SOIL SURVEY OF THE WILLIS AREA, TEXAS.

By J. O. MARTIN.

LOCATION AND BOUNDARIES OF THE AREA.

Montgomery County, in which the Willis area is located, is situated in the eastern part of Texas, about 30 miles north of the city of Houston, on the line of the Longview and Galveston branch of the International and Great Northern Railroad. It is located in the Coastal Plain region of the United States and is crossed and drained by the San Jacinto River. The intersection of the Gulf, Colorado

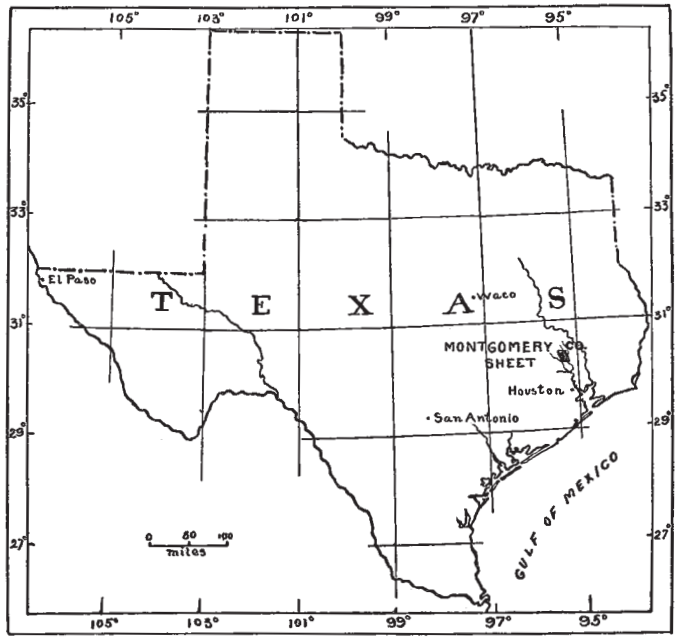


FIG. 24.—Sketch map showing area surveyed in Texas.

and Santa Fe Railroad, which runs east and west, with the San Jacinto River, running north and south, divides the county into four nearly equal sections.

The boundaries of the area surveyed may be given as Walker County on the north, San Jacinto County on the east, the Gulf, Colorado and Santa Fe Railroad on the south, and the San Jacinto River on the

west. In this section of Montgomery County has been grown the greater part of the Texas cigar-leaf tobacco. This section also contains two of the three towns in Montgomery County. Conroe, with a population of 1,500, is located at the junction of the International and Great Northern Railroad with the Gulf, Colorado and Santa Fe Railroad, and is the county seat. Willis, 8 miles north of Conroe, on the International and Great Northern, has a population of 1,000 and is the center of the tobacco industry, 90 per cent of the Texas leaf having been grown within a radius of 5 miles of this town. The area thus outlined contains approximately 215 square miles, of which at least 60 per cent is suited to tobacco culture.

The above area might well be extended on the east into San Jacinto County, but in this direction so much of the county is in forest that a further extension of the study of the area there was deemed inadvisable at this time. Even within the area selected only about 10 per cent of the land has been cleared, and this lies for the most part along the line of the International and Great Northern Railroad.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

By act of legislature of December 22, 1836, the Republic of Texas established the "Texas land office," to administer the disposition of the large unsettled tracts of land which the then republic had at its disposal. Scrip was issued authorizing the holders to locate and have surveyed given areas of land, the surveys to be reported to and recorded by the land office.

The holders of this scrip were authorized to locate and hold land found unsurveyed up to the limit of their scrip. Some of the holdings were quite large, comprising several square miles. These lands were largely utilized by the holders for cattle ranges, and cattle grazing became the first agricultural industry of the region. Gradually, however, with the increase in population, came the tillers of the soil, and the advent of crops especially suited to the climate.

Tobacco growing in Montgomery County was first seriously undertaken in Willis in 1885. Considerable attention was given to the possibilities of this district by tobacco men. In 1898 there was planted the maximum crop of about 1,000 acres, but lack of experience in handling the crop and the failure to obtain expected fancy prices have discouraged many of those who first embarked in the enterprise.

