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Soil Survey

of

Kiowa County, Oklahoma

By

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and

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Bureau of Chemistry and Soils

In Cooperation with the
Oklahoma Agricultural Experiment Station

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SOIL SURVEY OF KIOWA COUNTY, OKLAHOMA

By A. W. Goke, United States Department of Agriculture, in Charge, and C. A. Hollopeter, Oklahoma Agricultural Experiment Station

COUNTY SURVEYED

Kiowa County is in southwestern Oklahoma (fig. 1). Hobart, the county seat, is located in the northwestern part, about 136 miles southwest of Oklahoma City. The county comprises an area of 1,025 square miles, or 656,000 acres.

Kiowa County is part of a smooth plain which slopes slightly toward the east. Minor relief has been brought about by stream erosion, and most of the land is characterized by gentle slopes. The level areas are on the divides and in some of the sandy sections. The largest level areas, ranging from 1 to 4 square miles in extent, are east of Hobart and in the vicinity of Snyder and Mountain Park.

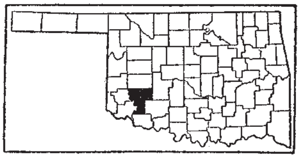

FIGURE 1.—Sketch map showing location of Kiowa County, Okla.

North Fork Red River, along the western edge, and Washita River, along the northeastern corner, are the two major streams. Both streams receive practically all the drainage waters through their many tributaries, including Rainy Mountain Creek and Stinking Creek, that empty into Washita River, and Otter Creek and Elk Creek, that flow into North Fork Red River. The tributaries have developed shallow valleys ranging from one-fourth to 1 mile in width.

The most outstanding physical features of Kiowa County are the isolated detached hills and short ranges, formed mainly of crystalline rocks, known as the Wichita Mountains, which rise rather abruptly from the broad gently rolling plains. The highest peaks are from 1,000 to 1,200 feet above the general surface level at the foot of the mountains. These mountains form a range of hills across the central part of the county. Most of them are composed of granite, except those of the northern range in the eastern part of the county, which are made up of limestone. The granite hills form rugged bouldery slopes, which are covered with a thin growth of post oaks, and the limestone hills are smooth and mostly barren of vegetation. Another important physical feature is the southward-facing escarpment which crosses the northern part of the county. This escarpment is composed of calcareous sandstones of the Duncan formation and the dolomite ledges of the Blaine formation.[1]

[1] SAWYER, R. W. KIOWA AND WAUSHITA COUNTIES. Okla. Geol. Survey Bull. 40, v. 2, pp. 311–321, illus. 1930.

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Kiowa County was organized in 1901 from a part of the Kiowa, Comanche, and Apache Indian Reservation. A part of the county was taken in 1910 to form part of Swanson County, but, through a decision of the Supreme Court of Oklahoma, August 9, 1911, the creation of Swanson County was declared illegal and the territory embraced therein was restored to the parent counties, Kiowa and Comanche. A part was annexed to Tillman County in 1911.

At the time the county was opened for homestead settlement, a county seat was located, platted into city lots and streets, and sold to the highest bidders at government auctions. The county seat was named Hobart in honor of Garrett A. Hobart, then Vice President under President McKinley. Other towns in the county were then being organized. In 1930 the population of Hobart was given as 4,982, Mountain View 1,025, Gotebo 827, Lone Wolf 1.023, Snyder 1,195, Mountain Park 459, Roosevelt 721, and Cooperton 151. The population of the county as a whole is evenly distributed. The total population was 29.630 in 1930, of which 24.648, or 83.2 percent, were classed as rural. More than 93 percent of the people are native whites.

The towns are so located that very few farms are more than 12 miles from a trading point. All the towns are connected by good dirt roads, most of which follow section lines.

Water on the farms is obtained from cisterns or wells that range from 30 to 50 feet in depth. They are constructed by digging a circular pit from 3 to 4 feet in diameter, and over this pit an ordinary pump or a hoist of some kind is used to draw up the water. The well pit is often constructed in low depressions or at the bottom of a small drainageway. Much of the water for livestock is obtained from ponds or reservoirs which are constructed near the heads of small drainageways. They are constructed by forming a dirt-constructed dike across a drainage channel, but water obtained in this manner does not always insure a plentiful supply. During droughty seasons the well pits may fail to fill through seepage from below, and the ponds are apt to dry up through use and evaporation. This handicaps the farmer in raising livestock successfully, and many farmers report that lack of a plentiful water supply curtails the livestock industry to considerable extent.

The native timber grows chiefly along the stream channels and on the mountain sides. Cottonwood prevails along the river channels of Washita and North Fork Red Rivers, elm and pecan grow along the stream channels of the creek bottoms, and oaks are confined mostly to the mountains.

All the rural communities are provided with schools by dividing the county into school districts embracing from 4 to 6 square miles. Some of the school districts have been combined, in order to enable the rural communities to build better schools provided with all modern conveniences and equipments. Most of the pupils attending these schools are transported by busses which are operated by the school districts. A few rural communities have churches.

The predominant industry of the county is agriculture. The only minor industry that has developed to any extent is the quarrying of granite. This industry is most extensively developed at Snyder, where tombstones and monuments are manufactured and building materials are quarried.

The largest cotton compress within the county is located in Hobart. All the towns have one or more cotton gins, a few of which are cooperatively owned by the farmers but most of them by individuals.

Cotton, wheat, and cattle are the chief sources of income, and they provide the principal products that are exported from the county.

CLIMATE

The climate of Kiowa County is characterized by a frost-free season of 213 days, extending from April 2, the average date of the last killing frost, to November 1, the average date of the first. One unusually late frost has been recorded on May 1, and the earliest recorded is October 8.

The average annual rainfall is 28.13 inches. The wettest year on record at Hobart is 1908, when 43.33 inches of rain fell, and the driest is 1910, when there were 12.72 inches of rain. The rainfall is so distributed throughout the year as to be most beneficial to growing crops. About 60 percent or more of the annual amount comes during the time the crops are making most of their growth. Short rains are often very severe during March and April and are accompanied with considerable wind from the south. A rainy period of several days is unusual, and when it does occur it is during the fall or occasionally during early spring. As a rule, a large percentage of the days are clear and accompanied with plenty of sunshine, and cultivation and harvesting of crops is very seldom delayed.

The winter season is usually mild, but in some years it is severe and accompanied with an abundance of snow which remains on the ground for a period of 2 or 3 weeks. In general, winds blowing from the south during the winter are accompanied by penetrating cold, owing to the dampness of the atmosphere, but winds coming from the north are generally not so disagreeable.

Table 1, compiled from records of the United States Weather Bureau station at Hobart, gives the more important climatic data for this county.

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

[Elevation, 1,536 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1910)	Total amount for the wettest year (1908)	Snow, average depth
	°*F.*	°*F.*	°*F.*	*Inches*	*Inches*	*Inches*	*Inches*
December	40.2	79	2	1.15	0.05	(1)	3.2
January	38.8	88	−10	.81	1.40	0.97	.8
February	43.3	92	−11	.92	.05	1.18	1.7
Winter	40.8	92	−11	2.88	1.50	2.15	5.7
March	52.8	100	5	1.64	.55	.55	1.3
April	61.0	98	23	3.20	.44	3.97	(1)
May	69.0	102	27	4.15	3.76	6.39	0
Spring	60.9	102	5	8.99	4.75	10.91	1.3
June	78.0	111	43	3.70	.95	7.32	0
July	82.5	111	54	2.42	.21	5.19	0
August	82.2	114	46	2.32	2.31	2.30	0
Summer	80.9	114	43	8.44	3.47	14.81	0
September	74.9	107	36	2.86	1.78	4.54	0
October	62.5	96	14	3.38	1.11	6.82	(1)
November	50.5	87	9	1.58	.11	4.10	.2
Fall	62.6	107	9	7.82	3.00	15.46	.2
Year	61.3	114	−11	28.13	12.72	43.33	7.2

[1] Trace.

AGRICULTURAL HISTORY AND STATISTICS

The original vegetation in Kiowa County consisted of grasses and a scattered growth of mesquite trees. Such trees as cottonwood, elm, and pecan grow only along the banks of the major streams. The grasses in the valleys grow more luxuriantly than those in the uplands, and for that reason, before the county was open for settlement, the land in the valleys was highly prized among the Indians for grazing purposes. During the winter the grasses in the valleys provide the chief source of feed for livestock.

Agricultural occupation of the land began in 1901 with the opening of the public land to homestead settlement. At this time each settler was allowed to select a quarter section, or 160 acres, surveyed by the Government, and after a certain number of improvements had been made on the farm, he received the right of ownership of the land. Each settler grew the crops to which he was accustomed. Farmers from the Northern States selected cereals as their major crops, and those from the Southern States grew cotton principally. But between the time of first settlement and the present, improvements in methods of cultivation have been made, and farming practices have been adapted to the demands of the soil and climate. Cotton is now the predominant crop, and wheat ranks second, with about one-half the acreage of cotton. Mebane is the principal variety of cotton grown. Other varieties are Half-and-Half, Kasch, Acala, Lone Star, Rowden, and Big Boll Russell.

Turkey and Blackhull are the popular varieties of wheat. Some Mediterranean, Fulcaster, and Stoner are grown. The census reports show that the acreage in wheat increased from 22,870 acres in 1909 to 91,296 acres in 1929.

Oats rank third in importance among the crops grown. Most of this crop is produced for local use as feed, and very little is sold outside the county. The average yield of oats during normal seasons ranges between 30 and 40 bushels an acre. Texas Red and Canote are the principal varieties grown.

During the first years after the county was settled, corn was an important crop, but since then its acreage has steadily decreased from 72,634 acres in 1909, to 6,964 acres in 1929, only 4,741 acres of which was planted for grain. The varieties of corn grown include Surcropper, Reid Yellow Dent, and Strawberry Dent, although, as with most crops grown in this county, very little attention is given to the variety.

Grain sorghums, chiefly kafir and milo, are grown by most farmers. They rank close to cotton in drought resistance. The Dwarf Yellow variety of milo and Blackhull kafir are the varieties commonly produced.

Barley is grown on a few farms. It is a valuable feed for livestock and often takes the place of oats in the rotation. Rye is a minor crop which is grown largely for the pasturage it provides for livestock during the winter. It is a crop that can be grown successfully, especially on sandy land where wheat cannot be successfully produced.

Alfalfa is grown mainly on the bottom lands or on low flat areas in the uplands. A very small part of the total crop is sold on the local market.

Potatoes and fruit crops, including apples, peaches, pears, plums, cherries, and grapes, are grown, mostly on the sandy soils in the western part of the county. Garden vegetables of such varieties as can be sold at local markets are also grown, chiefly on the sandy soils. They include cabbages, sweetpotatoes, tomatoes, cantaloups, and watermelons.

Most farmers maintain a small garden, in which such vegetables as spinach, turnips, onions, sweet peppers, okra, cabbages, tomatoes, mustard, beans, and peas are grown.

Table 2 gives the acreage and production of selected crops in Kiowa County, Okla., in stated years.

TABLE 2.—*Acreage and production of selected crops in Kiowa County, Okla., in 1909, 1919, and 1929*

Crop	1909		1919		1929	
	Acres	*Bushels*	*Acres*	*Bushels*	*Acres*	*Bushels*
Corn	72,634	965,080	11,588	301,436	4,741	97,088
Oats	17,415	366,560	15,900	641,419	16,287	545,991
Wheat	22,870	304,043	169,811	3,003,667	91,296	1,264,220
Barley	559	5,185	1,836	54,793	1,443	32,971
Rye	49	557	880	15,022	24	341
Grain sorghums [1]	12,039	128,858	16,285	335,078	2,756	44,561
Potatoes	224	8,606	171	13,316	268	20,769
Sweetpotatoes	30	2,517	107	10,728	138	10,298
		Tons		*Tons*		*Tons*
Alfalfa	11,173	12,883	14,430	22,478	4,151	8,967
Prairie grass	3,354	2,320	262	258	142	173
		Bales		*Bales*		*Bales*
Cotton	91,843	20,847	60,545	26,067	228,783	63,073
	Trees	*Bushels*	*Trees*	*Bushels*	*Trees*	*Bushels*
Apples	19,095	----------	3,514	4,025	1,324	1,259
Peaches	131,519	321	18,445	15,023	8,705	6,495
	Vines	*Pounds*	*Vines*	*Pounds*	*Vines*	*Pounds*
Grapes	45,699	16,325	2,890	7,962	3,567	15,700

[1] Mainly kafir and milo.

According to the 1930 census report, the average size of the farms is 200.8 acres, and 73.9 percent of the farm land is improved. The same census shows 61.8 percent of the farms operated by tenants, 38 percent by owners, and 0.2 percent by managers.

The farm buildings are kept in good condition. The average value of all farm property is $10,138, of which 73.3 percent represents the value of land, 12.8 percent buildings, 7.7 percent implements and machinery, and 6.2 percent domestic animals. The average value of land and buildings is $50.99 an acre.

