

U. S. DEPARTMENT OF AGRICULTURE,  
BUREAU OF SOILS—MILTON WHITNEY, Chief.  
IN COOPERATION WITH THE TEXAS AGRICULTURAL EXPERIMENT STATION,  
B. YOUNGBLOOD, DIRECTOR.

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# SOIL SURVEY OF DENTON COUNTY, TEXAS.

BY

WILLIAM T. CARTER, JR., IN CHARGE, AND M. W. BECK.

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HUGH H. BENNETT, INSPECTOR, SOUTHERN DIVISION.

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[Advance Sheets—Field Operations of the Bureau of Soils, 1918.]



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BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE TEXAS AGRICULTURAL EXPERIMENT STATION,  
B. YOUNGBLOOD, DIRECTOR.

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SOIL SURVEY OF DENTON COUNTY,  
TEXAS.

BY

WILLIAM T. CARTER, JR., IN CHARGE, AND M. W. BECK.

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HUGH H. BENNETT, INSPECTOR, SOUTHERN DIVISION.

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LETTER OF TRANSMITTAL.

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U. S. DEPARTMENT OF AGRICULTURE,  
BUREAU OF SOILS,  
*Washington, D. C., July 29, 1921.*

SIR: Under the cooperative agreement with the Texas Agricultural Experiment Station, B. Youngblood, director, a soil survey of Denton County was carried to completion during the field season of 1918.

I have the honor to transmit herewith the manuscript and map covering this work and to recommend their publication as advance sheets of Field Operations of the Bureau of Soils for 1918, as authorized by law.

Respectfully,

MILTON WHITNEY,  
*Chief of Bureau.*

HON. H. C. WALLACE,  
*Secretary of Agriculture.*

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### MAP.

Soil map, Denton County sheet, Texas.

# SOIL SURVEY OF DENTON COUNTY, TEXAS.

By WILLIAM T. CARTER, Jr., In Charge, and M. W. BECK.—Area Inspected by HUGH H. BENNETT.

## DESCRIPTION OF THE AREA.

Denton County is situated in what is locally termed north Texas, geographically lying a little east of the north-central part of the State. It is in the second tier of counties south from the Oklahoma line, which is distant about 35 miles. The eastern boundary is about 170 miles west of the eastern border of the State and about 270 miles northwest of Galveston, the nearest point on the Gulf of Mexico. The county is nearly square, on a dimension of approximately 30 miles. It comprises an area of 941 square miles, or 602,240 acres.

Physiographically Denton County consists mainly of a prairie plain dissected by a number of small streams that flow in shallow valleys. The surface of most of the area is undulating to gently rolling. Along Clear Creek, Elm Fork of the Trinity River, Hickory Creek, and Denton Creek the valleys are deeper, some of them being 100 feet lower than the general surface of the adjacent upland. In places the upland includes narrow belts of rough and hilly land along the streams. Usually such land occurs on only one side of the valley, the opposite upland being lower and of smoother configuration.

The county comprises three general belts of country which extend across it from north to south. The eastern belt lies in the Black Prairie and occupies about one-fourth of the county. The western belt lies along the eastern edge of the region known variously as the Western Prairie, the Fort Worth Prairie, or the Grand Prairie and forms approximately the western half of the county. Lying between these prairie belts is a strip of timbered country known as the East Cross Timbers.

The Black Prairie, or eastern belt, is undulating to gently rolling and is crossed by a number of shallow valleys, along which lie narrow strips of hilly to strongly rolling country. Between these valleys there are broad areas of nearly level to gently undulating surfaces. The village of Little Elm lies in one of these areas. Much of the Western Prairie belt is also dominantly undulating to gently rolling, but it is dissected by a larger number of streams than the Black



FIG. 1.—Sketch map showing location of the Denton County area, Texas.

Prairie belt, and its topography is more rolling as a whole. In this belt are some small areas with rough and moderately rough surface features. In the extreme northwestern corner of the county there are several rather small areas of a rough nature. In the East Cross Timbers belt the surface varies from gently rolling to strongly rolling, with some narrow belts of rough country along the valleys of the larger streams. There are some low rounded hills or "knobs" in this part of the county.

The prairies are treeless, with the exception of narrow strips of timber along the larger streams. Much of this timber has been cleared from the land. The East Cross Timbers belt was originally heavily forested, but much of it has been cleared and the land put in farms. Here the timber consists principally of post oak and blackjack oak, while in the stream bottoms it consists mostly of elm, hackberry, pecan, and spotted and bur oak. Clumps of elm and hackberry occur on the prairies, with an occasional mesquite tree.

In elevation Denton County ranges from approximately 500 feet to nearly 1,000 feet above sea level. The lowest elevation is where the Elm Fork of the Trinity River leaves the county, near the southeastern corner; the highest is in the northwestern part on the divide between Clear Creek and Denton Creek. The general slope of the county is toward the southeast.

All of Denton County is drained by the Elm Fork of the Trinity River. This stream enters the county from the north, nearly midway of the boundary, extends southward with a slight trend to the east, and leaves the county about 6 miles west of the southeast corner of the county. The stream has a fall in the county of between 100 and 200 feet. The channel is 100 to 200 feet wide and is tortuous and the flow of the river is sluggish. During the greater part of the year there is very little water in the stream and sometimes barely enough to flow.

The main tributaries of the Elm Fork from the west are Clear, Hickory, and Denton Creeks, which flow in parallel courses in a southeasterly direction, draining the Grand Prairie and portions of the East Cross Timbers, or approximately the western three-fourths of the county. Denton Creek empties into Elm Fork just south of the county line. On the east the main tributaries are the Isle du Bois, Little Elm, and Stewarts Creeks. These streams flow in a general southwesterly direction and drain the Black Prairie and parts of the East Cross Timbers, or about one-fourth of the county. All these streams, like the Elm Fork, are nearly dry during the greater part of the year, though some water usually remains, even in the driest seasons. Clear Creek and Denton Creek have more water in dry seasons than the other streams, being fed in their upper reaches by springs. After rains the streams of the county carry

large volumes of water and sometimes overflow the valleys, covering strips from one-fourth mile to 2 miles wide to a depth of several feet.

Smaller intermittent streams tributary to these main streams reach into all parts of the county, giving good drainage. Some of the steeper slopes are subject to severe erosion and most of the surface of the county is washed to some extent during rainfall. This condition, while not as yet critical, is becoming a matter of uneasiness to many farmers, and some means of preventing surface washing should be adopted on most farms. Certainly cultural methods should be adopted which will retard soil washing as far as possible.

Water for domestic use is usually plentiful and of good quality throughout Denton County. On the prairie land it is obtained mainly from wells several hundred feet deep, in which the water rises nearly to the surface, and is pumped on many farms by windmills. In the Cross Timbers section many of the wells are shallow. There are some springs in the western part of the county and many flowing wells in the creek bottoms. The largest creeks have water during all the year, though in long dry seasons these may get nearly dry and cease to flow, the water appearing only in pools.

Denton County was formed from a part of Fannin County in 1846 and named in honor of John B. Denton, a prominent pioneer settler. Most of the early settlers of the general region were from the Eastern and older Southern States. The first settlers came into the county about 1842 from the adjoining counties on the east and south. The population at present consists mostly of native whites, many of them descendants of the original settlers. There is a considerable negro population. Settlements of persons of German descent are established near Krum and Lewisville, many of whom came from Missouri and Illinois about 30 years ago. The population of Denton County was 35,355 in 1920. Seventy-eight per cent of the population of the county is classed as rural, and the average number of persons per square mile is about 29. The farming population is well distributed, but is most dense in the East Cross Timbers, where land has been cheap and building material accessible, so that no great financial outlay has been required to settle and open up a farm. The Black Prairie is the next most thickly settled section. Agriculture is the principal and practically the sole industry of the county.

The largest town is Denton, which is the county seat. It has a population of 7,626, is situated almost in the center of the county, and is an important trading center and shipping point. Two large State schools are located at Denton—the College of Industrial Arts for Girls and the North Texas State Normal School. These schools have a combined enrollment of nearly 3,000 students. Pilot Point, Lewisville, Sanger, Krum, Roanoke, Ponder, Justin, Aubrey, Argyle, and Garza are important railroad towns in the county. Denton, Pilot

Point, and Lewisville have each a cottonseed-oil mill. Flour mills are located at Denton, Krum, Lewisville, Aubrey, Ponder, Sanger, and Pilot Point. Clay from the local beds of the Woodbine formation is used for brickmaking in a large brick-manufacturing plant at Denton. Some pottery is also made from these clays.

A number of railroad lines pass through Denton County and give good transportation and shipping facilities. Dallas and Fort Worth, two important cities of Texas, are in counties adjoining Denton County on the south, and railroads radiating from these cities pass northward through Denton County. The Gulf, Colorado & Santa Fe Railroad passes through the western part of the county in a northerly direction. The Texas & Pacific Railroad reaches through the central part of the county in a general northeast-southwest direction. The Missouri, Kansas & Texas Railroad extends from Denton through the southeastern part of the county. The St. Louis, San Francisco & Texas Railroad parallels the Collin County boundary for a distance of about 9 miles in the southeastern part of Denton County. In the northwestern corner of the county some farms lie 10 or 12 miles from railroad shipping points, but in most other sections none of the farms are more than 6 or 8 miles from a railroad.

Nearly all the roads of Denton County are earth roads. They are graded for the most part, but in wet weather they are heavy and difficult to travel. This is especially true of the roads in the prairie sections, where the soils are heavy, and when wet are very stiff and tenacious. In the East Cross Timbers the roads are somewhat sandy, though where graded most of the road surface is clay. These roads are rough and poorly kept, even in dry weather, while the prairie roads are very good when dry. One turnpike leads from Denton westward to Krum and nearly to Ponder. Other roads surfaced with gravel or other materials extend from Lewisville south to the county line, from Lewisville east to Hebron, from Hebron southward, and from Roanoke south to the county line. There is considerable good road-building material in Denton County in the form of gravel beds along some of the stream valleys, limestone in the western part of the county, and chalk in the eastern section. Sand, sandy clay, and beds of fine stony material are abundant in the East Cross Timbers and are sometimes used to good advantage in road construction.

Practically all of the county is served by rural mail delivery. Telephones are in general use. Churches and schools are located in all sections of the county. Fort Worth and Dallas are the nearest large markets. The railroads give connections with many of the other large cities in Texas and other States. One of the Texas agricultural experiment stations (Substation No. 6) is located near Denton and is of great benefit to the agriculture of north Texas.

## CLIMATE.

Denton County has a mild and healthful climate. The winters are short, but marked by occasional sudden changes of temperature caused by the southerly extension of blizzards or cold waves in the north and west. These come in the form of north winds (northers), accompanied frequently by rain, which often changes to sleet and sometimes to snow. The summers are long and the temperature is high, but in the dry atmosphere and with an almost constant southerly breeze, the heat is not so oppressive as in localities farther east and north.

The mean annual temperature at Dallas<sup>1</sup> is 65° F. The mean temperature for the winter is 46.4°, for the spring 64.7°, for the summer, 82.8°, and for the fall 65.8°. The lowest recorded temperature is -10° F., and the highest is 115° F. The average date of the last killing frost in the spring is March 20, and of the first in the fall November 12. The date of the latest recorded killing frost in the spring is May 1, and of the earliest recorded in the fall, October 8.

Denton County is intermediate between the most humid parts of the State and the drier sections. The climate at best is decidedly variable, there being periods of too abundant precipitation and periods of drought. Many of the soils in this county are heavy, and many of them are of none too great depth. Under such conditions even a soil which may be termed reasonably well drained and which is so situated as to possess good surface drainage may, nevertheless, become too wet for the optimum growth of crops in rainy seasons.

In dry seasons, on the other hand, the rainfall is inadequate for maximum yields of all crops or even for fair yields of some crops. Thus in some years the rainfall is insufficient for the production of corn, and in such years the yields of other crops are materially lowered. As a rule, the eastern part of the county seems to receive more rain than the western part. Long periods of dry weather sometimes occur in the fall and winter, causing injury to wheat, and lack of rain in winter and spring produces conditions very unfavorable to the production of oats. Periods of drought in June and July frequently injure corn, which is also damaged at times by hot winds.

The mean annual precipitation at Dallas is 38.04 inches, which is nearly all in the form of rain. Some winters pass without snow, though two or three light snows during the winter are not unusual. The maximum rainfall recorded for any one year (1888) is 59.53 inches, the minimum (1909) 17.98 inches. The average annual depth of snowfall is 2.9 inches. Prolonged severe droughts are rare, and periods of excessive rainfall are infrequent. Local hailstorms con-

<sup>1</sup>The data used herein are taken from the records of the Weather Bureau station at Dallas, where climatic conditions are essentially the same as in Denton County.

fined to small areas occur sometimes, and occasional hard winds do some damage, though wind storms are not frequent. Occasional torrential rains cause some damage by washing the soils.

The question of precipitation is one which causes more uneasiness in farming operations here than any other factor affecting the growing of crops. Some farmers study climatic conditions carefully and attempt to facilitate the production of certain crops by early planting, special preparation of the soil, and through careful seed selection for drought-resistant strains. There also has been a tendency to meet conditions by growing crops affected less by drought, as in substituting oats and barley for feed in place of corn.

The fruit crop is occasionally ruined in Denton County by late frosts or by the blooming of trees before the period during which freezing temperatures are likely to occur has passed.

The following table gives the normal monthly, seasonal, and annual temperature and precipitation as recorded by the Weather Bureau station at Dallas:

*Normal monthly, seasonal, and annual temperature and precipitation at Dallas, Dallas County.*

[Elevation, 466 feet.]

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1909).	Total amount for the wettest year (1888).	Snow, average depth.
	° F.	° F.	° F.	Inches.	Inches.	Inches.	Inches.
December.....	46.9	85	8	2.72	2.58	4.27	0.5
January.....	45.1	95	2	2.59	.33	1.69	1.2
February.....	47.1	89	-10	2.69	1.35	4.92	1.1
Winter.....	46.4	95	-10	8.00	4.26	10.88	2.8
March.....	56.4	98	16	3.59	1.22	4.06	T.
April.....	64.8	98	30	3.98	1.01	7.20	.0
May.....	72.9	103	36	4.11	1.05	5.17	.0
Spring.....	64.7	103	16	11.68	3.28	16.43	T.
June.....	80.7	108	48	3.94	4.41	10.16	.0
July.....	84.0	108	57	3.30	T.	1.54	.0
August.....	83.6	115	52	3.01	1.58	13.67	.0
Summer.....	82.8	115	48	10.25	5.99	25.37	.0
September.....	77.5	107	40	2.87	.32	2.01	.0
October.....	65.1	100	26	2.46	2.22	.50	.0
November.....	54.8	92	15	2.78	1.91	4.34	.1
Fall.....	65.8	107	15	8.11	4.45	6.85	.1
Year.....	65.0	115	-10	38.04	17.98	59.53	2.9

## AGRICULTURE.

The first settlements were made in Denton County about 1843. The first settlers located along the timbered areas and valleys where material for houses and fences could be obtained, and where water could be had from the streams. They grew small patches of corn, wheat, and vegetables and raised cattle on the free range. The eastern prairie and Cross Timbers belts were settled more rapidly than the prairie country in the western part of the county. The first fences were built of rails split in the Cross Timbers and creek valleys. By 1885 wire fences were being built; this enabled an increased area of land to be placed in cultivation and decreased the free range. Gradually all the land was fenced and put in farms. A little cotton and considerable wheat were grown prior to the Civil War. These products were hauled to Jefferson and Shreveport, situated on the navigable streams; at a later time they were taken to railroad points in southeastern Texas; and still later they were carried to Denison and Dallas, where they were sold, and lumber and other supplies hauled back. Small patches of tobacco are said to have been grown in the early days.

At present the main industry of the county is agriculture, which consists of general farming. Stock raising and feeding, usually carried on in conjunction with the production of the general farm crops, are engaged in to a small extent. The principal crops are cotton, wheat, oats, corn, sorghum, and hay. Small quantities of the forage crops are grown, and in certain sections a small acreage is devoted to barley. Vegetables, berries, and fruits are raised for home use on most farms. Probably about 80 per cent of the improved land in farms in Denton County is used for crops, the rest being used for pasture.

