SOIL SURVEY

Cleveland County Oklahoma

Series 1942, No. 7

Issued October 1954

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

How to Use THE SOIL SURVEY REPORT

FARMERS who have worked with their soils for a long time know about soil differences on their own farms, and perhaps about differences among soils on the farms of their immediate neighbors. What they do not know, unless soil surveys have been made, is how nearly their soils are like those on experiment stations or other farms, either in their State or other States, where farmers have gained experience with new or different farming practices or enterprises. Farmers of Cleveland County can avoid some of the risk and uncertainty in trying new crop and soil management practices by using this soil survey report, for it maps and describes the soils in their county and therefore allows them to compare the soils on their farms with soils on which new developments have proved successful.

SOILS OF A PARTICULAR FARM

All the soils in Cleveland County are shown on the accompanying map. To learn what soils are on a farm (or any tract of land) it is first necessary to locate it on the map. Find the general locality the farm is known to be in by using township and section lines, and then use roads, streams, villages, dwellings, and other landmarks to locate boundaries. Remember that an inch on the map equals half a mile on the ground.

The next step is to identify the soils on the farm. Suppose, for example, one finds on a farm an area marked with the symbol Mb. Look among the rectangles in the margin of the map and find the one with Mb printed on it. Just above this rectangle is the name of the soil—McLain silty clay loam. Note the color of the rectangle. All areas of McLain silty clay loam, wherever they appear on the map, will be in this color.

What is McLain silty clay loam like, for what is it used, and to what uses is it suited? For this information turn to the section on Soil Descriptions. How productive is this soil? The answer will be found in table 7. Find in the left-hand column of this table the name McLain silty clay loam and then read in columns opposite the average estimated yields of different crops it can be expected to produce over a period of years. Compare these yields with those given in the table for other soils of the county.

What uses and management practices are recommended for McLain silty clay loam? For this information read what is said about use and management for this soil in the section on Soil Descriptions. Refer also to the section on Use and Management of Cleveland County Soils.

SOILS OF THE COUNTY AS A WHOLE

A general idea of the soils of the county is given in the section on The Soils of Cleveland County, which tells about the principal kinds of soils, where they are found, and how they are related to one another. After reading this section, study the soil map and notice how the different kinds of soils tend to be arranged in different parts of the county. These patterns are likely to be associated with well-recognized differences in type of farming, land use, and land use problems.

A newcomer to the county, especially if he considers purchasing a farm, will want to know about the climate; the types and sizes of farms; the principal farm products and how they are marketed; the kinds and conditions of farm tenure; availability of roads, railroads, and electric services; water supplies; industries of the county; and cities, villages, and population characteristics. Information about all these will be found in the section on General Nature of the Area and the section on Agriculture.

Those interested in how the soils of the county were formed and how they are related to the great soil groups of the world should read the section on Morphology and Genesis of Soils.

This publication on the soil survey of Cleveland County, Okla., is a cooperative contribution from the—

SOIL CONSERVATION SERVICE

and the

OKLAHOMA AGRICULTURAL EXPERIMENT STATION

Series 1942, No. 7 Issued October 1954

SOIL SURVEY OF CLEVELAND COUNTY, OKLAHOMA

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United States Department of Agriculture in cooperation with the Oklahoma Agricultural Experiment Station

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[1] The Division of Soil Survey was transferred to the Soil Conservation Service on November 15, 1952.

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CLEVELAND COUNTY, in the Osage Plains section of central Oklahoma, is an undulating to gently rolling plain with a general slope to the southeast. The climate is continental and humid. Agriculture is the only important industry, but some natural gas and oil are produced, mainly in the northern part of the county. The important crops are corn, cotton, oats, and wheat. More cattle are raised than any other livestock except poultry. Crop production is highest in the western part of the county near Norman, where a large proportion of the soil is well suited to crops and tractor-drawn machinery is used. In the eastern part a high percentage of the soils are unsuitable for crops or are of low fertility and produce low crop yields. To provide a basis for the best agricultural uses of the land, this cooperative soil survey was made by the United States Department of Agriculture and the Oklahoma Agricultural Experiment Station. Field work was completed in 1942, and, unless otherwise specifically indicated, all statements in this report refer to conditions in the county at that time.

GENERAL NATURE OF THE AREA

LOCATION AND EXTENT

Cleveland County is in central Oklahoma (fig. 1). Norman, the county seat, is 15 miles southeast of Oklahoma City. The county is

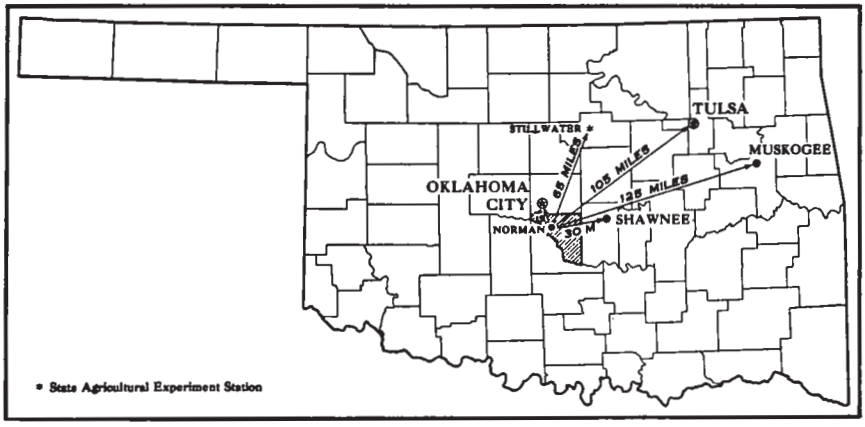


FIGURE 1.—Location of Cleveland County in Oklahoma.

almost triangular, with the Canadian River as its southwestern boundary. The total area is 559 square miles, including about 543 square miles of land and 16 of water.

PHYSIOGRAPHY, RELIEF, DRAINAGE, AND GEOLOGY

Cleveland County is in the Osage Plains section of the Central Lowland physiographic province.[1a] Its surface is that of an undulating to gently rolling southeastward sloping plain. The western and

[1a] FENNEMAN, N. M., PHYSIOGRAPHIC DIVISIONS OF THE UNITED STATES. (Map.) U. S. Geol. Survey. 1930.

northwestern parts of the county are prairie, and the eastern half is forested. The prairie areas are chiefly undulating to gently rolling, and the forested lands are gently rolling to rolling.

A series of undulating or nearly level benches or terraces occur in a strip 1 to 4 miles wide adjacent to the Canadian River. In places they are separated by rather steep southwest-facing escarpments. The terraces merge almost imperceptibly into the undulating uplands to the east. Except for the terrace escarpments, the undulating to gently rolling prairies of the western part of the county present few physiographic features other than broad very shallow valleys and nearly level low interstream divides.

The forested lands of eastern Cleveland County are more rolling, with broad fairly deep valleys and rounded or convex divides. In these areas nearly level land is confined almost entirely to stream bottoms.

Elevations[2] above sea level range from 1,320 feet about 3½ miles northeast of Moore in the northwestern part of the county to about 975 feet where the Little River leaves the county. The elevations of the principal towns are Norman, 1,158; Moore, 1,336; and Lexington, 1,083.

The western two-fifths of the county is drained by the Canadian River and its short tributaries. The eastern part is drained by the Little River, which heads in the county and flows eastward into the Canadian River about 44 miles east of the county line.

The Canadian River has a fall of 9 feet per mile. It has a broad sandy bed and is dry during much of the summer. The perennial streams—the Little River and Hog, Spring, and Pond Creeks—are fed by springs and do not go dry except during prolonged droughts.

Cleveland County is underlain by Permian red beds of the Paleozoic era. Three distinct formations of these rocks occur in the county. The highest, Duncan sandstone, is in the extreme northwestern part and consists of red soft calcareous sandstone. It is underlain by Hennessey shale, as are most of the prairie areas in the county except those of alluvium. Hennessey shale is red calcareous clay shale with a few thin beds of dolomite and sandstone. It is underlain by the Garber formation, which occupies the forested areas of eastern Cleveland County. The Garber formation consists of red sandstone with some beds of red clay shale that are from 2 to 10 feet thick.

Alluvial deposits from Pleistocene formations occur along the larger streams in the county. The largest area occupies a strip from 1 to 4 miles wide along the Canadian River.

WATER SUPPLY

A good supply of underground water is present in the sandy forested areas and in the areas of old alluvium adjacent to the larger streams. The depth to water usually ranges from 40 to 100 feet. It is at shallow depths in alluvial bottoms. A few flowing wells are present along the larger streams in the eastern part of the county.

Underground water is difficult to locate in the prairie areas underlain by the Hennessey shale, but water has been obtained in these areas at depths of 300 feet or more. The impervious character of this shale

[2] Data on elevations from United States Coast and Geodetic survey.

makes it well suited to hold water in ponds and lakes, and numerous artificial ponds and small lakes serve as good reservoirs for livestock and for recreational purposes.

NATIVE VEGETATION

On the prairies of western Cleveland County the native vegetation is dominantly little bluestem, or prairie beardgrass (*Andropogon scoparius*); bluejoint turkeyfoot, commonly called big bluestem (*A. gerardi*); side-oats grama (*Bouteloua curtipendula*); and buffalo grass (*Buchloe dactyloides*). Less important grasses on heavy-textured prairie soils are hairy grama (*Bouteloua hirsuta*) and blue grama (*B. gracilis*). On the moderately heavy textured prairie soils, the minor grasses are hairy grama, silver beardgrass (*A. saccharoides*), dropseed, and several others.

Short grasses, as buffalo grass and blue grama, stand pasturing better than tall grasses and are now dominant in many pastures, especially on heavier soils. Where pastures are overgrazed, the short grasses are gradually replaced by prairie three-awn (*Aristida oligantha*) and other unpalatable grasses and weeds.

The native vegetation on forested areas in the eastern part of the county is dominantly blackjack oak (*Quercus marilandica*) and post oak (*Q. stellata*), with minor proportions of hickory (*Carya tomentosa*) and persimmon (*Diosphros virginiana*). Red oak (*Q. Borealis* var. *Maxima*) occurs in addition to these near the bases of slopes where moisture conditions are more favorable. Some undergrowth of little bluestem occurs where the trees are scattered.

The native vegetation on alluvial bottoms includes the above mentioned trees with some bur oak (*Q. macrocarpa*), hackberry (*Celtis occidentalis*), American elm (*Ulmus Americana*), black walnut (*Juglans nigra*), pecan (*Carya pecan*), eastern cottonwood (*Populus deltoides*), willow (*Salix* sp.), sycamore (*Platanus occidentalis*), and wild grape (*Vitis* sp.). The undergrowth includes bluestems, Johnson grass (*Sorghum halopense*), Bermuda grass (*Cynodon dactylon*), and Canada wild-rye (*Elymus canadensis*).

Prairie three-awn grass, dropseed, little barley (*Hordeum pusillum*), bromegrass (*Bromus* sp.), sixweeks fescue (*Festuca octoflora*), red lovegrass (*Eragrostis secundiflora*), fall witchgrass (*Leptoloma cognatum*), hairy triodia (*Tridens pilosa*), hairy crabgrass (*Digitaria sanguinalis*), and several other grasses occur as weeds in abandoned fields and overgrazed pastures. Other annual weeds are pigweed, sunflower, cocklebur, horse nettle, buffalo-bur, sandbur, tick trefoil, and Texas croton.

GENERALIZED SOIL AREAS

The soils of Cleveland County form three general soil areas (fig. 2). These areas consist of related or similar soils having like agricultural use and developed under similar cover as a whole. This classification presents a broad picture of the areas of the county and conveys only general information. Those interested in more specific information are referred to other parts of the report and to the accompanying detailed soil map. The general soil areas are (1) soils of forested uplands, (2) soils of prairie uplands and high terraces, and (3) soils of low stream terraces and flood plains.

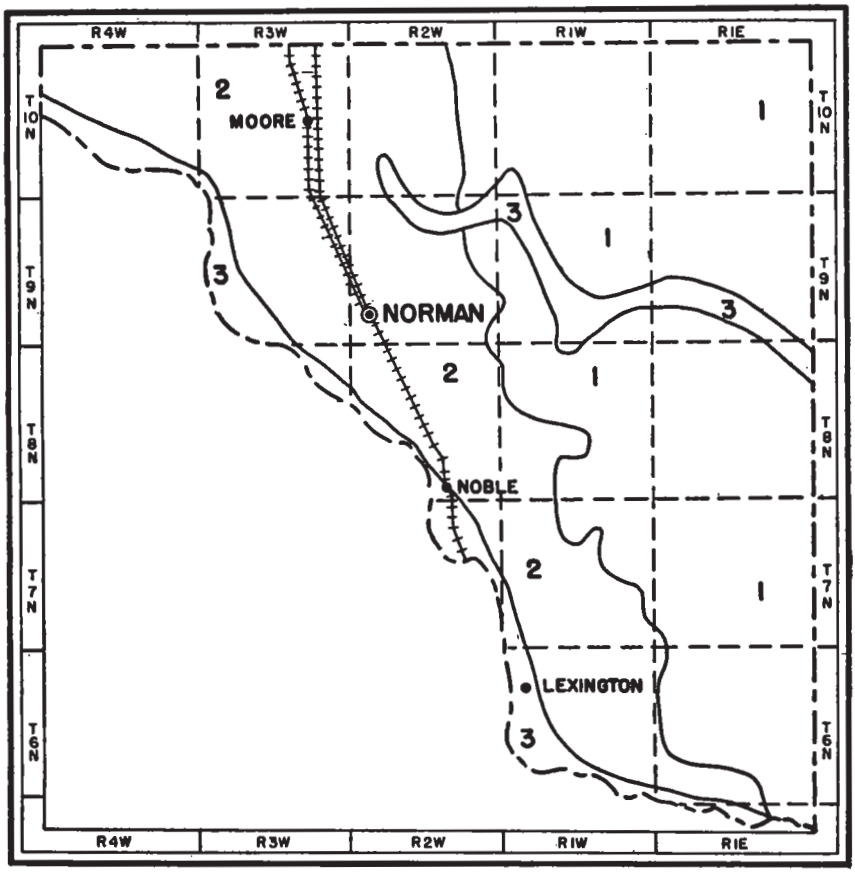


FIGURE 2.—Generalized soil areas of Cleveland County, Okla.:

1. Soils of forested uplands (Cross Timbers).
2. Soils of prairie uplands and high terraces (Reddish Prairies).
3. Soils of low stream terraces and flood plains (Bottom Land).

SOILS OF FORESTED UPLANDS

The soils of forested uplands occupy a broad belt covering approximately the eastern half of the county (pl. 1). These soils have developed mainly from red beds consisting of noncalcareous red sandstone and some shale. The relief is undulating to rolling, and surface drainage is rapid. The rate of runoff is high, and erosion is active on practically all cultivated areas. The native vegetation consists largely of small blackjack and post oaks that have a slow rate of growth and little economic value except for firewood or fence posts.

The soils are shallow to moderately deep and have light-colored friable, acid, leached surface layers with reddish-brown friable sandy clay or clay loam subsoils. They are of the Stephenville, Darnell, and Dougherty series. Low supplies of organic matter and essential plant nutrients result in low productivity, and crop yields under the usual management are low.

The principal crops are cotton, sorghums, and corn, but a small acreage on most farms is used for cowpeas, peanuts, vegetables, and fruits mainly for home use. A large part of this land was cleared and once cultivated, but most of it is now in abandoned-field pasture. Only a small proportion is suitable for or used as cropland. It is highly susceptible to erosion, and the more sloping areas have been seriously damaged by both sheet and gully erosion. Most of this land was never well suited for cropland. Small areas on gentle slopes that have not been seriously damaged, however, are suitable for cultivation under good management. Soils on these areas are responsive to management and will produce good yields if crop rotations including legumes, phosphate fertilizers, manure, and adequate erosion-control measures are used. Abandoned-field pastures and the more sloping eroded cultivated soils should be seeded to perennial grasses for pasture. Pastures need phosphate fertilizer and lime to increase the amount and nutritive value of forage.

SOILS OF PRAIRIE UPLANDS AND HIGH TERRACES

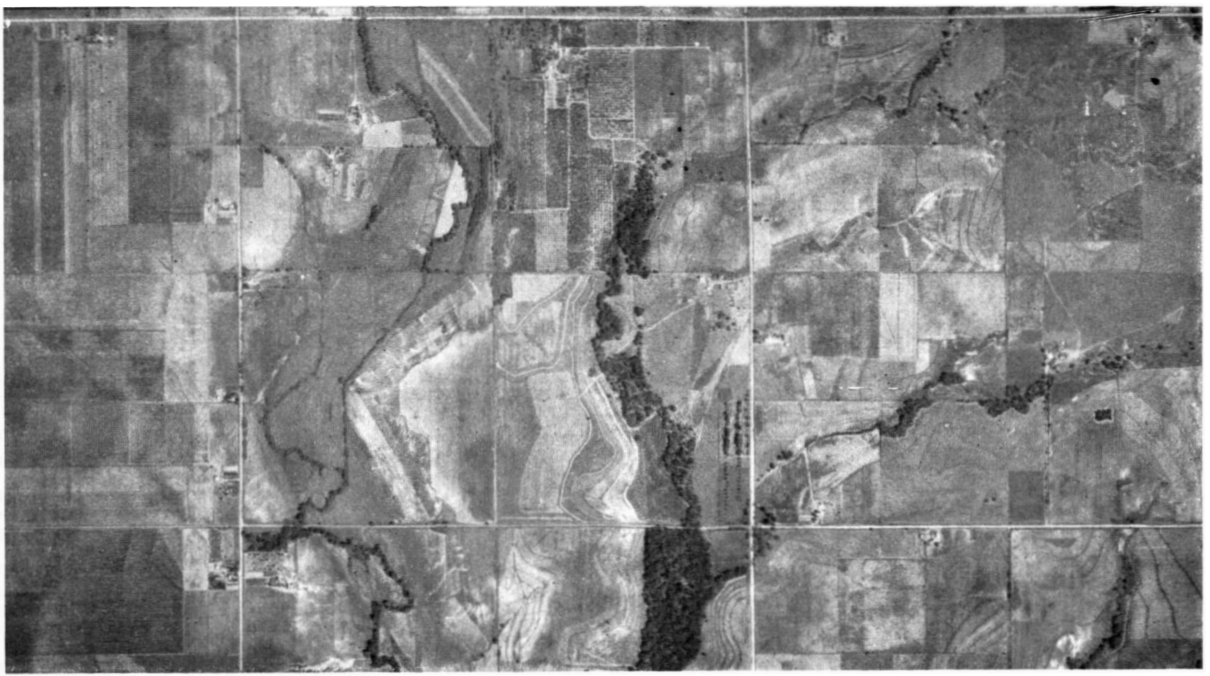
These soils ocupy the western part of the area and form an extensive prairie that extends from southeast to northwest across the west-central part of the county (pl. 2). The uplands of this area occur adjacent to and west of the forested uplands, and the high terraces occupy a narrow strip 1 to 5 miles wide along the western side of the uplands adjacent to the Canadian River. In most places the terraces merge with the uplands without a distinct line of separation.

The soils of these areas have developed under a grass cover and have many common characteristics and uses. They are the Renfrow, Kirkland, Zaneis, Chickasha, Vernon, Bethany, Vanoss, Minco, Norge, and Derby. They have developed from weakly calcareous shale and clay or sandy and silty clay of old alluvium or from a mantle of silty earth over clay and shale. Surface relief ranges mainly from nearly level to moderately sloping, but some strongly sloping narrow areas occur adjacent to stream channels. As a whole, relief is very favorable for farming. Surface drainage is slow to rapid, depending on the relief. The native vegetation is mainly bluestem, grama, and buffalo grasses, and some trees along the streams.

All but the Derby and Vernon soils have dark medium- to heavy-textured acid to neutral surface layers and reddish-brown or brown friable silt loam to heavy clay subsoils. They are moderately deep to deep soils, but somewhat droughty. The sloping areas are very susceptible to erosion under the usual management. However, they are naturally productive, have relief favorable for cultivation, and are responsive to management. Derby soils are of deep loose sands, and Vernon soils are shallow and in most areas severely eroded; both are unsuitable for cropland.

A large part of the prairie uplands and high terraces is cultivated. It is used for wheat, oats, cotton, sorghums, corn, and some alfalfa. The more sloping areas usually are still under a native grass and are used for pasture. Erosion damage is less serious than in the forested uplands, but in large part the more sloping cultivated soils have been affected. Most of this land can be cultivated successfully under good management, but some of the sloping eroded areas should be seeded to perennial grasses for pasture or hay. The use of crop rotations that

Vertical aerial view in eastern Cleveland County (secs. 7 and 8, T. 7, N. R. 1, E.): Tree-covered areas are largely Darnell-Stephenville fine sandy loams unsuited to cultivation; cleared areas on upland consist largely of Stephenville soils. Only a few areas on the upland are cultivated. A large part of the bottom land (Pulaski soils) is cultivated. Compare picture with soil map for location and extent of various soils.



Vertical aerial view of the prairie upland near Lexington (sec. 9 and parts of secs. 8 and 10, T. 6, N., R. 1, W.): Soils of old high terraces that developed from old alluvium are in middle and on left-hand side of picture, Vanoss soils on the smooth areas of upland, and Norge soils on the rolling and eroded areas of upland. Large orchard in top center of picture is on Vanoss and Norge soils. Soils on right-hand side of picture have developed from red beds. Compare picture with soil map for location and extent of the various soils.

include legumes and application of phosphate fertilizers will help maintain or increase crop yields. Contour cultivation and strip cropping will reduce runoff and erosion, but terraces are needed also on most of the sloping areas.

SOILS OF LOW STREAM TERRACES AND FLOOD PLAINS

These soils occur throughout the county, but only along the Canadian and Little Rivers are the areas large enough to be of agricultural importance. The low stream terraces lie usually a few feet above the flood plain and are occasionally inundated by shallow overflows from the streams or by runoff from higher lying areas. The soils are of the McLain, Reinach, Yahola, Lincoln, Pulaski, and Roebuck series and the Pulaski-Sweetwater complex. Most of them are deep and productive, but a few areas are poorly drained. Sandy alluvium, a land type, is included with this group of soils. The native vegetation is forest, mainly oak, cottonwood, willow, and elm.

These soils are variable in texture, drainage, reaction, and productivity. Overflow is irregular, and productivity is governed largely by the quantity of rainfall and frequency of flooding. During dry years high yields are usually obtained, but in extremely wet years low yields or even crop failures occur. The wider stream bottoms are largely cultivated, but many of the narrow bottoms and terraces are used for pasture. Corn is the principal crop, though some alfalfa, cotton, small grains, and sorghums are grown, especially on the low terraces. Most of these soils are farmed with higher lying soils, and the same type of equipment and power is used. Moderate to high yields can be produced for a long period under prevailing practices, but the use of crop rotations that include a legume will be beneficial in maintaining or increasing average yields.

WILDLIFE

Quail and doves are the principal upland game birds. Quail are plentiful in the eastern part of the county where natural cover is available. Migratory waterfowl, mainly ducks and geese, spend a short time in this section during fall and spring and provide sport near ponds and streams.

The principal fur-bearing animals are skunk, opossum, and muskrat. A few coyote, fox, and raccoon occur in the county, and rabbit and squirrel are common. Some fish, particularly catfish, bass, buffalo fish, carp, and crappie, are present in the perennial lakes and streams, and occasionally during floods catfish come up into the intermittent streams.

ORGANIZATION AND POPULATION

At the time of the Louisiana Purchase (1803) this part of Oklahoma was claimed by the Osage Indians, but the United States Government ceded it to the Creek Indians in 1825. Later it was settled by the Seminole Indians, and it was given to them in 1856. A few cattle ranches were established by white settlers about 1870, but the land was not formally opened for settlement until 1889. Cleveland County was organized in 1890 and settled almost overnight in units of 160 acres.

The population of the county is largely native American. Most of the early settlers came from Kansas, Arkansas, Texas, Missouri and Illinois. The population was 41,443 in 1950.