The machinery used on most farms includes modern labor-saving devices. Tractors are in common use on almost every farm. Tractor-drawn plows consist of several sections so that a broad swath is plowed at one trip across the field. Cultivators built to cultivate several rows at one time are gradually replacing the single-row machines. Combines are now being used in place of the binder and steam threshing machines for harvesting the grain crop. Since automobiles have come into common use, the 2- to 4-wheel trailer is used to haul the farm products to market, and is most commonly used in transporting cotton from the farm to the gin.

The number of livestock in the county on April 1, 1930, as reported by the United States Bureau of the Census, is as follows: Horses 9,849, mules 5,106, cattle 32,110, sheep 3,558, goats 125, swine 6,433, and chickens 222,379. The number of turkeys raised in 1929 was 34,656.

About one-half of the cows milked are of the beef types, principally Shorthorns. Jersey and Guernsey are popular breeds of the dairy type.

Hogs are raised on an extensive scale on only a few farms. Poland China is the most popular breed. The few sheep raised are kept chiefly on farms composed mainly of pasture land. Chickens are raised on practically all the farms. They include several breeds—

Plymouth Rock, Orpington, Leghorn, Wyandotte, and Rhode Island Red.

The total expenditure for feed on the 1,878 farms reporting its purchase in 1929 was $342,382, or $182.31 a farm. Other farm expenditures are as follows: For fertilizer used on 7 farms, $742; and for labor on 2.369 farms, $994,307, or $419.72 a farm reporting.

Most of the farm laborers are white, although many colored laborers are employed during the cotton-picking season, many of whom are transients who move from one section to another during this season.

The value of all crops produced in Kiowa County in 1929 was $8,063,620. On April 1, 1930, the total value of livestock was $2,-221.230. In 1929, the value of dairy products sold and butter churned was $436,407; of wool shorn, $3,262; of poultry raised, $415,845; and of chicken eggs sold, $262,485.

SOILS AND CROPS

The soils of 95 percent of the area of Kiowa County are heavy in texture either in the surface soil or subsoil, clay loam mainly in both, and the rest, which occur in irregularly shaped areas in different parts of the county, are sandy. One area of these sandy soils forms a narrow belt along the western county line and another crosses the northeastern corner.

The heavier soils, mainly clay loams, range in color from very dark grayish brown to reddish brown. They have friable surface soils ranging from very fine sandy loam to silty clay loam in texture. The surface soil extends to a depth ranging from 4 to 8 inches, where it grades into a clay subsoil that is, in most places, very plastic when wet and very hard when dry, especially at the greater depths. Between depths of 18 and 30 inches, lime is present, both in the form of hard concretions of calcium carbonate and in finely disseminated form of the same compound, as determined by acid tests. Wherever the surface soil has been badly eroded, lime is exposed.

The sandy soils have brown or reddish-brown friable surface soils that range from sand to very fine sandy loam. The surface soil extends to a depth ranging from 6 to 12 inches, where it passes into a red-brown friable sandy subsoil which, in turn, continues downward with no apparent change in color or texture to a depth of 36 inches, where the material contains a little more clay, making it slightly sticky when wet. None of the surface soil or subsoil contains sufficient lime to produce effervescence with acid, although acidity tests indicate that there is sufficient lime for the needs of growing crops.

The outstanding difference between the sandy soils and the clay loam soils is that the material in the former is much more friable throughout the surface soil and subsoil, continuing to considerable depths. This has its influence on the agriculture, in that the methods and practices used in cultivation and the kinds of crops predominately grown on the sandy soils differ from those grown on the clay loam soils.

In the following pages, the soils of Kiowa County are described in groups and in detail, and their agricultural adaptations are discussed; their location and distribution are shown on the accompanying soil map; and their acreage and proportionate extent are given in table 3.

TABLE 3.—*Acreage and proportionate extent of the soils mapped in Kiowa County, Okla.*

Type of soil	Acres	Per-cent	Type of soil	Acres	Per-cent
Foard silt loam	128,896	19.6	Vernon very fine sandy loam	3,584	0.5
Foard clay	39,040	5.9	Enterprise very fine sandy loam	14,272	2.2
Kiowa clay loam	1,984	.3	Enterprise loamy very fine sand	512	.1
St. Paul silt loam	15,552	2.4	Enterprise fine sandy loam	9,728	1.5
Tillman silt loam	27,712	4.2	Yahola loamy fine sand	3,328	.5
Tillman very fine sandy loam	18,688	2.8	Yahola fine sandy loam	3,328	.5
Randall clay	576	.1	Reinach very fine sandy loam	11,584	1.8
Portland clay loam	27,200	4.1	Enterprise fine sand	832	.1
Portland very fine sandy loam	1,920	.3	Enterprise fine sand, shallow phase	11,392	1.7
Canadian silty clay loam	26,752	4.1	Rough stony land	41,152	6.3
Miller clay loam	256	.1	Dune sand	4,928	.8
Miller clay	14,912	2.3	Vernon clay loam, eroded phase	19,392	3.0
Calumet very fine sandy loam	33,344	5.1	River wash	4,352	.6
Tillman clay loam	112,064	17.1			
Tillman clay loam, gravelly phase	13,184	2.0	Total	656,000	------
Vernon clay loam	65,536	10.0			

CLAY LOAM SOILS

The leading crops—cotton, wheat, and oats—are produced on the clay loam soils. The crops of minor importance include alfalfa, millet, and kafir, which are grown on very small acreages.

Some of the clay loam soils have characteristics which make it possible for most crops to be profitably grown, whereas others have a few unfavorable characteristics that make crop production more or less uncertain and unprofitable. Therefore these soils have been separated into two subgroups as follows: (1) Soils used mainly for cultivated crops; and (2) soils used mainly for pasture.

SOILS USED MAINLY FOR CULTIVATED CROPS

The most productive of the heavy soils include Foard silt loam, Foard clay, Tillman silt loam, Tillman very fine sandy loam, Kiowa clay loam, St. Paul silt loam, Randall clay, Portland clay loam, Portland very fine sandy loam, Miller clay loam, Miller clay, and Canadian silty clay loam.

Many of these soils form a good soil tilth after tillage and are rich in natural fertility, as is commonly interpreted from the dark color of the surface soils, their neutral reaction, and the presence of calcium carbonate or lime in the subsoil. A good soil tilth is made possible because of the granular condition of the surface material and the accumulated organic matter. This desirable tilth is most strikingly developed in Foard silt loam, Kiowa clay loam, and Foard clay. This condition allows moisture from rainfall to be readily absorbed and also allows good soil aeration, so that bacteria can function properly and thereby make available the nitrates necessary for growing crops. Good soil tilth prevents the formation of a surface crust which is often injurious to young plants. Under such conditions a surface mulch is easily maintained. Therefore, by readily absorbing moisture that falls on the surface and by providing a good soil structure for root penetration, such soils are potentially productive for crops. The fertile surface layer, produced by the action of decaying grass roots, also adds to the productiveness of these soils.

As some of the crops grown on the clay loam soils require a large amount of moisture for their successful growth, they are grown on soil types providing the greatest amount of available moisture. Such crops include chiefly alfalfa, which has a high water requirement, and corn, which is subject to injury from drought during the critical stages of its growth, and the soil types to which they are best adapted include Miller clay loam, Miller clay, Portland clay loam, Canadian silty clay loam, and the low flat areas included in Foard clay and Randall clay. In these soil types a large supply of available moisture is made possible only where local drainage is restricted and where moisture is available through subirrigation. In Randall clay and Foard clay, wherever the surface is flat or depressed, an unusual amount of water accumulates on the surface, which results in a forced storage of moisture as compared with normal conditions. But in the other soil types, the supply of moisture in large amounts is made possible through subirrigation and also because a large quantity of water is distributed over the surface at flood times, thereby affording the soils a chance to absorb more moisture than ordinarily occurs during a rainfall.

Foard silt loam.—Foard silt loam has a dark-brown surface soil that extends to a depth of 6 inches, where it gradually passes downward into a dark-brown or brown heavy plastic subsoil. This layer, in turn, continues downward with a gradual change in color from brown to yellowish brown. At a depth of 18 inches lime is present in the form of hard concretions, and the interstitial clay materials effervesce in acid.

The surface is friable. Although the thin silty surface soil is in general free from granulation, it tends to remain loose even during the winter when not covered by a crop. In places where the surface material consists of unusually heavy material, which is usually the result of removal by erosion of the silty surface layer, a good granular structure is developed. Acidity tests of the surface soil indicate that there is sufficient lime for growing crops.

In some areas of Foard silt loam the surface soil is thicker than in the greater number of areas, and consequently the heavy clay subsoil lies at greater depths, ranging to 10 inches. The subsoil clay is slightly more friable than in most areas and contains enough lime to effervesce in acid. It is, however, plastic when wet and hard when dry.

The most important areas of this deeper phase of the soil lie in the eastern part of the county. The largest body is in sections 2, 3, 4, 10, and 11, T. 4 N., R. 16 W. Two bodies lie west of a large area of Foard clay a few miles southeast of Cold Springs. Two areas lie just north of Glen Mountain southeast of Roosevelt, one body is a few miles southeast of Snyder, and several narrow strips lie along Long Horn and other mountains in Marshall Township. As a rule, this phase of Foard silt loam is slightly more productive than the typical soil.

Those areas of Foard silt loam lying on rolling relief, where surface drainage is somewhat better than on the main areas, have a faint-red color in the subsoil, are somewhat easier to work because of drying out more quickly after heavy rains, and are said to be slightly more productive. A large area of this kind lies along the west side of the long belt of Foard silt loam extending from a few miles north of Hobart southward. An area lies north of Long Horn Mountain, and areas are well distributed over the county, most of them as fringes along the sides of, or around, areas of the typical soil. They can be identified by their slightly red subsoil.

Foard clay.—Foard clay has a very dark grayish-brown heavy silt loam or clay loam surface soil that grades at a depth of 4 inches into a dark-brown clay subsoil, and this, in turn, continues downward to a depth of about 18 inches, merging into yellowish-brown clay containing lime. The surface soil is friable when moderately moist, but when wet it is very sticky and plastic. On drying, the soil material breaks into small pieces, thereby producing a mass of loose angular particles which do not become compact. The subsoil is very sticky when wet and very hard when dry. It is much more compact than the surface soil, and when the material is dry considerable effort must be used to break it into smaller units.

Foard clay is in general developed on much flatter areas than Foard silt loam. On account of the flatness of the surface, drainage is not so well established as in the silt loam areas.

Foard clay differs from Foard silt loam in that it has slightly more clay in the surface soil and in the occurrence of the heavy clay at slighter depth. On account of the shallow surface soil, the ordinary plow depth, in most places, extends into the subsoil, thereby making plowing a much harder task than in the thicker surface soils of Foard silt loam.

On account of the flat surface relief on which Foard clay is developed, drainage is slow, and much more time must elapse before the soil becomes dry enough for cultivation than on the better drained soils. If rains fall within too short intervals, field work will be delayed on the land of Foard clay for a considerable time during the season or crops will be retarded in their growth, whereas on better drained land cultivations can be made between rains, and as a result crops are capable of making good growth.

Kiowa clay loam.—The 7-inch surface soil of Kiowa clay loam consists of dark-brown clay loam. It is underlain by brown or faintly reddish brown clay loam which is somewhat heavier than the surface soil. At a depth of 24 inches spots of carbonate appear, and the material immediately above is somewhat deeper red than that of the upper part of the subsoil.

This soil occurs only in the extreme southeastern part of the county in association with Vernon clay loam. It is apparent that it is a soil developed mainly from the same reddish-brown material as that from which the Vernon soils have developed. The upper part of the soil probably contains some other materials, remnants of an original capping of loose deposits, but the main difference between this soil and Vernon clay loam is in stage of development. Kiowa clay loam is in a more advanced stage of development than Vernon clay loam, and the surface soil has accumulated more organic matter. It approaches more nearly a fully developed soil than does Vernon clay loam which generally consists of the clay resulting from the decomposition of red shales without much further development as a soil. The Kiowa soil has advanced probably halfway from the rather raw clay of Vernon clay loam toward the normal goal of soil development on the gently rolling well-drained land in this region—St. Paul silt loam.

Kiowa clay loam is intermediate in productivity between Vernon clay loam and St. Paul silt loam.

St. Paul silt loam.—The surface soil of St. Paul silt loam consists of very friable dark grayish-brown material to a depth of about 10 inches, where it grades into a strong-brown subsoil very slightly heavier in texture than the surface soil. The subsoil continues downward to a depth of 36 inches where lime is reached.

St. Paul silt loam differs from Foard silt loam in that it has a much more friable subsoil and in that, in most places, lime is first reached in sufficient quantities to produce effervescence with acid at a depth of 36 inches in place of 18 inches as in Foard silt loam.

St. Paul silt loam is a very productive soil, and it is claimed that crops growing on it can endure a droughty period for a much longer time than crops growing on the Foard soils. This is owing to the more friable character of the surface soil and subsoil material of the St. Paul soil, which are able to absorb and retain more of the moisture that falls on the surface.

St. Paul silt loam occupies a number of small areas in the northern and northwestern parts of the county, the most easterly area lying north of Gotebo.

