Issued June 15, 1907.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE LOUISIANA AGRICULTURAL EXPERIMENT STATION,
W. R. DODSON, DIRECTOR.

SOIL SURVEY OF CADDO PARISH, LOUISIANA.

BY

JAMES L. BURGESS, LEWIS A. HURST, HENRY J. WILDER, AND CHARLES F. SHAW.

[Advance Sheets—Field Operations of the Bureau of Soils, 1906.]

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1907.

[PUBLIC RESOLUTION—No. 9.]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided,* That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the Congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., June 20, 1906.

SIR: I transmit herewith a report on the soil survey of Caddo Parish, La., which was requested by the Shreveport Progressive League and by the Louisiana Experiment Station for the purpose of determining the character of the various soils of the parish and their adaptation to the production of the staple crops, particularly with reference to cigar tobacco, which it was believed could be profitably produced, as is being done in the adjoining counties of Texas. These requests were indorsed by the Hon. J. T. Watkins. I recommend that this report be published as advance sheets of the Field Operations of the Bureau of Soils for 1906, as provided by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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SOIL SURVEY OF CADDO PARISH, LOUISIANA.

By JAMES L. BURGESS, LEWIS A. HURST, HENRY J. WILDER, and CHARLES F. SHAW.

DESCRIPTION OF THE AREA.

Caddo Parish is situated in the extreme northwestern part of Louisiana. It is bounded on the north by Arkansas, on the east by Bossier Parish, on the south by Red River and De Soto parishes, and on the west by Texas.

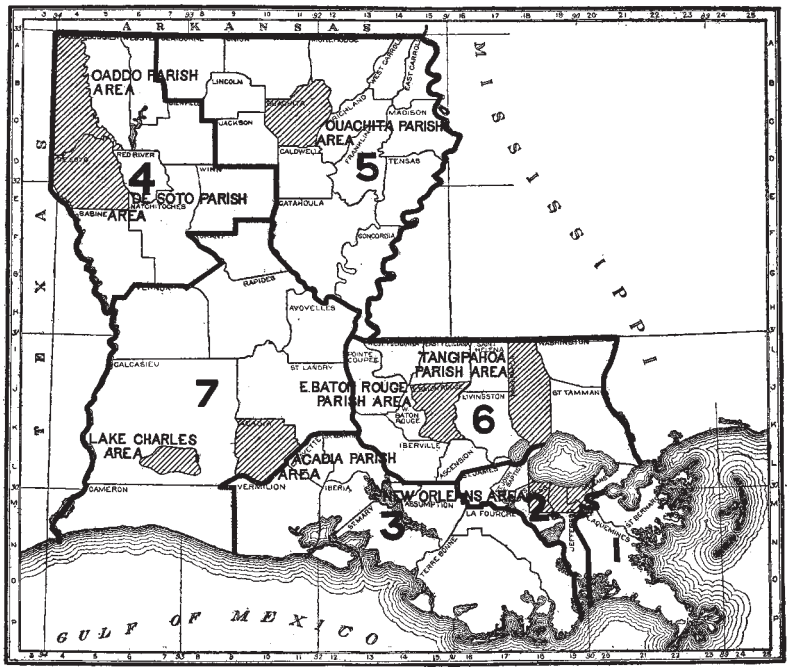

FIG. 1.—Sketch map showing location of the Caddo Parish area, Louisiana

The parish has three general physiographic divisions, namely, the Red River bottoms, which are separated from the uplands by a low bluff line; the lake region, which comprises the basins of Cross, Ferry, James, Clear, Soda, and other smaller lakes; and the uplands surrounding these lakes and flanking the river. A low bluff line also separates the lake basins from the surrounding uplands. The average elevation of the area is about 180 feet above sea level, with a general slope to the southeast.

The surface of the uplands is gently rolling, except in the northern part of the parish, where it frequently becomes rough and hilly, and in the immediate vicinity of the larger streams, where erosion has been most active. The drainage is effected almost wholly by the Red River and its tributaries, only a small fraction of the rainfall finding its way to the Gulf through the Sabine River. The most important streams flowing into the Red River are Cypress Bayou, Boggy Bayou, Quepaw Bayou, Black Bayou, and the outlets of the various lakes.

By far the greater number of the population are colored. A few Italians and Spaniards or "Mexicans" are found in the southern part of the area, but these compose only a small fraction of the population. The proportion of whites to negroes is much higher north of the lake region. The present white population is almost wholly southern in its origin, only a small percentage of the people coming from the North and West. The population in the rural districts is generally very sparse, except in the river bottom. On the uplands are wide areas yet in forest and still larger areas that were once farmed but are now abandoned for lack of labor to operate the plantations. Every tenant who can secure land on the rich bottoms or employment in the city is leaving the hill country. There are scattered here and there over the southern part of the parish many large residences without white occupants, standing as monuments to the social life that once existed in the rural districts. The owners of these estates have long since given them over to colored tenants.

The chief town and center of trade for the parish is Shreveport, which has a population of over 25,000. There are no other towns of importance in the area, but most of it is so situated with reference to shipping points that the farmer has no difficulty in getting his produce to market.

Caddo Parish has excellent transportation facilities, being connected with the northern markets by the Queen and Crescent, the Cotton Belt, the Kansas City Southern, and other lines of railroad; while the Texas and Pacific, the Kansas City Southern, and the Houston, East and West Texas railroads connect it with New Orleans and other Gulf ports. The principal markets are St. Louis, Chicago, and some of the eastern cities.

CLIMATE.

Caddo Parish is situated between parallels 32° and 33° north latitude and near the line of 94° west longitude. It has a temperate climate, and while extremes of heat and cold are not usually very marked the area frequently lies in the path of the "northers" during the spring, and care must be taken by the fruit and truck grower to protect his crops from the freezing temperature that nearly always accompanies these cold waves.

The accompanying table compiled from records of the Weather Bureau shows that the normal temperature for the winter months is about 45° F. and that of summer 83° F. The extremes of heat and cold are not so great as in more northern latitudes.

The long season necessary for the production of cotton and other crops requiring several months in which to mature is furnished by the climate found in this part of Louisiana. The average date of the last killing frost in spring is March 4, and that of the first killing frost in the fall is November 18. Thus the growing season is over eight months long, and is sufficient to allow the gathering of two harvests of some crops.

The maximum rainfall comes from November to February, and the minimum from June to October, August having the lowest average rainfall of any month in the year.

Normal monthly and annual temperature and precipitation.

