chisels used, and size of the chisel points. The following are suggested for conditions in this county:

1. Operate equipment at intermediate speeds, about 3 to 4 miles per hour.
2. Till to a depth that will bring up clods; this means that loose soils will have to be tilled deeper than the tight hardlands.
3. Space chisels according to the soil to be worked. If wind erosion is moderate, spacing of 44 to 54 inches is usually adequate. If wind erosion is more severe, a spacing of 27 to 36 inches is more effective. The wider spacing is especially desirable if an attempt is being made to protect a wheat crop.
4. Choose a chisel point according to the texture and the compactness of the soil. In a compact soil, use a narrow, heavy-duty chisel. If chisels are closely spaced, the width of the point will little affect the efficiency of the tillage. If chisels are widely spaced, however, the narrow-pointed chisel will be less effective than the broad-pointed chisel.
5. On loose, sandy soils, use a lister type plow for throwing up ridges; chisels are rarely effective on sandy soils.
6. Run rows at right angles to the prevailing wind.
7. Avoid use of any kind of equipment that will pulverize the surface soil.

Emergency tillage should be delayed as long as possible, but when started, should cover the entire area, not a few strips. It is seldom successful on sandy soils; its benefits do not last long on soils low in organic matter, as they run together when wet; and it depletes supplies of moisture.

Weed control

Johnsongrass is prevalent in all cultivated sections of the county. Roadsides, railroad rights-of-way, and creek banks are covered with it. The seed is spread to cultivated fields by wind, birds, overflow water, and tillage equipment. Continuous pasturing through the growing season is the most economical and effective way of controlling johnsongrass. Spot treatment of infested patches may be practical, and control can be achieved by tillage or using chemical sprays.

Bindweed is found throughout the county, normally in small areas within fields. It is probably the most difficult weed in the county to control on land that is to be kept in crop production. A combination of chemical spraying and tillage can be used with limited success. Sterilizing the soil is practical only if areas infested are so small that a hazard of wind erosion will not be created.

Field dodder, another noxious weed, is difficult to control. Clean cultivation is the only practice now successful.

Many other weeds grow in the county, but they can be controlled by proper cultivation and use of weed-free seed.

Grassed waterways

Grassed waterways are broad, flat-bottomed channels commonly sodded with bermudagrass or native grasses.

They may have a retaining dike on each side if such is needed to increase their capacity. Their purpose is to dispose of excess water without causing erosion of fields. They are used to supplement natural drains, and are needed where terrace systems, diversion terraces, or drainage or irrigation systems have been installed or are planned. They are not designed to control floodwaters from creeks, rivers, or very large drainage areas.

Each waterway needs to be especially designed. The size of the area drained and the slope, erodibility, and permeability of the soil are important. So, also, are the erosion control practices that are planned or in effect and the kind and quantity of vegetation on the watershed. All these factors are to be considered in determining the width, depth, and grade of the channel and the kind of sod needed.

Maintenance of an established waterway is essential. This involves fencing, if that is practical; mowing or spraying to control weeds; lifting farm implements before crossing; avoiding use of the waterway as a farm road; safeguarding against overgrazing; fertilizing as needed; and avoiding plowing or other farming too close to the waterway.

Assistance on proper design, layout, construction, and maintenance of grassed waterways can be obtained from a local representative of the Soil Conservation Service.

Fertilization

Use of fertilizer in an area having an annual rainfall of 29 inches is questionable for all except a few soils. The soils most likely to benefit are those that are moderately sandy to sandy, especially if they are inherently low in fertility. The amounts to be applied are difficult to determine because rainfall fluctuates between about 13 and 50 inches. Soil tests now being made show that the tight, or clayey, soils do not need fertilizer, though crops grown on them will respond during years when rainfall is high. Use of fertilizer should be based on recommendations of the Oklahoma Agricultural Experiment Station.

Most of the soils in this county do not need lime. Some can be improved by treating them with gypsum. The normal rate of application is 2 to 4 tons an acre, broadcast and worked into the surface layer.

Management of Grasslands ²

Current use of grassland in Kingfisher County, range sites and range condition, general practices of management appropriate for most areas used for range, and some special practices suitable for small pastures are discussed in the four main parts of this section.

Current use of grasslands

Native grasslands, with a small acreage of pasture in tame perennial grasses, total about 180,000 acres or approximately 32 percent of the land in this county. Most of this grassland is on farms where both crops and livestock are produced. Few operating units are used exclusively for raising livestock.

Most of the farmers use their grassland for cows and calves. A few keep sheep. The number of cattle and calves in the county normally ranges from 45,000 to

² By C. E. KINGERY, range conservationist, Soil Conservation Service.

50,000 head. In 1945 an all-time high of 55,600 head was estimated by the Agricultural Marketing Service, United States Department of Agriculture. The number of sheep and lambs in the county has declined about 42 percent in the last 20 years, or from an estimated 13,300 head in 1939 to 7,700 in 1959.

About three-fourths of the grassland in the county is in fair or poor condition. Some 44,700 acres, or about 22 percent of it, is infested with scrubby trees and various kinds of brush. This growth has greatly reduced yields of forage and continues to lower yields as it grows denser and invades new areas. The small, stomp-lot pastures of native grass on many wheat farms are frequently severely overgrazed because they are used as holding areas for livestock until they can be moved to land sown to wheat or to sudangrass or other temporary pasture.

The estimated normal number of grazing units in the county is 41,600, which leaves slightly more than 4 acres of grassland to carry each unit through the year. This low acreage per animal unit, considered with the low productivity of much of the grassland, shows how much operators depend on pasturing of fields sown to small grains and on supplemental feed. It is estimated that good range practices would double productivity of the native grasslands.

Range sites and range conditions

To manage efficiently, the operator who runs livestock must know the different kinds of rangeland on his holdings, the different combinations of plants they are capable of producing, and the effect of grazing on these different plants. To aid him in gaining this knowledge, the soils of Kingfisher County have been grouped by range sites.

A *range site* is an area of rangeland sufficiently uniform in climate, soils, and topography to produce a particular climax, or original, vegetation. For this reason a given range site needs management significantly different from that of other sites if its vegetation is to be maintained or improved.

Climax vegetation, the most productive growth on rangeland, is the combination of plants that originally grew on

a range site. This vegetation is altered under intensive grazing. Livestock graze selectively. They constantly seek out the more palatable and nutritious plants. If grazing is not carefully regulated, the better plants, called *decreasers*, are eventually eliminated. Less desirable plants, called *increasers*, take their place. If grazing pressure continues, even these second-choice plants are thinned out or eliminated and are replaced by undesirable weeds, or *invaders*.

Condition classes are used to indicate the degree of departure from the original, or climax, vegetation that has been brought about by grazing or other use. These classes show the present condition of the vegetation on a range site in relation to the vegetation that was on it originally. There are four classes, as follows:

Condition class	Percentage of present vegetation that is climax for the site
Excellent.....	76 to 100
Good.....	51 to 75
Fair.....	26 to 50
Poor.....	0 to 25

One of the main objectives of good range management is to keep rangelands in *excellent* or *good* condition. If this is done, yields improve, water is conserved, and the soils are protected. The problem is recognizing important changes in kind of cover on a range site. These take place gradually and can be misunderstood or overlooked. Growth encouraged by heavy rainfall may lead to the conclusion that range is improving, when actually the long-time trend is toward less desirable cover and lowered production. On the other hand, some rangeland that has been closely grazed for relatively short periods under the supervision of a careful manager may have a degraded appearance that temporarily conceals its quality and ability to recover.

Table 3 will be of value in judging the condition of range. It lists the grasses, legumes, forbs, and woody plants that are *decreasers*, *increasers*, and *invaders* on each range site, and gives estimated yields of forage.

TABLE 3.—Plants and estimated forage yields on range sites of Kingfisher County, Oklahoma

ALKALI BOTTOM-LAND RANGE SITE					
Kinds of plants	Decreasers	Increases	Common invaders	Estimated forage produced	
				Range condition	Pounds per acre
Grasses	switchgrass. tall dropseed. western wheatgrass. vine-mesquite. wildrye. white tridens. longspike tridens.	meadow dropseed. blue grama. buffalograss. inland saltgrass. side-oats grama. alkali sacation.	Annuals: All.	Excellent: Favorable years... Unfavorable years...	4,000 1,800
Legumes	Illinois bundleflower.	None.	None.	Good: Favorable years... Unfavorable years...	3,200 1,500
Forbs	None.	curlycup gumweed. smartweed. curly dock.	Annuals: rhombopod spp. saltbush spp.	Fair: Favorable years... Unfavorable years...	2,000 1,200
Woody plants	None.	None.	Perennials: baccharis. tamarisk.	Poor: Favorable years... Unfavorable years...	1,800 900
BREAKS RANGE SITE					
Grasses	big bluestem. little bluestem. Indiangrass. switchgrass. tall dropseed. vine-mesquite. Canada wildrye.	side-oats grama. blue grama. buffalograss. hairy grama. meadow dropseed. perennial three-awn. rough tridens.	Annuals: puffsheath dropseed. annual three-awn. Perennials: silver bluestem. tumblegrass. tumble windmillgrass.	Excellent: Favorable years... Unfavorable years...	1,800 1,200
Legumes	white prairie-clover. purple prairie-clover. wild alfalfa. Illinois bundleflower. groundplum milkvetch. trailing ratany. catclaw sensitive brier.	wild-indigo. bigtop dalea. prairie bundleflower.	None.	Good: Favorable years... Unfavorable years...	1,500 1,000
Forbs	Maximillian sunflower. compassplant. flaxleaf. falsegaura. halfshrub sundrop. Ozark sundrop.	hairy goldaster. curlycup gumweed. nailwort. big bluet. longleaf eriogonum. tenpetal mentzelia.	Annuals: western ragweed. Baldwin ironweed.	Fair: Favorable years... Unfavorable years...	1,000 700
				Poor: Favorable years... Unfavorable years...	800 500
CLAYPAN PRAIRIE RANGE SITE					
Grasses	little bluestem. big bluestem. Indiangrass. switchgrass. tall dropseed. Canada wildrye. Scribner panicum. white tridens.	vine-mesquite. side-oats grama. blue grama. buffalograss. meadow dropseed.	Annuals: fall panicum. Japanese brome. crabgrass. Perennials: windmillgrass. fall switchgrass. tumblegrass. silver bluestem. perennial three-awn. sand dropseed.	Excellent: Favorable years... Unfavorable years...	3,500 1,800
				Good: Favorable years... Unfavorable years...	2,200 1,200
				Fair: Favorable years... Unfavorable years...	1,800 1,000
				Poor: Favorable years... Unfavorable years...	1,400 800

TABLE 3.—Plants and estimated forage yields on range sites of Kingfisher County, Oklahoma—Continued

CLAYPAN PRAIRIE RANGE SITE—Continued

Kinds of plants	Decreasers	Increaseers	Common invaders	Estimated forage produced	
				Range condition	Pounds per acre
Legumes-----	Illinois bundleflower. Prairie bundleflower. leadplant.	wild alfalfa. wild-indigo.	Annuals: deervetch.		
Forbs-----	Maximillian sunflower. prairie Kuhnia. fringeleaf ruelia. Pitchers sage.	dotted gayfeather. prairie coneflower. heath aster.	Annuals: snow-on-the-mountain. annual broomweed. wax goldenrod. Perennials: dogbane. Baldwin ironweed. plains coreopsis. pricklypear. Carolina horsenettle. silverleaf nightshade. yarrow. western ragweed.		

DEEP SAND RANGE SITE

Grasses-----	sand bluestem. little bluestem. Indiangrass. switchgrass. purpletop. Canada wildrye. Texas bluegrass.	side-oats grama. blue grama. hairy grama.	Annuals: mat sandbur. sixweeks fescue. common witchgrass. Perennials: sand dropseed. silver bluestem. red lovegrass. fall witchgrass.	Excellent: Favorable years... Unfavorable years... Good: Favorable years... Unfavorable years... Fair: Favorable years... Unfavorable years... Poor: Favorable years... Unfavorable years...	3, 800 2, 000 2, 500 1, 300 1, 900 1, 100 1, 200 700
Legumes-----	Virginia tephrosia. leadplant. white prairie-clover. purple prairie-clover. Stueves lespedeza.	silky prairie-clover. bigtop dalea.	Annuals: showy partridgepea. trailing wildbean.		
Forbs-----	Pitchers sage. Engelmann daisy. spiderwort.	queens-delight. bush morning-glory. sand mentzelia. threadleaf groundsel. butterfly milkweed.	Annuals: puncturevine. poorland dozedaisy. annual wild buckwheat. rosering gaillardia. common sunflower. camphorweed. field snakecotton. dodder.		
Woody plants-----	grape.	skunkbush. sand sage. sandplum. elm.	None.		

TABLE 3.—Plants and estimated forage yields on range sites of Kingfisher County, Oklahoma—Continued

DEEP SAND SAVANNAH RANGE SITE

Kinds of plants	Decreasers	Increases	Common invaders	Estimated forage produced	
				Range condition	Pounds per acre
Grasses	big bluestem. sand bluestem. Indiangrass. switchgrass. Canada wildrye. arrowfeather three-awn. Scribner panicum.	tall dropseed. side-oats grama. knotroot bristlegrass. fringeleaf paspalum. Texas bluegrass. purple lovegrass. purpletop.	Annuals: annual three-awn. mat sandbur. Perennials: fall witchgrass. hairy grama. mourning lovegrass. red lovegrass. gummy lovegrass. silver bluestem. sand dropseed.	Excellent: Favorable years... Unfavorable years... Good: Favorable years... Unfavorable years... Fair: Favorable years... Unfavorable years... Poor: Favorable years... Unfavorable years...	3,800 1,800 2,500 1,200 1,500 900 900 400
Legumes	tickclover. roundhead lespedeza. Stueves lespedeza. trailing lespedeza. Virginia tephrosia.	silky prairie-clover. scurf-pea. bigtop dalea.	Annuals: showy partridgepea. trailing wildbean.		
Forbs	Pitchers sage. spiderwort. dayflower.	noseburn. bush morning-glory. queens-delight. sand mentzelia. butterfly milkweed. threadleaf groundsel. heath aster.	Annuals: rosering gaillardia. camphorweed. crotonweed. dodder. rough buttonweed. bullnettle. mullein. Perennials: Baldwin ironweed. wavyleaf thistle. western ragweed.		
Woody plants	grape. poison-ivy. Virginia creeper.	blackjack oak. post oak. hickory. coralberry. elm. dwarf chinquapin oak.	None.		

DUNE RANGE SITE

Grasses	sand bluestem. little bluestem. switchgrass. Canada wildrye. big sandreed. Texas bluegrass.	sand paspalum. purple three-awn. hairy grama.	Annuals: mat sandbur. sixweeks fescue. purple sandgrass. Perennials: fall switchgrass. gummy lovegrass. tumble lovegrass. tumble windmillgrass. tumblegrass. red lovegrass.	Excellent: Favorable years... Unfavorable years... Good: Favorable years... Unfavorable years... Fair: Favorable years... Unfavorable years... Poor: Favorable years... Unfavorable years...	2,500 1,500 2,000 1,200 1,500 1,000 800 500
Legumes	Virginia tephrosia. Stueves lespedeza. roundhead lespedeza.	silky prairie-clover. bigtop dalea.	Annuals: showy partridgepea. trailing wildbean.		

