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TEXAS SOILS:

A STUDY OF CHEMICAL COMPOSITION.

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS.

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SOILS.

(H. H HARRINGTON, M. SC.)

The question of the practical benefit shown to a farmer by soil analysis has been widely and long discussed. It is ably claimed that a soil analysis is not definite and conclusive in its results; that it does not determine for the farmer the comparative condition of his soil; that the chemist cannot by analysis decide upon the crop-producing power of a field. This is the extreme argument upon one side of the question. It has been erroneously, but somewhat popularly believed, on the other hand, in some localities, that a chemist could determine the exact fertility of a field. That just as he determines what should be the producing power of a fertilizer, properly applied, so by analysis he should be able to place an estimate upon the relative chemical value of a soil—other conditions being properly controlled. There can be no doubt but that this view is incorrect—and it is being rapidly abandoned. Neither should the extreme argument against soil analysis be allowed to go unchallenged. A soil analysis is of direct and practical benefit to a farmer; not when taken alone, perhaps, but in connection with a knowledge of the local conditions of the soil—its drainage, climate and behavior under cultivation; whether residual—that is, derived from disintegration and crumbling of the rock beneath it; whether a transported soil or an alluvial soil; character of timber growth, and indigenous plants; all of which, taken together, will aid greatly to an intelligent understanding of a chemical analysis.

It may be impossible to decide accurately upon the amount of any particular ingredient which a soil should possess to be fertile; it is none the less true that a knowledge of the amount of lime, humus, or sand, for example, may be made of great service in the treatment and preservation of the soil; as well as helping to interpret its probable adaptability to particular crops. Prof. Hilgard has indeed fixed certain amounts of the various constituents that should be present in fertile soils; for example he states 0.02 per cent of sulphuric acid is sufficient for a fertile soil; and lime, while varying from 0.1 to 0.3 per cent ordinarily, may rise with advantage to one or two per cent. But these fixed quantities, while emanating from so high an authority, have not been generally accepted either by practical or scientific men, so far as I am aware.

Let us look somewhat into the action of the various ingredients of a soil, and we may be better able to appreciate the value of a chemical analysis. If we head the list with lime we shall have a great factor in soil fertility. In the first place, the experience of practical men has proven that all calcareous soils are fertile—that it greatly promotes plant growth; and that calcareous under-rock, shale or rotten limestone, is a great help to a top soil. In Europe it has long been the practice to apply lime by two, three, or even twelve tons to the acre, on cultivated lands, at intervals of two, five or ten years, and this, in spite of the fact that only a comparatively small amount of lime is needed for actual plant food. By reference to table analysis the large amount of lime is noticeable from soils that experience has proven to be very fertile. The tendency of lime to break up a clay soil, and set potash free, to decompose humus and set nitrogen free, to increase the capillarity of sandy soils, are examples of the benefit accruing from a full supply of lime. Or, let us take sulphuric acid. This is of course combined as some salt. For example, sulphate of potash, sulphate of lime (gypsum), sulphate of ammonia (in fertilizers), or sulphate of magnesia. In many cases where one of these salts is present in the soil or applied to it, it breaks up what is known as a "vicious set" of chemical combinations in the soil—combinations that will not allow the full yield of particular crops—and in most instances the beneficial influences of sulphuric acid as sulphates, in a soil, are to be ascribed to chemical action upon other soil ingredients rather than any direct effect as plant food. But how is it with nitrogen and phosphorus, or phosphoric acid? These act mainly as foods to growing plants; and the quantity in the soil generally being so small in amount, they are applied in fertilizers as nutriment to the plant. The same is true, in a more limited sense, of potash. The humus, or organic matter in a soil, is the source of native nitrogen, and regulates to a great extent heat and moisture. So that its presence is always desirable, and is one of the surest indications of the lasting fertility of a soil. If, therefore, analysis showed the absence or merely a trace of any one of these consituents necessary for plant growth, such intelligence would be of great practical benefit to the farmer in the care and improvement of his soil.

In collecting the soils, the following directions were sent out: "When possible procure a representative virgin soil; but when this cannot be obtained, select from a field of average fertility, but not from one that has received manure at any time. Please state character of timber, what native grasses, or cultivated ones—average yield in corn, cotton, oats, and wheat if grown.

DIRECTIONS FOR COLLECTING SAMPLE.