The four towns in the county are incorporated. Norman, the county seat, had 27,006 inhabitants in 1950; Moore, 942; Lexington, 1,176; and Noble, 724. These towns are in the western part of the county along the route of the Atchison, Topeka & Santa Fe Railroad. The rural population is fairly well distributed except in the thinly settled rougher areas in the eastern part of the county.

TRANSPORTATION FACILITIES

The Atchison, Topeka & Santa Fe Railroad connects the towns (except Lexington) with Oklahoma City and Fort Worth, Tex. United States Highway No. 77, a paved road, parallels the railroad across most of the county and also passes through Lexington. United States Highway No. 277, a paved road, crosses the western end of the county. State Highway No. 74, which is also hard surfaced, connects Norman with Oklahoma City. State Highway No. 9 is gravelled from Norman eastward to Tecumseh.

A few gravel-surfaced roads are in the area around the oil fields near Moore. Roads follow most of the section lines in the prairie areas, but they are less plentiful in the rolling forested lands of eastern Cleveland County. Most of the county roads are of graded earth and are not well maintained. Travel is difficult in wet weather except on the hard-surfaced and gravelled roads.

According to census reports for 1950, there were 1,555 farms in the county, 960 of which were on dirt or unimproved roads, 310 of which were on hard-surface roads, and 266 of which were on gravel roads. For all farms reporting, the average distance to the trading center most frequently visited was 8 miles. On the average, 2.1 miles of this 8 miles was on unimproved roads.

COMMUNITY, FARM, AND HOME IMPROVEMENTS

The western part of the county is well supplied with schools; each town has elementary and high schools. Elementary schools, most of which are of one or two rooms, are located in the rural areas. A rural consolidated school is located in the southeastern part of the county. Oklahoma State University and the State hospital are located at Norman.

Rural mail delivery reaches all settled parts of the county. Telephones are in common use in the western part of the county only. According to 1950 census figures, there were 541 telephones on farms. Electricity is available in the towns and on most of the farms in the western part of the county. A total of 1,291 farms had electricity in 1950. Natural gas is obtainable in all towns and on farms along the lines connecting the towns.

In the western part of the county farm buildings are of moderate size and are painted occasionally. Houses are of four- or five-room frame construction; barns are of moderate to small size but usually adequate. In the less productive areas in the eastern part of the county, farm buildings are small and houses are usually of two- or

three-room frame construction, rarely painted, and not kept in good repair. Fences are kept in fair repair in the western part of the county, but few are well maintained in the eastern part.

INDUSTRIES

Agriculture is the principal industry in the county. Cotton gins, compresses, and oil mills process the cotton crop. Elevators are located in all towns to provide storage for grains. The chief nonagricultural industry is the production of natural gas and oil.

CLIMATE

The continental and humid climate of the county is characterized by hot dry summers and relatively short usually mild winters. Several rather severe cold spells occur each winter; they are locally called "northers," for they are accompanied by strong northerly winds. They are followed by south winds and rising temperatures. The "northers" usually last only 2 or 3 days, but occasionally they come very close together and may last as much as 2 or 3 weeks. Strong northwesterly winds are frequent in March, but temperatures rarely drop below freezing and the cold is less intense than in December, January, and February. Spring and fall are both pleasant, though there is less wind and rain in fall than in spring. Periods of hot dry weather during the summer last a few days to several weeks and are accompanied by hot dry winds from the south. In the driest years these winds severely damage crops.

Prevailing winds are from the south except in December, January, and February, when they are from the north. The average wind velocity is 11 miles per hour.

Minimum temperatures of 10 or 15 degrees Fahrenheit are common in winter, and occasionally subzero weather occurs. Daily maximum temperatures of 105 degrees are common during the hottest part of summer.

Farm work can proceed throughout the year, but during the more severe "northers" and during the hottest days of summer very little field work is done.

The frost-free season averages 209 days—from April 8 to November 4. Frost has been recorded as early as October 9 and as late as May 1.

The mean annual precipitation is 33.31 inches, but it has ranged from 19.19 to 56.64 inches. The wettest months are May, June, April, and October; the driest are February, January, and December. According to average figures, the rainfall is fairly well distributed during the growing season, but actually it is very erratic from year to year and droughts of several weeks duration are common. About 27 periods of 30 consecutive days or more without 0.25 inch of rainfall occurred from 1895 to 1914.[3]

Table 1 gives the normal monthly, seasonal, and annual temperature and precipitation at the United States Weather Bureau station at Norman.

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[3] UNITED STATES DEPARTMENT OF AGRICULTURE. PRECIPITATION AND HUMIDITY. *In* Atlas of American Agriculture, pt. 2, Climate, sec. A (Adv. Sheets No. 5), 48 pp., illus. 1922.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Norman, Cleveland County, Okla.*

[Elevation, 1,158 Feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total for the driest year	Total for the wettest year	Average snowfall
	°F.	°F.	°F.	Inches	Inches	Inches	Inches
December	40.7	80	−3	1.61	1.05	1.65	0.7
January	38.0	81	−9	1.40	.55	.76	1.5
February	41.5	90	−17	1.18	1.53	2.75	1.6
Winter	40.1	90	−17	4.19	3.13	5.16	3.8
March	51.7	97	3	2.49	.47	.29	1.2
April	60.8	98	24	3.47	2.22	7.60	0
May	68.9	100	28	5.20	6.74	6.60	0
Spring	60.5	100	3	11.16	9.43	14.49	1.2
June	77.6	109	43	3.90	1.48	12.02	0
July	81.5	112	53	2.53	.31	1.86	0
August	82.0	114	47	2.74	2.14	1.88	0
Summer	80.4	114	43	9.17	3.93	15.76	0
September	74.7	106	32	3.21	.88	4.54	0
October	62.7	100	10	3.34	.76	14.81	0
November	50.7	91	5	2.24	1.06	1.88	.2
Fall	62.7	106	5	8.79	2.70	21.23	.2
Year	60.9	114	−17	33.31	[1] 19.19	[2] 56.64	5.2

[1] In 1901. [2] In 1923.

The sun shines about 55 percent of the possible time in winter, 65 percent in spring, 75 percent in summer, and 75 percent in fall.[4]

The average relative humidity at 2:00 p. m. local time in January is about 55 percent, in April 35 percent, July 45 percent, and October 45 percent.[5]

Local hailstorms are common but occur about once in 10 or 15 years on any particular farm. Destructive tornadoes occasionally occur but generally affect only narrow strips. Torrential rains sometimes damage crops and cultivated land in spring and early summer.

AGRICULTURE

EARLY AGRICULTURE

The earliest recorded agriculture was that done by Indians. They farmed small patches along the stream bottoms. A few cattle ranches

[4] UNITED STATES DEPARTMENT OF AGRICULTURE. TEMPERATURE, SUNSHINE, AND WIND. *In* Atlas of American Agriculture, pt. 2, Climate, sec. B (Adv. Sheets No. 7), 34 pp., illus. 1928.

[5] See footnote 3, p. 9.

were established about 1870, but the ranchmen cultivated only small acreages to provide food for their families. Shortly after the land was opened to settlement in 1889, there was some cultivated land on nearly every quarter section. It is reported that by 1895 more land was in cultivation than at the present time. The Atchinson, Topeka & Santa Fe Railroad, constructed in 1887, provided an outlet for farm products at the time of settlement.

CROPS

Corn, hay, cotton, oats, and wheat have been the principal crops in the county ever since settlement. Table 2 gives the acreage of the more important crops in the county during stated census years.

TABLE 2.—*Acreages of the principal crops and number of fruit trees and grapevines in Cleveland County, Okla., in stated years*

Crop	1919	1929	1939	1949
Corn:	*Acres*	*Acres*	*Acres*	*Acres*
For grain	33, 237	32, 898	21, 315	14, 379
Cut for forage, hogged, or used for other purposes	506	675	130	497
Oats, threshed	13, 056	11, 131	16, 784	6, 664
Wheat, threshed	18, 347	9, 149	8, 659	6, 541
Barley, threshed	482	135	4, 321	409
Grain sorghum, grain and forage	12, 550	16, 670	13, 366	9, 362
Peanuts grown alone	292	538	211	161
Cotton	37, 992	32, 039	11, 398	3, 897
Hay, all	13, 414	10, 793	12, 176	14, 419
Alfalfa	6, 786	3, 622	4, 214	5, 736
Small grain hay	782	298	284	478
Other tame hay	1, 876	3, 222	5, 082	4, 760
Wild grasses	3, 970	3, 651	2, 596	3, 445
Blackberries	54	93	99	15
	Number	*Number*	*Number*	*Number*
Peach trees	30, 575	22, 436	25, 487	12, 908
Apple do	67, 372	17, 733	10, 631	5, 592
Cherry do	1, 782	1, 639	5, 523	2, 046
Pear do	4, 123	3, 732	3, 733	2, 082
Pecan do	2, 400	5, 944	15, 641	11, 465
Grapevines	31, 329	40, 343	30. 405	5, 927

The acreage of corn, the principal feed crop, has exceeded that of any other crop except in 1919 when cotton brought exceptionally high prices. Corn was formerly grown on most of the arable soils of the county, but decreasing soil fertility in recent years has caused farmers to plant it only on alluvial bottom lands and stream terraces where soils are still productive. Yields ranged from 20 to 30 bushels an acre when the land was first cultivated, but now the average yield is about 14 bushels. Yields average about 8 bushels during unfavorable years and about 18 bushels in more productive years. The greater part of the crop is fed to livestock on the farms where it is grown.

Land for corn is plowed, or listed, late in fall or early in spring. The crop is usually planted between March 20 and April 10, in the furrow between the beds, and spaced 18 to 30 inches in the rows. It is cultivated about three times, usually hoed once, and harvested by hand in

the fall and early winter months. Most of the corn is "snapped"—the shuck is not removed from the ear as it is gathered. Corn commonly has been grown without fertilizer, but the use of fertilizer is increasing rapidly. Corn usually follows cotton or small grains in the prairie section, and cowpeas or other special crops in the sandy forested section. The corn earworm is the principal pest, but chinch bugs also cause damage when small grains are grown nearby.

The acreage in cotton has decreased rapidly since 1919. Average yields have also decreased considerably since early days when yields of 200 to 300 pounds of lint an acre were common. Yields are now much lower and range from about 150 pounds for the county during unproductive years to 250 pounds during very favorable ones. Considerable cotton was formerly raised in the eastern part of the county, but low yields caused by decreasing soil fertility and damage from erosion have caused much of this land to be abandoned. As a result, most of the cotton is now produced in the western part of the county. Cotton is ginned locally and compressed at Norman. Most of it is shipped to Houston, Tex. The cottonseed is processed locally, and most of the cake or meal is fed to cattle in the county during winter.

The land for cotton is plowed late in winter or early in spring. The crop is planted about May 1 to 20. It is cultivated four or five times and is "chopped" by hand and usually hoed once thereafter. Picking usually starts the latter part of August and is finished about the first of December. The boll weevil causes severe damage during wet seasons, and flea hoppers cause some shedding of squares. Occasionally the leafworm eats the leaves of the crop before it is mature and reduces yields.

The acreage of wheat has decreased considerably since 1919, partly as the result of acreage-restricting programs but mainly because of declining yields. The greater part of the wheat is grown in the western and northwestern parts of the county; little is grown in the sandy sections. Yields are usually 10 or 12 bushels an acre but range from 8 to 16. Yields of 15 to 20 bushels were common in earlier days.

Land for wheat is usually plowed during summer, disked and harrowed early in fall, and seeded about October 1 to November 15 at the rate of 1 bushel an acre. The crop is combined about June 15 to 30. Green bugs (aphids) and army worms occasionally cause much damage. Leaf and stem rusts reduce yields during wet seasons.

The acreage of oats has decreased markedly since 1945. Most of the oats are grown in the western and northwestern parts. Yields have decreased considerably since 1890. Oats are fed to livestock on the farm or sold to elevators or neighboring farmers.

Oats are attacked by the same insects and diseases as wheat. Land to be planted to oats is plowed late in fall or early in winter and is planted about March 15 to 30.

Grain sorghums, sorgo, barley, alfalfa, fruits, and wild hay are minor crops. Sorghums are gradually replacing corn on upland areas. Alfalfa is grown on alluvial bottoms and low stream terraces.

Considerable fruit was raised in the early days, but the number of all fruit trees except cherries and pecans has decreased.

Vegetables are raised mainly for home use, but they are the principal source of income on a few farms. The chief commercial vegetable crops are potatoes, sweetpotatoes, watermelons, cantaloups, and toma-

toes. Most of these are grown on the high terraces in the western part of the county. In 1949, 50 acres of Irish potatoes and 40 acres of sweetpotatoes were grown for sale and home use. In that year a total of 408 acres was in vegetables harvested for sale. Green beans, melons, sweet corn, and tomatoes were the leading truck crops. The acreage of cantaloups, muskmelons, and watermelons totaled 200, and next in total acreage was tomatoes, at 111 acres.

FERTILIZER

Most of the fertilizer is used for potatoes, watermelons, cantaloups, and tomatoes. Its use for other crops is increasing. In the period July 1, 1948, to June 30, 1949, the Oklahoma Agricultural Experiment Station reported a total of 1,485 tons of all fertilizer materials and grades used in the county. About 85 percent of this was phosphate, including rock phosphate; about 10 percent was mixed fertilizer, mostly 5–10–5; and the rest was fertilizer high in nitrogen. The use of lime has been increasing, probably at about the same rate as that of fertilizer.

LIVESTOCK AND LIVESTOCK PRODUCTS

Table 3 gives the number of livestock on farms in Cleveland County in stated years.

TABLE 3.—*Number of livestock on farms in Cleveland County, Okla., in stated years*

Livestock	1920	1930	1940	1950
Cattle	17, 826	19, 249	[1] 17, 580	22, 661
Horses	7, 012	4, 428	[1] 3, 841	2, 036
Mules	3, 571	3, 029	[1] 1, 714	181
Sheep	833	1, 101	[2] 2, 544	732
Swine	13, 587	12, 283	[3] 8, 778	9, 339
Chickens	132, 235	[1] 140, 732	196, 673	[3] 86, 047

[1] Over 3 months. [2] Over 6 months. [3] Over 4 months.

The number of cattle exceeds that of any other class of livestock except poultry. Most of the cattle are dual-purpose and beef breeds, but about one-third of these are milked. Of the total cattle and calves reported in the 1950 census, 6,947 were kept mainly for milk production. Most of the cattle are grade Shorthorns and Herefords, but the bulls are usually purebred. In recent years a few herds of Holstein-Friesian and Jersey have been established in the county. Most of the Hereford cattle are kept in the forested areas in the eastern part of the county and in the rougher prairie areas nearby. The dual-purpose and dairy breeds are mainly in the western part of the county near the markets and better roads.

Whole milk sold increased from 14,284,609 pounds in 1944 to 19,479,839 pounds in 1949. Most of the cattle are marketed at Oklahoma City, but some are sold at local auctions. The number of cattle and calves sold increased from 7,243 in 1939 to 9,446 in 1949.

Horses and mules have rapidly decreased in number since 1930. They are being replaced by tractors.

Duroc, Chester White, and Poland China are the principal breeds of hogs. A few farmers have purebred herds. Hogs are sold at Oklahoma City and at local auctions, and replacements are raised on the farms.

Most farms have poultry flocks for home consumption. In 1950 there were 86,047 chickens on farms. In 1949, 44,669 chickens and 438,409 dozens of eggs were sold. In 1949, 2,603 turkeys were raised on 64 farms.

LAND USE

Since 1945 there has been a decrease in the proportion of the county in farms and in the number of farms, but a slight increase in the average size of farms. In the 1950 census the percentage of land in farms was 74.8, the number of farms was 1,555, and the average size was 168.4 acres. The most common size of farm is 140 to 179 acres. The smaller farms are near Norman and other towns where land prices are higher.

In 1949 the land in farms was distributed as follows:

	Acres
Cropland harvested	60,455
Cropland not harvested and not pastured	16,664
Cropland used only for pasture	18,804
Woodland pastured	61,427
Woodland not pastured	11,428
Other pasture (not cropland and not woodland)	79,055
All other land	14,005

FARM TENURE

Farm tenancy increased rapidly from 1890 to 1910, then rose more slowly, and then declined. In 1950 nearly 66 percent of the farms were operated by owners and part owners, and 34 percent by tenants. Only five farms were worked by managers.

The most common system of rental is called "third and fourth," in which the landlord furnishes land, houses, and fences, and in return receives one-fourth of the cotton and one-third of the other crops produced.

In the less common type of lease—share cropping—the landlord furnishes land, houses, fences, teams, feed, implements, and half the seed and fertilizer, and in return gets half the crop. "Standing," or cash, rent is used to some extent in the eastern part of the county.

The farmer and his family perform most of the work except on the larger farms where additional labor is hired during harvest.

FARM INVESTMENTS

The land values are highest in the western part of the county on the low alluvial terraces and in the vicinity of Norman. Soils on high alluvial terraces rank next in value, followed by those of upland prairies and alluvial bottoms. The lowest priced lands are mainly in the timbered areas in the eastern part of the county. These lands, considering their low productivity, are relatively high priced because income from oil leases bolsters their value.

According to the 1950 census, there are 1,092 tractors and 773 trucks on farms in the county. Tractor-drawn machinery is concentrated

mainly in the western part. Four-horse farm equipment also is common in the western part. The equipment on small-grain farms includes a tractor, three- or four-bottom gang plows, disk harrow, spike-tooth harrow, drill, wagon, and a small combine or binder. General farms, in addition to having all the equipment found on small-grain farms except a combine, usually have a planter and cultivator. Farms in the eastern part of the county have walking plows, walking or riding cultivators, and planters, wagons, harrows, and miscellaneous hand tools. Most of this machinery is of the one- or two-horse type.

TYPES OF FARMS

The 1950 census classifies the farms of the county by type as follows:

	Number
Field crop farms:	
Cash grain	45
Cotton	75
Other field crop	5
Fruit and nut	5
Dairy	221
Poultry	20
Livestock other than dairy and poultry	307
General farms:	
Primarily crop	50
Primarily livestock	30
Crop and livestock	65
Miscellaneous and unclassified farms	732

SOIL SURVEY METHODS AND DEFINITIONS

Soil surveying consists of examining, classifying, and mapping of soils in the field. The soil scientist walks over the area at intervals not more than one-quarter mile apart and bores into the soil with an auger or digs holes with a spade. Each such boring or hole shows the soil to consist of several distinctly different layers, called horizons, which collectively are known as the soil profile. Each of these layers is studied carefully for the things about it that affect plant growth.

The color of each layer is noted. There is usually a relationship between the darkness of the color of the topmost layer of soil and its content of organic matter; the darker color as a rule indicates higher organic matter. Streaks and spots of gray, yellow, and brown in lower layers generally indicate poor drainage and poor aeration. Soil colors change with moisture; they are darker when wet. When describing or comparing soils the dry color is generally used.

Texture—the content of sand, silt, and clay in each layer—is determined by the feel of the soil when rubbed between the fingers and is checked by mechanical analyses in the laboratory. Texture determines to a considerable extent the quantity of moisture the soil will hold available to plants, whether plant nutrients or fertilizers will be held by the soil or will be leached out, and the difficulty or ease of cultivating the soil.

Soil structure, or aggregation, and the number of pores or open spaces between soil particles determine the permeability or perviousness of the soil, and consequently the ease with which plant roots penetrate and water and air enter the soil.

Consistence, or the tendency of the soil to crumble or to stick together, determines the degree of difficulty that will be encountered

in keeping the soil open and porous under cultivation. Consistence covers such soil characteristics as hardness, friability, plasticity, stickiness, compactness, toughness, and cementation.

Surface soil ordinarily refers to the surface layer, which is usually 5 to 10 inches thick. The layer just below the surface soil is the subsoil; the layer beneath the subsoil, the substratum.

The kind of rocks and the parent soil material that develops from these rocks affect the quantity and kind of plant nutrients found in the soil. Simple chemical tests are made to show the degree of acidity of the soil, and the depth to bedrock or to compact layers is determined. The quantity of gravel or rocks that may interfere with cultivation, the steepness and kind of slope, the quantity of soil lost by erosion, and other external features are observed.

On the basis of all the characteristics here listed, soil areas much alike in the kind, thickness, and arrangement of layers are mapped as one soil type. Some soil types are subdivided on the basis of slope, erosion, stoniness, or some other factor. For example, if a soil type has slopes ranging from 2 to 10 percent, two subdivisions of the type may be mapped—one, gently sloping (2 to 5 percent), and the other, sloping (5 to 10 percent). A soil type that has lost part of the surface soil in places by erosion is subdivided also. For instance, Norge silt loam occurs mostly on slopes ranging from 1 to 8 percent and some areas of it are eroded. It is mapped as Norge silt loam, gently sloping (1- to 4-percent slopes), Norge silt loam, sloping (4- to 8-percent slopes), and Norge silt loam, sloping, eroded. The sloping eroded part has lost about half the surface soil and is of lower productivity and slightly more droughty than the uneroded part. If no subdivisions are needed to indicate differences within a soil type that are important to agriculture or to use of the land, no subdivisions are made and the soil is designated by the type name, as McLain clay. The slope of a soil, the frequency of outcropping bedrock found in it, the extent of its erosion or the artificial drainage used on the soil, for example, are characteristics that might cause a soil type to be divided.

Two or more soil types may have similar profiles; that is, the soil layers may be nearly the same, except that the texture of the surface layer may differ. As long as the other characteristics of the soil are similar, these soils are considered to belong in the same soil series. A soil series therefore consists of all soil types, whether the number be only one or several, that are, except for the texture of the surface layer, about the same in kind, thickness, and arrangement of layers.

The name of a place near where a soil series was first found is chosen as the name of the series. Thus, Renfrow is the name of a series of slightly acid reddish soils that were first found in Grant County. Two types of the Renfrow series are found—Renfrow silt loam and Renfrow silty clay loam. Each of these soil types has a different surface soil texture, as its name indicates. Renfrow silt loam is subdivided into two units because of slope. Areas of the soil having 1- to 3-percent slopes are designated as gently sloping; those having 3- to 7-percent slopes are designated as sloping.

When very small areas of two or more kinds of soil are so intricately mixed they cannot be shown separately on a map of the scale used,

they are mapped together, and the areas of the mixture are called a soil complex. Pulaski-Sweetwater fine sandy loams is a complex of Pulaski fine sandy loam and Sweetwater fine sandy loam in Cleveland County.

Bare rocky mountainsides, riverwash, or rough broken land that have little true soil are known as miscellaneous land types and are not designated with series and type names but are given descriptive names, as Rough broken land (Norge soil material), Sandy alluvium, and Oil-waste land.

The soil type, or a subdivision of the soil type, is the mapping unit in soil surveys. It is the unit or the kind of soil that is most nearly uniform and has the narrowest range of characteristics. For this reason land-use and soil-management practices can be more definitely specified for a soil type or its subdivision than for broader groups of soils that contain more variation.

THE SOILS OF CLEVELAND COUNTY

The mature soils of the county are of the Reddish Prairie and the Red-Yellow Podzolic great soil groups. The soils as a whole are moderately productive, but many are low in available phosphorus, lime, and nitrogen. As a rule the cultivated soils are very low in organic matter and have only moderate supplies of phosphorus and lime. Most soils have dark or moderately dark surface layers and sandy clay or clay subsoils with a high water-holding capacity. Many, however, absorb water slowly. The soils have developed from red shale and sandstone (red beds) and from ancient and recent alluvium. As a whole, the soils of the county are well drained, and sloping areas in cultivated fields are subject to erosion.

The soil series of the county are listed alphabetically in table 4, and the character of parent material, native vegetation, depth to parent material, relief and drainage, and character of surface soil and subsoil are given for each.

SOIL DESCRIPTIONS

In the following pages, the soils, identified by the same symbols as are used in the soil map, are described in detail and their agricultural relations and customary use and management are discussed.

The estimated average yields given in the discussion on use and management of each soil is based on customary, or average, management. This management includes the use of very little fertilizer, few erosion-control measures, and crop rotations with a very small proportion of legumes. The same crop, however, is seldom grown on the same area for more than two consecutive years. Row crops are cultivated three or four times but little hoeing is done except for cotton, and small grain stubble land usually is not plowed immediately after harvest. Yields for individual years may vary greatly from these estimates because of weather differences and other factors, such as insects. These same estimated average yields are given in table 7 along with another set of yield estimates for a higher level of soil management.