Month.	Shreveport.		Plain Dealing.		Month.	Shreveport.		Plain Dealing.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	*Inches.*	°F.	*Inches.*		°F.	*Inches.*	°F.	*Inches.*
January	45.9	4.60	45.7	4.68	August	81.3	2.19	81.4	2.84
February	51.2	4.16	46.0	3.32	September	75.5	3.73	75.6	3.21
March	57.6	4.64	56.8	4.64	October	65.3	3.11	65.2	3.39
April	66.4	5.20	64.3	3.58	November	54.6	4.78	54.9	3.33
May	73.1	4.19	71.9	4.39	December	49.5	4.68	46.0	4.34
June	79.9	3.79	77.5	5.19					
July	82.5	3.53	81.5	4.92	Year	65.2	48.60	63.9	47.83

AGRICULTURE.

Prior to 1836 the territory now comprised in Caddo Parish was occupied by the Caddo Indians, whose farming was of the most primitive type. In 1836 Captain Shreve, with a few other white men, settled at what is now Shreveport, and named the little town Bennett's Bluff. The following year the present parish of Caddo was organized, and the town of Bennett's Bluff was incorporated and rechristened Shreveport and made the parish seat.

For a long time there existed in the river bordering Caddo Parish a great raft or jam of logs that was not only a menace to navigation, but caused the stream to overflow its banks and change its channel so easily that profitable farming of the bottom lands was rendered very uncertain. In 1836 this raft or jam was cut and the river placed more nearly under control. These rich bottom lands were still subject to annual overflow, however, and it was not until 1892, when the present levees were first constructed, that the cultivation of the lowlands was rendered safe.

Cotton has been the staple crop of the parish ever since the white man took possession. Some corn, potatoes, and other household necessaries were produced, but frequently not in sufficient quantity to satisfy home consumption.

In 1884 the business of market gardening began to attract some attention, but the class of labor available and the unsatisfactory condition of the market have caused the industry to receive less attention than it merits.

The crop at present most popular in the area is cotton, and this is grown under the one-crop system. A few of the farmers are experimenting with alfalfa in the bottom lands, but there is no general movement in the parish to produce forage, not even to supply enough for the stock used in working the farms. The principal products of the area are cotton, corn, potatoes, vegetables, and forest products. It is a generally recognized fact that the sandy upland soils are better suited to cotton than to corn. The reverse seems to be true of the bottom lands, where the best yields of corn are secured from the lighter soils. Cotton appears to thrive best on heavy soils or on those soils which have a heavy subsoil. There is practically no systematic rotation of crops practiced in the area. Cotton follows cotton until the yield falls to the point where it no longer pays the cost of production, and then the field is abandoned and allowed to grow up to weeds and brush. Sometimes a part of a field of cotton is followed by corn, but the acreage of corn is so small as compared with cotton that the rotation can hardly be said to affect the prevailing one-crop system.

The agricultural methods now practiced are largely those used prior to the civil war. Tenants do most of the farming, and their methods represent the practices followed in the neighborhood for years past. Shallow plowing and shallow cultivation are practiced on light and heavy soils alike, and all crops are cultivated in ridges. No green manuring is done, and little barnyard manure is put on the fields. Consequently the soils of both uplands and bottoms are rapidly losing their native productiveness, and new lands are yearly being brought under the plow in order to maintain the yield of cotton.

The present custom among the planters is to furnish their tenants with supplies and in many cases with stock with which to cultivate the crop. It frequently happens that the tenant fails to make enough to pay his rent and store bill and is thus left in debt to the landlord with nothing with which to begin work the following season.

The labor problem among the farmers of this area is quite serious. The laborers are nearly all colored, with a few Italians and Spaniards. The farmers say the negro hands do not stay at one place for any length of time, but insist on moving from farm to farm in search of better quarters and higher wages. It is thought that the Mexican

and Italian laborers may prove more dependable in this respect. Farm laborers are paid from 75 cents to $1 a day.

Of the 528,000 acres of land in Caddo Parish only 350,000 are included in farms, and only about 180,000 acres are improved. This leaves about 66 per cent of the parish in uncleared lands. According to the Census of 1900 the average farm contained about 75 acres. This low average is due to the large number of very small farms in the hill lands and to classification of each tenancy as a farm, and must not be taken to indicate that most of the farm operatives own the lands they till, for such is not the case. The majority of the farm operators are tenants and are frequently located on immense landed estates, some of which contain as much as 5,000 or 6,000 acres of the best land in the area. Among the largest landholders, especially in the southern part of the parish, the average farm would contain about 500 acres. A very small proportion of the land is farmed by the owners, probably less than 25 per cent being operated by men who own and live on the land.

The value of farm lands in this area varies with the location and crop-producing power. There are thousands of acres of fairly good upland on the market for less than $5 an acre, while the best improved and most favorably located upland farms bring from $25 to $30 an acre. The lands lying in the Red River bottoms are uniformly higher in price than those in the hills. The price for lands in the bottoms protected by levees runs from $30 to $50 an acre, and much of it is not on the market at any price.

There are several lines along which the agricultural practices of the area might be improved. The one-crop system should be replaced by a crop rotation that would insure the production of sufficient forage and feed for the stock kept on the farm and at the same time increase the amount of humus in the soil. In this way 10 acres of land could be made to produce as much cotton as in many cases 20 acres do now, and the farmer would save in addition an important item in his expense account.

Some of the more progressive farmers are beginning to use modern farm implements, but their example is not being followed as rapidly as conditions would seem to warrant. Practically all the river bottoms and a large proportion of the uplands are of such a character that the most modern farm machinery could be used, but at present these lands are worked by the less efficient 1-horse implements. One man with one horse is expected to farm about 20 acres of land, while by the use of the latest machinery one man using three additional horses could easily farm 100 acres. Thus the cost of growing the cotton crop could be greatly reduced and the price of picking the cotton could be sufficiently advanced to induce laborers to seek employment on these

plantations. In this way the pickers would not need to be retained on the plantations the year around, as is now the common practice.

Most of the land is sufficiently level to admit of the use of the check-row system of planting cotton, and whenever possible this should be done. By this method of planting much of the expense of hoeing is done away with, since the rows can be cultivated both ways. On well-drained soils the crop should be planted early and level cultivation practiced.

It has been proven that the topping of the cotton when laid by is beneficial. After the last cultivation the cotton should be checked in its growth by cutting off the terminal bud on the main stem and the larger branches. This checks the growth of wood and tends to produce more bolls.

One of the great needs of this parish is a better road system. The material composing the roads is such that a few days of rain makes them so muddy that travel over them is almost impossible.

SOILS.

