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SOILS OF THE EASTERN UNITED STATES AND THEIR USE—XXVI.

THE HOUSTON CLAY.

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THE HOUSTON CLAY.

GEOGRAPHICAL DISTRIBUTION.

The Houston clay is an important and extensively developed soil type of the Cretaceous prairie region of the Gulf Coastal Plain. It has been encountered in 21 areas located in 4 States and mapped to an aggregate extent of 763,688 acres by the Bureau of Soils. The most extensive occurrences are in central and western Alabama, northeastern Mississippi, and west central Texas. In all of these areas it is associated with the black prairie soils.

CHARACTERISTICS OF SOIL AND SUBSOIL.

The surface soil of the Houston clay is prevalently a brown or black loamy clay ranging in depth from 4 to 10 inches underlain by a stiff, plastic, light-brown, yellow, or gray clay, which at an average depth of about 20 inches passes into a light-gray or white rotten limestone or chalk. The color of the surface soil is somewhat varied, depending upon its topographic position, the darker colored areas occurring in more level situations and in slight depressions, while the light-colored brown or gray surface soils are found upon steeper slopes where erosion has largely removed the surface soil material. The Houston clay is a residual soil derived from the weathering of the Selma chalk in central Alabama and northeastern Mississippi; of the "rotten limestone" of the Jackson stage of the Eocene in the south central counties of Mississippi; and from the Austin chalk in west central Texas. In all cases these formations consist of impure argillaceous limestones or marls of Eocene or Cretaceous age exposed in broad belts along the outcrops of the formations. Within each of the areas where these formations and their derivative soils occur there are also areas of varying size where more recent deposits have been laid down over the marls. In consequence there has been more or less mingling of material from other sources with that derived directly from the underlying marl, which has given rise to some variation in the composition and coloration of the type, particularly the surface soil. The brown or reddish-brown surface

soils overlying the plastic clay and the marl at greater depths are sometimes thin remnants of these latter formations.

The Houston clay, together with other members of the Houston series, is easily distinguished from all other soil types of the Coastal Plain region through its derivation from the underlying marls, the existence of a white or gray chalky material at depths ranging from 20 inches to 3 or 4 feet, the existence of calcareous nodules and fragments of shell in both soil and subsoil, and the prevalent brown, drab or black color of the surface soil itself. It can not be confused with the other dark-colored soils of the region, since these are prevalently alluvial, while the Houston clay occurs only upon the upland prairies.

SURFACE FEATURES AND DRAINAGE.

The greater portion of the Houston clay possesses a level to gently rolling surface. Large tracts are almost absolutely level or broken by low ridges from 15 to 30 feet above the general level of the country.

The surface of the Houston clay lies at elevations ranging from about 125 feet to 500 or 600 feet above sea level. In general the type is fairly well drained, so far as surface run-off is concerned. In fact, erosion occurs over extensive areas of its surface. The internal and subsoil drainage of the type, owing to its stiff, waxy nature, is not particularly good, although the tendency toward granulation in the surface soil somewhat assists in this respect.

LIMITATIONS IN USE.

The Houston clay is one of the more plastic clay soils of the upland portion of the Gulf Coastal Plain. In common with other soils of similar texture it is not so well suited to the production of special crops as to the growing of the great staples, including corn, cotton, oats, and hay. In fact very few vegetables, fruits, or other special crops may be grown to advantage upon the type because of its stiff, plastic nature, the large amount of moisture which is retained under normal conditions of rainfall and the difficulty of maintaining perfect tillage during the growing season. The same characteristics which prevent its general use for special crops render it particularly favorable to the production of the staples.

The Houston clay is a highly calcareous soil. Numerous analyses of the lime content of the subsoil have shown it to contain from 2½ to 35 per cent of calcium carbonate, while the percentage of lime in the gray chalky material at greater depths is even higher than this. In consequence, wherever drainage conditions are at all favorable, this type constitutes one of the best alfalfa soils to be found in the upland portion of the Gulf States. It also produces other leguminous

crops to good advantage, and its continued fertility under constant one-crop farming is a notable feature of the type.