CLIMATE.

The climate of Montgomery County is that of the Southern and Gulf States in general, rather than that of the higher plateau region of Texas. The winters are mild and, with few exceptions, free from severe frosts. The average date of the last spring frost at Conroe is March 11, and the first in the fall November 6. Occasionally, however,

north winds sweep down to the Gulf and periods of zero temperature result. These cold snaps are, however, seldom of more than a few days' duration. The growing season is practically from March to November, though it frequently happens that December is so mild that strawberries are to be had at Christmas.

Lying as it does within 75 miles of the Gulf of Mexico, the summer heat of the Willis district is tempered and made uniform by that great body of water, and there is little cool weather to retard the growth of crops.

The rainfall of the district is in the majority of years ample, frequently excessive, and it is seldom that any great period of drought occurs.

The showers are mostly local, and are almost always attended by thunder and lightning. Occasional hail storms occur. Violent wind and rain storms, having their origin in the Caribbean Sea or the Gulf, sweep across Montgomery County now and then; but these, fortunately, are not of common occurrence. The storm of 1900, which wrecked the city of Galveston, was a severe example of this class of storms, and was the first instance in the history of the region of such high wind velocity.

PHYSIOGRAPHY AND GEOLOGY.

Montgomery County lies within the great physiographic province of the United States known as the Coastal Plain, and presents a continuation of the features of this province found in the South Atlantic and Gulf States.

The Coastal Plain rises from the Gulf of Mexico with a gradual slope, and extends northwestward for a distance of some 200 miles from the coast. It consists of flat prairie land and gently rolling country.

Willis, the center of the tobacco district, is on a divide between the drainage of the San Jacinto River, on the west, and Peach Creek, a tributary of the San Jacinto, on the east. From Willis the rolling surface of the country slopes gently away in all directions, thus insuring good drainage for most of the area. The elevation of Willis above mean low tide is 383 feet, while that of Conroe, on the southern boundary of the district, is 225 feet. Thus in the 8 miles between these two towns there is a fall of 158 feet, or an average fall of 19.7 feet per mile. North of the Walker County line the drainage is mostly toward the Trinity River.

The general surface of the country is gently rolling, with almost no steep slopes. The creeks and the San Jacinto River flow in small ditch-like channels, bordered by broad flats or bottoms, over which the water rises during very heavy rainfalls. The courses of these streams are much more winding than the even nature of the formations over

which they flow would indicate, due to the meandering of the stream from side to side of the valleys. This meandering is due to temporary obstructions like floating trees and the deposition of bars in the stream course, which turn the current and cause it to cut now against one bank and now against the other. During flood seasons large areas are covered by water, so wide and flat are the valley bottoms.

The light sandy soils of this region are subject to considerable movement during heavy rainfall, when the rushing, rain-born rills carry great quantities of sediment into the streams, which then become very muddy. This shows the rapidity of stream erosion, which takes place in spite of the moderate slopes.

The geology of the Texas Coastal Plain is very imperfectly known, little systematic work having been done toward the solution of the stratigraphy of this region. It undoubtedly consists, however, of a succession of the upturned edges of Tertiary sediments, having a dip to the southeast and a general northeast and southwest strike. Overlying these earlier marine sediments are in some cases the later deposits of the Pleistocene.

The geological formation from which the Willis sand is derived and which covers the greater portion of the Willis area is probably either Upper Eocene or Miocene in age, though no fossils were encountered that would have determined the exact geologic horizon. Beyond the above statement, which is founded upon the few recorded facts, nothing further can be said at present concerning the geology of the Willis area.

SOILS.

The soils of the part of Montgomery County under consideration may all be grouped in one or another of five types, each possessing well-marked characters, though along the boundaries, owing to rain wash and other like causes, the adjoining types may become more or less mixed, and grade insensibly from one to the other.