Tillman silt loam.—Tillman silt loam has a brown friable silt loam surface soil that merges into a reddish-brown subsoil at a depth of about 6 inches. The subsoil consists of heavier material than the surface soil, although it is fairly friable and easily manipulated in cultivation. In most places, lime is present between depths of 36 and 40 inches.

Tillman silt loam differs from St. Paul silt loam in that it is more red in the surface soil, and the subsoil is somewhat heavier. The Tillman soil also occupies more rolling land than does St. Paul silt loam.

Tillman silt loam is a very productive soil. It is most extensively developed in the northern part of the county.

Tillman very fine sandy loam.—Tillman very fine sandy loam has a dark chocolate-brown friable surface soil which grades at a depth of 6 inches into a dark-brown friable silt loam or clay loam subsoil, and this layer, in turn, passes at a depth of 15 inches into chocolate-brown or reddish-brown tough plastic clay. At a depth of 18 inches, lime is present.

Tillman very fine sandy loam includes an area of 29.2 square miles, and occurs in widely scattered small areas, the largest of which are southwest and southeast of Mountain View. Most of the areas are closely associated with the nearby sandy soils, and these soils have perhaps contributed considerable wind-blown sandy material to the surface soil. The subsoil is somewhat less heavy than the subsoil of Tillman clay loam and not much heavier than that of Enterprise very fine sandy loam. This soil is intermediate between soils with heavy subsoils and those with friable subsoils. It is a productive soil for cotton and sorghums, but a little less so for wheat.

East of Mountain View, Tillman very fine sandy loam has some characteristics of Enterprise very fine sandy loam, in that it has a slightly deeper very fine sandy loam surface soil than ordinarily occurs in Tillman very fine sandy loam in Kiowa County.

Randall clay.—Randall clay consists of dark-gray or gray calcareous clay to a depth of 30 or more inches. The material from the surface to this depth is very plastic and sticky when wet, and when dry it is very hard. It is also very uniform in color, and there seems to be practically no difference between the surface soil and the subsoil. The surface soil is decidedly gray, a very distinct feature of Randall clay, as compared with the color of the surface soil of other upland soils in Kiowa County.

Randall clay occurs only in low wet depressions or old lake beds that have been recently drained by allowing the surplus water to escape along artificially made drainage ditches. Less than 1 square mile of this soil is mapped, near Pleasant Valley School south of Hobart.

Portland clay loam.—The 10-inch surface soil of Portland clay loam is dark brown and friable. It is underlain by a dark-brown clay subsoil which is very plastic and sticky when wet and very hard when dry. This layer, in turn, continues downward to a depth of about 18 inches where it grades into reddish-brown clay in which lime, in sufficient quantity to produce effervescence with acid, is first reached.

Portland clay loam occurs on second bottoms that are subject to overflow only after heavy rainfalls. Drainage is good.

This soil differs from Miller clay loam in that the surface soil is darker. Most of it occurs along stream bottoms that traverse areas in which the upland soils are dark, whereas the Miller soil occurs only in valleys that cross the eroded section of the county, in which most of the soils are of red shades.

Practically all the land of Portland clay loam is under cultivation. It is one of the most productive soils for all crops, especially for alfalfa.

Portland very fine sandy loam.—The surface soil of Portland very fine sandy loam is brown or dark grayish brown to a depth of 10 inches, where it grades into a dark reddish-brown friable clay loam subsoil. This layer, in turn, continues downward to a depth of 24 inches, where it passes into more friable material averaging very fine sandy loam in texture. With the exception of the surface soil, all the material is calcareous and effervesces with acid.

This soil is developed on a terrace along North Fork Red River. The surface relief is level or gently rolling, drainage is good, and the land is productive.

Canadian silty clay loam.—The 8-inch surface soil of Canadian silty clay loam consists of dark grayish-brown friable silty clay loam. It is underlain by a darker and slightly heavier subsoil. However, with depth, the color of the subsoil becomes lighter, and the material changes, at a depth of about 15 inches, into yellowish-brown clay that is very plastic when wet. In most places lime is first reached, in sufficient quantity to produce effervescence with acid, at a depth of 18 inches.

Canadian silty clay loam is the darkest soil developed along the stream valleys. Although it is subject to frequent overflows, drainage is good over most of the land. The entire acreage is under cultivation, and the soil is highly prized.

Miller clay loam.—Miller clay loam has a reddish-brown friable surface soil that grades at a depth of 6 inches or less into a plastic subsoil that is more red than the surface soil. The subsoil continues downward, and as depth increases the material becomes more yellowish red. The surface soil is very granular when dry but very sticky when wet. Throughout the subsoil and continuing downward, sufficient lime is present to produce effervescence with acid.

Miller clay.—Miller clay has a tough plastic clay surface soil when wet. At a depth of 8 or 10 inches this layer grades into a chocolate-brown clay subsoil which continues downward without great change in character. Both surface soil and subsoil are calcareous, containing sufficient lime to produce effervescence when acid is applied. When dry the surface soil breaks to a granular structure, and the subsoil becomes hard and almost impenetrable with a spade.

Miller clay occurs along the flood plains of some of the streams of the county. It is subject to frequent overflows. It is productive, but crops may be injured by flooding.

SOILS USED MAINLY FOR PASTURE

The less productive soils of the clay loam group (the ones used mainly for pasture) include Calumet very fine sandy loam, Tillman clay loam, Tillman clay loam, gravelly phase, Vernon clay loam, and Vernon very fine sandy loam. Because of their lower productivity, as compared with the more productive soils, these soils have a smaller percentage of their total acreage devoted to growing crops. But wherever they constitute a small acreage within areas of the more productive soils, they are placed under cultivation.

The character of the native vegetation growing on these soils indicates that they are not so productive as those described as soils used mainly for cultivated crops. The vegetation is shorter and does not develop so compact or so dense a turf as that on the more productive soils. Crops are in general not so vigorous as those growing on the more productive soils.

Perhaps these soils do not have so large an amount of available plant nutrients as the more productive clay loam soils. This is apparent by the lighter color of the surface soils, indicating a lower content of organic matter or nitrogen.

Some of the soils of this group have very red surface soils and are therefore low in organic content. The organic matter has either failed to accumulate in large quantities or has been lost. It may have failed to accumulate because the soil did not contain sufficient moisture to support a vegetation that could supply organic matter in amounts beyond that which was used. On the other hand, it may have been lost through erosion of the surface soil. The land slopes sufficiently that run-off is rapid enough to prevent most of the rainfall from being absorbed by the surface soil material and at the same time moves the loose soil material down the slope. This feature is more or less typical of the soils of the Vernon, Tillman, and Calumet series. These soils, listed in the following order—Vernon, Tillman, and Calumet—correspond to the degree to which the amount of organic matter has been removed or developed in the surface soil, according to our interpretation by the color of the surface soil. The Vernon soils would be interpreted as having the lowest content of organic matter, as their surface soils in general are more red than the surface soils of the other soils. The Tillman soils contain the greatest amount of organic matter in the surface soils, as they are usually darker than those of the other soils.

When drying after a wet season, an incrustation forms over the surface of many of these soils. This is most strikingly developed in Calumet very fine sandy loam. The incrustation forms a gray surface layer in patches promiscuously distributed over the field or over large areas of several acres each. Land having this characteristic is locally known as "white land". When wet the gray color on the surface disappears. The formation of the surface crust in these soils develops great compactness in the surface soil, which is caused by what is generally known as "running together of the soil material", that is, the very fine particles of soil are lodged so closely together as to leave very little pore space. On account of the small amount of pore space, the surface soil cannot be so easily penetrated by a spade or by germinating plants as the surface soils having an abundance of pore space.

Compactness of the surface soil is most noticeably developed in soils whose surface soil has previously been so completely saturated with moisture so as to become boggy. When dry the surface soil, in most places, becomes smooth and firm, with cracks forming at intervals ranging from 4 to 6 inches apart. Plants are checked in their growth and become yellow and poorly developed, and it is reported that crops on such soils are the first to show the injurious effects of a drought. This is partly because the soil condition allows moisture to escape more rapidly than from soils having a granular surface soil and partly because of the poor root growth. Small grains sown in the spring are most commonly injured by these conditions, especially if the season is unusually wet and accompanied with many heavy rains.

Calumet very fine sandy loam.—Calumet very fine sandy loam has a decidedly gray surface soil that rests on a dense very hard claypan subsoil. The surface soil forms a crust when dry that breaks into hard flat clods when the soil is cultivated. This surface crust is most strikingly developed in wheat fields, especially during a dry spring and fall. In the wheat fields, cracks prevail on the surface along the wheat rows, and between the rows a hard solid crust forms. This condition prevents rainfall from being readily absorbed, and as a result a large proportion escapes as run-off. Whenever this surface crust is prevented from forming by timely cultivation, the moisture is readily taken up, as the material below the surface is friable. In most places, however, the friable surface soil represents only a thin layer above the claypan subsoil, and, as the subsoil is almost impervious to moisture, very little moisture can be stored for future use.

The surface soil ranges from 6 to 8 inches in thickness, and the moisture stored in it is soon lost through evaporation and use by crops. As a result crops suffer on this soil sooner than the crops on other soils, where a larger quantity of moisture can be stored.

The semi-impervious character of the subsoil often causes the surface soil to become water-logged after prolonged rainy weather, and if drainage is restricted to any extent the surface soil remains wet for a longer period than that of soils having more friable subsoils.

Lime is present at a depth of 18 inches.

Wheat is better adapted to this soil than is any other crop grown in the county, especially since it is a shallow-rooted crop and relies mostly on the moisture available in the surface soil. If plenty of rainfall occurs at the time that the wheat crop makes most of its growth, a good crop is assured.

The areas of Calumet very fine sandy loam differ in size, and, as mapped in Kiowa County, very small areas of some of the most productive clay loam soils are included because they are too small to be indicated on the soil map.

The most extensive area of Calumet very fine sandy loam is around Lone Wolf, and practically all the land in this area is under cultivation. In other parts of the county the soil is mostly in pasture.

Tillman clay loam.—Tillman clay loam has a chocolate-brown friable surface soil that passes at a depth of 6 inches into a dark-brown friable subsurface soil. This is underlain, at a depth of about 12 inches, by a chocolate-brown or reddish-brown clay subsoil which when wet is tough and plastic and when dry is very hard and dense. Lime, in the form of hard concretions or in finely disseminated form, is first reached at a depth of about 24 inches.

Tillman clay loam differs from Foard silt loam in that it has a somewhat red surface soil, whereas Foard silt loam has a very dark surface soil. Tillman clay loam is developed on more rolling land than that occupied by Foard silt loam. On account of the sloping surface on which it commonly occurs, it is subject to sheet erosion.

Tillman clay loam is widely distributed. It occupies the smoother parts of the rolling land along the stream valleys. Its position is intermediate between the flat smooth interstream watershed areas on which the Foard soils are dominant and the rougher lands along the bluffs of the stream valleys where the Vernon soils predominate.

A number of areas of this soil lie in the southeastern part of the county, adjacent to the mountain areas. In places, these areas contain granitic rock fragments, usually a greater number in the subsoil than in the surface soil. In general, the bodies lying south and east of Roosevelt, and around and adjacent to the mountain chain containing Glen and Iron Mountains, are somewhat lighter in texture in the surface soil than the rest of the areas.

Tillman clay loam is a moderately productive soil, especially for wheat, but it needs to be cultivated with care, in order to prevent erosion which, on these rolling areas, takes place rather readily. The moderately heavy clay subsoil renders its water-holding capacity less favorable than in such soils as St. Paul silt loam where the entire soil is friable and porous.

Tillman clay loam, gravelly phase.—Tillman clay loam, gravelly phase, contains granitic or chert gravel in the surface soil and subsoil, the quantity ranging up to about 20 percent of the soil mass. Most of this gravel ranges from one-tenth to one-fourth inch in diameter. The larger gravel, 1 inch or more in diameter, are generally on the surface. The gravel tend to develop a droughty condition in the soils, and, wherever they occur in large quantities, crops are readily injured during dry weather, making a stunted growth and producing low yields. Where the soil occurs on well-defined colluvial slopes it receives an abundance of moisture that has escaped from the mountain sides through run-off, and the run-off carries with it much organic material and fertile soil.

Areas in which there is only a small quantity of gravel in the lower part of the subsoil are productive, and a larger proportion of land of this kind is under cultivation than of land in areas farther from the mountains.

Vernon clay loam.—The 4-inch surface soil of Vernon clay loam consists of reddish-brown, brown, or chocolate-brown friable material, and the subsoil is reddish-brown granular clay loam which continues to a depth of about 12 inches, where it grades into reddish-brown clay, plastic when wet but very hard when dry. In many places this material is stained with rust brown, red, and gray. In most places the subsoil and the underlying material contain sufficient lime to produce effervescence with acid, and in many places there is sufficient lime in the surface soil to produce effervescence with acid, especially where considerable sheet erosion has taken place. Much of the surface soil material has been deposited through colluvial wash from the higher slopes. The surface soil of Vernon clay loam is variable in color, and on one part of a slope the material may be darker or redder than on another part. Areas in which the surface material is reddest indicate that the surface soil has been removed by erosion leaving the red subsoil exposed. The subsoil is very sticky or waxy when wet, and wherever livestock are allowed to walk over fields of this soil during wet weather deep footprints are made into the subsoil, so that, after drying, the surface of the field is very rough.

