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TEXAS AGRICULTURAL EXPERIMENT STATION
AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
W. B. BIZZELL, President

BULLETIN NO. 301 SEPTEMBER, 1922

DIVISION OF CHEMISTRY

SOILS OF BELL, JEFFERSON, SMITH, TAYLOR AND WEBB COUNTIES

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†As of October 1, 1922.
*In cooperation with School of Veterinary Medicine, A. and M. College of Texas.
**In cooperation with United States Department of Agriculture.

CONTENTS.

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Bulletin No. 301 September, 1922

COMPOSITION OF THE SOILS OF BELL, JEFFERSON, SMITH, TAYLOR AND WEBB COUNTIES.

BY

G. S. FRAPS.

This bulletin deals with the chemical composition of samples of typical soils from five counties in Texas, and is the eighth bulletin of the series dealing with the chemical composition of typical Texas soils. The preceding bulletins are numbers 99, 125, 161, 173, 192, 213, and 244. Most of the samples analyzed were collected by field agents of the Bureau of Soils of the United States Department of Agriculture but some were collected otherwise.

Detailed reports of the surveys, with maps showing the location of the various soil types, have been published by the Bureau of Soils, United States Department of Agriculture, from which the descriptions given in this bulletin are taken, as follows:

Soil survey of Bell County, by William T. Carter, Jr., H. G. Lewis, and H. W. Hawker.

Soil survey of Jefferson County, by William T. Carter, Jr., L. R. Schoenmann, T. M. Bushnell, and E. T. Maxon.

Soil survey of Smith County, by L. R. Schoenmann.

Soil survey of Taylor County, by William S. Smith, in charge, A. E. Kocher, R. F. Rogers, and W. I. Watkins.

Soil survey of Laredo area, by A. W. Mangum and Ora Lee, Jr. This is part of Webb County, being a detailed survey.

Reconnaissance soil survey of South Texas; includes Webb County.

Requests for copies of the soil surveys should be addressed to the Bureau of Soils, United States Department of Agriculture, Washington, D. C. This Division has no copies of these reports for distribution.

Some of the analyses of the soils of Webb County published in this bulletin were published in Bulletins 125 and 161 of this Experiment Station, but both of these bulletins are now out of print, additional analyses have been made, and our methods of interpreting the analysis have been advanced by the research work done since these bulletins were published.

MAINTENANCE OF FERTILITY

The following are the chief essentials for the maintenance of soil fertility:

(1) The maintenance of vegetable matter and nitrogen by growing legumes in a proper crop rotation and by turning them under or grazing them off.

(2) Correction of deficiency in phosphoric acid, if needed, by proper use of phosphates.

(3) Correction for acidity, if present, by use of ground limestone or lime. Lime is also used to improve the physical character of the soil, or to supply the lime-needs of certain crops.

(4) Use of potash fertilizers for correction for deficiency of potash, if needed.

Maintenance of Vegetable Matter and Nitrogen. The maintenance of vegetable matter in the soil is essential to the fertility of soils, though some soils produce well for a long time without additions of vegetable matter, if they are liberally fertilized. Vegetable matter may be supplied in barnyard manure, which is excellent when sufficient quantities can be produced, but barnyard manure is usually not at hand in large enough quantities. Legume crops, in such case, should be grown in rotation with other crops, and either turned under or grazed off. Turning under a heavy green crop may sour the land; if the crop is heavy, it is best to allow it to become nearly mature before turning it under. The plant tissues are then harder, decay less rapidly, and are

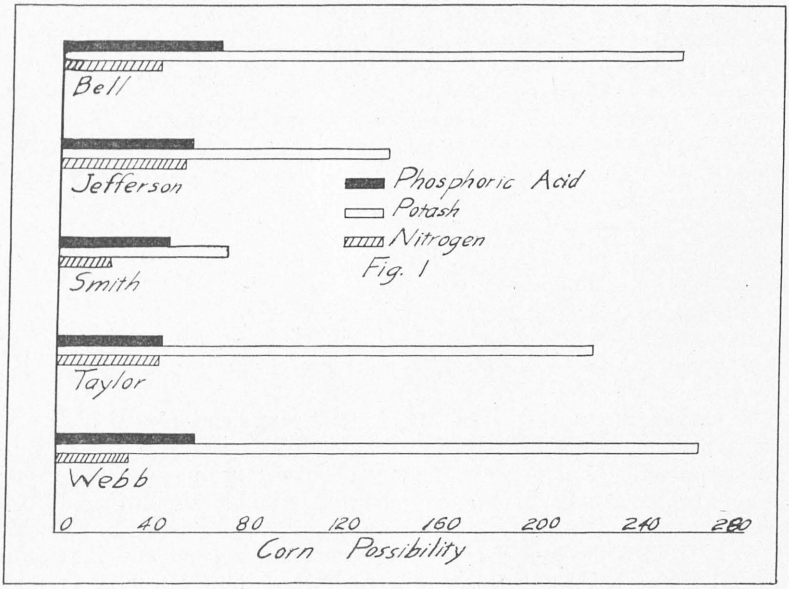

Figure 1. Number of crops of 40 bushels corn which the plant food in two million pounds would produce.

less likely to cause sourness. Grazing off the crop is better than turning it under, as in this case some of its feeding value is secured, while the droppings from the animal, together with the liquid excrement, contain the bulk of the plant food taken up by the crop. To make the crop into hay and to save the manure from it, is not so good from a soil-fertility standpoint, as a large part of the fertility is lost in the process. When the legume is made into hay to be sold, the land gains little in fertility. While other crops than legumes add vegetable matter to the soil when plowed under or grazed off, the legumes are the only plants which can store the free nitrogen of the air and place it into the soil. Hence, a legume should be selected for the crop to be turned under or grazed off.

The maintenance of the nitrogen supply of the soil is more important than the maintenance of the vegetable matter. The only prac-

tical way to do this for farm crops is to secure the nitrogen from the air by growing legumes. Nitrogen costs too much for the planter to purchase enough of it to maintain the nitrogen content of the soil. The purchase of a small supplementary quantity may be profitable, but the main supply for cotton, corn, kafir, etc., must come from the soil, which then loses in fertility, unless nitrogen is restored from the air by means of legumes.

Information as to the kind of legumes suited to the different sections of the State should be secured from the Division of Agronomy. Corn grown in six-foot rows with cowpeas between, in some sections produces as many bushels of corn the first year as corn grown in the usual way, and the second year, if the legumes are turned under or grazed off, it often produces eight or twelve bushels more. A cotton crop following the corn and cowpeas likewise is considerably larger. Crimson clover, velvet beans, peanuts, alfalfa, and vetches include some of the possible legumes.

(2) *Phosphoric Acid.* Texas soils are often deficient in phosphoric acid. The deficiencies of various soils are described in this bulletin. For a discussion of the use of phosphates and other fertilizers, see Bulletin No. 167. Deficiency of phosphoric acid may be readily corrected by the use of acid phosphate.

(3) *Acidity.* Some soils contain organic or inorganic acids, and are acid in character. Certain crops do not grow well in acid soils, especially clover, alfalfa, barley, rye, etc. There are other crops, such as cowpeas and watermelons, which do well in acid soils. Acidity may be corrected by adding lime; either slaked lime, quicklime, or ground limestone rock. The latter is usually the cheaper, and preferable in other respects. The acidity or non-acidity of the soils is shown in connection with the analyses. Some of the soils of Smith County are acid. An acidity of 100 parts per million requires about 500 pounds of ground limestone per acre to correct it. Acidity of soils is discussed in Bulletin No. 243. Ground limestone costs about $1.00 a ton in carload lots.

(4) *Potash.* The soils of Texas as a rule contain an abundance of potash to produce good crops, though there is a variation in this respect. In general, potash is least often needed of any fertilizer and is often needlessly used in the South. The use of manure, the turning-under of green crops, and the use of lime when needed, appear to assist the plants to secure potash from highly insoluble forms. The farmer should endeavor to secure the greatest benefit from his soil potash before undertaking to purchase fertilizer potash. The needs for potash are indicated in connection with the analyses of the various soils described.

HOW TO USE THE ANALYSES

Analyses are given in connection with the description of the various types of soil. The interpretation of the analyses is also given and will be discussed there also.

If the soil is well supplied with plant food, but does not give good yields, this indicates that its physical condition is poor, either in re-

spect to cultivation, drainage, physical character, or in other respects, some as yet unknown.

If the soil is well supplied with total plant food, but low in active plant food, attempts should be made to increase the activity of soil agencies which make the plant food available, by means of additions of manure, of green crops plowed under, or, if the soil needs lime, by additions of lime or ground limestone.

If the crop yields are low and the total plant food is low, then fertilizers should be used to supply plant food and increase crop yields.

EXPLANATION OF TERMS

Total phosphoric acid is the entire quantity of phosphoric acid contained in the soil. It represents the entire quantity in the soil upon which plants can grow. It cannot all be taken up by plants at once, as only a small proportion is available for their use.

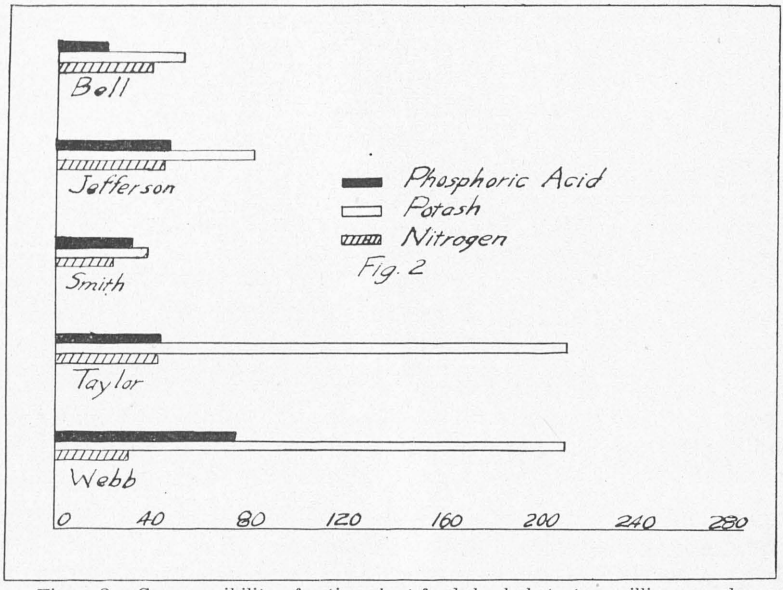

Figure 2. Corn possibility of active plant food, bushels to two million pounds.

Active phosphoric acid is the phosphoric acid soluble in N/5 nitric acid. As shown in Bulletins Nos. 126 and 267 there is a relation between the active phosphoric acid of the soil and the amount of phosphoric acid which crops are able to take from the soil in pot experiments. There is a closer relation between the active phosphoric acid of the soil, and the needs of the soil for phosphoric acid as a fertilizer, than between the total phosphoric acid and the needs of the soil, as shown in Bulletins Nos. 126 and 267.

Total potash represents the entire amount of potash in the soil. Some of this is locked up in highly insoluble silicates, and may not become available for the use of plants in many years. The total potash does not show what portion of this potash may be taken up.

Acid-soluble potash is the amount which is dissolved by strong hydrochloric acid, according to the former AOAC method. As pointed out by Hilgard, there is a relation between the acid soluble potash of the soil and the wearing qualities of the soil (Fraps, Principles of Agricultural Chemistry, page 171).

Active potash is a potash soluble in N/5 nitric acid. It represents potash which can be readily taken up by plants, as shown in Bulletin No. 145 of this Experiment Station with pot experiments (Fraps, Principles of Agricultural Chemistry, page 191).

Total nitrogen represents the entire quantity of nitrogen present in the soil. As shown in Bulletin No. 151 of this station, there is usually a relation between the total nitrogen of the soil, and the nitrogen which can be taken from the soil by crops in pot experiments. The total nitrogen is, therefore, an index as to the needs of the soil for nitrogen, although with worn soils the nitrogen is not as available as in new soils.

Acid soluble lime is the lime which is dissolved by strong hydrochloric acid, as in the former AOAC method. According to Hilgard, the amount of lime found by this method is a valuable indication as to the fertility of the soil (Fraps, Principles of Agricultural Chemistry, page 175).

Basicity. This term is applied to the bases (chiefly lime) which neutralize the N/5 nitric acid in the method for determining active phosphoric acid and active potash, expressed as carbonate of lime. This term is used as a convenient one for the determination referred to, and does not intend to imply that it is the best method for the determination of basicity of the soil. If all the acid is neutralized, the basicity is 10 per cent. or 200,000 pounds of 2,000,000 pounds of the soil.

Acidity is the amount of lime required to neutralize the soil as ascertained by the Veitch method. Acidity is discussed in Bulletin No. 243.

Corn possibility represents the amount of plant food which is withdrawn, on an average, in pot experiments from soils containing similar amounts of active phosphoric acid, active potash, or total nitrogen. It is based on 2,000,000 pounds of soil, which is approximately the weight of an acre of soil to a depth of $6\frac{2}{3}$ inches.

The corn possibility is not supposed to indicate the possible yield from the soil, as this depends upon other conditions in addition to the fertility of the soil. The corn possibility is a convenient way of comparing the deficiency of various plant foods in the soil. For example, with the Abilene clay of Bell County, the corn possibility for active phosphoric acid is 12, for active potash 120, and for total nitrogen 38. The soil is probably deficient first in phosphoric acid, and then in nitrogen; and it is much less likely to be deficient in potash. In a limestone soil like the Abilene clay, the interpretation of the active phosphoric acid is more difficult than with a soil not so high in lime.

The experiments on which this interpretation is based are published in Bulletins Nos. 126, 145, 151, 178, and 267 and the method is described in Bulletin No. 213.

PLANT FOOD REQUIRED BY CROPS

Table 1 shows the estimated average quantity of plant food required by the yields given of certain crops.

Table 1. Estimated quantity of plant food removed by crops.

	Phosphoric acid	Nitrogen	Potash
Corn, 40 bushels, grain and stalk	25	60	42
Cotton, 200 pounds lint, seed and stalk (Bull. 247)	14	50	30
Wheat, 25 bushels, grain and straw	18	42	22
Oats, 40 bushels, grain and straw	14	35	28
Potatoes, Irish, 100 bushels, tubers and tops	13	27	40
Potatoes, sweet, 200 bushels, tubers and tops	18	37	65
Alfalfa, 4 tons	50	183*	143
Sorghum hay, 3 tons	29	84	134
Sugar cane, 20 tons	15	153	144
Onions, 30,000 pounds, bulbs and tops	27	57	60
Rice 12 sacks, grain and straw	15	37	42

*Part of this comes from the air.

AVERAGE COMPOSITION BY TYPES OF THE SOILS OF THE COUNTIES STUDIED

The average of the soils of the various types studied is given in Table 2. In order to secure the average, all the types were used, without regard to their relative abundance. The figures secured must be accepted with caution; one or two types with a high content of any substance may raise the average of the whole decidedly above the average of the prevailing types. Types of limited areas are given the same weights as types of considerable extent, but it did not seem advisable, for this discussion, to prepare a weighted average. Such an average, however secured, made up from soils of widely differing composition, represents merely a basis for discussion and comparison. The averages for Bell County are probably lower than the prevailing types in Bell County; this has been indicated by + after the figures. Some of the other averages are probably too high. These are indicated by — after the figures. This is especially the case with active phosphoric acid in Jefferson County soils. Four of the types are very high in active phosphoric acid, while the other eight are much lower. The average for the eight is given by the figures in parenthesis (44).

Table 2. Composition of soils of counties averaged by types (pounds in two million pounds surface soil).

	Bell	Jefferson	Smith	Taylor	Webb
Total phosphoric acid	1621+	1356— (44)	1119—	1082	1428
Active phosphoric acid	62+	166—	84—	175	369
Total potash	16160	9400	.....	.....	32540
Acid-soluble potash	10587+	5620	2907—	9168	10960
Active potash	251+	307	180—	652	825
Total nitrogen	2486	3043	1273—	2524	1812
Acid-soluble lime	304100	10430	4567	79144	36280
Basicity	158571	1945	2964	107124	55160

CROP-PRODUCTION POWER OF AVERAGE SOILS

Table 3 contains the number of crops of 40 bushels of corn that the plant food in two million pounds (or an acre to the depth of $6\frac{2}{3}$ inches of the average soil) would produce, provided all could be extracted by the plant. The total phosphoric acid could produce 43 to 65 crops of 40 bushels, the acid-soluble potash could produce 61 to 261 crops, and the total nitrogen 21 to 51 crops.

Table 3. Number of crops of 40 bushels corn which the plant food in two million pounds soil would produce.

County.	Total phosphoric acid	Total soluble-potash	Total nitrogen
Bell	65 +	252 +	41
Jefferson	54—	134	51
Smith	45—	69—	21—
Taylor	43	218	42
Webb	57	261	30

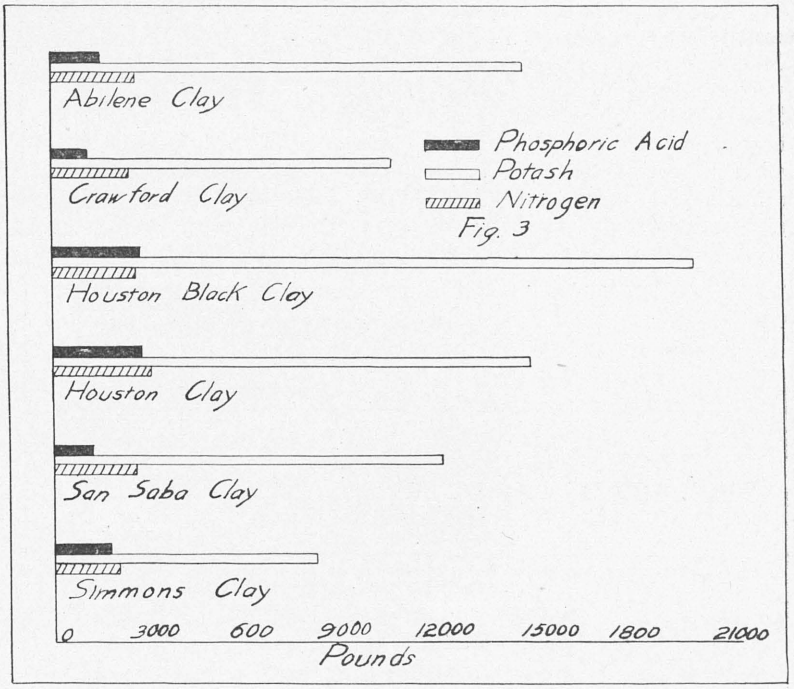

Figure 3. Pounds of total phosphoric acid, acid-soluble potash and total nitrogen to two million pounds of soil, Bell county.

Table 4 contains the corn possibility of the averages of the soils. That of the active phosphoric acid varies from 18 to 74 bushels, the active potash from 51 to 207, and the total nitrogen from 23 to 43. These figures show the importance of nitrogen and phosphoric acid in these soils.

Table 4. Corn possibility of average soils (bushels to two million pounds).

County	Active phosphoric acid	Active potash	Total nitrogen
Bell	18+	51+	38
Jefferson	45(18)—	80	43
Smith	30—	37—	23—
Taylor	40	207	38
Webb	74	207	28

SOILS OF BELL COUNTY

Bell County is in the black prairie and Grand Prairie regions of Texas and its soils are representative of those prevailing in 17,000 square miles in Texas. Its altitude varies from about 450 feet in the southwestern part to about 1200 feet in the extreme western part. The greater part of the county is gently rolling, but there are some deeply-cut stream valleys, with stony slopes and steep rugged bluffs. Cotton occupies the largest acreages, corn comes next, and oats third. Wheat and sorghum are also grown, together with some alfalfa, milo, Sudan grass, and alfalfa.

