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MISSISSIPPI AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 58.

MAY, 1899.

SOILS OF MISSISSIPPI: TEXTURE AND WATER CONDITIONS.

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W. L. HUTCHINSON, DIRECTOR.
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Soil Divisions.—In his Geology of Mississippi, and subsequently in his report on Cotton Production, for the Tenth Census, in 1870, Dr. Eug. W. Hilgard classified the soils of the state as follows, viz.:

1. Northeastern prairie region; including the Pontotoc ridge.
2. Flatwoods region.
3. Yellow and brown loam region.
4. Bluff or canehills region.
5. Alluvial or Yazoo Delta region.
6. Central prairie region.
7. Oak and hickory uplands region.
8. Pine woods region.

While such a classification has very little value for farmers, still, for purposes of description and reference, it is quite convenient. Farmers very naturally regard soils from a standpoint of productiveness, the ease with which they may be tilled, and the manner in which they

act towards water. In this way about all the soils in the state may be grouped into three classes:

1. Soils rich in plant food and with such texture as to furnish good water conditions.
2. Soils rich in plant food, but with water conditions poor or undesirable.
3. Soils with good water conditions, but deficient in plant food, and hence requiring the constant use of fertilizers.

After studying the virgin soils of Mississippi and the cotton states carefully, Dr. Hilgard was of opinion that, for an equal area, this state had as much rich soil as any state in the Union. When properly drained and cultivated the soils of the Yazoo Delta are justly regarded everywhere as typical fertile soils. In other sections of the state there are large areas of valleys and bottoms that, when properly drained and tilled, belong to the same class as the best Delta lands, though probably not quite so productive. Such valley lands constitute one-third or one-fourth of the cultivated land in the western part of the Northeastern prairie region. The best prairie lands, as well as the best lands in the brown loam section, when in good condition, deserve to be classed with the best and most productive lands in the state. These soils have never been fertilized, and it has not been necessary to use fertilizers in order to secure large yields.

In the pine woods region and in the oak and hickory uplands region, the amount of mineral plant food in the soil is small, and the lands in these sections require the constant use of fertilizers. But their texture is good; they respond liberally to every well-directed effort; they furnish an excellent place to put fertilizers; they are good soils.

Study of the Soils in the State. Appreciating the fact that the proper cultivation and management of soils is probably the most important thing in successful agriculture, and realizing that practical farmers must needs,

in future, give more attention to this subject, the Station has made it one of the principal lines for study and investigation.

Chemical and physical analyses of soils are valuable, but one should not depend entirely on these if he would be thoroughly familiar with all the conditions which have to do with the yield of crops, or, know the difficulties with which practical farmers have to deal. The chemists of the Station have collected, from cultivated fields, about two hundred and fifty samples of soil and made both chemical and physical analyses of them.

During the six or seven-hundred mile trip, through the country, for collecting samples, the apparent yield of the crops; the depth of the surface or cultivated soil; the manner of cultivation and drainage; the apparent texture of the soil, and the conditions affecting the supply of water for crops; the character and kind of natural plant growth on similar soils, were all recorded for use in interpreting the laboratory results. The different soils in the state are also being tested in pots each of which will hold about one hundred pounds, and so constructed as to give good control of the water supply. The yellow hill land on the College farm presents very unsatisfactory water conditions, and several acres of this are being used for field tests as to the best means of improving the texture and water conditions of a soil.

Texture, Water Supply and Productiveness. It is very well for soils to have large amounts of potash and phosphoric acid, but it is just as necessary that their **texture** be such as to allow the air to enter the soil and to circulate freely through it, and, also, to furnish a favorable supply of water for the crops that are to be grown. Practical farmers apparently never think of the fact that one of the most important things in a soil are the living germs, which all fertile soils contain. Some of these germs are favorable to the ends for which the farmer works, while others are unfavorable.