The location and distribution of the soils are shown on the soil map and their acreage, proportionate extent, and use are given in table 5.

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TABLE 4.—*The soil series of Cleveland County, Okla., and some of their important distinguishing characteristics*

Soil series	Character of parent material	Native vegetation	Depth to parent material (root-feeding zone)	Relief and drainage	Character of surface soil	Character of subsoil
Bethany	Silty clay loams or clays; alkaline to calcareous.	Prairie grasses, mainly bluestem, grama, and buffalo.	Very deep	Level to gently sloping; slow, but adequate.	Dark grayish brown; acid; friable.	Brown; friable in upper part; heavy and tight below.
Chickasha	Sandy shale and sandstone; usually calcareous.	Prairie grasses, mainly bluestem and grama.	Deep	Gently sloping; moderate to rapid.	Dark grayish brown to brown; acid; friable.	Brown sandy clay or sandy clay loam; friable; acid.
Darnell	Sandstone; slightly acid to neutral.	Scrub forest of blackjack and post oaks.	Shallow to very shallow.	Sloping to rolling; rapid	Grayish brown; friable to loose; acid.	None—thin formation of sandy loam over sandstone.
Derby	Wind-reworked sands; not calcareous; usually acid.	Coarse grasses and scattered trees.	Very deep	Undulating to hummocky, some dunes; rapid, mainly through the soil.	Brown loamy fine sand; neutral to slightly acid.	Light-brown loamy fine sand; neutral to slightly acid.
Dougherty	Old alluvial sandy clays and clay loams; not calcareous.	Forest, mainly blackjack and post oaks.	Deep	Sloping to gently rolling; moderate to rapid.	Light brown; friable; acid.	Reddish-brown or red sandy clay loam; acid.
Kirkland	Clay or shale; calcareous.	Prairie grasses, mainly bluestem, grama, and buffalo.	do	Gently sloping; moderate from surface, very slow internally.	Dark brown; friable, but crusty when dry; acid.	Dark-brown or grayish-brown dense clay; acid to alkaline.
Lincoln	Sandy alluvium; calcareous.	Forest, mainly elm and cottonwood.	do	Level flood plain; high water table much of the time.	Grayish brown or light brown; sandy; friable; calcareous.	Light brown or yellowish brown; sandy; calcareous.
McLain	Alluvial silty earths, silts to clays; calcareous.	Forest, mainly elm, oak, ash, and pecan.	do	Level, rarely flooded high bottoms; slow, but well drained.	Dark brown; granular; friable; neutral.	Reddish-brown silty clay or clay; friable; neutral to alkaline.
Minco	Wind-laid deposits of silts and sandy loams; generally calcareous.	Coarse grasses with some trees in places.	Very deep	Nearly level to sloping; rapid.	Brown or dark brown; friable; about neutral.	Brown or reddish brown; about neutral.
Norge	Alluvial or aeolian silty and sandy clays; weakly calcareous.	Coarse prairie grasses	Deep	Gently sloping to sloping; rapid.	Dark brown or reddish brown; friable; about neutral.	Red or reddish-brown sandy clay; firm to friable; neutral.
Pulaski	Sandy alluvium; not calcareous.	Forest, mainly elm, willow, ash, and pecan.	do	Level flood plain; moderate, adequate for crops.	Reddish brown; friable; neutral to slightly acid.	Light reddish-brown, somewhat stratified sandy loam and loam; neutral to slightly acid.
Reinach	Alluvial sandy and silty earths; calcareous.	Forest, mainly elm, hackberry, oak, pecan, and some grasses.	do	Level, rarely flooded high bottoms; moderate.	Reddish brown to brown; friable; neutral to calcareous.	Reddish-brown sandy loam to loam; friable; calcareous.
Renfrow	Shales and clays; calcareous.	Prairie grasses, mainly bluestem, grama, and buffalo.	Medium deep	Gently sloping to sloping; rapid.	Dark brown to dark reddish brown; friable; slightly acid.	Reddish-brown or red firm clay; crumbly; about neutral.

Roebuck	Clayey alluvium; calcareous.	Forest, mainly elm, willow, ash, sycamore, Osage-orange, oak, cottonwood, and hackberry.	Deep	Level flood plain; very slow.	Reddish brown; crumbly; calcareous to neutral.	Reddish-brown clay mottled with light gray; calcareous.
Stephenville	Sandstone; slightly acid to neutral.	Forest, mainly blackjack and post oaks.	Medium deep	Gently sloping to sloping; rapid.	Grayish brown to brown; friable; acid.	Reddish-brown or red sandy clay loam; friable; porous; acid.
Sweetwater	Sandy and clayey alluvium; neutral to calcareous.	Coarse water-loving grasses and willows.	Deep	Nearly level flood plains; very slow; high water table.	Dark grayish brown to dark brown; friable; neutral.	Dark-gray or dark grayish-brown clay or sandy clay; weakly alkaline to calcareous.
Vanoss	Alluvial silty and sandy earths; calcareous.	Mainly prairie grasses with scattered trees.	Very deep	Nearly level to gently sloping; moderate, well drained.	Grayish brown to dark brown; friable; slightly acid to neutral.	Dark brown silty clay loam; friable; porous; neutral to weakly alkaline.
Vernon	Shales and clays; calcareous.	Prairie grasses, mainly bluestem, grama, and buffalo.	Shallow to very shallow.	Gently to strongly sloping; rapid.	Reddish-brown or dark reddish brown; friable; neutral to calcareous.	Reddish-brown clay; slowly permeable; calcareous; thin to very thin.
Yahola	Silty or sandy alluvium; calcareous.	Forest, mainly elm, pecan, ash, oak, hackberry, and cottonwood.	Deep	Level flood plain; moderate.	Brown or reddish brown; friable; neutral to calcareous.	Reddish-brown or reddish-yellow silt loam to sandy loam; stratified; calcareous.
Zaneis	Sandstone or sandy shale; neutral to alkaline.	Prairie grasses, mainly bluestem and grama.	Medium deep	Gently to moderately sloping; rapid.	Reddish brown to brown; friable; slightly acid.	Reddish-brown to red silty clay or clay; friable; porous; neutral to alkaline.

TABLE 5.—*Total acreage, proportionate extent, and use of Cleveland County, Okla., soils in 1940*

Soil	County total	Proportionate extent	Cropland	Idle	Pasture	Woodland	Miscellaneous	Total in cultivation
	Acres	*Percent*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Percent*
Bethany silt loam:								
Level	15, 200	4. 4	12, 200	180	1, 420	----------	1, 400	80
Gently sloping	600	. 2	400	--------	70	----------	130	67
Chickasha very fine sandy loam:								
Gently sloping	2, 400	. 7	1, 800	210	370	10	10	75
Gently sloping, eroded	300	(1)	200	50	50	----------	----------	67
Darnell-Stephenville fine sandy loams	19, 200	5. 5	100	30	8, 800	10, 260	10	. 5
Derby loamy fine sand:								
Sloping	800	. 2	200	120	450	30	----------	25
Dune phase	1, 100	. 3	50	50	930	70	----------	. 4
Dougherty fine sandy loam:								
Gently sloping	700	. 2	500	100	70	30	----------	71
Sloping	900	. 3	200	70	250	370	10	22
Sloping, eroded	1, 700	. 5	800	400	500	----------	----------	47
Strongly sloping	800	. 2	10	10	530	250	----------	1. 3
Kirkland silt loam:								
Gently sloping	13, 400	3. 9	9, 700	230	3, 230	----------	240	72
Gently sloping, eroded	2, 700	. 8	2, 300	300	80	----------	20	85
Lincoln very fine sandy loam	1, 700	. 5	800	60	810	30	----------	47
McLain clay	1, 500	. 4	1, 400	10	70	20	----------	93
McLain silty clay loam	4, 900	1. 4	4, 400	60	260	50	130	90
McLain soils, saline phases	300	(1)	300	--------	----------	----------	----------	100
Minco silt loam:								
Gently sloping	2, 400	. 7	2, 000	140	240	10	10	83
Sloping	2, 800	. 8	1, 600	270	900	20	10	57
Minco fine sandy loam:								
Gently sloping	2, 400	. 7	1, 900	160	310	20	10	79
Sloping	2, 000	. 6	1, 300	220	450	20	10	65

See footnote at end of table.

Norge silt loam:								
Gently sloping	600	.2	500	50	30	----	20	83
Sloping	2,600	.7	1,200	40	1,200	20	140	46
Sloping, eroded	2,900	.8	2,300	420	180	----	----	79
Oil-waste land	100	[1]	----	100	----	----	----	----
Pulaski fine sandy loam	23,700	6.8	10,700	1,430	9,550	2,020	----	45
Pulaski-Sweetwater fine sandy loams	1,000	.3	400	40	340	220	----	40
Reinach silty clay loam	2,700	.8	2,500	50	130	20	----	93
Reinach silt loam	5,300	1.5	4,900	40	270	70	20	92
Reinach fine sandy loam	2,700	.8	2,100	130	440	10	20	78
Renfrow silt loam:								
Gently sloping	9,900	2.8	6,000	250	3,500	----	150	61
Sloping	8,400	2.4	1,400	90	6,730	----	180	17
Renfrow silty clay loam, sloping, eroded	10,700	3.1	7,900	1,650	1,150	----	----	74
Roebuck clay	2,100	.6	1,200	230	350	310	10	57
Rough broken land (Norge soil material)	800	.2	10	----	530	260	----	1.3
Sandy alluvium	3,300	.9	60	1,060	2,100	50	30	1.8
Stephenville fine sandy loam:								
Gently sloping	14,100	4.1	2,500	850	6,960	3,640	150	18
Sloping	66,700	19.2	3,000	810	20,580	42,150	160	4
Sloping, eroded	46,900	13.5	8,200	5,500	33,090	110	----	17
Vanoss silt loam:								
Nearly level	13,200	3.8	11,400	160	1,100	10	530	86
Gently sloping	800	.2	700	60	40	----	----	88
Vernon clay loam:								
Sloping	19,500	5.6	4,200	1,230	13,910	10	150	22
Moderately steep	8,200	2.4	20	10	8,150	10	10	2.4
Yahola silty clay loam	700	.2	500	60	80	60	----	71
Yahola silt loam	19,000	5.5	12,300	220	3,630	2,850	----	65
Zaneis very fine sandy loam:								
Gently sloping	500	.2	200	10	280	----	10	40
Sloping	1,600	.5	200	10	1,380	----	10	13
Sloping, eroded	2,000	.6	1,200	450	350	----	----	60
Total	[2] 347,800	100.0	127,750	17,620	135,840	63,010	3,580	----

[1] Less than 0.1 percent.

[2] This acreage is less than the one given in the 1950 census because smaller bodies of water were classed as land in the census.

Bethany silt loam, level (0–1% slopes) (Bb).—This dark deep noncalcareous soil of the prairies is not extensive but occupies a few fairly large areas totaling 15,200 acres northwest of Norman (pl. 3, *A*). Surface and internal drainage are both very slow, but the soil is adequately drained for all crops commonly grown. It has a high water-holding capacity and absorbs most of the precipitation, but crops are sometimes damaged during long droughts. One reason is that plants are unable to obtain water fast enough from the clay in the lower subsoil layers when the soil moisture content is low. Erosion is not a problem.

The surface soil—to a depth of about 15 inches—is a dark grayish-brown or dark-brown granular slightly acid silt loam that tends to crust on drying but is easily kept loose and granular under a wide range of moisture content. This grades into the upper subsoil, a dark-brown or grayish-brown porous granular soil of slightly acid silty clay loam. This upper subsoil, 4 to 8 inches thick, is neither tight nor hard, even when extremely dry, and is easily penetrated by moisture, air, and plant roots. The upper subsoil grades into a lower subsoil of brown firm blocky clay that continues with little change to depths of 40 or 50 inches. Next in profile is brown heavy noncalcareous clay mottled with yellow and reddish brown, which grades at depths of 6 to 8 feet into alkaline to calcareous reddish silty clay or silty shale. This shale may be of residuum or of ancient water-laid materials.

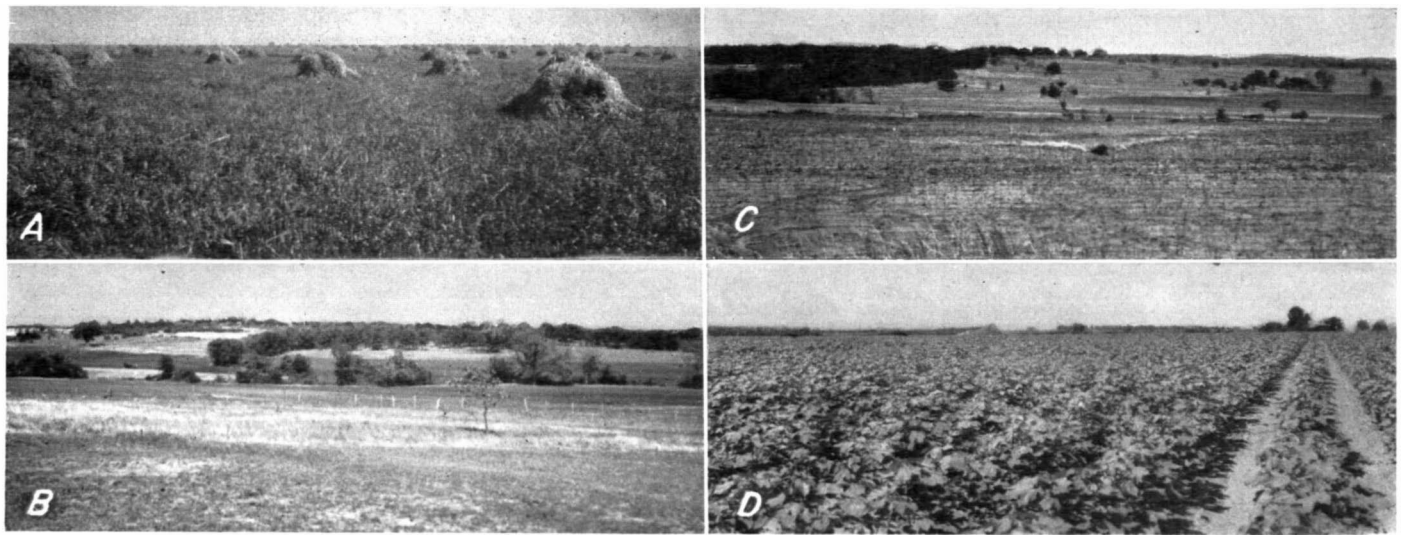
Use and management.—Bethany silt loam, level, is moderately productive and fairly well supplied with organic matter, but crop yields can be increased by using phosphate fertilizer and crop rotations that include legumes. By estimate, wheat occupies 25 percent of the cultivated acreage, oats 25 percent, corn 10 percent, cotton 15 percent, and alfalfa, grain sorghum, and miscellaneous crops the rest. Average yields under customary management are about as follows: 16 bushels of wheat, 30 of oats, 17 of corn, and 180 pounds of lint cotton an acre. Native pastures now consist largely of buffalo grass and have a carrying capacity [6] of one cow to about 5 acres.

Bethany silt loam, gently sloping (1–3% slopes) (Ba).—The small areas of this inextensive soil, which total only 600 acres, occur in association with large areas of the level Bethany silt loam. Except for having a slightly thinner surface soil and greater slopes, it is similar to the level Bethany silt loam. Its surface soil is 10 to 15 inches thick but averages about 12. The greater relief results in more rapid runoff and considerably greater susceptibility to erosion. Erosion is active in cultivated fields but has not progressed far enough to damage the soil appreciably or to reduce crop yields greatly.

Use and management.—The principal crops and acreages used for them are about the same as on level Bethany silt loam, but yields are slightly lower, mainly because more water is lost through runoff. In addition to the practices recommended for level Bethany silt loam, contour cultivation and strip crops [7] should be used to reduce runoff

[6] Carrying capacity is based on a 6- to 8-month grazing period, with supplemental feed during winter and long dry periods.

[7] Strip crops, or strip cropping, as used in this report, includes field strips also. Strip crops are narrow bands or strips of erosion-resisting crops planted on the contour with alternate bands of row crops. The strips are usually a minimum of about 30 feet wide, or about one-third the width of the row crop area between the strips. Field strips are much wider and are planted approximately at right angles to the slope.



A, Characteristic relief of Bethany silt loam, level.
B, Forested areas of Darnell-Stephenville fine sandy loams along ridge in background; Stephenville fine sandy loam, gently sloping, in foreground.
C, Sheet erosion on Stephenville fine sandy loam, gently sloping, in foreground; abandoned-field pasture on Stephenville fine sandy loam, sloping, eroded, in background.
D, Typical area of Vanoss silt loam, nearly level, showing lack of relief and vigorous growth of crops.

and erosion. Fields that have long slopes[8] or that receive runoff from higher lying areas should be terraced. If practically all the rainfall is retained on the soil, this phase should be as productive under good management as Bethany silt loam, level.

Chickasha very fine sandy loam, gently sloping (1–4% slopes) (CA).—This inextensive well-drained soil occurs mainly in the southeastern part of the county and occupies a total of 2,400 acres. It is a dark friable soil of moderate natural productivity and is well suited to most of the crops commonly grown in the area.

The surface soil, to a depth of about 12 inches, is dark-grayish brown or dark-brown friable acid very fine sandy loam. This layer is easily worked and does not crust on drying. It grades through a 2- or 3-inch transition layer into the subsoil, which is brown friable acid sandy clay or sandy clay loam slightly mottled with yellowish red in the lower part. This subsoil is readily penetrated by plant roots and moisture and has a fair water-holding capacity. Below depths of 36 to 40 inches the subsoil grades into a friable brown or reddish-brown sandy clay consisting of partly weathered sandy red beds. At depths of about 60 to 80 inches below the surface this is underlain by reddish-brown sandstone or weakly consolidated sandy shale or packsand of neutral to weakly calcareous reaction.

Use and management.—An estimated 20 percent of the cultivated soil is in oats, 30 percent in grain sorghums, 15 percent in cotton, 10 percent in wheat, 10 percent in corn, and the rest in cowpeas, peanuts, Sudan grass, and vegetables.

Approximate yields under ordinary management are 25 bushels of oats, 18 of sorghums, 10 of wheat, 15 of corn, and 170 pounds of lint cotton an acre. About 4 acres of native pasture will provide grazing for one cow if supplemental feed is supplied during winter and long dry periods.

The soil is not well supplied with plant nutrients but is very responsive to management. Increased yields can be obtained by the application of phosphate and nitrogen fertilizer and lime and by the use of crop rotations that include legumes. The more sloping areas need contour cultivation, strip cropping, and terracing to reduce runoff and erosion. These practices also will increase yields by aiding crops to withstand dry periods.

Chickasha very fine sandy loam, gently sloping, eroded (1–4% slopes) (CB).—This soil is similar to Chickasha very fine sandy loam, gently sloping, but because of erosion it has a thinner surface soil. It occurs in a few small areas that total only 300 acres and is mainly in the southeastern part of the county. The dark grayish-brown very fine sandy loam surface soil ranges from 5 to 8 inches in thickness. Otherwise the soil is like Chickasha very fine sandy loam, gently sloping. Shallow gullies and rills are common. A few small included areas are badly gullied and have lost all of the original surface soil, leaving the sandy clay subsoil exposed.

Use and management.—The cultivated areas of this soil are used for about the same crops and are farmed in the same manner as the gently sloping soil. The estimated average yield for oats is 18 bushels; sorghums, 12 bushels; corn, 10 bushels; and cotton, 120 pounds of lint.

[8] Long slopes, as used here, indicate a slope length of about 400 feet or more.

Some small areas have been returned to pasture along with sloping eroded areas of associated soils.

This soil has been seriously damaged by erosion but is still good cropland if well managed. Erosion control measures, including terracing, contour cultivation, strip cropping, and use of winter cover crops, are needed to reduce further soil losses. If the same soil management recommended for the gently sloping soil and adequate erosion control measures are used, crop yields can be increased 30 to 60 percent and further deterioration reduced to a minimum. Areas returned to pasture should be fertilized with phosphate and seeded or sodded to Bermuda grass.

Darnell-Stephenville fine sandy loams (4–8% slopes) (DA).—This unit consists of small areas of shallow Darnell fine sandy loam and of moderately deep Stephenville fine sandy loam. The two soils occupy such small areas and are so intermixed that it is not possible to separate each soil on a map of this scale. This soil complex is moderately extensive and occupies a total of 19,200 acres in association with large areas of Stephenville fine sandy loam. The relief is rolling; gradients range from 2 to 15 percent, but the greater portion has slopes of 4 to 8 percent. Drainage is rapid from the surface and internally.

The Darnell soil, occupying 55 to 65 percent of the delineated areas, has a grayish-brown surface soil 3 to 5 inches thick and a pale-brown subsurface layer of fine sandy loam or loamy fine sand. This subsurface continues to a depth of about 15 inches and rests on reddish-brown sandstone. The sandstone is slightly acid to neutral, and all layers above it are slightly acid.

The intermixed Stephenville fine sandy loam has a grayish-brown surface layer about 3 inches thick, with a light-brown or reddish-brown friable fine sandy loam subsurface layer about 8 inches thick. The subsoil is reddish-brown friable permeable sandy clay loam that rests on reddish-brown sandstone bedrock lying 30 to 40 inches below the surface. The soil is slightly acid, but the underlying bedrock is slightly acid to neutral. Outcrops of bedrock and a few large fragments of sandstone occur on the surface of the steeper slopes.

Use and management.—These soils are of low productivity and, if cultivated, very susceptible to erosion. The small cultivated areas, which comprise less than 1 percent, are used for cowpeas, sorghums, peanuts, and vegetables along with the adjoining Stephenville soils. Nearly all areas are used for forest or woodland pasture that has a carrying capacity of about 16 acres for each cow during the grazing season. The native vegetation is mainly scrub blackjack oak (pl. 3, *B*) with a thin undergrowth of bluestem. This soil complex as a whole is unsuitable as cropland, but small areas on gentle slopes can be used for special crops if well managed.

Derby loamy fine sand, sloping (3–7% slopes) (Dc).—This brown sandy soil occurs in small areas on high terraces along the Canadian River in association with soils of the Minco and Vanoss series. It occupies a total of 800 acres.

The surface is undulating to gently rolling; gradients range up to about 12 percent but are dominantly 3 to 7 percent. There is practically no runoff from the gentle slopes, and little from the steeper slopes,

as water sinks rapidly into the porous sandy soil. Considerable soil, however, is moved by wind in cultivated fields. The native vegetation is mainly bluestem and Indian grasses, with a scattered growth of sand plum, cottonwood, oak, and elm trees.

The surface soil to a depth of about 10 inches is brown loamy fine sand which grades into light-brown or light reddish-brown loamy fine sand several feet thick. The underlying material below 5 or 6 feet is brown or reddish-brown loamy sand or sandy loam. The surface soil and subsoil are neutral to slightly acid, but the surface 1 to 3 inches is weakly calcareous in places because of recent deposition by wind.

Use and management.—Derby loamy fine sand, sloping, has low productivity. About 45 percent of the cultivated land is planted to sorghums, 20 percent to corn, 20 percent to cotton, and the rest to cowpeas, peanuts, watermelons, grapes, fruits, and vegetables. Idle areas support a thin cover of three-awn and other annual grasses and weeds. The estimated average acre yield of corn is 6 bushels; sorghum, 8 bushels of grain or ¾ ton of fodder; and cotton, 75 pounds of lint.

Crop yields can be increased by using mixed fertilizers and barnyard manure and by turning under green manure crops of cowpeas or other legumes. Wind erosion and the damage to seedling plants by the cutting action of blowing sand particles can be reduced by leaving stubble on the soil or crop residues on the surface until the young plants are well established, by alternating row crops with strips of thick growing crops, and by increasing the organic-matter content of the soil. Late planting of some crops after the spring winds have abated also helps to reduce wind damage.