Table 5 contains the acreage and the per cent. of the areas occupied by the soil types of Bell County.

The Houston black clay, which is a productive and durable soil, occupies nearly 25 per cent. of the area. This soil is especially well adapted to cotton and corn. It is known as "black waxy" soil, and occupies a large area in Central Texas. The Houston clay, San Saba clay, Simmons clay, and Brackett gravelly clay each occupy about 8 per cent. of the area. The remaining area of the county is occupied by a variety of soil types.

Table 5 shows the average number of pounds of plant food to the acre in the various soils analyzed in this county. Table 6 contains the interpretation of the analyses of the surface soils and estimated yields reported by the soil survey. An examination of Table 6 shows that all the soils except Bell clay are good in total phosphoric acid. The soils are well supplied with acid-soluble potash, all except Wilson clay loam being good in potash. All the soils are high in lime except Miles fine sandy loam and Wilson clay loam. None of the soils are acid.

The soils are limestone in character, and many of them are quite high in lime.

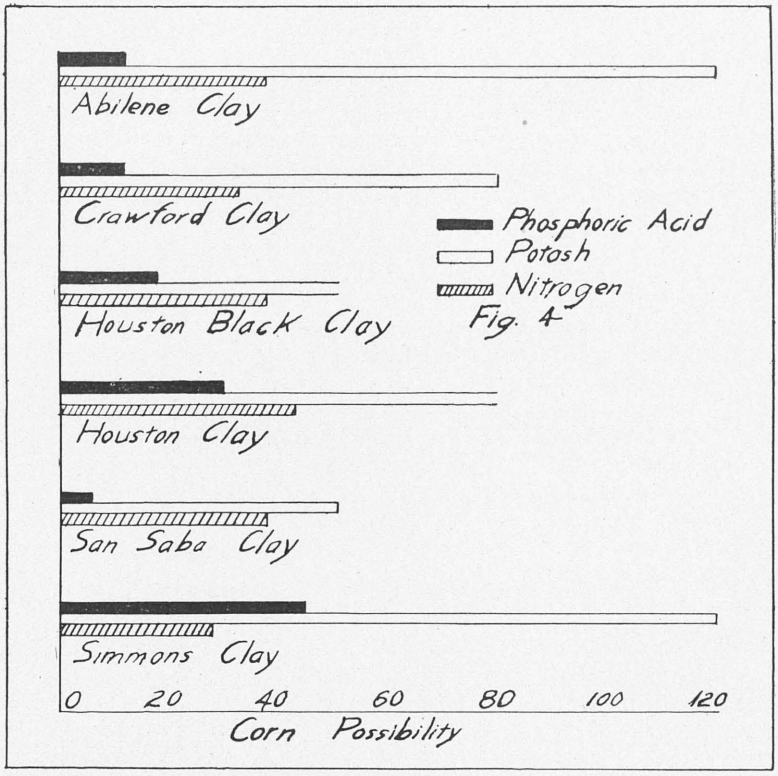

Figure 4. Corn possibility of active phosphoric acid, active potash, and total nitrogen, surface soils of Bell county,

The soils of Bell County do not seem to be well supplied with active phosphoric acid, although as stated above, the total phosphoric acid is good. However, it is difficult to judge of the quality of the phosphoric acid in limestone soils of this character. The availability of the phosphoric acid depends not only upon the amount of active phosphoric acid present in limestone soils of this kind, but also upon the treatment given the soils. Proper rotation, good cultivation, and the turning-under of legumes will enable the plants to secure more of the phosphoric acid than would poor methods of cultivation. Limestone soils of this character sometimes do not respond to applications of phosphoric acid in the field, when apparently such applications are needed. This especially applies to the Houston black clay. When run down, this soil seems to need something else more than it does the phosphoric acid, and this something else is probably rotation with legumes.

Table 5. Average in pounds per two million—soils of Bell county.

Type names	Phosphoric Acid		Potash			Nitrogen	Acid soluble lime	Basicity	Acidity	Acres	Per cent of area
	Total	Active	Total	Acid soluble	Active						
Abilene clay	1520	36	.....	14400	544	2620	237000	200000	0	30,144	4.4
Subsoil	1360	31	.....	16600	305	2160	228000	191300	0	.....	.....
Bell clay	480	117	20800	9600	610	1540	18000	38400	0	19,648	2.8
Subsoil	520	114	23600	9400	435	1100	20000	35400	0	.....	.....
Brackett clay	1040	14	10000	6200	90	2860	662400	200000	0	7,104	1.0
Subsoil	560	9	7200	4200	.....	1060	836000	200000	0	.....	.....
Brackett gravelly clay	.....	.....	14800	.....	.....	4400	.....	.....	.....	61,824	8.9
Subsoil	540	11	11200	7200	27	600	.....	.....	.....	.....	.....
Crawford clay	1100	21	16800	10400	330	2360	14800	26200	.....	41,024	5.9
Darnoc clay	2800	62	.....	17000	310	1840	255200	200000	0	2,112	0.3
Subsoil	2980	41	.....	15800	195	1420	279200	200000	0	.....	.....
Frio clay	.....	41	.....	14600	242	2120	449600	200000	0	35,776	3.2
Subsoil	2240	23	.....	14000	115	13600	460000	200000	0	.....	.....
Frio loam	2080	141	20000	11000	610	2360	377600	200000	0	7,936	1.1
Subsoil	1840	41	20400	10200	200	1320	442400	200000	0	.....	.....
Frio silty clay loam	5040	445	25200	16000	542	3700	376800	200000	0	11,776	1.7
Subsoil	2960	261	23600	14800	600	1120	433800	200000	0	.....	.....
Houston black clay	2600	60	.....	19600	242	2540	343000	200000	0	168,384	24.3
Subsoil	2720	102	.....	9200	.....	1880	345600	200000	0	.....	.....
Houston clay	2700	82	.....	14600	305	2980	317800	184600	0	57,472	8.3
Subsoil	2400	50	.....	8400	118	1980	454400	189200	0	.....	.....
Miles fine sandy loam	820	116	.....	8200	821	1680	19400	15200	0	8,512	1.2
Subsoil	680	16	25600	15400	565	1140	14100	39300	0	.....	.....
San Saba clay	1090	17	18400	11900	289	2510	360000	200000	0	56,128	8.1
Subsoil	1010	11	15800	8500	118	1840	326800	200000	0	.....	.....
Simmons clay	1660	263	12800	8000	554	1960	103000	125200	0	43,520	8.1
Subsoil	1940	98	12200	10600	208	1440	97800	140600	0	.....	.....
Trinity clay	3600	128	.....	14600	491	2950	341700	200000	0	17,984	2.6
Subsoil	1980	105	.....	12100	222	2080	309100	200000	0	.....	.....
Wilson clay loam	640	34	6000	2200	205	1360	9000	16200	0	3,712	0.5
Subsoil	580	14	5200	2400	157	700	10200	19200	0	.....	.....
Surface average	1941	105	16083	11886	412	2486	258353	147053	0	.....	.....
Subsoil average	1621	62	16160	10587	251	2229	304100	158571	0	.....	.....

Table 6. Soil types of Bell county.—Interpretation of analyses.

	Phosphoric acid	Potash	Lime	Acidity	Corn possibilities two million pounds			yields claimed		
					Active phosphoric acid	Active potash	Total nitrogen	Cotton bales	Corn bushels	Wheat bushels
Abilene clay	Good	Good	High	2	12	120	38	½	30–40	12–25
Bell clay	Low	Good	High	0	30	157	23	½–¾	25–50	12–30
Brackett clay	Good	Good	High	0	6	29	43	.....	.....	.....
Brackett gravelly clay	.....	.....	.....	.....	.....	.....	48 +	.....	.....	.....
Crawford clay	Good	Good	High	0	12	80	33	1–3–½	25–40	15–25
Darnoc clay	Good	Good	High	0	24	80	28	.....	.....	.....
Frio clay	.....	Good	High	0	18	51	33	½–1	35–60	15–20
Frio loam	Good	Good	High	0	35	157	33	½–¾	30–50	15–20
Frio silty clay loam	Good	Good	High	0	50	120	48 +	½–¾	30–50	15–20
Houston black clay	Good	Good	High	0	18	51	38	½–¾	35–40	15–20
Houston clay	Good	Good	High	0	30	80	43	½	20–40	15–20
Miles fine sandy loam	Good	Good	Good	0	30	182	28	.....	.....	.....
San Saba clay	Good	Good	High	0	6	51	38	½	25–35	12–15
Simmons clay	Good	Good	High	0	45	120	28	½–¾	25–40	15–25
Trinity clay	Good	Good	High	0	35	120	43	½–1	30–50	.....
Wilson clay loma	Good	Fair	Good	0	12	51	23	½–¾	20–40	10–15

The needs of the soil of this area are, first, nitrogen, properly secured by growing legumes and turning them under or grazing them off; second, phosphoric acid: at present there is little need for potash. A proper rotation of legumes is a necessity for permanent agriculture.

Alkali Soils. The dying of cotton on soils of Bell County, caused by root rot, is some times ascribed to alkali. Alkali is not the cause of this condition. We have analyzed a number of samples, taken from places when cotton died badly from root rot, and found no alkali in them. The trouble is caused by a fungus.

POT EXPERIMENTS

Pot experiments were made on Houston clay, one sample of surface and one of subsoil being used. The results are given in grams in Table 7. The column headed KPN shows the weights of dry matter with complete fertilizer. The column headed KP shows the weights with potash and phosphoric acid but no nitrogen, and the difference between this and the KPN crop shows the effect of nitrogen. With corn on Houston clay, addition of nitrogen doubled the crop. The difference between KN and KPN shows the effect of phosphoric acid. The addition of phosphoric acid increased the crop decidedly. While fertilizers increase the yield in pot experiments, they do not always increase the yield in the field.

Table 7. Pot experiments, Bell county, weights in grams.

		KPN	KP	KN
12739	Houston Clay, Corn 1919	20.0	10.1	7.8
	Sorghum 1919	32.5	7.1	20.0
12740	Subsoil to 12739, Corn 1919	4.8	7.0	1.3
	Sorghum 1919	18.2	6.6	9.1

DESCRIPTION OF SOIL TYPES IN BELL COUNTY

Abilene Clay. The surface is a brown to a rather dark-brown clay, having an average depth of about 10 inches. The subsoil is a brown, chocolate-brown, or light-brown, stiff clay, passing at depths of 16 to 36 inches into more friable, brownish or salmon-colored clay, with generally a bed of rounded gravel at 3 to 6 feet.

The Abilene clay is referred to locally as "chocolate land" or "red land." It occurs in strips along the Leon, Little, and Lampasas rivers and adjacent to the bottom lands of Salado, Cowhouse, and Noland creeks.

The surface in general is very nearly level to gently undulating. The soil dries out and warms up early in the spring, and crops grow more rapidly than on many other soils. Probably 90 per cent. of it is in cultivation. Yields of cotton, corn, and wheat are shown in Table 6. Oats yield 30 to 50 bushels or more. From 3 to 5 tons of sorghum hay per acre are obtained. Sudan grass gives three cuttings of 1 to 2 tons each. This soil is easily tilled, and is durable and productive.

Bell Clay. This consists of a black to very dark-brown, surface soil underlain at about 12 to 30 inches by a black, dark-bluish gray, or

brown, rather plastic clay. The subsoil is usually calcareous. The substratum is a grayish, calcareous clay, frequently containing thin beds of limestone and chert gravel.

The Bell clay is widely distributed as second bottom in long narrow terraces along many of the smaller streams in the eastern part of the county flowing through large areas of Houston black clay. It has a nearly level to very gently undulating surface, and lies about 5 to 15 feet above the first bottom. Practically all of it is in cultivation. In average seasons cotton yields one-half to three-fourths bale per acre, corn 25 to 50 bushels, oats 30 to 60 bushels, and wheat 12 to 30 bushels. Sorghum gives good yields of forage. The sample examined is low in active phosphoric acid.

Brackett Clay. This consists of a grayish to pale-yellow or brownish clay underlain at 6 to 10 inches by a layer ranging from pale-yellow clay to whitish, calcareous chalky material. Often the whitish, chalky material is mottled with pale-yellow. Frequently small, soft limestone fragments and shells occur on the surface and throughout the soil.

This is widely distributed throughout the western part of the county in small areas. It occurs usually on narrow slopes. In general, the surface is undulating to gently rolling, but in places the slopes are sufficiently steep to cause erosion and gullying. Only a small proportion of the type is cultivated. It supports a growth of mesquite and other grasses, as well as scattered small mesquite, cedar, and live oak trees, and is largely used as pasture. The sample analyzed is low in active phosphoric acid and active potash, though well supplied with total phosphoric acid, acid-soluble potash, and nitrogen.

Brackett Gravelly Clay. This consists of light-brownish to gray chalky clay, grading at a few inches into pale-yellow and white. The chalky material increases with depth. Fossil shells and fragments of limestone, both highly calcareous, are distributed over the surface and through the soil, being very abundant in some places.

The Brackett gravelly clay is widely distributed in small areas over the western part of the county, occupying ridges and the borders of the higher slopes. There is a rather thin cover of grass. Prickly pear, cactus, and Spanish dagger are characteristic plants. The land is used principally for grazing sheep and cattle.

Brackett Stony Clay. The surface soil is a gray, heavy clay, several inches deep, resting on highly calcareous, gray or white clay, or chalky material. Frequently, limestone lies near the surface. Hardened chalk fragments or hard, flat limestone fragments are scattered over the surface and through the soil. On many slopes the type simply represents exposures of chalk and soft limestone, with a scattering of stones over the surface. This is rather widely distributed over the western part of the county. The largest areas occur in the southwestern part, around Youngsport and Maxdale.

Practically none of this type is cultivated but it is used principally for pasture.

Crawford Clay. This consists from 6 to 10 inches of dull-red, reddish-brown, or dark-brown clay, underlain by reddish-brown, rather stiff clay which frequently rests on limestone or soft, chalky material

at about 15 to 36 inches. In occasional small areas, the surface soil is nearly black, and the subsoil red or reddish. The surface soil and subsoil in many places contain small, irregular chert and limestone fragments, giving rise to the local name of "flint land." More often, however, the type is called "red land."

Some small and medium-sized areas occur in the central part of Bell County in a belt several miles wide, extending from the northern border southwest. Good-sized areas occur near Belton, Salado, and Moffat.

The surface ranges from gently undulating to nearly level. As a rule, the type occupies the nearly level tableland areas of the high plateaus or "mountains," and high undulating to rolling prairie areas just west of the Black Prairie.

Probably 60 per cent. of it is in cultivation, the remainder supporting a growth of small post oak, live oak, Spanish oak, elm, cedar, and other trees.

Average yields of cotton are one-third to one-half bale per acre, corn 25 to 40 bushels, oats 35 to 60 bushels, and wheat 15 to 25 bushels. Sorghum and Sudan grass grew well, yielding several tons of hay per acre.

The Crawford clay responds readily to cultivation. It is sticky when wet, but is inclined to crumble on drying. Crops make an early start in the spring, and if rainfall is not too light grow rapidly and yield well. It is good in plant food, high in lime, and needs legume-rotation first.

Crawford Stony Clay. This is a brown, red, or reddish-brown, heavy clay, 6 or 8 inches deep. The subsoil is a red or reddish-brown, stiff clay. Hard limestone or a chalky formation is frequently reached at only a few inches below the surface. Scattered very abundantly through surface soil and subsoil are irregular fragments of chert or limestone. Locally the type is called "flint land." It occupies considerable areas throughout the central-western part of the county, principally southwest of Salado and north and northwest of Belton. Probably less than 5 per cent. of this soil is in cultivation, owing to its stoniness and inaccessibility. The principal crops are cotton and corn, with some sorghum. Areas from which the larger stones have been removed yield fairly well, the yields of cotton, corn, and sorghum approximating those obtained on the Crawford clay. Oats and wheat do well, but are grown to a small extent. The type is largely devoted to pasture. This soil is apparently suited to cotton, corn, oats, wheat, and sorghum, the principal general farm crops, but under present conditions it could probably be used best for pasture.

Darnoc Clay. This consists of a brownish or greenish-brown clay underlain at 8 to 10 inches by greenish-brown or greenish-yellow, plastic clay. Large and small limestone fragments are generally scattered over the surface. Greenish and slate-colored shale accurs in the sub-stratum. This type occurs in a few small, widely separated areas, extending in a general way, across the central part of the county from northwest to southwest.

The type occupies rather steep slopes, and is more or less eroded and gullied. Probably less than 1 per cent. of it is cultivated. It has

little agricultural value and should be used as pasture and woodland but it is well supplied with plant food.

Frio Clay. The Frio clay consists of a brown to a dark-brown friable clay nearly black along some of the smaller streams, underlain at 10 to 12 inches by brown or dark-brown clay which is moderately friable when dry and plastic when wet.

The Frio clay occurs along practically all the streams in the western and southern parts of the county. The surface is nearly level, but drainage is usually good. The type lies about 15 to 30 feet above the river channels and is overflowed occasionally.

This is an important soil in Bell County. Nearly all of it is in cultivation. The most important crops are cotton and corn.

Crop yields in average seasons are approximately as follows: Cotton one-half to 1 bale per acre, corn 35 to 60 bushels, and wheat 15 to 20 bushels. Sorghum yields several tons of forage per acre and Sudan grass gives excellent returns. Alfalfa has been grown very successfully in a few fields, and the soil is evidently well adapted to this crop. Yields range from 1 to 2 tons of hay per cutting, and three or four cuttings may be made in a year. Some large fields are devoted to Johnson grass, which gives good yields of hay.

The soil is very friable and works into a good seed bed. The subsoil conserves moisture well. Oats and wheat sometimes grow too rank on this soil and lodge badly. It is well supplied with plant food and would probably need legume-rotation first.

Frio Loam. This consists of a brown to a dark-brown, friable loam passing at about 10 to 12 inches into brown or yellowish-brown loam or friable clay. Near stream banks some small areas of sandy loam are included. This type occurs principally in narrow bottom-land areas along the Lampasas River in the western part of the county. Practically all of this type is cultivated. The most important crops are cotton, corn, oats, wheat, and sorghum for forage. In average seasons, cotton yields one-half to three-fourths bale per acre, corn 30 to 50 bushels, oats 20 to 50 bushels, and wheat 15 to 20 bushels. Vegetables give good yields. The Frio loam is very easily cultivated. It needs legume-rotation first.

Frio Silty Clay Loam. This consists of a brown to a dark-grayish friable silty clay loam, underlain at 5 to 8 inches by dark-brown to nearly black silty clay loam which passes into lighter brownish, stiffer clay.

This type occurs principally in a number of small areas along Leon River and Cowhouse Creek, in the northern part of the county. The type occurs in bottom-land situations in close association with the Frio clay. The same crops are grown under the same farming methods, and yields differ very little. The soil is well suited to vegetables. It needs legume-rotation first.

Houston Black Clay. The surface is a black or very dark-bluish gray, heavy clay, averaging about 12 inches in depth. The subsoil is a heavy, dark-bluish gray, brownish-gray, or yellowish-brown, waxy clay. Both are highly calcareous and contain small lime concretions, small shells, and shell fragments.

The surface soil when wet is very black and tenacious and termed "black waxy land," but upon drying the soil assumes a characteristic dark ashy color and crumbles to a favorable tilth, especially if cultivated when the moisture conditions are right. This is a very extensive soil type, occupying about 25 per cent. of the area and the greater proportion of the eastern half of the county. The surface is undulating to gently rolling. The surface drainage and underdrainage are good in most places. Practically all of it is in cultivation.