Vernon clay loam occurs chiefly on slopes along the valleys and in areas that are dissected with numerous drainage channels.

Vernon very fine sandy loam.—The surface soil of Vernon very fine sandy loam consists of brownish-red or reddish-brown friable material that grades, at a depth of 8 or 10 inches, into a dark brownish-red much heavier textured subsoil. The subsoil is sticky and very plastic when wet, and in most places, at a depth of 15 inches, it produces effervescence with acid and contains lime in the form of hard concretions and in the form of finely disseminated powder.

This soil is inextensive. Some areas occur in the southern part of the county, continuing into Tillman County. It is moderately productive for sorghums and cotton, but it erodes readily.

SANDY SOILS

The sandy soils embrace a small percentage of the cultivated lands. The soils of this group used in the production of crops are not so productive as the extensively cultivated soils in the clay loam group. However, during certain seasons when the moisture supply is small the crops on the sandy soils are better than on the clay loam soils. This is especially noticeable during abnormally dry years. On account of the friable character of both surface soil and subsoil, the sandy soils provide a more favorable physical condition for the growth of roots than the clay loam soils with their heavy surface soil material and impervious clay subsoil. The friable character of the material in the sandy soils allows the absorption of a greater quantity of moisture than in the clay loam soils which have impervious subsoils, thereby allowing moisture to accumulate only in the surface and subsurface soils. In the sandy soils moisture penetrates the material to considerable depths, and for this reason they have a much larger capacity for holding moisture for crop use. In addition to being able to store a large quantity of moisture for growing crops, the sandy soils are capable of furnishing the growing crop most of the moisture received from a slight rainfall. Therefore, a slight rainfall is often beneficial to growing crops on sandy soils, whereas very little benefit is received by crops growing on the clay loam soils. As the moisture received from a slight rainfall is not so readily absorbed in the clay loam soils as in the sandy soils, a large proportion of it escapes by evaporation and run-off, and the small part that is absorbed is held by the clay loam soil in a form unavailable to plant roots.

These sandy soils are better adapted to growing small fruits and vegetables than are the clay loam soils, and most of the fruit grown in the county is produced on the sandy soils. Fruit trees require a well-developed root system, and this is possible in the sandy soils where the material is friable. In the clay loam soils, on the other hand, the impervious subsoil material restricts root development, and as a result trees are not capable of enduring the dry climate of this region. Peaches and apricots are the principal kinds of fruits grown on the sandy soils.

Cotton is the predominant cultivated crop grown on the sandy soils. Corn and kafir are also successfully grown, although the total acreage devoted to these crops is very small.

The group of sandy soils includes Enterprise very fine sandy loam, Enterprise loamy very fine sand, Enterprise fine sandy loam, Reinach very fine sandy loam, Yahola loamy fine sand, and Yahola fine sandy loam.

Enterprise very fine sandy loam.—Enterprise very fine sandy loam has a dark grayish-brown or brown friable surface soil that extends to a depth of 12 inches, where it grades into a dark reddish-brown subsoil. The subsoil material is heavier than that of the surface soil, but it is friable. It continues downward to a depth of 36 inches, where it grades into friable reddish-brown sandy clay loam. None of the material in the surface soil and subsoil, except that between depths of 60 and 72 inches contains sufficient lime to produce effervescence with acid.

Enterprise very fine sandy loam is the darkest soil of the Enterprise series. The surface relief ranges from fairly level to gently sloping. Practically all the land is under cultivation, and it is very

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productive, comparing favorably with the best soils of the county. It is used mainly for cotton, corn, and sorghums, rarely for wheat.

Enterprise loamy very fine sand.—Enterprise loamy very fine sand has a reddish-brown friable surface soil that passes, at a depth ranging from 4 to 6 inches, into a reddish-brown friable subsoil similar in texture to the surface soil. The subsoil continues to a depth of 42 or more inches and there merges into reddish-brown friable clay loam. None of the material in the surface soil and subsoil will produce effervescence with acid.

Enterprise loamy very fine sand differs from Enterprise very fine sandy loam in that it has a more red surface soil which also contains more coarse material.

Enterprise fine sandy loam.—Enterprise fine sandy loam has a brown or grayish-brown friable surface soil that grades, at a depth of about 5 inches, into a dark reddish-brown very fine sandy loam subsoil, and this layer, in turn, continues to a depth of 18 inches, where it is underlain by light reddish-brown very fine sandy loam. None of the material in the surface soil or subsoil contains sufficient lime to produce effervescence with acid. In most places beds of sandstone lie at a depth ranging from 30 to 90 inches.

Land occupied by Enterprise fine sandy loam has smooth gently sloping surface relief. This soil differs from the other Enterprise soils in that the surface soil in many places is more reddish brown. In nearly all areas, the friable very fine soil material continues downward below the subsoil to considerable depths, whereas in the other Enterprise soils the material below the subsoil is sandy clay.

Yahola loamy fine sand.—The surface soil of Yahola loamy fine sand is brownish gray, in some places reddish brown. The material is friable and passes at a depth of 12 inches into a yellow friable fine sand or medium sand subsoil. This layer, in turn, continues to a depth of 36 or more inches with no change in color or consistence. The water table lies at a depth of 36 inches. The material throughout the profile produces effervescence with acid, an indication of plenty of lime.

This soil occurs only in the flood plains along North Fork Red River and Washita River. It is subject to frequent overflows. The surface relief is characterized by numerous low mounds and shallow depressions or abandoned stream channels.

Yahola fine sandy loam.—Yahola fine sandy loam has a brown or reddish-brown friable surface soil which passes, at a depth of 10 inches, into a reddish-brown fine sand subsoil. The subsoil continues to a depth of 30 inches, where it is underlain by reddish-yellow fine sand which continues to a depth of 60 inches, where it changes to reddish-yellow very fine sandy loam. This material extends to a depth of 84 or more inches. All the material throughout the profile, to a depth of 84 inches, is friable and contains sufficient lime to produce effervescence with acid.

This soil type differs from the Reinach soils in that it has much more friable, or porous, material below the subsoil. Yahola fine sandy loam occurs as alluvium, chiefly along North Fork Red River and Washita River. It is subject to occasional overflows during heavy rainfalls.

Reinach very fine sandy loam.—The 6-inch surface soil of Reinach very fine sandy loam consists of brown or dark grayish-brown friable material. The subsoil material is friable and is more or less tinged with red. There is no apparent change in texture of the material to a depth of 84 or more inches. In some places, the soil material between depths of 18 and 30 inches is slightly more compact than that in any other part of the profile. Lime in sufficient amounts to produce effervescence with acid is first reached at a depth ranging from 24 to 36 inches, and the quantity appears to be about the same throughout the material to considerable depths.

NONCULTIVATED LANDS

Some areas within the county are unsuitable for crop production, as they are either too rough or are covered with rocks so that the land cannot be cultivated. Some areas have too sandy a surface soil which drifts readily when disturbed and therefore would cause destruction of the crops that were planted. Most of these areas, with the exception of those designated as rough stony land, can be used to a small extent for pasture.

Enterprise fine sand.—Enterprise fine sand has a brown or brownish-gray surface soil consisting of loose incoherent sand that is subject to drifting. This passes, at a depth of 4 inches, into reddish-brown sand that is loose to considerable depths. None of the material contains sufficient lime to produce effervescence with acid.

The surface relief of the land embraced by this soil is rolling or hummocky.

Enterprise fine sand, shallow phase.—Enterprise fine sand, shallow phase, differs chiefly from typical Enterprise fine sand in that the land is badly eroded, and as a result sandstone outcrops on the surface. This soil occurs only along the sides of drainageways traversing the western development of Enterprise soils, and it is very unimportant.

Rough stony land.—The term rough stony land is applied to areas that are steeply sloping and covered with boulders. They include chiefly the Wichita Mountains that cross the central part of the county. Two types of rough stony land are in the county—one covers the mountainous areas having granite rocks on the surface, and the other is composed of limestone rocks. Most of the more stony areas include patches of soil which support a scrubby growth of blackjack oaks and some grass. The limestone areas are covered by a very sparse growth of grass.

Dune sand.—Dune sand includes hummocky and hillocky areas of drifted sand, on a part of which vegetation has established itself. Practically the entire area of dune sand is influenced by sandy material blown up from the sandy stream bottoms. Dune sand occurs mainly on low terraces or bottom land along North Fork Red River. Some of the land is used for grazing.

Vernon clay loam, eroded phase.—The eroded phase of Vernon clay loam represents areas of Vernon clay loam so severely eroded that most of the surface is dissected by deep gullies and is robbed of most of its surface soil. On account of the removal of most of the surface soil material and the deep dissection, much shale, sandstone, and gravel is exposed on the surface. Along the steep valley slopes, numerous lime concretions are strewn over the surface.

River wash.—River wash includes the areas of river-bed material occurring along North Fork Red River. It consists of deep beds of water-transported materials, mainly sands.

The surface of river wash is from 1 to 5 feet above the river channel, and the land is flat, with a gradual slope downstream. Some of the finer soil particles are blown onto higher adjacent bottoms, and the coarser materials are left along the river bed.

River wash never dries to a great depth, as water lies within 12 inches of the surface, even during the dry season.

AGRICULTURAL METHODS AND MANAGEMENT

The growing of cultivated crops is the chief occupation on most farms. The principal crops grown, in order of their importance, are cotton, wheat, oats, barley, and corn. The total acreage devoted to cotton is almost equal to the combined acreage of wheat, barley, oats, and corn.

Cotton and wheat are cash crops which provide the chief source of income on most farms. Cotton and wheat are preferable to crops that can be converted into feed for livestock, because they are more adapted to the existing climatic conditions than corn and other forage crops.

Livestock raising is developed only to the extent that any available feed can be utilized. In certain sections of the county where a large part of the land is untillable, especially areas of the less productive soils, enough cattle are raised to consume the feed provided from native grasses during the summer. During the winter, the cattle are taken to the wheat fields where an abundance of green feed is available. Forage feed from other sources is limited on most farms because of the preference for growing cash crops.

The cattle on most farms are of the dairy type, principally of the Jersey breed. The preference for this breed is because of its high production of butterfat and because of its being adapted to conditions of the region. The chief dairy activity is the production of cream for buttermaking rather than of whole milk for fluid use. Dairying has been fostered because it contributes to diversification of farming, which is essential throughout this section of the State. The frequent lack of moisture and tightness of the soil cause some difficulties in growing adequate quantities of suitable roughages. Good pastures are not so easily produced as would be desired for best results in dairying. Concentrates can be produced in abundance by growing kafir, oats, and wheat.

Cattle of the beef type are raised mainly on farms that have large acreages of native pasture grasses. A very few cattle are fed for the market by individual farmers. Any extra cattle that the farmer may have are usually sold as feeders at the local market. Several carloads of cattle are fattened at Hobart by a cotton-milling company. Cottonseed meal is the principal feed used in fattening the cattle.

No definite crop rotation is practiced to maintain the fertility of the soils. In the past, the price of the two best adapted crops, wheat and cotton, has resulted in only a small acreage of other crops being grown. On the clay loam soils a rotation of cotton and wheat is in common use, but on many farms either of these crops is grown on the same land for several years in succession. The same practice is followed with the sandy soils as with the clay loam soils, but, as a rule, cotton is the principal crop. Since soil conditions in most of the sandy soils are more favorable for growing a diversity of crops, a rotation can be used for the purpose of maintaining soil fertility, especially as alfalfa can be included in the scheme of crop rotation. A crop rotation, including alfalfa, on the clay loam soils is not successful, as great difficulty is experienced in obtaining a profitable stand of this crop. It is generally recognized that alfalfa can be grown successfully only on the best land having proper soil and moisture conditions. In many years the rainfall is not sufficient for good plant growth in the tight-land soils, and the tightness of the subsurface soil and subsoil hinders the development of the root system of deep-rooted plants like alfalfa.

Preparation and cultivation of the land is much the same throughout the county. Deeper plowing is practiced on the sandy soils than on the heavy soils. The sandy land may be plowed later because moisture conditions are better throughout the year. Land for wheat is plowed or listed in July, if moisture conditions are right, or if it is too dry at this time it is plowed later in the fall after rains. It is common practice to harrow the land after each rain, in order to prevent crusting of the surface soil and to pulverize it so as to prevent so much evaporation of moisture. On many farms wheat is drilled in between the cotton rows in the fall. Land for oats is generally broken in late winter or early spring.

Land for row crops, which consist mainly of cotton, corn, and grain sorghums, is usually bedded in the fall or winter with listers which make furrows 1 foot or more below the crest of the intervening ridges. At planting time the land is rebedded by running a lister down the ridges, making the new furrow there and the ridges where the old furrows were. The seed is planted in the bottom of the new furrow, often at the same time the land is rebedded. This method enables seed to be planted in moist soil. Plowing to a depth of 8 or 10 inches, followed by disking once or twice is another good method of seed-bed preparation. The plowing is started in January. Disk openers attached to the planters are also used. At each cultivation, soil is thrown around the roots of the cotton plants, until the last cultivation, when the surface is left level or slightly higher around the plants than in the middles.

