Series 1931 Number 24

UNITED STATES DEPARTMENT OF AGRICULTURE

Soil Survey
of
Craig County, Oklahoma

By

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United States Department of Agriculture

and

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Bureau of Chemistry and Soils

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SOIL SURVEY OF CRAIG COUNTY, OKLAHOMA

By A. C. ANDERSON, in Charge, and A. W. GOKE, United States Department of Agriculture, and O. H. BRENSING, R. E. PENN, and C. B. BOATRIGHT, Oklahoma Agricultural Experiment Station

COUNTY SURVEYED

Craig County is in the northeastern part of Oklahoma. It borders the Kansas State line and is the second county from the Arkansas State line (fig. 1). It extends 34 miles from north to south and 24 miles from east to west. It is roughly rectangular in shape and comprises an area of 486,400 acres, or 760 square miles.

The surface relief is largely that of a gently rolling prairie with rather narrow wooded stream bottoms and smaller areas of wooden hills and broken escarpments. There are four main physiographic divisions, as follows: (1) The northwestern part is a high benchlike area, covering about 212 square miles, in which the soil material has developed over limestone with interbedded layers of shale and coal. The general relief here is undulating with sharp breaks of rolling country along the streams, especially along Big Creek. Some small higher areas are in the northern part of this division which breaks off abruptly at the Fort Scott escarpment to the east. This escarpment is about 75 feet high and is one of the most conspicuous topographic features in the county. It extends from a point 6 miles west of the northeast corner to the southwest corner. (2) Just east of the Fort Scott escarpment and extending diagonally across the county from southwest to northeast is an area underlain by sandstone and shale. This belt is almost level along the western border and becomes more rolling to the east. It breaks off abruptly at the Bluejacket escarpment which extends from a point a mile east of the southwest corner of the county on the south county line toward the northeast corner. It forms the crest of an irregular chain of hills. The Whiteoak Hills in the southwest corner of the county, Donnelly Hill northwest of Vinita, and Timber Hill west of Bluejacket, are wooded hills capped with sandstone in this belt. Between these hills and extending to the northeast are rolling prairies with somewhat sandy soils. The underlying rock in the western part of the belt is largely shale, and the soils are largely silt loams. This belt covers an area of about 300 square miles. (3) Just east of the Bluejacket escarpment and covering about 150 square miles is another belt underlain by shale and some sandstone. This is an area of rather smooth

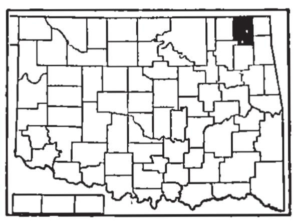

FIGURE 1.—Sketch map showing location of Craig County, Okla.

relief. The land has been eroded to a lower and more uniform altitude than the limestone and sandstone areas. (4) The fourth physiographic division is the Ozark border area covering about 53 square miles in the southeast corner of the county. This area is very hilly and broken. The hills are somewhat rounded. The land is more deeply dissected than the rest of the county. The hilltops are rocky and are wooded. The soil in the valleys is deeper and where not cultivated is covered with grass and some brush. Some calcareous shale and limestone outcrops occur in the valleys. A strip of very rough broken country lies along Cabin Creek where it crosses this belt. Bordering the belt to the northeast, and practically a part of it, is a fringe of limestone and calcareous shale covering about 36 square miles. This locality is characterized by smooth valleys and low rough hills. The relief is destructional. The ridges are largely areas having a hard cap rock that has resisted erosion, and the valleys are areas of material derived from the softer rocks, which was removed by erosion.

Elevations within the county range from about 650 feet, at the point where Cabin Creek crosses the southern boundary, to more than 1,000 feet at the Grant Mound School near the Kansas line. The land slopes irregularly to the south. Welch lies at an elevation of 838 feet above sea level, Bluejacket 779 feet, Vinita 700 feet, and Big Cabin 710 feet. The highest part of Timber Hill is about 950 feet above sea level, and the Whiteoak Hills are about 900 feet. These hills rise about 200 feet higher than the general level of the county to the east and are the most conspicuous topographic feature.

The western part is drained by Big Creek and other tributaries of Verdigris River, and the rest is drained by tributaries of Neosho River, mainly through branches of Cabin Creek. Stream heads have extended back into nearly all parts of the county, and the uplands have good surface drainage, except in a few flat areas where drainage is somewhat deficient. Only the alluvial belts along the streams are subject to flooding and these usually for a few hours at wide intervals. The stream valleys in the central plain are of moderate width, smooth, and range from only 10 to 20 feet below the bordering upland. In the limestone section in the northwest corner and the Ozark border section in the southeast corner, the stream valleys are narrow, rugged, and much deeper. The smaller streams are intermittent during the summer, but the water holes seldom become dry. The drainage system as a whole is a part of the Arkansas and Mississippi River system.

In their virgin state, approximately 45 square miles of the uplands and 35 square miles of the bottoms were timbered, and the rest of the uplands was natural prairie. The smooth uplands were originally prairie, and timber has encroached only on the broken hilly areas.

All the bottom lands, except those on which the Osage soils have developed, were formerly timbered. About 60 percent of the timberland on the bottoms has been cleared, and the rest is used for wood lots and pastures. Some of the most common trees and shrubs on the bottoms are white oak, red oak, pecan, black walnut, sycamore, blackjack oak, elm, wild cherry, wild plum, willow, elm, hackberry, blackberry, and dogwood.

During the summer, the upland prairies are covered with tall grass, many wild legumes, and a profusion of flowering plants. Little bluestem, big bluestem, and sedge grasses are most common. Broomsedge grows on the more sandy soils. Lespedeza is very common in the eastern part of the county. The timbered upland areas are covered with blackjack oak, hickory, sumac, post oak, dogwood, black oak, persimmon, wild cherry, bittersweet, Osage-orange, locust, elm, buckbrush, grapevines, and some other hardwoods. Only a small part of the timbered uplands has been cleared. The Craig soils are covered with grass and a scattered growth of black sumac, buckbrush, a few persimmon, and small elms.

The Missouri, Kansas & Texas Railway was built across the county in 1871. The St. Louis-San Francisco (Frisco) Railway was built as far as Vinita in the same year and west to Tulsa in 1882.

Craig County was organized in 1907. The population increased from 17,404 in 1910 to 19,160 in 1920 and dropped to 18,052 in 1930. In 1930, 13,789 people were classed as rural inhabitants, and the density of the rural population was 18 persons a square mile. The population consists largely of native-born whites, of whom many came from Missouri, Kansas, and Arkansas. There are only 706 Negroes. The census classes 2,438 people officially as Indians, but a large proportion of these are Cherokees of mixed Indian and white ancestry. There is a small settlement of full-blooded Pawnees in the Whiteoak Hills. The population is most dense in the southeastern part of the county, near the shipping points.

The Osage Indians occupied the area, of which Craig County is now a part, when it was acquired from France in 1803. The land was ceded to the United States in 1817, and it was later turned over to the Cherokee Indians in exchange for their lands in the Southeastern States. The forced migration of the Cherokees into the area took place mainly in 1838.

Vinita, with a population of 4,263, is the county seat and main trading point. It has a flour mill, cannery plant for vegetables, and a soybean plant for making soybean oil and other products. Welch, Bluejacket, Big Cabin, and Ketchum are small shipping points. Ketchum is on the Kansas, Oklahoma & Gulf Railroad which crosses the southeastern corner of the county. The central-western part is more than 15 miles from shipping points, and Centralia is the main trading point for this locality.

A large part of the feed crops grown is fed locally, but some is shipped to Kansas City and to the cotton sections to the southeast. Nearly all the cattle are shipped to Kansas City. Large quantities of vegetables and fruits are hauled in trucks to Kansas City and other points north for the early markets.

United States Highway No. 66 crosses the southern part of the county, and United States Highway No. 73 crosses the eastern part. Both roads are hard surfaced. A system of county highways has been laid out in other sections, and most of the roads are graded. Some of them are graveled. Most of the other roads are narrow graded dirt roads. The roads in the northwestern part are very poor. Here most of the roads have only a 33-foot right-of-way which is too narrow for this section where the ditches erode quickly.

Rural delivery of mail reaches all localities. The rural schools are good. Some are consolidated, but most of them are of the one-room type.

Enormous deposits of good bituminous coal underlie about 93,000 acres in the northwestern part of the county. Much coal is being mined with steam shovels in open pit mines and some in deeper mines for home use. Limestone and clay for making cement are available in the same locality. There are two small oil fields and many small gas fields in the western part. A trace of zinc and lead ore has been found in the southeastern part but so far none has been mined.

Most of the water for livestock is obtained from ponds made by damming small streams. Water obtained from wells in the sandy area is of good quality and in the rest of the area is of fairly good quality.

CLIMATE

The climate of Craig County is characterized by wide seasonal variations. The summers are rather hot, and the winters are comparatively cool, but temperatures falling below zero are rare. The mean annual precipitation of 43.15 inches is rather evenly distributed throughout the year. Owing to the dry atmosphere, the summer heat is not oppressive. The summer rains come in sudden showers and are followed by clear dry weather. Dry hot winds during the summer often cause crops to suffer from drought during prolonged dry periods, when evaporation greatly exceeds the rainfall. The dry weather is caused by high evaporation rather than by low rainfall. In many places the fields are too wet for satisfactory cultivation in May and June, and they are too dry in July and August.

The average annual snowfall is 11.7 inches, and the roads are seldom blocked with snow. Cattle forage most of the winter. The average date of the last killing frost is April 5 and of the first is October 21, giving an average frost-free period of 199 days, which is more than ample for the crops commonly grown. Cotton and sweetpotatoes are grown on suitable soils. The climate is especially favorable for crops that mature before the hot summer weather or those, like kafir, that are resistant to summer drought and make their growth in the early fall.

Table 1, compiled from records of the Weather Bureau station at Vinita, is representative of climatic conditions in the eastern part of the county. The precipitation is probably somewhat lower in the northwestern part.

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

[Elevation 702 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1910)	Total amount for the wettest year (1927)	Snow, average depth
	°*F.*	°*F.*	°*F.*	*Inches*	*Inches*	*Inches*	*Inches*
December	38.4	75	−16	2.41	0.50	2.61	3.0
January	35.8	76	−16	2.01	2.11	2.52	3.4
February	40.1	82	−27	1.73	2.08	.89	4.5
Winter	38.1	82	−27	6.15	4.69	6.02	10.9
March	49.7	95	5	3.41	.93	4.73	.1
April	59.1	90	20	4.47	3.43	7.53	(1)
May	66.9	97	27	5.50	7.10	3.11	.0
Spring	58.6	97	5	13.38	11.46	15.37	.1
June	75.5	107	43	5.49	1.50	11.03	.0
July	79.6	108	49	3.88	3.05	7.30	.0
August	79.6	110	45	4.16	5.60	8.10	.0
Summer	78.2	110	43	13.53	10.15	26.43	.0
September	73.4	105	30	3.44	.90	3.93	.0
October	60.7	96	14	3.67	1.98	4.27	(1)
November	48.8	85	9	2.98	.04	3.09	.7
Fall	61.0	105	9	10.09	2.92	11.29	.7
Year	59.0	110	−27	43.15	29.22	59.11	11.7

1 Trace.

AGRICULTURE

This has always been a very fine grazing area. It became an important range before the advent of the railroads in 1870. Soon afterward the range was well stocked with cattle, and great numbers were shipped out every year. The cattle were raised by Indians and by white men who leased the range. White immigration was somewhat restricted. The area of cultivated land increased slowly until about 1890. About a fourth of the land was under cultivation in 1897 when the country was divided into sections.

Slightly more than one-half the land in the county was classed as improved land in 1910. Since then some additional land has been cleared and some has been returned to grass, consequently the increase in the cultivated area has been very small. Much of the land is more suitable for grass and wild hay than for farming, owing to the heavy stand of native grasses and rather shallow soils. Corn has been the most important crop, except during a short post-war period when more wheat was grown, in order to supply the national demand. The acreage devoted to the principal crops grown in Craig County in 1909, 1919, and 1929 is shown in table 2.

TABLE 2.—*Acreage of principal crops in Craig County, Okla., in stated years*

Crop	1909	1919	1929	Crop	1909	1919	1929
	Acres	*Acres*	*Acres*	Soybeans:	*Acres*	*Acres*	*Acres*
Corn	104,991	37,535	78,769	Grown alone			5,131
Oats	12,601	70,456	31,372	Grown with other crops			299
Wheat	2,963	48,851	7,200	Potatoes	413	269	276
All hay	55,279	46,645	41,846	Other vegetables	599	180	379
Wild hay	52,348	45,369	37,517	Cotton	61	175	710
Legumes cut for hay		44	2,904				
Alfalfa	10	114	338				
Sorghum:							
For grain	571	2,193	2,850				
For forage		3,256	1,431				
For sirup	173	51	21				

Texas Red is the most popular variety of oats. Kansas Sunflower, Golden Beauty, Iowa Silvermine, and Franklyn Long John are some of the preferred varieties of corn. Some of the most popular varieties of wheat are Kanred, Turkey, Fulcaster, Red Cross, and Rattlejack. The production of soybeans, for both hay and seed, has increased greatly within the last 10 years. Some of the most popular varieties are Virginia, Laredo, Chiquita, Dixie, Harbin, Pine Bell, Tokyo, and George Washington. An increasing acreage is being devoted to cowpeas for hay. They yield fully as well as soybeans, but the hay is more difficult to cure. The Whippoorwill and Clay varieties of cowpeas are the most popular. Cotton has become popular in recent years because it escapes damage by the bollweevil here.

The production of kafir and other grain sorghums is increasing. These crops withstand the hot dry winds better than corn and are more certain crops, but the average yield is slightly lower. Blackhull kafir is the most popular grain sorghum.

Strawberries were an important crop for many years, but few are now grown, owing to difficulties in marketing. The favorite variety for this locality is Aroma. The production of grapes is increasing rapidly. Concord is the most important variety, and many grapes of the Munson variety are grown near Bluejacket. The Elberta and Indian varieties of peaches are most common. The favorite varieties of apples grown are Winesap, Delicious, Ben Davis, and Jonathan. The tendency is to restrict fruit growing and truck-crop production more and more to the Hanceville and Craig soils. Large quantities of pecans are gathered from native trees.

Wild hay has always been one of the main crops. Most of it is hauled to the baler with sweep rakes and baled in the field. Some is stacked with hay stackers. Much of the wild hay is fed to range cattle, and much is shipped to Kansas City and to the cotton-growing States.

The census of 1930 reports 2,219 farms in the county with an average size of 174.8 acres. The 80- and 160-acre farms are the most common, but there are some ranches and farms covering several thousand acres. Land values have decreased greatly within the last few years.

In 1930, owners operated 49.9 percent of the farms, tenants 49.6 percent, and managers 0.5 percent. Most of the tenant farms are rented on the crop-share basis. If the tenant furnishes the seed, the owner receives one-third of the crops from the cultivated land and from 50 cents to $2.50 an acre for native pasture and hay land, and if the owner furnishes the seed, he receives one-half of the crops.