This soil is probably best suited to pasture, or to the production of grapes or special crops if intensive measures are used to prevent soil blowing and to maintain or increase fertility. Native pastures have a carrying capacity of about 8 acres for each cow if supplemental feed is provided during winter. These pastures can be improved by controlled grazing to permit natural reseeding and the establishment of a better cover.

Derby loamy fine sand, dune phase (8–20% slopes) (Db).—This soil closely resembles sloping Derby loamy fine sand but occupies low dunes and hummocks. It occurs in small areas along the Canadian River in association with Minco and other Derby soils and occupies a total of 1,100 acres. Wind has caused the characteristic dunelike configuration; the dunes are relatively low and are now stationary. Slopes are short and steep. Soil blowing of any consequence occurs only where the vegetation has been removed. The natural vegetation consists of a thin stand of bunchgrasses—mainly bluestem, Indian, three-awn, and sand dropseed—and a scattered growth of oak, elm, chittam, and sand plum.

Use and management.—This soil is unsuited to crops and is used almost entirely for pasture, which has a carrying capacity of one cow to about 12 acres if supplemental feed is provided during winter and long dry periods. Grazing should be controlled to maintain the grass cover and prevent soil blowing.

Dougherty fine sandy loam, gently sloping (2–3% slopes) (Dd).—This is light-colored soil developed under forest on high nearly level to gently sloping terraces along the Canadian River Valley in the

southeastern part of the county. The total extent is 700 acres. Slopes reach a maximum of about 4 percent but are dominantly 2 to 3 percent. The native vegetation is blackjack and red oaks, hickory, and a scant growth of bluestem grasses.

The 2- to 4-inch surface soil is light-brown friable medium to slightly acid fine sandy loam that grades into light-brown friable acid fine sandy loam about 10 inches thick. In cultivated fields the surface layer is 6 to 8 inches thick and is pale brown. The surface soil grades into the subsoil of reddish-brown or red friable permeable acid sandy clay loam that continues to several feet. This is underlain by reddish-yellow moderately sandy alluvium, somewhat stratified and acid to weakly alkaline.

Use and management.—Although its inherent fertility and organic matter are low, Dougherty fine sandy loam, gently sloping, responds to management and produces well when fertilized. It absorbs moisture rapidly, has a moderately high water-holding capacity, and is not droughty. A few of the more sloping cultivated areas have been damaged somewhat by erosion, but erosion is not a serious problem and can be controlled easily under good management.

Woodland pastures have a carrying capacity of one cow to about 12 acres; Bermuda grass pastures, one cow to about 5 acres if supplemental fed is provided in winter or during long droughts. About 45 percent of the cultivated acreage is cropped to sorghums, 30 percent to cotton, 10 percent to corn, and the rest to peanuts, cowpeas, fruits, and vegetables. Average yields are 10 bushels of grain sorghum or 1½ tons of fodder, 10 bushels of corn, and 110 pounds of lint cotton an acre.

Productivity can be increased 50 to 100 percent by using phosphate fertilizer, barnyard manure, crop rotations, winter legumes, and contour cultivation. Strip crops and terraces can be used where erosion control is difficult. The carrying capacity and nutritive value of Bermuda grass pastures can be increased by using phosphate and nitrogen fertilizer and overseeding with lespedeza or other adapted pasture legumes.

Dougherty fine sandy loam, sloping (4–7% slopes) (DE).—This soil is similar to Dougherty fine sandy loam, gently sloping, but has a thinner surface layer and is more sloping. The fine sandy loam surface soil is about 10 inches thick in virgin areas but is slightly thinner where cultivated. The soil occupies a total of 900 acres, mainly in the southeastern part of the county. Although slopes reach a maximum of 12 percent, they are less than 7 percent in at least three-fourths of the area. Drainage is rapid, and considerable rainfall runs off after the natural cover is removed. Both sheet and gully erosion are active on cultivated fields, and some of the more sloping areas are moderately to severely eroded.

Use and management.—The cultivated areas of this soil are planted principally to cotton, corn, sorghums, cowpeas, peanuts, fruits, and vegetables. The average yield of corn is 7 bushels; grain sorghum, 8 bushels or 1¼ tons of fodder; and lint cotton, 90 pounds an acre. Woodland pastures have a carrying capacity of one cow to about 12 acres; Bermuda grass pasture, about 6 acres for one cow, if supplemental feeding is done during winter and long droughts.

This soil is of low natural productivity and very susceptible to erosion, but moderate yields can be obtained over a long period if effective measures for reducing runoff and erosion and maintaining fertility are used. Practically all cultivated land should be terraced, and careful attention should be given to the protection of terrace outlets. Contour cultivation, winter cover crops, legumes, and other recommended management practices for the gently sloping soil should be used also. The more eroded and gullied areas on which good management is not practical should be removed from cultivation and seeded or sodded to pasture. Under careful management, yields can be increased as much as 50 to 70 percent, but because of the expense and difficulty of maintaining soil fertility and controlling erosion, this soil should not be used for row crops if other land is available.

Dougherty fine sandy loam, sloping, eroded (4–8% slopes) (DF).—This inextensive soil—similar to the sloping soil but having a surface layer thinned by erosion—occurs in the southeastern part of the county. It occupies a total of only 1,700 acres. The surface soil is but 3 to 6 inches thick in most places, and the subsoil is exposed in many small areas. The surface is cut by numerous gullies, and in some places the soil is so severely eroded and gullied that cultivation is practically impossible. Gradients range from 3 to 12 percent, but the greater part has slopes of about 4 to 8 percent.

Use and management.—An estimated 50 percent of the cultivated soil is planted to sorghums, 30 percent to cotton, and the remainder to Sudan grass, cowpeas, peanuts, fruits, and vegetables. Crop yields are variable, the yield depending on the thickness of the surface soil and frequency of gullies. Estimated crop yields are 6 bushels of grain sorghum, 5 bushels of corn, and 60 pounds of lint cotton an acre. Pastures have a carrying capacity of one cow to about 12 acres during the grazing season. Idle areas support a thin cover of three-awn and other annual grasses and weeds, but bluestem grass and lespedeza are becoming established on most areas.

This soil is usually so sloping and eroded that it is not suitable for cultivation; however, some of the less sloping areas that are not severely gullied can be used for crops under careful management. Because of the expense and difficulty in controlling erosion and maintaining or increasing productivity, this soil should not be used for crops if other land is available. Good pastures can be established on it by plowing in gullies, diverting outside water, and seeding or sodding to Bermuda grass and lespedeza. Phosphate should be used on pastures, and in some cases mixed fertilizers and lime will be beneficial in establishing and maintaining a good cover of grasses and legumes.

Dougherty fine sandy loam, strongly sloping (7–15% slopes) (DG).—Areas of this soil occur adjacent to small streams and along the escarpment bordering the flood plain or lower terraces of the Canadian River. It occupies a total of only 800 acres. It is similar to Dougherty fine sandy loam, sloping, but has a thinner surface soil and is more sloping. The fine sandy loam surface soil ranges from 6 to 10 inches in depth, but averages about 8 inches, and the sandy old alluvial parent material lies 2 to 3 feet below the surface.

Use and management.—Practically none of this soil has been cultivated, and many areas are under a native forest cover of small post

oak, blackjack oak, hickory, and elm. This soil is unsuitable for crops and its best use is for woodland or pasture. Good pastures may be established on cleared areas by applying phosphate fertilizer, but careful management is needed to maintain a good cover and to keep erosion at a minimum. Uncleared areas probably should be left as woodland.

Kirkland silt loam, gently sloping (1–3% slopes) (KA).—This is the principal "hard land" or "tight land" type of the prairies and it occupies fairly large areas in the northwestern and, to slight extent, the southwestern parts of the county. The total area is 13,400 acres. It is a dark slightly acid claypan soil developed on gentle slopes from calcareous reddish clay and shale under a cover of bluestem, grama, and buffalo grasses. Surface drainage is slow to moderate, but internal drainage is very slow because of the heavy dense slowly permeable clay subsoil layers. The water-holding capacity of this soil is high, but water is released very slowly to plants, and crops often suffer from drought during July and August. Erosion is not a serious problem, but some shallow gullies and rills indicate that considerable runoff and some erosion occur on the more sloping cultivated areas.

The surface soil to a depth of about 12 inches is a dark-brown or grayish-brown moderately friable slightly acid silt loam. The lower part is slightly heavier, and in places the aggregates have a faint coating of light gray. The surface of fields is crusty and hard when dry, but the soil is easily maintained in a friable condition if cultivated when slightly moist. The subsoil is dark-brown dense blocky slightly acid clay. It is extremely hard when dry and separates into dense subangular aggregates or clods ½ to 1 inch in diameter. Below about 24 to 30 inches, the subsoil is slightly less dense and grades into slightly lighter colored brown clay mottled with reddish brown and containing a few small concretions of calcium carbonate. This layer grades into reddish-brown or brown calcareous clay or shale below about 70 inches.

The lower subsoil is variable from place to place and ranges from dark brown to brown, with or without mottling of reddish brown or gray. Nearly level areas are darker, and in these the upper subsoil ranges from dark grayish brown to dark brown to depths of 24 to 36 inches. Small areas, locally known as slick spots, are present in a few sloping somewhat eroded areas. These spots are indicated on the map by symbol and are described in the section on Morphology and Genesis of Soils. Such areas are practically worthless for crops, and no practical treatment has been found to reclaim them.

Use and management.—Although a moderately fertile soil, Kirkland silt loam, gently sloping, has lost some of its original productivity as a result of continuous cropping. Little or no attempt has been made to maintain the fertility or to improve the tilth by the use of fertilizers or legumes in the cropping system. About 30 percent of the cultivated land is planted to oats, 30 percent to wheat, 10 percent to cotton, 5 percent to corn, and the rest to barley, sorghums, Sudan grass, and cowpeas. Under customary management average acre yields are 25 bushels of oats, 12 bushels of wheat, 150 pounds of lint cotton, 12 bushels of corn, and 15 bushels of grain sorghums. Native pastures,

mainly of buffalo and grama grasses, have a carrying capacity of one cow for about 4 acres during the grazing season.

This soil is not highly susceptible to erosion, and profitable yields probably can be obtained for a long time under prevailing management. However, experiments on similar soils at Stillwater in Payne County indicate that profitable increases in crop yields can be obtained by using phosphate fertilizer, lime, and crop rotations including legumes. Contour cultivation and strip cropping aid in reducing runoff, and terraces should be used on the more sloping areas.

Kirkland silt loam, gently sloping, eroded (1–3% slopes) (KB).—Small areas of this soil occur in close association with Kirkland silt loam, gently sloping. It differs from the gently sloping soil mainly in having a thinner surface soil. The total area is 2,700 acres. Much of the original surface soil has been removed by accelerated erosion caused mainly by runoff from adjacent higher lying areas.

The brown or grayish-brown silt loam surface soil averages 5 inches in thickness but ranges from almost none to 8 or 10 inches. Gullies are common but not so numerous as to prevent successful cultivation of most of this soil. More slick spots that produce no crop are present than on the gently sloping soil and are partly responsible for the low productivity. The thin surface soil does not absorb much rainfall in a short period; consequently, runoff and erosion are greater than from soils with thicker more permeable surface layers. Lower crop yields result from the loss of soil and moisture, especially during the drier seasons when moisture is barely adequate even on the deeper soils.

Use and management.—About 30 percent of the cultivated soil is planted to wheat, 30 percent to oats, 10 percent to grain sorghums, 15 percent to cotton, and the rest to barley, cowpeas, Sudan grass, and sorghum. The estimated average yield of wheat is 6 bushels; oats, 16 bushels; grain sorghum, 10 bushels; and cotton, 100 pounds of lint an acre.

If this soil is kept in cultivation, careful management and adequate erosion control measures are necessary to prevent further deterioration. Terracing, contour cultivation, strip cropping, and use of cover crops will aid in reducing soil and water losses. Organic matter and nitrogen can be added by growing legumes fertilized with phosphate. Lime will be needed also for sweetclover and alfalfa. The more severely eroded and gullied areas should be returned to pasture and seeded or sodded to buffalo and Bermuda grasses.

Lincoln very fine sandy loam (0–2% slopes) (LA).—This alluvial soil occupies nearly level parts of the flood plain of the Canadian River and has a total area of 1,700 acres.

The surface soil, a light-brown or grayish-brown calcareous friable very fine sandy loam, is usually underlain below 20 inches by light-brown or yellowish brown friable calcareous fine sandy loam. In places, however, the underlying material is loamy fine sand or stratified loamy fine sand, silt, and fine sandy loam. Small areas with a loamy fine sand surface soil are included in this unit.

The soil is flooded occasionally, but the surface soil and upper subsoil are well drained. The lower subsoil is saturated with water most of the time, but drainage is adequate for all crops commonly grown.

The soil is low in plant nutrients and has a low water-holding capacity. Crop yields are generally low.

Use and management.—Nearly half of this soil is cultivated. Of the cultivated soil, about 55 percent is planted to sorghums, 20 percent to corn, 15 percent to cotton, and the rest to miscellaneous crops. The average yield of sorghums is 12 bushels of grain or 1½ tons of fodder; corn, 8 bushels; and cotton, 100 pounds of lint an acre. Bermuda grass pastures have a carrying capacity of one cow for about 3 acres.

Some areas produce fair yields of crops, but as a whole the soil is of low productivity, subject to destructive overflows, and better suited to pasture, especially when sodded with Bermuda grass and overseeded with sweetclover.

McLain clay (0–1% slopes) (MA).—This dark friable clay occupies a few moderate-sized areas totaling 1,500 acres, mainly on level high bottoms of the Canadian River.

The surface soil to a depth of about 10 inches is dark-brown or dark reddish-brown crumbly friable clay. The subsoil is brown or dark reddish-brown crumbly permeable silty clay or clay that becomes redder with increased depth. It grades into reddish-brown friable sandy or silty clay loam alluvium below 40 or 50 inches. The surface soil and upper subsoil are about neutral, and the lower subsoil and underlying alluvium are alkaline to calcareous.

Surface drainage is slow, and internal drainage is moderately slow, but the soil as a whole is sufficiently well drained for all crops grown, including alfalfa. A few small local slightly depressed areas remain wet for short periods after heavy rains but are cropped successfully without artificial drainage. Shallow ditches may be beneficial for removal of surface water from large level areas during extended wet periods. A few small saline spots, usually less than one-half acre in size, occur mainly on the lower areas. They are practically bare of vegetation; but since they comprise less than about 5 percent of the delineated tracts, they do not materially reduce productivity. These saline spots are indicated on the map by symbol.

Use and management.—McLain clay is a highly fertile and productive soil with favorable physical characteristics and excellent moisture relations. Crops withstand droughts better than on higher lying heavy-textured soils of the upland. An estimated 35 percent of the cultivated soil is used for corn, 25 percent for cotton, 20 percent for alfalfa, and the rest for sorghums, oats, wheat, and barley. The average yield of corn is 25 bushels; lint cotton, 200 pounds; alfalfa, 3 tons; oats, 35 bushels; grain sorghum, 22 bushels or 3 tons of fodder an acre.

This soil is well supplied with plant nutrients. It is doubtful that use of fertilizers will increase yields, but legumes may respond to phosphate. Crop rotations that include a legume are known to increase yields and should be used on all cultivated areas as a regular management practice.

McLain silty clay loam (0–2% slopes) (MB).—This soil resembles the associated McLain clay but has a less clayey and more friable surface soil. It occupies a total of 4,900 acres.

The 10- or 12-inch surface layer is dark-brown or dark reddish-brown granular friable silty clay loam. The subsoil is brown or dark

reddish-brown friable silty clay to 35 or 50 inches, where it grades into brown or reddish-brown friable sandy or silty clay loam alluvium. The surface soil and upper subsoil are about neutral in reaction, and the lower subsoil is weakly alkaline or calcareous.

Surface drainage is very slow, and internal drainage is moderately free. There is very little runoff, and water stands on the surface for only a short time before it is absorbed by the permeable surface soil and subsoil. The soil has a high water-holding capacity, and crops seldom suffer for moisture during extended dry periods. McLain silty clay loam has favorable physical characteristics and is more easily tilled than McLain clay.

Use and management.—Approximately 35 percent of the cultivated soil is planted in corn, 25 percent in cotton, 15 percent in alfalfa, 10 percent in sorghums, 10 percent in oats, and the rest in miscellaneous crops. Average yields of most crops are estimated to be slightly higher than on McLain clay, or about 30 bushels of corn, 240 pounds of lint cotton, 3½ tons of alfalfa, 25 bushels of grain sorghum, and 35 bushels of oats an acre.

This soil is well supplied with plant nutrients, but areas that have been in alfalfa for several years may respond to phosphate fertilizer. Use of crop rotations that include a legume, insect control, and plowing under crop residues should be regular management practices.

McLain soils, saline phases (0–2% slopes) (Mc).—This unit consists of a few small closely associated tracts of McLain clay and silty clay loam that are impregnated with salt as a result of a high water table. The total area is only 300 acres. The water table lies within 1 to 3 feet of the surface part of the year but it is usually at a greater depth. About 40 percent of the land is spotted with a white incrustation of salts. These saline areas are more noticeable during dry periods. The saline spots produce little vegetation of any kind, and the intervening less saline areas produce lower crop yields than the surrounding salt-free McLain soils.

Use and management.—Practically all areas of the saline phases are cultivated with the surrounding salt-free soils, but small areas are used for pasture or remain idle. Of the cultivated soil, about 25 percent is cropped to corn, 20 percent to cotton, 30 percent to sorghums, 10 percent to barley and oats, and the rest to miscellaneous crops. The estimated average yield of corn is 10 bushels; cotton lint, 120 pounds; grain sorghums, 14 bushels; oats, 16 bushels; and alfalfa, 1½ tons.

The productivity can be increased by installing deep drainage ditches to lower the water table. This practice will allow the salts to be leached by rainfall. At least 2 or 3 years of such drainage is required before enough leaching occurs to permit normal plant growth and production. As long as the water table remains near the surface, nothing can be done to correct permanently the salty condition, but the use of large quantities of manure or organic matter will be beneficial and will aid germination and growth of plants. The addition of gypsum or sulphur may also be beneficial.

Minco silt loam, gently sloping (1–3% slopes) (Mf).—This is a deep friable silt loam of moderate extent that occurs on old high undulating terraces of the Canadian River in association with soils of the Vanoss and Derby series. The total area is 2,400 acres.

The surface soil to a depth of about 15 inches is dark-brown friable silt loam that merges with the subsoil of brown or reddish-brown friable silt loam or loam. The subsoil continues to a depth of about 50 inches and grades into calcareous friable sandy or silty clay loam. The subsoil in places is light reddish brown. The surface soil and upper subsoil are slightly acid to neutral, and the lower subsoil below a depth of about 40 inches is alkaline to weakly calcareous. The parent materials are calcareous silty earths of alluvial or aeolian origin.

This is a friable easily worked soil with good water-holding capacity. It is moderately well supplied with organic matter and plant nutrients, responsive to management, and desirable for general crop use. Gradients reach a maximum of 4 percent but are dominantly about 1 to 3. Some water is lost by runoff from cultivated fields during heavy rains, but erosion is not a serious problem and can be effectively controlled by good soil management.

Use and management.—About 30 percent of the cultivated area of this soil is used for growing cotton, 20 percent for sorghums, 20 percent for corn, 15 percent for oats, and the rest for miscellaneous crops, mainly alfalfa, Sudan grass, wheat, cowpeas, peanuts, fruits, and vegetables. The land in pasture supports a good cover of bluestem and grama grasses that produce excellent grazing. Under customary management average yields of the principal crops are: Cotton, 175 pounds of lint; sorghums, 20 bushels; corn, 18 bushels; and oats, 25 bushels an acre.

Although this soil is moderately productive and only slightly susceptible to erosion, good management and simple erosion control practices should be used. Contour farming, strip cropping, use of crop rotations that include legumes, and use of phosphate fertilizer are of value in reducing runoff and erosion and increasing crop yields.

Minco silt loam, sloping (4–8% slopes) (Mo).—This soil is similar to Minco silt loam, gently sloping, but differs from it mainly in having a thinner surface soil and a more sloping surface. It occurs mainly in the northwestern part of the county in association with Derby, Vanoss, and other Minco soils. The total area is 2,800 acres. The surface soil is about 12 inches deep, and the lower subsoil is calcareous at about 30 inches below the surface. Considerable water is lost during heavy rains by runoff from cultivated areas, and both sheet and gully erosion are more active than on cultivated areas of Minco silt loam, gently sloping.

Included with this soil are a few areas having a reddish-brown to red subsoil and underlain in places by reddish sandstone 30 to 60 inches below the surface. These inclusions, which are mainly in the northwestern corner of the county, do not differ appreciably from the typical Minco soils except in color and the depth to underlying bedrock. The included areas developed from a relatively thin mantle of wind-laid materials deposited over sandstone.

Use and management.—This soil is used for growing about the same crops as Minco silt loam, gently sloping, but average yields are slightly lower. About the same management and cropping practices are recommended, but a larger part should be used for sorghums, small grains, and Sudan grass. A minimum of 35 to 50 percent of the

cultivated land should be planted in strips of these fibrous-rooted crops for reducing runoff and erosion. Terraces are not generally recommended on any Minco soil, because the friable substrata give rise to severe gully hazard at terrace outlets.

Minco fine sandy loam, gently sloping (0–3% slopes) (MD).—This soil occupies a total of only 2,400 acres on undulating terraces adjacent to the Canadian River. It is associated with other Minco soils and those of the Derby and Vanoss series.

The surface layer to a depth of about 14 inches is brown or dark-brown friable fine sandy loam, neutral to slightly acid in reaction. This grades into the subsoil of brown or reddish-brown friable fine sandy loam, which continues downward with little change to 4 or 5 feet and grades into reddish-brown sandy clay loam or loam of weakly alkaline or neutral reaction. The surface soil and subsoil are freely permeable to water, air, and plant roots.

This soil has favorable physical characteristics and is easily worked. Relief is nearly level to gently sloping. Most of the rainfall soaks in, and there is little runoff except during short extremely heavy rains. Slight erosion occurs on the more sloping cultivated fields, but the productivity of such areas has not been noticeably reduced.

Use and management.—About 50 percent of the cultivated soil is planted to cotton, 20 percent to corn, 20 percent to sorghums, and the rest to cowpeas, peanuts, Sudan grass, vegetables, and fruits. This soil is less productive than Minco silt loam, gently sloping. The estimated average yield of cotton is 150 pounds of lint; corn, 16 bushels; and grain sorghums, 18 bushels or 2 tons of fodder an acre. Fruit trees should thrive on this soil, and good yields of some vegetables can be obtained under proper management.

Contour farming and strip cropping on the more sloping areas will help to reduce runoff and erosion and result in higher yields. Use of crop rotations that include legumes and application of phosphate fertilizer will also increase yields.

Minco fine sandy loam, sloping (4–8% slopes) (ME).—This soil occupies a total of 2,000 acres and is associated with Derby and other Minco soils. It has profile characteristics similar to those of Minco fine sandy loam, gently sloping, but has a more sloping surface (slopes up to 10 percent in a few small areas), a higher rate of runoff, and greater susceptibility to erosion. Some areas have been considerably damaged by erosion, but none have been made unsuitable for crops.

Use and management.—The principal crops and acreages of each crop are about the same as on the gently sloping soil, but average yields are slightly lower. Corn yields average 14 bushels; cotton, 140 pounds of lint; grain sorghums, 16 bushels or 1¾ tons of fodder; and oats, 18 bushels an acre. Native pastures have a carrying capacity of one cow for about 5 acres during the grazing season.

Erosion control measures and proper soil management practices should be applied before the land is damaged further or the productivity decreased. The same practices as recommended for Minco silt loam, sloping, should be used on this soil. The more sloping and eroded areas should be used for pasture if cultivation is not possible under proper management.

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Norge silt loam, gently sloping (1–4% slopes) (NA).—This is a friable slightly acid soil developed on old high terraces above the Canadian River. The total area is 600 acres.