TABLE 3.—Plants and estimated forage yields on range sites of Kingfisher County, Oklahoma—Continued

DUNE RANGE SITE—Continued

Kinds of plants	Decreasers	Increaseers	Common invaders	Estimated forage produced	
				Range condition	Pounds per acre
Forbs.....	Englemann daisy. Berlandier daisy. spiderwort.	queens-delight. bush morning-glory. sand mentzelia. butterfly milkweed. threadleaf groundsel.	Annuals: puncturevine. poorland dozedaisy. annual wild buckwheat. rosering gaillardia. common sunflower. camphorweed. dodder. field snakecotton.		
Woody plants.....	grape.	skunkbush. sand sage. sandplum. hackberry.	None.		

ERODED RED CLAY RANGE SITE

Grasses.....	side-oats grama. little bluestem. vine-mesquite.	rough tridens. hairy grama. blue grama. buffalograss, purple three-awn.	Annuals: puffsheath dropseed. Perennials: red three-awn. silver bluestem.	Excellent: Favorable years... 800 Unfavorable years... 500	
Legumes.....	wild alfalfa. purple prairie-clover. trailing ratany. catclaw sensitive-brier. bigtop dalea.	None.	None.	Good: Favorable years... 600 Unfavorable years... 400	
Forbs.....	blacksamsom. halfshrub sundrop. Ozark sundrop. greenthread. compassplant. narrowleaf bluet. skullcap.	tenpetal menzelia. cutleaf goldenweed. nailwort. redroot wild buckwheat.	Annuals: bladderpod. silver evax. basketflower. Perennials: broom snakeweed. western ragweed. pricklypear.	Fair: Favorable years... 500 Unfavorable years... 300	
Woody plants.....	None.	None.	None.	Poor: Favorable years... 400 Unfavorable years... 200	

LOAMY BOTTOM LAND RANGE SITE

Grasses.....	big bluestem. Indiangrass. switchgrass. little bluestem. eastern gramagrass. Florida paspalum. wildrye. prairie cordgrass.	tall dropseed. western wheatgrass. side-oats grama. knotroot bristlegrass. Scribner panizum.	Annuals: All. Perennials: windmillgrass. fall witchgrass. meadow dropseed. buffalograss. tumblegrass. mourning lovegrass. purple three-awn. silver bluestem.	Excellent: Favorable years... 7,500 Unfavorable years... 4,000	
Legumes.....	Illinois bundleflower. tickclover. leadplant.	scurf-pea. American licorice.	Annuals: trailing wildbean. deervetch.	Good: Favorable years... 5,000 Unfavorable years... 3,000	
				Fair: Favorable years... 3,000 Unfavorable years... 1,500	
				Poor: Favorable years... 2,400 Unfavorable years... 1,200	

TABLE 3.—Plants and estimated forage yields on range sites of Kingfisher County, Oklahoma—Continued

LOAMY BOTTOM LAND RANGE SITE—Continued

Kinds of plants	Decreasers	Increasesers	Common invaders	Estimated forage produced	
				Range condition	Pounds per acre
Forbs.....	Maximillian sunflower. wholeleaf rosinweed. spiderwort. Pitchers sage. fringeleaf ruellia.	poppy-mallow. heath aster. prairie sagewort.	Annuals: crotonweed. Perennials: Baldwin ironweed. western ragweed.		
Woody plants.....	poison-ivy. grape.	coralberry. indigobush. western walnut. dogwood. American elm. buttonbush.	sumac. soapberry. willow.		

LOAMY PRAIRIE RANGE SITE

Grasses.....	little bluestem. big bluestem. sand bluestem. Indiangrass. switchgrass. Canada wildrye.	side-oats grama. blue grama. hairy grama. tall dropseed. meadow dropseed. fringeleaf paspalum	Annuals: fall panicum. stinkgrass. witchgrass. mat sandbur. sand dropseed. Perennials: silver bluestem. fall witchgrass. red lovegrass. windmillgrass. buffalograss.	Excellent: Favorable years... 4,500 Unfavorable years... 2,200 Good: Favorable years... 3,500 Unfavorable years... 1,700 Fair: Favorable years... 2,500 Unfavorable years... 1,500 Poor: Favorable years... 1,800 Unfavorable years... 900
Legumes.....	leadplant. sensitive brier. groundplum milk vetch. prairie-clover.	wild-indigo. bigtop dalea. wild alfalfa.	Annuals: trailing wildbean. deervetch.	
Forbs.....	Maximillian sunflower. Pitchers sage. wholeleaf rosinweed. halfshrub sundrop.	dotted gayfeather. prairie coneflower. heath aster. prairie sagewort.	Annuals: beebalm. black-eyed-susan. cocklebur. Perennials: curlyleaf gumweed. wavyleaf thistle. yarrow. ironweed. western ragweed.	
Woody plants.....	None.	None.	coralberry.	

RED CLAY PRAIRIE RANGE SITE

Grasses.....	little bluestem. big bluestem. Indiangrass. switchgrass. tall dropseed.	side-oats grama. hairy grama. blue grama. buffalograss. meadow dropseed.	Annuals: puffsheath dropseed. six weeks fescue. little barley. Perennials: silver bluestem. fall witchgrass.	Excellent: Favorable years... 2,500 Unfavorable years... 1,200 Good: Favorable years... 1,800 Unfavorable years... 1,000 Fair: Favorable years... 1,300 Unfavorable years... 800 Poor: Favorable years... 1,000 Unfavorable years... 500
Legumes.....	purple prairie-clover. white prairie-clover. trailing ratany. golden dalea. yellow neptunia. scurf-pea.	bigtop dalea.	None.	

TABLE 3.—Plants and estimated forage yields on range sites of Kingfisher County, Oklahoma—Continued

RED CLAY PRAIRIE RANGE SITE—Continued

Kinds of plants	Decreasers	Increaseers	Common invaders	Estimated forage produced	
				Range condition	Pounds per acre
Forbs-----	halfshrub sundrop. Missouri sundrop. compassplant.	nailwort. redroot wild buckwheat. bluet. prairie coneflower.	Annuals: bitter sneezeweed. pepperweed. snow-on-the-mountain. small soapweed.		
Woody plants-----	None.	None.	pricklypear. coralberry. sumac.		

SANDY BOTTOM LAND RANGE SITE

Grasses-----	sand bluestem. big bluestem. switchgrass. Indiangrass. little bluestem. Texas bluegrass. prairie cordgrass. Florida paspalum.	tall dropseed. fringeleaf paspalum. sand lovegrass. blue grama. carex.	Annuals: mat sandbur. sandgrass. annual three-awn. Perennials: red lovegrass. gummy lovegrass. tumble lovegrass. fall witchgrass. sand dropseed. silver bluestem.	Excellent: Favorable years... 4,000 Unfavorable years... 2,800 Good: Favorable years... 3,000 Unfavorable years... 1,800 Fair: Favorable years... 2,000 Unfavorable years... 1,200 Poor: Favorable years... 1,500 Unfavorable years... 900	
Legumes-----	leadplant. tickclover. slender lespedeza. Stueves lespedeza. Virginia trephrosia.	wild alfalfa. American licorice.	Annuals: trailing wildbean. partridgepea.		
Forbs-----	Pitchers sage. ashy sunflower. fendler aster. bush morning-glory.	sandlily menzelia. heath aster. poppy-mallow. butterfly milkweed.	Annuals: poorland dozedaisy. annual wild buckwheat. puncturevine. bullnettle. field snakecotton. camphorweed. pricklypoppy. Perennials: Carolina horsenettle. western ragweed. groundsel.		
Woody plants-----	poison-ivy. grape.	cottonwood. hackberry. willow. sandplum. indigobush. sand sage. skunkbush.	tamarisk.		

TABLE 3.—Plants and estimated forage yields on range sites of Kingfisher County, Oklahoma—Continued

SANDY PRAIRIE RANGE SITE					
Kinds of plants	Decreasers	Increaseers	Common invaders	Estimated forage produced	
				Range condition	Pounds per acre
Grasses	little bluestem. sand bluestem. big bluestem. switchgrass. Indiangrass. Canada wildrye. Scribner panicum. sand lovegrass.	side-oats grama. blue grama Texas bluegrass.	Annuals: mat sandbur. witchgrass. Perennials: fall witchgrass. gummy lovegrass. red lovegrass. sand dropseed. silver bluestem. red three-awn.	Excellent: Favorable years... Unfavorable years... Good: Favorable years... Unfavorable years... Fair: Favorable years... Unfavorable years... Poor: Favorable years... Unfavorable years...	4,000 2,500 3,000 2,000 2,200 1,400 1,900 1,000
Legumes	leadplant. roundhead lespedeza. Stueves lespedeza. catclaw sensitive-brier. trailing ratany.	silky prairie-clover. wild alfalfa.	Annuals: showy partridgepea. trailing wildbean. deervetch.		
Forbs	dayflower. spiderwort. Pitchers sage. heath aster. poppy-mallow.	prairie sagewort. dogbane. carex. common yarrow.	Annuals: puncturevine. beebalm. annual wild buckwheat. horseweed fleabane. red sagewort. Perennials: western ragweed. Baldwin ironweed. post oak. blackjack oak.		
Woody plants	Jersey-tea. grape.	skunkbush. sandplum. coralberry.			
SLICKSPOT RANGE SITE					
Grasses	switchgrass. blue grama. little bluestem. Indiangrass. Scribner panicum. purple lovegrass. tall dropseed. wildrye. western wheatgrass.	alkali sacaton. hairy grama. blue grama. fringeleaf paspalum. side-oats grama. meadow dropseed. inland saltgrass. purple three-awn.	Annuals: common witchgrass. fall panicum. rescuegrass. annual three-awn. Perennials: whorled dropseed. silver bluestem. fall witchgrass.	Excellent: Favorable years... Unfavorable years... Good: Favorable years... Unfavorable years... Fair: Favorable years... Unfavorable years... Poor: Favorable years... Unfavorable years...	1,800 900 1,250 600 1,000 500 600 400
Legumes	groundplum milk vetch. tickclover. leadplant. Illinois bundleflower.	wild-indigo. wild alfalfa.	Annuals: deervetch. partridgepea.		
Forbs	Maximillian sunflower. wholeleaf rosinweed. buffalogourd. Pitchers sage.	rhombopod. prairie coneflower. antelopehorn. groundcherry. heath aster. prairie sagewort.	Annuals: annual broomweed. wax goldenweed. daisy fleabane. crotonweed. Perennials: dogbane. Baldwin ironweed. western wheatgrass.		
Woody plants	None.	None.	None.		

TABLE 3.—Plants and estimated forage yields on range sites of Kingfisher County, Oklahoma—Continued

SUBIRRIGATED RANGE SITE

Kinds of plants	Decreasers	Increaseers	Common invaders	Estimated forage produced	
				Range condition	Pounds per acre
Grasses	switchgrass. wildrye. prairie cordgrass. sand bluestem. eastern gamagrass. little bluegrass.	alkali sacaton. inland saltgrass. tall dropseed. blue grama. vine-mesquite.	Annuals: silver bluestem. Perennials: alkali muhly. bermudagrass.	Excellent: Favorable years . . .	7,000
				Unfavorable years .	5,000
				Good: Favorable years . . .	6,000
				Unfavorable years .	4,500
				Fair: Favorable years . . .	5,000
				Unfavorable years .	4,000
Legumes	Illinois bundleflower.	American licorice.	Annuals: trailing wildbean. showy partridgepea.	Poor: Favorable years . . .	4,000
				Unfavorable years .	3,000
Forbs	stiff sunflower. Maximillian sunflower.	smooth goldenrod. sedge. sand mentzelia.	Annuals: annual wild buckwheat. camphorweed. crotonweed. Perennials: western dogweed. curly dock.		
Woody plants	None.	None.	tamarisk. baccharis. willow.		

The estimates in table 3 are based on yields obtained on similar range sites in other counties. On those sites, the total year's growth on deferred pasture was cut at ground level, air dried, weighed, and calculated in pounds per acre. The estimates do not include plants that livestock do not eat, nor annual grasses and weeds. Weeds and annual grasses produce amounts of edible forage so widely variable that estimating was not practical. The estimates of forage yield are given for favorable and unfavorable years because climate fluctuates widely in the county.

ALKALI BOTTOM LAND RANGE SITE

The one mapping unit in this range site is Clayey saline alluvial land. It is droughty, takes in water slowly, and contains alkali (fig. 4). The plants that grow on this site and estimated yields of forage under different range conditions are listed in table 3.

BREAKS RANGE SITE

The Breaks range site is in the southwestern part of the county and consists entirely of one mapping unit, Rough broken land. This land contains many areas of exposed bedrock, is steep, and produces less forage than the range sites on the smoother prairies (fig. 5). The plants that grow on this site and estimated yields of forage are listed in table 3.



Figure 4.—Alkali Bottom Land range site in fair condition. Switchgrass, vine-mesquite, and similar desirable grasses have been largely replaced by inland saltgrass and alkali-tolerant forbs. White spots show accumulation of alkali.



Figure 5.—Breaks range site in fair condition. Cattle graze mainly on the ridges and foot slopes because the other areas are too steep.

CLAYPAN PRAIRIE RANGE SITE

The soils in the Claypan Prairie range site are underlain by tight clay that restricts penetration of water and growth of plants. The soils of this site are—

- Bethany silt loam, 0 to 1 percent slopes.
- Kirkland silt loam, 0 to 1 percent slopes.
- Renfrow clay loam, 0 to 1 percent slopes.
- Renfrow clay loam, 1 to 3 percent slopes.
- Tabler clay loam.

Blue grama, buffalograss, and unpalatable weeds increase greatly when this site is continuously and heavily grazed.

It is difficult to restore the taller, more desirable grasses after the range has been depleted. The soils are droughty and the short grasses and weeds compete for the limited supply of moisture (fig. 6). The plants that grow on this site and estimated yields of forage under different range conditions are listed in table 3.

DEEP SAND RANGE SITE

This range site occupies undulating and hummocky, sandy areas on the uplands (fig. 7). The soils are—

- Pratt loamy fine sand, hummocky.
- Pratt loamy fine sand, undulating.

Skunkbush or other plants increase greatly on this site if it is overgrazed. The plants that grow on this site and estimated yields of forage in favorable and unfavorable years are shown in table 3.

DEEP SAND SAVANNAH RANGE SITE

The moderately productive loamy and coarse sands of this range site yield moisture readily. They are—

- Dougherty-Eufaula loamy fine sands, hummocky.
- Dougherty-Eufaula loamy fine sands, undulating.
- Eufaula fine sand.