A considerable proportion of the total acreage of the Houston clay can not be occupied for general farming operations. The level, rolling, and gently sloping areas of the type, where the surface soil extends to a depth of 6 inches or more, are well suited to general farming, but within many fields and universally along the margins of the type, erosion has proceeded so rapidly that the surface soil can not be maintained under the ordinary conditions of clean cultivation for cotton and corn, and many "galled" areas, numerous gullies, and other evidences of excessive erosion indicate less valuable soil areas than the normal for the type. Upon such eroded areas little moisture is absorbed during the periods of rain, and the surface soil is bodily removed with every heavy shower. In consequence, crop yields on such areas are small, even when any stand can be secured at all. Land of this character should be seeded down to the grasses, using alfalfa where it is possible to obtain a stand, and permitting Johnson or Bermuda grass, or even Melilotus to cover the ground where erosion has proceeded to such an extent that it is not practicable to seed down to alfalfa.

The Houston clay occurs under a considerable range of rainfall conditions. In Alabama, Mississippi, northern Louisiana, and northeastern Texas the precipitation is abundant for the production of the ordinary staple crops, but in west central Texas there are areas of the type which occur under semiarid conditions and in these localities periods of drought late in the summer frequently interfere with the production of either cotton or corn. In such localities large areas of the type are permitted to grow up to wild prairie grasses, which are either grazed off or cut for hay.

There is thus considerable variation in the character of the agriculture which is conducted upon the Houston clay.

IMPROVEMENT IN SOIL EFFICIENCY.

There are two almost equally important improvements in soil efficiency which may be effected in connection with the tillage of the Houston clay. The first of these is the prevention of excessive erosion, already indicated. Wherever the surface slopes within this type exceed 10 degrees of declivity it is practically impossible to maintain the land under cultivation. With the adoption of contour farming and of terracing, together with deep plowing, even the steeper slopes may be tilled to advantage, but in general it would be better to secure a stand of alfalfa, or, if this proves to be impossible, to allow Johnson grass, Bermuda grass, or Melilotus to grow upon such slopes, to be cut either as hay or to be grazed off by the work

stock, dairy, and beef animals of the plantation. Upon the gentler slopes deeper plowing, the careful rotation of crops, and an effort to maintain a winter cover crop to protect the surface soil during periods of heaviest precipitation will prevent excessive erosion and maintain the surface soil in its proper place.

Under the older methods of tillage, where cotton was raised consecutively for a long period of time, or at the most was only alternated with corn at infrequent periods, the surface drainage of the Houston clay was adequately maintained by plowing the land in ridges and permitting the excess water to flow off through the water furrows. While this promoted erosion upon all of the steeper slopes, upon the more gentle slopes it was adequate for the fairly effective drainage of the type. Within more recent years improved farming methods have been introduced, which require the rotation of cotton, corn, and some forage grass, particularly alfalfa. This improved method of farming tends to prevent the use of the ridge and furrow method of surface cultivation. It is rapidly bringing about the broadcast plowing of the type even when the fields are ridged later with an approach to the old water furrow method of cultivation. Then, too, the maintenance of portions of the type for several years at a time in alfalfa has necessitated greater attention to surface and subsoil drainage. It is only upon the better drained portions of the type that alfalfa is uniformly successful, and if the production of this crop is to be extended upon the Houston clay the installation of tile drains upon certain portions of the type will be necessary. While the subsoil to a depth of about 2 feet is waxy and plastic, still there is a constant tendency under proper methods of tillage toward granulation in the surface soil and immediate subsoil. Fields may be effectively tile drained, provided the tile are laid at a depth not less than 2 feet below the surface, and strung at intervals of approximately 40 feet. In the majority of cases the results will not be immediately evident, but increasing improvement will be noted from year to year. Attempts along this line have been made so recently that very little may be stated positively in regard to the outcome, although soils seemingly as plastic and impervious in the prairie regions of the North Central States have been effectively underdrained in this manner.

In addition to these two methods of improving the Houston clay it is essential that rotation of crops should be practiced upon this soil. A reasonably well-founded belief in the wonderful fertility of the type has led to its almost constant cultivation to one or at most two crops—cotton and corn. In certain instances in the eastern Gulf States, cotton has been raised continuously for 25 years upon this soil, maintaining an average yield of one-half bale to the acre or better,

in spite of seasonal variations due to climatic conditions. It is believed, however, that this constant cultivation of a single crop has materially reduced the yields over a considerable portion of the type. This in part is probably due to the promotion of excessive erosion and partly to unfavorable physical conditions induced by unvaried cultivation. In contrast, upon limited areas where a crop rotation has been adopted, yields of three-fourths of a bale to one bale of cotton per acre are easily obtained. The general adoption of suitable rotations throughout the area occupied by the Houston clay is therefore desirable.