Cotton yields one-half to three-fourths bale, and occasionally over 1 bale per acre. Corn yields 35 to 40 bushels, and wheat 15 to 20 bushels per acre. Sorghum yields 3 to 5 tons of hay per acre, and Sudan grass 3 to 4 tons. The gravelly areas apparently are about as productive as the typical soil.

Most of the land has been in cultivation for a long time, some of it for forty years, without the use of fertilizer, but the soil continues to be very productive, especially where the crops have been changed from time to time. It needs legume-rotation first.

Houston Clay. This consists of a brownish-gray to dark-grayish, calcareous clay, 10 to 12 inches deep, underlain by a light brown to brownish-yellow clay which becomes lighter colored and more friable with depth. The lower subsoil is usually a yellowish and whitish, highly calcareous, chalky clay. When dry the soil has an ashy color. When wet, this soil is very sticky, but on drying it crumbles to a favorable tilth and is easy to plow.

It occurs in a number of small bodies and in a few areas of several square miles' extent. The largest of these are in the northeastern part of the county, in the vicinity of Temple and Pendleton.

Its situation ranges from gently rolling to steeply sloping. It occupies much of the high ridge extending northward a mile or two west of Temple. Practically all of the type is in cultivation.

Cotton yields one-half bale per acre, corn 20 to 40 bushels, oats 30 to 60 bushels, and wheat 15 to 20 bushels. Sorghum gives good yields of hay.

A shallow phase of the Houston clay represents eroded areas of the typical Houston clay. Generally, small fragments of whitish limestone are scattered over the surface. This phase occurs in a number of small areas which aggregate several square miles in extent. Probably 85 per cent. of it is in cultivation. The soil appears rather thin, but it is said to produce good yields. For good returns, it requires ample and timely rainfall. Yields in average seasons are reported as, corn 25 bushels, oats 30 to 60 bushels, and wheat 15 to 20 bushels, cotton one-fourth to three-fourths bale per acre. Sorghum and Sudan grass do well. The productiveness of the Houston clay, shallow phase, varies with the depth of the surface soil.

The Houston clay needs first a proper legume-rotation for permanent soil-fertility.

Miles Fine Sandy Loam. The surface is a brown to slightly reddish-brown fine sandy loam or loamy fine sand 8 to 20 inches deep. In some places the immediate surface material is grayish when very dry. The subsoil is a red, stiff, slightly sandy clay. On some eroded slopes the

clay subsoil is exposed or lies very near the surface. In a few places the soil contains small gravel.

This type is not extensive, but is widely distributed throughout the eastern part of the county along the Leon and Little River Valleys. The type occupies terraces lying 20 to 100 feet above the stream bottoms. Probably 85 per cent. of the type is cultivated. Cotton and corn are grown to some extent and give fair yields, but the type is used largely for market gardening. Many vegetables, including watermelons, give good yields. Peaches, plums, and pears as well as various berries and grapes, are grown successfully and marketed with the vegetables. This soil is easily cultivated and responds readily to good farming methods.

It needs legume-rotation first.

Miles Gravelly Sandy Loam. This consists of a light brown to brown gravelly sandy loam, underlain at about 8 to 10 inches by reddish or brownish gravelly sandy loam, which passes at about 10 to 15 inches into red, stiff gravelly clay. This is often quite waxy in the lower part and mottled with yellow, and contains small rounded gravel, most abundant in the surface soil. Only a small proportion of the type is cultivated.

San Saba Clay. The surface soil is a black or very dark-brown clay, 8 to 15 inches deep. The subsoil is a black to dark-brown or dark-gray, heavy, tough, clay containing some fine chert particles and small calcareous concretions. In some places, a layer of hardened shell several inches thick occurs in the subsoil.

The San Saba clay is rather extensive in the western part of the county. The largest areas mapped are around Killeen. The type occurs in a number of short valleys reaching back into precipitous areas of rough stony land, locally called "coves." The type is also developed on the high plateaus in close association with the Crawford stony clay. It is generally rolling to undulating in topography, and generally has good drainage. Probably 90 per cent. of it is cultivated. Where the shell agglomerate lies near the surface, the land is rather wet and soggy just after rains, and in dry weather is droughty, and crops suffer considerably.

Vegetables, peaches, and plums do well, but are grown only in a small way for home use. The fruit crop is uncertain, owing to late spring frosts.

Cotton yields an average of one-half bale or slightly less per acre. Corn is estimated to yield 25 to 35 bushels per acre, and oats 25 to 40 bushels. Wheat ordinarily yields 12 to 15 bushels.

This soil is quite sticky when wet, but in cultivated fields it assumes a very loamy structure upon drying out. A legume-rotation is needed first.

Simmons Clay. This consists of a black or very dark-bluish gray clay, which, in the subsoil, may become a somewhat lighter-colored, dark drab or grayish-brown. The soil pulverizes on drying, but is very sticky when wet.

It occurs as a number of large areas near Little River, in the central part of the county.

The type ranges from nearly level to gently undulating. It lies 10

to 30 feet higher than the bottom lands. Practically all of it is in cultivation. Ordinary yields are reported as follows: cotton, one-half to one bale per acre, averaging probably a little more than one-half bale; corn, 25 to 40 bushels; oats, 30 to 50 bushels; and wheat, 15 to 25 bushels. Sorghum yields 3 to 4 tons of hay per acre. The yield of Sudan grass is large.

This soil does not dry out so quickly as some of the adjacent types, especially the Abilene clay, and is somewhat later in getting into condition for cultivation and planting in the spring. It is rather difficult to plow, and unless worked when in the best condition as regards moisture, clods on drying. It needs legume-rotation first.

A high phase of the Simmons clay is a black or very dark bluish-gray clay, 10 to 12 inches deep, locally referred to as "black mesquite land." Practically all the phase is in cultivation. Cotton in average seasons yields about one-half to three-fourths bale per acre, corn 25 to 40 bushels, wheat 15 to 30 bushels, oats 40 to 60 bushels, and a yield of 90 bushels has been obtained. Sorghum yields 2 to 3 tons of hay, and Sudan grass, which is grown very extensively, gives two cuttings of 1 to 2 tons each.

The surface soil of this phase is rather sticky when wet, but upon drying crumbles to a desirable tilth.

Trinity Clay. This surface is a very black, bluish-gray or brownish, friable clay, about 12 inches deep. On drying, the surface has an ashy cast and becomes crumbly. The subsoil is very similar to the surface soil, but somewhat lighter in color. Along the smaller streams, the soil is darker in color than along the larger streams.

The Trinity clay is confined to the black prairie region in the eastern part of the county. It occupies narrow land areas along the creeks.

The surface is very nearly level. The type is subject to overflow in part. The subsoil is very retentive of moisture.

This is an important soil type, though not extensive. Probably 90 per cent. of it is in cultivation. Corn and cotton are the principal crops. This soil is not used much for small grains, owing to the tendency of these crops to grow too rank, and to lodge, and because of the danger of destruction or damage by flood. Cotton yields about one-half to 1 bale per acre and corn 30 to 50 bushels.

The soil is easily tilled if plowed and cultivated when the moisture conditions are favorable. The soil is well supplied with plant food.

Wilson Clay Loam. The surface is a brown or light brown to brownish-gray clay loam, about 6 to 10 inches deep. The subsoil consists of a light brown to dark bluish-gray, tough clay, underlain at about 20 to 30 inches by a dark grayish-brown to bluish-gray tough clay, constituting a claypan. The local name is "pancake" land, owing to its peculiar property of baking after rains. If plowed or cultivated when wet, the soil upon drying forms very hard clods which are broken down with difficulty, and if not worked before thoroughly dry, it becomes too hard to cultivate.

It occurs in the extreme southeastern corner of the county. A fairly large body is mapped around Althea, and smaller bodies occur near Vilas and two miles west of this place. The surface ranges from nearly flat to very gently undulating. The type yields, under good methods

of cultivation, an average of one-half to three-fourths bale of cotton per acre, 20 to 40 bushels of corn, 25 to 50 bushels of wheat. A legume-rotation is needed first.

SOILS OF JEFFERSON COUNTY

Jefferson county is in the Coast Prairie region, which borders on the Gulf of Mexico. The elevation is not high, and there is marshy land in part of the county. To the eye, the surface is largely flat, but really the land slopes gradually. Sand mounds one to three feet high and 20 to 60 feet in diameter are found in various places. Rice is the most valuable crop grown in the county. A small amount of corn

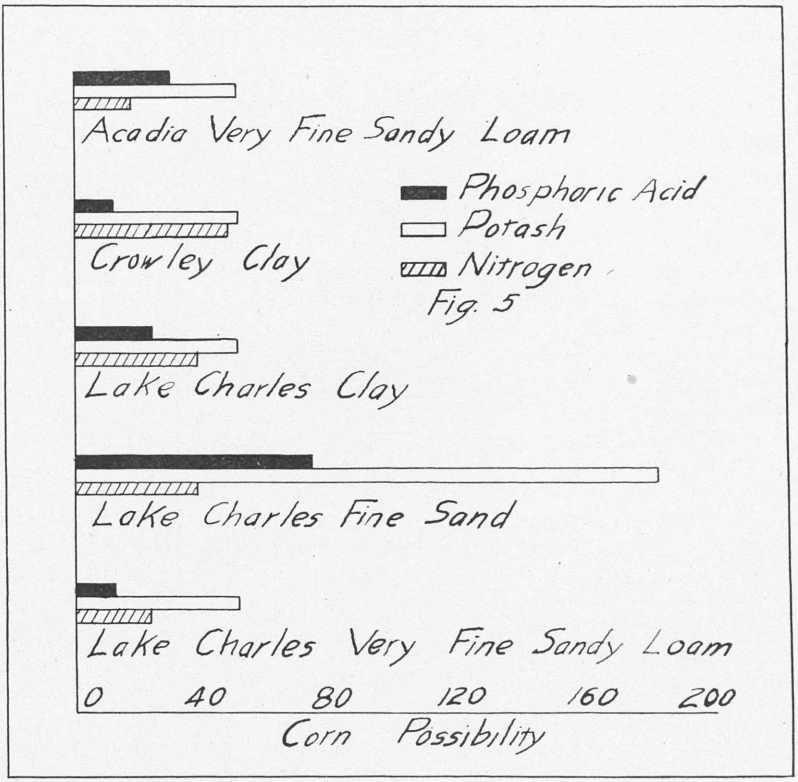

Figure 5. Corn possibilty of active phosphoric acid, active potash and total nitrogen soils of Jefferson county.

and cotton is grown, together with sorghum, and small amounts of oats and some vegetables. Sweet potatoes and Irish potatoes are grown to a considerable extent.

Rice is usually grown from year to year on the same land, until the productiveness becomes too low, when the land is turned out to grow up in weeds. A rotation of crops, including a legume, is needed. Commercial fertilizer is used to some extent.

Lake Charles clay occupies very nearly 30 per cent. of the area.

Next in order comes Lomalta clay, which occupies 24.3 per cent. of the area. Lake Charles silty clay loam occupies 14.4 per cent.; Lake Charles very fine sandy loam, 9.4 per cent.; and Crowley clay, 5.3 per cent. The remainder of the area is occupied by a variety of types of soil as shown in Table 8.

Table 8. Average in pounds per two millions, soils of Jefferson county.

	Phosphoric Acid		Potash			Nitrogen	Acid soluble lime	Basicity	Acidity	Acres	Per cent of area
	Total	Active	Total	Acid soluble	Active						
Acadia clay	1100	36	7600	4500	.....	2980	5800	15200	2800	20,352	3.5
Subsoil	700	14	7900	4800	256	980	12800	22100	2800	.....	.....
Acadia very fine sandy loam	860	36	7200	900	264	830	2700	3300	700	24,384	4.2
Subsoil	600	6	10000	5600	556	980	2800	6500	1800	.....	.....
Crowley clay	820	34	10600	4200	212	3280	7200	7400	600	31,232	5.3
Subsoil	740	10	13400	5400	282	1760	8200	13600	800	3,776	0.6
Lake Charles clay	800	73	11000	7400	239	2680	11200	22000	280	173,632	29.5
Subsoil	1140	19	12200	6800	223	1600	10000	23600	58	.....	.....
Lake Charles fine sand	2580	916	.....	4000	855	2400	6800	12400	0	1,792	0.3
Subsoil	1380	477	.....	3600	275	840	11800	28200	.....	.....	.....
Lake Charles silty clay loam	660	29	8800	3000	210	2080	21600	34600	0	85,376	14.4
Subsoil	960	10	8200	3800	223	3300	14200	24000	400	.....	.....
Lake Charles very fine sandy loam	460	14	7200	2200	212	1300	5400	2400	362	55,616	9.4
Subsoil	430	9	7800	2200	112	860	2800	7400	400	.....	.....
Lomalto clay	2140	384	.....	15400	.....	5740	9200	26200	.....	143,360	24.3
Subsoil	1940	480	.....	13800	.....	1440	5200	28200	.....	.....	.....
Marsh (fresh water)	1780	79	14000	7200	.....	5840	8800	27400	.....	27,136	4.6
Subsoil	840	15	15600	8800	372	2600	7400	25400	.....	.....	.....
Sanders clay	2360	57	8800	7400	158	3300	25600	43600	0	4,544	0.8
Subsoil	1160	25	6400	6800	127	2740	2280	36400	.....	.....	.....
Average surface soils	1356	166	9400	5620	307	3043	10430	1945	593	.....	.....
Average subsoils	789	106	10188	6160	269	1710	9800	21540	1043	.....	.....
Average excluding Lake Charles fine sand and Lomalto clay	1105	45	9400	4600	216	2786	11038	19488	677	.....	.....

Table 8 shows the average plant food in pounds per 2,000,000 of soil, which is approximately equal to the weight of one acre of soil to the depth of $6\frac{2}{3}$ inches. The average by types for the county has already been given in Table 2. The interpretation of the analyses of the soil is given in Table 9.

Table 9. Interpretation of analyses, Jefferson county.

	Phosphoric acid	Potash	Lime	Corn possibility two million pounds			Yield claimed	
				Active phosphoric acid	Active potash	Total nitrogen	Rice, bushels	Corn, bushels
Acadia clay	Fair	Fair	Fair	12	.....	43	.....	.....
Acadia very fine sandy loam	Fair	Low	Fair	30	51	18	.....	.....
Crowley clay	Good	Fair	Good	12	51	48	35–65	.....
Lake Charles clay	Good	Good	High	24	51	38	36–72	20–30
Lake Charles fine sand	Good	Good	Good	74	182	38	.....	Good
Lake Charles silty clay loam	Good	Fair	High	12	51	33	35–75	30–50
Lake Charles very fine sandy loam	Low	Fair	Good	6	51	23	.....	20–50
Lomalto clay	Good	Good	Good	45	.....	.....	.....	.....
Marsh	Good	Good	Good	24	.....	48	.....	.....
Sanders clay	Good	Good	High	18	37	48	.....	.....

The Lake Charles very fine sandy loam is low in total phosphoric acid, the Acadia clay and the Acadia very fine sandy loam are fair, and the remainder of the types are good. Five of the types are good in acid-soluble potash, four are fair, and one low. Five of the types are good in lime, three are high, and two are fair.

The corn possibility for the active phosphoric acid varies from 12 to 74 bushels to the acre. The latter figure, which is for the Lake Charles fine sand, is probably higher than this type really averages. Several of these types are low in active phosphoric acid, and the needs for phosphatic fertilizer is indicated.

Phosphoric acid can easily be secured in the form of bone meal, acid phosphate, or other materials. Fertilizers containing phosphoric acid are being used in this section.

The active potash is not as high as one would desire. Potash is less likely to be needed than phosphoric acid or nitrogen, but the amount of active potash shown could be exhausted so that the soil would become deficient in a comparatively short time. As rice is the most important crop grown in this locality, and as most of the potash taken up by rice is contained in the straw, the need of saving the potash contained in the straw is imperative. Rice straw ashes are quite high in potash, and if the straw stacks are burned, the ashes should be scattered upon the land to be cultivated and not left to wash away or to fertilize waste land. Proper use of the ashes of rice straw will decrease materially the loss of potash from the soils, and thereby decrease the needs of purchasing potash in the form of a fertilizer.

For total nitrogen the soils have a corn possibility of 18 to 48 bushels to the acre. This indicates that a shortage of nitrogen will occur after the land has been in cultivation for a few years. This shortage will occur more quickly, in the case of rice, on account of the conditions under which the rice is grown. The saturated condition of the soil does not permit the inactive soil nitrogen to become active, and available to plants, as readily as when the soil is in a cultivated condition.

While it is practical to purchase small amounts of nitrogen to assist that contained in the soil, the price of nitrogen is so high, and such large amounts are needed to maintain soil fertility, that profitable farming does not permit the purchase of enough nitrogen to keep soils in a fertile condition. It will therefore either be necessary to adopt some method by which the nitrogen content of the soils is maintained, or else to permit them to decrease in fertility until the production of rice upon them is no longer profitable. The nitrogen content may be restored to some extent by growing legumes, which have the power of taking nitrogen from the air, and either turning them under or grazing them off. By this method of procedure, nitrogen will be secured from the air, and added to the soil, and if the legumes are grown often enough, it is possible to maintain the soil so far as nitrogen is concerned. Such a rotation would also aid in eliminating red rice and weeds.

ACIDITY

A number of the soils of Jefferson County is acid, and the use of lime to correct the acidity of the soil is desirable in some cases. Table 10 contains a number of individual soil samples with the acidity of

each, and the amount of limestone that should be added. Limestone may be secured in the form of screenings from limestone quarries at about $1.00 a ton when secured in carload lots.

Table 10. Acidity of soils of Jefferson county.

	Number of samples	Number acid	Average acidity of acid soils per million
Acadia clay	1	1	1400
Acadia very fine sandy loam	3	3	333
Crowley clay	2	1	600
Lake Charles clay	10	4	350
Lake Charles fine sand	1	0	0
Lake Charles silty clay loam	2	1	200
Lake Charles very fine sandy loam	2	2	360
Sanders clay	1	0	0

The lime should be used in connection with a legume-rotation, as mentioned above. If the lime is applied without a proper legume-rotation, its application may result in a larger crop for a few years, but then the soil will be much poorer than it was at first. The lime and legume-rotation should go together and lime should not be applied in the absence of such a rotation. The use of lime on Texas soils is discussed in Bulletin No. 243.

NEEDS OF THE SOILS OF THE AREA

We would place as the first need for soil-fertility in Jefferson County, a proper legume-rotation, including a legume to be turned under or grazed off, for the purpose of securing nitrogen from the air and adding vegetable matter to the soil, eliminating rice weeds, and exerting other influences favorable to crop production. In order to prevent "straighthead" of rice following legumes or cultivated crops, it is recommended in Farmers' Bulletin No. 1212 of the United States Department of Agriculture to apply water when the rice is about 8 inches tall, and allow this water to dry off gradually. If there is any standing water five or six weeks after irrigation, it should be drained off and the land allowed to remain dry for two or three weeks. If the soil becomes dry enough to crack and the plants turn yellow and start to wither, the results will be better, says Farmers' Bulletin No. 1212.

The second need is the conservation and use of potash in the ashes of the rice straw so that they will be returned to the soil and thereby reduce the need of buying potash.

The third need of the soils is the application of moderate amounts of phosphoric acid, in the form of acid phosphate. If the rice straw ashes are saved, there is little need for buying potash.

As the fourth need, we recommend the application of lime upon land which is known to be acid but only in connection with a proper legume rotation.