These soils permit deep penetration of roots, which encourages growth of trees and woody plants. Post oak, blackjack oak, and other woody plants increase greatly if this site is overgrazed (fig. 8). Table 3 lists the kinds of

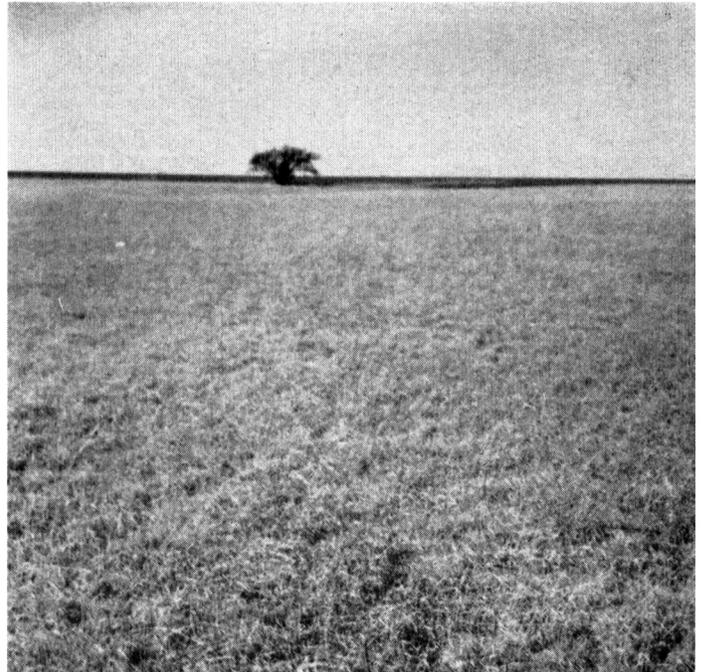


Figure 6.—Claypan Prairie range site: *Top*, a site in excellent condition because it has been grazed only with winter wheat pasture and occasionally cut for hay. *Bottom*, a site in fair condition and covered mainly by buffalograss, windmillgrass, and three-awn; annual broomweed in background.

plants on this site, and estimated yields of forage under different range conditions.

DUNE RANGE SITE

The one soil of this range site is Tivoli fine sand, which is on sandhills stabilized against wind by a sparse cover that is difficult to maintain under grazing (see fig. 7).

The plants that grow on this site and estimated yields of forage are listed in table 3.



Figure 7.—Deep Sand range site in good condition, in foreground, and Dune range site in fair condition, in background. When these two range sites are in the same pasture, livestock tend to overgraze the Dune range site.

ERODED RED CLAY RANGE SITE

The one mapping unit of this range site, Vernon soils and Rock outcrop, produces extremely little feed (fig. 9). Overgrazing results in invasion of yucca, pricklypear, mesquite, and three-awn. It is good practice to graze this site only during winter, with livestock that receive supplemental feed, or that graze mostly on small-grain pasture. The plants that grow on this site and estimated yields of forage under different range conditions are listed in table 3.

LOAMY BOTTOM LAND RANGE SITE

The deep, loamy soils of this range site are on bottom lands and, in places, are frequently flooded. The soils are—

- Broken alluvial land.
- Port clay loam, 0 to 1 percent slopes.
- Port silt loam, 0 to 1 percent slopes.
- Port silt loam, 1 to 3 percent slopes.

The soils of this site are productive and, for the most part, are cultivated (fig. 10). Most of the native range on this site is in frequently overflowed areas next to creeks. The plants that grow on this site and estimated yields of forage under different range conditions are listed in table 3.

LOAMY PRAIRIE RANGE SITE

The Loamy Prairie range site consists of soils that have good capacity for storing moisture and that allow good growth of roots (fig. 11). These soils are—

- Kingfisher silt loam, 1 to 3 percent slopes.
- Kingfisher silt loam, 3 to 5 percent slopes.
- Kingfisher-Lucien complex, 5 to 8 percent slopes, eroded.
- Norge fine sandy loam, 0 to 1 percent slopes.
- Norge fine sandy loam, 1 to 3 percent slopes.

- Pond Creek silt loam, 0 to 1 percent slopes.
- Pond Creek silt loam, 1 to 3 percent slopes.

Under heavy grazing, blue grama and side-oats grama increase, and sand dropseed, silver bluestem, and such woody plants as coralberry and sumac invade. The plants on this site and the estimated yield of forage under different range conditions are listed in table 3.



Figure 8.—Deep Sand Savannah range site. *Top*, a site in excellent range condition because it has not been overgrazed, burned over, or otherwise abused. *Bottom*, a site in poor range condition, and so completely invaded by blackjack oak and post oak that little grazing is available.

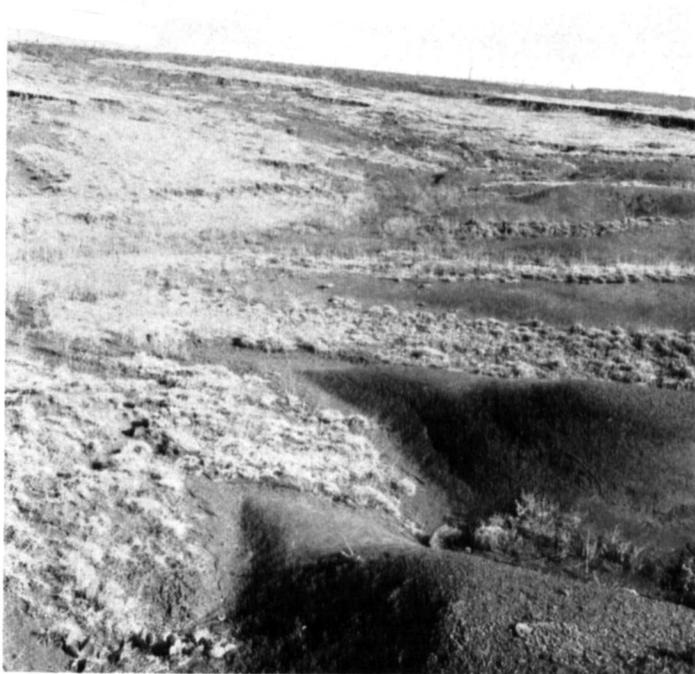


Figure 9.—Eroded Red Clay range site in fair condition; principal grasses are side-oats grama, hairy grama, and perennial three-awn; bare, eroded areas of clay are evident.



Figure 11.—Loamy Prairie range site: *Top*, a site in excellent range condition, lightly grazed in summer, and photographed in winter after cattle have been moved to wheat and other pasture. *Bottom*, a site brought to fair range condition by deferred grazing and controlled grazing. Previous heavy, year-round grazing for many seasons resulted in loss of little bluestem, big bluestem, and other productive tall grasses; better management in recent years has brought back a good growth of side-oats grama and blue grama.



Figure 10.—Cultivated area of Loamy Bottom Land range site soon to be returned to native pasture. This tract has been seeded to sudangrass, which will be lightly grazed, so as to leave a stubble in which native grasses can be seeded.

RED CLAY PRAIRIE RANGE SITE

This range site consists of gently sloping to rolling, clayey soils in many places broken by drainageways (fig. 12). In the drainageways the soils are deeper, and these add to the productivity of the range site. The soils are—

Alluvial and broken land.
 Vernon clay loam, 1 to 3 percent slopes.
 Vernon clay loam, 3 to 5 percent slopes, eroded.

Under continuous heavy grazing, buffalograss increases greatly on the deeper soils, and the steeper shallow areas lose their grass cover and are eroded rapidly. The plants that grow on this site and their estimated yield of forage under different range conditions are listed in table 3.

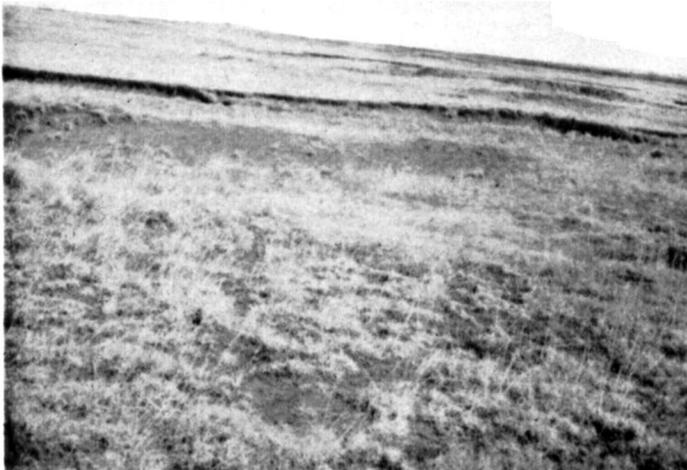


Figure 12.—Red Clay Prairie range site: *Top*, a site in excellent condition because operator has been practicing moderate year-round grazing and adjusting number of livestock in drought years to prevent damage to the grass. *Bottom*, a site in fair condition and showing bare spots resulting from erosion and lack of water. Year-long grazing has almost completely eliminated little bluestem, but side-oats grama, hairy grama, and buffalograss are still present.

SANDY BOTTOM LAND RANGE SITE

The soils of this range site are deep sands on bottom lands subject to frequent overflow. In some low swales they are subirrigated. The soils are—

Lincoln loamy fine sand.
 Lincoln sand.
 Sand dunes, Lincoln material.
 Yahola fine sandy loam.

This range site is productive because the soils are deep, are easily penetrated by roots, and generally have a favorable supply of moisture (fig. 13). Productivity is lowered in places where sand is deposited or the water table is too near the surface. The plants that grow on this site and estimated yields of forage under different range conditions are listed in table 3.



Figure 13.—Sandy Bottom Land range site in excellent condition steers grazed this site lightly during summer and were moved to vetch-and-rye pasture for winter grazing.

SANDY PRAIRIE RANGE SITE

The sandy soils of this range site allow good growth of roots (fig. 14). They are productive soils subject to wind erosion if not adequately protected by plant cover. The soils are—

Carwile loamy fine sand.
 Shellabarger fine sandy loam, 0 to 1 percent slopes.
 Shellabarger fine sandy loam, 1 to 3 percent slopes.
 Shellabarger fine sandy loam, 3 to 5 percent slopes.
 Shellabarger fine sandy loam, 5 to 8 percent slopes, eroded.

The plants that grow on this range site and the estimated yields of forage under different range conditions are listed in table 3.

SLICKSPOT RANGE SITE

The soils of this site are shallow to deep and range from fine to moderately coarse in texture. Slick spots, or alkali spots, cover 25 to 40 percent of this range site (fig. 15);



Figure 14.—Sandy Prairie range site in excellent range condition. Bluestem looks the way it should at the end of the summer grazing period, and there are none of the woody plants that invade this range site if it is abused by long periods of overgrazing.

the rest consists of soils that are of the same nature as those in the Loamy Prairie range site. The soils are—

- Drummond soils.
- Kingfisher-slickspot complex, 1 to 3 percent slopes.
- Kingfisher-slickspot complex, 3 to 5 percent slopes.
- Norge-slickspot complex, 1 to 3 percent slopes.
- Norge-slickspot complex, 3 to 5 percent slopes, eroded.
- Tabler-slickspot complex.

The plants that grow on this range site and the estimated yields of forage under different range conditions are listed in table 3.

SUBIRRIGATED BOTTOM LAND RANGE SITE

The one mapping unit of this range site is Wet alluvial land. It contains some alkali, which favors growth of the more alkali-tolerant plants. The high water table permits good production of forage (fig. 16). This water table fluctuates with the seasons, but in most years there is enough moisture for at least the deep-rooted plants. The plants that grow on this range site and the estimated yield of forage under different range conditions are listed in table 3.

Principles of range management

The basic purpose of good range management is to increase the number and encourage the growth of the best native forage plants. The main practices needed to achieve this objective are the following.

CONTROL OF GRAZING.—Without control of grazing, all other practices of range management will fail. In their green leaves, grasses manufacture the food they need to grow, flower, and reproduce. If too much of this green foliage is removed by grazing or mowing, the plant is weakened and stunted.

Because livestock constantly seek out and graze the



Figure 15.—Slickspot range site in good condition. Saltgrass, three-awn, and some blue grama on slick spots; common witchgrass and bluestem on surrounding deeper soils.

plants most palatable and nutritious, the less palatable plants and those that are low growing or matted tend to survive. For this reason, controlled grazing is practiced to assure that the desirable grasses survive and are vigorous enough to compete successfully. Generally, the desirable plants will do this if not more than half of their yearly growth is removed by grazing. The growth left on the ground does these things:

1. Serves as a mulch that encourages intake and storage of water. The more water stored in the ground, the better the growth of grasses for grazing.
2. Allows roots to reach moisture deep in the soils. Overgrazed grass cannot do this because not enough green shoots are left to provide food for good root growth.
3. Protects the soil from wind and water. Grass is the best cover for controlling erosion.
4. Allows the better grasses to crowd out weeds. When this happens the range improves.
5. Enables plants to store in their roots the food they need for quick, vigorous growth in spring and after droughts.
6. Provides a reserve of feed for dry spells that otherwise might force sale of livestock at a loss.

In stocking rangeland, the operator needs to (1) know the range sites on his holdings; (2) identify the plants currently on each range site so he may determine whether it is in excellent, good, fair, or poor condition; (3) consider that at least half of the growth in a year should be left on the land; (4) judge how much forage left on the land may be removed by weathering, wind, rodents, or other causes; and (5) decide how soon it will be practical to restore depleted pasture by lowering the stocking rate.

After livestock are put on the land, the operator observes the effect of grazing. If the key grasses on a range site



Figure 16.—Subirrigated Bottom Land range site in good condition. Picture was taken at close of grazing season and shows proper grazing. By fencing this range site the operator can obtain high returns without overgrazing the adjacent range.

are little bluestem, big bluestem, and switchgrass, are livestock cropping these too closely? Or if this range site was in lower condition when the cattle were turned in, and the key forage plant for that condition is blue grama, how much of it is being removed? The operator may judge by comparing ungrazed plants of blue grama with those grazed. If most of the blue grama has been cropped down, it is time to remove all or part of the livestock.

Adjusting the stocking rate for a pasture so as to obtain highest returns without lowering production of native grasses requires skill and experience. Table 3, in the preceding subsection, will be of value because it lists, for each range site, the plants on the site and the estimated yield of forage under the four range conditions, in both favorable and unfavorable years. The experience of other operators on similar rangelands may aid in making decisions. Also, the operator may obtain assistance from local representatives of the Soil Conservation Service or other agencies.

DEFERRED GRAZING.—Summer rest is a desirable way of hastening recovery of seriously depleted range (fig. 17). To do this, the operator needs other summer pasture, preferably temporary pasture on land normally used for crops.

RANGE SEEDING.—Seeding depleted cropland to grasses is proving profitable (fig. 18). To establish a stand it is usually necessary to keep livestock off the seeded area for at least 3 years.