Medium-sized machinery is used on most farms. Both 3- and 5-horse plows and many tractors are used. The horses and mules are good sized. The farm buildings are very good, considering the recent settlement of the land. Most of the range cattle are well-bred Herefords. Large numbers of cattle of mixed breeds are shipped in each spring, from lower Texas, Louisiana, and Mexico, for fattening on the range. The dairy cattle are mainly grade Jerseys and Holstein-Friesians. The value of dairy products sold in 1929 was $299,843.

Large flocks of chickens are kept on most farms, and most of the chickens are purebred. They are shipped out at regular intervals in carload lots. The value of poultry raised in 1929 was $239,378.

Land prices have fallen drastically within the last year, and little land is sold now except by foreclosure. Good bottom land and the better areas of Labette silt loam and Newtonia silt loam bring the highest prices. North of Centralia about 24,000 acres are leased for the coal rights. Many farmers have received some royalties from natural-gas wells.

On most farms the farmer and members of his family perform the farm work, except during harvesting, when many hire extra labor. The large cattle ranches employ many laborers. The 1930 census shows 30.6 percent of the farmers reporting an average annual cost of nearly $200 for labor.

Very little commercial fertilizer is used, but the quantity is increasing. Only 2.1 percent of the farmers reported the use of commercial fertilizer in 1930 at the rate of $112 a farm reporting. Much of this expenditure was for lime. Mixed fertilizer is used for truck crops and some superphosphate for corn.

SOILS AND CROPS

Craig County lies in a section where the agriculture consists of diversified farming and livestock raising. About 50 percent of the land in the county is now being cultivated. This includes some areas of shallow soil perhaps better suited to hay and pasture. About 10 percent more is suitable for farming in smaller fields. The rest of the land consists of areas of shallow soils, areas having steep relief, and such soils as sticky clays which are unsuitable for cultivation.

Corn is by far the most important crop, and it is grown on nearly all types of farming land. Yields range from 5 to 70 or more bushels an acre, and the average yield is about 20 bushels. The best yields are obtained on the stream-bottom soils, such as Verdigris silty clay loam, and on Summit silty clay loam. On these soils the average yield is about 25 bushels an acre. The claypan soils are not so well adapted to corn because they become very dry and hard in July and August when corn normally makes its greatest growth. The claypan also hinders deep rooting, which lowers the yield.

Oats rank next to corn among the cultivated crops. The yield ranges from 10 to 40 bushels an acre, and the average yield is about 21 bushels. Oats do well on the claypan soils, as they make their greatest growth in the spring when these soils are moist. In moist seasons they do especially well on the red limestone soils. The best yields are obtained on Verdigris silty clay loam and other stream-bottom soils.

Wheat ranks third in acreage. Yields range from 5 to 30 bushels an acre, with an average yield of about 13 bushels. Like oats, this crop does comparatively well on claypan soils and in moist seasons returns good yields on red limestone land. The highest yields are obtained on the bottom lands. The present tendency is to grow less wheat.

Kafir, feterita, and other grain sorghums do well. They can withstand the dry hot summer weather in a dormant stage and make a good growth with the late rains. They are a more dependable crop than corn, although the maximum yields are not so high. The average yield is about 15 or 20 bushels an acre. The average yields compare well with those of corn, but farmers do not like the grain sorghums for feed as well as corn. As with corn, the best crops are made on black limestone land, such as Summit silty clay loam, and on the bottom soils. This crop does better than corn on the red limestone soils, such as Labette silt loam and Newtonia silt loam, and on the Bates soils. Some sorgo (sweet sorghum) is grown for fall hay, and it makes large yields of rather low-grade fodder. Farmers claim that the roots of the sorgo penetrate the claypan layer of the Parsons soils and are valuable in helping to loosen this material.

The acreage in soybeans has increased greatly in recent years. Some leguminous crop is necessary to build up the fertility of the soils, and soybeans seem to fill this need as well as any crop. The average yield is about 8 bushels of beans or 2 tons of hay an acre, but yields of 14 bushels are common. The leaf worm has done much damage to soybeans and has prevented an expansion in the acreage. Soybeans are grown principally on the Parsons, Bates, and Craig soils near Vinita and to some extent on the darker soils developed from limestone.

Many cowpeas are grown on the Hanceville and Craig soils, but their total acreage is small. Like soybeans, they are especially adapted to acid soils. They add nitrogen and organic material to the soil and improve the structure of the surface soil and subsoil.

The area in alfalfa and sweetclover is increasing. These legumes can be grown on the Summit and Labette soils and on the better drained parts of the bottom soils, without using lime or fertilizer. On these soils sweetclover grows wild along the roadsides. On the Bates and Parsons soils it is necessary to use 2 or more tons of lime an acre to overcome the soil acidity, in addition to 200 or 300 pounds of superphosphate or its equivalent in phosphorus, to build up the fertility of the land before alfalfa can be grown successfully.

In order to discuss the utilization of the different soils, it is convenient to arrange them in groups having more or less similar adaptations to the common crops. This grouping, based on land utilization and crop adaptation, is as follows: (1) General-farming soils; (2) fruit-growing, trucking, and general-farming soils; (3) native-hay and grazing soils; (4) grazing soils; and (5) grazing and woodland soils.

In the following pages, the soils of Craig County are described, and their agricultural importance is discussed; their distribution is 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 Craig County, Okla.*

Type of soil	Acres	Percent	Type of soil	Acres	Percent
Parsons silt loam	93,952	19.3	Bates fine sandy loam	12,864	2.6
Cherokee silt loam	7,488	1.5	Bates fine sandy loam, red-subsoil phase	64	.1
Neosho silt loam	8,384	1.7	Craig silt loam	9,344	1.9
Woodson clay loam	9,152	1.9	Craig silt loam, deep phase	2,176	.4
Summit silty clay loam	32,384	6.7	Summit silty clay loam, shallow phase	9,920	2.0
Summit silty clay loam, colluvial phase	5,312	1.1	Labette silt loam, shallow phase	8,806	1.8
Summit silt loam, terrace phase	3,776	.8	Summit clay, poorly drained phase	1,536	.3
Summit clay	8,576	1.8	Parsons clay loam	3,776	.8
Labette silt loam	19,840	4.1	Woodson clay	1,088	.2
Labette clay loam	4,928	1.0	Osage silty clay loam, poorly drained phase	384	.1
Newtonia silt loam	2,816	.6	Bates loam, shallow phase	20,632	6.1
Bates silt loam	68,800	14.2	Summit stony clay	33,600	6.9
Bates loam	47,680	9.8	Summit silty clay loam, steep phase	1,536	.3
Verdigris silty clay loam	13,504	2.8	Hanceville stony loam	14,528	3.0
Verdigris silt loam	10,880	2.2	Okoee stony loam	6,656	1.4
Verdigris fine sandy loam	1,664	.3			
Lightning silt loam	2,560	.5			
Osage silty clay loam	1,920	.4			
Hanceville fine sandy loam	5,760	1.2			
Bates loam, red-subsoil phase	1,024	.2	Total	486,400	

GENERAL-FARMING SOILS

The general-farming soils cover about 550 square miles. They are the predominating farming soils of the general area and have had the most influence in determining the type of agriculture carried on in this county. Corn, oats, wheat, grain sorghums, and soybeans are the most important crops grown on these soils. Although these crops are grown rather indiscriminately, there is considerable variation in the yield and distribution on the different soil types.

The soils of this group differ widely in many features, including color, the character of the subsoils, and the underlying parent material. All these features have their influence on the productivity of the soils. The most obvious and striking difference in these soils is color. The light color of soils indicates not only a lack of organic matter but also, in this area, other chemical and physical properties that determine productiveness. The light color of the surface soils of this group is coextensive with the heavy compact condition of their subsoils. On the basis of these features the farming soils of the uplands and terraces may be divided into two general subgroups—the grayish-brown soils with claypan subsoils and the dark-colored soils with friable or moderately friable subsoils. The soils of the stream bottoms that are used principally for general farming may be regarded as a third subgroup.

GRAYISH-BROWN SOILS WITH CLAYPAN SUBSOILS ON UPLANDS AND TERRACES

The soils of four series, Parsons, Cherokee, Neosho, and Woodson, are characterized by a stiff clay subsoil or claypan. These soils do not favor the growth of deep-rooted plants, as the claypan restricts drainage and causes the formation of a temporarily high water table during wet weather. The claypan is too heavy and compact for plant roots to penetrate readily, and the small roots grow mainly on the outer surfaces of the soil particles and in the cracks between the cleavage planes. The claypan soils have nearly everywhere smooth surface relief. Optimum moisture conditions prevail only for short periods. When the soil is too wet the plants feed only at the surface, as the deeper roots drown out, and when too dry the roots cannot penetrate to a great depth as the clay expands and contracts, thereby breaking them and exposing them to the dry air in which they die. Good tilth is difficult to obtain, as the heavy spring rains cause the soil to pack and puddle.

Only shallow-rooted plants with widespreading root systems, such as small grains, grain sorghums, timothy, and a few grasses and annual legumes, will make satisfactory growth on these soils, and these only in favorable seasons. Corn cannot withstand the lack of moisture in critical periods of its growth.

Parsons silt loam.—Parsons silt loam is the most extensive soil in the county. The 8-inch surface layer consists of dark grayish-brown smooth silt loam. It overlies a subsurface layer of brownish-yellow or grayish yellowish-brown smooth silt loam. The color of the material in this layer is more gray when dry. In virgin areas the surface soil is sod-bound and very dark. In cultivated areas, it is mixed, in places, with the subsurface layer, and a grayish-brown color is produced. At an average depth of about 15 inches, the subsurface layer passes sharply into olive-brown dense plastic clay. The color of the lower part of this layer is variegated or finely mottled with yellowish brown, dark brown, some yellow, and splotches of rust red. This is the claypan layer which is sticky and impervious when wet and bakes very hard when dry. At a depth of about 28 inches this material is underlain by brownish-yellow clay variegated or finely mottled with olive drab, yellow, and gray, and splotched with aggregated clusters of rust red. This layer contains much crystalline gypsum, and there is nearly everywhere a 5-inch layer, about 10 inches below the claypan layer, with a large concentration of gypsum occurring as radially aggregated clusters. This soil is underlain by rotten shale at a depth ranging from about 6 to 8 feet. The depth to the shale or shaly sandstone may range frcm 2 to more than 15 feet.

The sod-bound layer is slightly acid or neutral in reaction. The rest of the surface soil and the subsoil are moderately acid, with a pH value of about 5.5 as far down as the gypsum layer which is strongly acid. Below the gypsum layer the material becomes progressively more neutral.

The surface soil and subsoil are comparatively free from rock and gravel, but a few soft brown concretions about one-fourth inch in diameter are present in the surface soil.

Parsons silt loam occurs in nearly all parts of the county in the flat upland, but the areas are more numerous and cover a larger proportion of the total area on the flat north of Welch and in two broad belts which extend northeasterly. One of these belts passes through Vinita, and the other lies parallel to the first one about 7 miles to the west.

A few small areas of Parsons very fine sandy loam are included with Parsons silt loam on the soil map, as their small extent did not justify separation.

Parsons silt loam in general is moist or wet during the spring and very dry in July and August. Therefore, it is somewhat better adapted to cereal crops, as oats and wheat, that mature early in the season, and not so well adapted to corn which makes its greatest growth in July and August. Corn, however, is the leading crop of the area and is the most important crop on this soil, but proportionately more oats and wheat are grown than in the county as a whole. Probably 40 percent of the cultivated area is devoted to corn, 30 percent to oats, 10 percent to wheat, 5 percent to kafir and other grain sorghums, and 5 percent to soybeans. The average yield of corn is about 14 bushels an acre, oats 21 bushels, wheat 13 bushels, and soybeans 8 bushels. In the most favorable years, corn and oats may yield as high as 60 bushels and wheat 30 bushels. Kafir does not give such high maximum yields as corn, but it yields better in adverse seasons and slightly higher average yields for a period of years. Some potatoes and a few garden vegetables are grown for home use, but the soil is poorly adapted to all truck crops and fruits.

This soil responds very well to fertilizers containing a high percentage of phosphorus, such as superphosphate, especially for corn and alfalfa. Results from experimental plots in the general area indicate that an application ranging from 200 to 300 pounds of superphosphate an acre will increase the average yield of corn on Parsons silt loam about 6 bushels an acre and will increase the yield of alfalfa about one-half ton an acre when used with 2 or 3 tons of limestone to correct the acidity. The soil seems to contain a fairly high content of potassium, sufficient for most crops. Stable manure should be returned to the soil, in order to maintain the fertility and the content of organic matter. For the same reason, legumes should be grown in the crop rotation.

Parsons silt loam has a cherty phase which is not shown separately on the map, but all areas of the typical soil bordering areas of Craig silt loam or Okoee stony loam are of this phase. In these areas the surface soil differs from typical Parsons silt loam in that it contains much chert gravel and more dark shot-sized concretions. The claypan layer is more yellow and has a distinct prismatic structure. It is underlain by cherty clay and this, in turn, by a cemented chert hardpan which passes into cherty calcareous clay. This clay is underlain by limestone at a depth ranging from 5 to 30 feet. About 80 percent of this cherty soil is cultivated, and crop yields are about 20 percent higher than on typical Parsons silt loam.

Cherokee silt loam.—Cherokee silt loam differs from Parsons silt loam in having a much lighter colored subsurface layer. The surface soil, to an average depth of 8 inches, is grayish-brown silt loam. The subsurface layer is light grayish brown which becomes lighter with depth, and at a depth ranging from about 14 to 18 inches or just above the claypan it is pale ash-gray silt loam. The color is slightly brown when moist but nearly white when dry. This layer varies considerably in depth below the surface. For this reason it shows up as a wavy or undulating streak in a cut bank. When cultivated, the surface soil becomes light grayish brown, owing to turning up of the gray subsurface layer. The character of the claypan subsoil is similar to that underlying Parsons silt loam. Areas of this soil surrounded by Craig silt loam differ from typical Cherokee silt loam in having a chert hardpan below the claypan.

Cherokee silt loam is poorly drained. Percolating water accumulates on the top of the impervious subsoil, and the topsoil becomes water-logged in the wet late-winter and early-spring months.

Cherokee silt loam covers less than 12 square miles and is therefore of no great agricultural importance, but it is an interesting soil because it represents the most advanced development of a claypan soil in this section. It is locally known as " ash land " where cultivated or " crawfish land " where uncultivated.

Probably 40 percent of the land is cultivated, and the rest is used for the production of native hay. This is one of the best hay soils in the county. On the cultivated areas crop yields are about 20 percent lower than on Parsons silt loam.

Neosho silt loam.—Neosho silt loam is similar to Cherokee silt loam in all characteristics that affect its productivity, except that its claypan layer is not so dense. The surface soil is slightly darker than that of Parsons silt loam, and the upper part of the claypan is more red. The substratum consists of stratified clay instead of rotten shale, such as underlies Parsons silt loam.