In the case of sweet potatoes, or other vegetables, the use of fertilizer containing some nitrogen and potash would probably be profitable. With these crops, fertilizers often pay even on good soils.

Table 11. Pot experiments Jefferson county, weight in grams.

			KPN	PK	PN	KN
4644	Acadia very fine sandy loam.	Corn 1911	47.7	19.2	49.1	37.6
		Corn 1915	42.0	.....	39.3	.....
		Sorghum 1915	28.1	.....	29.2	.....
		Corn 1916	21.7	.....	16.2	.....
		Sorghum 1916	20.1	.....	12.2	.....
7613	Lake Charles clay	Corn 1915	32.1	13.1	.....	24.3
		Sorghum 1915	33.5	17.2	.....	25.5
		Corn 1916	33.2	14.4	.....	14.4
		Sorghum 1916	34.2	7.0	.....	17.7
7614	Subsoil to 7613	Corn 1915	17.6	14.0	.....	.....
		Sorghum 1915	28.0	9.5	.....	.....
		Corn 1916	23.6	8.2	.....	.....
		Sorghum 1916	20.8	5.9	.....	.....
2410	Lake Charles clay, subsoil	Corn 1910	36.0	31.5	38.5	8.0
4186	Lake Charles clay	Corn 1913	15.7	.....	.....	12.6
		Sorghum 1913	12.9	.....	.....	13.2
		Corn 1914	36.0	.....	.....	19.0
		Sorghum 1914	37.0	.....	.....	27.7
4187	Subsoil to 4186	Corn 1913	20.0	.....	.....	9.6
		Sorghum 1913	4.4	.....	.....	4.9
		Corn 1914	18.5	.....	.....	3.1
		Sorghum 1914	20.5	.....	.....	12.0

Pot Experiments. The results of some pot experiments on soils of Jefferson County are presented in Table 11. The column headed PNK shows the weight in grams of the crop which received phosphoric acid, potash, and nitrogen. The column headed PK shows the weight of the crop which received phosphoric acid and potash. The column headed PN shows the weight of the crop which received phosphoric acid and nitrogen, and the one headed KN shows where the pot received potash and nitrogen. The difference between the PK pot and the KPN pot shows the effect of nitrogen. The test on the Acadia very fine sandy loam and the Lake Charles clay shows that these soils need nitrogen decidedly. The difference between the column headed PN and the column headed KPN shows the effect of potash. Potash does not seem to be needed excepting with the last two crops on Acadia very fine sandy loam. The difference between the column headed KN and KPN represents the effect of phosphoric acid. The Lake Charles needs phosphoric acid, although one sample, number 7613, needs nitrogen more than it does phosphoric acid. There was no test for need of nitrogen on soil 4186.

ALKALI

Sea water is sometimes driven on the soils located near the coast, during storms, thereby introducing salt, and giving rise to alkali injurious to crops. We have occasionally examined soils for the presence of salt. One sample of surface soil secured three miles southwest of Port Arthur contained 1409 parts per million of chloride of soda, while the subsoil contained 1074 parts per million. In case of doubt as to the presence of salt in the soil, it is best to have a chemical examination made of it.

DESCRIPTION OF SOIL TYPES, JEFFERSON COUNTY

Acadia Clay. Much of the Acadia clay has a "hog-wallow" surface. On the hummocks which lie about 6 to 10 inches above the depressions, the soil consists of a mottled yellow and gray plastic clay, marked by

occasional mottlings of red and containing in many places a few iron or lime concretions in the lower depths. Over this clay there may be a layer of 2 or 3 inches of dark-gray silty clay loam. In the depressions between the mounds the soil is darker, consisting of a mottled dark bluish-gray and yellowish-brown, heavy, sticky, clay, the mottlings becoming lighter with depth. Some areas do not have a "hog-wallow" topography.

This is a rather poorly drained type, water standing on the surface for considerable periods after rains. In general, the surface is nearly flat. It is an exceedingly difficult type to cultivate, with a pronounced tendency to puddle and bake. For this reason little of it is farmed. It is used for grazing and for its forest growth.

The poorly drained phase has a "hog-wallow" topography and the uneven surface of this soil interferes with drainage. Much of this phase is situated so that it is flooded by back water from the bayous and under natural conditions the recurrent overflows make the type of value only for grazing and for forestry.

Acadia Very Fine Sandy Loam. The surface consists of 2 to 4 inches of a yellowish-gray to grayish-brown very fine sandy loam, which grades into a subsurface layer of grayish or mottled grayish-yellow material of about the same texture. The subsoil begins abruptly, usually at a depth of about 12 to 16 inches, and consists of mottled yellowish, red, and bluish-gray clay, which becomes heavier with increase in depth, passing at about 24 inches into mottled gray, yellow, and brick-red, plastic heavy clay.

The above description applies to the soil between the numerous sandy mounds. In the mounds, the soil is a brownish-yellow to yellowish-brown loamy very fine sand to very fine sandy loam. The principal areas of this type are developed in the upland adjacent to the main-stream courses. The mounds are more or less circular in shape, 20 to 40 feet in diameter, and 1 to 3 feet above the general level of the intervening depressions.

The soil, on the whole, has fairly good surface drainage. The type occupies the highest topography positions. Ditches can usually be depended upon to drain the cultivated areas properly. It has not yet been extensively cultivated. At present, it is used mostly for the production of corn and truck crops. The indications are that this soil will prove to be better adapted to the production of truck than to general farming. The physical nature of the soil and its situation combine to make it an early soil.

A poorly drained phase is most extensively developed at the heads of some of the drainage courses, where drainage is markedly deficient. Inundations are frequent enough to make this phase practically useless under natural conditions for any purpose except grazing.

Crowley Clay. The surface is a bluish-gray to brownish-gray or brown to dark-brown silty clay, in many places slightly mottled, 4 to 8 inches deep. The subsoil consists of a bluish-gray to dark bluish-gray, sticky heavy clay, mottled with yellow or brown or shades of these colors.

Most uncultivated types of this area are marked by slight hummocks not more than 8 inches high with shallow intervening depressions but a few feet across. On the hummocks the subsoil comes to within 2 or

3 inches of the surface and consists of a mottled light bluish-gray and yellowish-brown clay. Where plowed this subsoil is turned up and causes light-colored spaces in the fields.

Cultivation is difficult in such areas for a few years until the subsoil has thoroughly weathered and has had organic matter incorporated with it. Where the surface soil is deep, it works up into a loamy, friable seed bed, even though plowed in a wet condition. This type occupies 5.3 per cent. of the area. It occurs in moderately sized areas in different parts of the county. The topography is nearly level. Drainage may be perfected by ditching. Much of the land is utilized for growing rice, to which it is well adapted.

Yields of rough rice range from 35 to 65 bushels per acre, with probably an average of about 45 bushels. Few crops besides rice are grown. This soil needs legume-rotation, with phosphoric acid and, sometimes, lime.

Lake Charles Clay. The surface is a dark gray or bluish-gray to black clay, frequently faintly mottled with yellowish-brown or rusty brown, 12 to 16 inches deep. The subsoil is similar to the surface soil, slightly lighter in color, which is generally a bluish-gray, more or less mottled with yellow and brown. Some iron or lime concretions occur in the subsoil, and gypsum crystals are occasionally present. The subsoil is close to the surface in spots in certain areas. The clay soil of this type is very plastic and sticky when wet, but usually crumbles and breaks down on drying, even when the land is plowed wet.

This is the most extensive and one of the most important soils in the county. Typical areas are found just west of Beaumont and in the vicinity of Port Arthur, Amelia, China, Nome, Fannett, Cheek, and Nederland.

Since the surface is apparently flat and level, natural drainage is poor. It is considered the most valuable type in the county for rice-growing, for which it is utilized almost exclusively. Yields range from 36 to 72 bushels of rough rice per acre. Where the crop is grown continuously several years, yields often fall to 25 to 30 bushels per acre or less. Some corn is grown, the yields ranging from 20 to 50 bushels per acre, but the soil is not adapted to this crop unless well drained and places in good condition. Cabbages, onions, turnips, and rutabagas make fair yields where drainage is adequate, but as a rule this soil is not well suited for vegetables. Forage crops, such as sorghum and Egyptian wheat, yield well. Pears, figs, plums, and blackberries are grown in a small way with fair success.

This soil is naturally quite productive, and with adequate drainage it could be utilized for many crops. A phase of the Lake Charles clay consists of a heavy black clay, 10 to 14 inches in depth, underlain by a slate-colored or light bluish-gray clay, which becomes lighter in color with depth, and faintly mottled in the lower part of the profile with yellow and brown.

It is low in active phosphoric acid, good in nitrogen, likely to need potash, and sometimes acid. A legume-rotation, with the use of acid phosphates, is the first need.

Lake Charles Fine Sand. This is a brown or dark brown fine sand, 8 to 15 inches deep, underlain by a lighter brown to yellowish-brown

fine sand. Sometimes the subsoil changes to gray to yellow in the lower part of the three-foot section. Shell fragments are present in the soil and subsoil in some areas.

This is not an extensive type. It is found in a few narrow strips in the southeastern part, just west and southwest of the town of Sabine Pass. It occupies slight swells, locally called "ridges," which lie a few feet above the Lomalta clay. These ridges are gently undulating and the drainage is good. The type is cultivated extensively. It is especially suited to the production of vegetables and is utilized largely for this purpose. Cotton and corn are also grown, and good yields of these crops are obtained. The principal vegetables grown are sweet potatoes, which yield 150 to 300 bushels per acre. Irish potatoes yield about 100 bushels per acre, and cantaloupes and watermelons are of fine quality and yield well. Cucumbers, peanuts, beans, peas, squashes, asparagus, and many other vegetables may be grown with success on this soil. The sample examined is well supplied with plant food and probably will need nitrogen first.

Lake Charles Silty Clay Loam. The surface is a dark gray to nearly black, rather friable silty clay loam, underlain at 10 to 18 inches by a heavy, plastic clay, mottled bluish-gray, yellow, and yellowish-brown, or gray slightly mottled with yellow or brown. The subsurface has a lighter color than the upper portion.

The soil clods when plowed but crumbles on drying to a better tilth than is usually the case with silty clay loam. No very large bodies of this type exist in Jefferson County, but there are many areas of moderate size scattered throughout the county.

The surface is nearly level, though a little more sloping than the Lake Charles clay. The native vegetation consists of prairie grasses and broom sedge. It is well adapted to the production of rice, and is largely utilized for that crop. From 35 to 75 bushels of rough rice are produced per acre. This is also the best general farming soil in the county, and it is utilized to a considerable extent for growing crops other than rice. Corn is said to yield 30 to 50 bushels and cotton as high as 1 bale per acre. With adequate drainage the soil may be used for the production of cabbage, beets, turnips, Irish potatoes, and other truck crops. It is also adapted to the growing of alfalfa, sugar cane, and sorghum. Blackberries, plums, figs, pecans, and pears grow well on the better drained areas. This type is capable of producing a great variety of crops and easily can be maintained in a high state of productiveness.

A phase includes those areas of the Lake Charles silty clay loam in which hummocks of very fine sandy loam are sufficiently numerous to interfere with cultivation and the proper distribution of irrigated water for rice-growing. Much of the land is utilized for rice, but the crop does not yield well on the mounds, which it is impracticable to irrigate. It may be used for growing truck crops or general farm crops.

This soil is likely to need phosphoric acid and nitrogen first.

Lake Charles Very Fine Sandy Loam. This consists of a very dark grayish-brown or dark brown to nearly black very fine sandy loam underlain at about 10 to 16 inches by a grayish-brown to brown very fine sandy loam or loamy fine sand, which is in turn underlain at 18

to 30 inches by mottled yellow and bluish clay, quickly passing into mottled bluish-gray and bright red, plastic heavy clay. Between the mounds of the typical soil described above there are frequent patches of the clay or silty clay loam members of the Lake Charles series.

The soil clods to some extent, but is easily brought into good tilth. It occurs in strips and in small bodies in all sections of the county except in the marsh region. This type is slightly elevated above the heavier-textured prairie soils, and has somewhat better drainage. The mounds, which rise from 1 to 3 feet above the intervening depressions, make the surface in detail gently undulating. Probably 50 to 75 per cent. of the area included in this type is formed by these mounds.

This is a prairie type. Much of this soil is in cultivation, as it is comparatively well drained. It is light and easy to cultivate and warms up early in the spring, producing a rapid growth of crops. The type is not considered a good rice soil, owing to the impracticability of irrigating the mounds. The soil gives good yields of cotton and corn and is adapted in texture and climatic conditions to the production of truck crops. Corn yields 20 to 50 bushels and cotton one-half to 1 bale per acre. Cabbage, rutabagas, and turnips are grown as winter crops, and sweet potatoes, Irish potatoes, peanuts, watermelons, cucumbers, cantaloupes, tomatoes, onions, squashes, beans, and peas are grown. Of these, sweet potatoes, Irish potatoes, watermelons, cantaloupes, and cucumbers are grown most extensively. The yield of sweet potatoes is ordinarily 200 to 250 bushels and of Irish potatoes about 90 bushels per acre. Some strawberries are grown, and yield early and abundant crops. The soil is also adapted to blackberries and dewberries. Of the tree fruits, figs do well. Pear, peach and pecan trees make a thrifty growth.

The soil needs phosphoric acid and nitrogen first. A legume-rotation is necessary for permanent fertility.

Lomalto Clay. This consists of a bluish-gray to bluish-black silty clay, mottled with rusty brown, 12 inches deep, passing into dark bluish-gray silty clay, and this into light bluish silty clay, faintly mottled with yellowish or brownish colors. The lower subsoil is sometimes a greenish-yellow or yellow sandy clay containing concretions of lime and fragments of seashells.

This is a very extensive type, occupying the entire southern part of the county in a large connected area, 3 to 14 miles wide, which reaches across the county east to west but is confined to the low, flat, semi-marsh area lying along the Gulf coast, and locally called "marsh" or "salt marsh." It is almost flat and basin-like, and much of the time water stands on the surface, which is very little higher than the water of the Gulf at ordinary high tide. At present it is not possible to cultivate any of the type owing to lack of drainage. It supports a heavy growth of the vegetation found in brackish or fresh water marshes. The only way the Lomalto clay could be drained would be by diking and pumping. The gentle slopes are somewhat better drained than the Lomalto clay. The land is utilized with the Lomalto clay for grazing.

Marsh. The surface is a dark bluish-gray to bluish-black silty clay, 12 to 15 inches deep, grading into a somewhat lighter-colored subsoil, usually a bluish-gray silty clay, slightly mottled with yellow or brown.

This type is found in a number of large areas along the Neches River, reaching from just below Beaumont to Sabine Lake. Marsh is a very low and flat or slightly basin-shaped land. It lies but a few inches above the streams and is overflowed by a slight rise above their normal levels. Water from rains remains on the surface until evaporated and the surface is wet for months. In fact, the soil is usually in a saturated condition. The only practicable method of drainage would be that of diking and pumping.

In its present condition Marsh is utilized for grazing. If properly drained, the soil would probably be capable of producing good yields of rice, cotton, corn, and other crops, including probably sugar cane.

Sanders Clay. This consists of a brownish-gray to dark bluish-gray silty clay, often mottled with yellowish-brown or rusty brown, underlain from about 2 to 6 or 8 inches by bluish-gray or gray plastic silty clay, mottled usually with yellow.

The Sanders clay lies in the first bottom of the Neches River and its main tributary, Pine Island Bayou. The principal areas are found in the northeastern part of the county. It is 15 to 20 feet below the general level of the upland and is comparatively flat, except for rather shallow, slough-like channels through which the run-off from the adjoining mainland finds its way to the main stream. The entire area of the Sanders clay is usually covered with water two or more times a year by overflows which take from one to several weeks to subside.

The Sanders clay is heavily timbered. The soil is not suited to any agricultural use in its natural condition.

SOILS OF SMITH COUNTY

Smith County is located in the northeastern section of Texas, in the district commonly termed East Texas. The elevation is 300 to 600 feet above sea level. The surface is mainly gently rolling to moderately hilly.

The three types of soil most widely distributed are the Ruston fine sandy loam, which occupies 22.7 per cent. of the area; the Susquehanna fine sandy loam, 21.9 per cent.; and the Norfolk fine sand, 18 per cent. The other types occupy small proportions. Table 12 shows the average pounds of plant food in the soil per two million pounds of soil, which is approximately equal to the weight of one acre of soil to the depth of $6\frac{2}{3}$ inches. The average composition of the soil has already been given in Table 2. The interpretation of analyses of the soil of Smith County is given in Table 13.

Three of these soil types are classed as good in total phosphoric acid, eight are classed as fair, and four as low. Five soils are classed as good in acid-soluble potash, three as fair, seven as low. One type is considered high in lime, five are good, seven are fair, and two low. A number of the soils are acid, but the acidity is usually not high. The corn possibility for active phosphoric acid varies from 6 to 45 bushels. The corn possibility of the active potash varies from 29 to 80 bushels. The corn possibility of the total nitrogen varies from

13 to 45 bushels. It is evident from the above that the soils of this county are generally only fairly well supplied with plant food. An examination of Table 2 shows that this county averages lower in plant food than any of the counties discussed in this bulletin.

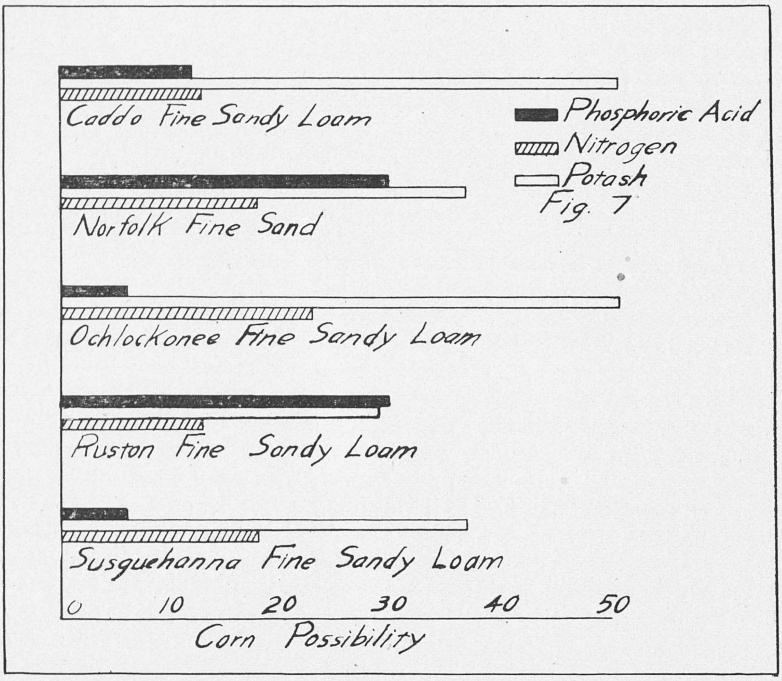

Figure 7. Corn possibility of active phosphoric acid, active potash and totals nitrogen, soils of Smith county.

Fertilizers are needed, are generally used in this county, and crops respond well to them. Phosphoric acid and nitrogen are needed most of all, and potash is needed to the smallest extent. The use of proper fertilizers and a good legume-rotation are very important to the agriculture of this county.

ACIDITY

A number of the soils of this county are acid, and the use of lime to correct the acidity of these soils is desirable in some cases. Table 14 shows the number of samples of each type examined for acidity, and the number found acid, and the average acidity of those which were acid. The use of lime on soils is discussed in Bulletin No. 243, and one should write for that bulletin for a complete discussion. We do not recommend the use of any lime except in connection with a proper legume rotation. It usually requires 500 pounds of lime to correct acidity of 100 parts per million.