In 1879, the acreage and production of the principal crops in Denton County were as follows: Cotton, 29,785 acres, producing 11,568 bales; corn, 43,818 acres, producing 1,184,523 bushels; wheat, 25,472 bushels; and oats, 6,233 acres, 112,681 bushels. The value of orchard products was reckoned at \$9,530, and of market-garden products at \$2,326.

In 1889, 41,190 acres were devoted to cotton, yielding 12,014 bales; corn, 43,818 acres, producing 1,184,523 bushels; wheat, 25,472 acres, which gave 310,759 bushels; oats, 11,431 acres, with a production of 274,238 bushels. The value of market-garden products, including small fruits, was \$8,529. On 12,263 acres, 15,586 tons of prairie hay were cut. Nearly 40,000 bushels of sweet potatoes were grown on 328 acres, and 157 acres of Irish potatoes yielded 13,024 bushels.

In 1899, 1,900,740 bushels of corn were grown on 64,423 acres; cotton was grown on 62,717 acres, yielding 17,746 bales; 92,800 acres of wheat yielded 1,352,060 bushels; oats on 22,032 acres yielded 804,410 bushels; 372 acres of barley yielded 8,550 bushels; and peanuts on 100 acres gave 2,731 bushels. Hay from wild grasses was cut from 4,003 acres, producing 3,725 tons; and millet from 1,351 acres, yielding 2,477 tons. Irish potatoes from 357 acres yielded 23,731 bushels; and sweet potatoes from 325 acres, 20,597 bushels. In that year all orchard products grown in Denton County were valued at \$24,967, animals sold and slaughtered were valued at \$482,389, dairy products, excluding those for home use, were valued at \$25,453, and poultry raised was valued at \$70,510.

At present, more land is devoted to cotton than to any other product, this crop being grown by nearly all farmers and on all the soils occurring in the county. In 1909, there were 113,554 acres of cotton, with a production of 25,483 bales. In 1919, 115,257 acres were in cotton, producing 33,175 bales. The principal variety of cotton grown is the Mebane. The Rowden and some other varieties also are grown. The Lone Star, a very promising variety of longer staple than the Mebane or Rowden, has been introduced by the United States Department of Agriculture and has been successfully grown for several years by a number of farmers. Its yield is not quite as high as Mebane, but the increased value of the lint more than offsets the difference in yield. The Houston black clay and the Bell clay, high-terrace phase, as a rule produce the highest yields of this variety.

Corn ranked next to cotton in acreage in 1909, there being 91,344 acres, yielding 938,620 bushels. At present it ranks only fourth, being exceeded in acreage by both oats and wheat. In 1919, 36,035 acres were in corn, yielding 1,050,206 bushels. Corn is grown by most farmers, though during some seasons, owing to dry weather and hot winds in early summer, corn yields are often very light. Farmers state that only one or two good crops of corn have been obtained in the last 10 years. The product is usually insufficient to supply the local demands. Many farmers are discontinuing the planting of corn and are growing oats, barley, or forage crops for feed. According to experiments and the experience of many farmers a corn known as Surcopper has given the best results in this section. It is especially valuable on account of its drought-resisting qualities. A number of small grist mills in the county manufacture corn meal for local use.

Wheat is a very important and valuable crop in Denton County. According to the census, 35,279 acres in this crop in 1909 yielded 334,846 bushels. This was a considerable decrease from the acreage and yield of 1899. However, since that time the production

of wheat has increased, until at present Denton County produces probably more wheat than any other county in the State. In 1919 wheat was grown on 97,192 acres, with a yield of 1,295,742 bushels.<sup>2</sup> Much of the wheat produced in Denton County is shipped to various parts of Texas for milling, but a large quantity is ground in the several flour mills of the county and the flour shipped to outside markets. The wheat grown is of several varieties, but in the main is a moderately soft bearded winter wheat. Mediterranean and Fulcaster are the prevailing varieties. Much mixed seed is used, as little care is taken by many farmers to keep strains pure. The culture of wheat is more extensive on the soils of the Western Prairie belt—San Saba clay and Denton clay—than on the other soils of the county. The production is considerable on Bell clay, high-terrace phase, and Wilson clay, though the relative area in cotton on these types is larger than on the two soils first mentioned. The type of wheat grown in this county produces a flour especially suitable for the southern trade, but there is a considerable demand for a harder wheat. Hard winter wheats grown here have been on the whole, it is said, somewhat inferior in quality and quantity. Durum spring wheat has been tried to a slight extent and in especially favorable seasons has yielded well, although the average yield for a number of years has been somewhat lower than that of the fall-sown wheat. Sometimes wheat is killed by freezing. The grain is pastured to some extent during the fall and winter and early spring.

The oat crop is very important. In 1909, 168,327 bushels were harvested from 13,120 acres. The acreage devoted to oats has been gradually increasing. In 1919, 46,093 acres were in oats, yielding 1,758,795 bushels. Part of the crop is used for feeding farm stock, but much of it is shipped to outside markets. It is estimated that about 10 per cent of the crop is sowed in the fall; of the remaining 90 per cent the greater part is seeded in February. Some crops result from volunteer seeding when seasonal conditions in the fall are especially favorable. As with wheat, oats are sometimes killed by freezing. The Texas Rust Proof is the principal variety grown, although a variety known as the White Oat is sowed to some extent on the sandy soils. Oats are harvested about the last of May. The grain is pastured to a large extent for several months in the fall, winter, and early spring, and this is said to reduce winter killing. Oat straw is used to a considerable extent for feeding farm stock, and a large quantity is baled and shipped to the large markets.

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<sup>2</sup> The decreased acreage of wheat and oats in 1909, as shown by the census, as compared with the figures for 1899, was doubtless due to the fact that 1909 was the driest year ever recorded in this section. Only 17.98 inches of rain fell that year, and it is probable that farmers gave no data for land that had been in wheat or oats but which was not harvested owing to failure of the crop, due to dry weather.

Hay is an important crop, and some kind of hay or forage crop is grown on most farms, though probably the production is insufficient for home and local use. Many farmers use sorghum or millet for hay. Some put up sorghum for silage. Johnson-grass hay is grown for the market on a few farms. Much more hay or forage could be profitably produced by growing Sudan grass.

Peanuts are becoming a very important crop on the lighter soils in Denton County, the acreage having increased largely in the last few years. Peanuts yield 30 to 50 bushels of nuts and about 1 ton of good hay per acre. There is a good market for the nuts. Most of this crop is fed on the farms where it is produced. The production of peanuts should be extended on the sandy soils. It is said that the peanuts produced in Denton County are especially suitable for making candy products. The Spanish variety is grown principally.

Bermuda grass grows well on practically all of the soils of the county. It is drought resistant, prevents erosion on steep slopes, and makes an excellent stock feed. This grass will be of value in extending the dairy industry, in steer feeding, and in hog or sheep raising.

Alfalfa has been grown to a small extent in various parts of the county with more or less success. The best results have been obtained on the alluvial soils of the Frio and Trinity series, on which some small fields have been established for several years. While these soils are subject to overflow, the water, as a rule, does not remain long enough seriously to damage the crop. The heavier alluvial soils, the Trinity and Catalpa clays, are especially suited to alfalfa, owing to the fact that these are deep, fertile soils, rich in lime. The calcareous upland soils are also well suited to alfalfa, but moisture conditions here are frequently unfavorable for the best results. The possibilities of sweet clover as a forage and pasturage crop should be investigated.

One of the great needs of the agriculture of the county is suitable legumes to be included in the general scheme of farming, as feed crops and soil builders. The only legume generally grown at present is the cowpea, and this crop is confined principally to the sandy soils. Peanuts also are grown on the sandy soils, but practically all of this crop is removed, so that the soil derives little benefit from it. From results obtained in growing legumes at the experiment station near Denton it seems that sweet clover (*Melilotus alba*) is about the best crop of this nature for the soils and climate of this region. It is especially suited to calcareous soils, is hardy and drought resistant, makes excellent pasturage and a fair grade of hay, and improves both the tilth and composition of the soil. If sweet clover is not mowed too short or grazed too closely it is well suited

to the region, otherwise it may be killed by heat and drought. The crop is easily seeded. The seed may be scattered on unprepared soil in the late summer or very early spring, and without further attention the plants will make a good growth if moisture conditions are at all favorable. It may be broadcasted with spring oats.

Small quantities of barley are grown in the county, mostly in the western part. Barley seems to be increasing in acreage and is taking the place of corn to some extent as feed for live stock. Barley usually yields well and is suited to many of the soils of the county. It is sowed in the fall and is principally of the Tennessee winter variety.

Small quantities of kafir, milo, and feterita are grown by some farmers for feeding farm stock. Some have good success in producing these crops, but many state that the grain does not develop during some seasons on account of "blasting." This blasting is caused by the sorghum midge, which develops especially well in damp weather. Grain sorghums in this region should be planted at such a time that the bloom will come in dry weather, about the middle of May being the best time to plant, which brings the blooming period in July or August.

It seems probable that rye could be grown to advantage on the heavy upland soils of the county. Broom corn also might prove successful on many of the soils.

Vegetables, berries, and small fruits are grown on nearly every farm for home use, and many farms have small orchards of peaches, pears, and plums, the surplus products being sold locally and in the towns of the county. Grapes are grown in a few small vineyards and do well on the Kirvin and Tabor fine sandy loams.

While the sandy soils are better suited than other soils to the production of fruits and vegetables, considerable success could be attained on the heavier soils, such as the San Saba, Denton, Houston, and Bell, by a liberal use of barnyard manure, plowing under straw or other vegetable matter, and thorough tillage. It would seem that the expenditure of greater effort in making gardens would be well repaid by an increase in the home food supply over large sections of the county.

In 1909 the total value of animals sold and slaughtered in Denton County was \$853,964; of dairy products, excluding those for home use, \$125,094; of poultry and eggs, \$202,644; and of wool, \$5,418. For 1919 the value of dairy products, excluding those for home use, is reported as \$251,237; poultry and eggs, \$371,932; wool, \$40,966.

There are only a few small dairies in the county, and these supply the towns. The local demand for butter outside the towns is supplied largely by farmers who keep a few cows and have a small

surplus after their home needs are satisfied. In view of the proximity of Dallas and Fort Worth, it would seem that a further development of the dairy industry might prove profitable in those parts of the county near shipping points.

In certain sections steers are brought into the county for fattening. These are fed cottonseed products and other feeds grown locally. Some farmers have silos which they fill with sorghum for winter feeding. In the western part of the county, where there are some good-sized areas of pasture land, the steers are both grazed and fed. A few beef cattle are also raised in the county.

There are many small flocks of sheep in the county, and the number is increasing. Some farmers own several hundred head. Hogs are raised on nearly every farm. Horses and mules also are raised, though ordinarily there are only a few on any one farm. Poultry is raised on all the farms, the surplus of chickens and eggs being shipped to markets outside of the county.

The farmers in Denton County recognize in a general way the adaptation of the soils to certain crops. It is well known that the Kirvin and Tabor fine sandy loams are better suited to vegetables and fruits than the heavier types. The Frio, Catalpa, and Trinity soils are recognized as being the best corn, cotton, and alfalfa soils. The San Saba clay, Houston black clay, Bell clay, high-terrace phase, and Wilson clay are considered as best suited to small grains and cotton and are known to be better for corn than are the associated Denton clay, Houston clay, and Sumter clay. The last three are good small-grain and cotton soils.

No definite system of crop rotation is used in the county. In the western part, where wheat is grown most extensively, the crop is often sown year after year on the same land. Also, where cotton is grown most extensively it occupies the same land for many consecutive years. The same is true of other crops. Many of the farmers, however, change crops from time to time in an effort to increase yields and prevent soil deterioration to some extent. No systematic effort is made to change crops according to suitability of one crop to follow another. This lack of systematic rotation tends to produce unfavorable conditions. Certain weeds are favored in growing small grains for a long time on the same land and become great pests. Certain plant diseases are also fostered. The mechanical condition of the soil is often rendered less favorable for plant growth. Erosion is often increased by a continuous production of one crop. Altogether, crop yields become lower. The Texas Experiment Station has developed some rotations for soils representing the Grand Prairie section of the county which may prove valuable. One, a three-year rotation, is corn (or cotton) in wide (6-foot)

rows, followed by wheat, the stubble of which is plowed very early in the summer, is followed the third year by oats, wheat, or barley, followed immediately after harvest by cowpeas, which are plowed under in the fall as a green-manure crop. The next year cotton or corn is again planted in wide rows. This rotation is believed to be especially suitable where wheat or other small grains are the main crop. Another rotation advised by the same authority is cotton or corn, followed the second year by cotton or corn in wide rows, and the third year by small grain, after the harvest of which cowpeas are immediately planted and turned under in the fall for green manure, the next year the land again being planted in cotton or corn. This rotation is considered very suitable for those parts of the county where cotton is the most important crop; that is, in the eastern part of the county on the Houston soils. The station also recommends a rotation for the sandy soils, such as the Kirvin and Tabor fine sandy loams, as follows: First year corn or cotton, second year oats, immediately followed by cowpeas plowed under late in the fall for green manure, third year cotton, and fourth year peanuts. Peanuts grown as a soil improver should preferably be grazed off by hogs.

Corn land is plowed in the fall by some farmers, in the winter by some, and by others in the early spring. It may be flat broken, bedded with sweeps or listers, or may be bedded and then rebedded and harrowed down. If corn follows small grains the land is more often flat broken in the fall, but if it follows cotton or corn it is frequently bedded. The methods of preparing corn land vary according to the preceding crop, moisture conditions, and convenience. Some plant corn between the beds in the low furrow and some on the bed, while others plant on flat-broken land that has been harrowed into good tilth. Corn is planted in March and is cultivated three or four times. Though many of the soils are adapted to corn and give fair yields in good seasons, this crop is frequently injured by dry, hot weather in June, and yields are often very light. Under the climatic conditions which obtain in this county the Frio clay, Trinity clay, and Catalpa clay are the best suited for corn. These soils are deep, rich alluvial soils containing considerable organic matter and nitrogen, and corn grows rapidly and seems to suffer less from drought on them than on the upland soils. On the Bell clay, high-terrace phase, corn does well with sufficient rain, and almost as well on the San Saba clay. These are the main upland prairie soils. The sandy soils of the Cross Timbers are not so well adapted to corn, though on the better farms corn does fairly well in seasons of ample rainfall. On the alluvial soil types 60 to 70 bushels per acre is considered a maximum yield of corn, on the upland prairie soils 40 to 60 bushels, and on the sandy

soils 30 to 40 bushels. Some farmers state that the best results in raising corn in dry seasons are obtained by flat-breaking the land in summer and harrowing it during fall and winter after rains. This tends to conserve the soil water and to increase the supply of available plant food. According to agronomists of the Texas Experiment Station, the seed bed should be prepared as early in the fall as possible, but if no work is done until spring it should not be worked too deeply. In most seasons corn should be planted in the water furrow or on flat land, and rarely does a season occur when planting on beds is justifiable, except in poorly drained areas. Seeding should be relatively heavy, so as to obtain good stands from the early planted corn, which usually makes the best yields. Excellent results have been obtained by placing the corn rows 6 feet apart and spacing the plants 18 to 24 inches in the row,<sup>3</sup> as wide rows are easier to keep clean and the land is better fitted for small grain in the fall. The proper rate of stand is said to be 9 to 12 square feet of land per plant in either wide or narrow rows. Clean cultivation is very necessary, and besides giving better yields it leaves the land in much better condition for seeding fall grain than where a growth of weeds and grass is allowed to remain.

Wheat is sowed in October and sometimes later. Where sowed on grain stubble, the land is flat broken as soon after harvest as possible and harrowed into a good friable condition before sowing, but land that has been in corn or cotton is not usually broken, the wheat being drilled in. In Denton County the heavy upland prairie soils are best suited to wheat, though the heavy alluvial soils are also used for the crop to some extent. Wheat is harvested in June.

Results at the Denton Experiment Station very closely confirm results at some of the more western stations in the State and indicate that stubble land which is prepared for sowing fall wheat should be plowed early and deep and given sufficient harrowing at once to break down all clods and put the soil in the condition of finely divided mulch. Thereafter until planting time the land should be harrowed or worked to a shallow depth to prevent the formation of a crust and to prevent all growth of weeds, grass, or volunteer grain. If stubble land can not be plowed early it should be plowed rather shallow. About 5 pecks of wheat per acre is considered the proper amount for seeding.