Neosho silt loam occupies terraces or second bottoms along streams. In most places the land slopes slightly toward the stream or in the general direction of stream flow. For this reason surface drainage is more rapid and subsoil drainage is slightly better than in the claypan soils of the flat uplands.

Neosho silt loam occurs in a number of areas on the higher terraces along the larger streams. The largest developments are along Cabin Creek in the southeastern part of the county and along Big Creek in the northwestern part.

The surface soil is low in organic matter, and the physical condition of the subsoil is unfavorable to most crops. In these respects, however, this soil is slightly superior to either the Cherokee or the Parsons soil. About 60 percent of the land is cultivated. Wheat is the most extensively grown crop. Kafir and several grasses are grown to some extent. A comparatively small acreage is planted to corn, but yields are not satisfactory.

Woodson clay loam.—Woodson clay loam is dark grayish-brown clay loam or heavy silt loam to an average depth of 10 inches and below this is grayish-brown clay loam or heavy silt loam to a depth of about 15 inches. Here it passes into a tan or olive-brown dense plastic claypan variegated with rust brown, grayish brown, and yellow, but it becomes more yellow with depth. Over a large part of the areas of this soil, the upper part of the claypan has a columnar structure with dome-shaped tops to the columns. It contains a large number of shot-sized rust-yellow and black rather soft concretions and more or less angular chert gravel. It is more yellow and less red than the claypan in the Parsons soils. At an average depth of about 30 inches the claypan is underlain by a well-defined tan-brown heavy clay layer 8 inches thick, containing much crystalline gypsum. This is underlain by yellow or brownish-yellow heavy calcareous clay, partly mottled with gray and splotches of dark material, containing a large number of chert fragments, many black shot-sized soft concretions, and some limestone fragments at a lower depth. In most places, this material is underlain by limestone at a depth ranging from 5 to 10 feet.

This soil contains a large number of small concretions and chert gravel that are comparatively scarce in the Parsons soils. It is closely associated with the Summit soils and seems to have developed or degraded from Summit silty clay loam in areas of restricted drainage. There are a few included areas containing a large quantity of chert gravel, which are of a somewhat redder shade when moist. Such areas are associated with areas of the Labette soils.

Woodson clay loam has poorer drainage and lower agricultural value than Parsons silt loam. Some areas approach Summit silty clay loam in productiveness, but most of the soil is comparable to Cherokee silt loam. About 25 percent of the land is cultivated, and the rest is used for pasture and hay.

DARK-COLORED UPLAND SOILS WITH FRIABLE OR MODERATELY FRIABLE SUBSOILS

The dark-colored soils which are devoted mainly to general farming have in common the dark color of the surface layers, which is imparted by a small percentage of black organic matter. This condition, so favorable to crop production, is associated with permeable subsoils that further increase the superiority of these soils over those of the claypan group. With this group are included soils with heavy yellowish-brown calcareous subsoils, soils with reddish-brown calcareous subsoils, and shallow soils overlying shales and sandstone.

Labette silt loam, Labette clay loam, and Newtonia silt loam are the dark-colored soils of the group of general farming soils that have red or reddish-brown subsoils. These soils are developed in upland areas where the parent rock is limestone, and in most places they are associated with the Summit soils. The largest areas are in the northwestern part of the county, especially west of Hollow, and a number of smaller bodies are southeast of Vinita.

These are the favorite farming soils of the section, as they are well drained, easy to cultivate, fairly retentive of moisture, adapted to a variety of crops, and return good yields. In this county, the average yield of corn is not so high as on Summit silty clay loam, but yields of kafir, oats, and wheat are higher.

There is another group of dark-colored farming soils which have yellow subsoils and are underlain at a greater or less depth by sandstone or shale. As these soils do not have a substratum of limestone they are more acid in their lower layers than the corresponding layers of the Labette and Newtonia soils.

Summit silty clay loam.—Summit silty clay loam, to an average depth of 12 inches, is dark grayish-brown or black silty clay loam which has a crumbly granular structure and is very friable for a soil of such fine texture. In virgin areas the upper part is strongly sod-bound. This layer is underlain by brownish-yellow or yellowish-brown faintly granular silty clay to a depth of about 20 inches, where it passes into yellowish olive-brown or yellowish drab-brown rather heavy calcareous clay. At an average depth of 36 inches below the surface this material, in most places, overlies clay containing considerable chert and rotten limestone, and it passes into limerock at a depth of about 48 inches. The depth to rock may range from 20 to 80 or more inches. Some areas are underlain by calcareous shale, and layers of coal are present just beneath the surface in many places in the northwestern part of the county. Areas in which the limestone rock is within 20 inches of the surface are mapped as a shallow phase of this soil and are of much lower agricultural value.

The topsoil ranges from neutral to slightly acid, and the subsoil is calcareous. There is much local variation in this soil, owing to differences in the depth of the rock and differences in drainage. Most of the soil has fairly good surface drainage and internal drainage, but there are some spots in which surface drainage is somewhat restricted. In such areas the soil is more or less degraded, and an incipient claypan is present in the upper part of the subsoil. These areas resemble the Woodson soils. Some areas with very good surface drainage have a red shade in the subsoil and resemble the Labette soils. The depth to rock is greater in the bodies east of Vinita.

This soil covers an area of 50.6 square miles, and probably 75 percent of it is cultivated. Virgin areas are covered with a heavy growth of bluestem grasses which are valuable for native hay and pasture. At least 60 percent of the cultivated area is devoted to corn, the average yield of which is about 20 or 25 bushels to the acre. Yields of 35 or 40 bushels are commonly obtained in good seasons. About 5 percent of the land is devoted to kafir and other grain sorghums. Yields of kafir seem to be somewhat lower than those of corn. This soil is not so well adapted to oats and wheat as to corn, because, on account of local variations in the soil, the small grains do not ripen evenly. Oats yield an average of about 21 bushels an acre and wheat about 13 bushels. Alfalfa and sweetclover can be grown with the addition of very little lime or fertilizer, but alfalfa is apt to be short-lived. The yield of the first cutting is usually 1½ or 1¾ tons an acre, and of the second cutting is considerably lower, owing to dry weather. There is often some difficulty in curing the first crop, on account of wet weather. As there is an abundance of native hay and pasture, there is little incentive to grow alfalfa or sweetclover. This soil is too heavy for the profitable production of fruit or truck crops.

Summit silty clay loam is a heavy soil and somewhat difficult to cultivate. It requires much power and heavy machinery. It is sticky and rather waxy when wet and needs to be cultivated only under optimum moisture conditions, in order to prevent the breaking down of the naturally good structure which is due largely to the high content of organic material and of lime. Because the underlying rock lies at a rather slight depth, the soil needs to be carefully protected from erosion.

Summit silty clay loam, colluvial phase.—The topsoil of Summit silty clay loam, colluvial phase, resembles that of typical Summit silty clay loam. It consists of a 10- to 24-inch layer of black granular silty clay loam washed down from higher limestone areas. The subsoil is brownish-yellow or drabbish-brown friable clay containing fragmentary shale or sandstone. This soil has about the same agricultural value as typical Summit silty clay loam. Most of it lies at the foot of long slopes as alluvial or colluvial fans below limestone escarpments, and some of it is in the smaller stream bottoms.

Summit silt loam, terrace phase.—Summit silt loam, terrace phase, is dark-brown silt loam to a depth of about 8 or 10 inches, where it grades into rather dark yellowish-brown silt loam. The topsoil is darker and thicker than the topsoil of Bates silt loam. At a depth of about 16 inches it passes into yellowish-brown or drabbish-brown silty clay. The lower part of the subsoil is more or less stratified and contains some fine brownish-gray, limonite-yellow, and rust-red mottling. It may contain a trace of shale or sandstone gravel, and in most places it is underlain by shale or sandstone at a depth of about 10 feet.

This soil is developed on level terraces lying above overflow. It has fairly good surface drainage and good internal drainage. Most of the areas are west of Vinita. Probably 90 percent of the land is cultivated. Corn is grown on about 60 percent of the cultivated area and returns an average yield of 20 or 25 bushels to the acre. Other crops yield about the same as on Labette silt loam.

Summit clay.—Summit clay has practically the same profile as Summit silty clay loam, except that it is heavier or finer textured. The topsoil is black or dark-brown clay, the upper subsoil layer is brownish-yellow or drabbish-yellow clay, and the lower subsoil layer is yellowish-, olive-, or drabbish-brown, or brown clay. This is underlain by limestone at a depth ranging from 20 to 80 or more inches. Much of this soil in the belt near Centralia is developed in well-drained areas overlying shallow cap rock, where the depth to limestone may range from only 20 to 30 inches. The bodies near Hollow and east of Vinita are at lower elevations in areas of slightly deficient drainage where the depth to rock ranges from 40 to 80 or more inches.

This is a very strong productive soil, but it is hard to cultivate. About 65 percent of the land is cultivated, and the rest is used for wild hay and pasture. Crop yields and the relative acreage devoted to crops are about the same as on Summit silty clay loam.

Labette silt loam.—Labette silt loam, to a depth of about 9 inches, is dark-brown heavy silt loam with smooth rather granular structure. The lower part of the surface layer has a faint-red shade, and at a depth ranging from 9 to 18 inches the material is rather dark reddish-brown granular heavy silt loam which becomes more red and somewhat heavier with depth. The granules have brownish-red centers, and there is a dark coating on the outsides. In many places the granules are not noticeable in position, but they fall apart readily when broken out and exposed to the air. The material in this layer grades into red granular clay loam having an infiltration of dark-brown material from the layer above. This is, in turn, underlain by a thin layer of yellowish-red clay containing some chert and rotten limestone, that passes into solid limerock. The depth to rock may range from 20 to 80 or more inches, with an average depth of 40 inches.

The surface soil and upper subsoil layer are slightly acid or neutral, and the lower subsoil layer is calcareous. In most places, more or less soft brown concretions about one-tenth inch in diameter are present in the upper part of the subsoil.

This soil covers a total area of 31 square miles. About 90 percent of the land is cultivated, and the rest is used for hay and pasture. About 45 percent of the cultivated area is devoted to corn, 30 percent to oats, 10 percent to kafir, and 15 percent to other crops. The average yield of corn is about 20 bushels an acre, oats 25 bushels, wheat 15 bushels, and kafir 21 bushels. In seasons of ample rainfall, this soil gives better yields of corn than does Summit silty clay loam, but the latter soil produces better yields in dry seasons. The yields of oats, wheat, and kafir on Labette silt loam are satisfactory in most seasons. Alfalfa and sweetclover can be grown with the use of very light applications of lime or fertilizer, but very little alfalfa is grown. Apples, peaches, and garden vegetables can be grown successfully but not so well as on the Craig and Hanceville soils.

Labette clay loam.—Labette clay loam is similar to Labette silt loam, except that the topsoil is heavier, darker, and slightly deeper, and the subsoil may have a faint-yellow shade. This is a gradational soil bordering Summit silty clay loam. The topsoil is dark-brown granular clay loam underlain by rather dark brown granular clay loam that becomes more red with depth. The subsoil is red granular clay loam containing some dark streaks. The granules have a slight dark coating.

The proportion of this soil in cultivation and the relative acreages devoted to the different crops are not widely different from those of Labette silt loam. The heavy texture renders this soil more difficult to work and increases the time necessary after rains before the land can be worked. The character of the subsoil is similar to that of Labette silt loam, and this soil is more favorable for the production of corn than are the claypan soils.

Newtonia silt loam.—Newtonia silt loam consists of dark reddish-brown smooth silt loam to an average depth of 4 or 5 inches, and beneath this is reddish-brown somewhat granular silt loam continuing to a depth of about 10 inches. The topsoil appears very dark when moist and decidedly red when dry. The dark surface layer may be 10 or more inches thick, but the average is about 8 inches. In cultivated areas, these two layers are so mixed as to give the field a distinctly reddish brown appearance. The upper subsoil layer, to a depth of about 15 inches, ranges from brownish-red heavy silt loam to rust-red smooth friable silt loam. The material in this layer is exceedingly soft and fluffy and appears to be fairly free from coarse grit or siliceous material. At a depth of about 24 inches it is underlain by bright-red friable clay containing many shot-sized black and rust-brown ferruginous concretions. The lower part contains considerable angular chert gravel and some rotten limestone. It is underlain by limestone bedrock at a depth ranging from 30 to 80 or more inches, with an average of about 50 inches. The depth to rock is greater than under the Labette soils.

The surface soil and upper part of the subsoil are slightly acid, and the lower subsoil layer is calcareous.

Newtonia silt loam is an inextensive soil. About 90 percent of the land is cultivated. The relative acreages of the different crops and the crop yields are about the same as for Labette silt loam. The Newtonia soil is not quite so well adapted as the Labette soil to corn but is better adapted to oats, wheat, kafir, and truck crops.

A few small areas of Newtonia silt loam differ from the typical soil, but they are not of sufficient size to justify separation on the soil map. The surface soil in these areas is redder than in the typical areas, as the original dark surface layer has been removed by erosion. This variation is produced in cultivated fields where the land has not been protected from erosion. The soil in these spots is not so productive as the typical soil, and its occurrence detracts from the value of a farm.

Bates silt loam.—The 8-inch surface layer of Bates silt loam is dark-brown silt loam containing a small proportion of very fine sand. It grades into yellowish-brown or brownish-yellow silt loam. The very fine sand gives the topsoil a single-grained crumby structure. Between depths of 12 and 20 inches the material is brownish-yellow or yellowish-brown friable clay, in most places faintly variegated with rust red and drabbish brown. A slight development of a claypan occurs in places in this layer. This layer overlies brownish-yellow friable clay containing more or less shale or sandstone fragments. At an average depth of about 30 inches the soil is underlain by rotten shale or shaly sandstone. The most common rock is brownish greenish-yellow, finely laminated, rather sandy shale which contains some red stains or splotches and a trace of gypsum. In places the depth to the shale or sandstone may range from 12 to 80 or more inches. The depth to the shale varies considerably within short distances—the more level areas having the thickest soil covering and the steep areas the more shallow covering.

A trace of shale and sandstone fragments occurs in most places in the surface soil but not enough to interfere with cultivation. The surface soil and subsoil are slightly or moderately acid, about pH 5.5, and the substratum is almost neutral.

The greater part of Bates silt loam is developed in undulating or gently rolling areas. Parsons silt loam is developed in more level areas from the same parent material. Bates silt loam has good surface drainage and good internal drainage. Owing to its loose structure and the slope, it washes readily. As it is a shallow soil, it is easily ruined by erosion, and measures should be taken to conserve the soil where cultivated. This soil holds moisture fairly well, but, owing to its slope, rain water runs off quickly.