Table 12. Average in pounds per two million, soils of Smith county.

	Phosphoric acid		Potash		Nitrogen	Acid soluble lime	Basicity	Acidity	Acres	Per cent of area
	Total	Active	Acid soluble	Active						
Bienville fine sand	1520	278	1800	305	920	6800	2600	0	1,024	0.2
Subsoil	1340	68	1400	390	480	4400	8800	0	.....	.....
Caddo fine sandy loam	560	38	1600	222	720	2800	3200	230	3,200	5.6
Subsoil	640	16	5400	134	920	2000	7000	1330	.....	.....
Kalmia fine sand	700	88	2400	160	1000	1800	0	0	1,984	0.3
Subsoil	940	48	1600	143	440	1000	0	0	.....	.....
Norfolk fine sand	660	83	400	50	480	1300	300	0	102,976	18.0
Subsoil	340	42	100	102	400	3000	400	0	.....	.....
Norfolk fine sandy loam	520	24	1000	172	660	5600	2000	.....	15,744	2.8
Subsoil	440	14	3800	285	680	4400	400	1800	.....	.....
Ochlockonee clay	2840	161	7200	230	2980	5800	1000	4200	12,046	2.1
Subsoil	1120	42	1000	312	1160	1400	3000	11700	.....	.....
Ochlockonee fine sandy loam	1040	18	2400	215	1500	2400	7200	.....	37,056	6.5
Subsoil	1220	16	1200	132	660	1800	7000	.....	.....	.....
Ochlockonee silty clay loam	1680	68	7200	305	2920	4200	6000	2200	11,136	2.0
Subsoil	1040	46	3600	177	1280	2000	2800	2200	.....	.....
Orangeburg fine sandy loam	620	74	1400	150	560	3200	2400	460	6,464	1.1
Subsoil	760	6	5400	247	620	3600	6300	460	.....	.....
Ruston fine sand	960	148	1200	141	1000	5000	2000	.....	7,360	1.3
Subsoil	760	36	1600	.....	520	2600	2000	.....	.....	.....
Ruston fine sandy loam	740	84	1200	85	540	400	800	.....	129,792	22.7
Subsoil	740	15	4800	310	640	6000	7600	.....	.....	.....
Ruston gravelly sandy loam	140	32	1600	332	940	3200	4000	0	9,536	1.7
Subsoil	1120	6	6000	346	940	3400	3000	460	.....	.....
Susquehanna fine sandy loam	1120	20	2600	.....	1100	2800	5600	0	125,184	21.9
Subsoil	1280	13	5000	.....	800	2200	4800	230	.....	.....
Susquehanna gravelly sandy loam	760	21	1200	72	760	1800	1000	0	13,248	2.3
Subsoil	1740	11	9400	285	1040	2600	3000	1200	.....	.....
Trinity clay	1920	122	11400	76	3020	21400	3400	0	3,648	0.6
Subsoil	1380	38	8600	.....	1800	16800	3000	0	.....	.....
Average surface soils	1119	84	2907	180	1273	4567	2964	645	.....	.....
Average subsoils	991	28	3926	239	826	3813	4221	1615	.....	.....
Average upland surface soil	743	62	1325	127	728	2863	2175	138	.....	.....

Table 13. Soil types of Smith county, interpretation of analyses.

	Total phosphoric acid	Acid soluble potash	Lime	Corn possibility two million pounds			Yields claimed	
				Active phosphoric acid	Active potash	Total nitrogen	Cotton, bales	Corn, bushels
Bienville fine sand	Fair	Fair	Good	45	80	18	¼–½	8–20
Caddo fine sandy loam	Low	Low	Fair	12	51	13	¼–2/3	15–30
Kalmia fine sand	Fair	Good	Fair	30	37	18	¼–½	8–20
Norfolk fine sand	Fair	Low	Good	30	37	18	1/5–1/3	5–20
Norfolk fine sandy loam	Low	Low	Good	12	37	13	1/3–¾	15–40
Ochlockonee clay	Good	Good	Fair	40	51	43	½–1	40–65
Ochlockonee fine sandy loam	Fair	Good	Fair	6	51	23	.....	.....
Ochlockonee silty clay loam	Good	Good	Good	24	80	43	1/3–¼	15–40
Orangeburg fine sandy loam	Fair	Low	Fair	24	37	13	¼–1	15–20
Ruston fine sand	Fair	Fair	Good	35	37	18	1/3–1/5	8–20
Ruston fine sandy loam	Fair	Low	Fair	30	29	13	1/3–¾	15–30
Ruston gravelly sandy loam	Low	Low	Low	12	80	18	½	.....
Susquehanna fine sandy loam	Fair	Fair	Fair	6	37	18	¼–½	10–20
Susquehanna gravelly sandy loam	Low	Low	Low	12	29	13	1/5–½	10–20
Trinity clay	Good	Good	High	12	.....	28	.....	.....

Table 14. Acidity of soils of Smith county.

	Number of samples	Number acid	Average acidity of acid soils per million
Bienville fine sand	1	0	0
Caddo fine sandy loam	2	1	230
Kalmia fine sand	1	0	0
Norfolk fine sandy loam	1	0	0
Ochlocknee clay	1	1	2100
Ochlocknee silty clay loam	1	1	1100
Orangeburg fine sandy loam	1	1	230
Ruston gravelly sandy loam	1	0	0
Susquehanna fine sandy loam	3	0	0
Susquehanna gravelly sandy loam	1	0	0
Trinity clay	1	0	0

NEEDS OF THE SOILS IN THIS AREA

The following suggestions are made for improving the fertility of the soils of Smith County:

The first suggestion is a proper legume-rotation, including a legume to be turned under or grazed off, for the purpose of securing nitrogen from the air and adding vegetable matter to the soil, and having other favorable influences upon the soil. Soils of this county are low in nitrogen, and a rotation of this kind is practically needed.

The second suggestion is the use of phosphoric acid, nitrogen, and potash, in fertilizers, varying in composition and quantity with the treatment that the soil has received and its character. After the legume-rotation has been established, the amount of nitrogen purchased in fertilizer should be limited. Nitrogen is too expensive to buy in large amounts for ordinary farming. The chief need of these soils for plant food, after the legume-rotation is established, is phosphoric acid. Potash will be needed, but in less quantities.

All manure and vegetable matter possible should be saved and returned to the soil. Wood ashes should be used as a fertilizer whenever possible, also ashes from cotton gins or sawmills if these ashes have not been exposed to rain.

Lime may be used on soils which are known to be acid, or which are heavy clay in character, but only in connection with a proper legume-rotation and for crops which respond to lime. Lime alone may result in increased crops on some of the soils for a few years, but the final result would be impoverishment of the soil, unless used with a legume-rotation. Watermelons, cowpeas, Irish potatoes, and some other crops receive little benefit from lime. Limestone screenings may be bought for about $1.00 a ton in carload lots.

Legume-rotation, proper fertilizer, and proper use of lime sum up the needs of the soil of Smith County for the increase and maintenance of fertility.

ALKALI

Although Smith County is in a section of the State which receives an abundant rainfall, alkali is sometimes found in low, poorly drained spots. A sample of soil taken from a garden at Tyler which appeared to be subirrigated, and on which vegetables died with no apparent reason, was found to contain, in parts per million, the following amount

of salts soluble in water: carbonate of lime 225, sulphate of lime 81, calcium chloride 105, chloride of magnesia 132, chloride of soda 71. Other samples of soil containing alkali have also been secured from East Texas. The remedy is underdrainage, either by tile drains, or by an open drainage ditch extending through the center of the spot. It should not be difficult to wash out the alkali with proper drainage conditions. The water must pass through the soil and into the drainage ditch, thereby carrying the alkali with it.

DESCRIPTION OF SOIL TYPES, SMITH COUNTY

Bienville Fine Sand. This consists of brown or grayish-brown fine sand, underlain at about 8 inches by light-brown fine sand, which grades below into yellowish-brown fine sand.

It occupies only a small area, mainly in and along the bottoms on the Sabine and Neches Rivers and their principal tributaries. This type occurs on low hummocks or swells and terraces standing above normal overflow.

A small part of the type has been cleared and is cultivated principally to corn and cotton. Cowpeas are grown to some extent in conjunction with corn. Crops are subject to injury by drought during protracted dry periods. Corn yields 8 to 20 bushels, and cotton one-fourth to one-half bale per acre. Cowpeas give fair yields.

This soil needs legume-rotation and phosphoric acid first.

Caddo Fine Sandy Loam. The surface is a gray or dingy gray loamy fine sand, which grades into yellowish fine sandy loam. The subsoil, beginning at about 12 to 18 inches, is a yellow fine sandy clay, which passes below into rather compact fine sandy clay, mottled with grayish and yellowish or grayish-yellowish and reddish colors.

Low, dome-shaped or irregular mounds, 2 to 3 feet in height and about 15 to 60 feet in diameter surrounded by poorly drained depressions, give some areas of this type a hummocky surface. It is moderately extensive, but widely distributed over the county, particularly in the southwestern and southeastern parts. It occupies the undulating tops of comparatively broad divides, the gently sloping valley sides and low-lying approaches to streams, and the slightly depressed areas around stream heads.

The surface drainage and internal drainage are not well developed. A fairly large part of the type is under cultivation. Cotton produces about one-fourth to two-thirds bale and corn 15 to 30 bushels per acre. Owing to the prevailing poor drainage, it is considered advisable to plant corn and cotton on ridges.

This soil needs legume-rotation first, phosphoric acid second, and it will probably need potash also.

Kalmia Fine Sand. The Kalmia fine sand consists of a grayish loose fine sand, overlying at about 6 inches a yellowish-gray to pale-yellow fine sand. This type occurs on stream terraces, standing 5 to 15 feet above the first bottom.

It is relatively unimportant in extent. The principal area mapped is in the Neches River bottoms between Wallace and Lake Bridge crossings.

The topography is generally level, but low mounds, small depressions, and slight ridges occur. This type possesses good natural drainage.

About 25 per cent. of this type is cultivated, mainly to corn and cotton. Newly cleared land is productive, but yields decline with continued cultivation. Cowpeas are grown to some extent. Corn yields 8 to 20 bushels per acre and cotton one-fourth to one-half bale, without fertilizers.

This soil needs legume-rotation first, phosphoric acid next, and potash will be needed also in a comparatively short time.

Norfolk Fine Sand. This consists of a gray loose, fine sand, which passes at 5 or 6 inches into pale-yellow, yellowish-gray, or gray, loose fine sand. Ordinarily the fine sand subsoil continues without change into a depth of 36 inches or more, but in places the lower subsoil is somewhat loamy, and in some spots the deep subsoil is a yellowish, friable sandy clay, such areas representing a deep phase of Norfolk fine sandy loam.

The Norfolk fine sand is widely distributed in this county. The largest continuous bodies extend from just north of Tyler northeastward for a distance of about ten miles. Small isolated areas are found in all sections of the uplands.

It occupies nearly level to undulating plateau-like areas on the tops of ridges or divides, gently sloping areas on the lower slopes or approaches to stream bottoms, and gently rolling to rolling or hilly areas, where it occurs in large tracts. The open or porous structure of this soil gives good drainage. Probably less than one-half of this type is in cultivation. The principal crops are cotton and corn. Cotton is the money crop and corn is grown chiefly for the work stock. Peaches, strawberries, blackberries, and dewberries are grown locally for market.

Cotton yields about one-fifth to one-third bale per acre, and corn averages 5 to 20 bushels per acre. Sweet potatoes yield 75 to 125 bushels per acre. This is a good soil for early truck, and it is used in many parts of the South for trucking. This soil needs legume-rotation, phosphoric acid, and evidently potash; a complete fertilizer is needed for truck.

Norfolk Fine Sandy Loam. This consists of 6 to 8 inches of fine grayish sand, which grades into pale-yellow to yellowish-gray loamy fine sand to fine sandy loam, and this at a depth of about 12 to 24 inches grades into yellow, friable fine sandy clay.

The largest areas occur in the vicinity of Tyler. This type is not extensively developed, but a number of isolated areas of about 10 to 400 acres occur throughout the county. The type occupies divides and gently sloping valley-sides. Some of the slopes need terracing to prevent erosion. The clay subsoil is retentive of moisture, a property which makes this type one of the most drought-resistant soils of the county. The soil can be worked under a wide range of moisture conditions.

It is a good farming soil. The principal crop is cotton. Corn yields about 15 to 40 bushels per acre, and cotton about one-third to three-fourths bale. Sweet potatoes yield about 100 to 200 bushels per acre. The type is considered well adapted to strawberries, tomatoes, blackberries and dewberries. Peanuts, cowpeas, sorghum, oats, rye, and milo are grown for forage.

This soil needs legume-rotation and phosphoric acid, and it will need potash in a comparatively short time.

Ochlockonee Clay. This is a brown to mottled brown and drab silty clay, which grades at a depth of about 2 to 5 inches into yellowish, plastic silty clay, usually mottled with light drab. The subsoil becomes more compact and more conspicuously mottled with drab as the depth increases.

It is the most extensive bottom-land soil in the county. It occupies a greater part of the Sabine River bottoms. The type is subject to deep overflow, and owing to the generally level surface and the impervious nature of the subsoil, drainage is poor. Owing to the probability of overflow, this type is not cultivated. It supports a large forest growth.

This soil is well supplied with plant food.

Ochlockonee Fine Sandy Loam. This consists of stream-bottom land varying widely in texture. The dominant soil is a brownish-gray to brown or dark-brown loamy fine sand to fine sandy loam, underlain at about 10 inches by brownish fine sandy loam to sandy clay usually mottled with rusty brown, or in places with yellowish and gray colors. Near the larger streams and the low-lying areas and depressions where drainage between the overflows is poorest, the subsoil is in places a sticky, mottled, fine sandy clay, while along the smaller streams the texture varies to loamy fine sand or loam.

It occurs along most of the streams of the county. The surface is nearly level. Drainage is fair. The soil is productive where protected from overflow, except in years of abnormally heavy rainfall during the growing season. The most important crops grown are corn, cotton, and sugar cane, with Bermuda grass for pasture and hay. In favorable years, where protected from overflow, corn yields 40 to 65 bushels, cotton as much as one bale, and sugar cane as much as 200 gallons of syrup per acre. Corn does much better than cotton on unprotected areas.

Bermuda grass and other grasses furnish good pastures through the greater part of the year.

This soil is well supplied with plant food. It will need a legume-rotation for permanent fertility.

Ochlockonee Silty Clay Loam. This is a brown or mottled brown, rusty drab silty clay loam, grading at about 8 to 10 inches into mottled brown, yellowish and drab, silty clay, which shows more yellowish and drab and less brown in the lower part. Strata of gray fine sandy loam and fine sand a few inches in thickness are often encountered in the subsoil.

This is an important bottom-land soil. The surface is comparatively level and subject to short periods of overflow. The drainage is slow, owing to the level surface and to the retentive nature of the subsoil. Owing to the probability of damaging overflows during the growing seasons, only a very small acreage of this type is cultivated. Corn, cotton, and sugar cane are the only crops grown. Corn does fairly well, yielding 15 to 40 bushels per acre. Cotton does best in seasons of moderate rainfall. Yields range from one-third to one-fourth bale per acre. Sugar cane is grown for syrup. Yields range from 100 to 250 gallons of syrup per acre.

Much of this type is capable of cultivation if protected from overflows. The main-stream channels can be straightened and lateral ditches constructed to provide for more rapid and complete removal of excess drainage water. This and the diking of the cultivated areas have been successfully employed in reclaiming a considerable area.

This soil is well supplied with plant food. It will need a legume-rotation first.

Orangeburg Fine Sandy Loam. This is a gray or slightly brownish-gray fine sand, which grades through several inches of pale-yellowish or reddish-brown fine sand or fine sandy loam into red, friable fine sandy clay at about 10 to 20 inches. In places a few iron concretions are present in the surface soil. The principal areas are associated with the Greenville soils in the southern and southwestern part of the county. Other areas of importance occur near Whitehouse and on both sides of Harris Creek, near Winona. A number of small isolated bodies are scattered over the remainder of the county.

This type occurs on broad divides and gentle slopes. The topography varies from almost level to undulating and gently rolling. Cultivation can be safely carried on within a day or two after heavy rains. The soil is quite retentive of moisture and crops do not suffer from drought, except during exceptionally long dry periods. It is easily cultivated. Practically all of the Orangeburg fine sandy loam is under cultivation.

This type is considered one of the most important soils of the county for general farm crops, vegetables, strawberries, and peaches. Cotton is the principal crop grown. It yields one-fourth to one bale per acre. Corn produces 15 to 20 bushels per acre. Oats are usually cut for hay, and produce good yields. Several peach orchards are located wholly or partly in this soil, and the growers consider it one of the best peach soils in the county.

This soil needs a legume-rotation and nitrogen first, phosphoric acid next, and it will need potash in a comparatively short time.

Ruston Fine Sand. This consists of a gray loose fine sand, which passes at about 12 to 16 inches into reddish-yellow and then into yellow-red or dull red fine sand, usually slightly loamy in the lower part of the three-foot section. Ordinarily this type is very uniform in character.

It occurs mainly in the western half of the county, on relatively broad ridges and gently sloping sides of valleys. The surface features vary from undulating to gently rolling or gently sloping.

During dry periods the crops often suffer from lack of moisture. Cultivated areas are devoted mainly to the staple crops, cotton and corn. Peaches, blackberries, dewberries, and strawberries are grown to some extent. Newly cleared fields give moderate yields of cotton and corn for several years, but under the prevailing methods of growing clean cultivated crops without rotation, the yields decrease rapidly. Cotton averages about one-third bale per acre on new land, and about one-fourth to one-fifth on old. The yield of corn ranges from about 8 to 20 bushels per acre. Peaches do well in favorable years.

This soil needs a legume-rotation first. It will need both phosphoric acid and potash in a short time.

Ruston Fine Sandy Loam. This consists of 6 to 12 inches of gray or slightly brownish-gray fine sand or loamy fine sand, grading below

into pale yellow to slightly reddish or buff fine sandy loam. The subsoil is a dull red or brownish-red to yellowish red, friable fine sandy clay. There are many places in which mottlings of yellow and red appear in the lower subsoil.

Fragments of iron sandstone and iron concretions are often encountered in small amounts in the surface soil. The Ruston fine sandy loam is the most extensive type in Smith County. The principal areas occur near Whitehouse and the Cherokee County line and to the east and north of Arp, but the greater part of the type occurs as relatively small areas, separated or interrupted by other upland soils. This type occurs both on rather broad, undulating ridges and on moderately sloping valley sides. The surface features vary from undulating to gently rolling and sloping.

Considerably more than one-half of the type has been cleared and put into cultivation. It is considered a very desirable soil for the general farm crops of the region. Cotton is the main crop; corn yields about 15 to 30 bushels per acre without fertilization. Cotton yields range from about one-third to three-fourths bale per acre. Sweet potatoes yield from 100 to 150 bushels, and Irish potatoes from 80 to 100 bushels per acre, but these are not very important crops.

This soil needs legume-rotation first. It will need phosphoric acid and potash in a short time.

Ruston Gravelly Sandy Loam. This consists of grayish to brownish gravelly fine sand. The subsoil, beginning at about 8 to 16 inches, is a yellowish to dull red, moderately friable fine sandy clay. The subsoil is usually compact in the lower part of the three-foot section, and is mottled with shades of red and yellow. Small angular fragments and pebbles of ironstone and iron sandstone are plentifully distributed over the surface and disseminated through the soil.