Row crops are in general cultivated 3 or 4 times. Sometimes cotton is cultivated more frequently. The young plants are cultivated with a go-devil, a kind of cultivator with flat metal wings that keep the soil from covering the young plants as it is thrown in the furrows.

Caution is taken to prevent blowing on the sandy soils. The land is prepared by listing, and the furrows are run east and west or at right angles to the prevailing winds, in order to prevent drifting. It is sometimes necessary to replant crops in places where the loose sands blow about to such an extent as to destroy young plants.

The practice of seeding the principal crops at certain times is followed by most farmers. Cotton is planted between April 20 and July 1, and the best time is from May 10 to May 15, according to the experience of the farmers over a period of years. Wheat is sown from September 1 to December 15. Early seeding is best. From September 10 to 15 is the best time for sowing wheat for winter pasture. When pastured with good judgment, the yields of grain are not materially reduced. Hard wheat is best adapted to the dry climate of this section. Barley has long been grown on a small scale by many farmers. It is valuable feed for livestock of all kinds and for this reason takes the place of oats on many farms, but it yields somewhat less than oats. It is used also for grazing and is sown at about the same time as wheat. Oats are seeded from January 15 to March 10, and corn is planted between March 10 and 15.

Land for alfalfa should be put in condition in July or August if moisture conditions are favorable. This crop should be drilled in during August or September. It may be necessary to inoculate the seed with soil from a field where alfalfa has been grown successfully or by using a prepared culture.

Blackhull kafir, White kafir, Dwarf Yellow milo, feterita, and darso are popular forage crops. Grain sorghums make very little growth if the weather is cool, and therefore should not be planted until danger of frost is over and the ground has become warm. The best practice to follow is to plant sorghums as soon as the ground is sufficiently warm to insure germination of the seed.[2]

African millet and Redtop sorgo are grown as hay crops. They are usually drilled in during April, but may be sown in the fall. Sudan grass is good for summer grazing, or it may be cut for hay. It is planted in rows and cultivated. It withstands droughty weather rather well and with plenty of moisture yields from 1 to 3 tons of hay an acre from the ordinary two cuttings.

Most of the land at present in cultivation has been used for the production of crops for 30 years. Corn was the first crop grown, and later, wheat, alfalfa, and cotton followed in the order of their importance. With the present system of cropping, which consists principally of growing cash crops, a large percentage of nitrogen and organic matter has been lost from the soil.

Commercial fertilizers have increased yields but not enough to pay for the expense, according to reports from the county agent. The growing of cash crops fails to promote the livestock industry, and as a result very little manure is applied to the land. Observations over many wheat fields that have been pastured indicate that manure is very beneficial. Legume crops are not systematically grown in the rotation. It is a common belief that yields have decreased about 20 percent on most of the soils since they were first brought under cultivation.

Soil erosion is an agency destructive to soil fertility where the land is improperly managed. The damage is greatest on the more rolling clay loam soils, because water does not penetrate the plastic clay subsoil, especially during heavy downpours. Moisture is readily absorbed in the sandy soils. Therefore, on them the erosion is not so

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[2] KILTZ, B. F., SIEGLINGER, J. B., OSBORN, W. M., BARNES, B. F., and FINNELL, H. H. SORGHUMS FOR GRAIN AND FORAGE. Okla. Agr. Expt. Sta. Bull. 210, 47 pp., illus. 1933.

great a problem as on the more rolling clay loam soils, as the Vernon and Tillman. The reddish-brown surface soil is washed away and the red subsurface material is exposed, rendering the land comparatively nonproductive. Crops suffer during dry weather and produce small yields. When the subsoil is exposed, the land is not so easily cultivated because the finer materials form a hard surface soil that is not so friable as the original surface soil material. The clay on the surface forms a sticky waxy material over the field, which will puddle easily if cultivated too wet.

Kiowa County is in the 25-inch rainfall belt. The erosion survey conducted by the agronomy department of the Oklahoma Agricultural and Mechanical College indicates that in this section about 15 of every 30 acres in cultivation are suffering from sheet erosion caused by uncontrolled soil moisture, and that about 8 of every 30 acres in cultivation are gullied.

Thus it may be seen that the system of farming in practice for the last 30 years, in which more than 95 percent of the cultivated land is planted to cash crops each year, has decreased the organic matter in the soil, decreased the power of the surface soil to hold moisture, increased the percentage of run-off from the rainfall, and increased erosion of the best topsoil through uncontrolled soil moisture.

The control of soil moisture consists of terracing the fields, in order to cause the water to run off more slowly and to hold the larger part of it in the soil, and of the use of legume cover crops for pasture and for plowing under, to maintain and increase the supply of organic matter.

On most of the upland soils in this county, in addition to soil moisture, organic matter and nitrogen are the chief limiting plant nutrients in crop production, both of which may be supplied very economically by the use of sweetclover, Austrian winter peas, hairy vetch, cowpeas, and mung beans. Soybeans may also be satisfactorily grown where protected from rabbits. The growing of more legumes is not only necessary for maintenance of soil fertility, but these crops provide the best and cheapest feed for livestock.

FERTILITY OF THE SOILS IN KIOWA COUNTY [3]

The greater part of the cultivated land has been farmed not more than 30 years. During this short period, some significant changes have taken place in the content of plant nutrients of the cultivated soil. Studies of the quantity of total nitrogen and total phosphorus, and degree of acidity in 24 samples of cropped and virgin soils were made, and the results of these analyses are given in table 4.

[3] This section of the report was written by H. J. Harper, professor of soils, agronomy department, Oklahoma Agricultural and Mechanical College.

TABLE 4.—*Effect of cultivation on the total nitrogen, total and readily available phosphorus, and acidity in several soils in Kiowa County, Okla.*

Soil type and sample number	Total nitrogen	Total phosphorus	Readily available phosphorus	Soil reaction
	Pounds [1]	*Pounds* [1]	*Pounds* [1]	
Tillman clay loam:				
421 [2]	2,730	730	280	Slight acidity.
422 [3]	1,250	490	260	Do.
Decrease	1,480	240	20	
Canadian silty clay loam:				
530 [3]	1,560	585	480	Neutral.
531 [2]	2,505	675	600	Basic.
Decrease	945	90	120	
Tillman silt loam:				
584 [3]	1,625	445	120	Do.
585 [2]	2,675	540	140	Do.
Decrease	1,050	95	20	
Reinach very fine sandy loam:				
594 [3]	2,910	890	400	Do.
595 [2]	2,875	775	400	Do.
Increase	35	115		
Foard silt loam:				
1293 [3]	1,635	665	300	Neutral.
1294 [2]	2,230	520	220	Do.
Decrease or increase	[4] 595	[5] 145	[5] 80	
Tillman clay loam:				
1747 [2]	2,620	530	64	Basic.
1753 [3]	2,180	530	96	Neutral.
Decrease or increase	[4] 440		[5] 32	
Foard silt loam:				
1754 [2]	3,345	745	100	Basic.
1761 [3]	3,050	670	64	Do.
Decrease	295	75	36	
Calumet very fine sandy loam:				
1762 [2]	2,055	520	100	Do.
1769 [3]	1,540	505	160	Do.
Decrease or increase	[4] 515	[4] 15	[5] 60	
Kiowa clay loam:				
1788 [2]	3,840	660	100	Do.
1790 [3]	2,365	560	100	Do.
Decrease	1,475	100		
St. Paul silt loam:				
1791 [2]	3,260	660	180	Do.
1797 [3]	2,055	840	160	Neutral.
Decrease or increase	[4] 1,205	[5] 180	[4] 20	
Tillman clay loam:				
2173 [2]	2,320	400	44	Do.
2177 [3]	1,985	360	48	Do.
Decrease or increase	[4] 335	[4] 40	[5] 4	
Tillman silt loam:				
2183 [2]	1,550	380	52	Basic.
2188 [3]	1,690	380	100	Do.
Increase	140		48	

[1] Pounds per acre in soil 6⅔ inches deep.
[2] Virgin soil.
[3] Cropped soil.
[4] Decrease due to cultivation.
[5] Increase due to cultivation.

Several different soil types were included in this investigation, and in all except two the total content of nitrogen was lower in the cultivated soil than in soil from adjacent areas which were covered with native prairie grass and had never been plowed. Sample no. 594 (Reinach very fine sandy loam) has been developed from alluvium and could vary considerably from one place to another. There is no explanation why the virgin soil, sample no. 2183 (Tillman silt loam), should be lower in total nitrogen than the cropped sample which was obtained from the adjacent field, unless wind erosion has deposited some soil low in organic matter over the adjacent area of virgin prairie. This condition was not detected when the samples were taken. The problem of maintaining the nitrogen and organic-matter content of the soils of Kiowa County is a very difficult one to solve. On the average upland soil legume crops do not produce large yields of forage. Cowpeas make a fair growth when the summer rainfall is favorable, but there is a very sparse development of nodules on the roots of legumes during the hot summer months. Winter legumes have not made a very good showing, owing to lack of rainfall during the winter and early spring. High wind velocity also removes large quantities of water from these plants. This not only retards their growth, but it seems to stunt the plants and they do not make a vigorous growth, even though climatic conditions are favorable during April and May.

Alfalfa can be grown on the sandier soils, but it does not make much growth during seasons when rainfall is low, unless it is planted on land where subirrigation is practiced. There is some indication that sweetclover can be grown in rows on some of these soils, although this crop requires twice as much water to produce 1 pound of dry matter as crops like Sudan grass or sorghum cane. The careful conservation of rainfall, by means of terracing and contour farming, will assist in increasing the yield of sweetclover on soils where crop yields are low, and, as a result of the growth of this crop, the nitrogen and organic-matter content of the soil will be increased, and better crops of wheat and cotton can be produced.

Changes in the total phosphorus content of cropped and virgin soils seem to vary considerably. When crops like wheat and cotton are sold and nothing is returned to the soil, there is normally a decrease in the plant-nutrient content of the soil. In most analyses, the virgin soils proved higher in total phosphorus than the cultivated soils. Some variation in the phosphorus content of different layers of soil may influence this comparison, since in some cases the cropped soil may have suffered from erosion, and the present surface soil is not the same layer of soil which composed the surface soil under virgin conditions. The availability of inorganic phosphorus in the greater number of soils in the county is high. Consequently, plants which develop an extensive root system will not suffer from a deficiency of phosphorus for some time. When such deficiency does occur, it may be necessary to supply phosphorus to the soil in the form of commercial fertilizer.

The soils of this county have been formed under the influence of low rainfall, and all except one of the samples of soil analyzed contained a fair supply of lime. This sample was only slightly acid and did not have a high lime requirement. One ton of finely ground limestone thoroughly mixed with the surface soil would correct the acidity and provide conditions which would be favorable for the growth of all lime-loving crops adapted to the prevailing climatic conditions.

Phosphorus is an important plant nutrient, and when this element is not present in the soil in available form, plant growth will be poor. The rate at which phosphorus will go into solution is an important factor in determining the response which may be obtained from phosphorus fertilization. Sixty-three samples of surface soil taken in different parts of the county have been analyzed, and the availability of the phosphorus in these samples has been classified; 25 were very high in readily available phosphorus, 32 were high, 2 were medium, and 4 were low. The available phosphorus was determined by treating 1 part of soil with 10 parts of fifth-normal sulphuric acid and analyzing the filtrate for this element. Six of the samples in this group would respond to phosphorus fertilization, and only four would be considered deficient in readily available phosphorus for most crops. A deficiency of phosphorus usually occurs in the sandier upland soils, and commercial fertilizer containing phosphorus may be needed on these soils before it will be required on soils containing a higher percentage of silt and clay.

The presence or absence of lime in soils is an important factor in stimulating or retarding the development of many crops. One hundred and sixteen samples of surface soil obtained from different parts of Kiowa County have been tested, in order to determine whether or not any of them are acid; 54 were basic,[4] 44 were neutral, 10 were slightly acid, 7 were slightly+ acid, and 1 was medium acid.

Soils which contain a good supply of limestone are basic in reaction. As the lime disappears, owing to the leaching effect of rainfall, a neutral condition occurs, after which acidity begins to develop. In general, slightly acid soils do not respond to limestone except when the subsoils, as well as the surface soils, are acid. Medium acid or strongly acid soils may require 2 or 3 tons of limestone an acre to neutralize the acidity. Only eight soils in this group were sufficiently acid to warrant the use of lime for maximum production of lime-loving crops. Tests made on the subsoils in this county indicate that lime is generally present at a short distance below the surface. Therefore, many of the samples which are acid in the surface layers may not respond to applications of limestone, because plants can obtain an adequate supply of lime after the roots penetrate into the lower layers. Another reason that soil acidity will not increase rapidly under the present system of soil management is the increasing rate of erosion which is removing the surface soil, thereby exposing soil material containing more lime than occurred in the virgin surface soil.

Experiments conducted in Oklahoma and elsewhere indicate that a cropping system including several crops is more desirable than one-crop farming, because labor is distributed more uniformly throughout the season, there is less danger of a low farm income

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[4] These soils contain rather large quantities of limestone.

caused by crop failure or unfavorable prices, and crop yields are maintained at a higher level.