Practically all the soils of this parish are either fine sands or fine sandy loams. But little coarse sandy soil is found and on the uplands only a limited area of clay.

The upland soils lying south of the lake region are derived in large part from interstratified beds of lignite, fine sands, fine sandy clay, and clays, some of which are semiconsolidated, belonging to the Lignitic Eocene. The beds everywhere lie nearly horizontal, and the differences in topography appear to be due wholly to erosion. The soils have been formed from the weathering of the sandy clay beds, and the different types have been developed by erosion and the weathering in place of the underlying material.

The country north of the lakes is thought to belong to the Eocene. It is probable, however, that a part of the strata lying near the lakes belongs to the Port Hudson formation. The soils derived from these formations are all composed of fine sand and fine sandy loam, but as a rule are much lighter in texture than those found in the southern half of the area.

The soils in the Red River bottoms are formed of material transported from the Permian red beds, together with fine sands and silts from the erosion of local material. These alluvial soils are very much mixed, the various types being so interspersed that in mapping them on the scale used it was impossible to show many small areas of one type that occurred in larger areas of another. All the bottom-land soils contain more or less lime carbonate derived from the calcareous formations to the northwest and brought down by the river during flood time. The types are composed of fine sands, silts, and clays and represent the most productive soils in the parish. The surface of the Red

River bottoms has a gentle slope from the river toward the hills, and during overflows the land lying back from the stream channel is subject to more serious damage than the front lands.

All the soils of the area have fairly good surface drainage, except those lying near the headwaters of some of the streams and in the immediate vicinity of the lakes. There are also areas of comparatively flat country along the divide where water stands on the surface for many hours after heavy rains. The subdrainage of most of the upland soils is rather sluggish, since the subsoils are generally composed of heavy clays or sandy clays. The underdrainage of the bottom-land soils is generally good, since they are all underlain at comparatively shallow depths by very fine sands. The water table fluctuates with the rise and fall of the river, and the crops in the valley are sometimes damaged by seepage water during freshets.

That part of the parish lying north of Vivian is much more rolling and dissected by erosion than that to the south. It is over the part of the area north and west of Vivian that most of the deep sands occur.

The soils of this parish fall naturally into four of the important series found along the Atlantic and Gulf Coastal plains, namely, the Norfolk, the Susquehanna, the Orangeburg, and the Miller; and a few isolated types occur associated with some of these series.

Fifteen types of soil were found in this area, the actual and relative extent of each being shown in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Norfolk fine sandy loam	114,304	19.9	Norfolk fine sand	17,344	3.0
Caddo fine sandy loam	93,120	16.3	Miller fine sand	16,960	2.9
Miller clay	87,808	15.3	Swamp	11,200	2.0
Susquehanna fine sandy loam	74,624	13.0	Susquehanna clay	7,424	1.3
Meadow	45,888	8.0	Lufkin clay	5,376	.9
Orangeburg fine sandy loam	30,144	5.2	Orangeburg sandy loam	1,088	.2
Orangeburg fine sand	27,264	4.7			
Miller fine sandy loam	24,064	4.2	Total	574,656	
Miller silt loam	18,048	3.1			

NORFOLK FINE SAND.

The soil of the Norfolk fine sand is of loose, open structure, and is composed for the most part of quartz sand with a small quantity of feldspathic sand. The depth of the soil varies from 8 to 12 inches, while the subsoil is generally over 3 feet deep. The soil is loose and incoherent and can be cultivated with ease. The structure of this type is such that both air and water pass readily into it, and the moisture passes quickly downward out of reach of the plant roots. The color of the soil in its virgin state is gray, but after a few crops

have been grown the soil changes to a light-gray or white, owing to the loss of organic matter. The subsoil grades in color from a gray to yellow and usually contains more fine material than the soil.

The greater part of the Norfolk fine sand is located in the northwestern part of the parish, with smaller areas scattered here and there. The surface varies from rolling to hilly, and the areas are greatly eroded in the vicinity of the streams. The soil is thoroughly well drained.

This type is derived from the weathering of what appears to have been beach sands, some portion of which has become consolidated into ferruginous sandstone. These beds of sand in all probability belong to a late period of the Eocene Tertiary age.

The native vegetation consists principally of oak and pine, and at present large sawmills are located on this type in the northern part of the parish. Only a small percentage of the type is under cultivation. When first brought under the plow, it produces fair yields of corn and cotton.

This is a good peach soil and is perhaps the best early truck soil in the area. Watermelons would do well on it. In some places a fine grade of wrapper tobacco is grown. At present from one-fourth to one-third of a bale of cotton per acre is secured while the land is new, but after five or six crops are gathered the productivity of the soil is reduced to a point where cultivation is no longer profitable, and the fields are abandoned. This sandy soil is known locally as "Blue-jack land" and is generally considered poor. Probably an average yield during the period of five years would be 8 bushels of corn and one-fourth of a bale of cotton to the acre.

On this light soil, in case general farming is to be followed, there should be practiced from the start a rotation of corn, cotton, and cowpeas. This should be made a three-year rotation, and the cowpeas should be turned under as a green manure. It is better to plow these light soils to a moderate depth, and to cultivate sufficiently deep to maintain an effective dust mulch, and throughout the handling the conservation of moisture and humus should be kept constantly in mind.

The farmers do not fertilize this soil as a rule, the general practice[a] being to abandon the fields after the fifth crop has been gathered. Most of this land can be bought for less than $5 an acre.

[a] The manurial requirements of the Norfolk fine sand occurring in this area were determined from a study of large samples collected in the vicinity of Shreveport and Myrtistown. The fields from which the samples were taken have been under cultivation for some years, and are devoted almost entirely to the production of cotton and corn in alternate years, though on one of them potatoes were grown two years in succession and but two crops of corn have been made, cotton being cultivated the remainder of the time. No fertilizer or manure has been used, but in one case three crops of cowpeas have been grown during sixteen years. The yields of corn average about 10 bushels

The following table gives the results of mechanical analyses of samples of this type:

Mechanical analyses of Norfolk fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
14669	Soil	0.1	2.0	11.7	63.3	15.5	4.6	2.6
14670	Subsoil	.0	.3	12.3	63.6	16.7	4.6	2.1

ORANGEBURG FINE SAND.

The soil of the Orangeburg fine sand consists of a fine sand of much the same texture and structure as the Norfolk fine sand and from 12 to 14 inches deep. The color of the soil is generally gray when newly cleared, but bleaches rapidly when brought into cultivation. The subsoil is always a red sandy clay and is generally reached within 30 inches of the surface, though there are small patches where the soil is 3 feet deep. The soil is easily kept in good tilth, but in this latitude, where oxidation proceeds so rapidly, great care needs to be taken to keep the supply of humus constantly replenished.