Bates silt loam covers an area of 107.5 square miles. It is one of the most extensive soils in the county. Probably 55 percent of the land is cultivated, and the rest is used for wild hay and pasture. Most of it could be cultivated if care were taken to prevent erosion, but under present conditions the more rolling areas should be used for pasture. About 40 percent of the cultivated land is used for corn, 25 percent for oats, 8 percent for wheat, and 10 percent for kafir. More kafir, sorghum, and cowpeas are grown on this soil than the average for this section. The average yields are slightly higher than on Parsons silt loam, but on some shallow eroded areas yields are less.

Bates silt loam warms up early in the spring and is easy to cultivate. It requires careful handling to prevent erosion but responds well to fertilizers and good farming.

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Bates loam.—Bates loam resembles Bates silt loam, except that the topsoil is a little coarser and the depth to shale less. This soil has a rather variable profile. The topsoil is commonly dark-brown rather coarse loam to a depth of about 6 inches, where it passes into brownish-yellow rather coarse loam. The subsoil is yellow or yellowish-brown friable clay or fine sandy clay to an average depth of 24 inches, where it is underlain by weathered sandy shale or shaly sandstone. In some of the more level areas, the depth to shale may be 10 feet or deeper. The surface relief in general is gently rolling, but some areas southwest of Vinita are almost level.

About 25 percent of the land is cultivated, 35 percent is used for native hay, and the rest is used for pasture. The relative acreages devoted to the several crops are the same as on Bates silt loam, but the yields are slightly lower. Most of the land could be cultivated if it were carefully terraced to prevent erosion.

SOILS OF THE STREAM BOTTOMS

Alluvium has been recently deposited along the present stream bottoms, and the soils developed from it are modified by occasional flooding. In this section they are often submerged in early spring but very seldom during the summer. The stream-bottom soils used for general farming are Verdigris silty clay loam, Verdigris silt loam, Verdigris fine sandy loam, Lightning silt loam, and Osage silty clay loam.

Verdigris silty clay loam.—The surface soil of Verdigris silty clay loam in virgin areas is medium dark grayish-brown silty clay loam to a depth of about 4 inches. Below this, and continuing to a depth ranging from 10 to 15 inches, is yellowish-brown or dark brownish-yellow silty clay loam. Where cultivated, the topsoil is rather light brown. The subsoil consists of brown or grayish-yellow clay mottled with gray, limonite yellow, and rust red. The lower part of the subsoil is distinctly stratified or laminated and, as in most soils developed from alluvium, it varies considerably. The surface soil is coarser and better drained on the natural levees on the outsides of the stream meanders and heavier on the insides of the stream meanders. The surface soil and subsoil are in most places slightly acid, with a range of pH 5 to pH 7.

This is considered the most productive soil in the county, but overflows make crops uncertain. One crop in every five may be lost by flooding. About 60 percent of the land is cultivated, and the rest is timbered with oaks, wild pecans, black walnuts, and other valuable trees. This soil is utilized to considerable extent for growing pecans, for woodland, and for pasture. About 60 percent of the cultivated area is used for corn, the average acre yield of which is about 25 or 30 bushels, but yields ranging from 50 to 70 bushels are often obtained without fertilizers. Oats average 30 or 35 bushels and wheat about 15 or 20 bushels an acre. Alfalfa does well on the better drained areas, but very little is grown.

Verdigris silty clay loam covers an area of 21.1 square miles. Most of it occurs in the larger stream bottoms where the stream gradient is low, whereas the silt loam member occurs more largely along the smaller streams where the stream gradient is greater.

Verdigris silt loam.—The surface layer of Verdigris silt loam, to a depth in most places ranging from 9 to 15 inches, is grayish-brown, brown, or dark-brown loose silt loam. The subsurface layer is grayish-brown or yellowish-brown silt loam. Below this is brown or grayish-yellow silty clay mottled with gray and some rust red. In some places seams of fine sand occur in the lower part of the subsoil. This soil differs from Verdigris silty clay loam principally in its slightly lighter texture and the grayer color of its surface soil.

Verdigris silt loam is suitable for a wide range of crops, mainly because of its exceptionally loose friable surface soil, subsoil, and substratum and its nearness to underlying ground water. Corn is the principal crop, but most farmers grow potatoes, oats, wheat, and alfalfa in addition.

This soil occurs mainly along Cabin, Little Cabin, and Big Creeks.

Verdigris fine sandy loam.—In most places Verdigris fine sandy loam consists of a 6-inch layer of brown fine sandy loam or very fine sandy loam grading into stratified layers of loamy fine sand, very fine sandy loam, and sandy clay, which are in general light yellowish brown but range from yellow to drabbish brown.

Crop yields are not so high on this soil as on Verdigris silty clay loam, but there are few crop failures caused by flooding. Corn is the most important crop. Truck crops would do well, but they are not grown, as markets are not accessible. A small acreage of this soil is devoted to cotton, but this county is near the northern climatic limit for successful cotton production.

This is an inextensive soil, most of which is in the southwestern part of the county along Pryor and Little Pryor Creeks.

Included with Verdigris fine sandy loam are small areas of bottom land that are nonagricultural because of their gravelly or rocky surface soils and subsoils, which resemble river wash, or because they are cut by stream channels. In such areas the surface soil is predominantly brown loam or sandy loam, containing more or less gravel, and the subsoil is yellow or brownish-drab stratified sand, clay, and gravel. Rock outcrops are common. The land supports a heavy growth of timber, including some pecan trees and black walnuts.

These areas are not of sufficient importance to be indicated on the soil map by a separate color, but the principal bodies are shown by gravel symbols.

Lightning silt loam.—The surface layer of Lightning silt loam is brown silt loam or silty clay loam to a depth of about 6 inches. It is underlain by grayish-brown or brownish-yellow silt loam or silty clay loam. At a depth ranging from 10 to 24 inches the material is brownish-yellow or drabbish-brown heavy clay variegated with gray and rust red. This may be termed a weak claypan. The lower part of the subsoil is mottled gray, yellow, and rust-brown clay extending to a depth of 40 or more inches.

This soil occurs on rather high bottoms that are submerged by floods only a few hours at a time but are wet and soggy for some time afterward. It is closely associated with the Verdigris soils, and the boundaries between these soils are not distinct. Lightning silt loam closely resembles Neosho silt loam, but the Neosho soil occupies higher terraces. Crop yields are about the same as on Parsons silt loam.

Osage silty clay loam.—Osage silty clay loam consists of dark grayish-brown or black silty clay loam to a depth of about 10 inches. This layer is underlain by bluish-brown or dark drabbish-brown similar material continuing to a depth of about 20 inches. The topsoil is faintly granular and nearly black in prairie areas and is dark grayish brown in wooded areas. The surface soil is neutral or slightly acid, and the subsoil is alkaline. About 75 percent of the land was natural prairie. The timbered areas resemble areas of the colluvial phase of Summit silty clay loam.

This is not an extensive soil. It is flat and rather poorly drained. Probably 40 percent of the land is cultivated, but it is rather sticky and hard to farm. Crop yields in favorable seasons are about the same as on Verdigris silty clay loam, but the average yields are lowered in wet years.

FRUIT-GROWING, TRUCKING, AND GENERAL-FARMING SOILS

The fruit-growing, trucking, and general-farming soils cover a total area of nearly 50 square miles. Most of the fruit, truck crops, and cotton produced in the county are grown on these soils. They are especially suited to fruit growing, truck growing, and diversified farming of a self-sustaining type on small farms.

These soils differ greatly from one another, but all have mellow surface soils, subsoils that are permeable and fairly retentive of moisture, and all are well drained.

The Hanceville soils have light-colored topsoils, whereas the Bates and Craig soils have rather dark colored topsoils. The Hanceville soils have red sandy subsoils, and the Craig soils have reddish-brown hardpan (not claypan) subsoils. The Bates soils, with the exception of the red-subsoil phases, have brownish-yellow subsoils.

Hanceville fine sandy loam.—The surface soil of Hanceville fine sandy loam is reddish-brown fine sandy loam to a depth of about 6 inches. This layer is underlain by brownish-red fine sandy loam which continues to a depth of about 12 inches. The topsoil, although in most places fine sandy loam, ranges from coarse sand to loamy fine sand. In timbered areas, there is a thin dark surface layer, about one-half inch thick, which contains much raw litter. In cultivated areas, red spots may be seen in the fields where the subsoil has been turned up. The subsoil is red fine sandy clay containing some fragments of sandstone. The proportion of sandstone increases with depth. Rotten sandstone is reached at a depth ranging from 12 to 60 inches and averaging about 40 inches. The topsoil is moderately acid or slightly acid, and the subsoil is moderately acid, ranging from pH 4.5 to pH 6. The underlying rock is rather coarse grained soft yellowish-red material interlaminated with grayish-yellow sandstone.

Hanceville fine sandy loam, as indicated on the soil map, includes some areas on the flat tops of the higher hills and ridges where the upper part of the subsoil is yellow or reddish yellow and somewhat coarser than the average. This included soil is very well drained. The subsoil appears excessively porous, but it holds moisture fairly well.

Probably 40 percent of Hanceville fine sandy loam is cultivated, and the rest is used for woodland and pasture. This soil is especially well adapted to Munson grapes, Concord grapes, cotton, and truck crops, including watermelons, cantaloups, tomatoes, peanuts, sweetpotatoes, sorgo, rhubarb, cowpeas, and other crops adapted to sandy soils. Probably 60 percent of the cultivated area is devoted to these crops, which is a higher proportion than of any other soil in the county.

Sorgo is grown for making sirup, and a very good quality of sirup is produced on this soil. The average yield is about 75 or 100 gallons to the acre. Most of the sweetpotatoes grown in the county are produced on this soil, and the average acre yield is about 100 bushels. Most of the watermelons and cantaloups produced in the county for more northern markets are grown on this soil. Apples do very well but hardly as well as on the Craig soils. The average yield of corn is about 15 or 20 bushels an acre. The grain sorghums seem to do especially well, and a larger proportion of this soil is devoted to these crops than is the average for the county.

Bates loam, red-subsoil phase.—The surface soil of Bates loam, red-subsoil phase, consists of dark-brown loam or silt loam to a depth of about 6 or 8 inches. It grades below into rather dark reddish-brown loam or silt loam, which has a crumbly, faintly granular structure. Between depths of 12 and 28 inches is the subsoil of red very fine sandy clay, silty clay, or clay loam, containing fragments of sandstone or sandy shale gravel and some dark pea-sized soft concretions. The lower part of the subsoil is of the same texture, but it is yellowish red or yellow splotched with red to a depth ranging from 60 to 80 or more inches, where it is underlain by sandstone or sandy shale. The surface soil and subsoil are faintly or moderately acid, ranging from about pH 5.5 to pH 6.5.

This soil occurs in small scattered areas, mainly in the eastern part of the county. Most of it occupies low well-drained knolls with gentle slopes. It is a favorite soil for gardens and the farm orchards, and it is well adapted to the common farm crops of the section. Yields are about the same as on Bates silt loam. Probably 90 percent of the land is cultivated.

This soil resembles the Newtonia soil, but the subsoil does not have the peculiar softness of the Newtonia, and it contains sandstone and shale fragments instead of limestone. It resembles the Hanceville soil, except that it has a darker colored topsoil.

Bates fine sandy loam.—Bates fine sandy loam consists of dark-brown fine sandy loam to a depth of about 4 inches, where it changes to less dark brown fine sandy loam. The subsoil is brownish-yellow or yellow fine sandy clay to a depth ranging from 12 to 18 inches and below this is brownish-yellow or yellow fine sandy clay, in many places splotched with some red and a trace of gray to a depth of about 30 inches, where it is underlain by sandstone or sandy shale. The depth to the rock ranges from 15 to 60 or more inches, with an average of 30 inches. Both surface soil and subsoil are moderately or slightly acid, ranging from about pH 5 to pH 6. This soil has a gently rolling or undulating surface relief, and it is well drained. The subsoil is porous but retains moisture fairly well.

Bates fine sandy loam covers a total area of about 20 square miles. The larger bodies are mainly in a belt extending from the northeast corner of the county to the southwest corner. A few areas north of Whiteoak were timbered instead of being prairie. They are not shown separately on the map as the soil is as dark as typical Bates fine sandy loam. About 25 percent of these included areas has been cleared for cultivation.

Probably 55 percent of the total area of this soil is cultivated. The deeper areas are very well adapted to peaches, and some very fine peach orchards are now growing on this land. Some cotton is grown, and the yield averages about one-fourth bale an acre. Corn is grown on about 40 percent of the cultivated area, oats on 20 percent, kafir on 10 percent, and soybeans on 10 percent. Crop yields are slightly lower than on Bates silt loam in dry seasons and about the same in moist seasons.

Bates fine sandy loam, red-subsoil phase.—The surface soil of the red-subsoil phase of Bates fine sandy loam, to an average depth of 8 inches, is dark grayish-brown fine sandy loam. In places there is a red tinge in the color of the surface layer. The upper subsoil layer is reddish-brown or dark reddish-brown loam or silt loam. It has a crumbly or granular structure and falls apart readily when broken up. The lower subsoil layer, beginning at a depth ranging from 15 to 24 inches, is red very fine sandy clay or sandy loam, containing fragments of sandstone or sandy shale. This material gives place to yellowish-red or yellow sandy loam. At a depth, in most places ranging from 60 to 80 inches, the soil is underlain by sandstone or sandy shale.

This soil is similar in crop adaptations to typical Bates fine sandy loam. At least 60 percent of the total area is under cultivation. The soil is adapted to a wide range of crops, but it is not profitable to grow many of these, on account of the lack of markets for the products. Corn, oats, and kafir are the principal crops. Soybeans do well and are coming into favor with the farmers. In years of average precipitation, yields on this soil are very slightly, if any, lower than on typical Bates fine sandy loam.

Craig silt loam.—Craig silt loam consists of dark grayish-brown friable silt loam free from gravel to a depth of 4 or 5 inches. This is underlain by brown silt loam which may contain a trace of gravel to a depth of about 12 inches. Here the material passes into a reddish-brown or splotched yellow and red friable clay which contains considerable chert gravel and small angular fragments of chert. The quantity of gravel increases with depth. At an average depth of about 20 inches, this material is underlain by a cemented hardpan composed of chert fragments and ranging from 2 to 3 feet in thickness. It consists of angular gray and red stained chert fragments ranging from one-half inch to 4 inches in diameter, together with mixed yellow, rust-brown, and black interstitial cementing material which is difficult to break up with a pick but is not sticky or plastic when once broken. The material is permeable to moisture. The substratum consists of calcareous clay containing about 25 or more percent of chert gravel and rock locally known as "chunk" rock. It is underlain by limestone at a depth ranging from 5 to more than 30 feet. The average depth to limestone is 12 feet. The surface soil and upper subsoil layer are moderately acid or slightly acid. This soil is developed on the higher elevations in areas of rolling or hilly relief.

Craig silt loam is resistant to erosion. The subsoil is permeable to moisture and absorbs much of the rain, which minimizes the run-off and retards erosion. Owing to the shallowness of the surface soil, even a small degree of erosion will soon be disastrous. Practically all the cultivated land should be terraced.