CONTROL OF BRUSH.—Forage yields increase greatly if brush is controlled on depleted rangelands (fig. 19). On range infested with blackjack and post oaks, two aerial sprayings with herbicides are normally required. After each spraying, grazing is deferred through the growing

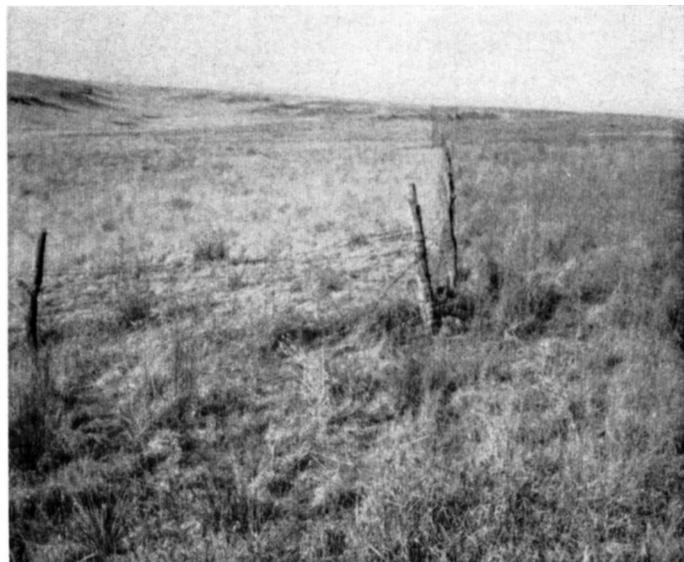


Figure 17.—Loamy Prairie range site in good condition that recovered rapidly during a summer's rest. Rainfall was good in spring and early in summer. With less favorable rainfall, two summers of deferred grazing might be needed to accomplish this

season. This treatment has increased yields of forage from 500 pounds to 2,300 pounds per acre in 2 years.

PROVIDING WATER FOR LIVESTOCK.—Good management of grassland requires that livestock have adequate water, of good quality, at places that will not require them to walk too far. In this county, only the wells drilled on the sandy lands are a dependable source of water. Ponds are the principal source of water in other parts of the county (fig. 20).

Management of small pastures

The small, stomp lot, pastures of native grass on many wheat farms are frequently severely overgrazed because they are used as holding areas for livestock until they can be moved to land sown to wheat or to sudangrass or other temporary pasture. These pastures, typically 20 to 50 acres in size, have been compacted by livestock and normally do not have sufficient plant cover to hold moisture and to slow runoff during periods of heavy rainfall.

Small pastures of native grass will respond to the same management as large areas of range. The difficulty is applying these practices, which do not fit well with the customary procedures on a wheat farm. Here are some ways that these small pastures can be improved:

1. Graze small pastures only in winter, along with fields sown to small grains. In this way, the plants have a chance to grow during summer, and the livestock harvest the forage when the plants are more or less dormant.
2. Determine how many animals a small pasture will carry in dry years, and put on a permanent herd of this size. Use stocker cattle to clean up the extra feed that will be available in wet years.
3. Hold in reserve a feed supply that will last a year. With this cushion for dry years, there is no reason to overgraze the small pasture.



Figure 18.—Top, excellent 4-year-old stand of bluestem and other native grasses on Sandy Prairie range site. Livestock were kept off for 2 years after seeding, and then grazing was carefully managed to permit accumulation of mulch and spread of the grass cover. Bottom, sowing in sorghum stubble with a drill specially designed to distribute the trashy and fine seeds of native grasses.

- Put cattle in fenced holding lots if they must be removed from one field before another field is ready to take them.

Woodland and Windbreaks ³

In this county native woodland is confined to bottom lands along the Cimarron River and its tributaries, and to a westward extension of a wooded region known as the cross timbers.

Along the Cimarron River and creeks, the trees are elm, cottonwood, willow, hackberry, and some walnut.

The extension of the cross timbers forms a band that parallels the north side of the Cimarron River. It covers some 44,000 acres, mainly on soils of the Pratt, Dougherty, Eufaula, and Shellabarger series. A considerable amount of good post oak has been cut on this land. Blackjack oak is now dominant, but it is gradually being eliminated to allow use of the land for native range, tame grasses, and crops.

³ By HERBERT WELLS, range conservationist, Soil Conservation Service.

Occasionally, small portable sawmills are moved into the county to cut rough material suitable for planks for small bridges, crates, and the like. Some cottonwood trees are cut for box wood. Most of the merchantable walnut logs are shipped out of the county for processing.

WINDBREAKS.—Some of the early residents of this county planted woodlots and windbreaks that still exist, and new plantings are made every year. The most extensive planting of windbreaks occurred between 1936 and 1942, under direction of the Prairie States Forestry Project, which was administered by the U.S. Forest Service. In that period some 60 miles of wide, multiple-use shelterbelts were planted to provide fuel, wood products, and protection from wind.

The windbreaks now used in this county are of two kinds, field windbreaks, and farmstead windbreaks. The two are managed somewhat differently.

Field windbreaks.—Windbreaks, spaced at regular intervals across a field, control wind erosion and protect crops on soils such as those of the Pratt, Dougherty, Eufaula, and Shellabarger series (fig. 21). The soils that will benefit from windbreaks, and that will support trees, are listed in table 4.

TABLE 4.—Suitability of soils for field and farmstead windbreaks and post-lot plantings

(E=excellent; F=fair; G=good; NS=not suitable)

Map symbol	Soil	Field wind-break	Farmstead wind-break	Post lot
Ab	Alluvial and broken land	NS	NS	F to G
BeA	Bethany silt loam, 0 to 1 percent slopes.	NS	F	NS
Br	Broken alluvial land	E to G	E to G	E to G
Ca	Carwile loamy fine sand	NS	F to G	NS
Cv	Clayey saline alluvial land	NS	NS	NS
DeB	Dougherty-Eufaula loamy fine sands, undulating.	G to E	G to E	G to E
DeC	Dougherty-Eufaula loamy fine sands, hummocky.	G	G	G
Dr	Drummond soils	NS	NS	NS
Eu	Eufaula fine sand	G	G	G
KfB	Kingfisher silt loam, 1 to 3 percent slopes.	F to G	F to G	F to G
KfC	Kingfisher silt loam, 3 to 5 percent slopes.	F	F to G	F to G
KgD3	Kingfisher-Lucien complex, 5 to 8 percent slopes, eroded.	NS	F	NS
KhB	Kingfisher-slickspot complex, 1 to 3 percent slopes.	NS	NS	NS
KhC	Kingfisher-slickspot complex, 3 to 5 percent slopes.	NS	NS	NS
KrA	Kirkland silt loam, 0 to 1 percent slopes.	NS	F	NS
Lc	Lincoln loamy fine sand	E to G	E to G	E to G
Ln	Lincoln sand	NS	NS	NS
NoA	Norge fine sandy loam, 0 to 1 percent slopes.	F to G	F to G	F to G
NoB	Norge fine sandy loam, 1 to 3 percent slopes.	F to G	F to G	F to G
NsB	Norge-slickspot complex, 1 to 3 percent slopes.	NS	NS	NS
NsC3	Norge-slickspot complex, 3 to 5 percent slopes, eroded.	NS	NS	NS
PcA	Pond Creek silt loam, 0 to 1 percent slopes.	F	F	F

TABLE 4.—*Suitability of soils for field and farmstead windbreaks and post-lot plantings—Continued*

(E=excellent; F=fair; G=good; NS=not suitable)

Map symbol	Soil	Field wind-break	Farmstead wind-break	Post lot
PcB	Pond Creek silt loam, 1 to 3 percent slopes.	F	F	F
PfB	Pratt loamy fine sand, undulating.	G	G	G
PfC	Pratt loamy fine sand, hummocky.	G	G	G
PoA	Port clay loam, 0 to 1 percent slopes.	G	G	G
PsA	Port silt loam, 0 to 1 percent slopes.	E	E	E
PsB	Port silt loam, 1 to 3 percent slopes.	E	E	E
RcA	Renfrow clay loam, 0 to 1 percent slopes.	NS	F	NS
RcB	Renfrow clay loam, 1 to 3 percent slopes.	NS	F	NS
Rg	Rough broken land-----	NS	NS	NS
Sa	Sand dunes, Lincoln material.	F to G	F to G	F to G
ShA	Shellabarger fine sandy loam, 0 to 1 percent slopes.	G to E	G to E	G to E
ShB	Shellabarger fine sandy loam, 1 to 3 percent slopes.	G to E	G to E	G to E
ShC	Shellabarger fine sandy loam, 3 to 5 percent slopes.	G to E	G to E	G to E
ShD3	Shellabarger fine sandy loam, 5 to 8 percent slopes, eroded.	F to G	F to G	F to G
Ta	Tabler clay loam-----	NS	NS	NS
Ts	Tabler-slickspot complex---	NS	NS	NS
Tv	Tivoli fine sand-----	F to G	F to G	F to G
VcB	Vernon clay loam, 1 to 3 percent slopes.	NS	F	NS
VcC3	Vernon clay loam, 3 to 5 percent slopes, eroded.	NS	F	NS
Vr	Vernon soils and Rock outcrop.	NS	NS	NS
Wa	Wet alluvial land-----	NS	NS	NS
Ya	Yahola fine sandy loam-----	G to E	G to E	G to E



Figure 19.—Deep Sand Savannah range site sprayed with 2 pounds per acre of 2,4,5-T in 1956 and again in 1957, and then not grazed for two summers. Most of the post oaks and blackjack oaks have been killed and tall grasses are returning.

as those in fields (fig. 22). They normally receive supplemental water during periods of drought, and, therefore, there is a wider choice in the kinds of trees that can be planted. Some trees and shrubs grown in local nurseries can be used along with trees normally planted in field windbreaks. Spacing and cultural practices do not differ much from those used for field windbreaks. The soils suitable for farmstead windbreaks are listed in table 4.

Post Lots.—On some soils of this county, plantings for posts can be profitable (fig. 23). Kinds of trees suitable for posts seldom produce as well as they should when they are planted in windbreaks. The management needed to produce posts is not compatible with that needed for windbreaks.

The trees commonly planted for posts are black locust, catalpa, and osage-orange. When woodlots containing these trees are thinned, sprouts come back and can be managed for later harvests. Russian mulberry and cedar have been used in a few post lots. The mulberry makes a reasonably good post but has not captured general interest. The cedar grows rather slowly and requires considerable management to obtain successive harvests. The soils suitable for post lots are listed in table 4.

Wildlife

Opportunities for improving habitats for wildlife are good in this county because about a fifth of it consists of soils in classes V, VI, and VII, which are considered nonarable. Groups of sportsmen and many individuals working with Federal and State agencies are active in improving these areas.

In many parts of the county, soils of class VI join with soils of class IV, which are arable and normally sown to small grains and sorghum. This combination of soils provides an exceptionally favorable habitat for bobwhite

According to present evidence, protection will be adequate, and loss of cropland least, if each windbreak has two rows of tall trees and one row of shrubs. If windbreaks are used with other practices that help to control erosion, the normal interval between each belt of trees is 18 to 20 times the height the tall trees will reach at maturity. The trees in each row can be 6 to 8 feet apart, and the distance between the rows can be adjusted to fit the operator's cultivation equipment. In most situations, 12 feet between rows is the most desirable spacing.

Deciduous species now considered suitable for the two rows of tall trees in windbreaks are sycamore, Siberian elm (*Ulmus pumila*), cottonwood, and thornless honeylocust. These trees can be obtained from public sources at near cost. Russian mulberry, spaced 4 feet apart in the row, serves well for the row to be planted to shrubs. Reliable conifers are eastern redcedar and Austrian pine.

Farmstead windbreaks.—Around farmsteads, windbreaks will serve their purpose even though they are not so high

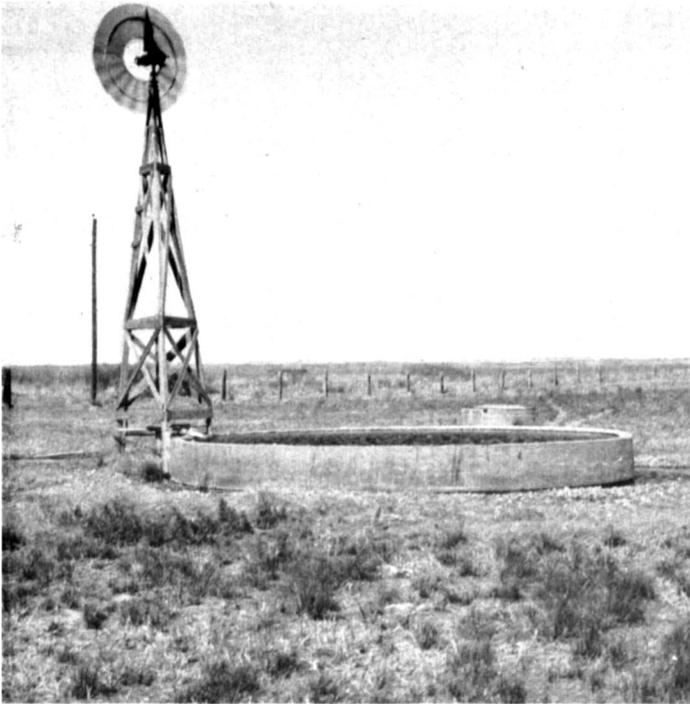


Figure 20.—*Top*, windmill and a storage tank of adequate size; most windmills in the county now have a steel tower. *Bottom*, cattle gathered around a stock pond; such ponds should be designed by a qualified engineer.

quail. The native grasses and woody plants on the soils of class VI provide nesting sites and cover, and the nearby fields on soils of class IV are a source of food. Where ponds have been constructed on soils of class VI, the quail population likely will be greater because the birds have water.



Figure 21.—This field windbreak on a deep Shellabarger soil checks wind erosion and protects crops.



Figure 22.—Vigorous young windbreak on three sides of this farmstead adds much to comfortable living.



Figure 23.—Harvest of black locust and catalpa posts on a favorably situated area of Pratt soil.

The Tivoli and Eufaula soils in class VI have good natural carrying capacity for quail. These soils occur at intervals along the north side of the Cimarron River; they support grass and sand sage, and, in places, clumps of sumac, wild plum, and other trees. The areas having the brush and trees are especially favorable. In these areas and others like them, proper grazing and protection from fire are needed to maintain the quail population.

Close to the Cimarron River and tributary streams, the cover is mixed grasses and, in most places, scattered, rather open stands of elm, cottonwood, willow, hackberry, chittamwood, soapberry, plum, roughleaf dogwood, and sumac. Bobwhite quail, cottontail rabbits, and red squirrels are the small game in these marginal areas. Along the streams that carry water the year around, there is a sparse population of raccoon, opossum, and mink. Skunk, badger, and coyotes frequent the water courses and the uplands. The take of fur is light.

In the extension of the cross-timbers that stretch westward along the north side of the Cimarron River, the natural growth of post oak, blackjack oak, and tall grasses supports a good population of small game. Quail, doves, cottontail rabbits, and squirrels are most numerous at the margins of woods, in open stands of trees, along fence rows, and at the borders of fields. This tract has high potential for these species if only minimum management is applied to maintain stable populations. Proper grazing and suppression of fires are most important, but planting of food and cover may be helpful in some places. Some of the stands of oak are too dense; they would be more productive of game if they were thinned by spraying or mechanical means.