The five types in this area have been given the following names: The Willis sand, the Norfolk fine sandy loam, the Norfolk sand, the San Jacinto clay, and Meadow. The first three of the above-named types are the tobacco soils of the area, the last two being unsuited for the growth of cigar leaf.

The area of each soil type in the district surveyed is given in the following table:

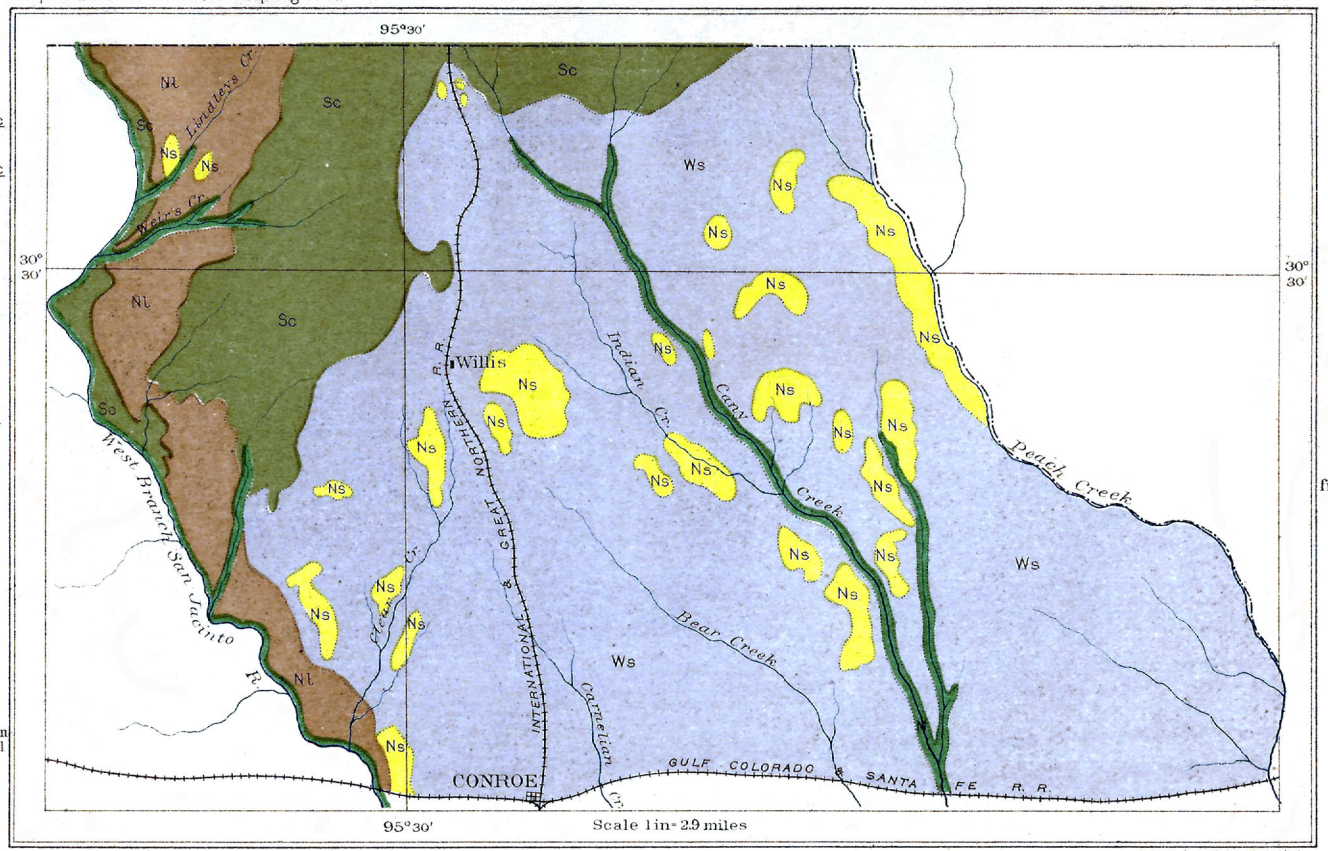
Areas of different soils.