With a hoe or spade carefully remove grass and trash. Dig up the surface soil to a depth of 4 to 6 inches, being careful to prevent mixture with subsoil; box this, and then carefully remove subsoil to a debth of 4 to 6 inches, keeping it free from top soil—box separately. Be careful in selecting a spot for the sample to get one having the same general character as the soil of the surrounding fields or wood. That is, do not run upon a spot totally different from the surrounding soil—either in top soil or subsoil. Remove all stones and pebbles larger than a partridge egg.

CLASSIFICATIONS.

It is impossible to make a general classification that will include the different local conditions throughout the state; but in a rough way, the soils of the State may be divided into six different types,—which will be briefly described separately. *1st. The Coast Belt. 2nd. The East Texas Belt. 3rd. The Black Prairie Belt. 4th. The Ft. Worth Prairie Belt. 5th. The Pandhandle Soils. 6th. The alluvial soils.*

THE COAST BELT.

Under this head we place two divisions as classified geologically by

Mr. E. T. Dumble, State geologist. The coast clays proper, and the soils of the Fayette Beds. The coast clays comprise a prairie region 50 to 100 miles inland from the coast. The surface of the country being generally very level—in many places too much so for proper drainage. The soil is a dark sandy loam—prairie—usually; but in many places is almost "black-waxy"—containing an abundance of lime and clay. The subsoil is clay, usually red or yellow. Almost the entire area is susceptible of cultivation and some of it very fertile. The district is given up mostly to cattle raising; but in certain localities very fine farms are maintained. It is well adaped to fruit, and the Alvin and Hitchcock localities are acquiring a wide reputation in this respect. Corn, cotton, oats, sorghum, sugar cane and rice are the leading field crops. Joining the coast prairies on the north, there is a belt of black sandy soil—giving way in some places to a sandy loam that is very fertile. On the east, this forms a part of the

SECOND DIVISION.

The soils of this division vary very widely in composition. The timber growth itself being widely different in character. The vast body of timber in the southern part being long leaf pine, but on the western border especially, this gives way to post oak, black jack, sweet gum and hickory, intermixed with other varieties of oak, sweet gum and cottonwood. The upland soil of the pine region is gray sand usually; not different from the same soil occurring in the pine belts of the older Gulf States. It is almost pure sand, as shown by analysis below of samples from Rusk, Cherokee county, and from Colmesneil, Tyler county. No. I from Rusk—No. II from Colmesneil :

ELEMENTS.	No. I.		No. II.	
	Surface.	Subsoil.	Surface.	Subsoil.
Moisture	0.8	0.4	0.37	0.3
Volatile and Organic Matter	2.05	0.73	1.18	0.67
Insoluble Matter and Sand	96.212	97.764	97.584	98.168
Iron Oxide	0.776	0.931	0.75	0.78
Alumina Oxide	Trace	0.009		
Calcium Oxide	Trace	Trace	....	....
Magnesium Oxide	Trace	Trace	0.079	....
Sulphuric Acid	Trace	Trace	Trace	Trace
Phosphoric Acid	Trace	Trace	Trace	Trace
Potash	Trace	Trace	Trace	Trace
Soda	Trace	Trace	Trace	Trace
Carbonic Acid	Trace	Trace	....	....

Of course such a soil can have very little fertility. But the lowlands, valleys and alluvial soils are in many places very fertile; as shown by analysis below of creek bottom soils from Colmesneil, Tyler county and valley soil, from Rusk, Cherokee county. The hillsides also frequently embrace a sandy loam rich in vegetable matter and underlaid by clay. This soil produces well and is generally easily cultivated.

No. I is creek bottom land, Tyler county. No. II valley land, Cherokee county.

ELEMENTS.	No. I.		No. II.	
	Surface.	Subsoil.	Surface.	Subsoil.
Moisture	2 30	1.77	1.32	1.02
Volatile and Organic Matter	3.22	2.55	4.60	3.31
Insoluble Matter and Sand	89.49	91.09	83.22	85.91
Iron Oxide	3.94	4.12	5.82	6.44
Alumina Oxide			2.12	1.70
Calcium Oxide	0.44	0.36	0.555	0.255
Magnesium Oxide	0.08	0.15	0.126	0.197
Sulphuric Acid	Trace	Trace	....	....
Phosphoric Acid	0.03	0.03	0.243	0.141
Potash	0.06	0.12	0.48	0.44
Soda	0.07	0.16	0.40	0 49
Carbon Dioxide	....	....	0.44	0.187

Both of these samples represent the better types of soil in the East Texas belt of soils, and while the analysis can not compare with that of the richer lands in the State, it is very favorable indeed.