Introduction of pheasants has not proved successful. Limited stocking of wild turkeys has been promising on a few areas that provide a suitable habitat.

Stream fishing in this county generally is not good, but some catfish and bluegill, and a few bass, are caught in them.

Some 1,200 farm ponds have been constructed over a long period. About 5 percent of these provide good fishing for channel catfish, largemouth bass, and bluegill and other sunfish. An additional 25 percent could be made productive through followup management, which would involve removing the present fish and restocking, controlling weeds, fertilizing the ponds, or some combination of these practices.

The shallow ponds and those that remain too turbid for good fish culture are of some value in wildlife management. They provide water for upland game and are frequented to some extent by wildfowl during migration.

Engineering Properties of Soils ⁴

This section records the engineering properties of several extensive soils in Kingfisher County.

⁴ By WILLIAM E. HARDESTY, civil engineer, Soil Conservation Service.

The information in this report can be used 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 the engineering properties of soils in the planning of agricultural drainage and irrigation systems, farm ponds, and terraces.
3. Make preliminary evaluation of soils and ground conditions that will aid in selecting highway and airport locations, and in planning detailed investigations of the selected locations.
4. Locate probable sources of road and highway construction materials.
5. Correlate performance of engineering structures with soils, and thus gain information that will be useful in designing and maintaining the structures.
6. Determine the suitability of soil units for cross-country movement of vehicles and construction equipment.
7. Supplement information obtained from other published maps and reports and aerial photographs for the purpose of making maps and reports that can be readily used by engineers.

This report, however, will not eliminate the need for sampling and testing soils at the site chosen for construction. The mapping and the descriptions of the soils mapped are somewhat generalized and, therefore, are not a substitute for detailed engineering surveys at a particular site.

Presented in tables 5, 6, and 7 are data based on engineering properties of several mapping units that together cover about 40 percent of Kingfisher County. In table 5 are the results of tests made on these soils by the Materials Test Laboratory, Oklahoma Department of Highways. The same soils are listed in table 6, which provides ratings indicating the suitability of each soil for highway construction, as well as appraisals of its hardness when dry, permeability, moisture-holding capacity, and shrink-swell potential. Table 7 lists the same soils as the two tables preceding, and properties of these soils that affect their use for ponds, reservoirs, drainage and irrigation systems, terraces, and waterways. The terms and classifications used in these tables are explained for farmers and others who are not engineers but are interested in engineering uses of soils.

TABLE 5: Samples were taken from the A, B, and C horizons of each soil listed in this table, at a site considered typical of that soil. The depth, or thickness, of these horizons is shown in inches in the "Depth" column. In this column the progression downward is not consecutive, because not all layers of each profile were sampled. In Bethany silt loam, for example, layers were sampled at 0 to 9 inches, at 18 to 32 inches, and at 54 to 66 inches. The layers intervening are transitional; that is, they have engineering properties partly like the layer above and partly like the one below.

TABLE 5.—Engineering test data on several

Map symbol	Soil	Laboratory number ¹	Depth	Horizon	Classification	
					AASHO ²	Unified ³
BeA	Bethany silt loam, 0 to 1 percent slopes.....	9276	<i>Inches</i> 0-9	A	A-6(9)	CL
		9277	18-32	B	A-7-6(14)	CL
		9278	54-66	C	A-6(12)	CL
DeC	Dougherty-Eufaula loamy fine sands, hummocky.....	9282	7-23	A	A-2-3(0)	SM
		9283	23-32	B	A-2(0)	SM
		9284	70-100	C	A-3(0)	SP-SM
KfB	Kingfisher silt loam, 1 to 3 percent slopes.....	9288	5-12	A	A-4(8)	CL-ML
		9289	18-27	B	A-6(12)	CL
		9290	36+	C	A-4(8)	CL
NoB	Norge fine sandy loam, 1 to 3 percent slopes.....	9294	7-18	A	A-4(3)	ML
		9295	18-30	B	A-4(5)	CL
		9296	30-60	C	A-6(7)	CL
PoA	Port clay loam, 0 to 1 percent slopes.....	9300	8-22	A	A-6(12)	CL
		9301	22-34	AC	A-6(11)	CL
		9302	34-52	C	A-6(10)	CL
PfB	Pratt loamy fine sand, undulating.....	9279	6-13	A	A-4(1)	SM
		9280	20-32	B	A-2-3(0)	SM
		9281	32-46	C	A-4(2)	SM
RcB	Renfrow clay loam, 1 to 3 percent slopes.....	9291	8-15	A	A-4(8)	CL
		9292	15-30	B	A-7-6(20)	CH
		9293	34-40	C	A-7-6(15)	CL
ShB	Shellabarger fine sandy loam, 1 to 3 percent slopes.....	9297	8-22	A	A-4(0)	SM-SC
		9298	22-32	B	A-2(0)	SM
		9299	32-42	C	A-2(0)	SM
Vr	Vernon soils and Rock outcrop.....	9305	0-5	A	A-4(8)	ML
		9306	5-70	C	A-4(6)	ML-CL
VcB	Vernon clay loam, 1 to 3 percent slopes.....	9303	0-15	A	A-6(10)	CL
		9304	15-60	C	A-4(8)	ML-CL

¹ Laboratory number, Materials Test Laboratory, Oklahoma Department of Highways.

² Based on combined physical tests developed by American Association of State Highway Officials (AASHO). The AASHO system is explained in STANDARD SPECIFICATIONS FOR HIGHWAY MATERIALS AND METHODS OF SAMPLING, AND TESTING, ed. 7, pt. I, 257 pp., illus. 1955. The Oklahoma Department of Highways has modified the AASHO subgroup A-2-4 by using three subgroups as follows: A-2-3, if soil material is nonplastic (NP); A-2, if plasticity index is 1 to 5; and A-2-4, if plasticity index is 6 to 100.

soils sampled in Kingfisher County, Oklahoma

Liquid limit	Plasticity index	Shrinkage limit	Shrinkage ratio	Volume change from FME	Mechanical analysis						
					Percentage passing sieve—				Percentage smaller than—		
					No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 60 (0.25 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.005 mm.	0.002 mm
36	12	21	1.67	12	100	100	98	91	80	19	15
47	22	14	1.91	53	100	100	98	92	85	41	37
40	19	14	1.89	40	100	99	97	84	63	32	29
(⁴)	100	98	80	19	10	3	3				
18	1	15	1.82	6	100	97	79	26	18	12	11
(⁴)	100	99	83	9	8	6	3				
26	6	20	1.72	7	100	100	100	82	49	18	15
38	20	17	1.81	27	100	100	100	91	69	31	29
27	9	17	1.77	15	100	100	100	87	50	19	17
19	2	15	1.81	5	100	96	78	51	27	8	7
26	9	15	1.86	14	100	97	81	61	44	17	15
33	15	14	1.83	28	100	97	84	61	45	25	23
39	19	17	1.83	33	100	100	100	94	81	35	30
37	18	15	1.88	32	100	100	99	87	67	32	30
33	15	16	1.84	26	100	100	100	85	61	28	24
(⁴)	100	97	84	42	26	7	4				
(⁴)	100	97	81	31	18	11	10				
21	3	16	1.81	6	100	96	81	47	30	14	13
29	9	17	1.80	17	100	100	100	99	83	27	25
58	33	13	1.99	52	100	100	100	99	90	62	57
47	26	13	1.97	36	100	98	97	94	80	55	48
22	5	15	1.84	11	100	98	83	37	25	13	11
19	17	16	1.58	7	100	99	88	29	19	11	10
19	1	17	1.76	3	100	99	93	28	16	10	10
34	6	24	1.60	15	100	93	85	76	67	20	13
33	9	22	1.66	13	100	89	80	67	58	27	19
36	15	16	1.79	29	100	99	98	94	80	36	30
34	10	23	1.66	15	100	98	89	73	60	26	20

³ For explanation see THE UNIFIED SOIL CLASSIFICATION SYSTEM, Waterways Experiment Station. Tech. Memorandum 3-357, v. 1, 30 pp., illus. 1953.

⁴ Nonplastic.

TABLE 6.—*Highway engineer interpretation*
 [Based on "The Relationship of Soils and Highways in Oklahoma,"

Map symbol	Soil name	Horizon	Suitability for highway construction			
			Subgrade	Shoulders	Erosion control	Seeding, sodding
BeA	Bethany silt loam, 0 to 1 percent slopes.....	A.....	Poor.....	Poor.....	Poor.....	Poor.....
		B.....	Poor.....	Poor.....	Good.....	Poor.....
		C.....	Poor.....	Poor.....	Fair.....	Fair.....
DeC	Dougherty-Eufaula loamy fine sands, hummocky.....	A.....	Fair.....	Poor.....	Poor.....	Poor.....
		B.....	Fair.....	Poor.....	Poor.....	Fair.....
		C.....	Good.....	Poor.....	Poor.....	Poor.....
KfB	Kingfisher silt loam, 1 to 3 percent slopes.....	A.....	Poor.....	Poor.....	Poor.....	Fair.....
		B.....	Poor.....	Poor.....	Fair.....	Poor.....
		C.....	Poor.....	Poor.....	Poor.....	Fair.....
NoB	Norge fine sandy loam, 1 to 3 percent slopes.....	A.....	Poor.....	Poor.....	Poor.....	Fair.....
		B.....	Poor.....	Poor.....	Poor.....	Fair.....
		C.....	Poor.....	Poor.....	Fair.....	Fair.....
PfB	Pratt loamy fine sand, undulating.....	A.....	Poor.....	Poor.....	Poor.....	Poor.....
		B.....	Fair.....	Poor.....	Poor.....	Poor.....
		C.....	Poor.....	Fair.....	Poor.....	Fair.....
PoA	Port clay loam, 0 to 1 percent slopes.....	A.....	Poor.....	Poor.....	Fair.....	Poor.....
		A ₁	Poor.....	Poor.....	Fair.....	Fair.....
		C.....	Poor.....	Poor.....	Fair.....	Fair.....
RcB	Renfrow clay loam, 1 to 3 percent slopes.....	A.....	Poor.....	Poor.....	Poor.....	Poor.....
		B.....	Poor.....	Poor.....	Good.....	Poor.....
		C.....	Poor.....	Poor.....	Good.....	Poor.....
ShB	Shellabarger fine sandy loam, 1 to 3 percent slopes.....	A.....	Poor.....	Fair.....	Poor.....	Fair.....
		B.....	Fair.....	Fair.....	Poor.....	Fair.....
		C.....	Fair.....	Poor.....	Poor.....	Fair.....
Vr	Vernon soils and Rock outcrop.....	A.....	Poor.....	Poor.....	Poor.....	Fair.....
		C.....	Poor.....	Poor.....	Poor.....	Fair.....
VcB	Vernon clay loam, 1 to 3 percent slopes.....	A.....	Poor.....	Poor.....	Fair.....	Poor.....
		C.....	Poor.....	Poor.....	Poor.....	Fair.....

¹ Permeability rating is based on the soil in its undisturbed condition.

for several soils of Kingfisher County, Okla.

pt. 1, sec. H. Oklahoma Department Highways. 1958]

Suitability for highway construction—Continued		Structure	Hardness when dry	Permeability ¹	Moisture-holding capacity	Shrink-swell potential
Soil binder	Stabilization					
No	No	Granular	Soft	Slow	High	Low.
No	No	Blocky	Very hard	Very slow	High	High.
No	No	Blocky	Very hard	Very slow	High	Medium.
No	Yes	Granular	Soft	Moderately rapid	Low	Low.
No	Yes	Granular	Hard	Moderate	Medium	Low.
No	Yes	Granular	Slightly hard	Moderately rapid	Low	Low.
No	No	Granular	Hard	Slow	High	Low.
No	No	Blocky	Hard	Slow	High	Medium.
No	No	Bedrock	Very hard	Slow	Very low	Medium.
No	No	Granular	Soft	Moderate	Medium	Low.
No	No	Granular	Hard	Slow	Medium	Low.
No	No	Blocky	Very hard	Slow	Medium	Medium.
No	Yes	Granular	Soft	Moderately rapid	Low	Low.
No	Yes	Granular	Slightly hard	Moderately rapid	Medium	Low.
No	Yes	Granular	Slightly hard	Rapid	Medium	Low.
No	No	Granular	Hard	Slow	High	Medium.
No	No	Blocky	Hard	Slow	High	Medium.
No	No	Granular	Hard	Slow	High	Medium.
No	No	Granular	Hard	Very slow	High	Low.
No	No	Blocky	Extremely hard	Very slow	High	High.
No	No	Bedrock	Extremely hard	Very slow	Very low	High.
No	Yes	Granular	Soft	Moderate	Low	Low.
Yes	No	Blocky	Hard	Moderate	Medium	Medium.
No	Yes	Granular	Hard	Moderately rapid	Medium	Low.
No	No	Granular	Hard	Very slow	High	Low.
No	No	Bedrock	Extremely hard	Very slow	Very low	Low.
No	No	Blocky	Hard	Very slow	High	Medium.
No	No	Bedrock	Extremely hard	Very slow	Very low	Low.

TABLE 7.—*Conservation engineering properties*

Map symbol	Soil	Dug ponds	Impounded ponds	
			Reservoir area	Embankment
BeA	Bethany silt loam, 0 to 1 percent slopes.	Low seepage; deep subsoil.	Little natural storage.	Stable.
DeC	Dougherty-Eufaula loamy fine sands, hummocky.	High seepage.	High seepage.	Easily eroded.
KfB	Kingfisher silt loam, 1 to 3 percent slopes.	Limited depth to bedrock.	Low seepage.	Stable.
NoB	Norge fine sandy loam, 1 to 3 percent slopes.	Moderate seepage; deep subsoil.	Moderate seepage.	Stable.
PfB	Pratt loamy fine sand, undulating.	High seepage.	High seepage.	Easily eroded.
PoA	Port clay loam, 0 to 1 percent slopes.	Low seepage; deep subsoil.	Little natural storage.	Stable.
RcB	Renfrow clay loam, 1 to 3 percent slopes.	Limited depth to bedrock.	Low seepage.	Stable.
ShB	Shellabarger fine sandy loam, 1 to 3 percent slopes.	Moderate seepage.	Moderate seepage.	Stable.
Vr	Vernon soils and Rock outcrop.	Limited depth to bedrock.	Limited borrow material.	Shale may leak.
VcB	Vernon clay loam, 1 to 3 percent slopes.	Limited depth to bedrock.	Low seepage.	Shale may leak.

of several soils in Kingfisher County, Okla.