This is not an extensive type, but it is rather widely distributed through the eastern half of the county. It occurs on the tops of rather narrow divides, on knolls, and along abrupt slopes and bluff lines. Cultivation is confined to the few smooth areas and the moderately sloping areas. The type is fairly productive. Cotton, peaches, and early tomatoes are the crops most commonly grown. Cotton yields about one-half bale per acre.

This soil needs phosphoric acid, legume-rotation first, and will shortly need potash.

Susquehanna Fine Sandy Loam. This surface consists of a grayish fine sand or loamy fine sand grading quickly into pale yellow to reddish loamy fine sand to fine sandy loam. The subsoil, beginning at a depth of about 6 to 20 inches, is red, plastic, heavy clay, which becomes increasingly mottled with drab or yellow or both colors as the depth increases. The texture and structure of the subsoil continue uniform to a depth of three feet or more.

It is an extensive and important soil widely distributed over the uplands of the county. The principal areas occur in the southeastern part of the county, east and northeast of Troup, and in the northwestern part between Starrville and the Sabine River. There are many smaller areas associated with the other upland soils of the county.

The type occurs mainly on valley slopes and varies from undulating and gently sloping to steep and hilly. The chief difficulty in the cul-

tivation arises from erosions on slopes. The heavy subsoil absorbs water so slowly that the loose, sandy surface soil is soon saturated during heavy rains. When it is in this condition, the drainage water flowing down the slopes carries with it large quantities of the surface soil and frequently develops pronounced gullies.

Less than one-half of the type is in cultivation. Farming is largely on newly cleared land and yields decrease with cultivation. Cotton and corn are the principal crops. Cowpeas are grown in the small acreage. Corn yields about 10 to 20 bushels and cotton one-fourth to one-half bale per acre. Winter oats are grown to a small extent for forage. Sorghum for forage yields moderately well but is not extensively grown.

This soil needs phosphoric acid and legume-rotation first, and will need potash soon.

Susquehanna Gravelly Sandy Loam. This is a gray to brownish-gray gravelly fine sand, 6 to 8 inches deep, passing into a brownish to reddish brown gravelly fine sandy loam. The lower subsoil consists of a red, plastic, heavy clay, usually mottled with yellow and gray in the lower part. The surface soil and, in places, the subsoil, is slightly gravelly.

The gravel consists mainly of fragments of ironstone, iron sandstone, and iron concretions, usually less than two inches in diameter. It occurs principally on the tops of hills, knolls or ridges, and on the abrupt slopes to the stream bottoms. The most pronounced slopes are in many places badly eroded and gullied. This type is fairly extensive and is widely distributed over the plains. Some of the principal areas are found west of Swan, in the vicinity of Red Springs school in the north-central part of the county, along the east side of Harris Creek, and in the southeastern section at Troup. Cultivation is confined to the smoother areas. The cultivated areas are devoted largely to cotton, which ranges in yield from one-fifth to one-half bale per acre.

Corn and oats are of some importance. Corn yields about 10 to 20 bushels per acre. Winter oats make good yields when cut for hay. The type is considered a good early soil for vegetables, such as tomatoes. Crops requiring a long growing season frequently are injured by drought in the latter part of the summer. Tomatoes are also grown. Sweet potatoes are grown for home use.

This soil needs phosphoric acid and legume-rotation first, and will need potash soon.

Trinity Clay. This is a dark-drab to nearly black silty clay, 4 to 6 inches deep, occasionally mottled with brown or rusty brown. This is underlain by a drab or a mottled drab and yellowish-brown, plastic, heavy clay, passing below to a lighter drab clay with little or no mottling. The soil cracks or crumbles when drying out. When wet, it is extremely tenacious and sticky, and travel over roads in areas of this soil is very difficult in rainy seasons.

Only one area of Trinity clay is mapped in Smith County. This consists of a strip ranging in width from a few yards to over one mile, in the Sabine River bottom, extending from the International & Great Northern Railway crossing to the northwestern corner of the county. The type is flat to nearly level, and much of it is poorly drained. It is an alluvial soil. It is subject to overflow and remains wet for long periods after heavy rains or overflows.

Practically none of the Trinity clay is cultivated at present, owing to the probability of overflow.

SOILS OF TAYLOR COUNTY

Taylor County is located just northwest of the center of the State. The central part of the county consists of a series of plateau remnants about 2 to 16 miles wide, with an elevation of 2200 to 2500 feet above sea level, locally referred to as "mountains." The lower part of the county is 2000 to 1700 feet above sea level, with a gently rolling to nearly level surface. The agriculture consists mostly in the production of cotton and live stock, with cereals and forages grown chiefly for feeding the stock. Grains, fruits, and vegetables are grown chiefly for home use.

Abilene silty clay loam is the most abundant type, occupying 12.9 per cent. of the area, and next comes Brackett stony loam, 11.7 per cent. Bastrop silty clay loam occupies 7.3 per cent., Simmons clay 5.2 per cent., and Abilene loam 5.0 per cent.

Table 15 shows the average plant food in pounds to 2,000,000 pounds of soil, or an acre to a depth of about $6\frac{2}{3}$ inches. Table 16 contains the interpretation of analyses of the soil. Twenty-one of the soils are good in phosphoric acid, one is fair, and four are low. Two of the soils are fair in potash, and the remainder are low. Three of the soils are fair in lime, and the remainder are good or high. Not any of these soils are acid. The soils range from 6 to 74 bushels to the acre in corn possibility for active phosphoric acid. Those soils low in active phosphoric acid are for the most part of minor importance. The more important soils are better supplied with phosphoric acid. The corn possibility of active potash ranges from 29 to 227 or more bushels of corn to the acre. The soils are generally well supplied with potash. The corn possibility of the total nitrogen varies from 13 to 48 or more bushels to the acre.

The average soil is compared with other averages in Table 2. The total phosphoric acid is lower than the other counties, but the active phosphoric acid is higher than any except for Webb County.

The acid-soluble potash is also high, as well as the active potash. The total nitrogen is a little larger than that for Bell County, and about twice as high as that for Smith County. The acid-soluble lime is the highest of all counties described in this bulletin.

NEEDS OF THE SOIL OF THE AREA

The first and most important need of the soil for this area is a proper rotation, including a legume to be turned under or grazed off, for the purpose of supplying nitrogen and vegetable matter to the soil, and otherwise helping maintain it in a productive condition. With a proper legume-rotation, connected with the saving of manure, and other sources of plant food, these soils should produce good crops for a long time without fertilizer. Phosphoric acid may eventually be needed on some of the soils, and potash is less likely to be needed. The first and foremost need for permanent soil-fertility is a properly established rotation, systematically carried out, in which a legume is grown for the purpose of renovating the soil.

Table 15. Average in pounds per two million, soils of Taylor county.

	Phosphoric acid		Potash		Nitrogen	Acid soluble lime	Basicity	Acidity	Acres	Per cent of area
	Total	Active	Acid soluble	Active						
Abilene loam	920	86	8600	685	1580	13000	2400	0	29,056	5.0
Subsoil	840	51	9400	377	1160	92600	13000	0	.....	.....
Abilene silty clay loam	1220	107	11100	389	2460	70000	64000	0	75,072	12.9
Subsoil	1260	27	12600	586	1520	120800	151800	0	.....	.....
Bastrop fine sand	420	40	1600	110	600	2400	4000	0	896	0.2
Subsoil	320	14	1800	105	200	2000	1000	0	.....	.....
Bastrop fine sandy loam	700	57	4800	192	1020	4600	7000	0	22,720	3.9
Subsoil	760	16	13200	122	1420	8400	12600	0	.....	.....
Bastrop loam	1160	305	9000	830	1580	31600	62400	0	21,568	3.7
Subsoil	1240	203	12400	445	1280	104600	192800	0	.....	.....
Bastrop silty clay loam	1000	104	17800	641	2220	75800	136800	0	42,432	7.3
Subsoil	1020	48	17400	373	1220	106000	169600	0	.....	.....
Brackett fine sandy loam	440	31	3800	267	640	57800	106000	0	5,696	1.0
Subsoil	460	2	9600	.....	540	364400	200000	0	.....	.....
Brackett gravelly loam	1090	14	8300	71	2740	309900	200000	0	22,400	3.9
Subsoil	1120	15	13800	82	1400	350600	200000	0	.....	.....
Brackett loam	1030	79	7770	408	2340	141100	179500	0	12,864	2.2
Subsoil	780	6	4600	140	1320	420400	200000	0	.....	.....
Brackett stony loam	2060	32	6400	.....	7080	388000	200000	0	68,032	11.7
Crawford silty clay loam	1090	73	14200	1050	3100	333000	57300	0	8,576	1.5
Subsoil	1310	15	13300	665	2090	134800	186000	0	.....	.....
Frio clay	2340	904	16400	1655	4040	57200	108000	0	6,784	1.2
Subsoil	2180	764	16200	.....	2060	56800	198800	0	.....	.....
Frio loam	1470	459	5000	817	1810	33100	61000	0	11,456	2.0
Subsoil	1930	271	10200	597	2350	48700	86900	0	.....	.....
Miles fine sandy loam	660	80	3800	522	900	2800	6600	0	11,712	2.0
Subsoil	1020	14	9800	135	1180	41200	200000	0	.....	.....
Miles gravelly clay loam	1130	74	11600	.....	1890	115000	104000	0	21,696	3.7
Subsoil	1130	36	11300	586	1390	133800	113400	0	.....	.....
Miles loam	1120	208	10400	892	1820	75400	123810	0	28,352	4.9
Subsoil	920	102	15000	252	1480	148200	200000	0	.....	.....
Miles silty clay loam	800	56	9100	765	1700	6100	11500	0	26,048	4.5
Subsoil	880	20	15300	714	1480	57600	97700	0	.....	.....
Miller clay	1720	663	13200	892	2080	46600	96000	0	18,752	3.2
Subsoil	1400	391	12800	675	1020	93000	178000	0	.....	.....
Miller fine sandy loam	730	42	5300	472	920	12400	8000	0	5,120	0.9
Subsoil	640	84	9100	478	920	44100	86100	0	.....	.....
Miller loam	1150	344	9300	951	1440	14500	30800	0	4,864	0.8
Subsoil	1190	350	9400	565	1170	76300	92900	0	.....	.....
Miller silty clay loam	1170	218	9100	345	1180	74000	137800	0	17,600	3.0
Subsoil	.....	.....	.....	.....	.....	.....	.....	.....	32,064	5.5
Rough stony land	980	176	12400	1304	1940	28600	50000	0	29,952	5.2
Simmons clay	1040	140	19200	1080	1440	38800	71000	0	.....	.....
Subsoil	750	45	5000	410	1150	3800	6000	0	1,920	0.3
Simmons fine sandy loam	680	22	16900	676	1160	9000	18500	0	.....	.....
Subsoil	1590	280	21300	560	3020	217800	191810	0	15,360	2.6
Vernon clay	1150	272	23100	182	1050	117000	97800	0	.....	.....
Subsoil										

Table 15. Average in pounds per two million, soils of Taylor County.—Continued.

	Phosphoric acid		Potash		Nitrogen	Acid soluble lime	Basicity	Acidity	Acres	Per cent of area
	Total	Active	Acid soluble	Active						
Vernon fine sandy loam	460	55	3000	470	940	3800	4600	0	16,512	2.8
Subsoil	640	6	15000	.....	1440	12800	23200	0	.....	.....
Vernon gravelly clay loam	1030	68	10100	.....	14300	227900	193100	0	23,616	4.1
Subsoil	1320	529	12700	274	700	22200	115000	0	.....	.....
Average of surface soils	1082	175	9168	652	2524	79144	80584	0	.....	.....
Average of subsoils	1056	145	12524	429	1247	107124	125765	0	.....	.....

Table 16. Interpretation of analysis, Taylor county.

	Phosphoric acid	Potash	Lime	Acidity	Corn possibilities two million pounds			Yield claimed			
					Active phosphoric acid	Active potash	Total nitrogen.	Cotton, bales	Corn	Wheat	Grain sorghums
Abilene loam	Good	Good	High	0	30	157	23	1/5–¾	.....	5–20	10–30
Abilene silty clay loam	Good	Good	High	0	45	157	38	1/5–¾	.....	5–20	10–30
Bastrop fine sand	Low	Fair	Good	0	12	37	13	.....	.....	.....	.....
Bastrop fine sandy loam	Good	Good	Good	0	18	37	18	1/5–¾	.....	.....	10–30
Bastrop loam	Good	Good	High	0	45	182	23	.....	.....	.....	.....
Bastrop silty clay loam	Good	Good	High	0	45	207	33	1/5–¾	.....	5–20	10–30
Brackett fine sandy loam	Low	Good	High	0	18	51	13	1/5–¾	.....	.....	10–30
Brackett gravelly loam	Good	Good	High	0	6	37	38	.....	.....	.....	.....
Brackett loam	Good	Good	High	0	24	120	33	1/5–¾	.....	.....	10–30
Brackett stony loam	Good	Good	High	0	12	.....	48 +	.....	.....	.....	.....
Crawford silty clay loam	Good	Good	High	0	24	182	43	1/5–¾	5–25	5–20	.....
Frio clay	Good	Good	High	0	74 +	227 +	48 +	.....	.....	.....	.....
Frio loam	Good	Good	High	0	50	182	28	1/5–¾	.....	5–20	10–30
Miles fine sandy loam	Fair	Good	Fair	0	24	120	18	1/5–¾	.....	.....	10–30
Miles gravelly clay loam	Good	Good	High	0	24	.....	28	.....	.....	.....	.....
Miles loam	Good	Good	High	0	45	182	28	1/5–¾	.....	.....	10–30
Miles silty clay loam	Good	Good	Good	0	18	157	28	1/5–¾	.....	5–20	10–30
Miller clay	Good	Good	High	0	50	182	33	.....	.....	.....	.....
Miller fine sandy loam	Good	Good	High	0	18	120	18	.....	.....	.....	.....
Miller loam	Good	Good	High	0	45	182	33	.....	.....	.....	.....
Miller silty clay loam	Good	Good	High	0	45	120	33	1/5–¾	.....	5–20	10–30
Simmons clay	Good	Good	High	0	40	207	28	1/5–¾	.....	5–20	10–30
Simmons fine sandy loam	Low	Good	Fair	0	18	120	18	.....	.....	.....	.....
Vernon clay	Good	Good	High	0	35	120	23	1/5–¾	.....	5–20	10–30
Vernon fine sandy loam	Low	Fair	Fair	0	18	120	18	1/5–¾	.....	.....	10–30
Vernon gravelly clay loam	Good	Good	High	0	24	29	23	.....	.....	.....	.....

DESCRIPTION OF SOIL TYPES, TAYLOR COUNTY

Abilene Loam. This consists of a dark reddish-brown to dark-brown or chocolate-brown friable loam, underlain at about 6 to 8 inches by dark reddish-brown to chocolate-brown clay, which passes into a dark yellowish-brown or chocolate-brown, tough clay. At about 24 to 36 inches hardpan of whitish chalky material is encountered. The hardpan is of two kinds: a limestone conglomerate and a clay pan frequently containing gravel.

This type is found in scattered areas in the lower or terrace-plain part of the county. The surface is flat to gently undulating or gently sloping. About one-half of the type is in cultivation. Cotton, milo, kafir, feterita, and Johnson grass are the principal crops, and some wheat and oats are grown.

Yields of cotton vary from one-fifth to three-fourths bale per acre. The grain sorghums yield about 10 to 30 bushels, wheat 5 to 20 bushels, oats 10 to 30 bushels, and Johnson grass about 1 ton to 3 tons of hay per acre.

This type, although loamy, becomes rather compact after heavy rains. A good organic-matter content would make the material mellow and more absorptive of water.

This soil is well supplied with plant food.

Abilene Silty Clay Loam. This consists of dark reddish-brown to dark-brown silty clay loam, underlain at about 6 to 10 inches by dark reddish-brown to brown clay, which passes into dark yellowish-brown or chocolate-brown, tough clay. The lime hardpan or gravel clay pan of the series is usually reached at about 24 inches. In some places only the whitish chalky material is encountered within the three-foot section.

In some places gravel is present on the surface, but not in quantities sufficient to interfere with cultivation.

It is quite extensively distributed throughout the plain-like lower part of the county. The surface is flat or undulating to gently sloping. This is the most extensive soil in the county. Because of its heavy texture, it is more or less subject to drought, but injury from this cause can be materially reduced by proper cultivation.

Cotton, milo, kafir, feterita, Johnson grass, and sorghum cane are the principal crops. The yield of cotton ranges from about one-fifth to three-fourths bale per acre. The grain sorghums yield about 10 to 30 bushels, and oats 10 to 30 bushels, wheat 5 to 20 bushels, while the yield of Johnson grass ranges from about 1 ton to 3 tons per acre. The soil is inclined to pack, and to ameliorate this condition the soil should be plowed deep in fall or early winter and organic matter should be added.

This soil is well supplied with plant food.

Bastrop Fine Sand. This consists of pale yellowish-brown to light reddish-brown, loose fine sand 10 to 15 inches deep, underlain by yellowish to reddish loose fine sand. Some included areas show a fine sandy clay in the lower part of the three-foot section. In the vicinity of Abilene there are some areas having a red mottled and yellow, stiff plastic subsoil.

It occurs in a few scattered areas of relatively small total extent on the old-stream terraces. The surface varies from hummocky to nearly level. This type is of importance in the production of peaches and vegetables, especially near Abilene. In other localities it is used for the production of cotton, corn, and grain sorghums.

It is retentive of moisture. Some trouble is caused by drifting, which at times makes replanting necessary. This tendency to drift can be combated by applying well rotted manure or by plowing under green cover crops.

This soil is low in phosphoric acid and nitrogen, and will probably need potash.

Bastrop Fine Sandy Loam. This consists of a brown to reddish-brown loamy fine sand or fine sandy loam, which is underlain at about 15 to 24 inches by a moderately friable, chocolate red sandy clay, becoming stiffer with increase in depth. In places the chocolate red is reached at 5 to 8 inches. This type is widely distributed over the stream terraces of the county. The surface is level to gently undulating.

It is one of the most desirable soils of the county. Owing to its naturally friable structure, it is easily cultivated, and by reason of its ability to absorb and conserve water, crops seldom suffer from drought. Probably one-half or more of the type is in cultivation. Cotton, milo, kafir, feterita, Johnson grass, sorghum, wheat, oats, and corn are the important crops. In places, as near Abilene and Merkel, vegetables are grown for local markets.

Cotton produces one-fifth to three-fourths bale per acre, the grain sorghums yield about 10 to 30 bushels, and Johnson grass 1 to 3 tons of hay per acre.

The soil examined is low in nitrogen and needs a legume-rotation. It may also need phosphoric acid and potash.

Bastrop Loam. This consists of a reddish-brown or chocolate-brown mellow loam, 6 to 10 inches deep, overlying a chocolate-brown or dark reddish-brown clay, which grades into a reddish-brown clay, containing frequently some whitish chalky lime. In places there is some gravel. This type occurs in several bodies on the old-stream terraces. The surface varies from level to gently undulating.

Cotton and the grain sorghums are the principal crops. Johnson grass, sorghum, oats, and corn are also grown. The soil is easy to work and to keep in a good condition of tilth. It gives good yields of the crops grown.

Bastrop Silty Clay Loam. This consists of a reddish-brown or chocolate-colored silty clay loam, underlain at 6 to 8 inches by a chocolate-red to chocolate-colored clay, which is rather stiff in the lower depths. In places whitish, chalky lime is present in the subsoil.