Capt. E. G. Douglas, of Rusk, in sending samples from Rusk, Cherokee county, has this to say: "Among the grasses I have observed Bermuda, sedge grass and crab grass. I understand that the average yield of corn per acre is about 12 bushels—and that of oats 15 bushels. This is evidently not a grain country, but judging from the products of the orchard and the vineyard, it has rare merits as a fruit growing region."

Of the soils from Colmesneil, Mr. James Wheat writes: The timbers on the creek bottom lands consists of cypress, gum, beech, magnolia, oak, hickory, sugar maple, and black walnut, Average yield of corn about 25 bushels, oats 20 to 30 bushels; cotton two-thirds of a bale to the acre. Bermuda and carpet grass grow well on old fields in the timber land—and the average yield of crops is about one half as much as in creek bottom. We have also an upland hammock here that is a good soil."

The next two divisions are based on the classification given by Mr. Robt. T. Hill in the first report of the State Geological survey—the description of each, being essentially the same as given by him in that report, p. 105 *et seq.*

THE BLACK PRAIRIE BELT.

There are four divisions of this with only slight variations: The first on the east, next to the timber belt, is distinguished by the presence of sand in the soil—with occasional pure beds of sand—illustrated by the analysis of soil samples from Terrell and Pecan Gap. West of this strip comes the main black waxy area—characterized by a substructure of light blue or yellow calcareous clay, called by the residents "soap stone" and "joint clay," from its laminated structure. Small depressions in the surface of the soil, called "hogwallows," are quite common. These are caused by the unequal drying and expansion of the calcareous clays in poorly drained places. Greenville, Terrell, Kaufman and Corsicana are situated near the dividing line between the above two divisions. Below will be found analyses of samples from Terrell, Pecan Gap, Forney, Belton and Manor—the three latter soils illustrating the main black waxy belt.

LOCALITY.	Water.	Volatile and Organic Matter.	Insoluble Matter and Sand.	Iron Oxide.	Alumina Oxide.	Calcium Oxide.	Magnesium Oxide.	Sulphuric Acid.	Phosphoric Acid.	Potash.	Sodium.	Carbon Dioxide.
TERRELL.												
Surface	2.09	6 84	85.96	1.08	1.63	0.55	0.28	0.24	0.28	0.17	.07	.....
Subsoil	2.09	3.81	87,95	1.45	2.71	0.37	0.32	0.11	0.23	0.13	.14	.....
PECAN GAP.												
Surface	6.34	7.88	68.06	4.23	9.48	.814	.32	.24	.13	.83	.64	.344
Subsoil	7.57	6.67	62.91	4.19	10.37	3.05	.34	.12	.18	1.29	.60	2.32
FORNEY—TIMBER LAND.												
Surface	4.55	6.03	60.55	2.42	4.53	11.00	.543	.127	.326	.316	1.28	8.49
Subsoil	4.36	7.42	60.96	2.27	5.59	10.05	.64	.16	.266	.419	1.85	7.78
PRAIRIE SOIL.												
Surface	7.57	11.06	56.5	2.82	7.04	6.62	.81	.151	.313	.837	.052	6.25
Subsoil	6.78	10.96	56.4	2.78	2.38	7.35	.615	.137	.294	.606	.109	6.06
HAMMOCK.												
Surface	7.91	6.92	62.98	2.86	7.35	6.30	.46	.147	.25	.68	.09	4.91
Subsoil	7.70	6.16	62.84	2.74	8.18	6.74	.297	.216	.499	.39	,25	4.43
MANOR—TRAVIS COUNTY.												
Surface	8.47	7.26	50.69	3.73	16.35	5.81	.317	.082	.115	.576	.151	5.84
Subsoil	3.27	7.18	51.17	4.74	14.33	6.96	.507	.147	.179	.604	.095	6.11
BELTON—BELL COUNTY. (Black waxie)												
Surface	2.42	7.34	44.23	(1.58)		23.98	.94	.15	.12	.22	.25	18.00
Subsoil	1.94	2.65	48.17	(2.68)		23.6	1.13	.21	.13	.28	.30	18.35
BELTON—BELL COUNTY. (Hammock.)												
Surface	3.56	6 52	77.05	2.66	4.91	1.03	.73	.02	.18	1.45	.93	.81
Subsoil	4.91	2.51	78.09	3.93	7.74	0,83	.9	.02	.17	1.07	.33	.65

The following explanations accompany these samples—from Terrell, by Mr. A. E. Alexander:

"I dug several holes and found that in different places, the subsoil and top soil about the same in one locality, as in another; the subsoil was taken about 6 to 8 inches below the top soil, and in appearance it seems to me that they are very much alike. Average yield of crops per acre—corn 25 bushels, wheat 12½ bushels, cotton ½ to ¾ bale."