Land for oats, if for fall sowing, is prepared in much the same way as for wheat. Oats are frequently sowed after cotton or corn, the land being either plowed or disked. Oats do well on the same soils as those suited for wheat, but they do better than wheat on some of the more rolling areas or on washed or eroded soils, such

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<sup>3</sup> Bulletin No. 230, Texas Agr. Expt. Sta.

as the Houston clay, Houston clay, shallow phase, Ellis clay, and Sumter clay. Oats produce heavy yields on the heavy alluvial soils, but sometimes are damaged by overflows.

Land for cotton is prepared in about the same manner as for corn. Cotton is planted in late April and early May, and sometimes later, but usually it is best to plant as early as possible, using plenty of seed and later thinning to a stand. Except in the case of very late planting, the seed should not be planted in the water furrow, but on a level surface or on a bed. Early cotton requires a warm, dry soil, being a very tender plant, and the seed bed should be well drained.

Farms and improvements are good in many parts of the county, more especially where the owners live on their farms. As a rule, farm buildings and other improvements are much better on the prairies than in the sandy Cross Timbers country. This is also true of the work stock, which on the prairie lands is generally very good. Many farmers on the prairie soils use large plows drawn by four or more horses or by tractors, and the other farm implements are of highly improved types. Smaller teams and implements are used on the sandy soils of the Cross Timbers.

Practically no commercial fertilizer is used, and little barnyard manure is applied to the soil. Some farmers improve the soil by growing cowpeas and plowing under the vines or that part of the vines not used for hay. Peanuts also improve the soil, especially when grazed off by hogs. These methods of soil improvement are used more on the sandy soils than on the heavy prairie soils.

The supply of farm labor is usually adequate but wages are high. The farm work is performed mostly by the farmer and his family, and labor is hired only at certain times as needed. Laborers hired by the month are paid \$25 or \$30 a month and board. Day laborers are paid \$1.50 to \$2 a day for chopping or hoeing cotton and \$2.50 to \$3 a day during grain harvest. Cotton picking is paid for at the rate of \$1 to \$1.50 per hundred pounds. A large part of the labor is colored. According to the census 31.5 per cent of the farms reported an expense for labor in 1909, the total expenditure being \$171,857, an average of \$126.74 per farm; and 46.7 per cent of the farms reported an expenditure in 1919 of \$494,540.

In 1909, 88.7 per cent of the total land area in Denton County was in farms, the average size of the farms being 125.6 acres, 63.6 per cent of which was improved. For 1919, 86.7 per cent of the total area is reported in farms, with an average size of 125.8 acres, of which 74.8 per cent is classed as improved land. There were 4,303 farms in the county in 1909, and 4,200 are reported in 1919, each tenancy being counted as a farm. The farms range in size from 50 to

several hundred acres, with a few holdings of 2,000 to 3,000 acres. The larger holdings are usually subdivided into tenant farms of 50 to 150 acres or more. The prairie farms are generally much larger than those of the East Cross Timbers.

In 1879, 38.3 per cent of the farms were operated by tenants, in 1889, 44 per cent, in 1899, 50 per cent, and in 1909, over 61 per cent, showing a steady and considerable increase up to that time. However, the census reports only 56 per cent of the farms as operated by tenants in 1919. Farms are usually leased on shares, the rent being one-fourth of the cotton and one-third of the corn. Where wheat and oats are grown largely one-third of the grain crops goes to the landlord. Little land is rented for cash.

Land prices vary in Denton County according to location, topographic conditions, distance from railroads and towns, farm improvements, and the nature of the soils. The prairie lands in the eastern part of the county are the highest, selling for \$125 to \$200 an acre. Prairie lands in the western part of the county sell for \$75 to \$125 an acre, and land in the East Cross Timbers may be bought for \$25 to \$75 an acre. The creek bottom lands, where in larger areas, bring somewhat less than the prairie lands, owing to the danger of overflows, although some tracts are held at more than \$100 an acre.

#### SOILS.

Denton County lies in the humid part of the United States. Its mature, well-drained soils present the characteristics of such soils the world over. They are leached of their carbonates, have light-colored, well-oxidized subsoils, and are invariably characterized by the presence of an upper subsoil somewhat heavier than the soil. They are typical humid soils, characteristic evidence of such being the presence of the lighter textured or eluvial<sup>4</sup> soil and the somewhat heavier textured or illuvial<sup>4</sup> subsoil, produced by the transference of fine material from the soil to the subsoil as a result of development under the influence of heavy rainfall. They have developed also under the influence of a high annual average temperature, where freezing is rare, decomposition rapid, and oxidation of the iron compounds in the soil well advanced. The subsoils, therefore, are usually red or reddish. The surface soils are grayish, brownish, or dark colored, depending on the character of the native vegetation under which they have developed. Where developed under timber cover the soils are light in color, the usual profile consisting, in the virgin soil, of an inch, or at most a very few inches, of leaf mold mixed with earth, and a grayish horizon ranging in

<sup>4</sup> Glinka, D. K. Die Typen der Bodenbildung, p. 18. Berlin, 1914.

thickness from a mere film to several inches, the thin gray horizon being found in the heavy types and the thick horizon in the light types. On rather light sandy loams the grayish horizon may reach a thickness of 8 inches. A brown horizon underlies the gray. It may remain brown throughout the extent of the weathered zone, or it may change downward to reddish brown or red. The disintegrated but imperfectly weathered material below the reddish or brownish horizon is usually bluish. The well-oxidized reddish or brownish horizon extends downward to a depth that varies mainly with the texture and with the character of the parent rock. In the light-textured materials the depth is usually greater than in the heavy, and it is deeper also where derived from unconsolidated rock. Where the soil is derived from hard limestone, the thoroughly weathered horizon is shallow, ranging from a few inches up. The brown horizon is uniformly heavier than the gray, and in the sandy soils the transition from the gray sandy horizon to the brown or reddish heavier horizon is rapid.

The soils developed under grass cover are dark in color, the degree of darkness increasing as a rule with increasing heaviness of texture. The usual profile consists of a black or dark-brown surface horizon extending to a depth varying from 5 to 14 inches. This is underlain by a brown or dark-brown usually heavier horizon which may change downward to a reddish-brown or red color. The latter takes place in localities where the subsoil and substratum are well drained, because of being made up of a sandy, gravelly, or porous consolidated rock material. Where the underlying parent material is heavy, the brown subsoil usually changes downward to a bluish or to a mottled blue, yellow, and red material. In all cases where the subsoil is poorly drained its color is variegated or mottled because of incomplete oxidation.

It was stated above that the soils of Denton County—the mature, well-drained soils—have been subjected to leaching long enough for the disappearance of their carbonates. This statement is not true of the young soils of the county, however, and a considerable part of the soils are still in that stage of development. The soils of the Houston, Brackett, and the heavy types of the Denton, San Saba, and Sumter will effervesce in the subsoil, and in some cases in the soil, while effervescence may take place in the deep subsoil of the Crockett soils. The carbonates present in these soils and subsoils are invariably those of the parent rock and are being slowly, if imperceptibly, leached away. In no place within the county, aside from certain seeps and springs, are carbonates increasing in either soil or subsoil. It is this absence of accumulated and accumulating carbonates in soil and subsoil that differentiates the soils of Denton

County from those farther west in what is known as the semiarid portion of the State. The semiarid soils of the State, defining these on the basis of the presence within the soil profile of accumulated carbonates, do not extend east of Wichita, Baylor, Throckmorton, and Brown Counties. The soils of the eastern part of Denton County are much more highly calcareous than those of the western part, the former being derived from highly calcareous beds of unconsolidated or only very faintly consolidated clays, while the latter are derived more largely from consolidated calcareous beds. In the eastern part of the county the disintegration into what is ordinarily called soil is so rapid that the soil has accumulated to considerable thickness before the carbonates in the parent rock have been removed. In the western part of the county the parent rock consists mainly of consolidated limestone which weathers very slowly. By the time a layer of weathered material thick enough to be called soil has been accumulated, the carbonates have all disappeared. In localities, however, in this part of the county where the parent rocks are soft, the soils are very much like those of the eastern part.

The parent rocks of the Cross Timbers strip in the central belt of the county are not calcareous, so that the soils developed from them are free from carbonates.

Denton County, as previously stated, includes on the east a strip of the well-known Black Prairie or Black Waxy belt, and on the west a strip of the western or Grand Prairie belt, with a timbered belt between. The Black and Grand Prairie region occupies several thousand square miles in northern Texas. The timbered belt is markedly different from the prairie belts on each side in that the soils are generally sandy and the surface rolling and forested, while the soils of the prairies are mostly dark heavy clay soils, the surface is gently rolling to undulating, and the natural vegetation consists of grass.

The strata underlying Denton County consist of marine sediments, mostly calcareous. In the prairie regions these strata range from calcareous clays and marl to chalk and indurated limestone; in the East Cross Timbers the strata consist of unconsolidated beds of sand and clay which have been cemented in places into ferruginous sandstone.

The older and harder rocks of the county underlie the western prairie belt and geologically belong in the Lower Cretaceous period, while the formations underlying the East Cross Timbers and Black Prairie belt belong in the Upper Cretaceous.<sup>5</sup>

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<sup>5</sup> The geological information in this chapter is from "Geography and Geology of the Black and Grand Prairies of Texas," by R. T. Hill, Twenty-first Ann. Rept., U. S. Geological Survey, 1899-1900, Pt. VII.

The soils of Denton County are with reference to origin divided into three general groups: (1) Those formed in place by the weathering of consolidated rocks; (2) those formed from the weathering of unconsolidated rocks, including sandy and clayey strata of low lime content and marls and chalky material or soft limestone; and (3) alluvial soils which have been formed by recent deposits of soil material from the overflow of streams. The material giving the alluvial soils in the county has been washed from areas of limestone, from other calcareous soils, and from areas of the more sandy sedimentary soils, which characteristically are of low lime content.

The prairie in western Denton County is underlain by the Fort Worth formation, consisting of bands of white and yellow limestone and calcareous clay or marl. This part of the Grand Prairie is called the Fort Worth Prairie. It is a broad, rolling prairie more or less dissected by streams. The limestone has not weathered deeply and is often exposed on the slopes. In the depressions and lower areas the soil is several feet deep, but on the higher swells and low ridges the rock lies less than 3 feet below the surface. In the extreme northwestern part of the county there are small areas of Edwards limestone. The soils derived from the limestones on the Fort Worth Prairie are heavy clay soils, being black in the low areas, depressions, and flats and brown on the higher positions on steep slopes. Where the rock is exposed there are considerable areas of stony land. The black soils of this western prairie have been grouped in the San Saba, the brown in the Denton series. A narrow strip along the eastern edge of the Fort Worth Prairie, known as the Gainesville Prairie, is underlain by ferruginous clays, sandy clays, impure limestone, and sand superimposed on the Fort Worth limestone. Here the soils are reddish to brown and chocolate colored and contain considerable quantities of ferruginous sandstone fragments. They range in texture from fine sandy loam to clay and are correlated with the Durant series.

Just east of the Denison formation is the Woodbine formation, which underlies the East Cross Timbers belt and consists of unconsolidated sediments of sand and clay. The clays are somewhat tough and compact and occur as beds or strata interbedded in the sands. The principal soils derived from these materials are fine sandy loams ranging in color from red to brown and gray with red and yellow clay subsoils. These soils belong to the Kirvin, Tabor, and Norfolk series. In many of the low flats associated with the Cross Timbers there are small areas of dark-colored soils of low lime content which have been included in the Wilson series.

The Black Prairie on the eastern side of the county is underlain mostly by the Eagle Ford formation, which consists of deep bituminous or calcareous clays and weathers into deep black and brown

clay soils which belong to the Houston, Sumter, and Ellis series. Much of the high, undulating surface of this prairie is covered with old alluvium which gives the Bell clay, high-terrace phase. The extreme southeastern corner of the county is occupied by a section of the Black Prairie known as the White Rock Prairie. This is underlain by the Austin chalk, which is superimposed on the Eagle Ford clays. The Austin chalk has weathered to shallow soils, mostly dark in color and classed with the Houston series. On steep slopes the chalk is exposed at the surface, is hard, and forms stony soils. The dark-colored soils of the prairies are mostly very calcareous, usually effervescing freely with hydrochloric acid. Locally the material gives very little or no effervescence (Wilson soils). The dark soil of the western or Grand Prairie resembles the dark soil of the Black Prairie, but in the former it is underlain at shallow depths by indurated rocks, though these often alternate with beds of marly material. The dark soils of the Grand Prairie seem slightly less productive than those of the Black Prairie and in many places appear to hold less water in periods of drought.

The alluvial soils of the county occur in strips along streams and are derived from sediments washed from areas of the calcareous soils of the Black and Grand Prairies and from the sedimentary soils of the Woodbine formation or related formations. They range from highly calcareous to a condition of apparently low lime content, in color from brown to black, and in texture from fine sandy loam and fine sand to loam, silty clay loam, and clay. Most of the alluvial soils are of recent formation and continue to receive fresh sediments from time to time. Some small discontinuous bands of high old stream terraces occur along the larger stream valleys. These are usually underlain by rounded limestone gravel at depths of several feet, and this gravel is frequently cemented into a conglomerate or "concrete."

There is very little nonagricultural land in Denton County, probably not more than 5 per cent. In the Grand Prairie belt small areas are so stony as to render cultivation difficult or impossible, and these are utilized for pasture. In the East Cross Timbers probably less than 10 per cent of the land remains in the original timber growth, while in the creek bottoms probably more than 75 per cent of the land is cleared of timber and cultivated. Practically all of the Black Prairie land is cultivated.

The soils are grouped into series on the basis of origin and characteristics of color, topography, structure, and lime content. The series are further divided into soil types on the basis of texture.

The soils of Denton County derived entirely or to a large extent from consolidated sedimentary rocks are correlated in the San Saba, Brackett, Crawford, and Denton series; those derived entirely or

largely from unconsolidated calcareous sedimentary strata, in the Houston, Wilson, Sumter, Crockett, and Ellis series; and those from the unconsolidated noncalcareous marine sediments, in the Kirvin, Tabor, Durant, and Norfolk series. The alluvial soils along the streams are correlated with the Frio, Trinity, Ochlockonee, and Catalpa series, and the older alluvial or terrace soils above overflow are included in the Simmons, Lewisville, Cahaba, Leaf and Bell series.

The surface soils of the San Saba series are black in color, the subsoils ranging from black through brown to yellow. Strata of limestone and marl lie near the surface, often less than 3 feet below. The San Saba soils average shallower to underlying rock and the material is derived much more largely from hard limestone than the similar black lands (Houston soils) of the black waxy belt which lies east of the region of occurrence of the San Saba soils. Two types, the San Saba clay and San Saba silty clay loam, were mapped in this area. In those areas where chalky clay and limestone lie near the surface or outcrop the soil is light colored to whitish and has been included in the Brackett series. This series in some respects resembles the Houston chalk and may be looked upon as the semiarid relative of the latter, just as the San Saba series can be looked upon as the semiarid representative of the darker colored Houston soils.

The soils of the Denton series, which are closely associated with the San Saba soils, are brown in the subsoil. The material is residual from the underlying limestone which is frequently associated with soft or chalky calcareous beds. The topography is gently sloping to quite rolling, and the drainage is good. These soils occur in the drier prairie region west of the black waxy belt. In this region the rocks are predominantly hard, much harder than in the black waxy belt. The soils characteristically do not have the ashy cast when dry that the Houston soils have, and the subsoils as a rule are not so yellow or greenish as those of the Houston series. The series represents the brown correlative of the San Saba. The interbedded limestone and marl are found frequently at less than 3 feet beneath the surface of the Denton soils. Two types are mapped, the Denton clay and Denton stony clay.

The Crawford series is composed of red to reddish-brown surface soils with red subsoils. Limestone is often found at depths of less than 3 feet. One type is mapped, the Crawford clay.