A few small areas of Okoee silt loam are included on the soil map with Craig silt loam, owing to their small extent and similar agricultural value. The soil in these areas differs from typical Craig silt loam only in its lighter color. Most of the small areas shown on the map surrounded by Okoee stony loam are of this light-colored phase.

Craig silt loam covers a total area of 14.6 square miles. Probably 70 percent of the land is cultivated, and the rest is used for pasture. The soil is very well adapted to apples, peaches, and Concord grapes. A large proportion of the apples and grapes produced in the county are grown on this soil. Very few vegetables are grown on a commercial scale. The relative acreages devoted to the farming crops are about the same as for the county as a whole. Yields are above the average for the county but slightly below yields on Labette silt loam.

Craig silt loam, deep phase.—Craig silt loam, deep phase, resembles Craig silt loam, except that the depth to the hardpan is greater. A claypan above the hardpan is present in places. This is a gradational soil between Craig silt loam and Parsons silt loam. The agricultural value is about the same or slightly lower than of Craig silt loam. The deeper soil is not so well adapted to apples, peaches, and grapes.

NATIVE-HAY AND GRAZING SOILS

The native-hay and grazing soils include Summit silty clay loam, shallow phase; Labette silt loam, shallow phase; Summit clay, poorly drained phase; Woodson clay; Parsons clay loam; and Osage silty clay loam, poorly drained phase. Cherokee silt loam, described in the group of general-farming soils is closely related to the soils of this group.

These soils cover a total area of 40 square miles. Most of the bodies are level or undulating. The soils are valuable for hay and pasture, but they are of lower value for cultivation, owing to their shallowness or heavy sticky character. They are all closely related to some soil previously described in the group of general-farming soils.

Summit silty clay loam, shallow phase.—The surface soil of the shallow phase of Summit silty clay loam is dark-brown or black silty clay or silty clay loam to a depth ranging from 5 to 10 inches. This material is underlain by olive-brown clay to a depth ranging from 8 to 20 inches, where it is underlain by solid limerock. Some fragments of limerock are scattered over the surface. This shallow soil includes areas of Summit silty clay and Summit silty clay loam, in which the depth to rock ranges from 8 to 20 inches.

This soil covers an area of 15.5 square miles. Probably 10 percent of the land is cultivated. Many areas are cultivated to preserve the regularity of the fields. More than half the land is used for native hay and the rest for pasture. The native grasses yield about 1 ton of hay an acre in average years. For pasture, about 3 acres of grass are required for each head of cattle. The cultivated areas are used for the same crops as are grown on Summit silty clay loam, but yields are lower, especially in dry seasons.

Labette silt loam, shallow phase.—The shallow phase of Labette silt loam has a 5- to 8-inch dark-brown or brown silt loam surface layer which is underlain by a reddish-brown granular silt loam layer from 3 to 12 inches thick, and this, in turn, by solid limerock. The depth to rock varies in different places from about 8 to 20 inches. Some loose rock is present on the surface.

About 5 percent of this soil is cultivated. About 50 percent of the cultivated land is used for hay and the rest for pasture.

Summit clay, poorly drained phase.—Summit clay, poorly drained phase, consists of dark grayish-brown or black heavy faintly granular clay to a depth of about 9 inches. The subsoil is dark-brown or dark drabbish-brown sticky or plastic clay which, at a depth ranging from about 24 to 36 inches, passes into rather dark drabbish-brown heavy plastic clay containing some mottling. The material becomes more mottled with depth and grades into mottled gray, yellow, drab, and rust-brown heavy calcareous clay.

The surface soil is neutral or slightly acid, and the subsoil is calcareous. Water seldom stands on the surface of this soil. The soil is sticky when wet and hard to cultivate. It occurs in level depressions, where it covers a total area of about 2½ square miles. Probably 15 percent of the land is cultivated, and the rest is used mainly for hay. Crop yields average somewhat lower than on Summit silty clay loam.

Parsons clay loam.—The 6-inch surface layer of Parsons clay loam consists of dark grayish-brown clay loam which is friable and crumbly when moist but bakes hard when dry. The subsurface soil is yellowish-brown clay loam to an average depth of 12 inches. The upper subsoil layer is drabbish-brown or olive-brown heavy rather plastic clay finely mottled with yellow, gray, and rust brown. The lower subsoil layer, between depths of 35 and 70 inches, is yellow or brownish-yellow, finely mottled with gray and rust red, heavy clay. The topsoil is heavier than the Parsons silt loam topsoil, but the claypan is not so heavy and dense as in that soil. In most places some brown soft concretionary gravel is scattered over the surface.

This soil occurs rather extensively near the foot of slopes. Some of it is associated with outcrops of heavy clay above the coal beds. It is not extensive.

Only about 10 percent of the land is cultivated. Possibly another 10 percent has been cultivated and abandoned, owing to gullying, as the soil is easily eroded. The rest of the land is used for pasture and hay. Crop yields are lower than on Parsons silt loam.

Woodson clay.—Woodson clay, to a depth of 10 inches, is dark-brown sticky clay, and beneath this the material is dark grayish-brown sticky clay which continues to a depth of 15 inches. This material is underlain by a dark olive-brown heavy plastic claypan. The lower subsoil layer, between depths of 28 and 50 inches, is drabbish- or olive-brown heavy sticky clay finely mottled with brownish yellow, gray, and rust red. This layer, in turn, is underlain by limestone or calcareous shale. The surface soil and upper subsoil layer are neutral or slightly acid, and the subsoil is calcareous.

None of this soil is cultivated, as it is too sticky and hard to work. Most of it is used for pasture, but the growth of grass is not so heavy as on the Summit soils.

Osage silty clay loam, poorly drained phase.—The 10-inch surface soil of Osage silty clay loam, poorly drained phase, is black or dark grayish-brown heavy sticky clay, and the subsoil is drabbish-brown heavy sticky clay mottled with gray, limonite yellow, and rust brown.

This is a very inextensive soil. It occurs in poorly drained depressions mainly along Little Cabin Creek and Big Creek. Practically none of it is cultivated. The greater part is used for grazing, and small areas produce a rather low grade of hay.

GRAZING SOILS

The grazing soils include Bates loam, shallow phase; Summit stony clay; and Summit silty clay loam, steep phase. These soils are used for grazing, and practically none of the land is cultivated, owing to the steep slopes or rocky soil. These are not such good grazing soils, however, as the native-hay and grazing soils.

Bates loam, shallow phase.—Bates loam, shallow phase, includes those areas of Bates soils which are too shallow, too rocky, or on which the slope is too steep to cultivate. In most places, the surface soil is dark grayish-brown loam or silt loam to a depth of about 5 inches. It is underlain by yellowish-brown silt loam containing some shale fragments and continuing to a depth of about 10 inches, where it is underlain by shale. The shale is largely brownish-yellow rather hard sandy shale laminated with bluish-brown soft shale or clay. Both surface soil and subsoil are moderately acid.

This soil includes many areas, especially near Timber Hill, in which the topsoil is fine sandy loam and is underlain by sandstone. Most areas of this soil range from rolling to hilly, with an average slope of 10 or 15 percent.

This shallow soil covers an area of 46.3 square miles, but practically none of it is farmed. A few areas have been farmed but have been abandoned, owing to washing away of the surface soil. This is a valuable grazing soil. About 5 acres of grass are required for each head of cattle.

Summit stony clay.—Summit stony clay has a shallow (8-inch) covering of black granular silty clay loam or clay, underlain by hard limerock which is partly disintegrated and contains some olive-brown clay in pockets and cracks in the rock. In many places, the rock outcrops, and there is much loose rock on the surface. The surface forms over which this soil occurs are largely benchlike, with many sharp breaks. Small areas of the soil also occur in depressions along small stream bottoms. The soil includes a total area of 52.5 square miles. It supports a heavy growth of grass and makes valuable pasture.

Owing to their small extent and similar characteristics, some areas of Labette stony loam are included with Summit stony clay in mapping. The surface soil of these areas is dark-brown silt loam to a depth of about 4 inches. Below this is reddish-brown silt loam continuing to a depth of 6 inches where the material is underlain by bedrock. The main occurrence of such areas is bordering areas of Labette silt loam.

Summit silty clay loam, steep phase.—The steep phase of Summit silty clay loam is shallower than the typical soil, and it occupies a section of very broken surface relief. The surface soil is nearly black clay which in most places rests immediately on limestone bedrock. Small patches within areas of this steep soil may have little or no soil covering over the rock; in other places, the soil material may be as thick as typical Summit silty clay loam.

This soil occupies steep slopes along the larger streams, principally in the northwestern part of the county. A few scrubby hardwood trees grow along these slopes. The only use to which this soil can be put is grazing, and even for this purpose it has only very low value.

GRAZING AND WOODLAND SOILS

All the grazing and woodland soils are covered with rather small hardwood timber, as most of the larger trees have been cut. These soils are pastured, but they are of low value for grazing. The group includes Hanceville stony loam and Okoee stony loam.

Hanceville stony loam.—Hanceville stony loam includes soils in rough broken timbered areas. They have rather light-colored coarse topsoils and red or yellow subsoils underlain by sandstone or sandy shale. The soil is variable in depth and in profile, owing to the broken surface relief.

In a few smooth areas where erosion is not so active, a soil deep enough to support crops has developed. The surface soil is light-brown or reddish-brown fine sandy loam or light loam, with a maximum thickness of about 10 inches, but in most places it is very shallow. Most of it is underlain by red fine sandy loam, but in some areas the subsoil is yellow. In many places red sandstone or sandy shale fragments are plentiful in the soil. Over the greater part of the soil, the sandstone or sandy shale bedrock is so near the surface that the soil will not support crops. The grazing value of this land is very low, and the land can best be utilized for growing trees for timber or fence posts.

Okoee stony loam.—Okoee stony loam has a rather dark grayish-brown silt loam surface layer, 1 or 2 inches thick. A thin layer of leaves and raw organic matter covers the surface, and considerable chert gravel and rock are scattered over the surface. Between depths of 2 and 6 inches the material is grayish-yellow or pale grayish-brown gravelly silt loam or loam. This is underlain by pale-yellow gravelly loam that passes sharply into a hardpan of cemented chert fragments. The depth below the surface to the cherty hardpan layer ranges from 3 to 24 inches, with an average of about 16 inches. This layer is from 12 to 24 inches thick and is underlain by a mixture of angular chert rock and gravel and red clay interstitial material that is not cemented. It continues to the limestone bedrock which lies at a depth ranging from 5 to 30 feet. Areas of this soil in rough areas along stream heads bordering the Craig soils have a somewhat darker topsoil.

This soil covers an area of 10.4 square miles, and only a very small part of it is cultivated. Some attempt has been made to use this land for fruit, and apples and Concord grapes are grown.

SOILS AND THEIR INTERPRETATION

A general description of the soils in Craig County has been given in the section on soils and crops. The physiography, relief, drainage, vegetation, and climate are also discussed in foregoing sections.

The most important factors in the development of different soils in any area are the native vegetation, the climate, the parent material from which the soils have been derived, the relief, and the length of time these forces have been in operation.

The parent materials of the soils of Craig County have been weathered from limestone, sandstone, and shale. The native vegetation is grass on about 680 square miles on the gently rolling or level upland and is rather scrubby hardwood timber on about 45 square miles of broken hilly areas.

The soils developed under a grass cover are dark colored, because grass roots have died and remained in the soil for a long time. The soils of Craig County, however, are not so dark as soils developed under grass cover farther northwest. There the soils are less leached, owing to a drier, cooler climate which has favored the accumulation of humus. The Craig County soils are much darker and less leached than soils developed in timbered areas to the southeast.

The timbered soils are predominantly light colored. The forest leaves fall on the surface where they decay and are largely dissipated, leaving only a very thin dark layer on the surface. There is no heavy sod of fine roots to decay and build up a thick dark layer.

The climate and rainfall here have favored the removal of calcium carbonate and other soluble salts from the surface soil and subsoil rather than their accumulation in the upper subsoil layer as in drier areas.

The surface soil, from which the sesquioxides have been removed and in which organic matter has accumulated, is known as the A horizon; the subsoil, in which the sesquioxides have accumulated, as the B horizon; and the substratum of parent soil material as the C horizon. Each horizon may consist of one or several subhorizons, for instance, A_1 horizon and A_2 horizon.

The claypan soils of Craig County are developed in areas of restricted or moderate drainage, mainly over limestones, shales, shaly sandstones, or terrace materials derived from the same source. The soils of the Parsons, Cherokee, Neosho, and Woodson series have developed claypans. Parsons silt loam is the most extensive of these soils.

A representative profile of a virgin area of Parsons silt loam, as observed in a pit in the SE¼ sec. 17, T. 26 N., R. 21 E., 5 miles south of Bluejacket, is described as follows:

0 to 2 inches, moderately dark grayish-brown smooth silt loam with a single-grain crumbly structure. The material is sod-bound. The soil clings to the root hairs, which gives it a faint granular appearance. The soil appears very dark when moist but is more brown when dry. The material in this layer is moderately acid, with a pH value of 5.4.[1]

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[1] pH determinations made by E. H. Bailey, Bureau of Chemistry and Soils, by the hydrogen-electrode method. pH 7 indicates neutral soil, higher than pH 7 is alkaline, and lower than pH 7 is acid. For example, pH 6 to 7 indicates a slightly acid soil, pH 5 to 6, moderately acid, and less than pH 5, strongly acid.

2 to 9 inches, dark grayish-brown silt loam with a crumbly structure. This material breaks up to pea-sized granules and subsequently to a single-grained structure. It is sod-bound. The acidity of the material in this horizon is pH 5.2.

9 to 12 inches, slightly dark grayish yellowish-brown smooth silt loam which readily breaks down to nut-sized fragments and then to a single-grain structure and is somewhat root-bound. The material contains traces of worm casts and ant clay balls. The material in this horizon has an acidity of pH 5.4.

12 to 17 inches, olive-brown rather plastic clay containing numerous fine specks of rust red. The color is finely variegated between darker brown and more yellowish brown. The red specks become more numerous with depth, and they smear out and become more conspicuous when crushed. The material in this layer breaks up into irregular nut-sized fragments. The fissure planes are shiny, and a cut surface has a dull polish. The material in this horizon is moderately acid, with a pH value of 5.4.

17 to 28 inches, greenish olive-brown heavy plastic clay variegated with yellowish brown and containing segregated splotches of rust red. The red becomes more conspicuous with depth. The material in this layer is sticky, tough, impervious, and gummy when wet and refractory when dry. It breaks up into fine angular fragments on drying. A few fine root hairs are in evidence. The acidity is pH 5.4.

28 to 37 inches, greenish-brown or yellowish-brown heavy clay variegated with grayish olive drab and splotched with bright rust red. The splotches of rust red consist of clusters of segregated irregular red specks. There are traces of root hairs followed by gray streaks. The material takes a dull polish on a cut surface. The natural fissure planes have a shiny surface. The acidity is pH 5.2.