Soil.	Acres.	Per cent.
Willis sand	95,300	69.1
San Jacinto clay	20,480	14.8
Norfolk fine sandy loam	11,880	8.6
Norfolk sand	8,560	6.2
Meadow	1,510	1.1
Total	137,730	

Report of Bureau of Soils, U.S. Dept. Agr. 1901.

SOIL MAP, WILLIS SHEET

PLATE XCVI



SOIL PROFILE (3 feet deep)

Willis sand — Ssc / Gr; Ssc / Gr

San Jacinto clay — C; C / Gr

Norfolk fine sandy loam — S / Gr; C / Gr

Norfolk sand — S

LEGEND

S Sand
C Clay
Ssc Sandy loam
Gr and gravel
C Clay and
Gr gravel
S Sand and
Gr gravel

LEGEND

Ws — Willis sand
Sc — San Jacinto clay
Nl — Norfolk fine sandy loam
Ns — Norfolk sand
M — Meadow

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WILLIS SAND.

The Willis sand is the most widely distributed and important soil in the tobacco section of Montgomery County, occupying as it does 95,300 acres or 69.1 per cent of the total area surveyed.

With the exception of the Norfolk sand it is the best tobacco soil of the area. It grows a fine grade of filler leaf under proper methods of cultivation. Less than 10 per cent of this soil is cleared of forest, the major portion being covered with pine and hard-wood timber.

The soil of this type varies in depth from 10 to 18 inches on the average, but occasionally runs as deep as 36 inches. This variation in depth is without doubt due largely to rain wash, which is at times very heavy in this region. The soil consists of a grayish-yellow medium sand, with a considerable amount of silt. Scattered through the soil are varying percentages of iron concretions from 0.08 to 0.40 inch in diameter, which consist of sand cemented together with limonite. In addition to the concretions there is also a varying percentage of rounded quartz pebbles. Occasionally the percentage of concretions runs very high, and the spots where this occurs are locally termed "Buckshot land."

The subsoil of the Willis sand consists of a sticky yellow, red, and gray mottled sand, containing a high percentage of iron salts. So high is the percentage of iron that in some instances the subsoil becomes cemented into an indurated iron crust, often 6 to 8 inches in thickness. The yellow color in the subsoil continues to a depth of from 4 to 6 feet, when it is red and gray. In the subsoil are found both the concretions and pebbles which occur in the soil. The efficiency of this subsoil in holding water is about the same as that of a clay, due no doubt to a considerable amount of silt and clay intermixed with the sand of which it is composed. At greater depths, as is shown in railroad cuts on the International and Great Northern line, this subsoil runs into a sandy red clay.

There are now and then spots in the Willis sand where the soil and subsoil consist of a red sandy loam to 40 inches and more in depth. These spots seldom contain more than a few acres, but they grow very fine filler tobacco. These red spots are probably due to outcrops of the above-mentioned red sandy clay.

The Willis sand is undoubtedly caused by the action of the weather upon an outcropping geological formation of Eocene or some later age, which in its unweathered condition is represented by the red sandy clay underlying the mottled subsoil. In the soil the iron salts have been changed to the higher oxides and are therefore yellow in color, while as we go deeper, where the chance of oxidation grows less, the red color of the lower oxides is more pronounced. At present the geology of the Coastal Plain of Texas is so little known that only the approximate age of this formation can be given.

The Willis sand is not confined to Montgomery County, but extends northwest and southwest across the county, running into San Jacinto and Walker counties on the northeast. South of the Gulf, Colorado and Santa Fe Railroad the drainage system is so poorly developed that the water stands within a few inches of the surface, and for that reason the soil has at present no agricultural value except as pastures for cattle. This wet phase of the Willis sand extends for a mile or more north of the Gulf, Colorado and Santa Fe Railroad, but there are spots in this vicinity high enough to be fit for cultivation. In this wet region the ground is frequently honeycombed with the holes of crawfish, and such land is known to the residents as "crawfish land."