The soils of the Houston series are black to brown in the surface, brown to yellow or greenish yellow in the subsoil, and have a substratum of calcareous clay. Two types were mapped, the Houston black clay, and the Houston clay with two phases—the Houston clay,

spotted phase, and Houston clay, shallow phase. The latter is underlain by a hard chalky formation at a depth of less than 3 feet.

The Sumter soils are formed by the weathering of exposed calcareous clays which underlie the Houston soils. They have yellowish-brown surface soils and yellow or greenish-yellow subsoils. One type, the Sumter clay, is mapped.

The Ellis series represents soils having brown or olive surface soils and a greenish-brown brittle clay subsoil. This series is derived from greenish, bluish, and brownish shaly clay. The Ellis soils are sometimes calcareous and frequently contain crystals of gypsum. One type, the Ellis clay, is mapped.

In the Crockett series the heavy types are brown in the surface and the sandy types light brown to grayish. The subsoil typically is mottled red and brownish or yellowish, the yellow becoming more conspicuous with increase in depth. In the substratum, and often in the lower part of the 3-foot section, greenish-yellow clay occurs, and this is either calcareous or contains whitish lime concretions. This soil resembles the Durant, but in the Durant the calcareous substratum is not common, at least not so near the surface. Spots of black soil (Wilson soil) are very common through the areas of brown soil, particularly in case of the heavy members. These are typical soils, the characteristic place of occurrence being along the edge of timbered soils, particularly the Tabor and Kirvin. Much of the series apparently represents a gradational zone between the timbered soils and the calcareous soils of the Black Lands or black waxy belt. It is covered with mesquite in some sections. In many places the surface is characterized by low hummocks and slight depressions. But one type is found in Denton County—the Crockett clay loam.

The Wilson soils are characteristically compact and black or very dark colored on the surface when dry and have tough, compact, dark subsoils. Frequently the immediate surface soil crumbles on drying, as does the Houston, but the crumbling does not extend as deep as with the Houston. In places the lower subsoil is somewhat calcareous, but the soil and upper subsoil usually do not effervesce with hydrochloric acid. Three types are mapped—the Wilson fine sandy loam, loam, and clay.

The Kirvin soils represent soil types having red to reddish-brown or brown surface soils and red plastic clay subsoils in places mottled slightly with yellow. Ferruginous sandstone and iron-ore fragments are characteristically present in the soil and subsoil, in places giving the subsoil a more crumbly nature than it otherwise would have. The series is timbered and formed from noncalcareous marine sedimentary deposits. The Kirvin soils are related to the Susque-

hanna series in about the same way as the Greenville soils of the Coastal Plain region are related to the Orangeburg soils. Two types and one phase are mapped in Denton County—the Kirvin fine sandy loam with a stony phase and the Kirvin clay.

The Durant soils are brown to dark brown, passing below into brown or yellowish clay or clay loam, which is usually faintly mottled with red or reddish brown. This grades into reddish clay mottled with yellow or brown or both, and this into yellowish-brown or yellow clay, with less and in many places no red mottling. The sandy types in many places are reddish brown at the surface. In the substratum of some areas greenish-yellow clay containing lime concretions is encountered, but this seldom lies within the 3-foot section. Fragments of ferruginous rock are of common occurrence, and in many places black and brown concretions are present in the soil and subsoil. Neither soil nor subsoil contains enough lime carbonate to effervesce with hydrochloric acid. Typically these are prairie soils. The type locality is the western Coastal Plain and the material is derived from Coastal Plain deposits. These soils in some respects appear to be the prairie equivalent of the Kirvin series, but are more brownish in the soil and less reddish. The Durant fine sandy loam, loam, and clay loam are mapped.

The Tabor soils are derived from marine sediments of the Woodbine formation. The surface soils are gray to brown and the subsoils are yellow, tough, heavy clays. The soils resemble those of the Norfolk series, but are not underlain by such friable subsoils. One type, the Tabor fine sandy loam, is mapped.

The Norfolk series is derived from noncalcareous marine sediments of sand and clay. The surface soils are gray, and the subsoils consist of friable, yellow sandy material. One inextensively developed type, the Norfolk fine sand, is mapped.

The Simmons soils are found on high old stream benches and represent alluvial material deposited before the present first-bottom soils were formed. The substratum consists of limestone gravel more or less cemented. These soils are black on the surface, and have black or brown subsoils. The soil material was probably washed from areas of calcareous soils, though much of the surface does not effervesce with hydrochloric acid. Only one type is mapped, the Simmons clay.

The Lewisville soils are found on the same or similar stream terraces as the Simmons soils. They are, however, brown in color in the surface, and yellow in the subsoil. They occupy more sloping areas, and have better drainage than the Simmons and are highly calcareous. The Lewisville clay is the only type mapped in the present survey.

The Cahaba series has brown to gray surface soils and light-red or yellow-red subsoils. This series occurs on stream terraces lying above

overflow and consists of old alluvium. The lime content is low, neither soil nor subsoil effervescing with hydrochloric acid. The soils are frequently underlain by beds of limestone gravel. The Cahaba fine sandy loam and the Cahaba clay loam, dark-colored phase, are the only representatives of the series in Denton County.

The Leaf soils are brown to gray on the surface and have stiff clay subsoils mottled with red, yellow, and gray. One type, the Leaf fine sandy loam, is mapped. The Leaf soils are found on old-stream terraces.

The Bell soils have dark-gray or dark-brown to black soils and yellow or brown clay subsoils. One phase is mapped, the Bell clay, high-terrace phase. This soil constitutes an extensive and important agricultural area in the eastern part of the county. It consists of old alluvium superimposed on the Eagle Ford formation. It seems probable that this alluvium was washed by small streams from the area of the Houston soils on the White Rock (Austin chalk) Prairie on the east.

The Frio soils are alluvial first-bottom soils occurring along the streams of the western prairie and having brownish surface soils and subsoils. They are calcareous throughout the 3-foot section. The material from which they are formed has been washed mainly from areas of calcareous soils. Probably in the lighter types, such as the Frio fine sandy loam, some of the coarser material has been brought from areas of noncalcareous soils. The Frio clay and silty clay loam are the other types mapped. These soils are closely related to the Catalpa soils and may be considered the semiarid equivalent of the Catalpa soils, which lie mainly in the humid belt.

The Trinity series includes black calcareous soils lying in the first bottoms of streams. The soil material has been washed from the dark calcareous soils of the Black and Grand Prairie regions. One type, the Trinity clay, is mapped.

The Ochlockonee series includes first-bottom alluvial soils that are brown in the surface soil and brown or yellowish brown in the subsoil which in places may be slightly mottled with yellow and gray. These soils have been formed from soil material washed from the sandy soils of the Woodbine formation. Only one inextensive type is mapped, the Ochlockonee fine sandy loam.

The Catalpa soils are brown calcareous soils found in the first bottoms of streams within the Black Prairie. The soil material has been washed from the adjacent calcareous prairie soils. The Catalpa clay is the only type mapped in Denton County.

Rough stony land represents areas of steep, rough land, with limestone outcrops and débris of large stony fragments.

In the following pages of this report the soils of Denton County are described in detail and their relation to the agriculture of the

county discussed. The accompanying map shows their location and distribution throughout the county. The following table gives the name and the actual and relative extent of each soil type mapped:

*Areas of different soils.*

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
San Saba clay .....	112,256	18.6	Kirvin clay.....	9,280	1.5
Denton clay .....	79,296	13.2	Ochlockonee fine sandy loam..	7,552	1.2
Kirvin fine sandy loam.....	52,288	10.5	Ellis clay.....	7,296	1.2
Stony phase .....	10,816		Denton stony clay.....	6,528	1.1
Bell clay, high-terrace phase...	36,224	6.0	Crockett clay loam.....	6,144	1.0
Frio clay.....	32,512	5.4	San Saba silty clay loam.....	5,760	1.0
Houston clay.....	15,744	5.0	Houston black clay.....	5,312	.9
Spotted phase .....	10,816		Wilson loam.....	4,800	.8
Shallow phase .....	3,520		Sumter clay .....	3,776	.6
Trinity clay .....	27,136	4.5	Durant clay loam.....	3,328	.6
Tabor fine sandy loam.....	24,128	4.0	Norfolk fine sand.....	2,752	.5
Durant fine sandy loam.....	16,448	2.7	Frio silty clay loam.....	2,368	.4
Brackett stony clay.....	16,192	2.7	Cahaba clay loam, dark-colored	2,240	.4
Lewisville clay .....	15,936	2.6	phase.....		
Wilson fine sandy loam.....	15,872	2.6	Frio fine sandy loam.....	1,600	.3
Catalpa clay .....	15,232	2.5	Leaf fine sandy loam.....	1,280	.2
Wilson clay.....	13,376	2.2	Crawford clay .....	1,216	.2
Durant loam.....	11,840	2.0	Rough stony land.....	576	.1
Simmons clay .....	11,456	1.9	Total.....	602,240	.....
Cahaba fine sandy loam.....	9,344	1.6			

SAN SABA SILTY CLAY LOAM.

The typical San Saba silty clay loam is a very dark brown to black silty clay loam underlain at 4 to 8 inches by black or nearly black clay which either extends to a depth of 3 feet without much change, or includes in the lower subsoil a zone of bluish-gray to yellowish-brown color. In some places the soil is more brownish and the subsoil is a brown tough clay, becoming yellowish brown in the lower part. These brownish spots associated with the typical black soil give freshly plowed fields a spotted appearance. Small iron concretions are found throughout soil and subsoil in many places. In places the surface soil does not effervesce with hydrochloric acid, but the lower subsoil in some areas does. The more brownish colored soil normally contains more lime carbonate. In many places there are small alkali spots in this soil. These are nearly circular and usually are from 50 to 100 feet in diameter. They show distinctly in fields, as the surface is nearly bare of vegetation or the vegetation present is stunted.

This type is not extensively developed in Denton County. It is found in a number of small areas in the west-central part of the county, the largest of these occurring in the vicinity of Krum. The

topography is nearly level to gently undulating. Surface drainage is fairly good, but many small areas occupy covelike depressions reaching into areas of slightly higher soils and receive seepage from these higher areas.

This is a prairie soil occurring in close association with the San Saba clay. Practically all of it is cultivated. The same crops are grown, and the land is farmed in the same way as the San Saba clay. Crop yields are approximately the same as on that type, but are lower in fields where alkali spots are present. The soil is best suited to the production of cotton, wheat, and oats. The same methods of soil improvement apply to this type as are advocated for the San Saba clay. The alkali spots could probably be reclaimed by underdrainage. The soil in these spots would be greatly improved by plowing under straw, stable manure, or organic matter of any kind. To be effective the applications should be large.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the San Saba silty clay loam:

*Mechanical analyses of San Saba silty clay loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
444909.....	Soil.....	0.0	0.4	0.5	4.7	21.0	50.3	23.1
444910.....	Subsoil.....	.3	.6	.4	3.1	15.1	45.0	35.6

SAN SABA CLAY.

The surface soil of the San Saba clay is a black or very dark brown clay, ranging in depth from 10 to 18 inches. The subsoil to a depth of 36 inches is a dark-brown to yellowish-brown, rather tough clay, the yellow color increasing with depth. In some low swales the soil is a black to dark bluish gray clay throughout the 3-foot section. At depths of 4 to 6 feet this soil in many places is underlain by hard limestone interbedded with chalky calcareous material, but on many of the gentle ridges or swells in the prairie the limestone lies at depths less than 3 feet. As a rule, where the rock comes to within 3 feet of the surface the soil is brown in color and is mapped as the Denton clay. In places there are a few limestone fragments on the surface. In some places the slopes are marked in freshly plowed fields by small brown and yellow spots a few feet across. These are developed where the yellow stratum of the subsoil lies at shallow depth. Soil and subsoil are normally calcareous, effervescing freely with hydrochloric acid except in depressions where the black soil is deep. Frequently the subsoil contains considerable chalky cal-

careous material, and where this is present it increases in amount with depth. A few small bare alkali spots are found in this soil.

The San Saba clay is a very extensive type, occupying the greater part of the western third of the county.

The topography is for the most part rolling to gently rolling, but there are some nearly level areas. The type usually occupies the lower areas in gently rolling to rolling prairies. Where uncultivated the surface has the regular slight depressions and hummocks that characterize land termed hog-wallow land.

Drainage is very good throughout the type. Owing to the fact that hard rock lies within a few feet of the surface, this soil seems to dry out somewhat more rapidly than the Houston black clay, which it resembles. The deep clay substratum of the Houston black clay appears to act as a better reservoir for moisture, so that crops may be expected to withstand the effects of drought better than on the San Saba clay with its hard limestone substratum.

Probably more than 95 per cent of the type is in cultivation. That not in cultivation supports a growth of prairie grasses. Originally sedge grass predominated, but in late years much mesquite grass has come in and the sedge grass has largely disappeared.

The principal crops grown are cotton, wheat, oats, corn, and sorghum. Small quantities of barley also are produced, and various forage and feed crops in a small way. Some farmers feed small herds of beef cattle on the farms on this type, but this is usually done where they also have pasture land on adjacent soils. Hogs and poultry are raised on every farm, and on many there are small flocks of sheep.

Owing to dry weather in the spring the corn crop is often a failure, but with good seasonal conditions corn yields from 30 to 50 bushels per acre. Wheat yields from 15 to 30 bushels, oats 30 to 75 bushels, and barley 20 to 40 bushels per acre. Cotton yields from one-half to three-fourths bale per acre in ordinary seasons, the average being probably not more than one-half bale. Sorghum gives heavy yields of forage and is used to a considerable extent for feeding beef cattle. Some is used for ensilage. During the last few years many farmers have been growing barley instead of corn, and the acreage in barley seems to be increasing gradually. Small quantities of kafir and milo are grown, though some farmers state these grains have not been very successful, as seed does not form, probably owing to injury by the midge. Small acreages of feterita and Sudan grass are grown, making good yields, and some millet is grown for hay. The type produces excellent muskmelons.

The San Saba clay is a rather heavy, sticky soil, but if plowed when moisture conditions are favorable the land is worked into a

friable, mellow seed bed. In very dry seasons the surface cracks, even in cultivated fields. No systematic crop rotations are practiced, though the land is frequently changed to different crops, most of the farmers growing cotton, corn, oats, wheat, and sorghum at different times on the same land.

No commercial fertilizers are used, and no special methods are employed to maintain soil fertility. The San Saba clay is naturally a productive soil, and much of it has been in cultivation many years without greatly decreased yields. The farms are well kept, the buildings and improvements are good, and the country occupied mainly by this soil has generally a prosperous appearance, but farmers state that crop yields in some places are not so good as formerly.

Farms on this type sell ordinarily for \$75 to \$100 an acre and near the larger towns for \$125 or more.

For the improvement of this soil organic matter should be plowed under and leguminous crops grown to store nitrogen in the soil. Possibly a large humus content in the soil might tend to counteract the effect of long periods of dry weather. Feed crops such as kafir, milo, feterita, and Sudan grass could be grown more extensively and with a greater certainty of success than corn.

Although the soil is not especially suited to fruit and vegetables, many small gardens and orchards produce an ample supply of these products for home use. Fair yields of peaches, pears, and small fruits are obtained.

#### BRACKETT STONY CLAY.

The Brackett stony clay consists of grayish to white or, in places, brownish soil, overlying at a depth of a few inches either limestone rock or a mass of limestone fragments and chalky material. The surface is thickly strewn with fragments of limestone, and outcrops of the bedrock occur on the steeper slopes. Some small areas of Denton stony clay not sufficiently large to map separately are included with this type.

Comparatively little of the Brackett stony clay is developed in Denton County. It is mapped in a number of small areas in the western part of the county along the steeper slopes of Denton and Clear Creek Valleys and some of their tributaries. It occupies what are known as the "breaks" along the valleys. The largest areas lie northwest of Bolivar.

The surface of the type is gently rolling to steeply sloping and rough. Drainage is excessive, and much of the surface is cut into small ravines and gullies.

This is a prairie type, though a few post oak trees grow in places. There is a fairly good stand of prairie grasses on the soil, and the land is practically all used for pasture. Where cattle are grazed on this

type, they are usually fed crops grown on adjacent soils, chiefly the San Saba clay, Denton clay, or some of the Frio soils occupying the stream bottoms.