Most of the Orangeburg fine sand is located in the region lying north of the lakes, though a rather large body is found south of Bethany, near the Texas line. Small areas are found on the river bluffs at various points, and some patches are scattered here and there throughout the parish.

The surface of this type is more rolling than that of the Norfolk fine sand. That part of it lying east of Rodessa is generally very much dissected by erosion, while that lying south of Bethany is less broken. As a whole the surface varies from heavily rolling to hilly. The deeper

and of cotton one-fourth to one-third bale to the acre. As is general throughout the area, the plowing and cultivation are shallow.

In determining the manurial requirements of this soil, nitrate of soda, acid phosphate, and sulphate of potash were applied to it, singly and in various combinations, as well as lime, stable manure, and cowpea vines. The largest increase of plant growth was obtained from an application of cowpea vines with lime, and the next greatest from the use of complete fertilizer to which lime was added.

In the latter case, however, the increase was only a trifle greater than that noted following the use of stable manure. Nitrate of soda, sulphate of potash, and acid phosphate, used separately, were beneficial, as were the same substances in various combinations. The use of lime alone also resulted in an increased growth. The increase in growth obtained by cowpea vines with lime, from stable manure, and a complete fertilizer with lime was somewhat greater than for any other soil type in this area.

In these tests wheat plants were used as an indicator, and while tne results are held to be strictly applicable only to related crops they are doubtless of value as suggesting the treatments most likely to prove beneficial on this soil type throughout the area, and strongly bring to notice the importance of maintaining the organic content of the soil either by including in the rotation some green manuring crop or by applying stable manure.

soil generally lies on the crests of the ridges. The type is everywhere well drained, occupying as it does the higher elevations and being everywhere cut by deeply eroded stream channels.

The origin of this type appears to be similar to that of the Norfolk fine sand, with which it is closely associated. There is perhaps more ferruginous sandstone to be found in the Orangeburg than in the Norfolk fine sand, but the principal difference is one of color of subsoil rather than of geological origin. Much of the rugged surface is due to the resistance offered the agencies of weathering by the beds of sandstone that occasionally outcrop.

This is a stronger type than the Norfolk fine sand, owing, it would seem, to the greater depth of the soil and the nature of the subsoil. In its native state it supports a growth of pine, oak, and hickory. Under cultivation it is well adapted to crops requiring a warm, well-drained soil. It is excellent for peaches, tomatoes, melons, peas, beans, and other varieties of early truck requiring a light soil.

The crops at present grown are cotton and corn, with maximum yields of about 25 bushels of corn and one-half bale of cotton to the acre. The minimum yields on those fields which have long been in cultivation range from 10 to 15 bushels of corn and from one-fourth to one-third of a bale of cotton. Fields on this type of soil are usually abandoned after the eighth year of cropping. An average yield of cotton and corn covering a period of eight years would be about 15 bushels of corn and one-third of a bale of cotton to the acre.

There is practically no rotation of crops practiced on this soil, though the need of rotation is very great. It is recommended that a three-year rotation of cotton, cowpeas, and corn be followed on the new lands, while on the older lands a four-year rotation of cowpeas two years, corn one year, and cotton one year is probably best. The main object should be to keep the soil in good physical condition and well supplied with humus.[a]

Fertilizers are not generally used on this soil, and when the productivity of the land is so reduced as to render cultivation no longer profitable it is abandoned and new land brought under the plow. Most of the land of this type of soil could be bought for less than $10 an acre.

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[a] To determine the manurial requirements of this soil two samples were studied by the wire-basket method. These samples were obtained from fields which have been devoted to the culture of cotton and corn for many years, upon one, corn being grown every ninth year and upon the other every fifth year. In both instances shallow plowing and ridge cultivation are followed. No fertilizer or manure is used and no cover crops or legumes are grown, though the stalks are turned under and not burned, as is frequently the custom. The average yield obtained from these fields is about one-third bale of cotton and 12 to 15 bushels of corn per acre.

In the laboratory tests large increases in plant growth were obtained from applications of cowpea vines and lime, from stable manure, and from complete fertilizer with lime;

The following table gives the results of mechanical analyses of samples of this type:

Mechanical analyses of Orangeburg fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
14679	Soil	Tr.	0.5	1.9	53.2	21.6	17.1	5.3
14680	Subsoil	0.0	.1	.2	36.1	10.2	5.4	47.8

ORANGEBURG FINE SANDY LOAM.

The soil of the Orangeburg fine sandy loam has a rather close structure, which gives rise to the popular term "tight land." The material composing it is mainly fine and very fine sand, with a smaller admixture of silt and clay. There is frequently found also quite a large percentage of iron concretions and fragments of ferruginous sandstone scattered through it. The arrangement of the particles composing the soil is fairly uniform. The finer particles being found in the lower stratum, the soil is generally more incoherent than the subsoil. The color of the soil is usually brown to red and more rarely gray.

The subsoil is a red sandy clay, rather heavier in this area than in others east of the Mississippi River, and frequently contains iron concretions and sandstone fragments. The stratum of the subsoil immediately underlying the soil, ranging in thickness from 6 to 15 inches, contains considerably more clay than is found below this depth. The subsoil changes from a red to a mottled red and gray color at from 3 to 4 feet below the surface.

The Orangeburg fine sandy loam, when freed from roots and stumps, is easily managed if sufficient vegetable matter is kept in it to prevent puddling. It is located for the most part north of the lake region in the vicinity of Vivian and along the river bluffs to the northeast. Other isolated areas are found at various points in the parish.

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the amount of increase, however, due to the introduction of the humus forming material being far in excess of that derived from the use of mineral fertilizer. Lime alone proved beneficial, but its good effect was increased when combined with the cowpea vines or fertilizer. Applications of nitrate of soda, sulphate of potash, and acid phosphate separately were of little benefit; the increase from the application of all three of them, however, was good.

The very superior increase of plant growth as a result of the introduction of nitrogen carrying humus forming material shows very strongly that with the introduction of green manure crops in systematic rotation great improvement in the productive capacity of these soils may reasonably be expected.

While the results are held to apply strictly only to the fields from which the samples were taken, they will no doubt prove valuable as indicating the manurial needs of this type of soil throughout the area.

The surface of this soil is less broken than that of the types previously described. It is usually found where erosion, though quite marked, has not yet produced the ruggedness of contour noticed in some of the other soils. The larger proportion of it is rolling to heavily rolling and sometimes hilly.