The best of them require a well drained, porous soil that they may get air, which is as necessary to them as it is to the farmer himself. These germs require moisture, but they do not want a soil saturated with water. They need organic matter for their growth and development, and from the nitrogen in this organic matter they make the necessary nitrates for growing crops. Crops must have **nitrates**, and the farmers of this state would do well to consider the fact that they depend entirely on the germs in their soils to furnish their crops this important plant food. The roots of plants need air as well as the stems and leaves. **Water is important.** The **texture** of the soil is of very great importance, for it has to do with the development and growth of plant roots; with the proper supply of water for crops; with the formation of nitrates by the growth and development of the proper germs in the soil. **In cultivating his soil, it is the business of the farmer to control the texture, and also, as far as he may, the supply of water for his crops.**

The system of farming which has been practiced in this state has not properly cared for soils; its sure result has been to make soils **poorer** each year. Our farmers would do well to so change their methods as to make their soils **better** each year. We need farmers who use good **judgment** in the management and cultivation of soils, and to this end, more than any other, perhaps, they need to know the value of a proper texture for soils and the functions of the soil in furnishing a proper supply of water. It is here that our farming operations are especially faulty. Good judgment, based upon a thorough knowledge of the objects and principles of tillage, and the functions of soils, should govern our farm operations and not a custom which always lessens fertility and productiveness and which has converted the fairest and most fertile lands into gullied and abandoned "old fields."

Advantage of Fertile Soils. The farmer, who persistently cultivates land that only yields a fourth, or a third, or a half a crop, is sure to work for small pay in

comparison with the man who secures a maximum yield. No good farmer should be satisfied to cultivate land unless it gives large yields. The man who produces one fourth or one-third of a bale of cotton per acre gets very little if anything for his labor, when cotton sells at five cents per pound, while the man who produces a bale or a bale and a half per acre, may receive good wages. It is the same with all crops. The man who is content to get only a part of a crop is sure to find farming unprofitable. Even at present prices **cotton** may be quite profitable to the producer if the yield be large, but, it is worse than folly to spend one's efforts growing cotton when the yield per acre is small. If one would produce **corn** at small cost per bushel the yield per acre must necessarily be large. The farmers of this State would do well to determine the unprofitable acres for cotton and corn and plant such in some crop that will return a profit, or else, increase their productiveness. It is a comparatively easy matter for Mississippi farmers to cultivate only such soils as will give large yields and the object of this bulletin is to direct their attention to the very great advantage in cultivating fertile soils, and to the further fact that the first thing needful to improve the lands in this state, and make them more productive is to give them better **texture** and **water conditions**.

Erosion and Soil Water. The never failing result of our system of cotton farming has been to wear out land, to injure the water conditions, to let it wash away. Some of the best land in the State, which should have lasted for all time, has been rendered almost worthless by erosion or washing. This practice still continues and the area of gullied land grows larger each year, and many seem to be wholly indifferent to this wholesale destruction of valuable soils. Other lands, once fertile, have constantly decreased in productiveness. The water conditions in these soil are not good. Let the farmers in this state learn to control water; control it so as to prevent washing; control it so as to have abundant water for crops during periods

of drouth and prevent injury during periods of wet weather, for this is one of the most important problems with which they have to deal.

Soils and Seasons. Farmers in this state fully appreciate the value of a proper supply of water for their crops. They generally admit that the **seasons** determine the yield and they sometimes plant on the dark of the moon in order to secure a proper water supply. **Soils** have much to do with the water supply for crops as well as the seasons. The farmer has no control over the seasons but he has entire control over the soil.

There probably is no appreciable change in the average weather conditions in Mississippi and consequently the seasons we have had for the last twenty years give an accurate idea of what we may expect in the future.

From forty to sixty inches of rain is sure to fall each year. There is just as sure to be periods of excessive rain and periods of drouth as well as rains which come in such manner and at such times as to be apparently of maximum benefit to growing crops. There will be **heavy rains** which as yet we do not control, and which are mainly responsible for all serious washing or erosion. This much at least farmers may expect of the seasons and their farming operations should be such as to prevent washing; to derive the greatest benefit from opportune rains; to lessen the ills of excessive wet weather; and, during periods of drouth, to conserve the water in the soil for the use of their crops.