Wheat farmers, as a rule, do not grow much cotton, and most of the cotton farmers do not grow much wheat. The cost of extra machinery required to handle different crops is frequently given as a reason why a one-crop system is followed. Some of the finer textured soils are adapted to the production of wheat because this crop grows during that part of the season when drought is not likely to be a limiting factor in plant development. Some of the sandier soils are better adapted to grain sorghums and cotton, because these crops can grow where wheat will fail. There are, however, many soil types on which all three of these crops can be grown.

Wheat may be planted after the cotton is harvested, but the success of this particular system depends largely on the amount of fall rain. Cotton removes much of the subsoil moisture during its growing period, and when the fall and winter seasons are dry the growth of wheat may be seriously retarded. Bad effects are also produced when wheat follows such crops as sweetclover or alfalfa. It is possible that poor yields of wheat following cotton may be due to lack of sufficient nitrogen in the soil. Cotton does not have so high a fertility requirement as wheat and will make a good growth on soil where yields of wheat are low. Under the present system of farming, in which the problem of soil fertility is neglected, the acreage of cotton should tend to increase rather than decrease, unless other factors besides soil fertility interfere. Grain sorghums also will grow on soil where wheat will not make a satisfactory yield. After the yields of cotton and grain sorghums decline there is no other crop which can be substituted unless the nitrogen and organic-matter content of the soil is increased.

Diversified farming will result in the introduction of more livestock. This will help in the maintenance of soil fertility if the farm manure is carefully preserved and returned to the soil. The return of cotton burs to the soil is another method which will assist in maintenance of the organic matter and nitrogen content.

Wind erosion is not serious, except on some of the very sandy soils. The use of proper tools for cultivation and careful soil management are effective in controlling this type of erosion. Where the subsurface soils contain enough clay to produce a cloddy condition when the surface soil is listed to a depth of 8 or 10 inches, movement of the soil can be reduced by deeper cultivation. On the deep, sandy soils vegetative methods for the control of wind erosion are most effective. If narrow strips of grain sorghum are planted at frequent intervals in rows running east and west and are allowed to stand until the adjacent ground has been listed and planted and the young cotton plants are large enough to protect the soil, the harmful effect of wind erosion can be eliminated.

The content of plant nutrients in a soil is an important factor in determining its agricultural value. Studies on the content of total nitrogen, organic matter, total phosphorus, readily available phosphorus, and acidity in typical soil profiles are given in table 5.

TABLE 5.—*Chemical composition of soils in Kiowa County, Okla.*

Location	Soil type and sample no.	Depth	pH	Total nitrogen	Total organic matter	Total phosphorus	Readily available phosphorus
		Inches		*Percent*	*Percent*	*Percent*	*Parts per million*
	Tillman clay loam:						
SE ¼ sec. 26, T. 2 N., R. 17 W	1741	0- 4	7.8	0.122	2.70	0.025	40
	1742	5-12	7.5	.126	2.45	.022	30
	1743	13-24	7.2	.072	1.60	.015	12
	1744	25-42	8.6	.044	.68	.013	24
	1745	43-60	9.0	.021	.20	.017	(1)
SW¼ sec. 6, T. 4 N., R. 16 W	1747	0- 4	8.3	.131	2.78	.026	32
	1748	5- 7	7.2	.091	2.58	.025	24
	1749	8-18	6.9	.095	2.30	.023	12
	1750	19-36	7.1	.074	1.45	.016	7
	1751	37-60	8.2	.049	.73	.013	12
	Foard silt loam:						
SE¼ sec. 28, T. 6 N., R. 19 W	1754	0- 6	7.9	.167	3.20	.037	50
	1755	7-18	8.0	.097	1.70	.025	40
	1756	19-36	8.6	.030	.95	.023	50
	1757	37-66	8.3	.034	.53	.021	60
	Calumet very fine sandy loam:						
SE¼ sec. 25, T. 6 N., R. 20 W	1762	0- 8	7.8	.102	2.20	.026	50
	1763	9-15	8.2	.072	1.30	.021	32
	1764	16-40	8.4	.042	.68	.029	30
	1765	41-60	8.6	.021	.30	.019	(1)
	Enterprise fine sand, shallow phase:						
NW ¼ sec. 27, T. 6 N., R. 20 W	1770	0- 6	8.0	.048	.85	.009	12
	1771	7-18	7.2	.052	.85	.010	8
	1772	19-36	7.0	.040	.58	.009	2
	1773	37-54	7.3	.030	.65	.007	0
	1774	55-80	7.6	.038	.10	.005	0
	Canadian silty clay loam:						
SE¼ sec. 33, T. 4 N., R. 17 W	1776	0- 8	7.3	.097	2.25	.036	160
	1777	9-18	8.7	.088	1.65	.031	140
	1778	19-42	8.8	.049	.80	.037	210
	1779	43-66	8.9	.027	.45	.035	200
	Foard silt loam:						
NE¼ sec. 10, T. 4 N., R. 17 W	1781	0- 6	8.5	.168	3.05	.025	60
	1782	7-18	8.7	.082	1.58	.015	40
	1783	19-36	8.3	.054	1.68	.039	90
	1784	37-55	8.4	.038	.93	.013	18
	St. Paul silt loam:						
NW¼ sec. 26, T. 7 N., R. 20 W	1791	0- 8	7.7	.163	1.85	.040	90
	1792	9-20	7.6	.107	1.98	.033	80
	1793	21-30	8.1	.114	1.23	.023	50
	1794	31-50	8.5	.033	.73	.027	70
	1795	51-72	8.0	.031	.23	.021	90
	Tillman clay loam:						
SE¼ sec. 18, T. 3 N., R. 18 W	1798	0- 6	7.7	.055	1.10	.017	80
	1799	7-20	7.2	.089	1.40	.032	70
	1800	21-50	7.5	.053	.90	.022	70
	1801	51-72	8.2	.079	.95	.018	60
	Foard clay:						
SE¼ sec. 9, T. 6 N., R. 15 W	1803	0- 2	8.0	.082	1.38	.027	120
	1804	3-20	8.1	.071	1.28	.025	60
	1805	21-60	8.9	.036	.58	.021	70
	Vernon clay loam:						
NW¼ sec. 36, T. 7 N., R. 14 W	1808	0- 6	8.4	.131	2.80	.027	90
	1809	7-12	8.5	.116	2.10	.028	110
	1810	13-36	8.8	.049	.63	.029	200
	Enterprise very fine sandy loam:						
NW¼ sec. 20, T. 4 N., R. 18 W	1811	0- 6	7.7	.071	1.50	.021	90
	1812	7-12	7.3	.062	1.40	.017	40
	1813	13-36	7.5	.051	.93	.016	34
	1814	37-60	7.8	.048	.73	.012	34
	Enterprise loamy very fine sand:						
SW¼ sec. 25, T. 3 N., R. 18 W	1817	0- 6	8.6	.063	1.23	.022	90
	1818	7-12	8.7	.069	.83	.022	120
	1819	13-60	8.5	.052	.83	.022	120
	Enterprise fine sand, shallow phase:						
NW¼ sec. 6, T. 3 N., R. 18 W	1827	0- 6	7.1	.066	1.40	.008	24
	1828	7-12	7.9	.027	.70	.006	30
	1829	13-36	6.8	.022	.55	.006	4
	1830	37-60	7.2	.015	.45	.005	4
	Portland clay loam:						
NE¼ sec. 27, T. 7 N., R. 15 W	1832	0- 6	7.6	.107	2.35	.039	140
	1833	7-12	7.7	.132	2.10	.033	140
	1834	13-36	8.0	.038	1.33	.025	100
	1835	37-40	8.8	.033	.55	.031	160

[1] Calcareous soil, neutralized acid used to extract phosphorus.

TABLE 5.—*Chemical composition of soils in Kiowa County, Okla.*—Continued

Location	Soil type and sample no.	Depth	pH	Total nitrogen	Total organic matter	Total phosphorus	Readily available phosphorus
		Inches		*Percent*	*Percent*	*Percent*	*Parts per million*
SW¼ sec. 10, T. 2 N., R. 18 W.	Portland very fine sandy loam:						
	1837	0- 6	8.4	.100	1.65	.029	150
	1838	7-12	8.4	.030	1.53	.027	150
	1839	13-60	8.5	.034	.75	.022	90
SE¼ sec. 1, T. 7 N., R. 15 W.	Yahola fine sandy loam:						
	1841	0- 6	8.6	.083	1.75	.039	170
	1842	7-12	8.5	.043	1.00	.025	160
	1843	13-60	8.5	.012	.48	.019	90
NE¼ sec. 9, T. 2 N., R. 18 W.	Yahola loamy fine sand:						
	1845	0-12	8.3	.031	.83	.012	60
	1846	13-72	8.2	.033	.35	.005	30
SW¼ sec. 26, T. 7 N., R. 15 W.	Vernon clay loam, eroded phase:						
	1847	0- 6	8.3	.147	3.03	.040	120
	1848	7-84	8.6	.050	1.43	.036	120
SE¼ sec. 7, T. 7 N., R. 14 W.	Tillman very fine sandy loam:						
	1849	0- 6	7.2	.113	2.80	.032	150
	1850	7-18	7.2	.090	2.18	.030	90
	1851	19-54	8.1	.042	.80	.021	90
NE¼ sec. 14, T. 7 N., R. 14 W.	Enterprise fine sandy loam:						
	1853	0- 6	6.5	.044	1.10	.011	12
	1854	7-12	6.4	.040	1.40	.014	8
	1855	13-36	6.7	.074	.65	.090	4
	1856	37-60	7.2	.039	.53	.070	12
SW¼ sec. 10, T. 7 N., R. 15 W.	Tillman very fine sandy loam:						
	1857	0- 6	7.8	.083	2.23	.022	50
	1858	7-14	7.7	.034	1.70	.019	50
	1859	15-24	7.5	.078	1.45	.017	40
	1860	25-84	8.5	.017	.45	.025	64
NE¼ sec. 2, T. 7 N., R. 14 W.	Reinach very fine sandy loam:						
	1861	0- 6	7.7	.078	2.00	.035	160
	1862	7-18	7.8	.079	1.58	.036	160
	1863	19-30	8.3	.049	1.08	.035	200
	1864	31-84	8.7	.043	.55	.036	200
NE¼ sec. 12, T. 5 N., R. 14 W.	Tillman clay loam:						
	2173	0- 6	6.9	.116	2.90	.020	22
	2174	7-14	7.0	.091	2.20	.019	8
	2175	15-42	8.3	.048	1.08	.010	12
SE¼ sec. 16, T. 7 N., R. 17 W.	Tillman silt loam:						
	2183	0- 5	7.9	.078	1.88	.019	26
	2184	6-14	7.0	.079	1.60	.025	22
	2185	15-32	8.7	.034	.55	.023	10
	2186	33-50	7.5	.034	.73	.013	4

The total nitrogen and organic-matter content in most of the soils of the county decreases rapidly with depth. Although many of the sandy soils are the most productive soils, their crop-producing capacity decreases more rapidly than that of many containing a higher percentage of silt and clay. According to the analyses, Miller clay loam is highest in total nitrogen and total phosphorus. This soil, if properly drained, should continue to produce good crops for a long time. Under virgin conditions, the average content of nitrogen in Oklahoma soils is about 0.145 percent. The data presented in table 5 were obtained from virgin soils, and most of the soils of the county do not contain so much total nitrogen and organic matter as the average for Oklahoma soils.

The total phosphorus content of the soils of this county is also low. The samples of Enterprise fine sand, shallow phase, nos. 1770 to 1774, are very low in total phosphorus. These soils are low in other plant nutrients, and the addition of a phosphate fertilizer would not necessarily produce a marked increase in crop yield. The average total phosphorus content of surface soils in Oklahoma soils is 0.03 percent. The availability of the phosphorus in Kiowa county soils is fairly high. Only 8 of the 25 profiles studied are higher in total phosphorus than the average for the State. Data on the content of readily available phosphorus in these samples show that none of them would respond to phosphorus fertilization, with the possible exception of Enterprise fine sand, shallow phase, and Enterprise very fine sandy loam. Tests made at the Oklahoma Agricultural Experiment Station indicate that soils which contain more than 25 parts per million of phosphorus soluble in fifth-normal sulphuric acid do not usually respond to phosphorus fertilization for most crops. Further information on the phosphorus content of Oklahoma soils may be obtained in a bulletin of the Oklahoma Agricultural Experiment Station.[5]

Data on the acidity of the profile samples are expressed in terms of pH values. A pH of 7 indicates that the soil is neutral in reaction. Values higher than 7 indicate the presence of lime. In soils having a pH of 8 or more, large quantities of lime in the form of calcium carbonate are generally present. In places where the pH of the soil is less than 7, the quantity of lime decreases, and applications of limestone generally produce profitable increases in crop yields where the pH is less than 6, especially where the subsurface soil also is acid. The most acid profile in the group is that of Enterprise fine sandy loam (nos. 1853 to 1856). According to data obtained from other soils, lime is not needed on this soil at present for the growth of crops having a high lime requirement.