The natural growth on the Willis sand consists largely of pine, sweet gum, and oak, with some chinquapin on the well-drained and magnolia on the wet portions. There is also a fair covering of various forest grasses, which with the underbrush furnish good grazing for cattle.

With good methods of cultivation the Willis sand is a fairly productive soil; besides growing a good filler tobacco, it is especially adapted to the growing of truck and small fruits.

The following table gives mechanical analyses of the Willis sand soil and subsoil:

Mechanical analyses of Willis sand.

[Fine earth.]

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
5705	¼ mile S. of Willis.	Medium sand, 0 to 12 inches.	0.02	1.50	1.92	5.48	9.90	36.92	10.04	31.62	1.58
5713	13 miles E. of Conroe.	Medium sand, 0 to 15 inches.	.01	1.28	3.44	7.70	12.08	34.70	15.22	22.04	2.97
5707	1 mile N. of Willis.	Fine sand, 0 to 14 inches.	.01	1.26	2.26	6.38	11.82	33.58	6.48	33.14	3.19
5715	2 miles W. of Conroe.	Fine sand, 0 to 24 inches.	.01	1.14	1.44	2.34	3.80	32.56	30.96	23.02	3.63
5714	Subsoil of 5313	Sticky sand, 15 to 40 inches.	.01	3.02	2.36	6.32	9.90	25.94	11.54	20.14	20.43
5716	Subsoil of 5715	Sticky sand, 24 to 40 inches.	.01	3.40	.74	1.88	3.40	24.02	10.40	35.22	20.43
5706	Subsoil of 5705	Sticky sand, 12 to 40 inches.	.01	3.08	2.08	4.42	6.74	23.10	5.62	32.70	20.61
5708	Subsoil of 5707	Sticky sand, 14 to 40 inches.	.01	4.46	2.24	5.94	7.66	21.38	3.64	27.12	26.57

NORFOLK SAND.

The Norfolk sand occurs scattered irregularly over the Willis sand area in patches varying in extent from a few acres to about 2 square miles. This type of soil is more highly prized by tobacco growers than the Willis sand, being, as a rule, better drained and producing a finer grade of filler leaf.

The soil of this type is 8 inches in depth and consists of coarse to medium yellow sand. The subsoil differs little in texture from the soil, but is as a rule lighter in color. Road cuts show these sand areas to have a depth of from 4 to 20 feet, and with this amount of porous sand good drainage in even the wettest weather is insured. The subsoil seems on the other hand to be a good retainer of moisture in dry seasons and dries out more slowly than the other soil types of this region.

The areas of Norfolk sand usually occur as slight mounds or ridges, but occasionally are found on slopes without any topographical indication of their existence. So little is known of the geology of this region that no explanation of the origin of these sand areas can at present be offered.

The Norfolk sand is not naturally a rich soil and soon becomes exhausted when planted in tobacco. Good crops are obtained for the first two or three years after clearing and then the use of fertilizers becomes necessary. Owing to the porous nature of the soil and subsoil, fertilizers that are soluble pass quickly down with the soil water and are lost. For this reason if such fertilizers are used they should be applied at a time when they can be immediately taken up by the plants. Probably the best form of fertilizers for this soil would be some form of green manure like cowpeas, as the long growing season of this latitude makes this method of fertilization the cheapest and most feasible. Cowpeas make a fine stand on this soil, and furnish a large quantity of nitrogeneous humus when plowed under in the late fall. Another fertilizer which is easily obtainable in this region and gives good results upon the Norfolk sand is cotton-seed meal. The use of commercial fertilizers on the Norfolk sand has thus far shown unremunerative results, with the exception of potash, a certain amount of this ingredient being necessary to give burning quality to the tobacco. Wood ashes are a cheap and easily obtainable material containing this necessary ingredient.

Besides being well adapted to the growth of filler tobacco, the Norfolk sand will undoubtedly grow a fair Sumatra wrapper when the proper and necessary methods are followed. This tobacco has been grown under lath shade with fair results.

Truck growing may also be made to succeed on this type of soil, and it is the best soil of the region on which to grow peaches.