If the **seasons** were always just right the growing of crops would be a perfectly simple operation. The best soils in this State produce good crops every year, and, at least, a small area of such may be found on every farm. The best soils will furnish abundant water for crops for a period of **six weeks** without rain. There are large areas in the State that, at present, are incapable of furnishing a proper supply for ten days of hot summer weather. Crops on such soils are sure to suffer and generally will

suffer severely. Farmers need to give more attention to their soils as agents for controlling and furnishing the necessary water for crops. Badly managed and improperly tilled soils are far more responsible for our crop yields than the seasons. We cannot control the seasons but it is comparatively easy to change the character of a soil and it is through the medium of his soil that the farmer may do much to control the supply of water for his crops, and in a great many cases he may have it just as he wants it.

Amount of Water Needed by Plants. For every pound of dry matter produced by plants they require from 300 to 500 pounds of water. The tender roots of plants absorb water from the soil, it passes upward through the body or stem and is evaporated from the leaves. When the soil is dry and the evaporation from the leaves is greater than the amount of water entering at the roots, the plants wilt and if they remain in this condition too long they become permanently injured.

One inch of rainfall over an acre represents about 100 tons of water. To produce a ton of hay requires that 300 tons of water pass through the plant and be evaporated from the leaves. A fifty bushel corn crop requires about 1200 tons of water, and a crop of cotton yielding a bale, 900 tons. We thus see that six inches of rain over an acre furnishes enough water to produce two tons of hay and twelve inches, enough for a crop of fifty bushels of corn and nine inches, enough for a crop of cotton yielding a bale per acre. While these amounts are large they are not nearly so large as our annual rainfall. We nearly always have, **during the period of growth**, a greater rainfall than is needed for the production of maximum crops. If the soils of Mississippi were properly managed and tilled our crops would rarely suffer for the want of water.

THINGS WHICH INFLUENCE SOIL WATER.

Clay and Sandy Soils. Every farmer is familiar with the marked difference between clay and sandy soils in their action towards water. Sandy soils being open and porous, water moves through them comparatively fast. The particles which compose **clay** soils are much smaller and the spaces between the particles are also small and the movement of water through them is very slow. Sandy soils till easily, while close compact clays are difficult to till. The flatwoods soils and the soils in the prairie regions are the only distinctively clay soils in the State. The soils in the yellow and brown loam region are characterized by a large amount of very fine material designated as **silt**, which determines their texture and also their action towards water. The valley and bottom soils usually have a loamy texture. In the pine woods region and in the oak, and hickory uplands region the surface soils are sandy or a sandy loam with subsoils of yellow or red clay, containing more or less sand, which gives them the texture of a clay loam.

Organic Matter or Humus. It is a comparatively easy matter to change the texture of a soil with organic matter or humus. By turning under green crops a clay soil may be made open and porous, with a loam texture. In this way the surface soil may be made to cultivate like a loam and it will, also, so manifest itself towards water. Organic matter in sandy soils makes them more retentive of moisture and prevents the too rapid sinking of water downward to a depth where it can no longer be of use to plants. Our system of farming is prone to destroy and deplete the **organic** matter in our soils and in doing so the texture has been changed and this in turn makes them act differently towards water. The water supply is not so uniform or so good as formerly. Crops suffer more from extremes of wet and dry weather; the yields are less. Organic matter prevents land from baking or forming a

crust on the surface and also from running together after heavy rains. Cotton soils stand greatly in need of organic matter, and it should be added to them as rapidly as circumstances may permit.

Restorative Crops. Cowpeas, lespedeza, hairy vetch, melilotus and other leguminous or restorative crops improve our worn soils in a most wonderful manner. These crops may be cut for hay or grazed and the beneficial effect is still very great. It is often the case that the beneficial effect of a crop of cowpeas, where the vines were used for forage, is just as great as where the vines were plowed under. While these crops are usually considered from the standpoint of their fertilizing value, still not the least of their beneficial effect on cotton soils is the improvement which they make in the water conditions. In this State these crops produce unusually marked results, and probably their greatest good at this time is found in the beneficial influence which they have on the texture of the soil and on the supply of water for succeeding crops. This gives to these plants a very great value for Mississippi farmers and they should be grown extensively in all parts of the State and in no section are they worse needed than in the northeastern prairie region. The soils in this region are rich in plant food and the decrease in their productiveness is not due to the exhaustion of the plant food but to the less favorable water conditions in the soil and a texture, too much like **putty**. Commercial fertilizers do not, as a rule, increase the yields on these soils but melilotus, clover, and cowpeas readily restore good water conditions and make them among the most productive in the state and as much so as when this section was known as the "Egypt of the South."