LIMITATIONS UPON SPECIAL CROPS.

Because of its characteristic texture, the Houston clay is not well suited to the production of any special crops. Moreover, it is usually associated with soils in every area which are well suited to the production of special crops, and it is, therefore, not advisable to attempt the production of any but the staple crops, including cotton, corn, oats, and hay, upon this type.

EXTENT OF OCCUPATION.

In the majority of the more eastern areas where the Houston clay is found, from 60 to 80 per cent of the type is occupied agriculturally. Probably one-half of the total area of the type thus far mapped is annually cropped. An additional one-fourth is used for pasturage purposes. The remaining 25 per cent, consisting chiefly of steep slopes and isolated patches of small size, remains unoccupied. Upon such areas a small amount of timber, principally cedar, is to be found. In the more western areas, under semiarid conditions not more than 10 to 15 per cent of the type is annually tilled, and the remainder supports wild grasses, which are cut for hay or grazed off. Wherever the type is found under suitable climatic conditions, it is considered desirable for farming purposes, and while there is a wide range in the selling price of different areas, dependent largely upon the surface configuration of the type and its location with regard to transportation facilities, yet all areas which are reasonably level and fairly near to railroad transportation are highly esteemed. Tracts so situated command prices ranging from $30 to $75 per acre.

CROP ADAPTATIONS.

The Houston clay is one of the important Upland cotton soils of the Gulf region. Portions of the type have produced cotton almost continuously for periods ranging from 25 to 75 years, maintaining a high average yield during the entire time. In spite of a tendency

toward droughty conditions during the latter part of the growing season it may be stated that the average cotton yield upon the Houston clay is undoubtedly in excess of one-half bale per acre. There are, of course, seasonal variations, dependent chiefly upon rainfall conditions, but in general the type produces from one-third bale as a minimum crop, to yields in excess of 1 bale per acre upon well-situated land which has been properly tilled. This soil is so highly esteemed for the production of cotton that in many areas this crop is planted almost to the total exclusion of any other.

Corn yields range from 30 to 50 bushels per acre, with maximum yields as high as 75 bushels. Under unfavorable conditions the production drops as low as 8 to 12 bushels per acre. The lower yields prevail over areas subjected to excessive erosion or areas waterlogged by excessive rainfall which has prevented the germination or subsequent growth of the corn crop during the earlier part of the season or where excessive drought in midsummer has cut down the grain yield.

Over considerable areas of the Houston clay Johnson grass, allied to the sorghums, has attained a foothold practically to the exclusion of cotton or corn. Johnson grass is considered one of the pests of the cotton planter, yet it yields from 1½ to 3 tons of hay per acre, worth from $15 to $18 per ton. Bermuda grass has so invaded some of the fields that they have been given up to it, being used for grazing or for the cutting of hay.

More recently alfalfa has been introduced upon the Houston clay and, particularly in Alabama and Mississippi, growing this crop has become a special feature of the agriculture of areas occupied by the type. The Houston clay possesses several characteristics requisite for successful alfalfa growing. In the first place it is decidedly calcareous, thus favoring the inoculation of the alfalfa and the maintenance of the requisite bacteria within the root nodules. When properly treated the surface soil of the Houston clay is also granular, friable, and easily maintained in good tilth. Consequently an even stand of alfalfa may be obtained. The crop is only suited to those portions of the type which are either naturally well drained or over which some effort has been made at the artificial underdrainage of the subsoil. Alfalfa is a deep-rooted plant, which is decidedly intolerant of a saturated condition of the subsoil. In consequence, extremely level areas of the Houston clay, where water stands either at the surface or within the subsoil, are not suited to the production of this crop. There are, however, thousands of acres of the type sufficiently well drained to constitute an admirable soil for alfalfa growing. Where a stand of the crop has been obtained it is possible, with the long growing season of the Gulf coast region, to obtain four and frequently

five cuttings annually, averaging about 1 ton of hay to the cutting. Some difficulty is experienced in curing the first crop, since it is ready for harvest during the rainy portion of the spring months, but the subsequent crops are matured at seasons which are usually favorable for the drying out of the hay.