37 to 42 inches, brownish-yellow heavy clay variegated with reddish yellow splotched with red and a trace of gray, and containing a large quantity of gypsum crystals. The gypsum crystals occur in spherelike bunches, with the crystals extending radially from the center. This horizon is the zone of gypsum concentration. It is strongly acid, with a pH value of 5.

42 to 50 inches, yellow heavy clay mottled with bluish gray. It contains a few shotlike soft concretionary black specks with brownish centers. A cut surface takes a bright polish. The material breaks up into large blocks. The acidity is pH 5.3.

50 to 90 inches, material similar to that in the horizon above, except that it becomes less acid with depth. The pH value is about 5.5.

The substratum is shale at a depth of about 10 feet.

This soil is covered with a heavy growth of native grasses. The surface drainage is fairly good.

The distinctive features of a Parsons silt loam profile are a dark A_1 horizon, a lighter colored but not gray A_2 horizon, a plastic claypan B_1 horizon, a layer of gypsum concentration in the B_2 horizon, and a shale or shaly sandstone C horizon.

Cherokee silt loam differs from Parsons silt loam in having a distinct gray layer, or A_2 horizon. The light color indicates that it is a highly leached soil. The iron oxide and alumina have been largely leached out of the A_2 horizon.

The Woodson soils resemble the Parsons soils but are somewhat darker and have developed from calcareous material which also included considerable gypsum. They occur in areas of restricted drainage where there probably has been a concentration of gypsum and other salts, in addition to much more than average leaching. These soils differ from the Parsons soils in having a darker A horizon and a more yellow claypan, with a more distinct prismatic structure.

The Bates soils are young shallow soils occurring on the well-drained and somewhat eroded upland, and they do not have a well-developed profile. They have dark surface horizons and somewhat lighter colored gradational horizons, resting on partly decomposed sandy shale or shaly sandstone. Bates silt loam is developed mainly from shale, Bates loam from sandy shale or shaly sandstone, and Bates fine sandy loam from sandstone.

The most important dark-colored soils developed on limestone or calcareous material in this county are the Summit and Labette soils. The Newtonia soils, in the same group, have rather thin dark surface soils. These are true Prairie soils. Where typically developed they show no podzolization, no gray layer, and no claypan layer.

Labette silt loam is representative of the dark-colored soils derived from limestone. A description of a profile of virgin Labette silt loam, observed in the SW¼ sec. 12, T. 27 N., R. 18 E., 2 miles north of Centralia, follows:

0 to 9 inches, dark-brown somewhat granular heavy silt loam with a faint red hue. The material is soft and friable and falls apart easily. It is faintly acid or moderately acid, with a pH value of about 6.

9 to 17 inches, dark reddish-brown granular heavy silt loam. The granules fall apart easily. These granules have reddish-brown centers and are thickly coated with dark brown.

17 ot 26 inches, red granular clay loam, with streaks of infiltration of a dark-brown covering on the red granules. The material in a cut has a faint purple shade. The material in this layer is slightly acid.

26 to 41 inches, red granular friable clay, with small specks of purplish-black soft concretions, underlain by yellow solid limerock at a depth of 41 inches.

This soil is developed only under good drainage. Its distinctive features are the thick dark very friable granular A horizon and the red very friable granular B horizon. The B horizon is strikingly free from gritty siliceous material, which is probably owing to a lack of siliceous material in the parent material.

Labette silt loam probably comes nearer to showing the full impress of the climate and grass vegetation of the general area than any other Prairie soil in this county.

The Newtonia soils differ from the Labette principally in having a thinner dark surface layer and a more red less granular B horizon. They occur on the highest best drained areas.

The Summit soils are closely related to the Labette soils. They have a darker thicker A horizon and a more calcareous B horizon which has a yellowish-brown or olive-brown rather than a dull-red color. The Summit soils are developed mainly in areas where surface drainage is not quite so good as in the Labette soils. In places they may be developed from softer limestone or calcareous shale.

The dark soils developed from highly weathered cherty material include only Craig silt loam and its deep phase.

A detailed description of a profile of virgin Craig silt loam observed in the NE¼ sec. 11, T. 24 N., R. 20 E., 4 miles south of Vinita is as follows:

0 to 5½ inches, dark-brown friable silt loam free from gravel.

5½ to 14 inches, dark grayish-brown friable crumbly rather heavy silty loam which takes on a slight yellow or more red color with depth. The material in this layer is slightly acid or moderately acid, according to colorimetric test.

14 to 23 inches, mottled rust-red and pale-yellow clay with some spots of dark material and a considerable quantity of chert gravel. When viewed from a distance this horizon appears decidedly red. The yellow color disappears when the material is crumbled. The material in this layer is moderately acid or slightly acid.

23 to 46 inches, a cemented chert hardpan consisting of gray chert gravel and rock stained with rust red, together with mixed rust-red, grayish-yellow, and dark purplish-brown interstitial clay cementing material. This material is very hard to penetrate with a pick. In most places the hardpan layer is underlain, at a depth of about 50 inches, by mixed chert gravel rock and clay, that is not cemented. Limerock is present at a depth ranging from 10 to 30 feet. The upper part of the hardpan layer is slightly acid or moderately acid, and the lower part is calcareous.

This is a characteristic profile of Craig silt loam. This soil has good surface and internal drainage. The hardpan is not impervious to moisture. The A horizon is conspicuously free from gravel and has a loesslike appearance. This is an old soil developed from calcareous material. Below it a great thickness of cherty limerock has weathered away to leave behind such a large deposit of chert rock and gravel.

The Hanceville soils are the only light-colored upland soils in the county developed on sandstone, and the Okoee soils are the only light-colored soils developed on the highly weathered cherty limestone.

The Hanceville soils are rather young shallow soils somewhat like the Bates soils, except they have light-colored surface soils with some forest litter on the surface and red instead of brownish-yellow subsoils. They are more acid than the Bates soils. Hanceville fine sandy loam is the most representative type of the Hanceville series mapped here.

Okoee stony loam resembles Craig silt loam in that it has a hardpan layer, but it is light colored in both the surface soil and upper subsoil layer.

A description of a profile of virgin Okoee stony loam, observed in the SW¼ sec. 32, T. 24 N, R. 21 E., one-fourth mile south of Okoee, is as follows:

0 to 2 inches, grayish-brown loam containing considerable angular chert gravel. A thin layer of leaves and organic material covers the surface, and much chert rock and gravel are scattered over the surface.

2 to 6 inches, light grayish-yellowish-brown gravelly loam. The gravel consists of angular pieces of chert ranging from about one-fourth to 1 inch in diameter. This horizon has an acidity of about pH 4.8, and all horizons above the hardpan are strongly acid.

6 to 16 inches, pale grayish-yellow coarse gravelly loam. The chert gravel in this layer become larger with depth.

16 to 30 inches, chert hardpan consisting of angular chert gravel and rock with gray interstitial cementing material. Most of the chert gravel are gray, showing some rust red where broken. All the gravel are coated with gray. The material in this layer is hard to break up with a heavy pick. It is moderately acid, with a pH value of about 5.5.

30 to 42 inches, mixed gray and red chert gravel and rock with red clay interstitial material. This material is not so hard as that in the horizon above, but it is hard to penetrate with a pick. It contains a trace of root hairs. It becomes more calcareous with depth and is underlain by limerock at a depth ranging from 5 to 30 feet.

This soil has a hilly broken surface relief, but it has a rather uniform profile. Like the Craig soils, it is derived from cherty limestone.

Table 4 shows the results of mechanical analyses of several soils in the county.

TABLE 4.—*Mechanical analyses of several soils in Craig County, Okla.*

Soil type and sample no.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Woodson clay loam:	*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
451201	0-12	0.3	0.3	0.4	2.2	4.2	63.2	29.3
451202	12-14	1.0	2.3	1.3	1.7	4.3	61.7	27.7
451203	14-24	.1	.3	.2	.7	2.2	31.9	64.4
451204	24-35	.2	.4	.2	.6	2.2	33.5	62.8
451205	35-47	.3	.4	.3	.8	2.3	33.1	62.7
451206	47-54	1.2	1.8	.9	1.9	4.7	34.0	55.6
451207	54-70	.6	.9	.5	1.2	3.2	37.2	56.5
Craig silt loam:								
451265	0- 4	2.6	2.6	1.5	3.1	10.9	63.9	15.4
451266	4-12	3.6	2.9	1.3	3.0	10.9	60.1	18.2
451267	12-14	2.7	2.6	1.2	2.4	8.4	53.6	29.0
451268	14-19	1.9	1.5	.8	2.0	6.5	45.0	42.4
451269	19-32	1.7	1.5	.7	2.2	7.2	49.6	37.2
451270	32-48	3.8	2.4	.9	2.3	7.5	51.3	31.7
451271	48-54	3.9	1.9	.5	1.3	4.2	34.2	54.0
Parsons silt loam:								
451289	0-11	.0	.5	.2	4.9	31.4	47.8	15.1
451290	11-25	.1	.4	.2	2.7	13.0	27.8	55.7
451291	25-38	.1	.2	.2	3.6	19.9	30.6	45.3

Table 5 gives the results of pH determinations of several soils in this county. These values were determined in the laboratories of the Bureau of Chemistry and Soils by E. H. Bailey, using the hydrogen-electrode method.

TABLE 5.—*pH determinations of several soils from Craig County, Okla.*

Soil type and sample no.	Depth	pH	Soil type and sample no.	Depth	pH
Woodson clay loam:	*Inches*		Craig silt loam:	*Inches*	
451201	0-12	6.3	451265	0- 4	5.0
451202	12-14	5.3	451266	4-12	4.7
451203	14-24	5.6	451267	12-14	4.5
451204	24-35	7.1	451268	14-19	4.5
451205	35-47	7.2	451269	19-32	5.1
451206	47-54	7.8	451270	32-48	6.2
451207	54-70	7.5	451271	48-54	7.1
Parsons silt loam:					
451289	0-11	5.4			
451290	11-25	5.1			
451291	25-38	5.6			

RECOMMENDATIONS FOR THE MANAGEMENT OF CRAIG COUNTY SOILS[2]

Most of the soils of Craig County have been developed under the influence of a prairie vegetation and an abundant rainfall. Consequently the organic-matter and nitrogen content are higher than in soils formed under the influence of forest or in soils formed in semiarid areas affected by similar temperatures. Although the soils here are high in organic matter and total nitrogen, the water which passes into the soil slowly dissolves some of the minerals in the surface soil and carries them into the lower horizons where they are not available for the growth of plants. As a result of this

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

weathering process, the content of available phosphorus and lime in a large proportion of the soils in Craig County is very low.

In order to obtain accurate information on the potential supply of plant nutrients in Craig County soils, a large number of samples were obtained from different soil types. These were analyzed, and the results are given in table 6. Most of the soil samples were taken from areas not in cultivation, and the content of plant nutrients was higher than that of the cultivated soils in adjacent fields. The average nitrogen and organic-matter content of the soils of Craig County is higher than the average for all soils which have been analyzed in Oklahoma. This condition is favorable for the production of forage crops where large quantities of nitrogen are required. A study of the acidity of the soils indicates that many of them are strongly acid to a depth ranging from 3 to 4 feet and that large quantities of lime will be needed for the production of such lime-loving crops as alfalfa, sweetclover, and many vegetables.

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

UPLAND SOILS

Soil type and sample no.	Location	Depth	pH	Total nitrogen	Organic matter [1]	Total phosphorus	Readily available phosphorus
Bates fine sandy loam:		*Inches*		*Percent*	*Percent*	*Percent*	*Parts per million*
2441	NW¼ sec. 15, T 28 N , R. 21 E.	0 – 3	5.3	0.203	4.48	0.022	0
2442	do	3 –13	5.1	.091	1.70	.021	0
2443	do	13 –19	5.1	.072	1.35	.022	0
2444	do	19 –29	5.3	.065	1 20	.023	0
2445	do	29 –34	6.5	.037	.60	.042	0
Bates loam, shallow phase.							
2422	NW¼ sec. 24, T. 29 N., R. 18 E.	0 – 4	6.1	.282	6.02	.055	22
2423	do	4 –10	6.0	.201	4.65	.051	12
2424	do	10 –27	7.5	.050	.72	.036	36
2425	do	27 –48	6.7	.041	.58	.035	28
Bates loam:							
2523	NW¼ sec. 1, T. 25 N , R 19 E.	0 – 6	5.4	.148	3.60	.025	2
2524	do	6 –11	5 1	.082	1 93	.020	1
2525	do	11 –24	5 6	061	1 18	.025	0
2526	do	24 –40	5.8	042	.73	.016	0
Bates loam, red-subsoil phase:							
2539	SE¼ sec. 30, T 26 N , R. 21 E.	0 – 7	5.9	.197	4.13	.037	4
2541	do	7 –13	5.6	.147	2.35	.038	1
2542	do	13 –29	5.7	.101	1.27	.038	1
2543	do	29 –40	5.6	.049	.45	.048	6
Bates silt loam:							
2492	NE¼ sec. 26, T 27 N., R. 21 E.	0 – 6	5.1	.200	4.45	.034	4
2493	do	6 –14	5.2	.132	2 13	.051	0
2495	do	14 –20	5.6	.135	1.92	.030	0
2496	do	20 –33	5.6	.073	1.38	.036	0
2497	do	33 –46	7.1	.054	.85	.039	100
Okoeo stony loam.							
2574	SE¼ sec 32, T 24 N., R. 21 E.	0 – 2	6.6	.298	8.86	.052	60
2575	do	2 – 6	4.8	.061	1.47	.022	18
2576	do	6 –16	4.9	.041	.77	.017	20
2577	do	16 –30	7.3	.046	.34	.011	12
2578	do	30 –42	5.3	.025	.18	.011	0
Woodson clay loam:							
2558	NE¼ sec. 29, T 26 N., R. 18 E.	0 –12	6.0	.184	4.20	.027	8
2559	do	12 –14	5.4	.102	1.83	.028	2
2560	do	11 –24	6.3	.111	1.40	.037	0
2561	do	24 –35	7.5	.075	.81	.028	0
2562	do	35 –47	7.9	.053	.27	.019	40
2563	do	47 –54	8.1	.049	.20	.278	100

[1] Determined by wet combustion method.