Earth or Dust Mulch. During the hot weather of summer a large amount of soil water, for which the crops stand greatly in need, is lost by evaporation from the surface of the ground. Any kind of good mulch largely prevents this loss. While it may be profitable to mulch

certain garden crops with straw, cotton seed or cotton seed hulls yet for farm crops such a system is not practicable; but a very effective and good mulch may be made of the surface soil by means of harrows, cultivators, hoes, sweeps or other implements that will leave a thin or shallow layer of **fine loose earth** covering the surface of the ground. This earth mulch may become very dry itself but it will prevent evaporation from the soil below. **Summer tillage** should be shallow and frequent if the best results are to be had. In dry, hot weather untilled land loses water very fast by evaporation and hence it is best to run the cultivators through the entire crop just as soon as the ground is dry enough on the surface to cultivate in order that the soil mulch formed by the cultivators may prevent further loss of water from the lower soil; whether it rains or not the surface should be stirred sufficiently often to keep it detached from the soil below. Any plow that leaves a hard bare furrow or which does not leave the entire surface covered with loose earth is a poor implement for conserving moisture in the soil.

Ridge and Flat Culture. One should always be able to tell whether ridge or flat culture would be best. Ridge culture exposes more surface for evaporation and hence is always to be preferred where the effort is to get rid of an excess of water. Flat culture has less surface for evaporation and is better for conserving moisture in the soil. **Ridge** culture is often used in this State where flat culture would appearantly give better results. The extensive use of the moldboard plow in cultivating crops, even at the last plowing, appears to be wrong in principle; and to use some form of cultivator to mulch the surface and disturb the roots less would doubtless be a better practice.

OTHER DIVISIONS OF SOILS.

Valley and Bottom Lands. When properly drained the valley and bottom lands are the most productive and the most desirable lands in the State. Good drainage lowers the water level four feet below the surface where an abundant supply is always present and with their loamy texture such soils are almost as safe as **irrigated** lands. As a rule we have found these lands but poorly drained and improperly cultivated and their owners do not seem to appreciate their great value. Generally it is neither expensive nor difficult to drain these lands even for cotton and corn while their value for **grass** seems not to be considered. Where they are too low and wet for ordinary crops they could be put in grass for summer pasture.

There is such a large area of these valley and bottom lands in the State; it is so easy to make their water conditions the very best; they are so safe and productive that we desire to impress on their owners the fact that these are the best lands in the State and as good as may be found anywhere.

Brown Loam Soils. Between the canehills, or bluff, on the west, and the flatwoods on the east, are the brown and yellow loam lands, extending from the Tennessee line as far south as the counties of Hinds and Yazoo. Underlying this section is a deep deposit of sand or gravel. Covering this sand or gravel is a layer of fine material, of a brown or yellow color, and varying in thickness from one to twenty feet. This material has a loam texture, and usually contains more than fifty percent of **silt**. Where these lands are rolling the formation and conditions are peculiarly favorable for washing and erosion, and some parts of it are already literally washed away. Where the silt layer is four feet thick or more the land originally was very productive, and no soils in the

state were more highly prized. Where the surface has been sufficiently level to prevent excessive washing, the lands in this section are still regarded as among the best. The yields obtained are not so large as when the lands were new, and the crops are more sensitive to the evil effects of unfavorable seasons. Except in localities where trucking is practiced, very little fertilizer is used in this section. Analysis indicates that the same kind of fertilization that pays best in the pinewoods section would give the best results in the brown loam section. The **potash** in these soils is four or five times as great as the phosphoric acid, and apparently it would be found profitable to use, on these lands, **phosphates** mixed with cottonseed meal or cotton seed. Where these lands are rolling, and to cultivate them in cotton or corn means to wash them away in a few years, they should be kept sodded with grass. No soils in the state seem to be better adapted to bermuda, carpet grass, and hairy vetch; while none grow lespedeza so well as the silt soils of this region.