The surface soil to a depth of about 12 inches is dark-brown to reddish-brown friable silt loam. It grades into a red or reddish-brown firm to friable moderately permeable silty or sandy clay subsoil, which extends to a depth of several feet. The subsoil is underlain by reddish-yellow silty or sandy earths of alluvial or aeolian origin. In a few places red clay or silty shale underlies the soil at 3½ to 5 feet. Such areas occur mainly along the edges of the high terraces where the silty mantle thins out adjacent to the higher lying uplands. The surface soil and subsoil layers are slightly acid to neutral in reaction, but the material below 4 feet is neutral to weakly alkaline.

Norge silt loam, gently sloping, is inherently of moderate to low fertility but is very responsive to management. It absorbs moisture fairly rapidly. It is friable and easily tilled, has good moisture-holding capacity, and will produce moderate to high yields of crops under proper management. Some of the more sloping cultivated areas have been slightly eroded, but their productivity has not been lowered more than 10 to 15 percent.

Use and management.—The principal crops are cotton, corn, and sorghums; minor crops are oats, Sudan grass, some vegetables, and fruits. The estimated average acre yield of sorghum is 15 bushels of grain or 1½ tons of fodder; corn, 12 bushels; and lint cotton, 160 pounds. Native pastures consist mainly of bluestem and grama grasses and have a carrying capacity of about 4 acres for one cow.

Crop yields can be increased considerably if crop rotations including legumes are used and phosphate fertilizers are applied. Contour cultivation and strip cropping should be used to reduce runoff and soil losses on all cropland, and the more sloping areas should be terraced. This highly responsive soil is adapted to a wide variety of crops and should produce 50 to 75 percent higher yields if well managed.

Norge silt loam, sloping (4–8% slopes) (NB).—This soil is similar to Norge silt loam, gently sloping, but has thinner soil layers and is more sloping. The total area is 2,600 acres.

The surface layer to a depth of about 10 inches is brown or reddish-brown friable silt loam. This layer grades into the reddish-brown firm to friable silty or sandy clay subsoil that continues to a depth of about 40 inches and is underlain by reddish-yellow alkaline sandy loam or silt loam.

The surface is moderately sloping. Gradients range dominantly from 4 to 8 percent but a few small areas have gradients up to 10 percent. Surface drainage is moderate to rapid, and considerable rainfall is lost by runoff from cultivated fields. Crops suffer more from lack of moisture in dry weather than on the gently sloping silt loam. Although very susceptible to erosion if cultivated, none of the soil has been so seriously injured as to make it unsuitable as cropland.

Use and management.—Sorghums, corn, cotton, and oats are the principal crops. Estimated average yields are lower than on the gently sloping soil. Sorghums produce about 12 bushels of grain or 1¼ tons of fodder; corn, 10 bushels; cotton, 140 pounds of lint; and oats, 25 bushels an acre. Native pastures have a carrying capacity of one cow for about 4 acres.

Terraces, contour cultivation, strip crops, and winter cover crops should be used to reduce runoff and erosion. The more sloping areas should be returned to pasture if erosion control is impracticable. The productivity can be increased by using crop rotations that include legumes and by adding phosphate fertilizer.

Norge silt loam, sloping, eroded (4–8% slopes) (Nc).—Because of erosion, this soil has a thinner surface soil than Norge silt loam, sloping, but it is similar in other characteristics. The surface soil is about 5 to 8 inches thick in most areas, but in places it is much thinner and the reddish-brown sandy clay subsoil is exposed or is brought to the surface by plowing. Gullies and rills are numerous, but they do not prevent cultivation. The total area of Norge silt loam, sloping, eroded, is 2,900 acres.

Use and management.—Approximately 40 percent of the cropland is used for sorghums, 20 percent for cotton, 10 percent for oats, 10 percent for cowpeas, and the rest for miscellaneous crops, including clover, Sudan grass, peanuts, fruits, and vegetables. About 10 per cent of the uncultivated land is covered with a good sod of Bermuda grass, and 15 percent has a fair cover of native perennial grasses; the rest supports a sparse cover of three-awn and other annual grasses and weeds that have little grazing value. Estimated average acre yields are 7 bushels of sorghum grain or 1 ton of fodder, 90 pounds of lint cotton, 14 bushels of oats, and 7 bushels of corn.

Because of its susceptibility to erosion and low productivity, this soil is not good cropland and should be used for pasture wherever feasible. However, under proper management erosion can be controlled and the productivity increased. Practices and treatment recommended for the sloping Norge silt loam should be used. Broadcast crops of small grains or sorghums should be used when possible, and row crops seldom planted. The more sloping eroded areas may be more productive in pasture.

Oil-waste land (0–10% slopes) (Oa).—This land type includes small areas covered by wastes of oil and salt water from oil wells. It also includes land covered by oil that surrounds oil tanks, as well as areas once occupied by oil tanks. The surface soil has been removed to form levees around the tanks, and the land has been practically ruined for agricultural use, as the oil and salt water prevent the growth of vegetation. The principal areas are in the vicinity of Moore. The total area is only 100 acres.

Pulaski fine sandy loam (0–2% slopes) (Pa).—This soil occurs on the narrow flood plains along small streams in the forested eastern part of the county and consists of alluvium washed mainly from areas of light-colored soils and a small admixture from the prairie. Its total extent is 23,700 acres.

The surface soil to a depth of about 16 inches is reddish-brown neutral to slightly acid friable fine sandy loam. The material below is light reddish-brown or yellowish-red fine sandy loam stratified with silt and fine sand; it is about neutral in reaction and continues downward several feet. The areas as mapped are variable in texture in the 5- to 12-inch surface soil because of recent local deposits by floodwaters; and thin strata, or layers, of finer texture or darker less red material are present at various depths.

Except for small local areas, this soil is well drained, though subject to frequent overflow. Most of the land can be successfully cultivated, for floodwaters remain only a short period. The soil is only moderately fertile but is the most productive in the forested section where it occurs.

Use and management.—Of the cultivated soil, about 35 percent is planted to corn, 30 percent to cotton, 25 percent to sorghums, and the rest to miscellaneous crops. The average yield of corn is 12 bushels; cotton, 150 pounds of lint; and sorghums, 15 bushels of grain or 2 tons of fodder. Yields about twice as large as these are obtained by some farmers during favorable years. Bermuda grass pastures have a carrying capacity of about 2 acres for each cow during the growing season.

Where stream channels have been straightened, as on the flood plains along parts of Pond and Buckhead Creeks, flooding is less frequent, drainage is more rapid after floodwaters recede, and yields are higher than the averages given above.

This soil is responsive to management, and increased yields can be obtained if legumes fertilized with phosphate are used in rotation with row crops. Narrow bottom lands that are too frequently overflowed for successful crop use should be sodded to Bermuda grass for pasture. Such areas may also be used for producing Johnson-grass hay.

Pulaski-Sweetwater fine sandy loams (0–2% slopes) (Pʙ).—This is a complex of alluvial soils that occurs in the flood plains of small streams that drain the forested lands in the eastern part of the county. It comprises small intermixed areas of Pulaski and Sweetwater fine sandy loams that are not suitable for cultivation because of poor drainage and frequency of overflow. The total area is only 1,000 areas.

Pulaski fine sandy loam, the most extensive soil of this complex, has a surface layer of reddish-brown fine sandy loam about 15 inches deep. The material below is light reddish-brown or reddish-yellow fine sandy loam to a depth of several feet; thin strata of darker or finer textured materials occur in it. Both surface soil and subsoil are neutral to slightly acid in reaction. The Pulaski soil occupies about two-thirds of the delineated areas and occurs in narrow strips and small patches in the better drained parts of the narrow flood plains. It has a high water table during part of the year and is frequently overflowed.

Sweetwater fine sandy loam consists of dark grayish-brown fine sandy loam, about 16 inches thick, over dark grayish-brown sandy clay that continues to a depth of several feet. The surface layer is neutral, but the underlying material is weakly alkaline to calcareous. The color and texture of the surface soil are variable. Within short distances the color ranges from dark reddish-brown to dark brown or black, and the texture from loamy fine sand to loam. Locally, small areas have a recent deposit of light reddish-brown loamy fine sand over the darker material.

This complex occupies nearly level narrow flood plains that are frequently overflowed. The water table stands at or near the surface most of the time, and natural drainage is not sufficient for successful crop use. The native vegetation is mainly elm, bur oak, and willow, with some coarse grasses and sedges.

Use and management.—Some of the larger areas of this soil can be cultivated successfully if they are drained by straightening the stream

channel and by ditching, but their best use probably is Bermuda grass pasture.

Reinach silty clay loam (0–1% slopes) (Rc).—This is a reddish-brown highly productive soil of low stream terraces and high bottoms occurring mainly in the valley of Little River. The total area of the soil is 2,700 acres.

The surface soil to a depth of about 15 inches consists of reddish-brown granular friable silty clay loam. It grades into reddish-brown silty clay loam or loam, which extends to a depth of about 42 inches and is underlain by reddish-brown silt loam or stratified silt loam and loamy fine sand of old alluvium. The surface soil and upper subsoil are about neutral, but the lower subsoil and substratum are alkaline to weakly calcareous.

Included with this soil as mapped are small bodies of Reinach silt loam and smaller bodies of Reinach loam. Also included are a few small areas where the surface soil, to a depth of about 10 inches, is dark reddish-brown silty clay loam and the subsoil, to a depth of about 30 inches, is dark reddish-brown loam that grades into stratified sandy and silty alluvium. These inclusions do not affect the crop adaptation or productivity of the areas in which they occur.

This soil is well drained, has a fairly high water-holding capacity, and has no runoff or erosion problems. Occasionally some areas are inundated to a shallow depth for short periods during extremely high floods, but little damage is done to crops. Crops withstand droughts better on this soil than on Reinach fine sandy loam.

Use and management.—Reinach silty clay loam is easily worked, highly productive, and well suited to cotton, corn, sorghums, and alfalfa. About 30 percent of the cropland is used for corn, 20 percent for cotton, 15 percent for sorghums, 10 percent for oats, 10 percent for alfalfa, and the rest for Sudan grass, clover, cowpeas, and other miscellaneous crops. Average acre yields are estimated at 28 bushels of corn, 240 pounds of lint cotton, 30 bushels of sorghum grain or 3½ tons of fodder, 35 bushels of oats, and 3 tons of alfalfa.

Under present management this soil will continue to produce good yields, but crop rotations that include legumes will maintain a higher level of productivity.

Reinach silt loam (0–1% slopes) (Rb).—This is a deep friable easily worked silt loam that occurs in large areas, mainly on low nearly level high bottoms along the Canadian River. The total area of the soil is 5,300 acres.

The surface soil to a depth of about 15 inches is reddish-brown or light-brown noncalcareous friable silt loam. The subsoil of reddish-brown or light reddish-brown friable loam or silt loam reaches a depth of about 40 inches and is underlain by calcareous reddish loamy sand of old alluvium. Some areas northwest of Lexington have a brown surface soil about 14 inches thick, then a reddish-yellow calcareous silt loam subsoil, and then a reddish-yellow calcareous loamy sand at depths of 25 to 40 inches. The soil is about neutral in reaction in the surface soil and subsoil layers, but locally it is calcareous throughout the profile.

Reinach silt loam is well drained and has a fair moisture-holding capacity, but crops sometimes suffer for lack of moisture during long dry periods, especially where the sandy substratum is within about

25 inches of the surface. It is a freely permeable soil, and there is practically no runoff and no erosion. The water table lies about 10 to 15 feet below the surface.

Use and management.—Practically all of this soil is cultivated because of its good productivity, favorable physical characteristics, and ease of cultivation. Of the cultivated land, about 30 percent is used for corn, 25 percent for cotton, 20 percent for sorghums, 10 percent for oats, 5 percent for alfalfa, and the rest for cowpeas, vegetables, and fruits. The estimated average acre yield of corn is 25 bushels; cotton, 250 pounds of lint; sorghums, 25 bushels of grain or 3 tons of fodder; oats, 32 bushels; and alfalfa, 2½ tons an acre. This soil is well supplied with plant nutrients and will continue to produce moderate yields of crops for a long period under prevailing management, but yields can be maintained at a higher level under better management. Increasing the organic matter and nitrogen content by use of legumes probably will bring greater increases in yields than any other management practice.

Reinach fine sandy loam (0–4% slopes) (Ra).—This soil occurs in association with Reinach silt loam but lies slightly higher and has more rapid drainage. It occupies nearly level to gently sloping high bottoms along the Canadian River, mainly in the southwestern part of the county. The total areas is 2,700 acres.

The surface soil is brown or light reddish-brown fine sandy loam, about 14 inches thick. In fields the plowed layer is slightly lighter colored. The surface soil grades into the subsoil, a light-brown or reddish-brown fine sandy loam that extends to a depth of about 40 inches, where it grades into stratified calcareous loamy fine sand. The surface soil is neutral to slightly alkaline, and the subsoil is weakly alkaline to calcareous in the lower part.

This soil is more sandy in all layers, has a lower water-holding capacity, and is less productive than Reinach silt loam, but it is used for the same crops.

Use and management.—About 30 percent of the cultivated soil is cropped to sorghums, 30 percent to cotton, 25 percent to corn, 10 percent to oats, and the rest to cowpeas, clover, fruits, and vegetables. The average yield of sorghum is 16 bushels of grain or 2 tons of fodder; corn, 15 bushels; cotton, 160 pounds of lint; and oats, 25 bushels an acre. Bermuda grass pastures have carrying capacity during the growing season of a cow to about 2 acres.

Crop yields can be increased and maintained at a higher level by using crop rotations that include legumes as often as practical. Mixed fertilizers or manure will give increased yields on areas that have been cropped to corn and cotton for many years.

Renfrow silt loam, gently sloping (1–3% slopes) (Rd).—This is a reddish-brown friable slightly acid soil developed from clays and shales (red beds) on gentle slopes under a grass cover. The total area is 9,900 acres.

The surface soil to a depth of about 10 inches is dark-brown or dark reddish-brown slightly acid friable silt loam that has more red in the lower part. This grades into the subsoil, a reddish-brown or red firm but crumbly clay that becomes slightly firmer with increased depth. The subsoil is neutral to weakly alkaline, but in places it is

weakly calcareous in the lower part. The parent material of reddish-brown clay or shale (red beds) is about 3½ feet below the surface.

The surface soil is friable, easily worked, and not so crusty and hard as that of the Kirkland soils, which occupy nearly level adjacent areas. The subsoil is slowly permeable but has a moderately high water-holding capacity. Crops sometimes suffer during long dry periods because water moves slowly through the heavy clay subsoil. Surface runoff is moderate to rapid, and during heavy rains considerable rainfall is lost from the more sloping cultivated areas. Erosion is active on these areas, especially where clean-tilled row crops are grown, and shallow gullies and rills are common. In addition, the surface soil has been noticeably thinned on many of them, though the productivity has not been permanently reduced.

Many areas contain slick spots, indicated on the map by symbol. These spots produce practically no crop and therefore reduce total yields on the areas in which they occur.

Use and management.—Renfrow silt loam, gently sloping, is only moderately productive, but profitable yields of adapted crops can be obtained under careful management. Pastures support a good cover of bluestem, grama, and buffalo grasses. Of the cultivated land, about 25 percent is cropped to oats, 20 percent to wheat, 15 percent to sorghums, 10 percent to cotton, and the rest to barley, cowpeas, and corn. Estimated yields are: Oats, 25 bushels; wheat, 12 bushels; sorghums, 14 bushels of grain or 1¾ tons of fodder; cotton, 135 pounds of lint; and barley, 13 bushels an acre. Native hay yields about 1 ton an acre, and native pastures have a carrying capacity of about 4 acres for each cow.

Under the usual cropping system this soil is moderately susceptible to erosion, and careful management is required to prevent deterioration. Special efforts should be made to hold as much rainfall on the land as possible for the purposes of preventing erosion and storing moisture for crop use. Contour farming, rotating crops, and strip cropping should be practiced on all cultivated areas planted to row crops, and terraces may be needed on the more sloping areas. Legumes fertilized with phosphate will increase yields of small grains and of other crops.

Renfrow silt loam, sloping (3–7% slopes) (RE).—Steeper slopes and a thinner surface soil are the main differences between this soil and Renfrow silt loam, gently sloping. The total area of this soil is 8,400 acres.

The surface layer is dark reddish-brown or reddish-brown silt loam about 7 inches thick. It grades into reddish-brown firm clay that continues to a depth of about 40 inches, where it is underlain by reddish-brown clays or shales (red beds).

Surface gradients are dominantly 3 to 7 percent, but a few small areas have gradients ranging up to 10 percent. Surface drainage is rapid, and a large proportion of the rainfall is lost by runoff from cultivated fields. As a result, less water is stored in the subsoil and crops suffer during dry periods. Areas cultivated for only a short time are usually affected by moderate sheet and gully erosion, but the soil has not been seriously damaged and is still fair cropland if carefully managed.

Use and management.—Less than 20 percent of this soil is cultivated; the greater part is used for native pasture or meadow. The cultivated land is used mainly for oats, sorghums, and wheat. The estimated average yield of oats is 18 bushels; sorghums, 10 bushels of grain or 1½ tons of fodder; and wheat, 8 bushels an acre. Native pastures have a carrying capacity of one cow for about 5 acres, and native hay yields 1 ton an acre.

Cultivated crops can be successfully grown if all effective measures for reducing runoff and erosion and for maintaining fertility are used. These practices should be followed: Terracing, contour cultivation, use of winter cover crops (preferably legumes) as often as feasible, application of phosphate and nitrogen fertilizers, and farming not less than 40 percent of the soil in strips of thick-growing crops such as small grains or broadcast sorghum. If management practices are neglected, this soil becomes unsuitable for crop use within a few years; under prevailing management its best use is for pasture or native meadow.

Renfrow silty clay loam, sloping, eroded (3–6% slopes) (Rf).—This soil differs from Renfrow silt loam, sloping, in having a thinner heavier textured surface soil. The total extent is 10,700 acres.

The surface soil of reddish-brown silty clay loam is about 5 inches thick, but on narrow divides or ridges between gullies it ranges from almost none to 8 or 10 inches. Originally the surface soil was probably 7 to 10 inches thick, but it has been so thinned by erosion that less than half now remains. Gullies are common but are not numerous enough to prevent cultivation. Much rainfall is lost by runoff, and crops suffer during dry periods. Small barren slick spots, indicated on the map by symbol, are common on this soil. These spots produce no crop.

Use and management.—The cultivated areas of this soil are used chiefly with more productive soils because their exclusion from cultivation would result in irregular fields. The estimated average yield of oats is 12 bushels; grain sorghums, 6 bushels; wheat, 5 bushels; and cotton 75 pounds of lint an acre. Native grasses are becoming reestablished on some idle areas and furnish grazing for short periods. Abandoned-field pastures support a thin cover of annual grasses, mainly three-awn, and furnish some grazing during spring and early summer.

This soil is not recommended for crop use, for it has low productivity and is susceptible to erosion. Some areas can be kept in cultivation if intensive erosion control and soil management practices are used, but the greater part should be seeded to perennial grasses and used for pasture or meadow.

Roebuck clay (0–1% slopes) (Rh).—This poorly drained soil occupies small areas on the flood plains of a few streams in the area. Its total area is 2,100 acres.

The soil is reddish-brown or dark reddish-brown calcareous clay to a depth of about 20 inches. This overlies mottled reddish-brown and grayish-brown calcareous clay that is stratified in places with sandy clay and clay loam 3 to 4 feet below the surface. The surface is level to slightly depressed, natural drainage is very slow, and the soil is frequently covered with water left by local runoff or by over-

flow from streams. In the lower lying areas water stands for several days after floods recede. The native vegetation is principally elm, willow, ash, sycamore, Osage-orange, oak, cottonwood, and hackberry.

Use and management.—About 40 percent of the cropland is used for corn, 20 percent for cotton, 20 percent for sorghums, and the rest for miscellaneous crops. Crop yields vary considerably, depending on the amount of rainfall and frequency of overflow. Yields are low in wet years, but high yields are produced during dry years. Estimated average acre yields are: Corn, 15 bushels; cotton, 120 pounds of lint; and sorghums, 18 bushels of grain or 3 tons fodder. Yields of up to 40 bushels of corn or 400 pounds of lint cotton are produced occasionally during dry years. Bermuda grass pastures have a carrying capacity of about 2 acres for each cow during the grazing season.

All areas require some artificial drainage for maximum crop production. Most cultivated areas are drained by shallow ditches, but many areas cannot be drained successfully because they are in low-lying positions or are frequently subject to overflow. The soil is well supplied with plant nutrients and would be highly productive if it were adequately drained and protected from overflows.

Rough broken land (Norge soil material) (15–30% slopes) (RK).—This unit consists of narrow areas of steep, broken, or severely gullied escarpments and canyons along the edge of high old terraces of the Canadian River. Rapid geologic erosion has prevented soil development. The material consists of deep beds of reddish-brown or light-gray sandy and silty old alluvium. The native vegetation is a thin forest of post, white, and red oaks, elm, and cottonwood, with some bluestem along the base of slopes. The total area is 800 acres.

Use and management.—This land has little agricultural use except for woodland or pasture. The narrow areas along the base of the slopes provide good pasture, but the steeper eroded slopes have little pasture value. These rough broken areas are best used for growing trees and for incidental grazing where feasible.

Sandy alluvium (0–2% slopes) (SA).—This unit comprises the low first bottom areas of the Canadian River lying slightly above the river channel. It is a mixture of recent alluvium consisting of light-brown or light reddish-brown calcareous sand or sandy loam or thinly stratified sand, silt, and sandy loam many feet deep. The total area is 3,300 acres. Overflows are frequent, and the areas receive fresh deposits of sandy material during each flood. A few small included areas have low ridges or dunes several feet high which have been formed by wind during dry periods. The native vegetation is a thin cover of willow, salt cedar, and cottonwood, with some bluestem in open areas.

Use and management.—Cleared areas support a fair cover of Bermuda grass and an overstory of willow and salt-cedar brush. The land is not suited to cultivation and is used entirely for pasture or as woodland. The carrying capacity is a cow to about 10 acres during the grazing season.

Stephenville fine sandy loam, gently sloping (1–4% slopes) (SB).—This is a light-colored friable acid soil developed under scrub forest in the eastern part of the county. It has a total area of 14,100 acres. It is of medium depth and low natural productivity but is very responsive to management.

The surface soil in virgin areas, to a depth of 3 or 4 inches, is grayish-brown acid fine sandy loam. This grades into a subsurface layer of light-brown or light reddish-brown acid fine sandy loam about 10 inches thick. Where cultivated, the surface layer, to a depth of about 6 inches, is brown or light brown. The subsoil is reddish-brown or red crumbly friable sandy clay loam that grades into soft reddish sandstone bedrock about 3½ feet below the surface.

Some included areas have a reddish-yellow or yellowish-red friable light sandy clay subsoil that becomes red in the lower part. In other places, especially on narrow ridge tops and divides, the subsoil is dark reddish-brown moderately heavy sandy clay or clay. This ridgetop inclusion represents a transition toward Windthorst fine sandy loam, but the areas are too small to warrant separation.

Stephenville fine sandy loam, gently sloping, occupies lower slopes (foot slopes) and divides in association with more sloping Stephenville soils. Surface drainage is moderate to rapid, and internal drainage is free. Most cultivated areas are slightly eroded (pl. 3, *C*) but not significantly damaged. In a few places additional runoff from higher lying areas has caused some gullying.

This soil is moderately permeable and has a fairly high water-holding capacity. It has favorable physical characteristics for plant growth, but crop yields are low because supplies of organic matter and essential plant nutrients are low. Under the system of farming normally followed in the area, crop yields decline rapidly after the land is cleared and put in cultivation.

Use and management.—Of the cultivated land, about 35 percent is cropped to sorghums, 25 percent to cotton, and 15 percent to corn; the rest is used for cowpeas, peanuts, fruits, and vegetables. The average acre yield of sorghums is 10 bushels of grain or 1½ tons of fodder; cotton, 110 pounds of lint; and corn, 8 bushels. Vegetables and fruits do especially well if properly managed. Native woodland pastures have a carrying capacity of about 15 acres for each cow. Bermuda grass pastures, during the growing season, have a carrying capacity of one cow to about 4 acres.