The natural growth of the Norfolk sand consists of hickory, oak, pine, and chinquapin, the latter being an almost certain indication of this soil type.

The following table shows the texture of this soil type:

Mechanical analyses of Norfolk sand.

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
5687	6 miles E. of Willis.	Sand, 0 to 6 inches.	0.01	1.04	0.68	12.82	27.02	43.26	4.86	8.16	1.67
5689	1⅛ miles S. of Willis.	Sand, 0 to 6 inches.	.01	.86	.90	6.98	14.26	46.62	10.06	18.06	1.73
5688	Subsoil of 5687....	Sand, 6 to 40 inches.	.01	.54	1.08	10.62	26.38	43.64	4.82	9.96	2.37
5690	Subsoil of 5689....	Sand, 6 to 40 inches.	.01	.64	1.16	6.66	13.14	45.40	8.78	21.40	2.43

NORFOLK FINE SANDY LOAM.

The Norfolk fine sandy loam occurs for the most part as a second bottom along the San Jacinto River, where it is largely in forest, very little being cleared and under cultivation. Where it has been cultivated it has proved to be a productive type, growing good crops of corn and cotton. From its position with reference to the river it is often subject to overflows, which sometimes ruin the crops. Elevated portions that are high enough to escape overflow are locally known as gray or hammock land, and in such locations good crops of tobacco have been grown.

The soil of this type consists of from 10 to 24 inches of medium to fine silty sand, containing in spots 20 to 30 per cent of rounded gravels, though for the most part it is free from gravel. The variation in the depth of the soil is largely the result of rain-wash, which is an important factor in movement of the soil in this region.

The subsoil of this type consists of a mottled red, yellow, and gray clay, containing a considerable amount of sand and reaching to an unknown depth. Cuts of any kind reaching through this subsoil have not been met with. This subsoil, like that of the Willis sand, owes its bright reds and yellows to the high percentage of iron salts which it contains.

At present the agricultural value of the Norfolk fine sandy loam is not great because of the existence of so much other cheap land that is both better drained and nearer the railroad. During dry seasons, like

that of 1901, it might be successfully cultivated, but the frequently heavy rainfall of this section makes the value of this soil for tobacco growing exceedingly problematical. On the hammocks, however, which rise above flood mark and in certain areas along the headwaters of the San Jacinto River tobacco might be grown. At present the sand is covered by forests of pine and oak, or where close to the river by dwarf palmetto and cane, the latter furnishing pasturage for cattle.

The following table shows the texture of typical samples of this soil:

Mechanical analyses of Norfolk fine sandy loam.

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
5691	5 miles W. of Willis.	Sandy loam, 0 to 14 inches.	0.01	1.92	0.62	1.24	1.10	22.90	21.64	42.68	7.19
5693	6 miles NW. of Willis.	Sandy loam, 0 to 18 inches.	.01	.95	.44	.88	4.62	55.06	11.62	18.42	6.99
5692	Subsoil of 5691....	Waxy clay, 14 to 40 inches.	.01	4.52	.10	.30	.66	10.66	9.56	33.34	40.45
5694	Subsoil of 5693....	Sandy clay, 18 to 40 inches.	.01	3.14	.42	1.68	8.14	27.14	3.78	12.92	42.33

SAN JACINTO CLAY.

The San Jacinto clay is not fitted for the growth of cigar-leaf tobacco, but is an important and fertile soil for other crops. It occurs in the northwestern portion of the area surveyed, increasing in area to the westward, until it becomes a very extensive soil, covering vast areas of prairie. The local name for this type of soil is "black land," or "black prairie land," due to the color of the larger part of it.

The soil of the San Jacinto clay consists of from 4 to 6 inches of drab to black clay, friable when dry and well cultivated, but becoming waxy and sticky when wet, and, if not continually cultivated, caking into a very hard and compact mass which cracks into irregular blocks on drying. The soil contains varying percentages of carbonate of lime concretions, usually ranging in size from small grains to pieces two-fifths of an inch in diameter, though frequently occurring as large as a hen's egg.