SOILS AND THEIR INTERPRETATION

The soils of Kiowa County may be divided into two groups on the basis of certain common characteristics. One consists of clay loam soils, embracing most of the county, except a narrow belt bordering the western part and northeastern corner; and the other includes the sandy soils. The soils of both groups are developed under a climate favoring an accumulation of organic matter which produces a dark-colored surface soil. The rainfall is sufficient to maintain a grass vegetation, which forms an abundance of organic matter through the decay of its roots, but there is not enough rainfall to favor the growth of trees, which produce a smaller amount of organic matter than the grasses and cause the formation of a lighter colored soil. Trees are grown successfully locally where an unusual supply of moisture is retained in the subsoil through subirrigation or poor drainage, commonly on bottom lands or along the banks of streams.

Many of the soils that at one time had a dark-colored surface soil have had it altered by borings of rodents, especially prairie dogs. These rodents congregate over large areas and pit the surface with numerous borings, bringing up the lighter colored material from below the subsoil. This material is deposited on the surface and later spread about, forming numerous patches with lighter colored surface soil sporadically distributed over the field. The surface color of these spots ranges from reddish brown to reddish yellow, whereas the undisturbed part of the surface soil is very dark grayish brown or almost black. In some places the patches having the lighter

[5] HARPER, H. J. EASILY SOLUBLE PHOSPHORUS IN OKLAHOMA SOILS. Okla. Agr. Expt. Sta. Bull. 205, 24 pp., illus. 1932.

colored surface soil are linked together, forming narrow strips separated by a narrow strip of darker colored soil. This causes a striped appearance over a cultivated field. The material brought up to the surface of these light-colored spots is rich in lime both in concretionary and in finely disseminated form. Therefore, when the land is cultivated, this material is spread about so that the surface soil over most of the area contains sufficient lime to produce effervescence with acid. Borings made with an auger in the surface soil of these light patches often reveal a black soil layer from 2 to 4 inches below the surface. This layer is the original surface soil before it was covered with soil material worked up and deposited by the prairie dogs. This condition is most typical in areas of Kiowa clay loam.

Wherever the soils in either group are unusually light in color, there is some local condition that inhibits the accumulation of organic matter, either through removal or prevention of its formation. The steep slopes have prevented the absorption of enough moisture by the soil to support a growth of grasses and the accumulation of organic matter, and in the very sandy soils plant growth has not been sufficiently great to produce much organic matter. The very flat areas of the sandy soils, however, favor an accumulation of some organic matter.

A surface soil consisting of fine material which prevails in the clay loam soils and occupying level or gently undulating relief is the most favorable environment for the accumulation of organic matter, and, as a result, a very dark colored surface soil has developed. Such soil occurs on divides where very little of the land has been cut by stream erosion.

A soil characteristic acquired within many of the soils of Kiowa County through the influence of vegetation and climate is the accumulation of calcium carbonate, which makes its first appearance at an average depth of 18 inches below the surface in a few soils and in others at a depth of about 30 inches. Rainfall penetrates the soil to these depths, and the calcium carbonate has been leached downward by percolating water. The calcium carbonate occurs as hard concretions, ranging from one-sixteenth to one-fourth inch in diameter, and in finely disseminated form, and the soil material in which it is present is so impregnated with lime as to produce effervescence with acid. The concretions are almost white and when crushed reveal a small cavity across their interiors. In the clay loam soils the calcium carbonate is most abundant between depths of 60 and 72 inches. This is the zone of maximum lime accumulation, and below it is the partly weathered or unweathered parent material of red clay and shale.

Many carbonate of lime concretions are abundantly distributed over the surface of the sloping areas, but they represent the zone of maximum lime accumulation which has been left exposed after excessive erosion has removed the upper horizons of the soil profile. The zone of maximum calcium carbonate accumulation is absent in most of the sandy soils because the lime is, perhaps, not in available form or it has been leached to great depths.

The zone of carbonate accumulation is also absent in most soils occurring on the alluvial plains because the deposit of soil material recently made has not had sufficient time to accumulate calcium carbonate in the profile. In most of the bottom-land soils, lime is first detected, through the application of acid, at depths ranging from 10 to 24 inches, but, unlike the lime in the soils on the level uplands, the quantity in few places diminishes or increases at a certain depth sufficiently to form a definite zone of maximum carbonate accumulation. This zone is not developed in poorly drained soils because of the constant leaching of any excessive deposit of calcium carbonate that may be suddenly brought down to the lower part of the profile.

The soils that have developed either of these characteristics, namely, a dark surface soil and a well-defined zone of calcium carbonate accumulation, may be regarded as having developed a typical regional profile because they occur over areas of smooth, level or gently sloping relief, where very little surface erosion has taken place, and the climate and vegetation have been allowed to make the strongest impression on them. They are developed from very fine material which is able to retain the characteristics developed through climatic influence and are therefore included entirely among the finer textured soils of the clay loam group. Such soils are considered mature soils. Wherever the climatic influence on the soils is modified by local conditions, these common soil characteristics are not normally developed, and the soils may be regarded as soils with imperfectly developed profiles, commonly known as immature soils.

A fully developed profile of a mature soil developed in many places in the county is divided into three color horizons as follows: A dark grayish-brown horizon, a brown or yellowish-brown horizon, and a reddish-brown horizon. Within the third horizon, at a depth ranging from 60 to 72 inches, is a zone of lime accumulation, and below this is the partly weathered or unweathered parent material of red clay and shale of the Permian "Red Beds." Foard silt loam and Foard clay are representative soils of this group. These soils are developed on smooth undulating surface relief, where surplus surface water is readily removed without disturbing the surface soil.

In some places slight removal of the soil material from the surface soil, through run-off of surplus water after a rainfall, has produced a reddish-brown soil which contains a zone of lime accumulation and has a soil structure like that commonly developed in Foard silt loam. Soil of this character is identified as Tillman clay loam.

Kiowa clay loam has almost the same color and structure characteristics of the surface soil as Foard silt loam, but it has a reddish-brown horizon beneath the surface soil instead of a yellowish-brown horizon as is commonly developed in Foard silt loam. It occurs in areas that have good underground drainage, that is, it lies adjacent to a deep valley or on moderately high ridges, where the surface relief is smooth and gently rolling.

Calumet very fine sandy loam occurs in terracelike positions where the land is very flat and receives such material as salts and very fine material washed on it from surrounding areas. The surface soil is gray, is friable or floury, and feels like very fine sandy loam when pressed between the fingers, but laboratory analyses show it to have a high content of colloidal clay.

The normally developed soil of the county, developed from mixed silt, clay, and very fine sand, in which the local character of the soil material, such as the presence of salts, or unusual flatness of relief or steepness of slope, has not prevented normal and unmodified operation of the climate and vegetative forces, is St. Paul silt loam. It represents the typical chernozem profile of this latitude, rainfall, and parent rock. Following is a description of a profile of St. Paul silt loam as examined in the NE¼ sec. 7, R. 18 W., T 7 N., and in other sections of the county. It is characterized by three color horizons that merge into each other. The first horizon is very dark grayish brown or dark grayish brown, the second is brown, and the third is reddish brown, beneath which is the lime concretionary zone.

The first horizon extends to a depth of about 14 inches and consists of very friable silt loam. From the surface to a depth of 4 inches there is no definite structure, and the material contains a dense network of grass roots. When crushed into fine powder no color change is revealed, indicating the soil to be thoroughly impregnated with dark-colored material formed by organic matter. Below a depth of 4 inches and continuing to the lower limits of this horizon, most of the material breaks into very small particles averaging one-sixteenth inch in diameter. The particles are easily crushed by hand, and the color on the outsides of them is darker than that on the insides.

The second horizon consists of material containing more clay than the material in the horizon above and is usually a silty clay loam. The material breaks into cubical pieces that average between one-half and 1 inch in diameter and three-fourths inch in length. These particles have smooth surfaces, and their color is similar to the basic color of this horizon. They are easily crushed by hand and when crushed reveal considerable change in color, indicating that the material on the insides of the soil particles is lighter than that on the outsides. When a large mass of material from this horizon is broken, so that many of the structure particles separate from each other voluntarily, a noticeable quantity of grass roots are found plastered on the sides of the small cubical pieces. Close examination reveals that very few roots occur through the centers of the particles. This horizon grades into the third horizon at a depth of 36 inches, where most of the grass roots terminate.

The third horizon is similar in character to the second horizon, in that the material has almost the same structure, although the structure particles are slightly larger than those in the second horizon. Very few grass roots are present in this horizon. Lime is present for the first time in sufficient quantities to produce effervescence with acid. Continuing downward to a depth of about 50 inches, there is an abundance of lime in the form of concretions that range from one-fourth to 1 inch in diameter, and the material consists of friable reddish-yellow clay. In some pits examined, this part of the horizon is almost white, as it is composed of almost pure lime. On slopes where this part of the profile is exposed, unusually large concretions, ranging from 2 to 3 inches in diameter, occur.

In a few very flat areas, as in sec. 26, T. 7 N., R. 20 W., this horizon has a grayish-red tint, and as depth increases it finally grades into friable pink clay loam which contains an abundance of lime in the form of concretions, that range from one-fourth to 1 inch in diameter, and also in small soft specks.

One distinguishing feature of St. Paul silt loam is the more friable character of the material throughout the profile as compared with the material in the Foard soils. Instead of the material in the second horizon being compact and forming large sharp angular pieces when broken out, as in the Foard soils, it is not so compact and breaks into smaller pieces which can be easily crushed by hand. Another important characteristic of this soil is the absence of a sprinkling of gray on the soil particles in the subsoil, such as occurs throughout the subsoils of the Foard soils.

St. Paul silt loam is most extensively developed in the northwestern part of the county and north of the line of escarpment that crosses the northern part. It occupies the most level upland sections in that part of the county, whereas Tillman silt loam, also developed there, embraces the rest of the uplands, which is more rolling.

A profile of Foard silt loam examined in sec. 28, T. 6 N., R. 19 W., shows the following characteristics:

In the first horizon, which is 14 inches thick, is a laminated layer, about one-half inch thick, which consists of very friable single-grained material. It is formed by numerous small overlapping particles. This layer is, perhaps, developed from wind-blown deposits that have become lodged among the grass roots. Beneath this laminated layer is very dark grayish-brown silt loam or silty clay loam, which on crushing fails to produce any change in color. At a depth of 4 inches, however, the color gradually changes to a lighter shade with depth. Below a depth of 4 inches the soil material is composed of larger particles, and it appears to be a silty clay. A light sprinkling of gray occurs on the surfaces of the soil particles in the lower 2 or 3 inches of this horizon. About 85 percent of the grass roots entering the surface soil are in the first horizon.

The second horizon, which continues to a depth of 66 inches in some places, but in most places to a depth of about 48 inches, consists of yellowish-brown material that is very plastic and sticky when wet, and when dry forms hard sharp angular clods ranging from one-half inch to 2 inches in diameter. Lime carbonate is present for the first time at a depth of 20 inches, distributed throughout the soil material in the form of hard concretions or as finely disseminated powder. The concretions are small and are hard to crush. They are almost white on the outsides, and many of them are hollow. The material in this horizon produces effervescence with acid throughout. Embedded within the soil material are numerous brown pellets ranging from one-sixteenth to one-fourth inch in diameter. Their centers consist of yellowish-brown fine material. On account of the compactness of the material in this horizon, a very small percentage of the grass roots penetrate it. In most places this horizon terminates at a depth of about 48 inches.

The third horizon consists of reddish-brown material that is not so compact as the material in the horizon above. It also contains lime carbonates and brown pellets, such as those described in the horizon above, but in the lower part, between depths of 70 and 78 inches, there is a greater amount of visible lime, both in the form of concretions and in soft splotches, than occurs in any other part of the profile. This is the zone of lime accumulation. In this part of the horizon the material is in general much more friable than in any other part of the profile.

Below the third horizon is the parent material consisting of red clay and shale. It is friable and is stained with gray, yellow, and rust brown. It is calcareous in reaction with acid and contains a few concretions of lime.

Kiowa clay loam has a surface horizon of dark grayish-brown friable very fine material passing at a depth of 7 inches into a brown or reddish-brown subsoil horizon, and this, in turn, continues downward, merging at a depth of 14 inches into the third horizon of light reddish-brown material. Below the third horizon, at a depth of 52 inches, is a distinct zone of lime accumulation, in which a greater amount of visible lime occurs than in either the horizon above or below. At a depth of about 72 inches lies the parent material of Permian red clay. Lime is first reached at a depth of about 25 inches. It occurs in the form of concretions sparingly distributed throughout the profile to the zone of lime accumulation.

Each of the three horizons of Kiowa clay loam differs from the others in certain characteristics besides color. The first horizon consists of very fine single-grained material that is faintly laminated in the topmost layer, but it is more or less structureless below, and the material is easily crushed between the fingers into fine powder. The second horizon is composed of material that is more or less granular and breaks from the vertical wall in columnar blocks. The third horizon contains the most compact material in the profile. It is very hard when dry and breaks into large massive irregular-shaped pieces or sharp-cornered clods.