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

UPLAND SOILS—Continued

Soil type and sample no.	Location	Depth	pH	Total nitrogen	Organic matter	Total phosphorus	Readily available phosphorus
		Inches		*Percent*	*Percent*	*Percent*	*Parts per million*
Cherokee silt loam:							
2487	SE¼ sec. 36, T. 26 N., R. 21 E.	0 – 9	5.1	0.132	3.40	0.021	8
2488	do	9 –16	5.1	.099	1.40	.015	0
2489	do	16 –19	5.3	.098	1.28	.013	0
2490	do	19 –37	5.3	.095	1.80	.023	1
2491	do	37 –48	5.2	.084	1.00	.007	0
Parsons silt loam:							
2426	SE¼ sec 32, T. 24 N., R. 21 E.	0 – 5	5.7	.173	3.44	.019	6
2427	do	5 –11	5.6	.107	2.31	.020	0
2428	do	11 –17	5.7	.084	1.39	.016	0
2429	do	17 –28	6.0	.093	1.70	.013	0
2430	do	28 –37	7.1	.071	1.30	.015	0
2431	do	37 –50	8.2	.038	.50	.016	1
Hanceville fine sandy loam:							
2446	SW¼ sec. 2, T. 28 N., R. 21 E.	0 – 1	8.0	.144	4.18	.051	20
2447	do	1 – 6	7.6	.068	1.85	.051	2
2448	do	6 –13	6.6	.043	.80	.036	2
2449	do	13 –29	5.4	.026	.42	.095	1
2450	do	29 –35	5.4	.022	.30	.085	2
2451	do	35 –53	4.9	.031	.48	.067	1
Hanceville stony loam:							
2465	SE¼ sec. 20, T. 24 N., R. 19 E.	0 – ¾	6.5	.132	3.05	.098	4
2466	do	¾– 4	4.6	.067	1.60	.024	0
2467	do	4 –12	5.7	.028	.25	.022	2
2468	do	12 –42	5.0	.030	.60	.015	3
2469	do	42 –52	4.7	.016	.30	.012	0
Labette clay loam:							
2475	SW¼ sec. 13, T. 27 N., R. 18 E.	0 –11	6.4	.246	5.25	.035	0
2477	do	11 –19	6.0	.148	3.23	.025	2
2478	do	19 –32	6.4	.110	2.05	.019	2
2479	do	32 –41	7.6	.135	2.15	.032	2
Labette silt loam:							
2482	SW¼ sec. 12, T. 27 N., R. 18 E.	0 – 9	6.0	.181	3.88	.035	2
2484	do	9 –17	5.7	.185	3.68	.027	4
2485	do	17 –26	6.1	.118	2.50	.025	2
2486	do	26 –41	6.8	.102	2.13	.025	0
Craig silt loam:							
2579	SW¼ sec. 21, T. 24 N., R. 21 E.	0 – 4	5.8	.156	3.96	.022	12
2580	do	4 –11	5.2	.160	3.41	.020	8
2581	do	11 –18	5.1	.079	1.33	.017	4
2582	do	18 –22	5.4	.070	1.02	.016	0
2583	do	22 –29	5.4	.065	.70	.018	0
2584	do	29 –48	6.8	.070	1.08	.021	0
2585	do	48 –59	6.6	.029	.34	.009	0
Craig silt loam:							
2434	SW¼ sec. 33, T. 24 N., R. 21 E.	0 – 4	5.3	.076	1.75	.021	4
2435	do	4 –12	4.7	.122	2.42	.020	1
2436	do	12 –14	4.4	.085	1.62	.017	1
2437	do	14 –19	4.4	.116	1.55	.017	1
2438	do	19 –32	5.1	.050	.75	.012	0
2439	do	32 –45	6.6	.041	.45	.012	1
Craig silt loam:							
2507	NE¼ sec. 11, T. 24 N., R. 20 E.	0 – 5½	6.3	.218	4.55	.028	6
2509	do	5½–14	5.9	.117	2.45	.026	0
2510	do	14 –23	5.7	.109	.70	.023	0
2511	do	23 –46	5.5	.050	.23	.011	3
Parsons silt loam:							
2458	SE¼ sec. 26, T. 28 N., R. 20 E.	0 –11	5.2	.141	3.10	.017	1
2459	do	11 –25	5.1	.098	2.05	.015	2
2460	do	25 –38	5.4	.056	.95	.020	6
Parsons silt loam:							
2565	SE¼ sec. 17, T. 26 N., R. 19 E.	0 – 2	5.6	.243	4.81	.038	8
2566	do	2 – 9	5.2	.155	3.41	.037	6
2567	do	9 –12	5.2	.128	2.31	.035	2
2568	do	12 –17	5.3	.160	2.94	.033	20
2569	do	17 –28	5.2	.129	1.90	.020	2
2570	do	28 –37	5.0	.062	.81	.009	0
2571	do	37 –42	4.9	.057	.41	.043	6
2572	do	42 –50	5.5	.050	.32	.046	10

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

UPLAND SOILS—Continued

Soil type and sample no.	Location	Depth	pH	Total nitrogen	Organic matter	Total phosphorus	Readily available phosphorus
		Inches		*Percent*	*Percent*	*Percent*	*Parts per million*
Summit silty clay loam:							
2461	NE¼ sec. 32, T. 28 N., R. 19 E.	0 -10	5.4	0.286	6.25	0.098	2
2462	do	10 -20	5.6	.113	2.40	.099	3
2463	do	20 -32	6.1	.107	2.00	.112	3
2464	do	32 -40	6.8	.094	1.80	.104	3
Summit silty clay loam, colluvial phase:							
2498	NE¼ sec. 33, T. 26 N., R. 18 E.	0 -16	6.1	.192	4.33	.049	12
2500	do	16 -30	8.0	.082	1.58	.035	0
2501	do	30 -44	8.7	.043	.73	.013	0
Summit clay:							
2415	SE¼ sec. 20, T. 28 N , R. 19 E.	0 -13	8.1	.205	5.09	.043	28
2417	do	13 -20	8.3	.097	2.14	.028	40
2418	do	20 -33	8.5	.076	1.84	.024	24
2419	do	33 -48	8.5	.099	.84	.021	24
Newtonia silt loam:							
2408	SW¼ sec. 15, T 28 N., R. 19 E.	0 - 2½	7.6	.182	4.42	.040	24
2409	do	2½- 7	7.6	.143	3.06	.032	12
2410	do	7 -12	7.6	.125	2.45	.030	12
2411	do	12 -20	7.3	.082	1.18	.024	0
2412	do	20 -36	7.1	.071	2.00	.023	0
2413	do	36 -52	7.6	.072	1.00	.036	16
ALLUVIAL SOILS							
Neosho silt loam:							
2549	SW¼ sec. 4, T. 25 N., R. 21 E.	0 - 6	5.4	0.224	4.54	0.014	20
2550	do	6 -16	5.4	.087	1.20	.040	4
2551	do	16 -34	4.3	.073	.81	.024	0
2552	do	34 -64	5.6	.050	.36	.017	16
Summit silt loam, terrace phase:							
2505	NE¼ sec. 17, T. 26 N., R. 19E.	0 - 9	5.7	.230	5.13	.047	12
2506	do	9 -16	5.5	.143	2.78	.047	1
2506A	do	16 -34	5.7	.136	2.38	.046	2
2506B	do	34 -46	6.1	.088	.85	.091	14
Osage silty clay loam:							
2452	SW¼ sec. 35, T. 29 N., R. 21 E.	0 -11	5.5	.177	4.08	.045	2
2453	do	11 -24	6.2	.092	2.50	.032	1
2454	do	24 -30	6.2	.097	2.88	.033	2
2455	do	30 -44	6.7	.080	2.38	.028	12
Verdigris fine sandy loam:							
2470	SW¼ sec. 19, T. 24 N., R. 19 E.	0 - 7	6.1	.075	1.45	.032	0
2471	do	[1] 0 - 7	6.3	.109	2.25	.037	2
2472	do	7 -27	6.0	062	.80	.020	2
2473	do	27 -36	5.9	.076	1.40	.030	2
2474	do	36 -70	5.8	.064	1.15	.025	2
Verdigris silty clay loam							
2527	SW¼ sec. 17, T. 25 N., R. 20 E.	0 - 3	6.6	.375	7.08	.078	40
2528	do	[1] 0 - 3	6.1	.177	4.45	.060	40
2529	do	3 -12	4.9	.125	3.73	.030	8
2530	do	12 -24	5.1	.089	1.23	.034	18
2531	do	24 -30	5.4	.069	1.88	.028	4
2532	do	30 -40	4.9	.049	1.00	.023	4

[1] Cropped.

A wide variation occurs in the total phosphorus content of the soils in the county. Many of the soils occurring along the streams are very high in total phosphorus. Since the alluvial soils have been formed from materials eroded from the adjacent uplands, it is possible that certain ledges of sedimentary rocks may be responsible for the variation in the phosphorus content. Sample 2563 (Woodson clay loam) in table 6 illustrates the condition in some places. This sample was taken from a layer which was much higher in total phosphorus than other parts of the profile. Sample 2564, which was not included in the table but was immediately below sample 2563 in the soil profile, was also very high in total phosphorus. Where the material in these layers outcrops at the surface or has been carried away by erosion it would materially increase the total phosphorus content of the alluvial deposits as compared with other alluvium derived from soil material low in phosphorus, such as that represented by samples 2426 to 2431 (Parsons silt loam).

The total phosphorus content of the soil is not so important in its relation to immediate crop production as the readily available phosphorus. Readily available phosphorus in these samples was determined by extracting the soil with one-fifth normal sulphuric acid, using 1 part of soil to 10 parts of solvent. Analyses indicate that the surface layers of soils are usually higher in readily available phosphorus than any other parts of the soil profile. This is owing to the accumulation of organic matter and subsequent decomposition, resulting in the liberation of organic phosphorus which is fixed as mineral phosphate in the surface layers of soil. A knowledge of this condition is exceedingly important in studying the problem of soil erosion, because in many areas where the surface soil is removed and no available phosphorus occurs in the subsurface soil crop production is exceedingly poor unless phosphate fertilizers are applied to the soil.

A study of the readily available phosphorus in 41 samples of surface soil taken in different parts of the county has been made and indicates that considerably more than 65 percent of the surface soils are either low or very low in this important plant nutrient. The results of the analyses show that 2 soils were very high in readily available phosphorus, 7 are high, 5 are medium, 17 are low, and 10 are very low.

Unless phosphorus is added to these soils, many crops will not produce maximum yields because phosphorus is the chief limiting factor in crop production. As a rule Craig County soils contain a good supply of organic matter and nitrogen, and experiments conducted in adjacent counties on similar soil types show that wheat production can be materially increased by the use of small applications of superphosphate made in the row with the seed at time of planting. The use of phosphorus in the production of corn is questionable, because of the climatic hazards which occur, and, where fertilizers are used, it is more desirable to apply them to crops which are not likely to be influenced by drought or unfavorable weather conditions.

Under virgin conditions, the soils produced a vigorous growth of native grasses. Grasses are low in lime and phosphorus, and in many places good grassland is not necessarily land which will continue to be productive when put into cultivation, because cultivated crops remove large quantities of mineral plant nutrients, which will soon deplete the available supply in the soil. Where native grass is cut for hay, the fertility of the soil is depleted more rapidly than in areas where the land is used for pasture.

One of the most rapid methods of depleting the fertility of the soil is to produce legume crops, such as soybeans, cowpeas, alfalfa, or sweetclover, remove the forage, and return no residues to the soil. Legume crops are higher in potash, lime, phosphorus, and nitrogen than native grass or forage crops, as Sudan grass or cane. Where soils are deficient in phosphorus, legume crops respond to phosphorus fertilization, and large quantities of phosphate fertilizer will eventually be used in order to supply this important plant nutrient which is necessary for the production of maximum crop yields.

A study of the variation in the lime content and acidity of the soils indicates that a wide variation occurs between the soils derived from limestone or calcareous shales, and are comparatively young, and old soils derived from sandstone or weathered limestone and shale under the influence of a forest or prairie vegetation. One hundred and thirty-two samples of surface soil have been studied. More than 50 percent of these soils need lime, in order to provide more favorable conditions for crop production. The results of these analyses are as follows: 23 soils basic, 17 neutral, 23 slightly acid, 14 slightly +acid, 20 medium acid, 16 medium +acid, and 19 strongly acid.

When agricultural limestone is applied to the soil, a maximum effect on crop production does not appear until this material is thoroughly mixed with the soil. In most places 2 or 3 cultivations are necessary before the lime is thoroughly mixed with the soil. Lime has both a direct and an indirect effect on plant development. In very acid soils, it supplies calcium as a plant nutrient and also provides conditions more favorable for bacterial action. Lime increases the rate of decomposition of organic matter, and, as a result, larger quantities of nitrogen are liberated, especially when weather conditions are unfavorable and low soil temperatures prevail. Since the application of limestone to the soil will increase the rate of decomposition of soil organic matter, legume crops must be grown in a cropping system, in order to supply the nitrogen which will be used by succeeding crops.

Many experiments have been conducted on the use of limestone and fertilizers in the production of sweetclover, and data on the effect of applications of lime and phosphate on the production of sweetclover on Parsons silt loam are shown in table 7.

TABLE 7.—*Effects of rate of application of fertilizer on yields of sweetclover on Parsons silt loam, Vinita, Okla.*

Plot no.	Soil amendment	Rate of application per acre	Acre yield of dry sweetclover	Plot no.	Soil amendment	Rate of application per acre	Acre yield of dry sweetclover
		Pounds	*Pounds*			*Pounds*	*Pounds*
1	None		106	7	20-percent superphosphate and limestone	[1] 200 [2] 2,000	2,938
2	Farm manure	12,000	732	8	20-percent superphosphate and limestone	[1] 200 [2] 6,000	4,094
3	Limestone	2,000	1,612	9	33-percent rock phosphate and limestone	[3] 400 [2] 6,000	4,254
4	do	6,000	2,058				
5	20-percent superphosphate	200	380				
6	33-percent rock phosphate	400	464				

[1] Superphosphate.
[2] Limestone.
[3] Rock phosphate.

All applications of limestone and phosphate fertilizers used in this experiment were broadcast and disked into the soil before the sweetclover was sown. These data show that both phosphate and limestone are needed on this soil, in order to produce large yields of sweetclover, but the initial cost of heavy applications of plant nutrients prevents many farmers from adopting this kind of a soil-improvement program. In order to determine whether smaller applications of fertilizer could be used in the successful production of sweetclover, a second experiment was conducted, in which the fertilizers were applied in the row with the seed at time of planting. The results of this experiment are given in table 8.

TABLE 8.—*Effect of row fertilization on the yield of sweetclover on Parsons silt loam, Welch, Okla.*

Plot no.	Soil amendment	Rate of application per acre (drilled with seed)	Acre yield of dry sweetclover	Plot no.	Soil amendment	Rate of application per acre (drilled with seed)	Acre yield of dry sweetclover
		Pounds	*Pounds*			*Pounds*	*Pounds*
1	None		[1] 800	9	33-percent rock phosphate	200	2,105
2	Farm manure	[2] 24,000	690	10	do	400	2,440
3	Limestone	400	1,377	11	20-percent superphosphate and limestone	[3] 200 [4] 600	2,909
4	do	800	1,987	12	33-percent rock phosphate and limestone	[5] 200 [4] 400	3,950
5	do	1,000	1,663	13	Rock phosphate and limestone	[5] 400 [1][4] 4,500	4,900
6	do	[2] 3,000	2,217				
7	do	[2] 6,000	2,458				
8	20-percent superphosphate	200	1,050				

[1] Average of 16 plots.
[2] Broadcast over plot and disked into soil.
[3] Superphosphate.
[4] Limestone.
[5] Rock phosphate.