The Houston clay and its related type, the Houston black clay, are undoubtedly the best alfalfa soils of the "black prairie" regions in Alabama and Mississippi, while these types are coming to be so recognized in the more western occurrences in Texas. Since the region is one which to the present time has not produced a sufficient amount of forage for the sustenance of the work stock, good hay, like that made from alfalfa, is always in demand, at prices ranging from $15 to $20 per ton. In consequence an acre well seeded to alfalfa constitutes a more certain and usually a more valuable acre than the same area planted either to cotton or corn. Considering the smaller amount of hand labor requisite for tending and harvesting the alfalfa crop, it is evident that the profits from alfalfa growing equal or exceed those to be derived from cotton culture, even when yields of the latter exceed one-half bale per acre.

Winter oats are also grown to some extent upon the various areas of the Houston clay. The yields when the grain is cut for thrashing range from 25 to 35 bushels per acre. The oats are usually cut as a forage crop.

In northeastern Texas some winter wheat is also grown upon the Houston clay, giving yields of 8 to 15 bushels per acre. The crop is unusual.

FARM EQUIPMENT.

The Houston clay ordinarily occurs in association with other types of soil, and the normal farm equipment of buildings, machinery, and stock does not differ materially from that of the average cotton plantation. In fact a considerable amount of difficulty in the management of this type has been experienced through the continued attempt to till it by means of the one-horse or one-mule hitch, which is adequate for the plowing and cultivation of the more sandy soils prevalent through the Gulf States. The stiff, waxy nature of the Houston clay does not lend itself to this treatment. In the more progressive communities there is an increasing tendency toward the use of the two or four mule hitch and of the disk plow and disk harrow in the preparation of this land. It is not possible to procure a properly granulated and thoroughly mellow seed bed with the ordinary light-weight equipment used most commonly upon cotton plantations. Heavier teams and better tools are required to bring the Houston clay to its full degree of productivity.

SUMMARY.

The Houston clay is an important Upland cotton soil of the "black prairie" regions of Alabama, Mississippi, and Texas.

The surface soil to a variable depth is a brown or black granular clay loam or clay. This is underlain by a lighter brown or yellow plastic clay subsoil to an average depth of about 20 inches, where the gray or whitish chalk or rotten limestone is usually encountered. It occupies level to rolling prairie areas, frequently bordered by steeply sloping and eroded sections along the stream courses.

The drainage of the type is usually fairly well established, although upon the more level areas the internal drainage of the subsoil may be defective.

Erosion is one of the principal difficulties experienced in the occupation of this land, and slopes in excess of 10° should be covered with grass for pasturage purposes.

Tile underdrainage should be installed upon the more level areas, especially if alfalfa is to be grown.

The Houston clay is in no sense a special crop soil, but is considered one of the best Upland cotton soils. It is also fairly well suited to the production of corn and is coming to be especially esteemed for the growing of alfalfa.

In general the greater portion of the different areas of the Houston clay is occupied for agricultural purposes. The more eroded areas and those remote from lines of transportation are less completely occupied, while in the semiarid portions of southwestern Texas the grazing of the wild grasses constitutes the chief use of the type.

The proper tillage of the Houston clay requires heavier farm teams and improved machinery.

Approved.

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *October 30, 1911.*

APPENDIX.

The following table shows the extent of the Houston clay in the areas surveyed to this time.

In the first column is stated the particular soil survey in which the soil was encountered; in the second column its extent of development in acres; and in the third column the volume of the Field Operations of the Bureau of Soils in which the report upon the area may be found. Those desiring a detailed description of the soil and of the general conditions which surround it in any particular area may consult these volumes in almost any public library.

Areas of Houston clay encountered in the soil survey.

Survey.	Area of soil.	Date.[1]
	Acres.	
Alabama:		
Autauga County	1,664	1908
Butler County	10,880	1907
Dallas County	149,184	1905
Hale County	55,104	1909
Macon County [2]	8,576	1904
Montgomery County	86,400	1905
Perry County	136,128	1902
Sumter County	59,048	1904
Louisiana:		
Winn Parish	1,728	1907
Mississippi:		
Clay County	28,608	1909
Jasper County	11,392	1907
Monroe County	58,176	1908
Oktibbeha County	10,368	1907
Pontotoc County	11,008	1906
Prentiss County	5,632	1907
Texas:		
Austin area [3]	61,440	1904
Franklin County	832	1908
Grayson County	44,096	1909
San Antonio area [3]	4,480	1904
San Marcos area	6,080	1906
Waco area	12,864	1905

[1] Year of publication, Field Operations.
[2] Mapped as Houston black clay.
[3] Mapped as Austin clay.