Kiowa clay loam occurs on divides where the surface relief is smooth and gently rolling, enabling the surplus water to run off without causing any disturbance of the surface material. This soil differs from Foard silt loam in that it has a reddish-brown subsoil and the depth to lime is greater, as determined by tests with hydrochloric acid. In most cultivated fields the surface soil of Kiowa clay loam has a slight tint of red over the surface, as compared with the dark-colored surface of Foard silt loam, although this difference in color between the two soils is not readily detected, except when they are dry.

Kiowa clay loam more closely resembles Tillman clay loam than it does Foard silt loam, in depth to lime and color of the soil profile below the surface horizon. Kiowa clay loam has a dark grayish-brown surface horizon, and the corresponding horizon of Tillman clay loam is reddish brown.

Examination of a profile of Calumet very fine sandy loam shows the following characteristics:

The material in the surface soil is laminated near the top, and in the lower part it forms small almost square blocks averaging 1 inch in diameter. The laminated material forms tiny platelike disks that overlap each other. The disks are very fragile and are easily destroyed when disturbed. When the material in the surface soil is wet, all structure is destroyed.

The surface soil forms a distinct gray layer above the claypan subsoil horizon. Near the top of the second horizon the material shows very little or no change in color when crushed, but in the lower part there is a change to a brown color. The claypan subsoil horizon consists of heavy compact material that is very hard when dry and extremely plastic or sticky when moist. On removal with a spade, the material breaks into large irregular-shaped pieces ranging from 4 to 10 inches in diameter, which are hard to break and, if thrown to the ground with considerable force, remain intact. Drying of the material in this horizon produces cracks that extend both horizontally and vertically, and the material breaks into irregular shapes. Very few roots are present in this horizon. Black or brown manganese pellets, averaging one-twelfth inch in diameter, and specks of gypsum are noticeable.

In the third horizon all the material is more easily penetrated with a spade or auger than the material in the second horizon; it is very similar in structure. Lime concretions or brown pellets and gypsum are embedded in the material of the third horizon.

Large areas of soils occur, which are intermediate in profile characteristics between St. Paul silt loam, the normal soil, and Foard silt loam, the extreme of the soil without a normal profile. Tillman clay loam is a good representation of this intermediate group. It is characterized by a profile in which there is a gradual change in color of the material from the surface downward, dividing it into three color horizons. Extending from the surface downward to a depth ranging from 7 to 10 inches, the first horizon is brown or chocolate brown, the second horizon, between depths of 10 and 42 inches, is reddish brown, and below this and continuing downward to a depth of 72 or more inches is the third horizon of pink or salmon red.

The first horizon consists of friable material that can be easily crushed. The material in the upper 3 inches is of single-grain structure and resembles very fine sandy loam. The soil material is filled with a thick network of grass roots and, when crushed, shows no change in color as does the material in the lower part of the horizon. In the lower part of the horizon the material tends to be more or less granular, some of it forming granules and some being of single-grain structure.

The second horizon consists of heavier material than the first. It is very plastic when wet and very hard when dry. When dry it breaks into irregular-shaped clods that range from one-fourth to 1 inch in diameter. The exteriors of the clods are similar in color to the face of the profile, but when reduced to powder they reveal a much redder color. Small quantities of very fine granitic material are embedded within the material of this horizon. Lime in the form of concretions is first reached within the second horizon, at a depth of 24 inches, but not in sufficient quantity to produce effervescence with acid, except immediately on the concretions.

The third horizon contains an abundance of lime in the form of concretions, and there is also considerable gravel material. This horizon represents the zone of maximum lime accumulation. At a depth of 60 inches, the lime content seems to decrease.

Soils developing from sandy material include several members of the Enterprise series. The sandy loam members have a profile approaching that of the normal chernozems, but they are all lighter in color than the chernozems, have no granulation, and have very slight development of the calcium carbonate zone. The following description of Enterprise very fine sandy loam will illustrate the more noticeable features of the soils of this series:

Enterprise very fine sandy loam has a dark-brown or brown surface horizon that grades at a depth of about 12 inches into a reddish-brown friable clay loam horizon. This, in turn, continues downward to a depth of 36 inches, where it passes into a third horizon consisting of reddish-brown sandy clay loam. Between depths of 60 and 72 inches an abundance of lime is reached. Below this the material consists of friable brown fine sandy loam. This is the darkest colored sandy soil in Kiowa County.

Table 6 shows the results of mechanical analyses of samples, taken at different depths, of several soils in the county.

TABLE 6.—*Mechanical analyses of samples of several soils in Kiowa County, Okla.*

Soil type and sample no.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Foard silt loam:	*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
451578	0- 4	0.1	0.2	0.2	0.6	8.2	55.2	35.4
451579	4- 12	.1	.3	.2	.6	7.7	42.9	48.2
451580	12- 25	.1	.3	.2	.7	7.7	41.5	49.6
451581	25- 36	.9	1.1	.4	.7	6.4	40.5	50.0
451582	36- 66	.7	.9	.5	.8	7.2	52.2	37.6
451583	66- 78	.7	2.3	1.8	2.4	6.6	31.7	54.6
451584	78- 96+	1.6	1.1	.7	1.1	3.2	40.2	52.1
St. Paul silt loam:								
4515114	0- 8	.1	.3	.6	2.6	27.7	45.2	23.4
4515115	8- 16	.1	.2	.4	1.7	16.4	44.9	36.2
4515116	16- 30	0	.5	.8	1.9	13.8	41.2	41.8
4515117	30- 50	.4	.7	.6	1.8	13.0	39.2	44.2
4515118	50- 72	.3	.4	.5	1.7	14.5	38.6	44.1
4515119	72- 90	1.6	2.9	1.3	2.7	13.9	31.1	46.5
Portland clay loam:								
451548	0- 10	0	.1	.1	.3	6.8	56.7	36.1
451549	10- 18	0	0	.1	.1	4.7	42.3	52.8
451550	18- 36	0	.1	.1	.1	7.9	43.2	48.5
451551	36- 48	.2	.1	.1	.1	13.5	51.5	34.5
451552	48- 60	.1	.2	.2	.2	2.1	38.8	58.4
Canadian silty clay loam:								
451585	0- 8	.1	.1	.2	.7	11.1	62.4	25.3
451586	8- 18	0	.1	.2	.7	7.3	56.8	34.8
451587	18- 42	.1	.2	.3	1.4	8.7	52.9	36.4
451588	42- 66	.7	.9	1.6	4.4	15.6	53.6	23.1
451589	66- 84+	.5	.6	.9	3.7	16.3	53.6	24.3
Calumet very fine sandy loam:								
4515108	0- 8	0	.4	2.3	11.2	25.8	39.8	20.4
4515109	8- 15	0	.4	2.2	10.0	21.4	28.4	37.5
4515110	15- 40	.3	.4	1.1	6.1	12.4	35.8	43.9
4515111	40- 66	.9	1.0	1.2	4.2	12.2	32.9	47.7
4515112	66- 84	1.3	2.6	1.5	4.1	13.7	23.0	53.8
4515113	84-100+	1.4	2.7	1.6	4.5	16.2	24.8	48.7
Tillman clay loam:								
4515102	0- 3	.3	1.4	1.4	2.2	18.8	51.5	24.4
4515103	3- 10	.4	1.7	1.6	2.3	18.6	45.8	29.6
4515104	10- 24	.3	2.0	1.5	2.2	16.3	37.4	40.2
4515105	24- 42	.8	2.8	1.6	2.1	17.6	37.4	37.6
4515106	42- 60	3.0	3.9	2.2	3.0	18.0	37.0	33.0
4515107	60- 72	5.6	8.0	4.2	5.3	12.7	33.2	31.1
Enterprise very fine sandy loam:								
451501	0- 12	.4	4.6	6.5	9.7	17.3	44.1	17.3
451502	12- 36	.3	4.0	5.8	9.4	13.6	35.7	31.2
451503	36- 60	.7	4.5	8.4	14.0	15.6	28.7	28.0
451504	60- 72	1.9	4.2	6.6	12.0	6.5	31.5	37.3
451505	72- 84	.8	6.9	16.2	31.9	10.6	19.1	14.4

TABLE 6.—*Mechanical analyses of samples of several soils in Kiowa County, Okla.*—Continued

Soil type and sample no.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Enterprise fine sandy loam:	*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
451535	0- 5	0.1	0.1	0.4	31.8	37.3	17.0	13.2
451536	5- 18	0	.2	.3	25.4	32.1	23.2	18.8
451537	18- 36	.1	.1	.3	22.4	32.9	23.8	20.3
451538	36- 60	0	.1	.2	22.1	52.3	12.9	12.3
Reinach very fine sandy loam:								
451539	0- 6	0	0	.1	2.3	23.3	54.8	19.4
451540	6- 18	0	.1	.1	2.3	23.4	51.9	22.2
451541	18- 36	0	0	.1	2.4	24.8	49.9	22.7
451542	36- 60	0	.1	.1	2.2	26.6	56.2	14.7
451543	60- 84+	0	.1	.1	1.4	32.3	50.6	15.4

Table 7 gives the pH values of the soil material in the different layers of the profiles of several soils, as determined in the laboratories of the Bureau of Chemistry and Soils. The hydrogen-electrode method was used in making these determinations.

TABLE 7.—*pH determinations of several soils in Kiowa County, Okla.*

Soil type and sample no.	Depth	pH	Soil type and sample no.	Depth	pH
Foard silt loam:	*Inches*		Tillman clay loam:	*Inches*	
451578	0- 4	7.70	4515102	0- 3	7.17
451579	4-12	7.39	4515103	3-10	6.93
451580	12-25	7.47	4515104	10-24	7.03
451581 [1]	25-36	8.53	4515105 [1]	24-42	8.20
451582 [1]	36-66	7.93	4515106 [1]	42-60	8.65
451583 [1]	66-78	7.80	4515107 [1]	60-72	8.79
451584 [1]	78-96+	8.22	Enterprise very fine sandy loam:		
St. Paul silt loam:			451501	0-12	6.80
4515114	0- 8	7.85	451502	12-36	6.90
4515115	8-16	7.32	451503 [1]	36-60	7.72
4515116	16-30	7.89	451504 [1]	60-72	8.10
4515117	30-50	8.30	451505 [1]	72-84	8.63
4515118	50-72	7.85	Enterprise fine sandy loam:		
4515119	72-90	8.17	451535	0- 5	6.69
Portland clay loam:			451536	5-18	6.52
451548	0-10	6.93	451537	18-36	6.52
451549	10-18	7.67	451538 [1]	36-60	7.42
451550	18-36	8.42	Reinach very fine sandy loam:		
451551	36-48	8.67	451539	0- 6	6.77
451552	48-60	8.20	451540	6-18	6.85
Canadian silty clay loam:			451541	18-36	7.17
451585	0- 8	6.82	451542 [1]	36-60	8.57
451586	8-18	8.13	451543 [1]	60-84+	8.60
451587 [1]	18-42	8.29			
451588 [1]	42-66	8.65			
451589 [1]	66-84+	8.53			
Calumet very fine sandy loam:					
4515108	0- 8	7.39			
4515109	8-15	7.87			
4515110	15-40	7.99			
4515111	40-66	8.25			
4515112	66-84	8.50			
4515113	84-100+	8.40			

[1] Lime present.

SUMMARY

Kiowa County is in southwestern Oklahoma. It comprises an area of 1,025 square miles, or 656,000 acres. It is part of a smooth plain that slopes toward the east.

The total population in 1930 was 29,630, of which 83.2 percent was classed as rural. The rural population is evenly distributed throughout the county.

Agriculture, including the growing of crops and the raising of some livestock, is the principal industry. Cotton and wheat are the leading crops, and oats, barley, and corn are of minor importance. Livestock are raised only to the extent of making use of the available feed and the pasture provided by the wheat fields during the winter or the natural vegetation on land that cannot be used for cultivation.

The average annual rainfall is 28.13 inches, and most of it is well distributed during the growing season. The average length of the frost-free season extends over a period of 213 days.

The average size of the farms is 200.8 acres. Tenants operate 61.8 percent of the farms.

The value of all crops produced in 1929 was $8,063,620, and the value of livestock on the farms on April 1, 1930, was $2,221,230.

The crops of Kiowa County are grown on two kinds of soils—clay loam soils and sandy soils. The clay loam soils embrace about 95 percent of the cultivable land. In addition to the cultivable soils are areas mapped as rough stony land, dune sand, and river wash, which are of very little agricultural value.

○

Authority for printing soil survey reports in this form is carried in the Appropriation Act for the Department of Agriculture for the fiscal year ending June 30, 1933 (47 U. S. Stat., p. 612), as follows:

There shall be printed, as soon as the manuscript can be prepared with the necessary maps and illustrations to accompany it, a report on each soil area surveyed by the Bureau of Chemistry and Soils, Department of Agriculture, in the form of advance sheets bound in paper covers, of which not more than 250 copies shall be for the use of each Senator from the State and not more than 1,000 copies for the use of each Representative for the congressional district or districts in which a survey is made, the actual number to be determined on inquiry by the Secretary of Agriculture made to the aforesaid Senators and Representatives, and as many copies for the use of the Department of Agriculture as in the judgment of the Secretary of Agriculture are deemed necessary.

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