Land of the Brackett stony clay type has a selling price of \$40 to \$50 an acre, though farms containing a larger proportion of cultivable soils than of the Brackett soil bring a higher figure.

#### CRAWFORD CLAY.

The Crawford clay is a chocolate-brown or reddish-brown friable clay, 6 to 10 inches deep, underlain by dull-red clay. The surface soil contains some small iron sandstone fragments, and limestone lies at 2 to 4 feet below the surface. The material is calcareous.

There are only a few very small areas of this type, these being located in the western part of the county and closely associated with the Denton clay. Some small areas could not be shown on a map of the scale used and were included with the Denton clay. The type occupies gentle ridges or slopes and is well drained and productive. The same crops are grown and approximately the same yields obtained as on the Denton clay.

There are several small included areas of Crawford clay loam in the western prairie section of the county. It is usually associated with the Denton clay, and in the surface resembles the Durant clay loam.

#### DENTON STONY CLAY.

The Denton stony clay is a rather variable soil, owing to the fact that erosion has greatly altered the character of the surface material. The surface soil varies from brown to yellowish brown, and in places to black or nearly black, and ranges in depth from 2 to 8 inches, varying according to the degree of erosion. The subsoil is brown in the upper part and yellowish below. The yellow subsoil is exposed in places, but typically the surface is brown. Limestone fragments are numerous and in places some ferruginous sandstone fragments are present. Bedrock (limestone) lies near the surface and outcrops in places. This is not an extensive type. It occurs in a number of small spots on the prairie in the western part of the county. Small areas of Brackett stony clay are included with the type as mapped.

The Denton stony clay occupies the steep slopes and in some cases crests of ridges. It has good to excessive surface drainage, and some of the slopes are eroded and gullied.

This is a prairie type. It is normally too stony for farming, and practically none of it is cultivated except a few very small patches included in fields of better soil. It supports a good growth of prairie grasses and is valued chiefly as pasture land.

## DENTON CLAY.

Typically the Denton clay consists of about 10 or 12 inches of a brown friable calcareous clay, underlain by a subsoil of brown, chocolate-brown, or yellowish-brown calcareous clay, usually becoming more yellowish in the lower subsoil and containing fine limestone fragments. In some areas, and particularly on slopes, the limestone rock lies within 12 to 15 inches of the surface, with occasional outcrops. In some places the soil and subsoil are brown and contain small ferruginous sandstone fragments. In these areas the soil and subsoil are not calcareous, even though in places resting at less than 36 inches on limestone rock. A characteristic difference from the Houston clay is the brown or rather ashy brown color of the soil. Some areas mapped as Denton clay include small bodies of Denton stony clay and San Saba clay, too small to show separately. The limestone lies within less than 3 feet of the surface under most of the type and is usually interstratified with yellow chalky clay. In the extreme western part of the county areas with a shallow surface soil of grayish color would have been mapped as the Brackett clay if they had occurred in bodies of sufficient size.

The Denton clay is found in a number of small areas throughout the western part of the county, where it is associated with the San Saba clay. It occupies the slight swells and gently sloping ridges of the prairie and the lower adjoining land is composed of the San Saba clay. Some of the largest areas of the type lie around Justin in the extreme southwestern part of the county.

The Denton clay is gently rolling to rolling in topography and has good drainage throughout. Probably more than 80 per cent of this prairie type is in cultivation, the rest being used for pasture. The leading crops are cotton, wheat, oats, corn, and sorghum. Sorghum and small quantities of other forage crops such as kafir, milo, feterita, and Sudan grass also are produced. Owing to the shallow depth of soil and subsoil, crops suffer sooner from drought than on the San Saba clay, but with normal rainfall fair yields are obtained. It is said that cotton and small grains do better than corn on this soil.

In ordinary seasons cotton yields one-fourth to one-half bale or more, wheat 10 to 25 bushels, oats 20 to 50 or 60 bushels, and corn, in good seasons, from 15 to 30 bushels per acre. Crop production is proportional to the rainfall and to the depth of the fine earth material over the rock. The soil of the Denton clay works into a friable loamy condition. The methods of improvement advocated for the San Saba clay apply to this soil. Farms composed of this type, or in part of this and other prairie soils, sell for \$75 to \$100 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Denton clay:

*Mechanical analyses of Denton clay.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
444979.....	Soil.....	1.2	2.0	1.1	3.5	9.0	47.3	36.0
444980.....	Subsoil.....	3.7	3.7	1.1	3.1	9.6	41.6	37.2

HOUSTON BLACK CLAY.

The surface of the Houston black clay is a black or very dark brown clay, 10 or 15 inches deep. The subsoil may be like the surface soil to a depth of 3 feet, but usually it is a brown or yellowish-brown clay. Both soil and subsoil are highly calcareous. Small thin fragments of limestone occur here and there in the subsoil, and in many places lime concretions are present.

The Houston black clay is not a very extensive soil type in Denton County. It occurs in several small areas in the eastern part of the county, the largest of these lying 3 miles east of Pilot Point. The surface is gently rolling and the drainage good. This type is closely associated with the Bell clay, high-terrace phase, from which it is distinguished with difficulty. The Houston black clay is slightly more rolling in topography, but the texture and color of the soils and subsoils of the two types are very much the same.

Practically all of the type is in cultivation. The same crops are grown as on the Bell clay, high-terrace phase, and the land is handled in the same way in farming operations. Practically the same yields are obtained, and the crop adaptation is almost identical.

HOUSTON CLAY.

The surface soil of the typical Houston clay consists of an ashy-brown clay from 6 to 12 inches deep. The subsoil is a yellow or yellowish-brown clay, passing below into greenish-yellow clay, commonly containing some chalky lime material. Both soil and subsoil are calcareous, effervescing freely with hydrochloric acid. In places the subsoil contains small quantities of rounded limestone gravel. Spots of Sumter clay and of Ellis clay are included in the areas as mapped.

This type occurs in a number of small areas in the eastern part of the county, in close association with the Houston black clay, Bell clay, high-terrace phase, and the Wilson clay. The areas have a gently rolling to steeply sloping surface and are well drained.

Some of the steeper slopes are subject to erosion. The type occupies positions on the slopes leading down from the nearly level areas of Bell clay, high-terrace phase, and Wilson clay. The soil crumbles to a highly desirable condition on drying, making cultivation easy.

Probably more than 75 per cent of this soil is cultivated. Some of the steeper areas on farms composed principally of the Houston black clay are utilized for pasture. The principal crops grown are cotton, wheat, oats, and sorghum. The soil is better suited to small grains, especially oats, and to cotton than to corn. Wheat yields 12 to 25 bushels per acre, oats 25 to 50 bushels, corn, in good seasons, 20 to 40 bushels, and cotton about one-half bale per acre.

The Houston clay, although a rather heavy soil, is comparatively easy to cultivate when moisture conditions are favorable. It contains considerable lime, and when stirred is very loamy and friable. The same crops are grown and practically the same methods employed as on the Bell clay, high-terrace phase. For the most part this Houston type occurs in long, narrow strips on the slopes of narrow stream valleys extending through the Houston black clay. The price of farm land of this type is about the same as or a little less than that of the Houston black clay.

This soil is especially in need of organic matter, and can be improved by growing and plowing under leguminous crops, such as cowpeas. Owing to the steepness of the slopes and the consequent washing, the productiveness of this soil decreases more rapidly than that of the Bell clay, high-terrace phase. Cultivated fields would be greatly improved by terracing and contour plowing to prevent surface washing.

*Houston clay, spotted phase.*—The name Houston clay, spotted phase, is used in mapping certain areas closely associated with the Bell clay, high-terrace phase, and Houston clay. This soil consists of small alternate spots, 20 to 50 feet across, of the brownish Houston clay and Houston black clay, with also some small spots of Sumter clay. Freshly plowed fields of this land have a peculiar spotted black, brown, and yellow appearance.

This phase occurs in narrow strips, mainly in the central-eastern part of the county and within a few miles of and around the village of Little Elm. It occupies gentle to somewhat steep slopes and some gently rolling areas, and is a result, probably, of the gentle erosion of the Houston black clay with the consequent partial exposure of the subsoil. Drainage is good, and in some places the slopes where unprotected show some erosion.

Practically all the spotted phase is cultivated, the same crops being grown as on the Houston clay and Houston black clay. Crop yields are about the same or a little less than on the Bell clay, high-

terrace phase, but possibly a little better than on the Houston clay. The same methods of improvement should be used as advocated for the Houston clay.

*Houston clay, shallow phase.*—The Houston clay, shallow phase, consists of brown or black heavy clay about 5 to 20 inches deep, underlain by white, chalky material. The deeper soil is black in color; the shallow soil is brown, or in some small spots gray, as the result of the admixture of material from the underlying chalky stratum. In a few places there are spots on the steeper slopes where the chalk outcrops, but these are too small to map separately. In many cultivated fields fragments of the hardened chalk have been brought to the surface by the plow.

This phase is of small extent. It is developed in the extreme southeastern part of the county as a narrow continuous belt along the southern part of the Denton-Collin County line. It occurs in the formation known as the White Rock Prairie escarpment, which extends for many miles from the Red River southward through a number of counties.

This phase occurs in a ridgelike formation, or steep to gently sloping escarpment, facing westward. It occupies a considerably higher position than the Bell clay, high-terrace phase, which it joins abruptly on the west, but has a very slight, gentle slope as it merges into the Houston black clay in Collin County on the east. The drainage is good. A large number of intermittent, westward-flowing streams have their origin in this phase, and these have carved deep, short valleys with steep slopes and have given a rather rough topography in places. Probably 75 per cent or more of the soil is in cultivation, the rest being utilized as pasture land. This is a prairie soil, but there are a few post oak and elm trees on it in places.

The crops grown on this land are the same as on the Houston black clay, namely, cotton, wheat, oats, corn, and sorghum. The soil is said to be a fairly good soil for small grains, such as wheat and oats. Wheat produces 12 to 20 bushels per acre and oats 30 to 60 bushels. In good seasons corn yields 15 to 25 bushels per acre. Cotton produces from one-fourth to one-half bale per acre on the areas of deeper soil. The productiveness of this type is proportional to the depth of the fine-earth material over the chalk, the deeper soil producing the better.

#### WILSON FINE SANDY LOAM.

The surface soil of the Wilson fine sandy loam consists of a very dark gray fine sandy loam or loamy fine sand with an average depth of 10 inches. The subsoil to 36 inches is typically a dark bluish gray heavy, tough clay, slightly mottled with brown or yellow, the

latter colors increasing with depth in many places. On drying, both surface soil and subsoil are extremely compact, the surface soil in many places containing a sufficient amount of silt and clay to give the apparent texture of a loam. A variation of this type is found in many places where the typical soil merges into the other sandy soils or in places near small drainage ways. It has the typical surface soil, but a tough, heavy, brown clay subsoil. This development was of insufficient importance to separate on the map.

In the northeastern part of the county some included areas have a lighter colored soil and in places a calcareous lower subsoil. They consist of gray to brownish-gray fine sandy loam, underlain at 8 to 12 inches by gray to bluish-gray stiff plastic clay, in places mottled with rusty brown. The lower subsoil to 36 inches or more is a yellowish-green calcareous clay. When dry, the surface soil as a rule has an ashy-gray color. In a few local areas, especially immediately east of Pilot Point, there are numerous small circular mounds 1 to 2 feet high and 50 to 100 feet across. The material described occupies the flat areas between the mounds, while the soil on the mounds consists of 10 to 12 inches of a grayish-brown fine sandy loam, underlain to a depth of 36 inches by a yellowish-brown sandy clay. No large areas of the Wilson fine sandy loam occur, but there are a large number of small areas scattered through the Cross Timbers belt. Areas lie a few miles southwest of Pilot Point, east and southeast of Denton, and in many other parts of the belt.

The type, with the Kirvin and Tabor soils, forms low flats surrounded by higher land. It commonly occurs in covelike situations in which small streams head. While drainage is not naturally good, it is sufficient to allow successful cultivation. In some places drainage conditions have been improved by ditching.

Probably 95 per cent of this type is in cultivation. Apparently most of these areas originally were occupied by more or less open forest, being locally known as "glades." The present timber growth consists of a few post oak and mesquite trees. Some of the areas were natural prairies.

The main crops grown on the Wilson fine sandy loam are about the same as those grown on the Tabor and the Kirvin fine sandy loams and consist of cotton, corn, peanuts, sorghum, small quantities of wheat and oats, and some vegetables. In good seasons cotton yields about one-half bale per acre, corn 15 to 25 bushels, peanuts 20 to 40 bushels, oats 20 to 50 bushels, and wheat 12 to 20 bushels. When moist, the soil works up into a friable seed bed, but has a tendency to pack, even when cultivated, during a long dry season. It is usually farmed in about the same manner as the surrounding sandy soils and, not being of great extent, is often found as part of a field composed principally of the other sandy soils. It seems best adapted to small

grains such as oats and wheat, and to cotton rather than to corn. It is held at about the same price as the surrounding sandy soils, that is, from \$40 to \$70 an acre. The soil can be improved by the application of barnyard manure and the plowing under of green-manure crops. In places ditching or underdrainage would probably be beneficial.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Wilson fine sandy loam :

*Mechanical analyses of Wilson fine sandy loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
444965.....	Soil.....	0.2	0.3	1.5	48.2	24.4	19.8	4.9
444966.....	Subsoil.....	.2	.2	1.0	26.5	16.1	23.8	32.0

WILSON LOAM.

The surface soil of the Wilson loam consists of 10 or 12 inches of a very dark gray or dark-brown to nearly black loam, somewhat silty in places and sandy in others, and very compact when dry. The subsoil to 36 inches is a tough, heavy, compact clay, bluish gray in basic color, but modified by rusty-brown, yellow, or yellowish-brown mottlings, especially in the lower subsoil.

This type occurs in a number of small areas scattered throughout the Cross Timbers belt and closely associated with the fine sandy loam of the series. Some of the larger and more typical areas lie about 3 miles southeast of Sanger and along the road between Denton and Mingo.

Like the fine sandy loam, the loam is developed in flats or coves throughout the rolling sandy country composed mainly of the soils of the Kirvin and Tabor series. Sometimes it occupies all of these small areas, while in other places it occupies only the interior of these coves, the margins being composed of the fine sandy loam type. Small areas of the other Wilson types are included.

The surface is nearly flat or slightly basinlike, but as small streams or gullies commonly head in these areas, the run-off is fairly good. Owing to the compact nature of the subsoil, the downward passage of water is less satisfactory. The type has sufficient drainage, however, to allow cultivation. In some places the conditions have been improved by ditching.

Practically all the type is under cultivation. Originally the areas were glades, supporting a few scattered post oak and mesquite trees. The crops include cotton, corn, oats, a small acreage of wheat, peanuts, and sorghum. Cotton does fairly well in seasons of ample rainfall, but corn is less satisfactory. The soil is well adapted

to oats and other small grains, but it is not so well suited to peanuts as the lighter sandy types. In good seasons corn yields 15 to 30 bushels, cotton about one-half bale, oats 25 to 50 bushels, and wheat 12 to 20 bushels per acre.

When it contains the proper amount of moisture, the Wilson loam is easy to cultivate, but when dry it bakes into a very hard and compact condition, even when cultivated. The physical condition can be greatly improved by the addition of organic matter. Applying barnyard manure and growing such leguminous crops as cowpeas and peanuts and turning under the stubble would also tend to increase yields. However, the soil is fairly productive, and with sufficient rainfall profitable yields are obtained under existing conditions.

Owing to its small extent, this type generally forms only a part of farms, and it sells for about the same prices as the surrounding sandy types—\$40 to \$60 per acre. Nevertheless, it is considered a more valuable soil than the sandy types.

#### WILSON CLAY.

The Wilson clay is a nearly black to black clay which quickly passes into black or dark bluish gray heavy clay, commonly slightly mottled with brown or yellow in the lower subsoil. Slight reddish mottlings may be present. In places, as the area 1 mile north of Lewisville, the surface consists of clay loam or silty clay loam. When wet, the surface soil being nearly black, the type resembles the Houston black clay, but it is not calcareous, and on drying has a peculiar dull, dead, ashy-gray color. Neither soil nor subsoil effervesces with hydrochloric acid. The surface compacts on drying or crumbles to a shallower depth than either the San Saba or Houston black clays.