These data show that sweetclover can be grown successfully by applying small quantities of fertilizer in the row with the seed. They also show that farm manure does not supply enough phosphorus or lime for the production of good crops of sweetclover. Lime is more important than phosphorus in the production of sweetclover on many acid soils which are high in organic matter, but where both limestone and phosphorus are applied to acid soils, more than twice as much sweetclover will be obtained as where limestone is applied alone.

Experiments conducted in other counties of Oklahoma indicate that the effect of 2 or 3 tons of agricultural limestone an acre will produce conditions favorable for the growth of such crops as sweetclover for at least 10 or 12 years. Where lighter applications are made, it will be necessary to repeat them each time that a lime-loving crop is planted. The initial cost of treatment is the chief advantage in favor of the lighter rates of application.

Many experiments have been conducted to show the desirable effect of sweetclover on subsequent crop production, but none of these tests has been conducted in Craig County. The important problem at present is to determine what method can be used to produce sweetclover most economically in a rotation system. Recent investigations conducted in many different locations show that, under average conditions, row fertilization of sweetclover is the most economical method to use in the improvement of poor acid soils.

Cultivation accelerates the decomposition of soil organic matter, and where crops are removed from the soil and nothing returned, the supplies of organic matter and nitrogen in the soil gradually decrease. The total organic matter, total nitrogen, and total phosphorus content of 11 cropped soils has been determined, and the average composition of these soils compared with that of the same number of virgin soils obtained from adjacent areas. The results of these comparisons are given in table 9.

TABLE 9.—*Losses of plant nutrients in Craig County soils as a result of cultivation*

Soil condition	Nitrogen	Phosphorus	Organic matter
	Pounds [1]	*Pounds* [1]	*Pounds* [1]
Virgin	4,290	875	96,400
Cropped	3,580	770	75,200
Loss through cultivation	710	105	21,200

[1] Pounds per acre in soil 6⅔ inches deep.

The data show that nearly 20 percent of the total nitrogen in the surface soil has been lost. A marked reduction in total phosphorus has occurred, and nearly 25 percent of the total organic matter has disappeared. Although crop yields may not be decreasing on some soils, the potential supply of plant nutrients is disappearing, and the time will come, if it is not already present, when some very definite soil-building program must be adopted, in order that a permanent type of agriculture can be maintained on all the farms in the county.

No single cropping system can be devised, which is applicable to all farms in a particular area. Consequently, it will be necessary to make general recommendations which may be modified to meet the requirements of the individual farm. Farmers interested in the production of cash crops are following a more costly type of farming, so far as the maintenance of soil fertility is concerned, than farmers who depend on livestock to produce the greater part of their cash income. It is unfortunate that the average landowner, who rents his farm to a tenant for cash or grain rent, does not understand or at least does not appreciate the fact that each crop removed decreases the potential supply of plant nutrients in that soil. When the value of a crop is low, it is not economical to apply mineral plant nutrients in order to increase crop yields. Certain crops, such as grain sorghums, do not respond to fertilization on the average soil. When fertilizers are used, they should either be applied to a crop which will return a high cash income per acre or to a crop which will produce a marked response to fertilization. Wheat, cotton, and alfalfa return a relatively high cash value per acre and respond to phosphate fertilization when planted on phosphorus-deficient soils. A residual effect from phosphate fertilization will usually occur on subsequent crops; therefore, the total cost of the fertilizer should not be charged to one crop. In general, fertilizer should not be used on the oat crop, as oats following a cotton crop which has been fertilized will produce larger yields than oats planted on cotton land where no fertilizer has been applied. Oats are usually low in price, and it requires a large increase in yield to pay for the fertilizer.

Farmers who produce legume crops for feed can afford to use phosphate fertilizers to increase their production of hay, because larger yields of feed will make it possible to increase the number of livestock on the farm or decrease the quantity of feed purchased.

Legumes when properly inoculated take nitrogen from the air and incorporate it into the plant tissues in the form of protein; consequently, a large crop of legumes produced by the addition of phosphate fertilizers will fix more nitrogen than a small crop produced on untreated soil.

Very few farmers in Oklahoma use green-manure crops. Hairy vetch is one of the most promising crops for early spring pasture and for use as green manure. It will grow on acid soils without lime. It can be planted early in September on a well-prepared seed bed and can be plowed under and a grain sorghum crop planted the following year. Where lime can be applied, sweetclover will improve the soil more rapidly than any other legume, with the possible exception of alfalfa. The most profitable cropping system to use will depend on the fertility of the soil. Two good cropping systems are as follows: For good soil—(1) corn, (2) oats in alternate rows with sweetclover, (3) sweetclover for pasture and seed, and (4) corn following sweetclover; and for poor soil—(1) grain sorghums, (2) soybeans, mung beans, or cowpeas, (3) oats followed by hairy vetch, and (4) hairy vetch plowed under in preparation for grain sorghums.

On many farms a larger acreage should be devoted to alfalfa. Limestone and phosphate fertilizers may be needed, in order that alfalfa may make a satisfactory growth and compete with weeds and grass. All legume seeds should be inoculated if that crop or a crop which cross-inoculates with the crop to be planted has not been grown on the land.

Sandy soils absorb water readily, but in areas where compact layers of clay occur a short distance below the surface, moisture movement is restricted, and, during periods of abundant rainfall the pore space in the soil is filled with water and conditions are not favorable for root development. This condition exists in many Craig County soils, and there is no economical method which can be used to change the texture or structure of the subsoil. Where claypan soils exist, high yields of crops cannot be obtained unless climatic conditions are favorable, although surface drainage is helpful in improving conditions and rendering them more favorable for root development. Grain sorghums should be grown instead of corn on these soils, because they are planted later in the season when the soil is not too wet. Terrace ridges will remove the excess water which cannot be absorbed by the soil and will prevent the accumulation of water on lowlands.

Soils containing too much clay are not easily cultivated, and during periods of rainy weather, it is difficult to control the growth of weeds on them when row crops are being grown. During periods of drought, the clay soils, especially on the upland, are quickly affected. Therefore, the sandy land, although it may be lower in potential plant nutrients, is more favorable from the point of view of tillage, moisture absorption, and root development of plants.

Soil erosion is an important problem in this county, but many farmers do not appreciate how much soil is being lost, because gullies do not appear in the fields. Sheet erosion is responsible for the greater part of the soil losses of both soil and plant nutrients. Every farmer appreciates the fact that the surface soil gradually becomes thinner on sloping land and that the subsoil appears on the hillsides, but few individuals have attempted to reduce these soil losses to a minimum. In many places contour farming will reduce the damage from soil erosion, and terraces are important because they prevent the accumulation of water on adjacent areas of nearly level land and, in addition, reduce the concentration of water responsible for both sheet and gully erosion. The control of soil erosion should be a very definite part of any farm-management program. Under natural conditions where the surface of the soil is covered with grass, the rate of erosion is exceedingly slow. Farmers who grow wheat and other noncultivated crops suffer less loss caused by soil erosion than farmers who grow cotton, corn, or other cultivated crops. The greater part of the available plant nutrients in the soil is in the surface layer.

SUMMARY

Craig County is in the northeastern part of Oklahoma, the second county to the west of the northeast corner. The total area is 760 square miles.

The surface relief is largely that of a gently rolling prairie with narrow wooded stream bottoms, and it includes smaller areas of rounded hills and broken escarpments. The four main physiographic divisions include a mesalike area underlain by limestone and interstratified coal and shale in the northwestern corner, a large lower central area underlain by shale and sandstone, a smoother area underlain by shale and some sandstone, and a broken area underlain by highly weathered cherty limestone in the southeastern corner. The elevation ranges from 650 feet along Cabin Creek on the south county line to more than 1,000 feet in the northern part.

The county was organized in 1907. In 1930 the total population was 18,052. The rural population was 13,789, or 18 persons a square mile.

The mean annual rainfall is 43.15 inches, the mean annual temperature is 59° F., and the average frost-free period is 199 days. The rainfall is fairly evenly distributed, but the summer months are dry, owing to high evaporation.

The agriculture consists of diversified farming and livestock raising. About 50 percent of the land is cultivated, and the rest is used as native-hay and pasture land. Corn is the most important cultivated crop, followed by oats, wheat, kafir, and soybeans. A large proportion of the feed crops is fed to cattle locally, and the surplus is shipped to Kansas City and other markets.

The soils of this county differ widely in those characteristics that influence their crop adaptations and yields. In this report the soils have been grouped according to their most common utilization. A number of the soils have heavy dense impervious subsoils called clay-

pans. These soils are best adapted to the growing of short-rooted crops. With this group are most of the soils of the Parsons, Cherokee, Neosho, and Woodson series.

Parsons silt loam is the most extensive soil. The surface soil is moderately dark grayish-brown silt loam, and the subsoil is characterized by a dense clay layer, or claypan. Although this soil is not especially favorable to the production of corn, more than 40 percent of the acreage in cultivation is devoted to this crop. Oats, wheat, kafir, and soybeans rank next in importance.

Cherokee silt loam has a lighter colored surface soil than Parsons silt loam and a light-gray or almost white subsurface layer between the surface soil and the claypan. This soil is poorly drained and has a lower agricultural value than Parsons silt loam. Both the Parsons and the Cherokee soils are developed over shales or sandy shales. The same crops are grown, but yields average about 20 percent lower on Cherokee silt loam.

Neosho silt loam is a terrace soil that has a profile very similar to that of Cherokee silt loam. It is better drained and has a slightly higher agricultural value than the Cherokee soil.

Woodson clay loam is a claypan soil having poor drainage. It has a somewhat lower agricultural value than that of Cherokee silt loam. Only about 25 percent of this soil is cultivated.

Summit silty clay loam is an extensive dark-colored upland soil developed over limestone. Alfalfa, wheat, oats, corn, and forage crops do well on this soil. Summit clay is slightly heavier than Summit silty clay loam and has somewhat lower agricultural value.

Labette silt loam and Labette clay loam occur on the rolling upland. These are the best farming soils in the county, as they are easy to cultivate, retentive of moisture, and adapted to a wide range of crops.

Newtonia silt loam also occurs on the upland. The surface soil is dark reddish brown, and the subsoil is red. The agricultural value is slightly lower than that of the Labette soils. Oats, wheat, kafir, and some corn are grown.

Bates silt loam occurs on rolling uplands over a large part of the county and is a rather shallow soil developed over shales and sandstone. About 55 percent of this soil is cultivated. Corn, oats, kafir, and wheat are the principal crops, named in order of their relative acreages.

Bates loam is coarser in texture and more shallow than Bates silt loam. Crop yields are slightly lower than on the silt loam.

The better soils of the stream bottoms, including those of the Verdigris, Lightning, and Osage series, are cultivated. Yields in favorable seasons are as high as those on the upland soils, but average yields are lowered by flooding when the streams are swollen.

Several soils have mellow surface soils, permeable subsoils, and are fairly retentive of moisture. The greater part of the fruit and truck crops are grown on these soils. The sandy soils of the Bates and Hanceville series and Craig silt loam belong to this group.

The other soils are not farmed to great extent but are used for the production of native hay, for grazing, and for growing timber.

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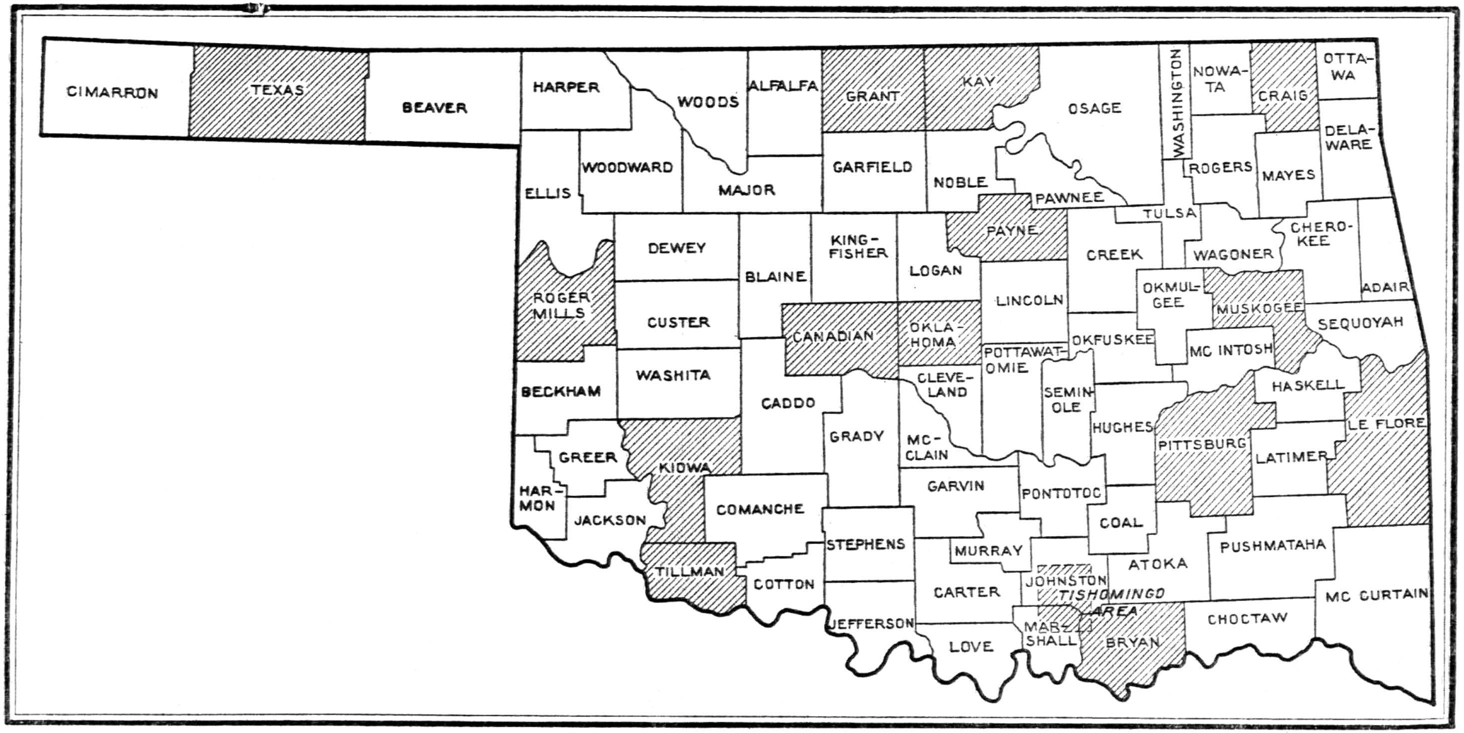

Areas surveyed in Oklahoma, shown by shading. Detailed surveys shown by northeast-southwest hatching.

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