Drainage	Irrigation	Field terraces and diversion terraces	Waterways
Needed in depressed areas...	Slow intake rate.....	Stable.....	Stable; fertile.
Not needed.....	Susceptible to wind erosion; very high intake rate.	Susceptible to wind erosion; unstable.	Easily eroded; susceptible to wind deposits.
Good on surface.....	Slow intake rate.....	Slick spots are unstable.....	Slick spots are unstable and droughty.
Good on surface.....	Moderate intake rate.....	Slight wind erosion.....	Some wind deposits; fertile.
Not needed.....	Susceptible to wind erosion.....	Susceptible to wind erosion; unstable.	Easily eroded; susceptible to wind deposits.
Needed in depressed areas...	Slow intake rate; deep.....	Stable.....	Stable; fertile.
Good on surface.....	Very slow intake rate.....	Stable.....	Stable; droughty.
Good on surface.....	Moderate intake rate; slight wind erosion.	Slight wind erosion.....	Slight wind deposits.
Excessive.....	Too shallow.....	Too shallow.....	Too shallow and droughty.
Good on surface.....	Too shallow.....	Stable.....	Shallow; droughty.

Two engineering classifications are shown: the AASHO (American Association of State Highways Officials), which is widely used by highway engineers; and the Unified, which is used mainly by the U.S. Bureau of Reclamation, U.S. Army Corps of Engineers, and the Soil Conservation Service.

AASHO classification: In this system soils are placed in seven principal groups. The groups range from A-1, consisting of gravelly soils of high bearing capacity, to A-7, consisting of clay soils that have low strength when wet. Within each group, the relative engineering value of the soil material is indicated by a group index number. These range from 0 for the best materials to 20 for the poorest. The group index number is shown in parentheses following the soil group symbol.

Unified classification: In this system soils are grouped on the basis of their texture and plasticity and their performance as materials for engineering structures. Soil materials are identified as coarse grained (8 classes), fine grained (6 classes), or highly organic.

Liquid limit: The moisture content at which a soil passes from a plastic to a liquid state.

Plastic limit: The moisture content at which a soil passes from a semisolid to a plastic state.

Plasticity index: The numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil is in plastic condition. Nonplastic, indicated by NP, applies to soils that are without cohesion, for which liquid or plastic limit cannot be determined.

Shrinkage limit: As moisture leaves the soil, the soil shrinks and decreases in volume in direct proportion to the loss in moisture until a condition of equilibrium is reached, where shrinkage stops although additional moisture is removed. The moisture content where shrinkage stops is called the shrinkage limit.

Shrinkage ratio: The volume change resulting from drying of a soil material, divided by the loss of moisture caused by drying, is the shrinkage ratio. The ratio is expressed numerically.

Volume change: The change in volume that will take place in a soil material when it dries from a given moisture content to the point where no further shrinkage takes place.

Field moisture equivalent (FME): The minimum moisture content at which a smooth soil surface will absorb no more water within 30 seconds when the water is added in individual drops.

Mechanical analysis: Tests to determine the percentage of soil particles that will pass through sieves of specified sizes. The very small particles, those that pass through a No. 200 sieve, are analyzed in engineering tests by the hydrometer method, rather than by the pipette method that is commonly used by soil scientists.

TABLE 6: The ratings for the various uses of soils in highway construction are primarily based on criteria using the soil characteristics of plasticity and gradation. Other characteristics shown, such as hardness when dry, permeability, moisture-holding capacity, and shrink-swell potential, are based on data in table 5 and on field experience.

Permeability: The rate at which moisture moves downward in the soil; the rate is expressed in inches per hour.

Moisture-holding capacity: Estimated number of inches of water available to plants in each foot of soil.

Shrink-swell potential: The volume change of a soil; that

is, the shrinking of a soil when it dries and swelling as it takes up moisture. Soils with a high shrink-swell potential are normally undesirable sites for building concrete structures.

TABLE 7: The data in table 7 are interpretations based on data in tables 5 and 6 and on field experience.

How the Soils Formed and Are Classified

In this section are discussed the five major factors of soil formation, some of the common processes that take place in soils of the county, the classifying of soil series by orders and great soil groups, and the results of laboratory analyses of six important soils.

Factors of Soil Formation

Soil results from the interaction of five major factors of soil formation. The characteristics of the soil at any given point are determined by (1) the climate under which the soil material has accumulated and existed since it accumulated; (2) the plant and animal life in and on the soil; (3) the type of parent material; (4) the topography; and (5) the length of time the forces of soil development have acted on the soil materials.

One of the five factors may have more influence than others on the development of the soil and may be responsible for fixing most of its properties. For example, if the parent material of the soil is quartz sand, the soil generally has only weakly developed horizons. Even in quartz sand, however, distinct profiles can be formed under certain types of vegetation where the topography is low and level and the water table is high. As a rule, however, more than one of the five factors influences the development of the soil.

Climate.—Kingfisher County has a subhumid climate. The average annual precipitation is about 29 inches. The average summer temperature is 82° F., and the average winter temperature, 40°.

Vegetation.—About eight-tenths of the county consists of soils formed under grass cover, and the rest, of soils that formed under a mixed cover of grass and trees.

Parent material.—The soils of this county have developed mainly in materials of Permian and Late Tertiary and Quaternary ages. The relationships of soils and parent materials are shown in figure 3, facing p. 4.

Relief.—In this county the effects of relief are most evident in soils located in level or slightly depressed, poorly drained areas.

Time.—Soil age is reckoned in terms of maturity of the soil, not in terms of age of the materials from which it was formed. In this county, the soils range from mature to young. Young soils, those having slight genetic difference in horizons, are in the minority.

Processes of Soil Formation

Each kind of soil has a distinctive profile in which horizons, or layers, are more or less evident. The formation of these layers depends on several processes, or combinations of processes, which reflect the interactions of climate, living organisms, parent material, relief, and time.

In this county, the processes that form different layers are (1) accumulation of organic matter, (2) translocation

of silicate clay minerals, (3) desalinization and alkalization, (4) leaching of carbonates and salts, (5) podzolization, and (6) reduction and transfer of iron.

Evidence of these various processes can be seen in the profiles described in the section "Descriptions of Soils" and in the laboratory data given in table 8 for six virgin soil profiles of this county.

Accumulation of organic matter.—Organic matter from plants is broken down by micro-organisms to form humus. Normally, the amount of organic matter and humus is greatest in the surface layer and decreases with depth. The humus in a soil affects its structure, color, consistence, and capacity to hold moisture and plant nutrients.

Most soils of this county formed under a cover of grasses, which supply more organic matter than trees. The Bethany, Kingfisher, Norge, Pond Creek, and Renfrow soils are among those that formed under grass. Before cultivation, they had a good supply of organic matter in the surface layer and decreasing amounts with depth (see table 8).

The soils that formed under a mixed cover of trees and grass, the so-called savanna type of vegetation, contain less organic matter than those that formed under grass alone. In soils that formed under savanna vegetation, there is a sudden and sharp decrease in organic matter close to the surface. The Dougherty and Eufaula soils, for example, show this kind of decrease.

A few soils, though formed under grass, contain little organic matter, mainly because of their coarse texture. Among these sandy soils are those of the Lincoln, Tivoli, and Yahola series.

Translocation of silicate clays.—Through long periods, silicate clays are moved downward in soils. The movement of clay from the upper part of a soil profile to a lower eventually causes formation of distinct layers. In this county translocation of clay is evidenced by darker colored clay coatings and films on the surfaces of peds in the B horizon. Results of the process are evident in Bethany, Dougherty, Eufaula, Kingfisher, Kirkland, Norge, Renfrow, and Tabler soils. In the Bethany soils, however, the clayey B horizon may be more the result of the way the materials were deposited than the result of translocation of clay. In some soils, such as the Eufaula and Pratt, the movement of clay has been slight. Nevertheless, it has contributed in forming separate horizons.

Desalinization and alkalization.—In materials where the proportion of sodium is high in relation to the proportion of calcium, the fine clay particles, or colloids, migrate downward and collect at lower levels. Thus, a thin, light-colored, coarse-textured crust, low in organic matter, is left at the surface. Below is a B₂ horizon that is clayey—heavy and plastic when wet and very hard and of prismatic or columnar structure when dry. The areas of this kind are called alkali claypans, or slick spots. In this county they are mapped with soils of the Kingfisher, Norge, and Tabler series.

Leaching of carbonates and salts.—Through leaching, calcium is moved downward in some soils and accumulates in a zone within the profile. Among the soils showing such accumulation are those of the Bethany, Kingfisher, Kirkland, Norge, Pond Creek, Renfrow, and Tabler series. In other soils, leaching has removed all of the calcium. Soils of the Dougherty, Eufaula, Pratt, and Shellabarger series are of this kind.

The soils on older alluvium, among them the Lincoln, Pratt, and Yahola, show little evidence of accumulation of carbonates or salts in lower layers. An exception is Clayey saline alluvial land. The shallow Vernon soils, which formed over Permian red beds, do not have a zone in which lime has accumulated, nor do the Tivoli, which are on sand dunes.

Podzolization.—This is a process in which soils are depleted of bases, become acid, and develop a surface layer that contains little or no clay. The A₂ and B₂ horizons of podzolized soils are normally distinct. The thickness of these layers varies within short distances, and in some places there is a thin transitional layer between them. Soils of this county showing podzolization have coarse-textured parent material and a mixed cover of grass and trees. Typical are the Dougherty and Eufaula soils.

Transfer and reduction of iron.—In a few very poorly or poorly drained soils, reduction and transfer of iron has formed gray layers or mottled layers in the lower part of the profile. The soils that show evidence of this process are the Carwile and Tabler.

Classification of Soils by Higher Categories

Soils are placed in narrow classes for the organization and application of knowledge about their behavior within farms or counties. They are placed in broad, more inclusive, categories for study and comparison of several counties or larger areas. The lower categories of classification, the soil series, types, and phases, are discussed briefly in the section "How Soils are Named, Mapped, and Classified," and they are defined in the Glossary. Discussed here are the commonly used higher categories, the soil orders and great soil groups, and placement of the soil series in these.

The soil series of Kingfisher County are classified by soil order and great soil group as follows:

ZONAL SOILS	INTRAZONAL SOILS
Reddish Prairie soils	Planosols
Bethany	Carwile
Kingfisher	Tabler
Kirkland	Solonetz
Norge	Drummond
Pond Creek	
Renfrow	AZONAL SOILS
Shellabarger	Alluvial soils
Red-Yellow Podzolic soils	Lincoln
Dougherty	Port
Eufaula	Yahola
Reddish Chestnut soils	Lithosols
Pratt	Lucien
	Vernon
	Regosols
	Tivoli

Zonal soils

Zonal soils have well-developed characteristics that reflect the influence of the active factors of soil formation—climate and living organisms, chiefly vegetation. The zonal great soil groups of Kingfisher County are the Reddish Chestnut, Reddish Prairie, and Red-Yellow Podzolic.

The Reddish Chestnut great soil group is represented by soils of only one series, the Pratt. Pratt soils formed under tall grasses. Their surface layer is 10 to 16 inches

of brown loamy fine sand. The subsoil is yellowish-brown sandy loam.

The Reddish Prairie soils of this county have developed under tall and mid grasses. They have a dark reddish-brown or brown, slightly acid A horizon that ranges from 8 to 16 inches in thickness. Their B horizon is influenced by the parent material and may be of blocky, massive, or prismatic structure. In this county the soil series representing the Reddish Prairie soils are the Bethany, Kingfisher, Kirkland, Norge, Pond Creek, Renfrow, and Shellabarger.

The Red-Yellow Podzolic soils developed in sandy parent materials, are more leached than the Reddish Prairie soils, and support a mixed forest-grass, or savanna, vegetation. Soils of the Dougherty and Eufaula series are the only soils in this county in the Red-Yellow Pod-

zolic great soil group. They have a grayish-brown layer at the surface and a lighter colored subsurface layer, or A₂ horizon. Their B horizon is yellowish-red or pale yellowish-brown sandy loam or light sandy clay loam.

Intrazonal soils

Intrazonal soils have more or less well developed characteristics that reflect the dominating influence of some local factor of relief or parent material over the normal influences of the climate and vegetation. The intrazonal great soil groups in this county are the Planosols and the Solonetz soils.

The Planosols, soils of the Carwile and Tabler series, are in level or depressed areas that have little or no surface runoff, contain excess water all or part of the time, and

TABLE 8.—Chemical and mechanical

Soil	Plant cover	Horizon	Depth	pH 1:5	Chemical analyses					
					Organic matter	Organic carbon	Nitrogen	Carbon- nitrogen ratio	Esti- mated salt	Cation exchange capacity
Bethany silt loam, 0 to 1 percent slopes (300 ft. north and 800 ft. west of southwest corner sec. 13, T. 19 N., R. 7 W.).	Native grass pasture.	A ₁₁	<i>Inches</i> 0-9	6.6	-----	1.07	0.120	8.9 to 1	0.02	14.80
		A ₁₂	9-15	6.9	-----	.78	.900	8.7 to 1	.02	19.77
		B ₁	15-18	6.9	-----	.78	.900	7.7 to 1	.02	19.77
		B ₂	18-32	7.0	-----	.46	.060	6.7 to 1	.045	30.00
		B ₃	32-54	8.3	-----	.16	.024	5.2 to 1	.070	23.27
		C	54-75	8.1	-----	.11	.021		.080	23.80
Dougherty-Eufaula loamy fine sands, hummocky (450 ft. north of southwest corner sec. 13, T. 18 N., R. 7 W.).	Native trees and tall grasses.	A ₁	0-7	5.4	-----	.35	.034	10.3 to 1	<.02	2.99
		A ₂	7-23	5.7	-----	.10	.014	7.2 to 1	<.02	1.56
		B ₂	23-32	5.7	-----	.15	.024	6.3 to 1	<.02	9.36
		B ₃₁	32-49	6.5	-----	.06	.014	4.3 to 1	<.02	5.32
		B ₃₂	49-70	6.7	-----	.12	.026	4.6 to 1	<.02	3.37
		C	70-100	6.8	-----	.04	.007	5.7 to 1	<.02	2.34
Eufaula fine sand (2,000 ft. north of southwest corner sec. 36, T. 18 N., R. 6 W.).	Native trees and tall grasses.	A ₁	0-6	6.2	-----	.30	.032	10.7 to 1	<.02	2.78
		A ₂₁	6-14	5.7	-----	.17	.016	10.6 to 1	<.02	1.39
		A ₂₂	14-29	6.6	-----	.09	.010	9.0 to 1	<.02	.94
		AB	29-36	6.7	-----	.08	.010	8.0 to 1	<.02	2.58
		B ₂	36-68	6.7	-----	.08	.011	7.3 to 1	<.02	4.77
		B _u	68-94+	6.0	-----	.07	.011	6.4 to 1	<.02	10.12
Kingfisher silt loam, 1 to 3 percent slopes.	Native trees and tall grasses.	A ₁₁	0-7	6.4	2.05	.99	.102	9.7 to 1	-----	9.59
		A ₁₂	7-14	7.0	1.50	.73	.077	9.5 to 1	-----	11.18
		B ₁	14-19	7.2	1.27	.61	.067	9.1 to 1	-----	11.83
		B ₂₁	19-28	7.3	.97	.47	.063	7.5 to 1	-----	16.63
		B ₂₂	28-36	7.3	.85	.41	.048	8.5 to 1	-----	17.27
		B ₃	36-44	7.3	.45	.22	.038	5.8 to 1	-----	13.24
		C ₁	44-56	7.8	.37	.18	.029	6.2 to 1	-----	8.44
		C ₂	56-68	8.2	.15	.07	.027	2.6 to 1	-----	9.09
Pratt loamy fine sand, undulating (NE¼NW¼ sec. 7, T. 18 N., R. 7 W.).	Native grass pasture.	A ₁₁	0-6	7.1	-----	.88	.100	8.8 to 1	<.02	6.53
		A ₁₂	6-13	6.9	-----	.47	.057	8.2 to 1	<.02	5.55
		B ₁₁	13-20	7.1	-----	.33	.047	7.0 to 1	<.02	5.68
		B ₁₂	20-32	7.2	-----	.34	.050	6.8 to 1	<.02	6.93
		B ₂₁	32-46	6.9	-----	.23	.048	4.8 to 1	<.02	9.66
		B ₂₂	46-62	7.1	-----	.20	.027	7.4 to 1	<.02	7.60
		C _u	62-80	7.4	-----	.16	.031	5.2 to 1	<.02	10.42
Shellabarger fine sandy loam, 1 to 3 percent slopes.	Native grass pasture.	A ₁	0-10	6.5	-----	1.04	.085	12.2 to 1	<.20	8.80
		B ₁	10-18	6.3	-----	.70	.064	11.0 to 1	<.20	14.50
		B ₁₂	18-27	6.5	-----	.41	.039	10.0 to 1	<.20	14.20
		B ₂₂	27-36	6.5	-----	.22			<.20	9.20
		C ₁	36-48	6.5	-----	.08			<.20	5.20
		C ₂	48-55	6.5	-----	.11			<.20	8.70
		C ₃	55-64	6.7	-----	.06			<.20	7.60
		C ₄	64-78+	6.9	-----	.05			<.20	6.30

are not subject to erosion. They have a grayish-brown A horizon and a compact layer in the B horizon.