This type occupies a relatively high position and numerous small tributary streams finger out into it. It has good surface drainage, but the internal drainage is sluggish on account of the close structure of the subsoil. The soil and subsoil both have great water-holding capacity, and moisture can be easily conserved under proper management.

The origin of this type appears to be similar to that of the types previously described, namely, the weathering in place of beds of sand and sandy clays of the Upper Eocene. It appears, however, that erosion has played quite an important part in the development of this soil, having removed much of the product of weathering from the surface and reduced the thickness of the sandy loam material from several feet to less than 20 inches. This is evidenced by the fact that over small spots and on narrow ridges where the surface has been protected by plant growth the soil is over 2 feet deep. This type has probably been developed by erosion from the Orangeburg fine sand.

The native vegetation consists of oak, hickory, and pine, together with a small amount of ash and gum. This is perhaps the best peach soil in the parish, and is also an excellent truck soil. The crops grown at present are cotton and corn, with an occasional crop of oats. When first brought under cultivation this soil will produce about 25 bushels of corn and 300 pounds of lint cotton to the acre, but after six or eight years continuous cropping the productiveness of the land is reduced to a point where profitable yields can be obtained only by the use of manure or fertilizers.[a] The fields are usually "thrown out" when less than 10 bushels of corn and one-fourth of a bale of cotton can be harvested. An average yield on this type of soil

[a] Two large samples of this soil were obtained in the neighborhood of Vivian, from fields cleared in 1890, upon which cotton and corn have been grown since clearing. Shallow plowing and ridge cultivation have been practiced, cotton being planted two or three years in succession, followed by a crop of corn, the average yields being about one-third bale of cotton and 15 bushels of corn to the acre. No cover crops have been grown, nor has any fertilizer or manure been applied.

These samples were the subject of a study by the wire-basket method in order to determine the manurial requirements of this type of soil as it occurs in this area, and the results of the test, while held to be strictly applicable only to the field from which the samples were taken, probably indicate in some degree the fertilizer needs of all of this type of soil in the area.

Nitrate of soda, sulphate of potash, and acid phosphate, when used separately, show but little increase in growth over that on the untreated soil. With combinations of any two of these salts some improvement was noted, the maximum being reached when all

covering a period of eight years would be about 200 pounds of lint cotton and 15 bushels of corn. As a rule no plowing is done prior to "bedding" for cotton or corn in the spring. The land is then thrown up in narrow beds on the crest of which the cotton is planted. These ridges remain and the ridge method of cultivation is practiced throughout the season.

It is recommended that experiment should be tried to determine whether level cultivation would give increased yields on this type, and it is thought that where the texture is close the land would give better returns if plowed in the fall. The same rotation and same general practice as suggested for the Orangeburg fine sand would apply with equal force in the case of the soil under discussion. A few acres should be kept in grass for meadow or pasture. Most of this type of soil could be bought for less than $15 an acre.

The following table gives the average results of mechanical analyses of samples of this type:

Mechanical analyses of Orangeburg fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
14675, 14677	Soil	1.2	2.5	2.5	29.2	34.4	23.5	6.5
14676, 14678	Subsoil	.5	1.4	1.7	26.6	13.8	14.1	41.4

NORFOLK FINE SANDY LOAM.

The soil of this type ranges from 12 to 20 inches in depth, and is composed of very fine sand and silt with sufficient clay to give it the texture of a medium heavy fine sandy loam. The particles of which it is composed appear to have a uniform distribution, the coarser material lying near the surface, while the finer material is found in the substratum overlying the subsoil. The color of the soil is generally gray, but may change to brown or dark gray, varying somewhat with the quantity of humus contained.

The subsoil is composed of a fine sandy clay which is generally yellow, but may vary in color from ashy-gray to mottled-gray and red. The deeper subsoil is generally a very heavy sandy clay, which not infrequently changes to clay at from 24 to 36 inches.

three were used. The addition of lime to this mixture increased slightly the plant growth, and lime alone proved of some benefit.

The addition of stable manure was attended by an increase superior to that derived from any of the applications of mineral fertilizer, and this was in turn greatly surpassed by the green manure, in this instance cowpea vines with lime. The increase derived from this source is a strong appeal for the introduction of green manuring crops into the rotation, that the supply of humus may be maintained, which in all soils, and especially soils of this texture, is of vital importance.

This type, composed of light fine sand, is easily put in good tilth, and when properly managed is cultivated with ease. Its structure is such, however, that without an abundant supply of humus much of it is liable to bake during dry weather following heavy rains, rendering cultivation difficult.

The greater part of this soil is found south of the lake region and in the southwestern part of the parish. Other areas are found scattered throughout the survey. The surface is level to gently rolling. Near the streams the type is more or less cut by gullies, but the greater proportion is relatively level.

Occupying as it does a rather depressed topographic position and possessing in general a rather heavy sandy clay subsoil, the drainage of this type is frequently insufficient to permit the best development of the crops grown on it. It would be well to dig broad open drains through much of it, so that water could readily drain off the surface.

The Norfolk fine sandy loam is derived from the weathering in place of the sandy clay beds of the lignitic Eocene. The silt and clay particles have been largely washed from the weathered products.

The native vegetation consists of pine, oak, gum, and persimmon. Of the cultivated plants the soil is well adapted to late truck crops. In certain parts of the Gulf States it produces a fine quality of cigar-wrapper tobacco. Cotton and corn are the crops grown at present. When first placed under cultivation this soil will produce from 20 to 25 bushels of corn and from one-third to one-half of a bale of cotton to the acre. The productiveness is so greatly reduced within four or five years, however, that the fields must either be fertilized or else abandoned. An average yield covering a period of six years would be about 10 bushels of corn and one-fourth of a bale of cotton to the acre.

The Norfolk fine sandy loam is generally deficient in organic matter after it has been farmed only a short while. It is the general practice not to use a cover crop or any kind of green manure, hence oxidation goes on unchecked from the start, and the soil soon changes from a dark-gray loamy sand to a light-gray sand, when further attempts to farm it prove unprofitable. The ridge method of cultivation is universally practiced. Except on fields that are known to be too wet for level cultivation the value of ridging is open to question. Even where wet it would be well to ascertain whether it would be cheaper to drain such fields than to cultivate them in ridges. The ridge method is said by some experimenters not only to reduce the yield of the crop, but rapidly to decrease the crop-producing power of the land. It is recommended that a three-year rotation of corn or cotton one year and peas two years be practiced on this soil. This land would produce excellent winter vetch, and this should be included in the rotation wherever practicable.