The Wilson clay, while not an extensive type, is found in some fairly large areas, and there are also small areas throughout the eastern part of the county. The largest bodies are those a few miles southeast of Pilot Point, around Mustang, and just west of Salt Branch School. There are several areas in the southeastern part of the county around Lewisville.

The topography of the Wilson clay is nearly level to very gently undulating. It occurs as a prairie type in the eastern part of the county in the region of the Houston soils, but is also developed in gladelike areas in a few places in the East Cross Timbers. The type has fairly good surface drainage, but the internal movement of moisture is slow, owing to the very compact subsoil.

About 95 per cent of the type is in cultivation. The chief crops are cotton, corn, wheat, oats, and sorghum. Crop yields vary widely with seasonal conditions. In good seasons cotton averages one-half

bale or more, corn 20 to 40 bushels, oats 30 to 60 bushels, and wheat 12 to 25 bushels per acre. Sorghum gives good yields of forage.

Land of the Wilson clay works up into a fairly good tilth when the moisture conditions are favorable, but when dry it is compact and difficult to till. The soil is better adapted to the production of cotton and the small grains than to corn or vegetables. Corn yields in particular are often lowered by dry weather. In the northeastern part of the county, where there are large farms of this type, the soil is well esteemed, especially for cotton and small grains. It is fairly productive under favorable climatic conditions; that is, when the rainfall is ample. Land of this type sells for \$100 or more an acre.

The compact condition of the soil can be modified by plowing under straw or other vegetation. It is probable, if the soil is kept in a good mechanical condition and nitrogen added by growing leguminous crops, that the use of phosphoric acid fertilizer would be beneficial. The land is farmed and handled practically the same as the Houston black clay. The growing of Sudan grass, feterita, milo, and kafir as feed crops would prove especially profitable.

#### SUMTER CLAY.

The surface soil of the Sumter clay is a brown or yellowish-brown, friable calcareous clay, with a depth of 4 to 8 inches. The subsoil to 36 inches is a yellow to greenish-yellow friable clay containing white lime nodules. In places the surface has a spotted brown and yellow appearance, owing to the occurrence of eroded areas in which the subsoil material appears at the surface.

This is a type of very slight extent occupying a number of long narrow strips in the central-eastern part of the county. The most prominent areas occur within a few miles of the village of Little Elm. The type occupies rather steep slopes along the valley of Little Elm Creek and some of its tributaries. This soil has probably been formed by the erosion of Houston black clay, with which it merges on the upper slopes, and the exposure of the underlying soil material.

Probably 80 per cent of this prairie soil is in cultivation and the steeper sloping portions are utilized for pasture. The same crops are grown and about the same yields obtained as on the Houston clay. It is better suited to small grains than to either cotton or corn. On the steeper slopes the productiveness has been greatly decreased by erosion. The soil can be improved by the addition of organic matter. Surface wash can be controlled to a considerable extent by contour plowing and by terracing.

## CROCKETT CLAY LOAM.

The Crockett clay loam is a spotted soil in its typical development, consisting of brown clay loam 6 to 10 inches deep, over brown clay, which passes below into mottled reddish and yellowish plastic clay, and this into yellow plastic clay or greenish-yellow sticky clay. The reddish and yellowish clay does not effervesce with hydrochloric acid, but the greenish-yellow clay, which is encountered in the lower subsoil or substratum (the material below 3 feet), does react to acids. In places the greenish-yellow calcareous clay comes near the surface. This soil resembles the Durant, except that the calcareous layer lies deeper in the latter. There are spots of black clay or clay loam (Wilson clay or clay loam) through the areas of the brown soil, and as a result freshly plowed fields have a spotted brown and black appearance.

Soil of this type occupies a number of small areas in the eastern and southeastern parts of the county. It occurs on prairies or at the margins of prairies adjacent to the sandy timbered soils. The largest areas of the type lie just east of Floyd Chapel and near Lewisville. The surface is gently rolling and the drainage good. Although a prairie type, some areas, known as glades, have a scattering of post oak trees in places.

Over 90 per cent of the Crockett clay loam is in cultivation. The main crops are cotton, corn, wheat, oats, and sorghum. In good seasons corn yields 20 to 40 bushels per acre, cotton one-fourth to one-half bale or more, wheat 15 to 25 bushels, and oats 30 to 50 bushels.

The soil is fairly friable and forms a loamy seed bed if properly handled. It is farmed in much the same way as the adjoining prairie types of the Wilson and Houston series. With sufficient rainfall this soil is productive, and this productiveness can be maintained or increased by systematic rotation of crops, including cow-peas or other leguminous crops, and by increasing the supply of organic matter.

## ELLIS CLAY.

The Ellis clay consists of about 10 inches of brown or olive-brown heavy clay, underlain by an olive-colored or greenish-brown, stiff, brittle clay, which in places is mottled at depths of 30 to 36 inches with bluish gray. Here and there small crystals of gypsum are present in the subsoil, and in places the soil and subsoil are calcareous, though ordinarily they do not effervesce with hydrochloric acid.

There are only a few areas of this type in the county. These lie in the eastern and southeastern parts, the largest about 3 miles east

of Lewisville and another of some importance about 3 miles south-east of Little Elm. This soil has a rolling to rather hilly surface and is well drained. In some spots the soil has been removed by erosion, and the underlying green, blue, and yellow clay shales are exposed. This is a prairie type, though a few mesquite trees grow on the uncultivated areas.

Not more than 50 per cent of this type is cultivated, the rest being used as pasture land. The type is closely associated with soils of the Houston series and is farmed in about the same way as those types. It is fairly well suited to the production of small grains, wheat being reported as doing better than oats, but it is not so well suited to corn. Cotton does fairly well, yielding one-fourth to one-half bale per acre. Wheat yields 15 to 20 bushels per acre and oats 30 to 50 bushels. The soil is rather difficult to cultivate, but if worked when moisture conditions are favorable a fairly friable seed bed can be prepared.

This soil is deficient in organic matter and nitrogen. It could be improved by growing leguminous crops, such as cowpeas, and by plowing under pea vines and other vegetable matter. Barley and rye would probably do fairly well on this soil. The Ellis clay sells for somewhat less than the Houston types with which it is associated.

#### KIRVIN FINE SANDY LOAM.

The typical Kirvin fine sandy loam is a brown to reddish-brown or red fine sandy loam or loamy fine sand, passing at about 5 inches into reddish loamy fine sand or fine sandy loam, underlain at 8 to 14 inches by dull-red to reddish-yellow stiff clay, grading below into mottled reddish and yellowish clay. In places the subsoil is red and shows little or no change within the 3-foot section; again it shows more yellow or only yellow material in the lower subsoil. Some gray mottling may occur in this horizon. In places the color of the surface soil is grayer or lighter brown. Fragments of reddish and brownish ferruginous rock are present through the soil and subsoil. As a rule, where the soil is most red it contains a larger proportion of such fragments than where it is lighter, and occasionally, especially where the soil is quite red, there are many large stones. The surface soil is rather light and incoherent, although in most places it contains sufficient quantities of silt and clay to give a rather loamy texture.

The Kirvin fine sandy loam constitutes one of the important soils in the sandy timbered belt and occupies a number of small and some fairly large areas in this section. Several of these areas lie near Denton, Pilot Point, Argyle, and Lewisville. As a rule, the type occupies a somewhat higher position than the surrounding soils of other series. The topography is gently rolling to rolling, and drain-

age is good throughout all areas. The light surface soil absorbs water readily, and the heavy subsoil retains a considerable quantity of water, even through dry seasons. While erosion is not usually very active, some slopes are steep enough to wash during heavy rains, especially when the surface is not protected by vegetation.

This soil is easily cultivated, and probably 85 to 90 per cent of it is farmed. The rest is in forest, consisting principally of post oak, blackjack oak, and some hickory. Cotton, peanuts, some corn, and sorghum are the leading crops. Cotton is the important cash crop, though within the last few years an increasing acreage of peanuts has been planted. This crop has proved valuable, both in the sale of nuts, which are shipped out of the county, and as a source of hay. A few vegetables are grown for the market, but there has not been much development in truck farming or vegetable gardening. Some oats are also grown. Hogs and poultry are raised on practically every farm.

In favorable seasons corn yields from 20 to 30 bushels, cotton from one-fourth to one-half bale, and peanuts 25 to 60 bushels and about one ton of hay per acre. Some sorghum is grown for the manufacture of sirup and yields 60 to 100 gallons per acre.

No systematic crop rotation is practiced, and no commercial fertilizers are used, but it is well understood by the farmers that growing cowpeas and peanuts improves the soil. As a rule, this soil is deficient in organic matter and nitrogen. It can be greatly improved by plowing under barnyard manure, green-manure crops, and crop residues. Phosphatic fertilizers possibly could be used profitably.

The greater part of this type ranges in price from \$30 to \$60 an acre. It is especially adapted to the production of vegetables, peaches, grapes, plums, and berries.

*Kirvin fine sandy loam, stony phase.*—The Kirvin fine sandy loam, stony phase, consists of a reddish-brown to brown fine sandy loam or loamy fine sand, underlain at 8 to 14 inches by a dull-red stiff clay, which in a few places shows some mottlings of yellow in the lower subsoil. In places the surface soil is only 4 or 5 inches deep. Scattered over the surface and throughout the soil mass to a depth of several feet are many small and large fragments of red or brown ironstone or ferruginous sandstone. Some areas are very stony, representing a stony sandy loam, but as a rule, the important areas have less stone than a true stony sandy loam. The phase, as mapped, includes small spots of the typical Kirvin fine sandy loam and the Kirvin clay.

This phase occurs in a number of small scattered areas in the Cross Timbers belt. Relatively important areas lie a few miles southwest of Pilot Point, and southeast of Denton. The characteristic position is on the higher parts of the rolling to hilly sandy belt, the areas occupy-

ing slight ridges, ridge crests, and hilltops. Drainage is good, and in places excessive, as on the steeper slopes where erosion has been severe.

Comparatively little of this land is in cultivation, being avoided because of its stony nature which makes cultivation difficult. It is for the most part covered with a forest of blackjack oak, post oak, and hickory. The crops grown on the small area cleared of this growth are the same as on the typical soil. The yields are somewhat smaller. The soil may be improved in the same way as the Kirvin fine sandy loam.

#### KIRVIN CLAY.

The Kirvin clay consists of 1 to 4 or 5 inches of brown to red very fine sandy loam or loam, underlain by a subsoil of plastic clay, red in the upper part and mottled with yellow and here and there with gray in the lower part. Sections in some deep cuts show spots in which the subsoil is yellow or mottled gray and yellow and red. Scattered over the surface and throughout the soil and subsoil are large numbers of red, brown, or black ferruginous sandstone fragments. In some places these fragments are large, being several feet in diameter.

This type is not of great extent, but small areas of it occur throughout the central timber belt. The larger areas lie a few miles east, southeast, and south of Denton and southwest of Garza. The areas are developed in the rough belts adjacent to the larger stream bottoms. The surface is steeply sloping and is thoroughly dissected by gullies and small ravines. The rougher areas are found along the valley slopes of the Elm Fork of Trinity River, Hickory Creek, Denton Creek, and some of their tributaries. A number of small areas a few miles southeast of Denton form ridge crests and hilltops. Drainage is excessive and erosion very active. The type really represents the eroded and gullied subsoil of the sandy types of the Kirvin series. It approaches Rough stony land in character.

Practically all this type is covered with a forest of post oak and blackjack oak. The timber growth is rather thin and the trees small, but there is little grass, so that the type has a low pasturage value. Its best use is as woodland.

#### TABOR FINE SANDY LOAM.

The surface soil of the Tabor fine sandy loam consists of a gray to light-brown fine sand, passing at 3 to 6 inches into pale-yellow fine sand, which extends to a depth of 8 to 24 inches. The subsoil is a yellow sandy clay, passing below into a rather tough and less sandy yellow clay. In some places the lower subsoil shows faint gray and reddish spots. The surface soil of this type is loose and

porous, but the subsoil is sufficiently heavy to be retentive of moisture. When quite dry the surface drifts in extremely high winds. This type resembles in some ways the Norfolk fine sandy loam, but differs from it in having a heavier and less friable subsoil.

With this type are included a few very small areas consisting of 12 or 15 inches of brown loamy fine sand to fine sandy loam, underlain by a yellow to reddish heavy loam to clay, both soil and subsoil carrying considerable lime and small limestone fragments washed from higher areas. This variation occupies a few small areas in the extreme northwestern corner of the county, along the breaks of Clear Creek. It occupies narrow slopes reaching from limestone outcrops down to creek bottoms. It supports a growth of live oak.

The Tabor fine sandy loam is one of the more extensive soils of the East Cross Timbers belt, occurring in a number of large and small areas in close association with soils of the Kirvin series, particularly the Kirvin fine sandy loam. The largest areas lie just southeast of Aubrey, a few miles southeast of Denton, and south and southeast of Argyle.

The topography of the Tabor fine sandy loam is undulating to gently rolling. Areas lie on the lower slopes, which are long and gentle. Drainage is good throughout most of the type, though some areas could be improved by ditching or underdraining.

The original vegetation consisted of post oak, blackjack oak, and some other trees. At least 90 per cent of the type is in cultivation, the principal crops being cotton, peanuts, corn, and sorghum. Cotton is the important cash crop. Peanuts also are a cash crop of increasing importance. A relatively small acreage of corn is planted, but owing to unsatisfactory seasons during the last few years, the crop is being displaced by peanuts. Some vegetables are grown, mainly for home use. Sorghums are grown both as forage crops and for making syrup.

In good seasons corn yields 15 to 30 bushels, cotton one-fourth to one-half bale, and peanuts 20 to 50 bushels and about 1 ton of hay per acre. Small patches of oats are sometimes sown for winter and spring grazing. No systematic crop rotation is practiced, and no commercial fertilizers are used. This soil is well adapted to vegetables, especially for the early market. Peaches, pears, plums, grapes, and berries are grown for home use, but rarely for sale.

The selling price of this type ranges from \$30 to \$70 an acre. The type has about the same agricultural value and crop adaptation as the Kirvin fine sandy loam, but the crops are probably earlier on the latter type, owing to better drainage, which allows it to warm up earlier in the spring. The methods for improvement suggested for the Kirvin fine sandy loam apply equally well on the Tabor fine sandy loam.

## DURANT FINE SANDY LOAM.

The surface soil of the Durant fine sandy loam consists of 8 or 10 inches of a brown to reddish-brown loamy fine sand or fine sandy loam. The subsoil to 36 inches is a brownish-red or reddish-brown clay, very tough and compact when dry. In places the lower subsoil is yellowish, and faint gray mottlings are sometimes found in the lower red subsoil. Soil and subsoil both contain considerable quantities of small ferruginous sandstone fragments or fine concretionary iron rocks. In places the subsoil contains a large amount of this material. Occasionally greenish-yellow calcareous clay is encountered at about 30 inches. Much of the soil in the vicinity of Aubrey and Pilot Point has a grayish surface.

This soil occurs in a number of small bodies in the central part of the county, and in larger areas about 3 miles southeast of Sanger and near Aubrey and Pilot Point.

The surface of the type is gently rolling and the drainage is good. This is essentially a prairie soil, though a few post oak trees grow in places. Probably 90 per cent of the type is cultivated, the principal crops being cotton, corn, sorghum, and peanuts. In good seasons cotton yields one-half to three-fourths bale per acre, and corn 20 to 40 bushels.

The Durant fine sandy loam is somewhat like the Kirvin fine sandy loam in appearance, has about the same agricultural adaptation, and may be improved in the same way. Farms composed in part of this type sell for \$70 to \$100 an acre. The type is especially adapted to the production of vegetables, peanuts, peaches, pears, plums, grapes, and berries.