Under good management moderate yields of adapted crops can be produced on Stephenville fine sandy loam, gently sloping. Applying moderate quantities of fertilizer (especially phosphate and lime or manure) and using crop rotations that include legumes as often as practical will increase yields as much as 40 to 100 percent after several years. Contour cultivation and strip crops should be used on all cropland, and terraces will be needed to reduce runoff and erosion on long slopes. The badly gullied areas of fields on which good management is not feasible should be seeded or sodded to Bermuda grass and used for pasture, or seeded to bluestem and used for meadow. Moderate applications of phosphate fertilizer will improve Bermuda grass pastures.

In the forested section of the uplands this is the principal soil well suited for crops. Because of its small acreage, the soil should be so managed that productivity will be increased and maintained at a higher level than at present.

Stephenville fine sandy loam, sloping (5–10% slopes) (Sc).—This soil differs from the gently sloping unit mainly in having greater slopes. Slopes range from 4 to 12 percent but are dominantly in the

5- to 10-percent range. The total area of the soil is 66,700 acres. The surface soil and subsurface soil are somewhat thinner in virgin areas than are those of the less sloping soil. The rate of surface runoff is much higher on this sloping soil, and cropland on it is much more susceptible to erosion than that on Stephenville fine sandy loam, gently sloping. The surface soil in cultivated areas averages 8 inches in depth but ranges from 4 to 12 inches. Shallow gullies are common, but for most of the soil are not numerous enough to prevent cultivation.

Use and management.—A large proportion of the cropland is used for sorghums, but small areas are planted to miscellaneous crops and fruits. Yields of sorghums average 7 bushels of grain or three-fourths ton of fodder an acre. The cleared areas in native grass have a carrying capacity of about 6 acres for each cow; the Bermuda grass pastures, about 4 acres per cow; and woodland pastures, about 15 acres per cow during the grazing season.

This soil is moderately productive for a few years after being cleared, but crop yields decline rapidly under the management usually practiced. The soil is not well suited for use as cropland. None of it should be used for clean-tilled row crops, for effective erosion control is impractical. Some of the less sloping areas can be successfully used as cropland under very intensive management, but crops other than row crops should be grown. All cropland should be terraced. Phosphate fertilizer should be applied, crop rotations that include a legume should be used as often as possible. Areas on which intensive management is not feasible should not be used for crops.

Stephenville fine sandy loam, sloping, eroded (4–12% slopes) (SD).—This soil consists of areas of Stephenville fine sandy loam, sloping, that have been eroded and as a result have a much lower productive capacity. The fine sandy loam surface soil has been so thinned by erosion that it is now only about 2 to 6 inches thick, and in some places the sandy clay loam subsoil is exposed. Gullies are so frequent and deep that cultivation is impossible on a large part of the area. The total area of this soil is 46,900 acres.

Use and management.—The small cultivated areas are used with less sloping more productive soils to avoid irregular-shaped fields. Sorghum, the principal crop, produces about 5 bushels of grain or one-half ton of fodder; cotton, about 60 pounds of lint an acre. Most pastures (pl. 3, *C*) have a thin cover of three-awn, with some bluestem and grama grasses, and a carrying capacity of one cow for about 12 acres during the grazing season.

This soil is unsuitable as cropland and should be kept under perennial grass cover and used for pasture or meadow. Controlled grazing and some seeding with adapted grasses and legumes will be necessary to reestablish a good cover on most areas. Practices that will aid in reducing erosion and reestablishing a grass cover are: The use of phosphate fertilizer on the less gullied areas; diversion of water; seeding or sodding gullies; and deferred grazing.

Vanoss silt loam, nearly level (0–1% slopes) (VB).—This is a deep dark friable soil developed on old high terraces of the Canadian River. It occurs in the southwestern part of the county in association with the Norge and Minco soils. The total area is 13,200 acres.

Surface gradients range up to 2 percent (pl. 3, *D*) but the greater part has slopes of 1 percent or less.

The surface soil, to a depth of about 16 inches, is grayish-brown or dark-brown friable silt loam, neutral in reaction. It grades into the subsoil, a dark-brown friable granular noncalcareous silty clay loam faintly mottled with reddish yellow in the lower part. This subsoil material continues to a depth of about 4 feet, where it grades into yellowish-red or yellowish-brown sandy or silty clay loam parent material. This parent material is weakly alkaline to calcareous and consists of alluvial or aeolian deposits several feet thick.

The surface soil has favorable physical characteristics, is fairly high in organic matter, and is easily maintained in a friable granular condition under cultivation. The subsoil is permeable and has a high water-holding capacity but it readily gives up moisture to plants and enables crops to withstand droughts much better than some of the heavier subsoils. There is practically no runoff from the nearly level surface, but the soil is well drained, and there is no erosion problem. The native vegetation consisted mainly of bluestem and grama grasses and a few scattered trees.

Use and management.—Vanoss silt loam, nearly level, is one of the most desirable and productive soils in the county. It is easily tilled, responds well to management, and produces good yields of field crops, vegetables, and fruits. Of the cultivated land, about 20 percent is used for corn, 20 percent for cotton, 15 percent for oats, 15 percent for sorghums, 10 percent for wheat, and 5 percent for alfalfa; the rest is used for cowpeas, peanuts, vegetables, and fruits. The average acre yield of corn is 22 bushels; cotton, 200 pounds of lint; oats, 30 bushels; sorghums, 24 bushels of grain; wheat, 15 bushels; and alfalfa, 3 tons.

This soil can be cropped for many years under customary management without serious declines in yields, but the prevailing average yields can be increased and maintained at a higher level under good management. Use of systematic crop rotations that include a legume as often as feasible should be standard practice for all cropland. Phosphate fertilizer probably will produce increased growth of legumes on land that has been row cropped for many years, and all crops will produce higher yields because of the nitrogen added by the legumes.

Vanoss silt loam, gently sloping (2–4% slopes) (VA).—This soil closely resembles the nearly level Vanoss silt loam but is more sloping. Gradients range from 2 to about 7 percent, but about four-fifths of the soil has slopes of less than 4. The more sloping areas have slightly thinner soil layers that are somewhat less dark throughout than those of Vanoss silt loam, nearly level. Otherwise, the two soils are similar. Some runoff occurs during heavy rains because of the more sloping relief. The surface soil has been thinned somewhat by slight erosion but productivity has not been lowered more than about 15 percent. The total area of this soil is 800 acres.

Use and management.—About 15 percent of the cultivated soil is used for corn, 20 percent for sorghums, 20 percent for oats, 30 percent for cotton, and the rest for cowpeas, peanuts, alfalfa, wheat, Sudan grass, fruits, and vegetables. Crop yields are slightly lower than on

the nearly level soil, mainly because surface runoff reduces the amount of moisture that is stored for plant use. Estimated average yields are: Corn, 18 bushels; sorghums, 20 bushels; oats, 30 bushels; and cotton, 180 pounds of lint an acre. Alfalfa yields about 3 tons of hay to the acre. Good yields are usually obtained from fruits, vegetables, and other crops. Native pastures support a good stand of bluestem, grama, and buffalo grasses and have a carrying capacity of one cow to about 3 acres during the grazing season.

Under proper management the productivity of this soil can be increased easily and erosion can be controlled effectively. Use of contour cultivation and strip crops and keeping a high percentage of thick-growing crops on the more sloping areas will reduce runoff and help store more water in the soil. Use of crop rotations that include legumes as often as feasible and application of phosphate fertilizers will increase crop yields and maintain a high level of productivity. On the more sloping areas and long gentle slopes, diversion terraces, or a complete terrace system, may be necessary in addition to the above practices.

Vernon clay loam, sloping (2–10% slopes) (VD).—This is a very shallow reddish-brown soil over reddish-brown or red sandy shales and shale (red beds). It occupies gently sloping to rolling areas adjacent to drains and streams in the north-central part of the county in association with the Renfrow and Kirkland soils. The total area is 19,500 acres. Gradients range from about 2 to 15 percent but are dominantly less than 10.

The surface soil to a depth of about 4 inches consists of reddish-brown or dark reddish-brown friable clay loam. It grades into the thin subsoil of reddish-brown crumbly clay, which is underlain at depths ranging from about 10 to 18 inches by the parent material of slightly weathered sandy shales or shale. The surface soil, subsoil, and substratum are calcareous in most places, but small areas mapped in small prairies within the forested eastern part of the county are not calcareous and are underlain by alkaline to weakly calcareous clays or shales.

Surface drainage for this soil is rapid, but internal drainage is very slow, and much of the rainfall is lost by runoff. Most areas have been overgrazed and the dominant grasses now are buffalo, grama, and three-awn.

Use and management.—This thin droughty unproductive soil is unsuitable for crops, though some small areas are cultivated with surrounding more productive soils to avoid having irregularly shaped fields. The small cultivated areas are used principally for growing sorghums, oats, and wheat. Yields are low and in average years probably only repay the cost of seed and tillage. Native pastures have a carrying capacity of about 6 acres for one cow, and abandoned fields on which native grasses have become reestablished have a carrying capacity of about 8 acres per cow during the grazing season. Native hay yields about 1 ton an acre. Controlled grazing, weed control, seeding of legumes, and the use of fertilizer are management practices to be considered for this soil.

Vernon clay loam, moderately steep (10–20% slopes) (VC).—This soil is similar to Vernon clay loam, sloping, but occupies more sloping

and dissected areas. It occurs below less sloping Vernon and Renfrow soils, mainly along small streams and drains and around streamheads. Gradients range from about 8 to 30 percent but are dominantly 10 to 20. The total area of this soil is 8,200 acres.

Together, the thin surface soil and subsoil layers are about 10 inches thick over the calcareous red clays and shales. Included with this soil are small areas of deeper soils similar to the Renfrow. These inclusions are on lower slopes and small areas of exposed red beds and they make up less than 10 percent of the areas occupied by this moderately steep soil. The greater acreage has a fair cover of buffalo, bluestem, and grama grasses, but the small inclusions of exposed red beds are barren and usually gullied.

Use and management.—This soil is unsuitable for cultivation and is used almost entirely for pasture. The carrying capacity is about 7 acres for a cow during the grazing season. Management practices to be considered are controlled grazing, weed control, seeding of legumes, and the use of fertilizer.

Yahola silty clay loam (0–1% slopes) (Yb).—This soil closely resembles the associated Yahola silt loam but has a finer textured surface layer and occupies slightly lower positions. The total area is 700 acres.

The surface layer is reddish-brown or brown friable crumbly silty clay loam that averages 20 inches thick. It is underlain by deep beds of light-red alluvial deposits consisting of stratified silt loam, loam, and fine sandy loam. In places this material is fine sandy loam that contains thin strata of silt loam or loamy fine sand. This soil is alkaline but not calcareous where it occurs on the flood plains of the Little River and smaller streams. It is calcareous on the flood plain of the Canadian River.

The soil occupies low nearly level areas but is well drained. It is occasionally overflowed, but floodwaters remain for only a short time and seldom cause crop damage or complete losses. The water table lies 10 to 15 feet below the surface, and water rapidly penetrates the substrata.

Use and management.—Yahola silty clay loam is well supplied with plant nutrients and will continue to produce moderate to high yields under ordinary management for a long time. Farmers regard it as especially desirable for corn and cotton. Corn yields about 25 bushels; cotton, 200 pounds of lint; sorghums, 26 bushels of grain or 3¼ tons of fodder; and alfalfa, 3 tons an acre. Such minor crops as cowpeas, clovers, Sudan grass, and oats are grown. Crop yields vary according to the damage from overflow and the time of year the soil is inundated, but there are few crop failures from flooding. Bermuda grass pastures have a carrying capacity of about 1 acre for a cow during the growing season. Some areas are under native forest.

Average yields can be increased by using rotations in which a legume is included, controlling insects, and planting adapted high-yielding varieties. Frequently flooded areas on which crop production is hazardous should be sodded with Bermuda grass and used for pasture.

Yahola silt loam (0–1% slopes) (Ya).—This is a well-drained reddish-brown soil that occupies nearly level flood plains, chiefly those along the Little River and other streams that drain soils of the

prairie. Its total extent is 19,000 acres. It is overflowed occasionally, but floodwaters usually remain for only a short time, and most of the soil is successfully cultivated. The native vegetation is forest, mainly elm, oak, hackberry, ash, pecan, and cottonwood.

The surface layer is reddish-brown or light reddish-brown friable silt loam that ranges from 15 to 26 inches thick but averages about 20. Below this, to a depth of several feet, the alluvium is reddish-yellow or reddish-brown friable silt loam or fine sandy loam containing thin strata of loamy fine sand. In some narrow flood plains, considerable variation in color and thickness of the surface layer occurs within short distances, and, as mapped, the area includes small bodies of fine sandy loam and silty clay loam. The surface layer and underlying alluvium are alkaline in reaction, and a few small areas are calcareous.

Use and management.—Practically all of the wider stream bottoms are cultivated, but many of the narrow bottoms are in pasture or woodland. Corn, cotton, alfalfa, and sorghums are the principal crops. The estimated average yield of corn is 20 bushels; cotton, 180 pounds of lint; alfalfa, 2 tons; and grain sorghums, 22 bushels an acre. Bermuda grass pastures have a carrying capacity of 1 acre for each cow during the growing season. During very favorable years, yields obtained by the better farmers are about 50 percent greater than the averages given above.

This is a moderately fertile and productive soil with good moisture relations. Nevertheless, occasional loss or reduction of crop yields and weed infestation are caused by overflows, and this has led to indifferent management. The result has been low average yields. Under good management, prevailing average yields should increase 50 to 100 percent. Such management would include use of crop rotations that included legumes about 1 year in 3, insect control, timely cultivation and weed control, and the use of adapted high-yielding varieties.

Zaneis very fine sandy loam, gently sloping (1–4% slopes) (Za).—This is a dark reddish-brown friable soil of medium depth over reddish sandy shale or sandstone. Its total extent is 500 acres. It is similar to the Renfrow soils but has more friable and permeable subsoil layers.

The surface soil, to a depth of about 10 inches, consists of brown or dark reddish-brown friable very fine sandy loam. This grades into the subsoil of reddish-brown crumbly friable silty clay or clay. The subsoil rests on slightly weathered sandy shale or sandstone about 3 feet below the surface. The depth of the soil over parent rock (sandstone) is variable; the range is from about 2 to 4 feet. The surface soil and subsoil are slightly acid to neutral, but the parent material is neutral to aklaline in reaction.

Surface runoff on this soil is slow to moderate, and internal drainage is moderate because of the permeable subsoil. Slight erosion has occurred on the more sloping cultivated areas, but the thickness of the surface soil and productivity of such areas have been reduced no more than about 15 percent because of erosion. This soil has a fair to low water-holding capacity, depending on the depth to bedrock.

Use and management.—This soil is only moderately fertile but is responsive to management. It is easily tilled, and where not too

shallow, produces moderate yields of common field crops and vegetables during years of average rainfall. About 40 percent is used for sorghums, cotton, oats, and some peanuts, cowpeas, and wheat; most of the rest is native pasture of bluestem and grama grasses. A small percentage of the soil is in cultivation, mainly because it occurs in small areas in association with shallow soils unsuitable for crops. The estimated average yield of grain sorghum is 12 bushels of grain or 1½ tons of fodder; oats, 20 bushels; and cotton, 140 pounds of lint an acre. Native pastures have a carrying capacity of about 5 acres for a cow during the grazing season.

This soil is not high in plant nutrients, and moisture is usually limited during the critical growing period of crops. These conditions can be improved by the use of crop rotations that include a legume fertilized with phosphate, and by contour cultivation and strip cropping if row crops are grown. Terraces may also be needed to reduce runoff from the more sloping areas of cropland.

Zaneis very fine sandy loam, sloping (4–6% slopes) (ZB).—This soil is similar to Zaneis fine sandy loam, gently sloping, but has thinner layers and a more sloping surface. Its total extent is 1,600 acres. The average thickness of the surface soil is 8 inches. Depth to bedrock is generally about 24 inches but the range is from 18 to 30. Surface drainage is rapid, and the land is very susceptible to erosion if cultivated.

Use and management.—Sorghums, oats, and wheat are the principal crops, but small areas are used for cowpeas, peanuts, and Sudan grass. Crop yields are slightly less than those on the gently sloping soil. They are estimated to be about 10 bushels of grain sorghum or 1 ton of fodder, 20 bushels of oats, and 8 bushels of wheat an acre. Crop yields decline rapidly under the usual method of farming because supplies of plant nutrients have been reduced by cropping and erosion. Native pastures have a carrying capacity of one cow for about 5 acres.

This soil should be used for pasture or meadow wherever possible, for it is susceptible to erosion and low in productivity. It can be successfully cultivated under very intensive management, but because of the small size and irregular shape of areas suitable for crops, good management is very expensive and difficult. If the soil is used for crops, terraces should be constructed, legumes fertilized with phosphate used in the rotation, and thick-growing crops planted as often as possible.

Zaneis very fine sandy loam, sloping, eroded (3–8% slopes) (ZC).—This soil differs from Zaneis very fine sandy loam, sloping, mainly in having thinner surface soil caused by accelerated erosion. The total area is 2,000 acres. The surface soil averages about 5 inches in thickness but ranges from about 3 to 7. Gullies are common but not numerous enough to prevent cultivation. Surface drainage is rapid.

Use and management.—Most of the cultivated soil is used for sorghums and oats; only small acreages are used for wheat, cotton, corn, and Sudan grass. Crop yields are low and variable, the yield depending on the depth of soil. The average yield of sorghums is 7 bushels of grain or three-fourths ton of fodder; oats, 12 bushels; and cotton,

85 pounds of lint an acre. Idle land and abandoned-field pastures support a thin cover of three-awn and some bluestem grasses. The quality of grazing is low, and the carrying capacity is about 9 acres for a cow during the growing season.

This land is not well suited to crops and should be retired to pasture if better land is available for crops. The less sloping areas can be cropped sucessfully if intensive management practices are used, but pasture or meadow is probably a more profitable use.

USE AND MANAGEMENT OF CLEVELAND COUNTY SOILS [9]

The control of erosion is one of the first soil management requirements on all areas of sloping cultivated land. A large acreage of soils of forested uplands, originally cultivated, has been abandoned because of soil loss by erosion. Eroded fields are the result of poor soil management. Row crops have been responsible for the greatest loss of surface soil. Soil fertility cannot be maintained or improved where loss of surface soil by erosion exceeds the rate of soil formation. A change in land use may be required to reduce the harmful effect of accelerated erosion on many farms.

HOW TO CONSERVE THE SOIL

Although different farming systems may be used on the same types of land, the conservation requirements of sloping cultivated soils are similar. Intensive soil conservation practices are required to prevent serious loss of soil when cultivated crops are planted on moderate to steep slopes. Simple practices are needed on gentle slopes. Terrace ridges should be used to control gully erosion and reduce sheet erosion on all upland farms if satisfactory outlets for water disposal are available or can be constructed before terrace ridges are built. Contour planting of crops will increase the efficiency of rainfall and protect terrace ridges that frequently break where runoff water is retarded by rows of small grain growing across the terrace channel or where cultivation of row crops lowers the effective height of the terrace ridge. Strip crops should be planted in an east-west direction to control wind erosion on sandy land.

Too many farmers have not learned that the maintenance of a terrace system is just as important as maintaining a fence. It is a part of the job of better land management.

It is not easy for a farmer who has been following a destructive system of soil exploitation to change his method of farming without temporary reduction of acreage in cash crops. Farm income will be reduced unless livestock are available to utilize grasses and legume crops planted to protect or improve the soil. Grain sorghums and cotton will grow on eroded land where small grains will not produce a good crop until a legume has been grown for soil improvement.

The county agent or local Soil Conservation Service staff can assist in making recommendations or can supply bulletins containing information on erosion control practices for specific areas.

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CHEMICAL COMPOSITION OF REPRESENTATIVE SOIL PROFILES

Chemical analyses of representative soil profiles collected from different parts of Cleveland County are given in table 6. Ten profiles were collected from soils of prairie uplands, three profiles from the forested uplands, and the rest from low terraces and bottom lands.

Although Cleveland County is in an area of moderate rainfall, chemical tests show the virgin soils of the uplands are usually neutral or only slightly acid and for the most part have not been strongly leached. The organic-matter content of these soils is quite variable. A deeper accumulation of soil organic matter will be found on gentle slopes than on steeper slopes, although the percentage of organic matter in the surface soil of shallow and deep soils may be somewhat similar. The total phosphorus content of all soils of the uplands was low. The Chickasha and Norge soils were very low in available inorganic phosphorus in the subsurface layers. Soils formed on shales or sediments containing a high percentage of clay are usually higher in available phosphorus than soils on sandier materials.

Most soils of forested uplands have developed on sandstone. Leaching has decreased the lime content of these soils to a lower level than that of the soils of the prairie. However, the two profiles of Stephenville fine sandy loam indicate that the degree of leaching is not uniform within the soil type. Forested soil profiles are low in organic matter except in the surface layer of virgin soil and are very deficient in both total and available phosphorus. The Dougherty fine sandy loam, which has developed on sandy alluvial deposits, is not so acid as the other forested soils. This soil profile is very low in total phosphorus but will grow good crops of sweetclover without fertilizer treatment because it is not acid and is high in available inorganic phosphorus.

Soils on the low terraces and flood plains in Cleveland County are normally not acid. The bottom lands along the South Canadian River are usually higher in total and available phosphorus than the bottom lands of smaller streams in the forested or prairie upland areas. Alfalfa can be grown on all soils of bottom lands without fertilization wherever drainage conditions are favorable for deep root development.