Little or no commercial fertilizer is used by the farmers who till this type of soil, and a large percentage of it is in a "run-down" condition.[a] Large tracts of this land are on the market for less than $5 an acre.

The following table shows the average results of mechanical analyses of samples of this type:

Mechanical analyses of Norfolk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
14665, 14667	Soil	0.2	0.4	0.3	34.8	28.4	26.4	9.3
14666, 14668	Subsoil	.3	.4	.3	30.4	20.1	20.9	27.1

CADDO FINE SANDY LOAM.

The soil of the Caddo fine sandy loam consists almost wholly of fine sand, very fine sand, and silt, the samples analyzed showing less than 10 per cent of clay. It usually varies from 8 to 20 inches in depth, with a general average of about 14 inches, the depth depending largely on the nature and number of the sand mounds by which it is characterized. The particles composing this soil have widely different arrangements. The more silty materials collect at the base of the mounds and become so compact as to be almost impervious to water, while the fine sand of the mounds is quite leachy. After heavy rains the water remains on the surface of this intermound soil for several days, and in some cases

[a] Four large samples of this soil were obtained from as many points within the parish for the purpose of determining its manurial requirements.

The fields from which the samples were taken, though under cultivation for varying periods of time, have all been devoted to the production of cotton and corn, and in no case has there been any use made of commercial fertilizer or manure. The yields range from one-fifth to one-third bale of cotton and from 8 to 15 bushels of corn.

The rotation practiced varies upon the several fields from cotton and corn in alternate years to as high as seven years in cotton to one of corn. No cover crops or legumes for green manure have been sown, though in one instance the field has been allowed to lie fallow and the growth of weeds has been plowed under prior to planting cotton.

In testing the manurial requirements of this soil, nitrate of soda, sulphate of potash, acid phosphate, lime, stable manure, and cowpea vines were used, singly and in various combinations. The largest increase in plant growtn, followed the use of a complete fertilizer with lime followed by cowpea vines and lime, stable manure, and complete fertilizer without lime, in the order named.

The results following the use of nitrate of soda, sulphate of potash, and acid phosphate, applied singly and in combinations other than that comprising all three, with and without the addition of lime, as well as an application of lime alone, indicate the inadvisability of their use in any other form than as a complete fertilizer with the addition of lime.

These results, while held to apply strictly only to the fields from which the samples were taken, probably indicate in a general way the manurial needs of this soil type throughout the area.

until removed by evaporation. The color of the soil varies, the intermound areas usually being dark brown, while the sandy hillocks are of a lighter color. This variation in color gives fields of this soil type a spotted appearance.

The subsoil is usually heavy, being composed of silt and clay, except where the sand mounds are quite prevalent. Here the subsoil is lighter, having somewhat more the nature of the soil. The color of the subsoil is generally gray, though much of it is yellow and mottled red and gray. It is usually quite impervious to water, and in some cases the structure is such as to form a real hardpan. These hardpan areas are found where the surface is flat and are usually very wet. It is possible to bore down through some of these flat swampy places and find almost dry material only a foot or two from the surface, on which water may be standing. There are many swampy areas scattered over this type which owe their existence largely to the presence of this hardpan.

The Caddo fine sandy loam is easily tilled when in proper physical condition, yet there is much complaint among the farmers that the soil is always too wet or too dry to plow. During wet seasons the water stands on the surface, being kept there by the peculiar topography and the impervious subsoil. When the water is eventually removed there is little moisture stored away in the subsoil, so that during dry periods the soil quickly loses its moisture by evaporation. The land then parches and cracks open and the crops suffer.

The greater proportion of this type is found in the eastern and southeastern parts of the parish. There is quite a large area in and around the lake region and along Black Bayou. It is also found in many parts of the parish in areas of smaller extent.

The type occupies a rather depressed topographic position. The surface is generally level to gently rolling. It not infrequently marks the flat swampy areas out of which streams take their rise, and it is also found in the low, flat areas skirting the lakes. Some small areas are more elevated, but as a whole it occupies the lowest elevation of any of the upland soils.

This type is imperfectly drained, and before it can be used for such crops as cotton and corn thorough drainage is imperative. Drainage is generally feasible.

The Caddo fine sandy loam is derived from what appears to have been old lake beds or swamp lands that are just beginning to develop drainage channels. The materials are quite similar in composition to those from which the Norfolk fine sandy loam is derived, and they are probably identical in original composition, the only difference being one of topographic position, which in the case of the latter type has caused a more complete assortment of the materials. It is thought,

however, that the beds of sandy clays from which this type is derived belong to the Port Hudson group.

The native vegetation consists of pin oak, water oak, gum, cypress, ash, persimmon, and elm. This soil is well suited to plants requiring a moist soil, and it is probable that sugar cane, rice, and certain varieties of truck, such as strawberries and cabbage, would do well. Where the sand mounds are not too numerous to interfere with flooding there is little risk in attempting to grow rice on this soil, the greater part of it being better adapted to this crop than to any other.

The crops grown at present are corn and cotton, with yields ranging from 20 to 30 bushels of corn and from 300 to 400 pounds of lint cotton to the acre. There is not much of this soil under cultivation because of its undrained condition, but when properly handled it is probably the strongest upland soil in the area. Little or none of this type has been cultivated for a time and then abandoned, as has been the case with other types, though the yield decreases under continuous cultivation, and the average covering a period of four years would be about 15 bushels of corn and one-third bale of cotton to the acre.

This soil should be drained for general farming and a rotation practiced which would include some leguminous crop. Perhaps a four-year rotation of corn one year, cotton two years, followed by cowpeas, to be turned under for green manure, would be as profitable as any.

The farmers do not fertilize this soil, since it produces fairly well without fertilization.[a] Most of this type is still forested and can be purchased for less than $10 an acre.

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[a] Tests of the manurial requirements of this soil were carried on in the Bureau laboratories, using three samples collected from fields under cultivation for the last ten years. Since these fields were cleared, cotton and corn have been grown continuously—three years in cotton to one in corn—the yields averaging about one-third bale of cotton and 12 to 15 bushels of corn to the acre. One field received a small application—200 pounds per acre—of a fertilizer composed of acid phosphate and cotton-seed meal, and another has grown cowpeas twice in the ten years, cattle being allowed to pasture on the vines. Other than this there has been no rotation practiced or fertilizer or manure used. A very large increase in plant growth, much greater than that obtained from any other treatment was secured from applications of cowpea vines with lime. The soil also responded to applications of lime used alone, to a complete fertilizer with and without the addition of lime, and to stable manure. When used separately, the nitrate of soda, sulphate of potash, and acid phosphate were effective in the order named.