## DURANT LOAM.

The surface soil of the Durant loam is a brown to reddish-brown loam, 8 to 12 inches deep, containing a considerable quantity of small ferruginous sandstone fragments. In places the first inch or so of the surface carries a relatively large proportion of fine sand. The subsoil is typically a yellowish-brown or brown clay, but in some places is reddish brown and becomes yellow in the lower part. Much of the type is a brown to deep-brown loam, passing at 6 to 15 inches into brown or yellowish-brown clay faintly mottled with reddish brown, this passing abruptly into mottled reddish-brown and yellowish-brown stiff clay, the yellow increasing and the red decreasing with depth. In places greenish-yellow clay containing lime concretions is reached at about 30 inches. Frequently the subsoil is a red clay containing enough ferruginous rock fragments to give it a friable character. In some areas the subsoil has a bluish-gray mottling and small red spots. The subsoil is tough and heavy, and

like the soil, contains small ironstone fragments. When dry, both soil and subsoil are hard and compact. Residual limestone material lies but a few feet below the surface of this type.

The Durant loam is found in a number of areas, some small and some fairly large, throughout the central part of the county from north to south. The type usually occurs in parts of the prairie section lying adjacent to or near the Cross Timbers belt. The topography is rolling to gently undulating, the areas occupying the crests of smooth prairie ridges. It has good drainage throughout.

The type is used either for cultivated crops or as natural pasture. Practically all of it is under the plow. The main crops are cotton, corn, wheat, oats, and sorghum. Ordinarily cotton yields about one-third bale per acre, corn 20 to 25 bushels, wheat 15 to 25 bushels, and oats 30 to 50 bushels. All yields are considerably lower than these in very dry seasons and may be somewhat higher in exceptionally favorable seasons.

The Durant loam works into a very friable seed bed, but the uncultivated surface packs very hard. The soil is deficient in organic matter, and the supply of this constituent should be increased. The soil will return fair yields of peanuts and cowpeas, and the growing of these crops will result in decided improvement. The type is fairly well suited to the production of vegetables and small fruits. It is a very early soil, drying out quickly and warming up early in the spring. Farms composed of the Durant loam sell for \$60 to \$100 an acre.

#### DURANT CLAY LOAM.

The surface soil of the Durant clay loam is a brown or reddish-brown clay loam or silty clay loam, containing in most areas considerable quantities of small ironstone fragments. The subsoil is a dull-red, reddish-brown, or brown clay. The lower subsoil in places has a yellowish, mottled yellow and red, or yellowish-red color. Like the soil, the subsoil contains large quantities of small ferruginous sandstone fragments, and at 3 feet or a little deeper the residual limestone material which gives rise to the surrounding soils is found. On slopes the materials giving the Durant clay loam gradually become thinner with the descent, and the type gives way to the Denton clay.

The Durant clay loam is a prairie soil of small extent, normally occupying the crests of knolls and gentle ridges in the western part of the county. The surrounding lower lying soils are of the Denton and San Saba series. The topography of the type is rolling and the drainage good.

Practically all this soil is in cultivation. It ordinarily is included in farms made up in part of other soils. The leading crops are

cotton, corn, wheat, oats, and sorghum. The yields vary with the rainfall, but are about the same as on the Durant loam. The type seems best suited to cotton and small grains.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Durant clay loam:

*Mechanical analyses of Durant clay loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
444981.....	Soil.....	1.8	2.2	2.8	18.6	20.6	30.8	23.2
444982.....	Subsoil.....	2.7	2.2	1.3	8.8	19.3	24.9	40.3

NORFOLK FINE SAND.

The Norfolk fine sand is a gray fine sand, grading at about 4 to 10 inches into yellow fine sand, which extends to a depth of 3 feet or more. In places large ironstone fragments are found throughout the soil. There are some small included areas having a yellow, friable, sandy clay subsoil, representing areas of deep Norfolk fine sandy loam.

This type is developed in only a few small areas closely associated with the Tabor fine sandy loam. Little of it is cultivated, as it drifts badly in high winds where unprotected. Uncultivated areas support a growth of post oak and blackjack oak. This soil is well suited to the production of vegetables, sweet potatoes, and melons. Other crops of the region are grown on it with varying results.

SIMMONS CLAY.

The Simmons clay is a black to very dark brown clay, 10 or 12 inches deep, passing into a subsoil of black to dark bluish gray tough clay, more or less mottled with brown or yellow. In places there is little change within the 3-foot section, the material being a nearly black to bluish-gray clay throughout. In other places, especially where drainage is slightly better, the subsoil is rather brown in color, particularly in the lower subsoil. The surface soil becomes compact and cracks when very dry, even in cultivated fields, but with sufficient rain it can be kept in fairly good tilth. This soil in color and topography bears a marked resemblance to the Wilson clay. Beds of rounded limestone gravel, in many places cemented, lie at depths ranging from 6 to 20 feet below the surface.

The Simmons clay, though not very extensive, forms some good-sized areas in the central part of the county along the larger stream valleys. Some of the more important lie a few miles northeast, east,

and southeast of Sanger, around Vaughan Store, Prairie Chapel School, and near Green Valley School. Smaller areas are mapped in the vicinity of Mingo, Roanoke, and a few miles southeast of Justin.

As mapped, the Simmons clay includes some Simmons silty clay loam, which is a very dark brown to black heavy silty clay loam, underlain at 6 to 8 inches by dark bluish gray clay somewhat mottled with brown and yellowish brown. There are a few small bodies of this type in the southern part of the county, just east of Roanoke and a few miles south of Denton. It is nearly all in cultivation, is used for the same crops as the clay, and gives about the same yields.

The Simmons clay has a nearly level topography. It is situated on flat benches adjacent to, and 25 to 50 feet higher than, the large stream bottoms. Drainage is fairly good, although in very wet seasons the water stands in places after rains. Ditching or under-drainage would improve such areas.

Most of the Simmons clay was originally more or less open prairie land, though parts of it had a scattering growth of post oak, elm, and hackberry. Probably 95 per cent or more of the type is now in cultivation. The principal crops are cotton, corn, oats, wheat, and sorghum. Small quantities of various other feed crops also are produced. In good seasons corn yields 30 to 40 bushels per acre; cotton one-half to 1 bale, though probably not averaging much more than one-half bale; oats 30 to 60 bushels; and wheat 15 to 30 bushels. Sorghum is grown for forage.

The Simmons clay is a rather heavy soil to cultivate, clodding badly if plowed when wet. Under proper moisture conditions, however, a fairly friable seed bed can be prepared. This soil is farmed and handled in about the same way as the other heavy black soils of the county, the Houston black clay and San Saba clay. No commercial fertilizers are used, and no systematic crop rotation is practiced, although crops are changed from time to time. Land of this type is held at \$75 to more than \$100 an acre.

In good seasons this soil is quite productive, and the yields of corn and cotton could probably be increased by the use of barnyard manure, by growing and plowing under legumes, such as cowpeas, and any practice that will add to the supply of organic matter in the soil. The type seems well adapted to the production of cotton, corn, and small grains.

#### LEWISVILLE CLAY.

The surface soil of the Lewisville clay consists of about 10 inches of a brown to dark-brown friable clay. The subsoil to 36 inches is a yellowish-brown friable clay, becoming in many places more yellowish below 18 inches. In some places on the more nearly level areas the subsoil is darker brown in color. The surface soil is calcareous in

most places, and the subsoil normally contains lime nodules and is strongly calcareous. At a depth of several feet the type is underlain with limestone gravel, more or less cemented.

Although not a very extensive type, this soil is found in a number of good-sized areas bordering the larger stream valleys in various parts of the county. Some of these areas lie in the vicinity of Bolivar and Sanger in the northwestern part of the county, around Vaughan store and Gribble Springs School in the northern part, bordering Hickory Creek and Elm Fork of the Trinity River in the central part, and around Lewisville in the southern part. Other areas border the Denton Creek Valley and tributaries in the vicinity of Roanoke and Justin.

In topography the Lewisville clay ranges from gently undulating to steeply sloping. The drainage is generally good, and on some of the steeper slopes the run-off is so rapid that washing results, the surface soil being removed and the lighter colored subsoil exposed.

This type is found in close association with the Simmons soils, having the same origin, but it occupies the sloping areas of old stream terraces or benches and represents better drained and more highly oxidized material. As a rule, the flat surface of these benches is composed of the Simmons clay.

The few trees growing on the Lewisville clay consist of elm, post oak, and hackberry. Over 90 per cent of the type is cultivated. Cotton, corn, oats, sorghum, and wheat are the leading crops. In favorable seasons corn yields 15 to 30 bushels, cotton one-half bale, wheat 15 to 20 bushels, and oats 30 to 40 bushels per acre. The Lewisville clay works up easily to a mellow, friable seed bed. Practically the same methods of handling the soil are used as on the Simmons clay, but owing to its sloping position in many places, the soil deteriorates through erosion. It is deficient in organic matter, which can be supplied by the application of barnyard manure and the plowing under of green-manure crops. This is especially necessary in growing corn. The steeper slopes should be protected from washing by terracing and by contour plowing. Land of the Lewisville clay sells for about the same price as the Simmons clay, with which it occurs on many farms.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Lewisville clay :

*Mechanical analyses of Lewisville clay.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
444903.....	Soil.....	0.2	0.3	0.6	8.2	25.3	41.7	23.9
444904.....	Subsoil.....	.7	.7	.3	3.6	15.0	49.3	30.6

## CAHABA FINE SANDY LOAM.

The surface soil of the Cahaba fine sandy loam is a brown or grayish-brown loamy fine sand, 10 to 15 inches deep, underlain by a red, dull-red, or yellowish-red friable sandy clay subsoil extending to 36 inches. In places where the upper subsoil is red the lower subsoil is yellowish red or yellow. The material is low in lime. There are some included patches of fine sand along the Elm Fork of the Trinity River consisting of gray fine sand, underlain at 8 to 12 inches by yellow to yellowish-red fine sand of a loose stratum. The type as a whole is underlain by beds of rounded limestone gravel.

The Cahaba fine sandy loam is not very extensive in Denton County, but is found mainly in a number of widely scattered small areas bordering the valleys of the larger streams throughout the south-central and western parts of the county. It occurs along Clear Creek in the northwest part of the county, along Elm Fork of the Trinity River in the central-eastern part of the county, and along Denton Creek in the southwestern and southern parts of the county. A good-sized and typical area is situated about 3 miles north of Lewisville.

This type has a gently undulating topography. It occupies low benches or terraces, in most places only a few feet above the stream bottoms which it borders. Both surface drainage and underdrainage are good.

The forest growth on this type consists principally of post oak and blackjack oak. About 75 per cent of it has been cleared and the land placed in cultivation.

The important crops are cotton, corn, and sorghum. A small acreage is devoted to oats for grazing. Peaches, in small orchards, and various small fruits are grown on some farms. These crops apparently do well.

In favorable seasons corn yields 20 to 30 bushels and cotton one-half bale per acre. The soil conserves moisture and is well adapted to the production of vegetables, melons, and small fruits.

It is deficient in nitrogen and can be greatly improved by plowing under organic matter in the form of barnyard manure or green-manure crops. It is well suited to the production of peanuts, and some are grown on it with good results. Few of the included sand patches are cultivated, most of them being covered with post oak, blackjack oak, prickly pear, bear grass, and nettles. Where cultivated, this sand gives fair yields of watermelons, peanuts, and vegetables. Land of the Cahaba fine sandy loam type sells for \$40 to \$70 an acre.

## CAHABA CLAY LOAM, DARK-COLORED PHASE.

The surface soil of the Cahaba clay loam, dark-colored phase, consists of about 6 inches of a brown to reddish-brown clay loam. In places, however, the surface soil to a depth of 2 or 3 inches consists of two layers, the upper one having a loamy texture. The subsoil is a dull-red or brownish-red clay, the lower part becoming somewhat yellowish, more friable, and calcareous. Neither the surface soil nor the upper subsoil is calcareous. At a depth of several feet there occurs a bed of cemented limestone gravel.

A few small areas of this type lie in the vicinity of Bolivar, in the northwestern part of the county, and several small areas within a few miles of Justin, in the southwestern part. The type is situated on the old stream terraces, in a position similar to that occupied by the Lewisville clay, from which it is distinguished by its redder color.

The surface is gently undulating to rolling and the drainage good. The same crops are grown as on the Lewisville clay, and about the same yields are obtained. The suggestions for improvement of the Lewisville clay apply equally well to this type.

## LEAF FINE SANDY LOAM.

The Leaf fine sandy loam consists of 10 or 15 inches of brown or grayish-brown fine sandy loam or loamy fine sand, underlain to 36 inches by a mottled red, yellow, and gray stiff clay subsoil. In places where drainage is very poor the subsoil may be gray with faint red mottlings. The red and yellow colors in the subsoil predominate where the material is well drained. Because of their small extent a few areas of Irving<sup>6</sup> fine sandy loam and loam were included in mapping this soil.

There is little Leaf fine sandy loam in Denton County, this type being confined to some small areas situated on an old terrace near Lewisville. The surface is for the most part nearly level to gently undulating, but in places is sloping.

More than 75 per cent of this type is in cultivation, the original growth, consisting of post oak and black oak, having been largely cleared away.

The chief crops are cotton, corn, and sorghum. The yields where drainage is good are approximately the same as on the Cahaba fine sandy loam. The well-drained soil is naturally adapted to the production of vegetable and fruit crops.

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<sup>6</sup> The Irving soils have gray to brown surface soils, with gray, ashy-gray, or bluish-gray, stiff, waxy subsoils. In places the surface crusts and bakes considerably.

## BELL CLAY, HIGH-TERRACE PHASE.

The surface soil of the Bell clay, high-terrace phase, is a black or very dark bluish gray clay, in most areas 10 or 12 inches deep, although this dark color may extend in places to a depth of 24 inches, or even to 3 feet. The subsoil in the normal areas consists of a brown, yellowish-brown or greenish-yellow clay, though in places it may be a dark-gray or ashy-gray color and contain some whitish marly material.

Where the subsoil is yellowish, the yellow color increases with depth. At depths of 3 feet or more there are thin beds of small limestone and hard chalk gravels. As a rule, the soil and subsoil are both highly calcareous, effervescing freely with hydrochloric acid. Lime concretions and chalky nodules are common in the subsoil. In the extreme eastern part of the county there are some areas that are exceptionally gray when dry, consisting of an ashy-gray, calcareous, friable clay to 36 inches. In the vicinity of Little Elm there are some flat areas of the phase which consist of 36 inches of a black or very dark bluish gray clay which does not effervesce with hydrochloric acid above a depth of 2 feet, although the friable condition of the soil in cultivated fields would seem to indicate the presence of some lime. This phase resembles closely the Houston black clay and is locally considered about the same as that type. However, the very nearly level surface and thin beds of underlying gravel indicate that the soil is water laid and comprises an old veneer or covering of alluvium over the Eagle Ford clays and shales.

The Bell clay, high-terrace phase, is a rather extensive and important soil in Denton County. It occupies a large proportion of the Eagle Ford Prairie. Some of the areas are several miles wide, extending into Collin County. The topography of the phase is undulating to nearly or quite level. Where uncultivated, the surface is covered with numerous small mounds and depressions which are locally called hog wallows, and the type is called black hog-wallow land or black waxy land, the latter name being derived from the black color and tenacious character of the soil when wet. Drainage is fairly good in most seasons, but during periods of heavy rainfall water may stand for a considerable time on some of the more nearly level areas. Small streams reach into all parts of the region occupied by this type.

Over 95 per cent of this type is cultivated. It is a prairie soil and originally supported a growth of native grasses with occasional clumps of mesquite, hackberry, and elm trees. The pastures contain considerable mesquite grass.

The principal crops grown on this soil are cotton, wheat, oats, corn, and various forage crops, including millet and sorghum.

Small home gardens are found on many farms, and a few small orchards of peaches and pears. On some of the larger farms beef cattle are bought and fattened, and sorghum silage is fed to stock during the winter. Hogs and poultry are raised on practically all the farms, and on a number there are small flocks of sheep.

In good seasons cotton yields from one-half to 1 bale per acre, the average being probably only a little more than one-half bale. With favorable conditions corn yields 40 to 60 bushels per acre, but frequently dry weather reduces the yield very materially. Wheat averages about 20 bushels per acre and in good years returns as much as 30 to 35 bushels, and sometimes more. Oats yield from 50 to 75 bushels per acre and under exceptionally favorable conditions somewhat more. Sorghum ordinarily yields well. Small quantities of kafir, milo, feterita, and Sudan grass are produced successfully. Millet yields 1 to 3 tons of hay per acre.