TABLE 6.—*Chemical composition of soils in Cleveland County, Okla.*

SOILS OF THE PRAIRIE

Soil type and sample No.	Location	Depth	pH	Organic matter	Total nitrogen	Total phosphorus	Easily soluble phosphorus
		Inches		*Percent*	*Percent*	*Percent*	*Parts per million*
Bethany silt loam, level:							
8517	SW¼ sec. 23, T. 10 N., R. 3 W.	0–6	6.4	2.59	0.121	0.018	24
8519		6–11	6.5	2.19	.097	.011	8
8520		11–18	6.8	1.72	.067	.010	8
8521		18–36	8.4	.99	.036	.010	40
8522		36–48	8.5	.45	.010	.008	44
8523		48–64	7.9	.28	.006	.011	76
8524		64–90	7.6	.19	.012	.031	192
Bethany silt loam, level:							
8510	NE¼ sec. 15, T. 9 N., R. 3 W.	0–6	6.4	1.62	.077	.011	10
8512		6–12	7.0	1.36	.059	.009	8
8513		12–18	7.5	1.53	.067	.015	38
8514		18–26	7.7	1.13	.055	.014	60
8515		26–54	8.4	.42	.020	.015	80
8516		54–72	7.9	.26	.024	.013	72
Chickasha very fine sandy loam, gently sloping:							
8549	NE¼ sec. 33, T. 8 N., R. 1 W.	0–6	5.9	3.32	.121	.011	12
8550		6–14	5.9	1.97	.089	.008	4
8551		14–20	5.7	1.97	.081	.010	2
8552		20–30	5.8	1.32	.057	.006	0
8553		30–42	5.8	.98	.044	.008	0
8554		42–60	6.1	.50	.026	.004	2
8555		60–72	6.2	.38	.022	.005	0
Minco fine sandy loam, gently sloping:							
8543	SE¼ sec. 12, T. 7 N., R. 2 W.	0–6	7.0	1.78	.081	.010	18
8545		6–14	6.8	1.83	.073	.010	10
8546		14–30	6.8	1.39	.059	.008	6
8547		30–52	6.3	.85	.036	.004	2
8548		52–72	6.8	.51	.022	.005	14

TABLE 6.—*Chemical composition of soils in Cleveland County, Okla.*—Continued

SOILS OF THE PRAIRIE—Continued

Soil type and sample No.	Location	Depth	pH	Organic matter	Total nitrogen	Total phosphorus	Easily soluble phosphorus
		Inches		*Percent*	*Percent*	*Percent*	*Parts per million*
Minco silt loam, gently sloping:							
8570	SE¼ sec. 26, T. 9 N., R. 3 W.	0–6	6.5	2.69	0.101	0.017	22
8572		6–14	6.3	2.02	.075	.016	16
8573		14–30	6.5	1.39	.053	.011	8
8574		30–50	7.0	.65	.028	.005	4
8575		50–82	6.6	.53	.026	.003	2
Norge silt loam, sloping:							
8564	NW¼ sec. 35, T. 8 N., R. 2 W.	0–6	6.8	2.80	.113	.014	16
8567		6–14	6.1	1.49	.071	.009	0
8568		14–36	7.8	.70	.032	.005	0
8569		36+	7.4	.36	.022	.002	2
Renfrow silt loam, gently sloping:							
8597	SW¼ sec. 2, T. 10 N., R. 2 W.	0–7	6.5	4.40	.196	.019	18
8598		7–12	6.5	1.58	.071	.009	2
8599		12–20	7.8	1.03	.048	.014	56
8600		20–36	8.4	.42	.028	.024	84
Vanoss silt loam, nearly level: [1]							
8592	SE¼ sec. 9, T. 6 N., R. 1 W.	0–6	7.2	1.68	.071	.012	30
8593		6–14	6.6	1.90	.075	.015	12
8594		14–20	6.0	1.78	.077	.013	4
8595		20–34	6.3	.95	.042	.012	20
8596		34–44	6.7	.40	.022	.003	6
Vernon clay loam, sloping:							
8576	N½ sec. 8, T. 9 N., R. 2 W.	0–6	8.0	2.25	.095	.030	80
8577		6+	8.5	.41	.026	.028	84
Zaneis very fine sandy loam, gently sloping:							
8585	SW¼ sec. 14, T. 8 N., R. 2 W.	0–6	7.4	2.15	.111	.015	24
8586		6–12	7.4	1.83	.105	.015	26
8587		12+	8.2	.40	.024	.004	38

Soils of Forested Uplands							
Dougherty fine sandy loam, sloping:							
8530	NE¼ sec. 33, T. 6 N., R. 1 E.	0–6	7.3	1.74	0.065	0.006	22
8532		6–10	6.8	.73	.022	.005	8
8533		10–25	6.0	.52	.012	.002	4
8534		25–34	5.9	.39	.020	.006	4
8535		34–44	6.4	.81	.026	.008	4
8536		44–64	6.7	.37	.020	.003	2
Stephenville fine sandy loam, gently sloping:							
8504	SE¼ sec. 1, T. 10 N., R. 1 E.	0–6	5.3	2.09	.075	.007	8
8506		6–16	5.1	.47	.014	.001	0
8507		16–22	4.8	.56	.028	.001	0
8508		22–36	5.3	.40	.022	.002	0
8509		36–46	5.8	.56	.030	.001	0
Stephenville fine sandy loam, gently sloping:							
8578	NE¼ sec. 16, T. 9 N., R. 1 E.	0–6	6.7	1.44	.046	.008	12
8579		6–12	6.2	1.01	.028	.006	2
8580		12–16	5.8	.62	.024	.006	2
8581		16–22	5.6	.79	.026	.005	4
8582		22–26	5.5	.38	.024	.014	0
8583		26–36	7.6	.30	.018	.003	0
8584		36+	7.4	.23	.007	.002	0
Soils of Low Terraces and Bottom Lands							
McLain silty clay loam:[1]							
8525	NE¼ sec. 19, T. 6 N., R. 1 W.	0–6	6.8	2.16	0.109	0.029	96
8526		6–18	6.9	2.89	.135	.027	96
8527		18–26	6.9	.71	.036	.016	96
8528		26–44	8.4	.82	.040	.021	2
8529		44–90	8.1	.19	.022	.037	144
McLain silty clay loam:[1]							
8559	NW¼ sec. 34, T. 9 N., R. 3 W.	0–6	8.1	2.90	.127	.043	52
8560		6–14	8.0	1.68	.083	.037	60
8561		14–26	8.1	1.68	.069	.042	64
8562		26–38	8.2	1.70	.069	.039	44
8563		38–45	8.4	1.03	.046	.033	6

See footnote at end of table.

TABLE 6.—*Chemical composition of soils in Cleveland County, Okla.*—Continued

SOILS OF LOW TERRACES AND BOTTOM LANDS—Continued

Soil type and sample No.	Location	Depth	pH	Organic matter	Total nitrogen	Total phosphorus	Easily soluble phosphorus
		Inches		*Percent*	*Percent*	*Percent*	*Parts per million*
McLain clay:[1]							
8613	SW¼ sec. 4, T. 9 N., R. 3 W.	0–6	7.7	2.75	.137	.045	160
8614		6–24	8.1	1.08	.057	.036	168
8615		24–36	7.9	.90	.041	.032	112
8616		36–52	8.3	1.35	.065	.044	104
Pulaski fine sandy loam:[1]							
8556	SW¼ sec. 34, T. 8 N., R. 1 W.	0–6	7.3	1.20	.040	.010	20
8557		6–50	7.4	.79	.018	.006	6
8558		50–70	7.8	1.70	.081	.011	20
Pulaski fine sandy loam:[1]							
8605	SW¼ sec. 34, T. 8 N., R. 1 W.	0–6	6.8	2.39	.086	.013	24
8606		6–12	7.2	1.90	.071	.011	24
8607		12–22	8.2	1.04	.034	.009	26
8608		22–30	8.4	.60	.022	.005	10
8609		30–42	8.4	.42	.012	.005	10
Reinach fine sandy loam:[1]							
8601	SE¼ sec. 17, T. 9 N., R. 3 W.	0–6	8.1	.83	.024	.024	84
8602		6–20	8.4	.58	.022	.016	80
8603		20–42	9.3	.58	.018	.015	60
8604		42–54	9.3	.24	.002	.021	60
Reinach silt loam:[1]							
8617	NE¼ sec. 29, T. 9 N., R. 3 W.	0–6	7.9	1.30	.055	.029	96
8618		6–16	8.0	1.12	.048	.028	104
8619		16–34	8.0	1.36	.059	.036	88
8620		34–50	8.5	.48	.008	.023	56

Reinach silty clay loam: [1]							
8621	SW¼ sec. 19, T. 10 N., R. 2 W.	0- 6	7. 5	2. 12	. 087	. 023	52
8622		6-20	6. 7	1. 89	. 085	. 015	40
8623		20-32	6. 5	1. 18	. 053	. 008	16
8624		32-55	6. 7	. 59	. 032	. 013	48
8625		55-65	8. 2	. 42	. 026	. 016	60
Reinach silty clay loam: [1]							
8610	SE¼ sec. 23, T. 8 N., R. 2 W.	0- 6	6. 8	2. 88	. 123	. 028	68
8611		6-28	7. 8	. 80	. 042	. 021	96
8612		28-48	8. 1	. 35	. 014	. 012	52
Yahola silt loam: [1]							
8538	SE¼ sec. 12, T. 8 N., R. 2 W.	0- 8	7. 5	1. 66	. 065	. 015	52
8540		8-20	7. 8	1. 27	. 057	. 010	26
8541		20-26	7. 8	1. 85	. 081	. 019	80
8542		26+	8. 3	. 34	. 028	. 016	88
Yahola silt loam: [1]							
8588	SW¼ sec. 26, T. 8 N., R. 1 W.	0- 6	7. 7	1. 75	. 083	. 020	80
8589		6-14	7. 5	1. 32	. 065	. 023	96
8590		14-46	8. 0	. 58	. 032	. 014	80
8591		46+	8. 2	. 48	. 026	. 011	64

[1] Cultivated soil.

CULTIVATION REDUCES ORGANIC MATTER AND NITROGEN

More than one-third of the organic matter and nitrogen in the cropland of the county has disappeared as a result of cultivation. When crops are removed, the fertility of the soil gradually declines. Every bushel of corn removes about a pound of nitrogen; every bale of cotton, 35 pounds. A study in the loss of plant nutrients from Cleveland County soils as a result of cultivation, from an average of nine comparisons, showed results as follows:

Condition of soil:	*Organic matter* [1] *Lb.*	*Nitrogen* [1] *Lb.*	*Phosphorus* [1] *Lb.*
Virgin	45,000	1,820	240
Cropped	28,600	1,180	200
Loss	16,400	640	40

[1] Pounds per acre, 6⅔ inches deep.

These results show that Cleveland County soils have lost 16,400 pounds of organic matter, 640 pounds of nitrogen, and about 40 pounds of phosphorus as a result of cultivation and crop removal. These losses represent 36.4 percent of the organic matter, 35.2 percent of the nitrogen, and 16.7 percent of the phosphorus originally present in the surface soil, which was about 6⅔ inches deep. Losses on areas of severely eroded land would be much greater than indicated.

CHANGES IN SOIL REACTION

Decomposition of soil organic matter will gradually increase soil acidity in a humid region. Lime, which is needed to keep a soil neutral, is removed from the mineral matter in the soil by rain. Lime and other basic substances are carried into the subsoil during periods of abundant rainfall, so acid residues gradually accumulate in the surface soil.

The need of lime is determined by chemical tests. A study of 304 soil samples collected from Cleveland County indicates that 213 samples were well supplied with lime and would grow good sweetclover and alfalfa without treatment, and that 47 were slightly acid, 31 moderately acid, and 13 strongly acid. The last three groups of soils would need approximately 1, 2, and 3 tons of lime per acre, respectively, to grow alfalfa or sweetclover. Most soils of the uplands should be limed to produce maximum yields of sweetclover. Only a small percentage of the soils of the bottom lands need lime to grow better crops of alfalfa.

PHOSPHORUS AVAILABILITY

Chemical tests will determine the relative availability of inorganic phosphorus in a soil, but they do not measure the availability of phosphorus in soil organic matter. Two hundred and twenty samples of soils were tested for easily soluble phosphorus. Seventy-one of the samples were high or very high in available phosphorus; field crops would not respond to phosphate fertilization on these soils. Fifty-nine samples were moderately high in available phosphorus; alfalfa and many vegetable crops would not respond to phosphate

fertilization on these soils. Ninety samples were low to very low in available phosphorus.

All crops respond to phosphorus fertilization when the available phosphorus is low or very low and other factors are favorable for growth. Cowpeas and peanuts can feed more readily on relatively insoluble inorganic phosphate than alfalfa and sweetclover. Consequently, on some of the sandier soils a rotation with cowpeas will tend to maintain crop yields without fertilization, whereas phosphate fertilization is needed to grow alfalfa or sweetclover successfully. A very high percentage of all soils of the uplands require phosphate to increase the growth of the legume crops needed to maintain or improve crop production. Soils of the bottom lands are usually high in available phosphorus and will produce maximum yields of legumes without fertilization.

CROP ADAPTATION AND SOIL IMPROVEMENT

The adaptation of soil-depleting crops to different soils has been determined from farm experience over a long period. Less is known of the adaptations of soil-improving crops. The planting of soil-building crops in regular rotation with soil-depleting crops is not a common practice but will increase as farmers begin to realize that low crop yields are caused more frequently by low soil fertility than by unfavorable climatic conditions. Slope of the land and depth, texture, and structure of the soil profile are important factors that determine the kind of crops or plants that should be used to maintain or improve the productivity or grazing value of soils of the uplands. Overflow hazards, the need for drainage, and methods of maintaining the fertility of the soil are important factors affecting cropping systems on soils of the bottom lands.

Cultivated soils with slowly permeable subsoils, such as those of the Kirkland, Bethany, and Renfrow series, should be used principally for small grain. Alfalfa can be grown on the Kirkland and Bethany soils if soil acidity is corrected by liming and phosphate fertilizers are applied. Under average conditions on these soils, sweetclover should be grown in a crop rotation to supply the nitrogen for succeeding crops. Planting small grain in rows 14 or 16 inches apart will provide a more favorable condition for the early growth and survival of sweetclover seedlings. Phosphate fertilizer should be applied in alternate drill rows, between rows of spring oats spaced 14 to 16 inches apart, at a rate equivalent to 150 pounds of 20-percent superphosphate an acre. Either rock phosphate or superphosphate can be used. The sweetclover seed should be dropped on the surface of the soil above the fertilized zone. This surface seeding of sweetclover is a safe method of soil improvement in this area, where climatic conditions may limit plant development and prevent a crop from utilizing a fertilizer applied to increase the yield of grain or cotton. Forage yields are increased by fertilization during many seasons when no increase in grain yield will be obtained.

Deep soils of the upland with permeable subsoils, such as those of the Vanoss, Minco, and Norge series, are good soils for small grains. These soils also may be used for the production of summer crops,

such as corn, cotton, and grain sorghums, because the subsoils are favorable for moisture storage and root development. Sweetclover should be grown in a crop rotation with small grain on these soils to add nitrogen to the soil. Contour farming is very important on sloping areas to reduce soil loss from runoff water. If peanuts are grown in a cropping system, rye should be planted after the peanuts are harvested to provide some protection against wind erosion, or the land should be listed to prevent soil movement. Another legume, such as hairy vetch, cowpeas, or sweetclover, should be grown in a cropping system with peanuts to provide the nitrogen needed to maintain or increase the yields of other soil-depleting crops.

A forage crop rotation adapted to many different soils would include oats and sweetclover the first season; sweetclover for pasture the second year, with rye planted in the fall, pastured in the spring of the third year and plowed under to be followed by Sudan grass for hay or summer grazing; and Atlas or Sumac sorgo or Sunrise kafir the fourth year for silage or fodder.

The soils of the Stephenville and Darnell series are the more important soils of the upland forested area of Cleveland County. They are normally rather shallow. Hairy vetch is a good crop for soil improvement. Its successful production will depend on the inoculation of the seed and use of phosphate fertilizer, preferably drilled in the row at time of planting at a rate equivalent to 150 pounds of 20-percent superphosphate an acre. Rye and hairy vetch in alternate years is a good pasture rotation. The residues of each crop should be left on the surface to control erosion. Crop residues can be left on the surface by using sweeps to control summer weeds and by disking to prepare the seedbed for the following crop. Cowpeas can also be grown in alternate rows with grain or forage sorghums to increase crop yields.

Dougherty soils have a favorable physical structure where they have not been damaged by gully erosion and may be made highly productive by proper cropping and soil treatment. Sweetclover planted alone or in small grain is the best legume for soil improvement. Hairy vetch, planted in the fall after small grain or an early corn crop, can also be used to increase the nitrogen content of these soils. A solid cover is needed to reduce runoff on sloping areas, consequently, cowpeas planted in 36- to 42-inch rows are not so desirable for soil improvement or erosion control as a solid planting of vetch or sweetclover.

The natural fertility of the soils of low terraces and bottom lands in Cleveland County is high. Alfalfa can be grown without phosphate fertilizer or lime on all well-drained soils not affected by severe overflow. The nitrogen content of a soil will increase during the years that alfalfa is growing; consequently, yields of corn, cotton, small grains, and grain sorghum can be maintained by planting alfalfa in a rotation with these crops. The McLain and Reinach soils are better adapted to alfalfa than the soils of the low bottom lands (Pulaski, Yahola, Lincoln, and Roebuck). Occasional floods do not injure alfalfa plants if the subsoil is well drained and surface water does not stand on the field longer than 2 or 3 days. Spring floods usually occur before June 15. Early maturing grain sorghums, cow-

peas, mung beans, or cotton can be planted after that date, and normally good yields will be obtained. Cowpeas in alternate rows with grain sorghums, or the use of hairy vetch, can be recommended for improvement for many of these sandy soils. Surface drainage is needed to improve the Roebuck and Sweetwater soils. Soils of low bottom lands planted to Bermuda grass produce good pasture. Pasture is probably the best use for these soils under average conditions. Johnson grass is abundant in some areas and can be grazed or cut for hay.

Vernon soils are shallow and usually occur on moderate to steep slopes. They should be used for pasture. Pasture management that includes controlled grazing, use of fertilizer, growing of legumes, and weed control, will increase the grazing value of these soils.

Derby soils are very sandy, and wind erosion is a problem on cultivated areas. Hairy vetch followed by cowpeas and corn or cotton the second year would be a good rotation to maintain crop production. Late planting will prevent wind erosion, which is usually most severe late in winter and early in spring. The use of alternate strips of cowpeas and grain sorghums and phosphate fertilizer to increase the yield of cowpeas, is a good cropping system. Hairy vetch planted in the fall between rows of berries or fruit trees will add organic matter and nitrogen needed to increase fruit production.

Crop varieties adapted to this area are: Stoneville, Mebane, or Deltapine cotton; Fulghum oats for spring planting; Wintok and Tennex oats for fall planting; Tenkow barley; Early Triumph or Pawnee wheat; and hybrid corn of similar maturity to U. S. 13. Sorghums for grain include Standard Blackhull kafir, or Oklahoma No. 1 Darso if damage from birds is severe. Sorghums for fodder include, Sumac sorgo, Sunrise kafir, or Atlas sorgo. Abruzzi rye is one of the best varieties for pasture and grain. Oklahoma Common alfalfa is the best variety of alfalfa until seed of wilt-resistant strains is available. Biennial white sweetclover is better than yellow-blossom sweetclover because it will make a larger forage yield the second season.

YIELD ESTIMATES FOR THE SOILS OF CLEVELAND COUNTY

Estimated average acre yields of crops to be expected on the soils of Cleveland County over a period of years are given in table 7 for two levels of soil management. Estimated yields for customary management are under columns A; those for good management, under columns B.

TABLE 7.—*Estimated average acre yields of principal crops and carrying capacities of pasture to be expected over a period of years on the soils of Cleveland County, Okla., under two levels of management*

[Management levels:
For crops:
A. Customary: See p. 62 for definition. B. Good: See section on Soil Descriptions and section on Use and Management of Cleveland County Soils.
For pasture:
A. Customary: Unimproved native pasture unless otherwise indicated. B. Improved: Includes control of weeds, but not by burning, and control of grazing to permit natural reseeding. Unless otherwise indicated, does not include improvement of drainage or application of fertilizers. Pastures on some soils in the county will respond to fertilizer and drainage.
Blank spaces in columns indicate soil is not suited to use specified]

Soil	Map symbol	Corn		Oats		Sorghum for—				Wheat		Cotton lint		Alfalfa		Pasture [1]			Principal use or crops
						Grain		Fodder											
		A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B		
																Acres per cow for grazing season [2]	*Acres per cow for grazing season* [2]	*Cow-days per acre for the year* [3]	
Bethany silt loam:		*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Lb.*	*Lb.*	*Tons*	*Tons*				
Level	BB	17	25	30	45	20	30	2.5	3.5	16	20	180	250	2.5	3	4	3	85	Wheat, oats, cotton, corn.
Gently sloping	BA	14	25	30	45	18	30	2.5	3.5	15	20	160	250	2.25	3	4	3	85	Do.
Chickasha very fine sandy loam:																			
Gently sloping	CA	15	25	25	35	18	25	2.0	3.0	10	15	170	225	1.75	2.5	4	3	85	Sorghums, wheat, oats, corn, cotton.
Gently sloping, eroded	CB	10	16	18	30	12	18	1.5	2.5	7	12	120	175	1.25	2.5	----	4	65	Cotton, sorghums, oats.
Darnell-Stephenville fine sandy loams.	DA	----	----	----	----	----	----	----	----	----	----	----	----	----	----	[4] 16	[4] 12	[4] 20	Forest, woodland pasture.
Derby loamy fine sand:																			
Sloping	DC	6	12	----	----	8	14	.75	1.5	----	----	75	125	----	----	8	6	40	Pasture.
Dune phase	DB	----	----	----	----	----	----	----	----	----	----	----	----	----	----	12	8	30	Do.
Dougherty fine sandy loam:																			
Gently sloping	DD	10	20	14	25	10	20	1.5	2.5	----	----	110	175	----	----	[4] 12	[4] 10	[4] 25	Cotton, sorghums, pasture.
Sloping	DE	7	15	12	18	8	15	1.2	2.0	----	----	90	150	----	----	[4] 12	[4] 10	[4] 25	Do.
Sloping, eroded	DF	5	----	10	----	6	----	1.0	----	----	----	60	----	----	----	[4] 12	[4] 5	[4] 50	Idle, sorghums, pasture.
Strongly sloping	DG	----	----	----	----	----	----	----	----	----	----	----	----	----	----	[4] 16	[4] 12	[4] 20	Forest, woodland pasture.
Kirkland silt loam:																			
Gently sloping	KA	12	18	25	40	15	20	2.0	3.0	12	16	150	200	1.5	2.0	4	3	85	Wheat, oats, cotton, sorghums.
Gently sloping, eroded	KB	----	----	16	30	10	15	1.0	2.0	6	10	100	150	----	1.5	----	4	65	Do.
Lincoln very fine sandy loam	LA	8	15	----	----	12	16	1.5	2.5	----	----	100	175	----	----	7	[5] 3	[5] 85	Pasture, sorghums, corn, cotton
McLain clay	MA	25	40	35	40	22	30	3.0	3.5	18	20	200	250	3.0	4.0	4	[5] 2	[5] 125	Corn, cotton, alfalfa.
McLain silty clay loam	MB	30	55	35	45	25	35	3.0	4.0	18	22	240	300	3.5	4.0	4	[5] 2	[5] 125	Do.
McLain soils, saline phases	MC	10	[6] 40	16	[6] 30	14	[6] 30	1.5	[6] 3.0	----	[6] 15	120	[6] 200	1.5	[6] 3.0	6	[5] [6] 3	[5] [6] 85	Sorghums, corn, cotton, pasture.
Minco silt loam:																			
Gently sloping	MF	18	30	25	35	20	30	2.0	3.0	12	15	175	225	1.5	3.0	4	3	85	Cotton, corn, sorghums.
Sloping	MG	15	25	25	35	18	25	2.0	3.0	12	15	160	200	1.25	2.5	5	4	65	Do.
Minco fine sandy loam:																			
Gently sloping	MD	16	25	20	30	18	25	2.0	3.0	10	14	150	200	1.25	2.5	5	4	65	Do.
Sloping	ME	14	20	18	25	16	22	1.75	2.5	8	12	140	175	----	2.0	5	4	65	Do.

Norge silt loam:																			
Gently sloping	NA	12	20	25	35	15	25	1.5	3.0	10	15	160	200			4	3	85	Do.
Sloping	NB	10	16	25	35	12	18	1.25	2.5	8	12	140	175			4	3	85	Sorghums, cotton, corn, oats, pasture.
Sloping, eroded	NC	7		14	25	7	14	1.0	2.0	6	10	90	150			6	4	65	Do.
Oil-waste land	OA																		Wasteland.
Pulaski fine sandy loam	PA	12	20			15	20	2.0	3.0			150	200			7	[5] 2	[5] 125	Pasture, corn, cotton, sorghums.
Pulaski-Sweetwater fine sandy loams	PB															7	[5] [7] 2	[5] [7] 125	Pasture.
Reinach silty clay loam	RC	28	50	35	45	30	40	3.5	4.0	15	18	240	300	3.0	3.5	3	[5] 1	[5] 250	Corn, cotton, sorghums, oats.
Reinach silt loam	RB	25	50	32	40	25	40	3.0	4.0	14	18	250	300	2.5	3.0	3	[5] 1	[5] 250	Do.
Reinach fine sandy loam	RA	15	30	25	35	16	25	2.0	3.0	10	14	160	200		2.0	4	[5] 2	[5] 125	Sorghums, cotton, corn.
Renfrow silt loam:																			
Gently sloping	RD	10	15	25	35	14	20	1.75	2.5	12	15	135	180			4	3	85	Oats, wheat, sorghums, pasture.
Sloping	RE	8		18	30	10	15	1.5	2.5	8	12	120	170			5	4	65	Pasture, oats, sorghums, wheat.
Renfrow silty clay loam, sloping, eroded	RF	5		12	20	6	10	1.0	1.5	5	8	75				8	4	65	Idle, pasture, oats, sorghums.
Roebuck clay	RH	15	[5] 35			18	[5] 25	3.0	[5] 4.0			120	[5] 250		[5] 2.5	5	[5] [8] 2	[5] [8] 125	Corn, cotton, sorghums, forest, pasture.
Rough broken land (Norge soil material)	RK															[4] 10	[4] 8	[4] 30	Pasture, woodland.
Sandy alluvium	SA															[4] 10	[5] 4	[5] 65	Do.
Stephenville fine sandy loam:																			
Gently sloping	SB	8	15		25	10	15	1.5	2.5			110	175			[4] 15	[5] 4	[5] 65	Forest, woodland pasture, sorghums, cotton, corn, pasture.
Sloping	SC	5			20	7	12	.75	1.5			90				[4] 15	[5] 4	[5] 65	Forest or woodland pasture.
Sloping, eroded	SD	4				5		.5				60				12	[5] 5	[5] 50	Abandoned-field pasture, idle, sorghums, corn, cotton.
Vanoss silt loam:																			
Nearly level	VB	22	45	30	45	24	35	2.5	3.5	15	22	200	300	3.0	3.5	3	2	125	Corn, cotton, oats, sorghums.
Gently sloping	VA	18	40	30	45	20	35	2.5	3.5	15	22	180	275	3.0	3.5	3	2	125	Do.
Vernon clay loam:																			
Sloping	VD			12		6		.75		6		75				6	5	50	Pasture.
Moderately steep	VC															7	6	40	Do.
Yahola silty clay loam	YB	25	55	30	40	26	35	3.25	4	15	20	200	300	3.0	4.0	4	[5] 1	[5] 250	Corn, cotton, sorghums, alfalfa, pasture.
Yahola silt loam	YA	20	50	25	40	22	35	3.0	4	12	16	180	275	2.0	3.5	[4]	[5] 1	[5] 250	Corn, cotton, sorghums, pasture.
Zaneis very fine sandy loam:																			
Gently sloping	ZA	8	15	20	35	12	18	1.5	2.5	8	12	140	175			5	4	65	Pasture, sorghums, oats, cotton.
Sloping	ZB	5		20	30	10	15	1.0	2.0	8	10	100	150			5	4	65	Pasture, sorghums, oats.
Sloping, eroded	ZC			12	25	7	12	.75	1.5	5	8	85				9	4	65	Sorghums, oats, idle, abandoned-field pasture.