Basin Soils. In Neshoba, Scott, Leake, Winston, and Kemper counties, are small areas of very fine land known locally as basin land. The two largest bodies, of this character of soil, that we have seen, are in Neshoba county, and known as the Muckalusha and Yazoo basins. These lands are very similar to the best types of the brown loam, which they resemble very much in texture, color, and composition. Probably no upland soils in the state furnish such desirable water conditions, and in this respect they resemble the best drained valleys and bottoms, with which they deserve to be classed. They are undoubtedly among the best soils in the state. As they were cultivated by the Indians, no one knows how many crops they have produced, and hence they naturally stand in need of fertilization. The hills or elevated parts of these basins have a decided sandy texture and are a little too open and porous. They should have the benefit of an occasional crop of cow-peas, lespedeza, and hairy vetch.

A fertilizer, made by mixing 650 lbs. of cottonseed meal, 1150 lbs. of acid phosphate, and 200 lbs. of kainit, would apparently be well suited to the wants of these soils and should give good results.

Reedbrake Soils. In the same section of the state, where the basin lands occur, on the tops of hills and ridges, in the valleys and bottoms, occur what is locally known as reedbrake soils, which are subdivided into timbered and spongy reedbrake. The timbered reedbrake is nothing more than a fertile valley soil after it is properly ditched and drained; while the spongy reedbrake consists mainly of a mass of organic matter, more or less decayed, very much resembling a mass of leaf mold in the forest. Though these spongy reedbrakes are very fertile when first tilled, they soon wear out and only five or ten bushels of corn are made where formerly was obtained a yield of eighty bushels per acre. These worn out reedbrakes are very acid or **sour**, and the organic matter is so coarse as to give a texture so open and porous as to make it difficult to control a proper supply of water for crops. **Lime** applied at the rate of two tons per acre would correct the acidity and also hasten the decay of the organic matter, and would help to form a good quality of humus. Where soil farther up the valley or from the adjacent hills can be washed on to these spongy reedbrakes, it should be done, as it would convert them into similar soils to those of the timbered reedbrakes.

Sandy and Sandy Loam Soils. The soils of the pine woods region are either sandy or sandy loams with a clay or clay loam subsoil. In the oak and hickory uplands region the soils are of the same type, though both the surface and subsoils contain somewhat less sand.

The plant food in these soils is small, and this is especially true of phosphoric acid. This is the **fertilizer** region of the state, and these soils respond well to fertilizers consisting mainly of phosphates with a small amount of nitrogen. No soils in the state are more benefited by

cowpeas, and **restorative** crops should always be grown extensively in this section. Investigations in the laboratory indicate that these soils are acid and that they would be benefited by lime. From one to two thousand pounds of lime per acre on these soils would be sufficient. Lime should be slaked to a dry powder, applied broadcast and thoroughly harrowed in with the surface soil.

These soils are easily tilled; they have a desirable texture and manage water well; they respond liberally to any good treatment given them. They are ideal soils for truck farming, and by the use of cowpeas and fertilizers the yield of crops on them may be increased to the maximum.

Prairie Soils. The prairie soils, in the state, are as a rule, rich in the mineral elements of plant food and the present yield of crops on them is determined by their texture and the conditions which control the supply of water. They contain from forty to fifty per cent of clay and generally from a half to one per cent of lime though in some places the lime is as much as five and even fifteen per cent.

Restorative crops and proper tillage readily restore these lands so that they have a loamy texture and furnish a good water supply, the yields being doubled and even increased fourfold. Farmers in this section should make constant use of cowpeas, hairy vetch, red clover and melilotus. Where the lime rock comes to the surface melilotus is the best plant to use as it will make a good growth on the bare rock where nothing else will grow.