From Forney, by Mr. Jno. M. Lewis: "I send 3 samples of soil—one from our hammock land. one from our prairie hay farms, and one from timber land next to Trinity bottom, not above overflow. This is fast coming into cultivation and is covered with a heavy growth of timber of all varieties, but the larger trees consist principally of spanish oak."

From Manor, Travis county—by Mr. Joe M. Puckett: "I have selected an average soil of the surrounding fields. The timber is very scarce; mesquite, elm and hackberry, are the principal kinds. The average yield of corn is from 40 to 50 bushels per acre; cotton ¾ to 1 bale, oats about 75 bushels per acre. Wheat is not grown here much, the yield being very small. Potatoes yield very large crops, but do not know the amount per acre. The principal uncultivated grasses are sedge and mesquite." An examination of the table of analyses presents a remarkable group of fertile soils, rich in all those substances that contribute to the fertility and endurance of a soil; vegetable matter, carbonate of lime, phosphoric acid and potash. The quantity of sulphuric acid is small in comparison, but according to Prof. Hilgard, in actual amount, sufficient in quantity

The next division of the black prairie belt lies to the west of the "black waxy" proper. It is a narrow strip, only about 2 miles wide; and reaching from Red river to the Rio Grande. Its surface is characterized by an outcrop of "white rock," or chalky country. Some of the most prosperous towns of the State are situated upon this narrow belt: Paris, Sherman, McKinney, Dallas, Waxahachie, Waco, Austin, New Braunfels and San Antonio.

Below will be found anaysis of samples from Waxahachie and New Braunfels. West of this strip there is still another narrow belt having a distinctive soil type; but which greatly resembles the main "black waxy." This is the country east of Denton and Whitesboro, and reaching along the Missouri Pacific from Alvarado to Waco.

A comparison of these with soils from the main "black waxy" show that they do not vary greatly except in the lime of the subsoil. The following explanatory notes accompanied the samples: Mr. W. P. Metcalf writes of the Waxahachie soil: "I got the samples from a pasture that has never been cultivated. There are fields all around it. The average yield of cotton is about one-half bale to the acre; about twenty bushels of wheat. The grass is the common prairie grass—no timber adjacent.

Mr. Emil Giesecke writes of the New Braunfels sample: "The black soil is found in many places to a depth of three feet—sometimes reaching to seven feet—then you strike the yellowish black subsoil and in some places gravel. The samples sent have not been cultivated, and are of the same character as the soil for miles around. The live oak seems to be the largest and most common of the timber growth, and next to this is the cypress. Mesquite and Bermuda are the prevailing grasses. The average yield of cotton is from three-fourths to one bale per acre; oats thirty-five to forty bushels; corn twenty to thirty bushels; wheat is not grown."

Analysis of samples from Waxahachie and New Braunfels. No. I, Waxahachie, No. II, New Braunfels:

ELEMENTS.	No. I.		No. II.	
	Surface.	Subsoil.	Surface.	Subsoil.
Moisture	9.06	7.64	7.22	7.34
Volatile and Organic Matter	7.77	5.80	4.96	2.24
Insoluble Matter and Sand	59.9	53.17	61.99	51.07
Oxide of Iron	5.44	5.18	4.03	4.15
Oxide of Alumina	6 81	6.32	5 62	5.76
Oxide of Calcium (Lime)	5.17	10 62	7.32	14.66
Oxide of Magnesia	.67	1.41	1.31	.96
Sulphuric Acid	.14	.29	.30	.17
Phosphoric Acid	.15	.65	.41	.57
Potash	.35	.41	.22	.47
Soda	.04	.24	.13	.12
Carbon Dioxide	3.98	8.11	5.8	11.52

West of the Black Prairie Belt comes our fourth division of Texas soils.