The type occurs in both large and small areas on the stream terraces. The surface varies from level to gently undulating, and the drainage is adequate though seldom excessive. Probably one-third or more is in cultivation. Cotton, milo, kafir, feterita, Johnson grass, and sorghum for forage are the principal crops. Wheat, oats, and corn are of minor importance. The raising of beef cattle and hogs is important. The yield of cotton ranges from one-fifth to three-fourths bale per acre. The grain sorghum yields 10 to 30 bushels, wheat 5 to 20 bushels, oats

about 10 to 30 bushels, and Johnson grass 1 to 3 tons per acre. The yields of garden crops are uncertain and variable owing to the susceptibility of the type to drought.

This soil is well supplied with plant food.

Brackett Fine Sandy Loam. It consists of grayish-brown fine sandy loam, underlain at a depth of 8 to 12 inches by gray to yellowish-gray, calcareous clay of fairly compact structure. The subsoil in places is somewhat sandy, and sometimes it has a pinkish hue. The surface material includes small limestone fragments, and quartz, chert, and other gravel. The substratum consists of massive limestone and soft, or "rotten," limestone, which is encountered at depths of 1 to 2 feet or more.

This type occurs almost exclusively at or near the base of the rough stony land escarpments of the plateau areas. It occupies fairly steep to long, gentle slopes. The areas are never very large, and the aggregate area of the type is relatively small. Possibly more than one-half of this type is in cultivation, the remainder being largely in pasture. Much of the land is covered with catclaw, cedar, shin oak, and grasses. The principal crops are cotton and the grain sorghums with some corn and small patches of garden crops. The crop yields are one-fifth to three-fourths bale of cotton and 10 to 30 bushels of grain sorghums per acre. The minor crops produce variable yields, the returns depending largely on the amount of rainfall.

This soil is low in nitrogen, and will need phosphoric acid after a few years' cropping.

Brackett Gravelly Loam. It consists of brownish to light gray loam, silty clay loam or clay, underlain at about 3 to 10 inches by whitish, chalky material consisting of soft, partially decomposed limestone. In places yellowish clay is present in the subsoil. Small and moderately large angular fragments of limestone and chert are abundant over the surface and are present throughout the soil section. Limestone exposures are of common occurrence. The type is found in considerable extent at or near the base of the rough, stony land escarpments. Other areas occur mainly in the eastern part of the county. Nearly all of this type is used for grazing. It is low in phosphoric acid.

Brackett Loam. This consists of a grayish brown to dark ashy-gray loam, underlain at about 6 to 8 inches by grayish to yellowish-brown clay, which, in turn, passes into grayish-yellow or whitish, calcareous material. The surface material in places is somewhat sandy, being influenced by colluvial wash from sandy types, and in places it includes an admixture of small limestone fragments, quartz, chert, and other pebbles.

It occurs almost exclusively at or near the base of the rough, stony land escarpments. The surface varies from gently sloping to nearly level. One-half or more of this type is in cultivation, the remainder being largely included in pastures, used mainly for cattle. The principal crops are cotton, the grain sorghums, and hay or forage crops, such as Johnson grass and sorghum. Relatively small quantities of wheat, oats, corn, and garden crops are grown.

Its rather light, friable structure causes the greater part of the type to be easy to work. The soil warms up earlier than the heavier-textured

soils, and crops mature earlier. Crop yields are about the same as those obtained on the Brackett fine sandy loam, and the land is handled in about the same way.

This soil will probably need nitrogen and phosphoric acid first.

Brackett Stony Loam. This surface consists of a brownish to dark gray loam to silty clay loam, grading into whitish, calcareous material, and underlain by limestone, at depths varying from about 2 to 20 inches. In most places angular fragments of limestone and chert are very abundant, and there are occasional exposures of limestone.

This type is found in the tops of the plateaus, remnants occurring as gentle slopes and relatively flat to gently rolling areas. This land supports a scattered growth of cedar, live oak, mesquite, and shin oak. It affords good pasture in favorable seasons, and is largely used for cattle pasture. It is not used for cultivated crops.

Crawford Silty Clay Loam. This consists of a reddish-brown to chocolate-brown friable, silty clay loam, underlain at a depth of 5 to 8 inches by a dull red clay, which becomes quite stiff in the lower part of the three-foot section. Massive limestone is encountered at a depth of about 2 or 3 feet or more. Between the subsoil and the massive limestone there is a layer of several inches of friable chalky material.

It occurs in the top of the plateau remnants as gentle slopes and in flat to gently rolling areas. This type, though not very extensive, is quite important. It includes the greater part of the tillable land of the high plateaus.

The principal crops grown are cotton, the grain sorghums, such as milo, kafir, and feterita, and corn, oats, and wheat. The yields of cotton range from one-fifth to three-fourths bale per acre. Corn yields from about 5 to 25 bushels, grain sorghums 10 to 30 bushels, wheat 5 to 20 bushels, and oats about 10 to 20 bushels per acre. This type includes a number of stony areas in which the bed rock is encountered usually at 5 to 36 inches, and slabs of limestone are scattered over the surface. These areas afford valuable grazing.

This soil is well supplied with plant food.

Frio Clay. This consists of dark-brown to black clay, underlain at 1 inch to 3 or 4 inches by black or very dark-brown calcareous clay. The subsoil is lighter colored in the lower part, usually being brown.

This type is encountered in several areas within the stream bottoms. The surface is flat. Cotton, milo, feterita, kafir, Johnson grass, sorghum cane, wheat, oats, and corn are the principal crops, together occupying about one-third of the total area. This is a very valuable bottom-land soil, well suited to cultivation. The low-lying areas most subject to overflow or with poor drainage are best used as native pasture.

This soil is rich in plant food.

Frio Loam. This consists of a dark-brown to black loam, 6 to 15 inches deep, underlain by brownish-colored to dark drab clay. The lower subsoil in places is calcareous. This soil forms part of the bottom lands. The surface is ordinarily flat, though the area includes hummocks and broad swells.

While of moderate extent, this is one of the more desirable soils of the county. It is easy to till, and with proper cultivation fairly re-

tentive of moisture. Cotton yields about one-fifth to three-fourths bale per acre, the grain sorghums about 10 to 30 bushels, wheat 5 to 20 bushels, and oats about 10 to 30 bushels. Johnson grass yields about 1 ton to 3 tons per acre. Garden crops are uncertain.

This soil is well supplied with plant food.

Miles Fine Sandy Loam. It consists of reddish-brown fine sandy loam or loamy fine sand about 8 to 20 inches deep, underlain by reddish-brown to pinkish, compact fine sandy clay to clay with frequently considerable white, powdery to compact lime layers in the lower subsoil. Some quartz, chert, and small limestone fragments are present in the surface soil of some areas. In the subsoil or substratum, gravel is frequently present as a hardpan or heavy material, forming "concrete" beds.

This type occurs in the lower plain section of the county, where it forms low knolls and ridges and relatively flat to gently sloping areas. The natural drainage is adequate. Like the other sandy soils, it is better able to withstand drought than the heavy textured soils. Probably two-thirds of the type is in cultivation. Cotton, grain sorghums, and Johnson grass are the chief crops, with relatively small acreages in wheat and oats. This soil warms up earlier in the spring than do the heavier soils, and crops mature somewhat quicker. Cotton yields about one-fifth to three-fourths bale per acre and the grain sorghums about 10 to 30 bushels.

This soil is low in nitrogen and needs legume-rotation.

Miles Gravelly Clay Loam. It consists of a reddish-brown gravelly clay loam 6 to 10 inches deep, overlying reddish-brown to pinkish gravelly stiff clay. Gravel clay pan or a calcareous conglomerate usually is reached at about 20 to 30 inches. The soil contains in some places such large accumulations of quartz, chert, and other non-calcareous gravel that cultivation is impracticable.

It is encountered in scattered areas within the terrace-plain section of the county. It includes steep slopes, low knolls, and ridges, with occasional areas of relatively flat to gently sloping surface. Only about 10 per cent. of its area is in cultivation. Cotton, grain sorghum, and Johnson grass are the principal crops.

It is fairly well supplied with plant food.

Miles Loam. This consists of a reddish-brown, rather mellow loam, 6 to 10 inches deep, underlain by reddish-brown to pinkish, compact clay, which becomes stiffer with increasing depth. Like the other Miles soils, this type in many places contains lime conglomerate hardpan in the subsoil. In some areas a clay pan is present.

It is found in some fairly large areas scattered through the terrace-plain portion of the county. It occupies low ridges and relatively flat, gently rolling country. It withstands drouth well and is easy to cultivate. Probably three-fourths of it is in cultivation, the remainder being mainly in pasture. Cotton, according to local estimate, yields about one-fifth to three-fourths bale per acre, and the grain sorghums about 10 to 30 bushels of grain.

This soil is well supplied with plant food and will probably need nitrogen first.

Miles Silty Clay Loam. This consists of a reddish-brown compact silty clay loam, underlain at an average depth of about 6 inches by brownish-red to pinkish-red clay, but at about 24 inches there is a whitish lime hardpan, or mortar-bed layer, containing gravel in places, or a reddish gravel clay pan and whitish chalky material.

The type is quite extensively distributed throughout the terrace-plain section of the county. The surface is for the most part level to gently undulating. This type is one of the most extensive members of the series. Probably one-third or more of it is in cultivation, the remainder being user largely for grazing. The common staple crops, cotton, milo, kafir, feterita, and Johnson grass, are grown, with some wheat and oats. The yield of cotton ranges from about one-fifth to three-fourths bale per acre. The grain sorghum yields 10 to 30 bushels, wheat 5 to 20 bushels, and oats about 10 to 30 bushels per acre. The soil packs after heavy rains and the maintenance of a good supply of organic matter is necessary to keep the soil in good tilth.

This soil will probably need nitrogen and phosphoric acid.

Miller Clay. This is a reddish-brown or dark brownish-red clay somewhat silty and friable in some areas, but grading at a depth of 4 or 5 inches into brownish-red, stiff clay. This is an important stream bottom soil in the eastern part of the county. It forms large areas west of Abilene. It has a level surface favorable to cultivation, though its heavy texture makes tillage somewhat difficult, and heavy teams and implements are necessary.

Most of the type is in cultivation. Good yields of the various crops of the region are obtained. Alfalfa succeeds on it.

This soil is well supplied with plant food.

Miller Fine Sandy Loam. This consists of a reddish-brown to brown, friable sandy loam, 6 to 15 inches deep, underlain by reddish clay. In places the subsoil consists of fine sandy loam. This soil is limited to a few scattered areas, within the alluvial bottoms.

The type is subject to overflow, but crop injury from this source is of rare occurrence. This is one of the desirable soils of the county, in that it is easily cultivated and has good drouth-resisting qualities. Most of it is in cultivation for staple field crops and some truck crops.

This soil will need nitrogen first, and then phosphoric acid.

Miller Loam. This consists of a reddish-brown to chocolate-brown mellow loam, 6 to 10 inches deep, overlying brownish-red clay. The lower subsoil is a stiff clay, usually of a lighter shade of red than the upper subsoil. This type occupies a few areas in the stream bottoms. The surface is generally level and drainage is good.

The Miller loam, although not extensive, is one of the important types of the county. It is easy to cultivate and very productive. The greater part of it is in cultivation. Cotton, milo, feterita, kafir, and Johnson grass are extensively grown and sorghum for forage, wheat, oats, and corn, to a less extent.

This soil is well supplied with plant food.

Miller Silty Clay Loam. This consists of a reddish-brown silty clay loam, underlain at 5 to 8 inches by brownish-red clay, which becomes

compact and of a light red color in the lower part. In places the subsoil is calcareous.

It has a comparatively extensive occurrence in the overflowed bottoms. The surface is generally level, but the areas for the most part are well drained. It is an important soil. The heavy texture makes the cultivation somewhat difficult, but the natural productiveness is recognized and possibly one-half of the type is in cultivation. Cotton, milo, kafir, feterita, Johnson grass, sorghum cane, wheat, oats, and corn are crops of more or less importance. Some alfalfa is grown.

The yield of cotton ranges from one-fifth to three-fourths bale, grain sorghum 10 to 30 bushels, wheat 5 to 10 bushels, oats 10 to 30 bushels, and Johnson grass about 1 to 3 tons per acre. The yields of garden crops are uncertain, except where irrigated.

This soil is well supplied with plant food. It will probably need nitrogen first.

Simmons Clay. This consists of dark brown to black clay, usually somewhat silty and friable at the surface, but stiff and plastic below. Frequently there is little change in color throughout the three-foot section, but ordinarily the lower subsoil is somewhat lighter brown or drab. There are in places spots of brown to dark-brown clay overlying a brown clay, which becomes lighter-colored below.

When wet, the soil is sticky, but it is crumbly when dry. Small rounded quartz is frequently present on the surface. The surface is level; so the natural drainage is imperfect, although under existing climatic conditions the soil dries out sufficiently. About one-third of it is in cultivation. Cotton, milo, kafir, feterita, Johnson grass, and sorghum cane are the most important crops. Wheat, oats, and corn are grown to some extent. A large proportion of the type is used for cattle raising. Raising hogs is also important. Cotton produces one-fifth to three-fourths bale per acre. The grain sorghums yield 10 to 30 bushels, wheat 5 to 10 bushels, and oats 10 to 30 bushels. The yield of Johnson grass hay ranges from 1 to 3 tons per acre. Garden crops give uncertain and variable yields, owing to the occurrence of drouths.

Owing to the tendency of this heavy soil to pack on drying and to form intractable clods if plowed when wet, care must be taken to plow when the material is in the most favorable conditions as regards moisture. Heavy teams and implements are needed to plow the land properly. Plowing should extend to a depth of 6 to 8 inches. Frequent shallow cultivations must be given to prevent loss of moisture.

This soil is well supplied with plant food. It will probably need nitrogen first.

Simmons Fine Sandy Loam. This consists of dark-brown to dark-gray friable fine sandy loam 6 to 10 inches deep, underlain by dark-drab or dark-brown, stiff clay. In the more poorly drained situations the subsoil is bluish. After heavy rains, or in the absence of cultivation, the soil becomes compact, but with cultivation under normal moisture conditions it has a good tilth.

It occurs in a few small areas within the lower or terrace-plain portion of the county, mainly in the eastern part. The surface is level to slightly depressed. The type is of relatively small extent. Most of it is in cultivation, being used mainly for the production of staple field crops.

This soil will need nitrogen and phosphoric acid.

Vernon Clay. It consists of a chocolate-red or reddish-brown clay about 5 to 10 inches deep, underlain by chocolate-red clay or rather compact structure. When dry the surface is usually compact and hard, and when wet the soil is sticky, though under normal moisture conditions the cultivated soil is mellow. This type occurs at or near the base of the plateau, occupying small knolls, ridges, and slopes. About one-third of the Vernon clay is in cultivation. The principal crops are cotton, milo, kafir, feterita, and Johnson grass. Cotton yields less than one-fifth to three-fourths bale, grain sorghums 5 to 30 bushels, and Johnson grass 1 to 3 tons per acre. Wheat and oats, which are of minor importance, yield 5 to 25 bushels per acre.

Owing to its heavy character, the soil requires deeper plowing and more thorough cultivation than the lighter textured soils.

This soil will need nitrogen first.

Vernon Fine Sandy Loam. This consists of reddish-brown to brownish fine sandy loam, 8 to 20 inches deep, underlain by red or chocolate-red, rather compact fine sandy clay to stiff clay. There are some included areas of loamy fine sand and also eroded spots of clay loam. In places small, angular fragments of limestone and chert, and occasionally rounded gravel are present.

Under normal moisture conditions, this type is loose and friable when cultivated. It occurs along the base of plateaus. It occupies slight knolls, ridges, and slopes, though there are some flat areas.

One-half or more of the type is in cultivation, the remainder being used for pasture. Uncleared areas support a growth of catclaw, prickly pear, scrub oak, and various grasses and weeds. The principal crops are cotton, grain sorghums, and some corn. The type withstands drouth better than the heavier soils. Cotton yields about one-fifth to three-fourths bale and the grain sorghums 10 to 30 bushels per acre.

This soil will need nitrogen and phosphoric acid.

Vernon Gravelly Clay Loam. This consists of a chocolate-red clay loam, underlain at a depth of about 5 or 6 inches by a chocolate-red clay of a stiffer nature, with some whitish, powdery, limy layers and lime nodules in the subsoil. Rounded chert and quartz gravel, and angular fragments of red shale and sandstone are thickly scattered over the surface, and to a less extent through the soil. Bedrocks of the parent shale, sandstone, and conglomerate are present within the three-foot section in places.

This type adjoins the base of the plateaus and occurs as detached areas throughout the terrace-plain section. It occupies steep slopes, low ridges, and some rather large level areas. Practically all of this land is used for pasture.

It is low in potash and will also need nitrogen.

SOILS OF WEBB COUNTY

The soils around Laredo were mapped in the soil survey of Laredo area, and included in the reconnoissance survey of Southwest Texas.

Webb county is located in the southwestern part of the State, on the Rio Grande River, and the land in cultivation is chiefly irrigated from this river. Probably the most important crop consists of onions, al-

though other crops are grown, including alfalfa, sweet potatoes, and various vegetables.

The average composition in pounds per two million in the soils of Webb County is shown in Table 17. An examination of Table 2 shows that Webb County averages highest in active phosphoric acid, total potash, acid-soluble potash, active potash, and next to the highest in total phosphoric acid of any of the counties reported on in this bulletin. The total nitrogen, however, averages lower than the other three counties.

Table 17. Average given in pounds per two million, soils of Webb county.

	Phosphoric acid		Potash			Total Nitrogen	Acid soluble lime	Basicity	Acidity	Number of samples
	Total p. p. m.	Active	Total	Acid soluble, per cent	Active					
Laredo clay loam	2080	660	37200	16000	853	1800	50600	60200	0	6
Subsoil	1860	947	43400	12810	905	1640	68600	83400	0	7
Laredo silt loam	2160	689	39600	8400	903	1460	94400	154800	0	12
Subsoil	1880	577	34400	18600	720	1180	104800	16000	0	10
Webb fine sand	660	71	23000	8800	518	1800	6400	15000	0	5
Subsoil	1000	70	21600	10000	735	1040	19600	21000	0	4
Webb fine sandy loam	1340	344	29400	8800	856	1400	14600	23200	0	8
Subsoil	1160	244	31600	13000	776	1260	13400	31000	0	8
Webb gravelly sandy loam	900	82	33500	12800	996	2600	15400	22600	0	2
Subsoil	1200	218	33400	11400	.....	2300	8600	15000	0	2
Average surface soils	1428	369	32540	10960	825	1812	36280	55160	0	7
Average subsoils	1420	411	32880	13160	784	1484	43000	33280	0	6

The interpretation of the analyses of the soils of this county is given in Table 18. The soils are fair to good in phosphoric acid, four types being good and one fair. They are all good in potash, and good to high in lime. Not any of these soils are acid. The corn possibility for the active phosphoric acid varies from 24 to 50 bushels to the acre, of active potash, 150 to 182 bushels to the acre, and of total nitrogen, 18 to 38 bushels to the acre. The soils apparently need nitrogen first,

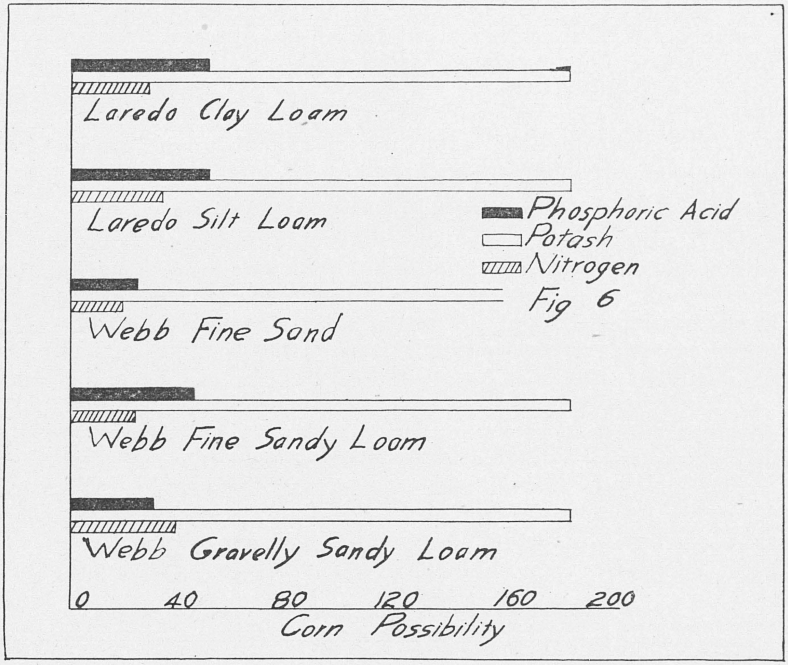

Figure 6. Corn possibility of active phosphoric acid, active potash and total nitrogen, soils of Webb county.

phosphoric acid second, and active potash least. They contain an abundance of lime, and do not need lime. The Webb fine sand averages lowest in phosphoric acid and nitrogen, the Laredo silt loam and the Webb fine sandy loam are nearly the same, the Laredo clay loam is somewhat better, and the Webb gravelly sandy loam appears to be best in nitrogen, although lower in phosphoric acid.