The subsoil consists of a drab to black waxy clay, very stiff and tenacious and 20 feet in depth in the one well boring which was noted. The carbonate of lime concretions occur also in the subsoil.

There is a drab or light colored phase of this type. Both colors of this soil occur mixed together, the drab variety occurring in pockets

and lenses in the black, and vice versa. The two varieties often grade into each other. While both varieties possess the same physical properties, and both are found on treeless prairies, it is undoubtedly a fact that the black soil is the more fertile and durable of the two. In both varieties there occur patches that are slightly sandy, and frequent pockets of rounded quartz pebbles are met with.

For general purposes this is one of the richest and best agricultural soils of this part of Texas. Some of the prairie farms have been under cultivation for a quarter of a century without fertilizers and still are growing good crops of corn and cotton.

Corn and cotton are the crops commonly grown on the San Jacinto clay, but with proper handling it would grow good crops of grass, especially Bermuda grass, which gives a fine quality of hay. Fields might also be profitably put into sod for pasture, of which at present there is very little, except the wild forest pastures.

The natural growth of the San Jacinto clay prairies consists of various shrubs and wild grasses, the only trees being an occasional white oak. Along the creeks the growth comprises oak, pecan, hackberry, and prickly ash. Among the characteristic shrubs of these prairies are a species of milkweed, the "mustang grape," and the common "maypop" or passion flower. Such treeless lands of high fertility were the first lands to be settled in this region, and black-land farms sell at present for much higher prices than do those in the areas of the lighter adjoining soils.

Mechanical analyses of several typical samples of this type of soil are given in the subjoined table.

Mechanical analyses of San Jacinto clay.

No.	Locality.	Description.	Soluble salts, as determined in mechanical analysis.	Organic matter and combined water.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
5697	4 miles W. of Willis.	Clay loam, 0 to 6 inches.	0.04	2.94	1.22	1.18	1.98	26.62	16.12	40.38	8.98
5695	3 miles NW. of Willis.	Black clay loam, 0 to 4 inches.	.05	7.04	2.08	1.50	1.20	11.62	10.32	49.42	15.83
5699	4½ miles W. of Willis.	Crumbly clay, 0 to 6 inches.	.06	6.82	.04	.28	.74	6.38	17.30	48.40	20.30
5698	Subsoil of 5697.	Waxy clay, 6 to 40 inches.	.02	5.16	.70	1.26	1.84	19.92	5.64	50.20	17.02
5696	Subsoil of 5695.	Black waxy clay, 4 to 40 inches.	.04	5.18	.54	1.18	1.30	12.26	5.38	53.74	18.62
5700	Subsoil of 5699.	Drab waxy clay, 6 to 40 inches.	.06	9.42	.00	.00	.00	.00	.00	67.16	22.98

MEADOW.

This type, like the "meadow" of more northern States, consists of soils of varying texture occurring along stream courses. It is well drained as a rule, though subject to frequent overflow. The streams of this region, which flow in narrow, trench-like courses, in times of heavy rains are unable to carry off the water that falls in their drainage basins. At such times they rise above their banks, spread out on the bordering flat lands, and cover large areas with sediment-bearing water. Much of this sediment is deposited on these bottoms, so that after each overflow a new covering of soil is added. As a rule, the character of the soil deposited varies with the height of the flood and variations in the currents. In dry seasons these bottom lands might be profitably cultivated, but the ever-present danger of overflow makes the risk of losing the crop too great. Wild pecans grow in these bottoms in great numbers, and seem to indicate that this land, which is otherwise fit only for pasture, might be turned into orchards of the cultivated varieties of this nut.

METHODS OF CULTIVATION.

The tobacco soils of the Willis district are light and easily exhausted, especially with a crop that, like tobacco, draws heavily upon the available supply of plant food. This is especially true of the Norfolk sand, which, being made up largely of quartz grains, does not contain any great store of plant food other than the vegetable matter, or humus, which may be in it.