FORT WORTH PRAIRIE BELT.

This extends across the State immediately west of the Black Prairie, and parallel with it. The soils, except in the valleys, are generally shallow and rocky—tending to a yellow or chocolate brown in color. No samples of soils from this locality have been collected.

THE FIFTH DIVISION.

This includes the Pan Handle proper, and much of what is known as the "arid portions" of the State. The Pan Handle is the grain producing portion of the state—wheat, oats, barley and rye. The amount of rain fall is limited, varying from five inches to thirty inches. In some localities the rain fall is sufficient for the maturity of corn, cotton and sorghum. It is devoted principally to stock raising—the native mesquite grass affording good pasturage in summer and drying in winter where it grows, there is not sufficient rain at at this season to destroy its nutrition. Below will be found analysis of samples from Abilene, Wichita and El Paso counties, the last from the valleys of the foothills adjacent to the "Quitman Mountains:"

LOCALITY.	Water.	Volatile and Organic Matter.	Insoluble Matter and Sand.	Iron Oxide.	Alumina Oxide.	Calcium Oxide.	Magnesium Oxide.	Sulphuric Acid.	Phosphoric Acid.	Potash.	Soda.	Carbon Dioxide.
PANHANDLE.												
ABILENE--Black Loam.												
Surface	4.52	3.05	73.78	1.78	6.51	4.04	1.4	.154	Trace	1.137	.957	2.25
Subsoil	4.80	2.69	64.3	2.23	5.05	9.32	1.00	4.22	.102	.588	.305	5.20
WICHITA—Chocolate Loam.												
Surface	1.62	3.01	88.46	2.06	3.82	.074	Trace	.058	Trace	.426	.139	.....
*Subsoil												
EL PASO COUNTY SOILS.												
No. I Red Sandy	.....	8.33	78.63	7.44	2.22	.57	.....	.38	.34	.52	.46	Trace
No. II Sandy Loam	.....	7.65	74.85	4.08	3.84	3.83	Trace	.73	.60	.43	.85	2.13
ALLUVIAL.												
FORT BEND COUNTY.—Sandy Loam.†												
Surface	1.17	1.54	84.31	2.36	3.87	2.74	.24	Trace	.166	.46	.37	2.24
Subsoil	2.26	2.91	79.5	2.91	5.87	2.01	.23	Trace	.26	1.24	1.25	1.58
BRAZORIA COUNTY.—Chocolate Loam.												
Surface	3.04	3.09	78.59	2.80	6.05	1.66	.126	Trace	.136	1.09	.856	2.04
Subsoil	3.28	2.50	77.57	3.18	8.28	1.82	.18	Trace	.128	.841	.443	1.71
Brazoria County.—River Deposit	3.26	2.69	70 92	3.62	5.58	5.66	1.85	.29	.34	.885	.224	4.00
BRAZORIA COUNTY.—Peach Ridge.												
Surface	4.62	9.39	76.45	2.60	3.51	.600	.73	.079	Trace	.545	.32	.34
Subsoil	3.11	4.70	82.79	2.33	4.73	.424	.368	.134	.154	.482	.262	.28

*Subsoil of same character as surface. †Soil from State Sugar Farm.

These fairly represent, in a general way, the soils of what is here denominated the Pan Handle. The chocolate loam predominates, and is easier cultivated. The black loam from Abilene is a richer soil, more clay and lime, as well as more organic matter. It is very sticky and waxy when wet. The samples from El Paso county represent *Mesa*, and valley soils, not alluvial. It is sufficiently rich, and would produce well with any thing like a fair amount of moisture, being now supplied in some localities by irrigation. But this land is sometimes burden d with "alkali," which will be discussed separately.

ALLUVIAL SOILS.

It is impossible to treat fairly of Texas alluvial soils; from the black hammock of the smallest stream, to the chocolate loam of the Brazos, there is every possible variety, all vieing with each other in fertility; a richness that is annually increased in many instances by inundation from the streams. But while much of this land is subject to overflow this overflow comes at a time not to seriously interfere with growing crops, or can be easily and safely levied. Perhaps the richest type of Texas alluvial soil is that of the Brazos. A valley 300 miles in length, from Waco to the Gulf, averaging 4 miles in width. It comprises a body of land not surpassed for fertility and endurance, in the State; and that will compare favorably with the richest alluvial land in the world; much of it is annually inundated with water carrying silt that is itself almost a commercial fertilizer. Indeed the whole river valley is made of a soil similar in composition to this silt, for 50 feet of the same general character.