The Solonetz soils are members of the Drummond series. The slick spots in the Kingfisher, Norge, and Tabler soils are also solonetzic. High salt content in the parent material accounts for the formation of these soils and the slick spots.

Azonal soils

Azonal soils have little or no profile development; most of them are so young that there has not been time for formation of distinct genetic layers. The azonal great soil groups of this county are the Alluvial soils, Lithosols, and Regosols.

The Alluvial soils are members of the Lincoln, Port, and Yahola series. The Lincoln and Yahola are sandy soils

along the Cimarron River; the Port are finer textured soils on wide terraces in the broad stream valleys. Soils of these three series do not have a B horizon, because their parent material has not been in place long enough for development of distinct horizons.

The Lithosols are members of the Lucien and the Vernon series. These are shallow soils without a B horizon.

The Regosols of this county are soils of the Tivoli series. Tivoli soils are on sandhills and consist of deep, loose, fine sand.

Laboratory Analyses

Shown in table 8 are the results of laboratory analyses on six virgin profiles. The soils sampled are considered to be representative of the range of soil conditions in this

analyses of six extensive soils

Chemical analyses—Continued										Mechanical analyses			
Extractable cations				Exchangeable sodium	Saturation extract (soluble)				Total phosphorus	Moisture saturation	Sand	Silt	Clay
Ca	Mg	Na	K		Na	K	Ca	Mg					
<i>meq./100 gm.</i>	<i>meq./100 gm.</i>	<i>meq./100 gm.</i>	<i>meq./100 gm.</i>	<i>Percent</i>	<i>meq./100 gm.</i>	<i>meq./100 gm.</i>	<i>meq./100 gm.</i>	<i>meq./100 gm.</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>	
10.75	3.37	0.11	0.68	0.74	0.020	0.025	0.131	0.084	46.7	21.1	60.3	18.6	
14.46	4.38	.36	.47	1.82	.067	.008	.087	.091	45.6	19.4	54.4	26.2	
14.46	4.38	.36	.47	1.82	.067	.008	.087	.091	45.6	17.8	54.0	28.2	
21.50	8.08	1.28	.53	4.27	.159	.008	.085	.067	60.9	14.0	45.9	40.1	
28.50	6.61	2.44	.58	10.49	.890	.014	.308	.228	61.7	26.7	38.9	34.4	
20.01	6.02	2.71	.58	11.39	1.040	.018	.426	.213	62.7	23.6	42.2	34.2	
.93	.40	.09	.10	3.01	.017	.008	.055	.044	21.9	81.6	15.2	3.2	
.62	.40	.09	.10	5.77	.012	.004	.022	.041	21.7	84.4	13.1	2.5	
3.03	1.73	.09	.22	.96	.028	.005	.054	.068	35.8	75.8	7.3	16.9	
4.48	2.32	.17	.14	3.20	.034	.004	.058	.047	29.3	84.7	5.3	10.0	
1.56	1.01	.09	.10	2.67	.029	.005	.044	.057	25.8	91.0	3.5	5.5	
.93	1.00	.09	.10	3.85	.023	.004	.032	.050	22.8	93.1	2.6	4.3	
1.66	.40	.09	.14	3.24	.015	.008	.052	.022	24.9	82.0	15.3	2.8	
.41	.20	.09	.10	6.47	.015	.004	.040	.047	23.7	86.6	11.6	1.7	
1.03	.00	.09	.10	9.57	.016	.004	.067	.049	25.8	91.6	6.4	2.0	
1.86	1.26	.09	.10	3.49	.011	.003	.057	.030	23.6	92.9	2.2	4.9	
2.39	1.91	.09	.14	1.89	.013	.004	.057	.045	25.1	88.8	3.0	8.2	
4.62	3.76	.17	.26	1.68	.032	.006	.071	.065	32.4	68.0	16.2	15.8	
6.03	3.04	.42	.81	-----	-----	-----	-----	-----	0.0216	23.3	63.8	12.9	
7.70	4.03	.46	.74	-----	-----	-----	-----	-----	.0176	21.8	60.8	17.4	
8.30	5.35	.32	.50	-----	-----	-----	-----	-----	.0162	20.7	59.9	19.4	
10.90	6.25	.73	.46	-----	-----	-----	-----	-----	.0156	18.8	53.4	27.8	
10.90	6.99	.62	.52	-----	-----	-----	-----	-----	.0156	18.4	53.7	27.9	
8.30	7.16	1.15	.42	-----	-----	-----	-----	-----	.0152	19.2	58.4	22.4	
4.35	6.54	2.31	.31	-----	-----	-----	-----	-----	.0136	20.0	63.3	16.7	
12.20	9.21	3.46	.29	-----	-----	-----	-----	-----	.0196	21.5	58.8	19.7	
3.64	.81	.17	.46	2.60	.022	.025	.090	.040	33.4	63.5	28.8	7.7	
3.74	.81	.17	.31	3.06	.023	.017	.053	.069	31.3	67.4	24.3	8.3	
1.76	1.21	.17	.26	3.01	.011	.007	.085	.024	30.5	70.1	20.9	9.0	
3.44	1.01	.17	.31	2.45	.011	.008	.070	.065	29.4	66.1	21.9	12.0	
3.98	1.93	.17	.36	1.76	.013	.009	.068	.057	35.9	59.4	23.8	16.8	
3.44	2.13	.17	.31	2.24	.016	.007	.012	.039	32.6	66.0	20.3	13.7	
4.93	2.34	.21	.31	2.01	.030	.007	.076	.047	36.0	44.4	37.4	18.2	
5.10	1.60	-----	.80	-----	.300	.900	-----	-----	32.6	64.0	23.6	12.4	
8.00	3.60	-----	.90	-----	.300	.500	-----	-----	45.9	56.3	19.1	24.6	
7.80	4.30	.10	.40	-----	.400	.100	-----	-----	46.8	58.7	16.3	25.0	
5.20	3.10	.10	.30	-----	.600	.200	-----	-----	34.5	71.4	12.0	16.6	
2.80	1.60	.10	.20	-----	.700	.200	-----	-----	29.0	86.8	4.1	9.1	
4.40	3.10	.10	.30	-----	.600	.200	-----	-----	35.9	72.6	11.7	15.7	
4.00	2.60	.10	.20	-----	.700	.100	-----	-----	39.9	71.2	12.0	16.8	
3.30	2.50	.10	.20	-----	1.000	.100	-----	-----	38.8	-----	-----	-----	

county. Since the samples are from virgin areas, they analyze higher in total nitrogen and organic matter than similar soils that are cultivated. Comparison of data in table 8 with those on similar cultivated soils in an adjoining county indicates that cultivation has reduced total content of nitrogen by 730 pounds per acre and total organic matter by 22,800 pounds per acre.

The potential fertility of these soils is rather closely related to their texture. The sandier soils are lower in available plant nutrients than those of medium texture. The percentages of sand, silt, and clay in the soils tested are shown in table 8.

The capacity of soils to hold exchangeable cations, termed "cation-exchange capacity," or "base-exchange capacity," affects the fertility of soils. Cation exchange is the process whereby certain metallic cations or hydrogen move between the surface of the solid phase and the liquid phase in a soil. This exchange takes place in the clay-mineral fraction and the organic-matter fraction in a soil. The capacity for this exchange influences the availability of plant nutrients in a soil and the desirability of the soil as a medium for growth of plants. Plant nutrients held as exchangeable bases are readily available to plants but not readily leached from the soils. Normally, the higher the exchange capacity, the lower the loss of nutrients through leaching. Thus, cation-exchange capacity is an expression of the extent to which the soil is buffered, or protected, from rapid changes in supply of available plant nutrients. Sandy soils generally have a low exchange capacity; and clay and organic soils, a high exchange capacity.

The exchangeable cations that most affect plant nutrition are calcium, magnesium, sodium, and potassium. The amounts of these in the six soils tested are shown in table 8. Other cations are also present in these soils, but in smaller amounts. The different cations are held to the solid phase of a soil with different binding energies. Calcium is most tightly held; sodium and potassium, the least tightly.

Exchangeable sodium can drastically affect the suitability of a soil for agriculture. Calcium and magnesium are the principal cations in the soil solution of most soils in this area. But if soils come in contact with drainage water having a high content of sodium, the sodium cation becomes dominant in the soil solution and then replaces some of the calcium and magnesium on the solid soil phase. When sufficient sodium replaces calcium and magnesium, an alkali (or Solonetz) soil is formed. Exchangeable sodium is given for four soils in table 8. In the A₁ horizon, the percentage of exchangeable sodium among the exchangeable bases ranges from 0.74 to 3.24. The highest percentages are 10.49 and 11.39 in the B₃ and C horizons, respectively, of Bethany silt loam. These percentages are nearing an alkali condition. A soil with an exchangeable sodium percentage of 15 or more is considered an alkali soil.

Rainfall in this county has not been sufficient to remove a high percentage of bases and thus create acid soils. Where acidity is encountered, it is generally confined to surface layers. The Dougherty-Eufaula loamy fine sands, however, are acid. Their pH ranges from 5.4 to 5.7 in the upper 32 inches.

Glossary

Acidity. Acidity or alkalinity of soils is measured by pH. A pH of 7.0 indicates precise neutrality; larger numbers, alkalinity, and smaller numbers, acidity. Relative terms for pH are 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 alka-	7.9 to 8.4
Strongly acid.....	5.1 to 5.5	line.	
Medium acid.....	5.6 to 6.0	Strongly alkaline..	8.5 to 9.0
Slightly acid.....	6.1 to 6.5	Very strongly	9.1 and
Neutral.....	6.6 to 7.3	alkaline.	higher.

Aggregate (soil). Many fine particles held in a single mass or cluster, such as a clod, crumb, block, or prism.

Alkali (soil). Soil affected by saline salts, sodium, or both. A soil affected by saline salts is frequently called "white alkali"; one affected by sodium, "black alkali."

Alluvium. Sand, silt, or clay deposited by streams.

Animal month. The forage needed to keep a cow in good condition for 30 days.

Animal unit. A cow weighing approximately 1,000 pounds, live weight. On western range, an animal unit is 1 cow, horse, or mule, or 5 sheep or goats.

Base (engineering). Selected material, of planned thickness, used as foundation for road pavement.

Bedrock. The solid rock underlying soils and other earthy surface formations.

Blanket (engineering). Relatively thin, extensive layer of soil placed on the upstream floor of an embankment to retard seepage through the foundation.

Bottom land. Land bordering streams that may be flooded.

Calcareous. Containing lime.

Channel. That part of a natural stream where water normally flows.

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 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.

Claypan. A dense horizon, containing much clay, and normally very slowly permeable.

Clean tillage. Cultivation to prevent growth of all vegetation except the particular crop desired.

Coarse textured (soil). A sandy soil.