Stable manure, which is probably the best form of fertilizer, is practically unavailable in this district, as most of the cattle are allowed to run at large throughout the year. There is, therefore, a great tendency toward the use of commercial fertilizers. The use of such fertilizers on these light soils, if practiced at all, should be very sparing and judicious, for their retention in the soil long enough to be taken up by the crop is doubtful, and in the case of the Norfolk sand improbable. The experience of the best growers about Willis seems to be that commercial fertilizers on these light soils do not give returns in any instance proportionate to the cost.

The long growing season makes the possibilities of green manuring very great, as it is frequently practicable to grow two crops of cowpeas besides a tobacco crop in one season. Cowpeas plowed under furnish a supply of nitrogenous matter, which not only serves as a store of plant food, but exerts a beneficial physical effect upon the soils, increasing their moisture-holding capacity and making them more friable when they have any tendency to lump.

Cotton-seed meal is, next to cowpeas, the most readily obtained and valuable fertilizer of the district.

There is at present no well-recognized system of crop rotation with

reference to the tobacco crop, even the most successful growers having no agreement upon this important topic. More attention should, however, be given to the fertilizing value of plowing under crops of cowpeas or the possibility of turning cattle into the pea fields to pasture, and thus enrich the soil.

AGRICULTURAL CONDITIONS.

The agricultural conditions of the Willis area are those of a sparsely settled forest country, over 75 per cent of the area still being covered with timber. It is only along the line of the International and Great Northern Railroad that there is much cleared land. The larger part of the country awaits the settler's ax and the investment of new capital.

In the limited portion of the area which has been under cultivation corn and cotton are the staple crops. Of these crops cotton is the one upon which the farmers at present depend for their cash returns. The outlook for the cotton growers is, however, very far from promising, for at the present time the Mexican boll-weevil is threatening the very existence of the crop. Up to the present no method has been devised to prevent the ravages of this dreaded cotton pest, and it seems to be on the increase everywhere.

The farmers are everywhere looking for a substitute crop. Among the possibilities none appears more promising than tobacco. The rates of transportation on the railroads are too high to permit anything but carload shipments, and this militates against the otherwise promising truck industry. On the other hand, the growing of tobacco requires the investment of some capital which must be tied up in the crop until it has gone through the processes of curing. For this reason many of the farmers are unable to undertake the growing of tobacco, owing to lack of capital. They require a crop that can be quickly converted into cash.

The general lack of capital has given rise to a system of crop mortgaging that is a very serious drawback on the material advancement of the region. The farmers are in many cases obliged to mortgage their prospective crops to obtain seed and tools for the season. Except in years of unusually good prices for cotton this form of investment seldom leaves the farmer ahead, and more often makes the crop the property of the storekeeper almost before it is ripe.

To those who have capital to invest the tobacco crop offers much the best of present opportunities. The average yield is at present from 700 to 1,000 pounds per acre, and the cost of production at the outside should not be more than 10 cents per pound. At this cost the crop could still be sold at a very reasonable rate for cigar tobacco and bring a profit.

Up to the present the great drawback to the industry has been the fancy price expected by the growers for their product. Their demands have tended to discourage prospective buyers and to keep the Texas crop out of the market. Added to this has been the lack of experience in curing and sweating the crop, during which rather critical processes many crops have been injured, bringing discouragement to their owners. These two are the chief causes that have led to the retardation of a promising beginning in the industry and to the shrinkage in the crop from 1,000 acres in 1898 to 70 acres in 1901.

Much could be done toward improving this condition if a cooperative warehouse were to be established, where the cured crop could be carried through the final sweating process by a trained expert. Up to the present, however, all efforts in this direction have failed, owing to the same influences that have militated against cooperative enterprises in other agricultural districts.

Land in the Willis district is exceedingly cheap. Good tobacco lands, of which there are thousands of acres, may be bought at from $3 to $10 an acre, according to location and distance from the railroad. The cost of clearing these lands averages about $10 an acre, making the total cost of cleared land from $13 to $20 an acre.

The region undoubtedly offers inducements to the investment of capital under careful management, and it is on the above possibility that the chief hope of the region as a tobacco center must depend.

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