But before passing to the analysis of this silt, it is well to bear in mind that the Red river, Trinity, Navasota, Colorado, and Guadalupe, besides a great number of small streams, have soils almost equal to that of the Brazos, the richest portion of which perhaps is Oyster creek and Old Caney. The Brazos bottom perhaps may be said to carry three distinct types of soil: One is the chocolate loam, already mentioned, the most common type. Then a sandy loam, sometimes giving way to almost pure sand. The third type is a black soil, "peach ridge" as it is called, from the characteristic growth of the wild peach. The Brazos soil is not difficult to cultivate, gives itself good natural drainage and is adapted to a great variety of crops, the only difficulty being that small grain grows too heavy, and falls down usually before ripe enough for harvesting. Compared to the growth along rivers in the other Gulf States, the timber is light and the ground easily put in cultivation. Above will be found analysis of chocolate loam, and peach ridge, together with deposit from back water of an overflow. From which can be seen the character of material the water carries in suspension. This sample was gathered about 50 miles (by river channel) above the Gulf.

It needs little comment in addition to the face of the analyses. It may not be out of place to say that samples of this soil were sent to chemists in several different States, and of the reported work from four or five different experiment stations, the analyses closely agree with the work here published—verifying, if need be, the remarkable fertility of the Brazos river deposit; but the amount of lime is rather smaller than I anticipated previous to the analysis.

MISCELLANEOUS SOILS.

Under this caption we shall touch briefly the question of *"Alkali" Soils*. The term "alkali" as used popularly is intended to express the presence of any incrustation (usually white) upon the soil, or any chemical substance disseminated in the soil, that will retard or prevent plant growth. Such spots in the western part of the State are common, and are not unknown even in the eastern part; but it is the exception to find any large body of land unsuited for agricultural purposes from the presence of alkali. The "alkali" of Texas generally consists of common salt—sodium chloride. Sometimes there may be present sodium corbonate, and in one instance I have found calcium chloride—chloride of lime. The following analysis reported for the State geological survey will illustrate the composition of Texas "alkali" spots:

Black Alkali from Ysleta.

Lime	4.48 per cent.
Sulphuric acid	6.39 per cent.
Carbon Dioxide	2.23 per cent.
Soda (Oxide)	11.23 per cent.
Potash (Oxide)	.09 per cent.
Chlorine	6.53 per cent.

The soda is present as chloride, sulphate, and carbonate; the lime as silicate and carbonate.

Sample from Rio Grande valley—ten miles south of Ft. Hancock.

Lime	7.73 per cent.
Sulphuric acid	.51 per cent.
Carbon dioxide	2.80 per cent.
Oxide of sodium	1.16 per cent.
Potash	0.41 per cent.
Chlornie	1.16 per cent.

This is the sample containing the chloride of lime, in sufficient quantity to keep the surface of the spot moist, although there had been no rain for several months.

White Alkali.

A sample of this has following composition: In 100 parts of the water soluble material which amounted to forty-four per cent of the entire mass.

50.99 parts alkaline chlorides.
3.88 parts of lime.
19.77 parts sulphuric acid.
No magnesia present.

Sample from Laredo.

Calcium oxide	3.92 per cent.
Sulphuric acid	.563 per cent.
Carbon dioxide	2.36 per cent.
Chiorine	.87 per cent.
Potash	1.32 per cent.
Sodium	.48 per cent.

The general tendency of "alkali" when the soil is cultivated is to work its way to the surface; accumulating here, it frequently prevents the growth of certain crops. To prevent this surface accumulation, the soil should receive deep cultivation; or be flooded with water that is allowed to drain from the soil—carrying the "alkali" with it.

RECLAIMING ALKALI SPOTS.

First, there should be made a chemical analysis of the alkali. If it is a chloride that is giving the trouble, use means above mentioned to prevent "surface accumulation." In addition make applications of barn yard manure when this can be obtained. Certain crops will grow in spite of "alkali," unless there is a very large amount of it. Beets and sorghum are conspicuous for their ability to grow upon an alkaline soil. Frequently the crops are unfitted for use from the presence of chlorides in them, unless for feeding purposes. If carbonate of soda is giving the trouble, this may be neutralized by application of gypsum (sulphate of lime) as shown by Dr. Hilgard, giving corbonate of lime and sulphate of soda, and restoring the soil to fertility.