[1] Native grass pasture unless otherwise indicated by footnote. Figures based on averages for a number of years and rounded to the nearest acre per cow. It is assumed that supplemental feed is provided in winter and in dry periods when pasture growth is normally retarded. Grazing capacity in any given year may vary from the estimates given because of variations in weather, density of grass cover, and other conditions.

[2] *Acres per cow for grazing season:* Number of acres required to carry 1 cow for the 8- or 9-month grazing season prevailing in the county.

[3] *Cow-days per acre for the year:* The number of days 1 cow can be grazed on 1 acre during the year. Given the 8- or 9-month grazing season in Cleveland County, 1 *acre per cow for the grazing season* is about equal to 250 *cow-days per acre for the year.*

[4] Woodland pasture having post oak, blackjack oak, hickory, and some bluestem grasses. A much higher grazing capacity is possible where clearing and sodding with Bermuda grass is practical.

[5] Bermuda grass pasture.

[6] Drained areas where salts have been leached from soil.

[7] Undrained improved pasture.

[8] Ditched and drained.

Customary management includes little or no attempt to maintain soil fertility by use of crop rotations that include legumes. Fertilizers, green-manure crops, or erosion control measures are not used extensively. The same crop, however, usually does not occupy the land for more than two successive years. The percentages of the different crops grown are given in the discussion of each soil unit. The estimates of expectable average yields are based on reports by farmers, on field observations, and on data from records kept by the United States Department of Agriculture. They represent acre yields of the principal crops that may be expected over a period of years and can be considered only as a reasonable estimate. Yields from a given soil type vary greatly from year to year with differences in the weather, and from farm to farm with differences in management.

Average yields on most soils can be greatly increased by applying phosphate and nitrogen fertilizers, practicing effective erosion control measures, and using crop rotations that include legumes. Erosion control is not feasible on some soils when they are cultivated; such soils should be seeded to perennial pasture grasses. Without the use of these practices, the fertility of the soils and the crop yields can be expected to decline, and considerable areas of some soils will soon become unsuitable for crops. Estimates of the increases in crop yields resulting from better soil management practices can be obtained by comparing in table 7 the expected yields for the two levels of soil management.

MORPHOLOGY AND GENESIS OF SOILS

Soil is the product of the forces of weathering and soil development acting on the parent material deposited or accumulated by geologic agencies. The characteristics of the soil at any given point depend on (1) the physical and mineralogical composition of the parent material; (2) the climate under which that material has accumulated and has existed since accumulation; (3) the plant and animal life in and on the soil; (4) the relief or lay of the land; and (5) the length of time the forces of development have acted on the soil material. The climate, and its influence on soil and plants, depends not only on temperature, rainfall, and humidity but also on the physical characteristics of the soil or soil material and on the relief, which, in turn, strongly influences drainage, aeration, runoff, erosion, and exposure to sun and wind.

The soils of Cleveland County have developed in a warm-temperate humid zone with an average annual rainfall of 33.31 inches. The area lies entirely within a climatic zone wherein the normal soils are of pedalferic[10] development. The zonal soils are of the Red-Yellow Podzolic and Reddish Prairie great soil groups.[11] The relief ranges from gently rolling or rolling in the eastern part of the county to undulating in the western part, but fairly large nearly level areas occur adjacent to the Canadian River. Drainage for the most part is maturely developed except in a few flat divides and on nearly level

[10] MARBUT, C. F. SOILS OF THE UNITED STATES. U. S. Dept. Agr. Atlas of American Agriculture, pt. 3, Adv. Sheets No. 8, 98 pp., illus. 1935.

[11] BALDWIN, MARK, KELLOGG, CHARLES E., and THORP, JAMES. SOIL CLASSIFICATION. U. S. Dept. Agr. Yearbook 1938 (Soils and Men): 979–1001. 1938.

stream terraces. The greater part of the county is drained by the Little River, which heads in the northwestern part. The Canadian River drains the western and southern parts. The native vegetation varies with the type of parent materials; it is predominantly forest of oak and hickory in the eastern part of the county and prairie grasses in the western part.

The principal geologic[12] materials, in a slightly weathered form, from which the soils have developed are reddish-brown or red sandstone of the Garber formation and red shales of the Hennessey formation, both of which belong to the Enid group of the Permian system. Extensive areas of old alluvium of Pleistocene and Recent age occur in the valley of the Canadian River and to a slight extent in the valley of the Little River.

The Garber formation consists of a lower shale (Lucien) and an upper sandstone (Hayward). The Lucien shale is considerably more sandy in Cleveland County than farther north and its boundaries are indistinct. The Hayward sandstone is characterized by massive red sandstone with minor quantities of interstratified shale. The upper contact of the Garber formation is readily traced by its forest-covered surface, which is in distinct contrast with the smoother prairie land on the Hennessey outcrop to the west.

The Hennessey shale rests upon the Garber formation with apparently conformable contact in Cleveland County and is characterized by predominantly red shales, thin and frequently laminated. This shale weathers to a dark comparatively rich loam that forms a prairie belt over its entire outcrop. The boundary between the Hennessey and Garber formations extends in a northwest-southeast direction across the county; the upper contact is easily traced by the west side of the timber and by the change in characteristics of the soils.

The Duncan sandstone overlies the Hennessey shale and is exposed in a narrow strip in the extreme northwestern corner of the county. Here the formation is covered by a mantle of wind-laid materials, from which the soils have developed. Duncan sandstone is unimportant as a soil parent material in the county.

Recent alluvium has accumulated on the Canadian River flats and along larger stream valleys, forming narrow flood plains. Windblown sandy and silty material has accumulated on the north side of the Canadian River. Some of the finer wind-carried materials are found incorporated with the soil several miles from the river.

Red-Yellow Podzolic soils (Stephenville and Dougherty), together with associated Lithosols (Darnell), occupy much of the eastern half of the county—the Cross Timbers section. They are developed on rolling to gently rolling surfaces in sandy formations that are neutral to alkaline but not high in lime. The Stephenville and Dougherty have the general characteristics of Red-Yellow Podzolic soils but have developed in a somewhat drier environment and are less acid and less leached than soils developed from similar parent materials farther east. They are characterized by thin dark-colored A_1 horizons with sandy light-colored leached A_2 horizons over B horizons of reddish friable sandy clay loam. These soils are low in organic matter and moderately low in essential plant nutrients.

[12] ANDERSON, G. E. CLEVELAND AND M'CLAIN COUNTIES. *In* Oil and Gas in Oklahoma, Okla. Geol. Survey Bul. 40 (2): 179–192, illus. 1927.

A profile of Stephenville fine sandy loam, gently sloping, which represents the normal Red-Yellow Podzolic soil of this environment, was observed one-half mile north of Rose Hill School in NE¼SE¼ sec. 2, T. 6 N., R. 1 E. The surface gradient was about 2 percent. The vegetation was a native cover of blackjack and post oaks and some bluestem. This profile had the characteristics of normally developed Stephenville soils on gentle slopes where erosion is not excessive. Most Stephenville soils in this area, however, are more sloping, have a thinner solum, are somewhat eroded, and have more reddish subsoils. Following is a description of the profile observed:

A_1 0 to 4 inches, grayish-brown (10YR 4/2; 10YR 3/2, moist) light fine sandy loam; structureless; friable; slightly acid; contains considerable organic matter; grades to horizon below.

A_3 4 to 10 inches, brown (7.5YR 5/2; 3/2, moist) light fine sandy loam; structureless; friable; slightly acid; grades through a 2-inch transition layer to the underlying horizon.

B_{21} 10 to 22 inches, reddish-yellow (5YR 6/6; 5YR 5/8, moist) light sandy clay loam; massive to weakly blocky; friable; medium acid; grades to horizon below.

B_{22} 22 to 40 inches, red (2.5YR 5/6; 4/8, moist) sandy clay loam; massive to weakly blocky; porous; friable; hard when dry; slightly acid.

C 40 inches +, red (2.5YR 4/6) weakly indurated slightly acid to neutral sandstone many feet thick.

The parent material in the above-described profile is slightly weathered sandstone of the Garber formation. The associated Darnell soils are immature and of shallow development, usually lacking a B horizon, but they are underlain by similar parent materials. The Dougherty soils have profile characteristics similar to those of the Stephenville soils but have developed from old alluvium on high terraces of the Canadian River.

The Reddish Prairie group, which occupies the central and western parts of the county, includes soils representing several stages of development and age. They have developed under grass from alkaline to weakly calcareous parent materials of shales and clays of the Hennessey formation, which is of Permian age, and from old alluvium of Pleistocene or Recent age. For the most part these soils have dark medium-textured surface layers with reddish-brown or brown subsoils ranging from clay to sandy clay loam, the texture depending on the character of the parent material and stage of development. They are slightly acid in the surface soil and upper subsoil but alkaline to weakly calcareous in the lower subsoil. The normal soils are moderately high in essential plant nutrients but medium to low in organic matter.

A profile of Kirkland silt loam, gently sloping, was observed about a quarter of a mile north of SW¼ sec. 23, T. 10 N., R. 3 W. This Kirkland soil represents a mature soil of the Reddish Prairie developed from shales on a gentle slope of about 2 percent. It is in a well but not excessively drained position. The vegetation was a moderately thick native cover of bluestem, grama, and buffalo grasses. The profile is described as follows:

A_1 0 to 8 inches, dark grayish-brown (10YR 4/2; 3/2, moist) silt loam; moderately granular; friable; slightly acid; the surface ½ to 1 inch is weakly platy; grades to horizon below.

A_3 8 to 12 inches, dark grayish-brown (10YR 4/2; 3/2, moist) light silty clay loam; weakly granular; friable; slightly acid; aggregates and crevices have a faint sprinkling of light brownish gray; grades shortly to or rests on horizon below.

B_1 12 to 20 inches, brown (10YR 5/2.5; 3.5/2, moist) clay; strong medium blocky, very compact; extremely hard when dry; slightly acid; grades to horizon below.

B_{22} 20 to 36 inches, brown (7.5YR 5/3; 4/3, moist) clay; massive to weakly blocky; very firm; extremely hard when dry; about neutral; grades to horizon below.

B_3 36 to 50 inches, light-brown (7.5YR 6/3; 5/3, moist) clay; slightly mottled with reddish brown; massive; slowly permeable; slightly alkaline; contains a few small concretions of $CaCO_3$.

C 50 to 70 inches +, reddish-brown (2.5YR 5/4; 4/4, moist) clay; alkaline to weakly calcareous; grades into calcareous reddish shale 6 to 8 feet below the surface.

The Kirkland soils occupy gently sloping areas with gradients ranging mostly from about 1 to 2 percent. Small included nearly level areas of only 1 to 3 acres are not drained so well as the typical Kirkland soil and have slightly darker A and upper B horizons. These areas are transitional toward Tabler soils.

The more sloping parts of the Reddish Prairie are occupied by soils mainly of the Renfrow and Vernon series. The profile of Renfrow silt loam, gently sloping, is considered representative of the normal soils developed on slopes of about 2 to 6 percent. Surface drainage is rapid, and where the vegetative cover is thin or lacking, considerable water is lost by runoff. The vegetation is a moderately thick native cover of bluestem, grama, and buffalo grasses. Following is a profile of Renfrow silt loam, gently sloping:

A_1 0 to 6 inches, dark-brown (7.5YR 3/3; 2/3, moist) silt loam; weakly granular; friable; slightly acid; the surface ½ to 1 inch is weakly platy and slightly darker; grades to horizon below.

A_2 6 to 10 inches, reddish-brown (5YR 4/4; 3/4, moist) heavy silt loam; weakly granular; friable; hard when dry; slightly acid; grades through a 2-inch transition of silty clay loam to horizon below.

B_{21} 10 to 22 inches, reddish-brown (5YR 4/4; 3/4; moist) clay; weak blocky; firm (moist); very hard when dry; slowly permeable; neutral to weakly alkaline; grades to horizon below.

B_{22} 22 to 34 inches, red (2.5YR 4/6; 3/6, moist) clay; massive; slowly permeable; firm; very hard when dry; weakly alkaline.

C 34 to 50 inches +, red (2.5YR 3.5/6; 3/6, moist) somewhat stratified silty shale and shale; alkaline to weakly calcareous.

The associated Zaneis soils are somewhat similar to the Renfrow soils in profile development but have developed from more sandy and silty parent materials and have more reddish, more friable, and less clayey subsoils. Chickasha soils have brown clay loam subsoils over sandy and silty red beds. These two series are of slight extent and occupy small transitional areas between the prairies and forested uplands. The associated Vernon is a Lithosol over silty shales and shales of the red beds.

In that part of the Reddish Prairie along the central-western part of the county, where the soils developed from red beds merge with those developed from ancient alluvium, there are fairly large areas of Bethany silt loam soils. Superficially, the Bethany soils resemble

the Kirkland but differ mainly in having thicker A horizons, granular upper B horizons, and usually more silty permeable substrata. The origin of the parent material is obscure, and there is as yet no conclusive evidence indicating whether it is of alluvium, loess, or residuum. Bethany soils merge with the Kirkland and Vanoss in places without perceptible change in elevation, and possibly the thick A horizon in these places is due to aeolian deposits on the original Kirkland profile.

The characteristics of the Bethany soils, a series established in Cleveland County, are represented by the profile of the type location for the series. This location is a quarter of a mile north of Wheatland in Oklahoma County and lies about 2 miles north of the northwest corner of Cleveland County. It is a cultivated well-drained area with a surface gradient of less than 1 percent. A large area of Bethany silt loam, level, with a similar profile occurs just northwest of Norman in SW¼ sec. 19, T. 9 N., R. 2 W. The profile of Bethany silt loam, level, at the type location is as follows:

A_1 0 to 14 inches, dark grayish-brown (10YR 4/2; 2.5/2, moist) silt loam; moderate to strong medium granular; not crusty; friable; slightly acid; grades to next horizon.

B_1 14 to 18 inches, brown (10YR 4/3; 3/2.5, moist) silty clay loam; strong coarse granular; no gray film evident; firm; slightly acid to neutral; grades to horizon below.

B_2 18 to 30 inches, brown (10YR 5/3; 3/2, moist) clay; very firm and compact; weakly blocky, the exteriors of the blocks being slightly varnished; extremely hard when dry; neutral to mildly alkaline; grades to horizon below.

B_3 30 to 54 inches, brown (10YR 5/4; 4/3, moist) clay; very firm and compact; noncalcareous but contains a few (2 percent) small semi-indurated concretions of $CaCO_3$; alkaline.

C_1 54 to 70 inches, red (3 YR 5/6) clay mottled with 20 percent of light brownish gray (10YR or 2.5Y 6/2); slightly less compact than B_3 horizon; grades to horizon below.

C 70 to 90 inches +, red (2.5YR 5/6; 4/6, moist) silty clay loam; firm to friable; distinctly less compact than B_3 horizon; noncalcareous; pH 8.5; contains a few ferromanganese concretions—no conclusive evidence whether this is alluvium, loess, or residuum.

The high old terraces of the Canadian River are occupied by soils of the Vanoss, Norge, Minco, and Derby series. These terraces lie about 30 to 100 feet above the channel of the river and merge with the prairie to the east with little perceptible change in elevation in most places. The natural vegetation is prairie grasses, but some oak trees were present in moist situations before the soils were put into cultivation. The soils on these terraces have some characteristics in common with the older soils of the prairies but for the most part have less distinct profile development.

A profile of Vanoss silt loam, nearly level, was observed about a mile southeast of Warren Cemetery in SE¼ sec. 22, T. 9 N., R. 3 W. The area was a nearly level well-drained cultivated part of the old stream terrace lying 40 or 50 feet above the flood plain of the Canadian River. The profile description follows:

A_1 0 to 16 inches, grayish-brown (10YR 4/2; 3/2, moist) silt loam; moderate medium granular; friable; about neutral; grades into horizon below.

B_2 16 to 32 inches, brown (7.5YR 4/2; 3/2, moist) silty clay loam; strong coarse granular; friable; about neutral; grades to horizon below.

B_2 32 to 54 inches, brown (7.5YR 5/5; 4/4, moist) silty clay loam slightly mottled with reddish brown; firm to friable; weakly alkaline; grades to horizon below.

C 54 to 70 inches +, reddish-yellow (7.5YR 6/6; 5/8, moist) weakly alkaline silty or sandy old alluvium.

The associated Minco soils are more youthful and have slightly lighter colored and lighter textured more friable and permeable subsoils than the Vanoss soils. They have developed from more sandy parent materials of alluvial and aeolian origin. The Derby soils are sandy throughout, occupy undulating or dunelike surfaces adjacent to the river, have been more or less reworked by wind, and have little profile development. The Norge soils usually occupy the highest terraces and have developed from alkaline or weakly calcareous silty and clayey old alluvial or aeolian deposits. They are normal soils similar to Renfrow in stage of development, but the subsoils are more friable and contain less clay than those of the Renfrow.

The soils of alluvium that have little or no profile development are the Pulaski, Lincoln, Yahola, Roebuck, and Sweetwater of occasionally to frequently flooded bottoms, and the Reinach and McLain of high and rarely inundated parts of flood plains of the Washita River and other larger streams. These soils range from fine sandy loam to clay in texture and from slightly acid to calcareous in reaction. The color of the soils and content of plant nutrients are variable and depend on the character of the source materials. The McLain and Reinach soils have weak profile development, and their surface layers consist of an accumulation of organic matter; these soils show slight textural differences between the surface layer and underlying alluvium.

Small round or roundish-oval spots, known as slick spots, occur in parts of the Reddish Prairie, especially on Kirkland and Renfrow soils. They also occur to some extent on Vernon soils. Slick spots are small barren areas ranging from 30 to 80 feet in diameter and are indicated on the map by the symbol "S". Each symbol represents an area of 2 to 3 acres. These spots are almost bare of vegetation. The greatest concentration of these spots occurs in an area comprising several square miles about 2 miles southeast of Norman; other fairly concentrated areas also occur northeast of Norman.

These areas, where not eroded, have a 2- to 6-inch surface horizon of light brownish-gray or grayish-brown silt loam. When dry the first inch of the surface horizon is a light gray or whitish siliceous crust, and the lower part is a vesicular mass. This rests abruptly on the subsoil, a dark-brown or dark grayish-brown dense clay containing a few concretions and crystals of noncalcareous salts. The subsoil is a puddled almost impervious mass when wet, but when dry it separates vertically into irregular prisms composed of extremely hard subangular blocky fragments 1 to 2 inches in diameter. The aggregates are tightly bound together and have shiny dark film-coated exteriors. This horizon is 7 to 15 inches thick and grades below into reddish-brown or grayish-brown less dense clay, which in turn grades into slightly weathered reddish shales 3 to 5 feet below the surface.

Practically all these spots are severely eroded and have lost most of the silt loam surface horizon and part or all of the dark dense horizon. Where exposed, the clay has on the surface a whitish film of silt or very fine sand that is most distinct when dry. The spots

occur where the soil is or has been saturated by ground water during wet seasons. The subsoil is puddled and impervious, probably because there is some residual effect from soluble sodium salts once concentrated in the soils by ground water and now mostly leached out. The spots appear to represent various stages of Solonetz or Soloth development. Most of them no longer contain more than a trace of soluble salts.

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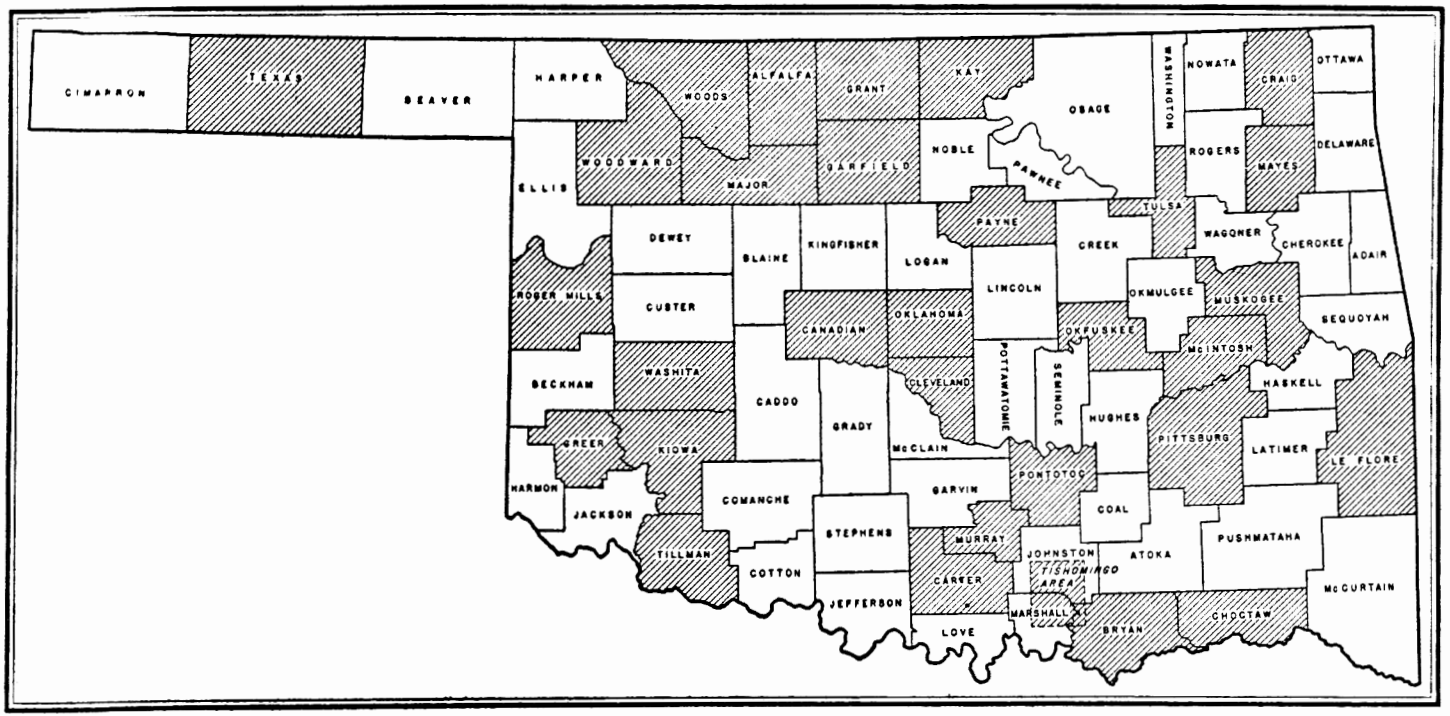

Areas surveyed in Oklahoma shown by shading.

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