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 determines 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. 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.
- Continuous grazing.** Grazing, without interruption, throughout the season.
- Contour farming.** Conducting plowing, planting, cultivating, harvesting, and other field operations on the contour or at right angles to the natural direction of the slope.
- Cover crop.** A close-growing crop grown primarily for the purpose of protecting and improving the soil between periods of regular crop production.
- Cover (vegetation).** All plants, of all sizes and kinds, in an area, irrespective of their value for forage or other purposes.
- Cropland.** Land regularly used for production of crops other than forest crops and permanent pasture. Ordinarily includes land in rotation pasture, summer fallow, and orchards, and land normally used for crops but temporarily idle.
- Crop residue.** The portion of a plant or crop left in the field after harvest.
- Cropping system.** Growing of different crops on the same land, not necessarily in a rigidly defined sequence.
- Crust (soil).** The hard, brittle layer that forms on many soils when they dry.
- Deep plowing.** A tillage practice, generally used as a protective measure against wind erosion, whereby the finer textured materials in the subsoil are turned up and mixed with a coarser textured or sandy surface layer.
- Deflocculation.** The breakdown, or separation, of soil aggregates containing clay into individual particles.
- Deposition.** The accumulation of soil material dropped by wind or water. Alluvial fans, sand dunes, and accumulations at the foot of eroded slopes are examples of deposition.
- Desalinization.** Removal of salts from a saline soil, usually by leaching.
- Diverson terrace.** A channel with a supporting ridge on the lower side. It is constructed to intercept runoff, minimize erosion, and prevent excess flow to lower areas.
- Dryfarming.** Farming in semiarid or arid areas without irrigation; usually involves a system of fallowing and stubble mulching designed to improve the capacity of a soil to absorb and hold moisture.
- Dune.** A mound, or ridge, of loose sand piled up by the wind.
- Dust mulch.** The loose, dry surface layer on a cultivated field.
- Erosion.** The wearing away of the land surface by water, wind, and geological agents.
- Fertility (soil).** Presence in a soil of necessary elements, in sufficient amounts and proper balance, and available for growth of plants, when other factors, such as light, temperature, and tilth of the soil are favorable.
- Field crops.** General grain, hay, root, and fiber crops, as contrasted to truck (vegetable) and fruit crops.
- Fine textured (soil).** Predominantly silt and clay.
- Forage.** Unharvested plant material available for livestock, which may be grazed or cut for hay.
- Forb.** Any herbaceous plant that is neither grass nor sedge, including both legumes and nonlegumes.
- Granular (soil).** A soil composed largely of aggregates that have rather indistinct faces or edges.
- Grassed waterway.** Natural or constructed waterway, typically broad and shallow, covered with grasses that will protect the soil from erosion, and used to carry surface water away from cropland.
- Grazing capacity.** The maximum number of animal units per acre that a grazing area is able to support adequately without deteriorating.
- Habitat (wildlife).** The environment in which the life needs of a wild animal are supplied.
- Hardpan (soil).** A cemented, or hardened, soil horizon.
- Heavy (soil).** A fine-textured soil.
- Herb.** A plant having a stem that does not become woody but dies down to the ground annually after flowering.
- Herbicide.** A chemical used to kill plants, especially weeds.
- Horizon, soil.** A layer of soil, approximately parallel to the soil surface, that has characteristics produced by soil-forming processes. The relative positions of the several soil horizons, and their nomenclature, are as follows:
- A Horizon.** The master horizon consisting of (1) one or more mineral horizons in which there has been maximum accumulation of organic material; or (2) the surface or subsurface horizons that are lighter in color than the underlying horizon and which have lost clay minerals, iron, and aluminum, with resultant concentration of the more resistant minerals; or (3) horizons belonging to both of these categories.
- B Horizon.** The master horizon of altered material characterized by (1) an accumulation of clay, iron, or aluminum, with accessory organic material; or (2) blocky or prismatic structure together with other characteristics, such as stronger colors, that are unlike those of the A horizons or the underlying horizons of nearly unchanged material; or (3) characteristics of both of these categories. Commonly, the lower limit of the B horizon corresponds to the lower limit of the solum.
- C horizon.** A layer of unconsolidated material, relatively little affected by organisms and presumed to be similar to at least part of material in overlying layers in chemical, physical, and mineralogical characteristics.
- D horizon.** Any stratum underlying the C, or the B if no C is present, which is unlike the C, or unlike the material from which the solum has been formed.
- Humus.** Organic matter that has reached an advanced, more or less stable, stage of decomposition.
- Impervious (soil).** A soil resistant to penetration by water, and usually by air and roots.
- Infiltration (soil).** The downward entry of water into soil.
- Intensive cropping.** Maximum use of the land by means of frequent succession of harvested crops.
- Intermittent grazing.** Alternate grazing and resting of pasture and range for variable periods of time.
- Internal drainage (soil).** Movement of water through the soil profile. Relative terms used are *none*, *very slow*, *slow*, *medium*, *rapid*, and *very rapid*.
- Leaching.** The removal of soluble constituents from soils or other materials by percolating water.
- Legume.** Cultivated or native plant that serves as a host to microorganisms that are able to store nitrogen in nodules on the roots of the plants.
- Mapping unit.** Any soil, miscellaneous land type, soil complex, or undifferentiated soil group shown on the detailed soil map and identified by a symbol.
- Medium textured (soil).** A loamy soil.
- Mottled (soil).** Marked with spots of color. Mottling is usually associated with impaired drainage.
- Organic matter.** Plant and animal material, in or on the soil, in all stages of decomposition.
- Overgrazing.** Grazing so heavy it impairs future production of forage and causes deterioration through damage to plants, soil, or both.
- Parent material (soil).** The horizon of weathered rock or partly weathered soil material from which the soil was formed. The C horizon of the soil profile.
- Percolation (soil).** The downward movement of water through the soil, especially the downward flow of water in a soil saturated or nearly saturated.
- Permeable (soil).** Easily penetrated, as by water or air.
- Phase (soil).** A subdivision of the soil type that varies in characteristics not significant to its classification in the natural landscape, but significant to use and management.
- Plastic (soil).** Capable of being molded or modeled without rupture; not friable.
- Platy (soil).** A term for soil structure showing thin, horizontal plates, usually not well defined.
- Plow layer.** That part of the soil profile in which tillage takes place.
- Plowpan.** A compacted layer formed in the soil immediately below plow depth.
- Prismatic.** Type of soil structure in which the vertical axis is longer than the horizontal; vertical faces are well defined; aggregates are without rounded tops.
- Profile (soil).** A vertical section of the soil through all its horizons and extending into the parent material.

- Range.** Land that produces mainly native forage suitable for grazing by livestock.
- Range site.** An area of range sufficiently uniform in climate, soil, and topography to result in a particular climax vegetation.
- Relief.** Elevations or inequalities of the land surface, considered collectively.
- Runoff.** Surface drainage of rain or melted snow.
- Sand.** Individual rock or mineral fragments having diameters ranging from 0.05 to 2.0 millimeters. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.
- Series (soil).** A group of soils that have genetic horizons similar, except for the texture of the surface layer, as to differentiating characteristics and arrangement in the soil profile, and developed from a particular type of parent material.
- Silt.** Individual mineral particles of soil that range in diameter from the upper size of clay, 0.002 millimeter, to the lower size of very fine sand, 0.05 millimeter. Soil of the textural class called silt contains 80 percent or more of silt and less than 12 percent of clay.
- Single grain (soil).** A structureless soil in which each particle exists separately, as in dune sand.
- Slope.** The inclination of the land surface from the horizontal: Vertical distance, divided by horizontal distance, times 100. A slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.
- Soil.** The natural medium for the growth of land plants. A natural three-dimensional body on the surface of the earth, unlike the adjoining bodies. In this report "soil" is frequently used as a term equivalent to "mapping unit."
- Soil association.** A group of soils, with or without characteristics in common, that occur in a regular geographical pattern.
- Solum.** The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soils includes the A and B horizons.
- Structure (soil).** The aggregation of primary soil particles into compound particles, or clusters of primary particles, which are separated from adjoining aggregates by planes of weakness.
- Stubble mulch.** A protective cover provided by leaving plant residues of any previous crops as a mulch on the soil surface when preparing for and planting the following crop.
- Stubble mulching.** A type of tillage used in areas subject to wind erosion. Tillage implements loosen the subsoil and eradicate weeds but leave the crop stubble more or less undisturbed.
- Subgrade (engineering).** Material in cuts, fills, and foundations for fills that is placed immediately below the first layer of subbase, base, or pavement, and to such depth as may affect the structural design.
- Subsoil.** Technically, the B horizon of soils with distinct layers; roughly, that part of the profile below plow depth.
- Subsurface layer.** The layer next to the surface layer. Normally, a part of the A horizon.
- Summer fallow.** Tillage of uncropped land during summer to control weeds and store moisture for growth of a later crop.
- Surface soil.** The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches thick.
- Temporary pasture.** A pasture to provide grazing for only a short period, usually sown to annual plants.
- Texture (soil).** The relative proportions of the various size groups of individual soil grains in a mass of soil; specifically, the proportions of sand, silt, and clay.
- Tilth (soil).** The condition of the soil in its relation to the growth of plants. A soil in poor tilth is nonfriable, hard, and difficult to till.
- Type (soil).** A subdivision of the soil series based on the texture of the surface soil.
- Windbreak.** A barrier of trees and shrubs, usually in three or more rows, to reduce the force of the wind.
- Wind stripcropping.** The production of crops in long, relatively narrow strips, placed crosswise to the direction of the prevailing wind, without regard to the contour of the land.

GUIDE TO MAPPING UNITS

Map symbol	Soil name	Page	Capability		Range	
			Unit	Page	Site	Page
Ab	Alluvial and broken land.....	5	VIe-1	25	Red Clay Prairie.....	43
BeA	Bethany silt loam, 0 to 1 percent slopes.....	6	I-2	19	Claypan Prairie.....	40
Br	Broken alluvial land.....	6	Vw-1	24	Loamy Bottom Land.....	41
Ca	Carwile loamy fine sand.....	7	IIw-1	20	Sandy Prairie.....	43
Cv	Clayey saline alluvial land.....	7	IVw-1	24	Alkali Bottom Land.....	39
DeB	Dougherty-Eufaula loamy fine sands, undulating.....	7	IIIe-5	22	Deep Sand Savannah.....	40
DeC	Dougherty-Eufaula loamy fine sands, hummocky.....	7	IVe-4	23	Deep Sand Savannah.....	40
Dr	Drummond soils.....	8	Vs-1	24	Slickspot.....	44
Eu	Eufaula fine sand.....	8	VIs-3	25	Deep Sand Savannah.....	40
KfB	Kingfisher silt loam, 1 to 3 percent slopes.....	9	IIe-3	20	Loamy Prairie.....	41
KfC	Kingfisher silt loam, 3 to 5 percent slopes.....	9	IIIe-3	21	Loamy Prairie.....	41
KgD3	Kingfisher-Lucien complex, 5 to 8 percent slopes, eroded.....	9	IVe-2	23	Loamy Prairie.....	41
KhB	Kingfisher-slickspot complex, 1 to 3 percent slopes.....	9	IIIs-1	22	Slickspot.....	44
KhC	Kingfisher-slickspot complex, 3 to 5 percent slopes.....	10	IVe-5	23	Slickspot.....	44
KrA	Kirkland silt loam, 0 to 1 percent slopes.....	10	IIs-1	20	Claypan Prairie.....	40
Lc	Lincoln loamy fine sand.....	10	IIIe-5	22	Sandy Bottom Land.....	43
Ln	Lincoln sand.....	10	Vw-2	24	Sandy Bottom Land.....	43
NoA	Norge fine sandy loam, 0 to 1 percent slopes.....	11	I-2	19	Loamy Prairie.....	41
NoB	Norge fine sandy loam, 1 to 3 percent slopes.....	11	IIe-3	20	Loamy Prairie.....	41
NsB	Norge-slickspot complex, 1 to 3 percent slopes.....	11	IIIs-1	22	Slickspot.....	44
NsC3	Norge-slickspot complex, 3 to 5 percent slopes, eroded.....	11	IVe-5	23	Slickspot.....	44
PcA	Pond Creek silt loam, 0 to 1 percent slopes.....	12	I-2	19	Loamy Prairie.....	41
PcB	Pond Creek silt loam, 1 to 3 percent slopes.....	12	IIe-3	20	Loamy Prairie.....	41
PfB	Pratt loamy fine sand, undulating.....	13	IIIe-5	22	Deep Sand.....	40
PfC	Pratt loamy fine sand, hummocky.....	13	IVe-4	23	Deep Sand.....	40
PoA	Port clay loam, 0 to 1 percent slopes.....	13	I-1	18	Loamy Bottom Land.....	41
PsA	Port silt loam, 0 to 1 percent slopes.....	13	I-1	18	Loamy Bottom Land.....	41
PsB	Port silt loam, 1 to 3 percent slopes.....	13	IIe-1	19	Loamy Bottom Land.....	41
RcA	Renfrow clay loam, 0 to 1 percent slopes.....	14	IIs-1	20	Claypan Prairie.....	40
RcB	Renfrow clay loam, 1 to 3 percent slopes.....	14	IIIe-1	21	Claypan Prairie.....	40
Rg	Rough broken land.....	14	VIIIs-1	25	Breaks.....	39
Sa	Sand dunes, Lincoln material.....	14	VIIs-1	25	Sandy Bottom Land.....	43
ShA	Shellabarger fine sandy loam, 0 to 1 percent slopes.....	15	IIe-2	19	Sandy Prairie.....	43
ShB	Shellabarger fine sandy loam, 1 to 3 percent slopes.....	15	IIe-2	19	Sandy Prairie.....	43
ShC	Shellabarger fine sandy loam, 3 to 5 percent slopes.....	15	IIIe-4	21	Sandy Prairie.....	43
ShD3	Shellabarger fine sandy loam, 5 to 8 percent slopes, eroded.....	15	IVe-3	23	Sandy Prairie.....	43
Ta	Tabler clay loam.....	15	IIs-1	20	Claypan Prairie.....	40
Ts	Tabler-slickspot complex.....	15	IIIs-1	22	Slickspot.....	44
Tv	Tivoli fine sand.....	16	VIIs-2	25	Dune.....	40
VcB	Vernon clay loam, 1 to 3 percent slopes.....	16	IIIe-2	21	Red Clay Prairie.....	43
VcC3	Vernon clay loam, 3 to 5 percent slopes, eroded.....	16	IVe-1	22	Red Clay Prairie.....	43
Vr	Vernon soils and Rock outcrop.....	16	VIe-1	25	Eroded Red Clay.....	41
Wa	Wet alluvial land.....	16	Vw-3	24	Subirrigated Bottom Land.....	44
Ya	Yahola fine sandy loam.....	17	IIe-1	19	Sandy Bottom Land.....	43



Growth Through Agricultural Progress

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Nondiscrimination Policy

The U.S. Department of Agriculture (USDA) prohibits discrimination against its customers, employees, and applicants for employment on the basis of race, color, national origin, age, disability, sex, gender identity, religion, reprisal, and where applicable, political beliefs, marital status, familial or parental status, sexual orientation, whether all or part of an individual's income is derived from any public assistance program, or protected genetic information. The Department prohibits discrimination in employment or in any program or activity conducted or funded by the Department. (Not all prohibited bases apply to all programs and/or employment activities.)

To File an Employment Complaint

If you wish to file an employment complaint, you must contact your agency's EEO Counselor (<http://directives.sc.egov.usda.gov/33081.wba>) within 45 days of the date of the alleged discriminatory act, event, or personnel action. Additional information can be found online at http://www.ascr.usda.gov/complaint_filing_file.html.

To File a Program Complaint

If you wish to file a Civil Rights program complaint of discrimination, complete the USDA Program Discrimination Complaint Form, found online at http://www.ascr.usda.gov/complaint_filing_cust.html or at any USDA office, or call (866) 632-9992 to request the form. You may also write a letter containing all of the information requested in the form. Send your completed complaint form or letter by mail to U.S. Department of Agriculture; Director, Office of Adjudication; 1400 Independence Avenue, S.W.; Washington, D.C. 20250-9419; by fax to (202) 690-7442; or by email to program.intake@usda.gov.

Persons with Disabilities

If you are deaf, are hard of hearing, or have speech disabilities and you wish to file either an EEO or program complaint, please contact USDA through the Federal Relay Service at (800) 877-8339 or (800) 845-6136 (in Spanish).

If you have other disabilities and wish to file a program complaint, please see the contact information above. If you require alternative means of communication for

program information (e.g., Braille, large print, audiotape, etc.), please contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

Supplemental Nutrition Assistance Program

For additional information dealing with Supplemental Nutrition Assistance Program (SNAP) issues, call either the USDA SNAP Hotline Number at (800) 221-5689, which is also in Spanish, or the State Information/Hotline Numbers (<http://directives.sc.egov.usda.gov/33085.wba>).

All Other Inquiries

For information not pertaining to civil rights, please refer to the listing of the USDA Agencies and Offices (<http://directives.sc.egov.usda.gov/33086.wba>).