Phosphate Rock (?)

From Corpus Christi supposed samples of phosphate of lime were obtained and subjected to partial analyses:

	No. 1.	No. 2.
Water	1.64	2.80
Volatile and organic matter	2.96	1.07
Silica and Sand	38.84	25.74
Iron and Alumnia	4.22	3 89
Calcium (Lime)	28.82	35.26
Magnesium	.24	1.00
Sulphuric acid	9.55	2.03
Phorphoric acid	.338	.294
Potash	.468	.. ...
Soda	.397	......

By inspection it will be seen that the phosphoric acid is little more than that contained in some of the soils. But this, with the potash present together with the large quantity of carbonate of lime, make it an excellent marl for local use.

College Clay.

The College is located upon a black sandy soil with a white clay subsoil, almost impervious to water. But it contains occasional pockets and streaks of sand that makes it cave and wash badly when once the top soil is taken away. It seems to be a formation of considerable extent; characterized by a post oak and black jack growth of timber along the Brazos; giving way on the east to belts and spots of prairie. But sometimes, the white clay is replaced by yellow or red clay.

Below is given analysis of a sample from the College farm :

Water	5.82 per cent.
Volatile and Organic Matter	3.94 per cent.
Silica and Insoluble Matter	76.17 per cent.
Iron Oxide	2.99 per cent.
Alumina	8.33 per cent.
Calcium Oxide (Lime)	.60 per cent.
Carbon Dioxide	.47 per cent.
Magnesium	.55 per cent.
Sulphuric Acid	.106 per cent.
Phospharic Acid	.083 per cent.
Potash	.8 per cent.

It will be noticed there is a large amount of potash, but a small amount of lime. If this were applied, by subsoiling, either as quicklime or the carbonate or even as the sulphate, (gypsum) it would probably help to unlock the potash and improve the mechanical condition of the soil. So that better crops would be obtained during a drouthy year. It can not be said, that this *would* result, but it is most likely that such would be the case.

Of the work here reported, samples from State Farm, Brazos bottom deposit from the river, College clay, Forney, Kaufman county, hammock soil from Bell county, upland soil from Colmesneil, Wichita and Abilene soils, Manor soil, Pine Ridge and Valley soils from Rusk, Pecan Gap soil, and phosphate rock were analyzed by Associate Prof. Duncan Adriance. Assistant Prof. P. S. Tilson analyzed samples of black waxy from Bell county, Brazos river deposit, creek bottom soils from Tyler county, Waxahachie soil, Terrell, New Braunfels, two soils Cherokee county, and "alkali" soils reported.

ANALYSES OF TEXAS SOILS.