The Bell clay, high-terrace phase, is very sticky and tenacious when wet, but when dry it crumbles into a mellow, friable seed bed. This condition of tilth is due to the relatively high lime content. No systematic rotation is practiced, though the fields are changed from crop to crop at irregular intervals with good results. No commercial fertilizers are used, and no special effort is made to maintain the natural productiveness of the soil. Nevertheless it has been farmed many years without a marked decline in yields, although it seems probable that under the present methods of farming the productiveness of this type will gradually decrease.

This is a very desirable soil, the improvements are generally good, and prices range from \$100 to \$200 an acre. A considerable area of the land is farmed by tenants. Systematic crop rotations, the growing of leguminous crops, and the addition of organic matter is recommended for the improvement of this soil, especially for corn and forage crops.

#### FRIO FINE SANDY LOAM.

The Frio fine sand loam is a dark-gray calcareous fine sandy loam, 12 or 15 inches deep, underlain by a calcareous brown or yellow fine sandy loam. In places the subsoil is a rather light fine sand. There are some included patches of Frio fine sand.

This type is of very small extent, occupying unimportant areas in the creek bottoms composed principally of the Frio clay. The surface is nearly level, but the drainage is good, except at times of overflow.

Most of the area of this type is in cultivation, the important crops including cotton, corn, peanuts, and sorghum. Cotton yields about one-fourth bale per acre. The yield of peanuts is satisfactory. Corn, especially where the subsoil is lighter than the surface soil, does not do as well as other crops. Sorghum and Sudan grass do well. Oats

supply good grazing. The type is well suited to vegetables and small fruits and is especially adapted to watermelons and peanuts. It dries out more readily than the associated Frio types.

#### FRIO SILTY CLAY LOAM.

The surface soil of the Frio silty clay loam consists of 8 to 15 inches of a brown, grayish-brown, or dark-gray silty clay loam. The subsoil to 36 inches is a brown to yellowish-brown clay. Both soil and subsoil are calcareous.

This type, which is not very extensive, is mapped in a number of small areas throughout the larger areas of the Frio clay. The surface is nearly level, but as the areas lie near the streams, the drainage is good except during overflows. This is a stream-bottom soil, having practically the same position as the Frio clay.

The forest growth in the virgin areas is principally elm, hackberry, and pecan, but over most of the type the trees have been removed and the land placed in cultivation. The same crops are grown, with approximately the same yields as on the Frio clay. The same farm methods are used on the two types, which are similar in all respects except texture, the clay loam being somewhat easier to work.

#### FRIO CLAY.

Except in a few places in which the upper inch or two is a silty clay loam, the surface soil of the Frio clay consists of 10 inches of brown, dark-brown, or grayish-brown friable clay. The subsoil to 36 inches is a brown or yellowish-brown friable clay. Both soil and subsoil are highly calcareous. Included with this type in mapping are spots of silty clay loam, loam, and fine sandy loam of the Frio series which were too small to map separately.

The Frio clay is a very important soil type. It occupies stream bottoms that range from a few hundred feet to more than a mile in width. It occurs in all parts of the county, the largest bodies lying along the Elm Fork of the Trinity River, Clear Creek, and Denton Creek.

The areas of this type lie from 10 to 20 feet above the stream beds, and though level, have good surface drainage except in periods of considerable rainfall or during overflows. The soil adjacent to the banks of the streams is somewhat sandy, and many of these sandy strips would be mapped separately if they were wider. The surface is higher along the banks, and there is a gentle slope in many places toward the upland. There are low drainage ways adjacent to the upland, and in places small channels traverse the type, carrying off the surface water. Occasional overflows occur which cover the surface to a depth of several feet. There may be several of these in

one year, and again two or three years may pass without an overflow. Sometimes crops are ruined by these floods, but usually a late crop of some kind may be planted and good yields obtained after the first crops have been destroyed.

Probably three-fourths of this type is cultivated, the uncultivated area remaining in the original forest of elm, hackberry, pecan, bur oak, spotted oak, and a few other species of trees.

The principal crops grown are cotton, corn, oats, wheat, and sorghum. Oats and wheat do well, but if overflowed when near maturity the crop is a total loss. The most certain crops seem to be cotton and corn. Some alfalfa is grown, both for grazing and for hay, with splendid results. A small acreage is devoted to the production of Johnson grass for hay, which is here a profitable crop.

Although corn does well on this type, it is more or less injured by lack of moisture in the spring and summer, though not to the same degree as on the upland soils. Corn yields from 30 to 60 bushels per acre, oats 25 to 90 bushels, and wheat 10 to 30 bushels. Alfalfa yields as high as 5 tons of hay per acre per year in three to five cuttings. Johnson grass yields 3 to 5 tons of hay per acre. Sorghum yields heavily. Much of the type is devoted to cotton, which yields one-half to 1 bale per acre.

Small areas of kafir, milo, feterita, and Sudan grass growing on the type indicate that it is well adapted to such crops.

The Frio clay works up into a mellow, friable seed bed, which is easily maintained in good condition. The soil is not fertilized, and no efforts are made to maintain the productiveness of the land. It is naturally a very strong and productive soil and apparently rich in organic matter and nitrogen. Farms of the Frio clay are valued at \$75 to \$100 an acre. Very few of the farms have large buildings or permanent improvements other than fences on this type, owing to overflows. Building sites are found on the adjacent uplands. Some of the land could be improved by ditching; and if it were protected from overflows by dikes or levees, the agricultural value would be greatly increased.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Frio clay:

*Mechanical analyses of Frio clay.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
444911.....	Soil.....	0.0	0.2	0.3	7.8	17.8	45.8	28.2
444912.....	Subsoil.....	.2	.4	.6	9.8	19.4	42.3	27.6

## TRINITY CLAY.

The Trinity clay is a black or very dark ashy brown clay, 12 inches or more deep, overlying plastic clay which differs only in being slightly grayer in places than the upper soil. In most places both soil and subsoil are calcareous, effervescing freely with hydrochloric acid. The surface crumbles on drying, but it does not appear to have so pulverulent a structure as the Frio clay.

The Trinity clay occurs in good-sized areas along many of the streams in the county, as in the bottoms of Elm Fork. It usually occupies the slightly lower parts of the bottom lands lying away from the streams and adjoining the upland. These areas have a nearly level to slightly basinlike surface, and water stands longest here after rains or overflows. However, there is usually sufficient drainage to allow cultivation.

Uncleared areas support a timber growth consisting principally of elm, hackberry, pecan, spotted oak, and bur oak. Seventy-five per cent of the type is cropped.

Cotton and corn are the most important crops, though wheat, oats, and sorghum are grown to a considerable extent. Although the land is overflowed occasionally, crops are seldom lost altogether in this way. The soil is well suited to alfalfa, but owing to poor drainage conditions, this crop would probably not be quite so successful as on the Frio soil. Oats and corn do well.

The Trinity clay is a very rich and productive soil. Drainage by ditching and protection from overflow water by means of levees would be of great benefit. The type sells for about the same price as the Frio clay.

## OCHLOCKONEE FINE SANDY LOAM.

The Ochlockonee fine sandy loam is a brown fine sandy loam, about 12 inches deep, overlying brown fine sandy loam which becomes yellowish brown below 24 inches. In places the subsoil, at depths of 2 to 4 feet, rests on dark clay or sandy clay. The material does not effervesce with hydrochloric acid.

This type is of slight extent, being found only along some of the smaller streams as narrow bottom lands. One good-sized area, about 6 miles northeast of Denton, lies in the edge of the Elm Fork bottoms and is composed of soil washed from the adjacent upland sandy soils onto areas of the Frio clay.

The type occupies bottom lands and has a nearly level to very gently sloping surface. Drainage is good ordinarily, though the type is occasionally overflowed along the smaller streams. An area of Ochlockonee loam about 6 miles east of Denton in the Elm Fork

bottom has been included with the fine sandy loam on account of its small extent.

The timber growth consists of elm, hackberry, and a few other trees. Probably 85 per cent of this soil is in cultivation, the principal crops being cotton, corn, and sorghum. Cotton yields one-fourth to three-fourths bale, and corn, in favorable seasons, 20 to 40 bushels per acre. No farm is composed entirely of this type, but many include a small area of this soil. It makes excellent pasture land.

#### CATALPA CLAY.

The Catalpa clay is a brown calcareous clay which passes downward into yellow or yellowish-brown calcareous clay. In places the lower subsoil has a greenish shade. On drying, the soil crumbles to a desirable condition, but, like the other clays of the county, it is very sticky when wet.

This type forms narrow strips of bottom land along all the streams in the eastern part of the county. The largest of the areas are one-half mile or more in width. Important areas are mapped along the Elm Fork of the Trinity River and along Little Elm, Stewarts, and other creeks and branches. Though level and low lying, the type has good drainage except during the occasional overflows.

Elm, hackberry, and bois d'arc are the principal species of trees now growing on the soil, but originally it supported a heavy and more varied forest growth. More than 85 per cent of it is cleared and in cultivation. Cotton and corn are the leading crops, with wheat, oats, and sorghum of secondary importance. Cotton yields one-half to 1 bale per acre, corn 20 to 50 bushels, wheat 20 to 25 bushels, and oats 30 to 80 bushels.

The Catalpa clay resembles the Frio clay and has about the same crop adaptation and productive capacity as that soil. It appears somewhat darker in the surface soil and more yellow in the subsoil than the Frio. It is a very valuable agricultural soil. Alfalfa would grow well on it, and Sudan grass and feterita would doubtless give heavy yields. Farms on this type, or composed in part of this type, sell for \$75 to \$100 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Catalpa clay:

*Mechanical analyses of Catalpa clay.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
444938.....	Soil.....	0.1	0.8	0.6	7.2	10.5	41.4	39.7
444939.....	Subsoil.....	.2	.3	.2	1.7	7.0	37.7	53.1

## ROUGH STONY LAND.

The Rough stony land consists of some steep, rough, and stony slopes and bluffs in the extreme northwestern part of the county, along Clear Creek and some of its larger tributaries. The slopes rise 100 to 200 feet above the valley bottoms. The upper slopes are formed of limestone outcrops, and the lower slopes are covered with fragments of this rock. The soil material between the rocks is mostly black or brown clay, but in places is chalky. There is a scattering growth of live oak trees on the type. The land is too rough and stony for cultivation, but has some value as pasture and woodland. The total extent of the type is small.

## ALKALI.

There are no large areas of alkali soil in the county. In the western part, however, there are a number of small affected spots, mostly in the San Saba silty clay loam and San Saba clay. These spots are mainly in the western part of the Grand Prairie section, where the San Saba types lie close to and just a little lower than the Durant soils. They are seldom more than 100 feet across. When dry, the surface material forms a hard crust of grayish or whitish color. In most of the areas a very plastic, unwieldy clay lies near the surface. The subsoil contains some small black concretions, and the lower subsoil white particles, probably gypsum. Soft yellow crystals resembling gypsum are present in some areas at depths of 3 or 4 feet.

Most of these spots occur in shallow basins or coves reaching into higher areas. Crops do not do well in these spots, and in places the land is bare, though plants come up and make a light growth if there is considerable rain. In other affected areas light yields are obtained.

This alkali condition can be ameliorated by the plowing under of vegetable matter, such as straw and manure. Probably the alkali could be removed by tile drainage, though these spots are perhaps not large enough to warrant any great expense for their reclamation.

## SUMMARY.

Denton County is situated in northern Texas, not far from the Oklahoma boundary. The county is about 30 miles across each way and has an area of 941 square miles, or 602,240 acres.

The western half of the county lies in the Grand Prairie region. The eastern one-fourth approximately is in the Black Prairie region. Extending through the county, between these prairie sections is a north-south belt of country several miles wide, known as the East Cross Timbers.

The topography ranges from gently undulating to strongly rolling and hilly, the greater part having a rolling surface. The general slope is to the southeast. The local slope is inward from the east and west to Elm Fork of the Trinity River, which passes through the east central part from north to south and thoroughly drains all of the county. The greater part of the county lies between 500 and 800 feet above sea level.

In 1920 the population of the county was 35,355. Most of the inhabitants are engaged in agricultural pursuits. Denton, Pilot Point, Lewisville, and Sanger are the largest towns in the county. Krum, Ponder, Justin, Aubrey, Argyle, Roanoke, Garza, and Hebron are smaller important towns. Railroads connect these towns with Dallas and Fort Worth in adjoining counties and with other important cities in Texas and other States. Railroad facilities are good. There are very few first-class improved roads in the county, although many of the roads are good in dry weather. Many of the most important roads are in a poor condition.

Practically all the county is reached by rural mail delivery routes. Telephones are in general use through the entire county, and good schools and churches are numerous in the rural districts as well as in the towns.

Fort Worth and Kansas City are the principal markets for live stock. Much wheat is ground in the flour mills of the county, and considerable is shipped to outside markets. Cotton is bought by local buyers and shipped to various parts of the world.

The climate is mild, but in winter is subject to sudden changes. The mean annual temperature as recorded at Dallas is 65° F., and the mean annual precipitation 38.04 inches. There is a normal growing season of 237 days.

The agriculture of Denton County consists chiefly of general farming, the principal crops being cotton, wheat, oats, corn, peanuts, sorghum, for feed and sirup, some barley, and small quantities of vegetables and fruits for home use. Cattle feeding is an important branch of agriculture in parts of the county, and a few beef cattle are raised. Sheep and hogs are raised in a small way on many farms. Many of the farms are well improved, and, especially in the prairie sections, appearances indicate a very prosperous condition. No systematic crop rotations are practiced. Almost no fertilizers are used, and no method of soil improvement is in general use. Farm labor is high priced, but the supply is usually adequate.

The census of 1920 reports 4,200 farms in the county, with an average size of 125.8 acres. Farm land sells for \$40 to \$200 an acre. It is highest in the Black Prairie, on the eastern side of the county, and cheapest in the Cross Timbers section.

The soils of the Grand Prairie are derived from the rocks of the Lower Cretaceous and are composed of limestone and limestone interbedded with marl or chalky clays. The soils of the Black Prairie are derived from chalk, marly clays, calcareous clays, and bituminous clays of the Upper Cretaceous age, and from alluvium from these areas. The Cross Timbers soils represent unconsolidated noncalcareous marine sediments of sand and clay, geologically correlated with the Woodbine formation.

The limestones give rise to the soils of the San Saba, Denton, Brackett, and Crawford series, and Rough stony land. The unconsolidated marine calcareous sediments of chalk and clays give soils of the Houston, Sumter, Wilson, and Ellis series. The Woodbine sediments of the Cross Timbers have developed soils of the Kirvin, Tabor, Norfolk, Durant, and small areas of the Wilson series. The recent alluvial deposits along the streams constitute soils classed with the Frio, Trinity, Catalpa, and Ochlockonee series, and the older stream deposits on the high benches along the valleys are of the Simmons, Lewisville, Cahaba, Leaf, and Bell series.

The San Saba clay, Bell clay, high-terrace phase, Denton clay, Frio clay, and Kirvin fine sandy loam are the most extensive and important soils in the county.

The Frio clay, Trinity clay, Catalpa clay, Bell clay, high-terrace phase, and San Saba clay are the soils best suited to cotton and corn. The San Saba clay, Denton clay, and Bell clay, high-terrace phase, are probably the best for oats and wheat. The Kirvin fine sandy loam, Tabor fine sandy loam, and Durant fine sandy loam are the best soils for peanuts, vegetables, and fruits.

The soils are variable in productiveness, but with sufficient rainfall good yields of the main crops are obtained on all of them. The sandy soils are not well adapted to wheat or other small grains, and vegetables and fruits are not grown so successfully on the clay soils of the uplands.

The soils of the uplands, especially the sandy types, can be greatly improved by growing cowpeas, peanuts, or other leguminous crops and by plowing under the vines and other vegetation. The more sloping areas of the uplands can be improved by terracing and by contour plowing. The valuable bottom-land soils can be improved by building levees or dikes to prevent overflows, where sufficiently large areas are included to warrant the expense of such works.

[PUBLIC RESOLUTION—No. 9.]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

*Resolved by the Senate and House of Representatives of the United States of America in Congress assembled,* That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided,* That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]



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