Table 18. Interpretation of analyses soils of Webb county.

	Phosphoric acid	Potash	Lime	Acidity	Corn possibilities two ½ million pounds		
					Active phosphoric acid	Active potash	Total nitrogen
Laredo clay loam.....	Good	Good	High	0	50	182	28
Laredo silt loam.....	Good	Good	High	0	50	182	22
Webb fine sand.....	Fair	Good	Good	0	24	157	18
Webb fine sandy loam....	Good	Good	High	0	45	182	23
Webb gravelly sandy loam	Good	Good	Good	0	30	182	38

ALKALI IN SOILS OF WEBB COUNTY

At the instance of Mr. F. W. Mally, and with his co-operation and assistance, the writer collected a number of samples of soil of Webb County for alkali during an epidemic of pink root of onions. The alkali determinations are presented in Table 19. Dr. J. J. Taubenhaus has shown in Texas Bulletin No. 272 that the pink root of onions is due to a plant disease, but, as he points out, the presence of alkali in the soil may decrease the resistance of plants to the disease organism, and thereby aid in spreading an attack of this disease. Six soils were sampled where onions suffered from pink root and five where the onions did not suffer. Of the six soils where the onions suffered, four contained more alkali than any of the soils where the onions did not suffer. This indicates that alkali may contribute to the disease. Two of the samples were high in nitrates.

Table 19. Alkali in parts per million of soil, Webb county.

		Nitrates	Sulphates	Chlorides	Total
	Pink root present.				
11528	Webb fine sandy loam, 0–6 inches	1050	237	114	1401
11529	Subsoil 11528, 6–12 inches	750	258	125	1123
11530	Subsoil 11528, 12 to 24 inches	1050	95	166	1201
11531	Subsoil 11528, 24 to 36 inches	300	208	197	705
11533	Webb fine sand, near flume	120	286	284	680
11534	Subsoil 11533, 6 to 12 inches	90	204	148	462
11535	Subsoil 11533, 12 to 24 inches	0	201	99	300
11540	Laredo silty loam	4200	0	472	4672
11541	Subsoil to 11540, 6 to 12 inches	1500	54	417	2071
11543	Laredo clay loam	3	438	429	870
11544	Subsoil to 11543, 6 to 12 inches	0	302	261	563
11559	Webb fine sandy loam	8	298	289	596
11560	Subsoil to 11559, 6 to 12 inches	10	217	256	483
11557	Laredo silty loam	0	226	170	396
11558	Subsoil to 11557	0	233	117	350
	No pink root				
11536	Webb fine sandy loam, no pink root	30	300	191	521
11537	Subsoil 11536, 6 to 12 inches	30	296	172	498
11538	Webb fine sand	30	216	147	383
11539	Subsoil to 11538, 6 to 12 inches	8	200	218	426
11545	Laredo silt loam	15	320	244	579
11546	Subsoil 11545, 6 to 12 inches	5	237	241	483
11547	Laredo silt loam	3	176	203	382
11548	Subsoil to 11547, 6 to 12 inches	0	138	219	357
11549	Webb fine sandy loam	3	213	180	396
11550	Subsoil to 11549, 6 to 12 inches	0	160	201	361
11588	Soil near peeler	.....	.....	.....	9950
11589	Subsoil to 11588	.....	.....	.....	3298
11532	Alkali scrapings	.....	5650	1465	2501
11542	Alkali scrapings	.....	450	570	345

The ordinary precautions for preventing accumulation of alkali in irrigated land are to irrigate only as often as may be necessary, in quantities sufficient to penetrate the soil, and carry off the alkali into the country drainage; to cultivate the surface and prevent evaporation from the surface with consequent rise of alkali; to put in drainage ditches where necessary, so that the water can pass through the soil, and into the drainage ditches, carrying the alkali with it. These drainage ditches may be open, or some form of tile drain. Nitrate of soda should be used with caution on the heavier soils of this area, through which the irrigation water does not pass so rapidly, especially when there are indications or appearance of pink root. When nitrate of soda is used by the plants, the nitrogen is taken up, and the soda is left behind, for the most part as carbonate of soda. This acts physically

upon the soil grains, deflocculates them, and causes the soil to run together and pack, thereby hindering the irrigation water in passing through it. This, together with the actual amount of soda left in the soil by the nitrate of soda, renders its use not so desirable upon heavier irrigated land in this section. It would be better to use sulphate of ammonia, cottonseed meal, bat guano, or some other form of nitrogen on such soils. On the other soils, such as the Webb gravelly sandy loam, the Webb fine sandy loam and the Webb fine sand, the nitrate of soda is much less likely to give rise to alkali, but even here it should be used cautiously when there are outbreaks of the pink root.

POT EXPERIMENTS

The results of pot experiments on some soils of Webb County are given in Table 20. The difference between the column headed PKN and the column headed NK gives the effect of phosphoric acid. The difference between the column headed PN and column headed PNK shows the effect of potash. The difference between the column headed PK and the column headed PNK is the effect of nitrogen. On Laredo fine sand the phosphoric acid increased the corn from 3.7 grams to 16.2 grams or a total increase of 12.5 grams, due to the addition of phosphoric acid to the pot. The potash had no effect, but on the other hand the crop without potash was somewhat larger than the one with potash. The addition of nitrogen increased the crop from 12.5 grams to 16.2 grams, an increase of 3.7 grams. There is a decided increase from the addition of phosphoric acid on all of the soils used in the pot experiments, with the exception of the Laredo silt clay. There were only a few experiments for potash, but potash was apparently not needed. There were a number of tests for the need of nitrogen. In some cases the nitrogen had little effect but with others there was a decided increase in crops caused by the addition of nitrogen.

Table 20. Pot experiments on Webb county soils, Webb county.

			Weight of crops in grams			
			NK	PNK	PN	PK
816	Laredo fine sand, surface soil.	Corn 1907	3.7	16.2	22.2	12.5
		Sorghum 1908	.....	25.0	22.2	18.4
827	Laredo silt loam	Corn 1907	4.3	15.5	20.3	10.3
		Sorghum 1909	4.8	13.3	13.1	8.1
962	Laredo silt loam	Corn 1914	.....	14.7	.....	21.5
		Sorghum 1914	.....	15.5	.....	5.1
		Corn 1915	.....	15.6	.....	4.5
		Sorghum 1915	.....	22.5	.....	1.5
877	Laredo silt loam	Corn 1913	.....	11.8	.....	10.0
		Sorghum 1914	.....	3.3	.....	5.8
		Corn 1914	.....	20.9	.....	13.4
869	Laredo silt clay	Corn 1915	.....	8.8	.....	8.6
		Sorghum 1915	.....	15.4	.....	21.2
		Corn 1916	.....	20.5	.....	5.9
		Sorghum 1916	.....	15.3	.....	4.0
831	.....	Corn 1907	53.3	60.0	.....	26.3
		Corn 1908	48.9	46.9	.....	14.0
830	Laredo gravelly loam	Corn 1908	4.5	.....	17.5	17.2
833	Laredo fine sandy loam	Corn 1907	13.0	29.0	24.8	22.5
872	Laredo fine sand	Corn 1914	.....	12.8	.....	15.5

COMPOSITION OF ONIONS

Table 21 contains the analysis of a number of samples of onions, collected partly in connection with the pink-root study, and partly for

the purpose of ascertaining the amount of phosphoric acid, potash, and nitrogen removed from the soil by onions in this district. The average estimation of plant food removed by onions is given in Table 1. On reference to this table we find that a crop of 20,000 pounds of onions removes approximately the same amounts of phosphoric acid and nitrogen as a crop of 40 bushels of corn, but about 50 per cent. more potash.

Table 21. Composition of onions as dried for analysis.—Per cent.

	Phosphoric acid	Nitrogen	Potash	Insoluble ash	Lime	Magnesia	Moisture lost in preparation
Bulbs normal							
4745	1.03	2.50	2.40	.....	.....	.....	92.1
4746	.94	2.42	2.35	.....	.....	.....	91.6
11515	0.61	1.85	1.65	0.43	0.28	0.22	93.8
11520	0.50	1.20	1.40	2.60	1.93	0.49	90.8
7209	1.00	1.80	1.85	.....	.....	.....	91.1
7210	0.84	1.56	1.99	.....	.....	.....	91.0
7211	0.73	1.61	1.70	.....	.....	.....	91.1
Bulbs pink root							
11518	1.52	3.75	2.46	1.89	0.43	0.20	87.0
11522	1.55	3.97	2.66	7.67	0.26	0.32	89.0
11516	1.54	3.60	2.69	.....	.....	.....	81.4
Tops, normal							
11521	0.14	0.55	1.32	.....	4.45	0.36	86.8
Tops, pink root							
11517	0.60	2.18	2.98	5.60	0.17	0.28	72.7
11519	0.59	2.12	4.00	1.56	0.19	0.23	83.0
11523	0.46	1.85	2.79	.....	1.82	0.58	78.3

FERTILIZERS FOR ONIONS IN WEBB COUNTY

A crop of 30,000 pounds of onions takes about 7 pounds of phosphoric acid, 57 pounds of nitrogen, and 60 pounds of potash from the soil. Soils of Webb County are high in potash, and much lower in nitrogen and phosphoric acid. Table 22 shows the onion possibility of the average soil of this county, assuming that onions have the same power of taking plant food as corn and that an acre-foot weighs two million pounds. The table shows that the soil contains an abundance of potash and is not likely to need nitrogen. The Webb fine sand is low both in phosphoric acid and nitrogen. The first need for onions as a fertilizer on these soils is nitrogen, next is phosphoric acid, and last is potash. A liberal application of fertilizer would consist of 25 pounds of phosphoric acid, 100 pounds of nitrogen, and 30 pounds of potash to the acre. With applications of barnyard manure and a legume-rotation, the amount of nitrogen need not be near the quantity stated.

Table 22. Onion possibilities of Webb county soils, pounds per two million of soil.

	Active phosphoric acid	Active potash	Total nitrogen
Laredo clay loam	35000	91000	21840
Laredo silt loam	35000	91000	25740
Webb fine sand	16800	78500	14040
Webb fine sandy loam	31500	91000	17940
Webb gravelly sandy loam	21000	91000	29640

A good fertilizer would be 1000 pounds containing about 5 per cent. phosphoric acid, 5 per cent. nitrogen, and 3 per cent. potash. The nitrogen could then be supplemented by a top dressing of 100 to 200 pounds of nitrate of soda or sulphate of ammonia. The above fertilizer would supply 50 pounds of phosphoric acid, while the onions require only 7 pounds. It would seem that the amount of phosphoric acid supplied could be reduced.

A fertilizer containing 6 per cent. phosphoric acid, 3.3 per cent. nitrogen, and 3.3 per cent. potash is used by some onion growers at the rate of 1000 pounds to the acre with supplements of nitrate of soda. This fertilizer supplies 60 pounds of available phosphoric acid, while onions need only 7, so that about eight times as much phosphoric acid is supplied as is needed. It would be better to reduce the phosphoric acid and increase the nitrogen.

Consideration of the composition of the soil and the analysis of the nitrogen lead to the opinion that the best fertilizer should be 500 pounds of a 5-5-5 fertilizer, supplemented by 25 to 50 pounds nitrogen in the form of nitrate of soda or cottonseed meal or sulphate of ammonia.

LEGUME-ROTATION IMPORTANT

A proper legume-rotation is important for the soils of Webb County. Where alfalfa does well, it would be a good renovating crop. A legume-rotation is important not only for the purpose of supplying vegetable matter and nitrogen to the soil, and placing it in better physical condition, but also for eliminating or reducing insect pests and plant diseases, such as the pink root of onions. As recommended by Dr. Taubenhaus in Bulletin No. 273, a rotation of crops would be a great help in reducing the action of this disease. A good rotation is, therefore, highly to be recommended.

DESCRIPTION OF SOIL TYPES OF WEBB COUNTY

Laredo Clay Loam. The surface to an average depth of 10 to 12 inches, cansists of a heavy light brown loam, which contains enough clay to make it sticky and tenacious when wet and to cause it to bake and sun crack on drying. This soil grades into a heavy brown silty loam, of slightly heavier texture, which becomes heavier, until at an average depth of about 20 inches it changes to a stiff, compact, silty clay of a dark-brown color.

The Laredo clay loam, though of very limited extent, is considered one of the most productive soils. The surface soil, when properly cultivated, breaks up into a friable loamy condition. The heavy subsoil is retentive of moisture, and the effects of fertilizer are lasting.

The type occurs in two narrow strips, seldom more than a quarter of a mile wide, located in the valley of the Rio Grande. One is situated a few miles north of Laredo, and the other in the extreme northwestern part of the area. The Laredo clay loam is an alluvial soil, formed from material deposited in the old flood plain of the Rio Grande. This soil is well adapted to the production of onions which are grown under irrigation. The average yield is about 20,000 pounds per acre. If heavy rains occur about the harvest season, the water which collects in the shallow depressions occupied by this soil, damages the crop.

Alfalfa has been grown to a limited extent on the irrigated lands. Cabbage and beets have also been successfully grown, but Irish potatoes do not do well. Corn has been grown on the irrigated areas and has yielded 15 to 20 bushels per acre on unirrigated lands. Sorghum produces fairly good yields on irrigated soil. Cowpeas do exceedingly well on both the unirrigated and irrigated land, and where this crop has been grown and turned under the physical condition and general productiveness of the soil have been greatly improved. Sweet potatoes have been grown under irrigation with yields of about 150 bushels per acre.

This soil is good in plant food; it is weakest in nitrogen.

Laredo Silt Loam. The surface soil to a depth of about 12 inches consists of a gray to very light-brown silt loam, which usually contains a considerable amount of fine and very fine sand. The subsoil, from 12 to 36 inches, similar to the surface, usually contains less fine sand and is slightly lighter in color. The silty to very fine sandy texture of this soil makes it easy to cultivate, and the surface of the areas which have been cultivated, is friable and loamy. The surface of the uncultivated land is very dry and compact and often has the general appearance of a soil of heavier texture.

The Laredo silt loam occurs in one continuous strip, which borders the Rio Grande and extends along the entire western boundary of the area except in the extreme northwestern and southwestern corners, where the rolling hills extend down to the present channel of the stream. The topography as a whole is almost level. Because of its favorable situation and almost level topography, irrigation is practicable over nearly all of its area; it is one of the most valuable soils of the area.

The soil originated as an alluvial deposit of the Rio Grande. A large percentage of the type is cultivated under irrigation. When irrigated, it produces very profitable yields of all the crops grown, but on the unirrigated areas the yields are usually light and the crops are often a total failure.

The type seems well adapted to the production of onions and a very large proportion of the cultivated land is used for this crop. The average yield has been estimated at about 18,000 to 20,000 pounds per acre, but during a favorable season 25,000 pounds per acre have been secured. Cotton has been grown under irrigation. Sweet potatoes have produced yields of 150 to 200 bushels per acre. Sweet potatoes, however, require a large amount of water, and it has been found necessary to irrigate them very frequently in order to get the very best results. Some corn has been grown on the irrigated land and produced a yield of about 40 bushels per acre.

Cabbage produced about 13,000 pounds per acre. Beets and turnips do exceedingly well, and when irrigated and properly cultivated, fair yields of Irish potatoes have been obtained. Alfalfa is grown under irrigation, but it does not do well for more than one season.

This soil is good in plant food; it needs nitrogen most.

Webb Fine Sand. The Webb fine sand, to a depth of about 12 inches, consists of a fine sandy loam of red to reddish-brown color. The top 2 inches is usually a loose incoherent fine sand, but the struc-

ture of the soil as a whole is very compact. The subsoil is similar to the surface in color and texture, but usually becomes more loamy in its lower part and from about 20 to 36 inches becomes a very light sandy loam of a red to reddish-brown color.

Two small areas of the Webb fine sand occur in the northwestern part of the survey. They occupy comparatively level to gently rolling country in the uplands, and often have an elevation of 50 feet or more above the level of the stream valleys. The soil is easily eroded.

The native vegetation consists mainly of cactus and mesquite.

The soil will need nitrogen and phosphoric acid first.

Webb Fine Sandy Loam. The surface is a light-brown to reddish-brown fine sandy loam 10 to 12 inches deep. A few round gravel are sometimes found but the type is very uniform in texture, color, and general topographic features. The subsoil consists of a very sandy clay, which varies from brown to reddish-brown in color.

This soil before being cleared supports a heavy growth of cactus and mesquite, but when cleared the fine sandy texture of the soil makes it easy to cultivate, and the heavy subsoil enables it to conserve moisture. For this reason, the crops grown on the irrigated areas of this type do not require as much water as those grown on the soils underlain by a lighter-textured subsoil. The type is found occupying valleys and more level areas in all parts of the area surveyed. It also occupies that portion of the Rio Grande Valley that lies between the silty deposits bordering the stream and the foothills of the rolling uplands.

The soil is productive and under irrigation gives very profitable yields of all the crops suited to the climatic conditions of the area. The irrigated land is used mainly for growing onions and seems well adapted to this crop, the average yield being about 20,000 pounds per acre. Cabbage, turnips, and beets have been grown. A few fruit trees planted on the type in recent years are in good condition. Sweet potatoes have been grown, the average yield being about 150 bushels per acre. Sorghum is grown for feed purposes and does fairly well without irrigation. A very large percentage of this type is still undeveloped agriculturally.

This soil is good in plant food. Nitrogen is needed most, according to our analyses.

Webb Gravelly Sandy Loam. The surface soil consists of a light-brown to reddish-brown fine sandy loam containing large quantities of rounded, water-worn gravel, with an average depth of about 10 inches, but on the steep hill sides the fine sandy loam is eroded and is seldom more than a few inches deep. Rounded gravel left on the steep slopes cover 40 to 60 per cent. of the surface. The subsoil consists of a very sandy clay, brown to reddish-brown in color. It is sticky and tenacious when wet. It covers large portions of the area. It occupies uplands which extend from the northern to the southern boundary of the survey in an almost unbroken series of rounded hills and narrow ridges. It is not well adapted to agricultural purposes, as it would be impracticable to attempt its irrigation.

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SUMMARY AND CONCLUSIONS

This bulletin deals with the chemical composition, fertility, and possible chemical needs of various types of soils from Bell, Jefferson, Smith, Taylor, and Webb Counties.