LOCALITY.	Moisture.	Volatile and Organic Matter.	Insoluble Matter and Sand.	Iron Oxide.	Alumina Oxide.	Calcium Oxide.	Magnesium Oxide.	Sulphuric Acid.	Phosphoric Acid.	Potash.	Soda.	Carbon Dioxide.
Brazos River Silt	3.26	2.69	70.92	3.62	.558	5.66	1.85	0.29	0.34	.885	.224	4.00
Brazos Bottom. Harlem	1.17	1.544	84.31	2.36	3.87	2.74	.24	Trace	.166	.46	.37	2 24
Subsoil	2.26	2.91	79.5	2.91	5.87	2.01	0.23	Trace	.26	1.24	1.25	1.58
Brazos Bottom Chocolate Loam	3.04	3.09	78.59	2.80	6.05	1.66	.126	Trace	.136	1.091	.856	2.04
Subsoil	3.28	2.50	77.57	3.18	8.28	1.82	.18	Trace	.128	.841	.443	1.71
Brazos Bottom Peach Ridge	4.62	9.39	76.45	2.60	3.51	.609	.73	.079	Trace	.545	.32	.34
Subsoil	3.11	4.70	82.97	2.33	4.73	.424	.338	.134	.154	.482	.252	.23
Kaufman Hammock	7.91	6.92	62.98	2.86	7.35	6.30	.46	.147	.25	.68	.09	4.91
Subsoil	7.70	6.16	62.84	2.74	8.18	6.74	.297	.216	.499	.39	.20	4.48
Kaufman County Timber Land	4.56	6.03	60.55	2.42	4.53	11.00	.543	.127	.326	.316	.128	8.49
Subsoil	4.36	7.42	60.96	2.27	5.59	10.05	.64	.16	.266	.419	.185	7.78
Kaufman Prairie Soil	7,57	11.06	56.5	2.82	7.04	6.62	.81	.151	.313	.857	.052	6.26
Subsoil	6.78	10.96	56.4	2.78	2.38	7.35	.615	.137	.294	.606	.109	6.06
Manor	8.47	7.26	50.69	3.73	16.35	5.81	317	.082	.115	.576	.151	5.84
Subsoil	8.23	7.18	51.17	4.74	14.33	6.96	.507	.147	.119	.634	.095	6.11
New Braunsfels	7.22	4.96	61.99	4.03	5.62	7.32	1.31	.30	.41	.22	.13	5.80
Subsoil	7.34	2.24	51.07	4.15	5.76	14.66	.96	.17	.51	.47	.12	11.52
Waxahachie	9.06	7.77	59.9	5.44	6.81	5.17	.67	.14	.15	.35	.04	3.98
Subsoil	7.64	5.80	53.17	5.18	6.32	10.62	1 41	.29	.65	.41	.24	8.11
Bell County Black Waxie	2.42	7.34	44.23	(1.58)		23.98	.94	.15	.12	.22	.25	18.0
Subsoil	1.94	2.65	48.17	(2.68)		23 6	1.13	.21	.13	.28	.30	18.35
Bell County Hammock	3.56	6.52	77.05	2.66	4.91	1.03	.73	.02	.18	1.45	.96	.81
Subsoil	4.91	2.51	78.09	3.98	7.74	.83	.90	.02	.17	1.07	.33	.65

ANALYSES OF TEXAS SOILS.

LOCALITY.	Moisture.	Volatile and Organic Matter.	Insoluble Matter and Sand.	Iron Oxide.	Alnmina Oxide.	Calcium Oxide.	Magnesium Oxide.	Suulphric Acid.	Phosphoric Acid.	Potash.	Soda.	Carbon Dioxide.
Pecan Gap Prairie	6.34	7.88	68.06	4.23	9.48	.814	.32	.236	.128	.83	.636	.344
Subsoil	7.568	6.668	62.91	4.19	10.36	.305	.34	.12	.179	1.29	.60	2.32
Terrell Prairie	2.09	6.84	85.96	1.08	1.68	.55	.28	24	.28	.17	.07	....
Subsoil	2.09	3.81	87.95	1.45	2.71	.37	.32	.11	.23	(.27)		.....
Cerokee County, Rusk Valley Soil	1.32	4.60	83.22	5.82	2.11	.555	.126	......	.243	.48	.40	.44
Subsoil	1.02	3.31	85.91	6.44	1.71	.255	.197	......	.141	.442	.486	.187
Ridge Soil	.42	1.96	95.25	1.22	.69	.16	Trace	Trace	.07	Trace	Trace	......
Subsoil	.30	.92	96.38	1.18	.66	Trace	.18	.10	.15	Trace	Trace	......
Pine Ridge	.8	2.05	96.21	.776	......	....	......	Trace	Trace	Trace	Trace	.34
Subsoil	0.4	.73	97.76	.93	.009	....	....	Trace	Trace	Trace	Trace	.21
Tyler County Creek Bottom	2.30	3.22	89.49	[3.94]		.44	.08	Trace	.03	.06	.07	.....
Subsoil	1.77	2.56	91.09	[4.12]		.36	.15	Trace	.03	.12	.16	....
Tyler County Upland Soil	.37	1.18	97.58	[.75]		....	.08	Trace	Trace	Trace	Trace	....
Subsoil	.3	.67	98.17	[.78]		....	....	Trace	Trace	Trace	Trace	......
Taylor County. Abilene	4.52	3.05	73.78	1.78	6.51	4.04	1.41	.154	Trace	1.14	.96	2.25
Subsoil	4.8	2.69	64.3	2.23	5.06	9.33	5.2	1.1	4.23	.102	.588	.305
Wichita	1.62	3.01	88.46	2.06	3.82	.07	Trace	.06	Trace	.426	.139	....
College Clay	5.82	3.94	76.17	2.99	8.33	.6	.55	.106	.083	.8	Trace	.47
Phosphate Rock (?)	1.64	2.90	38.84	[4.22]		28.82	.237	.955	.338	.468	.397	N. E.