The very superior results obtained from the use of green manure argues very strongly in favor of the employment by the planters of a regular rotation, including a legume to be used as green manure. This treatment, maintaining as it does the humus content, of the soil, is especially valuable where cultivated crops form so great a part of the agricultural products. The results of the laboratory tests, while held to be strictly applicable only to the fields from which the samples were taken, are probably indicative of the best methods of handling this type of soil throughout the area.

The following table gives the average results of mechanical analyses of samples of this type:

Mechanical analyses of Caddo fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
14653, 14655	Soil	0.8	1.0	0.6	13.0	33.7	41.9	8.3
14654, 14656	Subsoil	.2	.5	.4	8.2	17.9	32.3	40.4

SUSQUEHANNA FINE SANDY LOAM.

The soil of the Susquehanna fine sandy loam is composed of a medium to fine loamy sand or fine sandy loam that lies rather loosely over the subsoil. Both air and water enter it readily. The materials—very fine sand, fine and medium sand, silt, and clay—are so arranged that the finer particles occupy a position nearer the subsoil. This structure is easily broken up by deep and thorough cultivation, however, and the soil usually assumes a closer structure after having been under the plow for a few years.

The color of the soil varies with the quantity of humus present and ranges from a gray to a reddish-brown, and the depth from 6 to 18 inches, depending on topographic position and the degree of local erosion. The soil at some points is highly ferruginous, and in these places numerous red sandstone fragments and iron concretions are found. The soil in such areas is very much like the Orangeburg fine sandy loam, and had it not been for the great physical difference between the subsoil of the two types they could have been mapped as one.

The subsoil of the Susquehanna fine sandy loam is composed largely of clay and is very plastic and tenacious. There is an appreciable quantity of fine sand, very fine sand, and silt in it, but so far as concerns crop production the effect of the subsoil is that of a clay. Sometimes the change from soil to subsoil is gradual and sometimes it is abrupt, according to the nature of the underlying material. The subsoil is frequently a stratum of heavy clay from 2 to 3 feet thick, beneath which the material becomes sandier and lighter in color. The color of the subsoil is generally red, though some spots occur where, on account of the impervious nature of the material, oxidation has progressed very slowly and the color is mottled gray and red. At an average depth of about 24 inches the color generally changes to a mottled gray and red. The type is easily cultivated, except where the heavy subsoil comes too near the surface, when it assumes the nature of a clay loam and cultivation is difficult.

The Susquehanna fine sandy loam is found generally along well-developed drainage channels and on the divides where weathering and

erosion have been more pronounced. There are quite large areas south of Greenwood, southeast of Bethany, and northwest, west, and southeast of Shreveport. There is also a large area in the vicinity of Mooringsport. Other smaller areas are found at various points in the parish.

The surface of the Susquehanna fine sandy loam is generally rolling to hilly. Near the streams and the lakes the surface is badly cut by small streams. The more gently rolling areas lie along narrow divides, while the rougher areas follow the south bank of Boggy Bayou. The type is generally well drained.

There is little doubt that this type is derived from the same interstratified beds of sand and clay from which the Norfolk fine sandy loam is derived. In many places where erosion has exposed deep sections of the underlying material, it is found to be composed of thin beds of very fine sand, fine sandy clay, and clay, all lying horizontally and having a gray color. The color changes to yellow and red upon long exposure. These beds have weathered considerably within the surface 8 to 20 inches, and the coarser material has been separated from the clayey matrix and left on the surface to form the body of the present soil, while the silt and clay have been carried away with the drainage.

The native vegetation consists of pine, oak, gum, and hickory, with a smaller proportion of other hardwood species.

This soil is fairly well adapted to truck crops, and where the sandy material is 12 to 18 inches deep and the field sufficiently elevated to possess good air drainage, peaches would doubtless prove profitable. It is probable, too, that certain grades of light tobacco could be successfully grown on the more sandy areas.

The crops at present grown are cotton and corn. This is a stronger cotton and corn land than the Norfolk fine sandy loam. When first cleared it will produce sometimes as much as 1 bale of cotton and from 30 to 40 bushels of corn to the acre. The virgin strength of this soil is rapidly reduced, and after five or six years' continuous cropping the yields fall to less than one-half bale of cotton and about 15 bushels of corn to the acre. An average yield covering a period of ten years would be about one-half bale of cotton and 20 bushels of corn to the acre.

The cultural methods in use are similar to those practiced on the other types of the area, namely, shallow plowing and cultivation, with the plants in drills and the land thrown in ridges. On this as well as on most of the upland soils level cultivation should be tried and, where not too sandy, the land should be plowed at least twice as deep as at present. Practically all of this type is in need of humus, and to obtain this most cheaply the use of green manuring is recommended. Experience has proven that, in the latitude where oxidation goes on very

rapidly and where dry spells are likely to occur in the middle of the growing season, green manures, and indeed all manures of a coarse nature, should be turned under deeply, say, from 6 to 8 inches, in order that oxidation may not proceed too rapidly.

Comparatively little commercial fertilizer is used on this soil, but it is said to have more lasting effects than on some of the other types. This is doubtless due to the close, heavy structure of the subsoil.

A large proportion of the area of this type is in forest. Where not too rolling for general farming, it is probably the highest priced of the upland soils. It will produce a larger average yield for a greater number of years than the other sandy upland types. The price varies with the location, but most of it can be purchased for less than $15 an acre.

The following table gives the average results of mechanical analyses of samples of this type:

Mechanical analyses of Susquehanna fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
14681, 14683	Soil	0.4	0.7	1.2	37.7	30.6	20.7	8.5
14682, 14684	Subsoil	Tr.	.6	.8	14.2	17.6	21.8	45.0

ORANGEBURG SANDY LOAM.

The soil of the Orangeburg sandy loam is composed mainly of medium to fine sand with which is mixed an appreciable quantity of finer material. The structure is open and the soil admits water and air freely. In color the soil varies from yellow to gray, but frequently has a brownish cast. The depth of the soil varies from 10 to 20 inches, with a general average of about 15 inches. The subsoil, which has a heavier texture and less open structure than the soil, is composed of a rather light sandy red clay.

There is but a small area of this type in Caddo Parish, located in the southeastern part, near Forbing Station. It lies near the bluffs of Red River, and has been subjected to heavy erosion. The surface, which is generally cut by ravines and gulches, is very rolling, and most of the type is unfit for general agriculture. It is thoroughly well drained.

The Orangeburg sandy loam is derived from the weathering of the coarser sandy clay beds of the Lignitic Eocene. During the weathering of this material the finer particles of clay and silt have been washed out and carried away in the drainage, and the present surface soil is therefore considerably lighter in texture than the material as deposited.

The native vegetation is oak, dogwood, and hickory, while of the cultivated crops peaches and early truck crops, such as require a light,

well-drained, warm soil, should prove most profitable. There is but little of this type under cultivation, the most of it having been left uncleared on account of its rough surface.

Following are the results of mechanical analyses of samples of this type:

Mechanical analyses of Orangeburg sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
14673	Soil	Tr	0.6	9.9	41.8	18.2	21.9	7.2
14674	Subsoil	0.1	.4	6.5	30.3	12.2	22.4	28.1

LUFKIN CLAY.

The soil of the Lufkin clay is composed of very fine sand, silt, and clay, the silt forming approximately 50 per cent of the mass. It has a very compact, close structure, and water falling on it stands for weeks in ponds and swampy places, where the slope is not sufficient for it to drain off. The color of the soil is prevailingly gray, though small areas of yellow and brown are found where the surface soil is thin. The depth of the soil varies from 4 to 8 inches, but by far the greater proportion is not more than 4 inches deep.

The subsoil is a heavy silty clay, with a very close structure, rendering it practically impervious to water. The color is usually gray or mottled gray and red, though in some small areas where the drainage is better it is brown.

Very little of this type is under cultivation, since it is thought to be too heavy and too poorly drained to produce profitable crops.

The greater proportion of this type is found in the southeastern part of the survey, east of Keithville, and in the vicinity of Cypress Bayou, and there is an area of several hundred acres just north of Cross Lake.

The surface is generally level to gently rolling, and as a whole it is poorly drained and includes many small swampy areas, though some areas lying near streams have fairly good surface drainage.

The Lufkin clay is derived from the more clayey strata of the Port Hudson formation. It would appear that at some time during the past continuously-flowing water has swept over the parts of the area where this type is found and removed the lighter particles of fine sand and silt from the surface, thus producing a much heavier soil type than the Caddo fine sandy loam, which has a similar origin and frequently lies at the same level as the Lufkin clay.

The native vegetation is composed almost wholly of pin oak. There are a few other water-loving oaks and some post oaks; but the pin oak so predominates as to give rise to the local name "pin oak flats."

This type would doubtless produce certain varieties of grass, and might be profitably used for pasture; but at present there is practically none of it under cultivation, and it is generally considered of little value.

The results of mechanical analyses of the soil and subsoil of this type are shown in the accompanying table:

Mechanical analyses of Lufkin clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
14687	Soil	1.1	2.2	0.4	3.7	27.3	47.4	17.4
14688	Subsoil	.1	.3	.1	1.0	8.6	40.7	48.8

SUSQUEHANNA CLAY.

The soil of the Susquehanna clay is a heavy silty clay, and yet of such a structure as to allow the passage of water with comparative freedom. The color is prevailingly brown to reddish-brown, and the soil is always very shallow, having an average depth of less than 4 inches. The subsoil is quite deep, and is composed of a heavy red clay which has a comparatively open structure.

This soil is found most typically developed in the southeastern part of the parish, west of Keithville, and in the vicinity immediately north of Cypress Bayou. There are other less typically developed areas along the bluffs of Red River and skirting the shores of some of the larger lakes in the central part of the area. The surface is gently to heavily rolling, and the soil always possesses good surface drainage.

The origin of the Susquehanna clay type appears to be similar to that of the Lufkin clay, both these types having been formed from the weathering of the clayey strata of the Port Hudson formation. It generally occupies a position between the other upland types and the alluvial soils, and hence has been subjected to more severe erosion than most of the other soils, which accounts for the absence of the lighter surface soil that generally characterizes the upland types.

This is the only one of the upland soils that contains an appreciable quantity of calcium carbonate. Lime concretions are numerous, and both the soil and subsoil give a strong effervescence when tested with hydrochloric acid.

This is probably the strongest upland soil in the parish, comparing favorably in natural productiveness with the "black waxy" soils of Texas. The native vegetation consists of a good growth of hardwoods, such as oak, hickory, red haw, and ash.

The soil is, however, very difficult to cultivate, and for this reason has been avoided by the farmers, the more sandy and easily cultivated

lands being developed instead. When cropped, owing to the inadequate methods used, the yields are far below what might be obtained.

It is probable that alfalfa could be grown successfully on this soil. At present about 30 bushels of corn and 1 bale of cotton are considered the maximum yield, while in an average year it will produce about half these quantities.

Shallow plowing and cultivation and ridging are practiced on this heavy soil, as well as on the lighter soils. This type requires deep plowing and moderately deep and level cultivation. The use of the disk plow is recommended, and a liberal supply of green manure should be turned under deeply in order to increase the capacity of the soil for holding water. So far as could be learned no fertilizer or green manures have ever been used, and the great need of the latter is shown by the poor physical condition into which all the cultivated areas are rapidly falling. The price of this land is generally lower than its natural productiveness would warrant. Most of it could be purchased for less than $20 an acre.

The results of mechanical analyses of samples of this type are given in the following table:

Mechanical analyses of Susquehanna clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
14685	Soil	0.5	0.9	0.2	2.2	17.0	50.9	28.4
14686	Subsoil	Tr.	.3	.2	.6	2.7	51.6	44.7

The following sample contained more than one-half of 1 per cent calcium carbonate ($CaCO_3$): No. 14,686; 3.36 per cent.

MILLER FINE SAND.

The soil of the Miller fine sand is a very fine sand, composed of over 60 per cent of very fine sand, nearly 20 per cent of fine sand, and about 14 per cent of silt, the proportion of clay being negligible, so far as effect on texture is concerned. The material is quite uniform and almost fluffy in texture, and possesses a loose, open structure that admits water with ease. There is but a fair percentage of organic matter in the soil of the cultivated areas, and some loss of crops is sustained from drought during dry summers. The color varies from grayish-brown to salmon, and the depth from 12 to 24 inches, with an average of about 18 inches. It is easily kept in proper tilth.

The Miller fine sand is an alluvial type and is always found on or near the banks of the river and along the principal bayous in the Red River bottoms. The largest areas are found in the vicinity of recent breaks in the levees and on the numerous peninsulas made by the windings of the river and subject to annual overflow.

In general the surface is level, but in minor details it is gently undulating and frequently dotted here and there with narrow ridges and hillocks of sand left by the changing currents of the floods.

The drainage is generally good, except when the river is high. During floods the crops are sometimes damaged by seepage water which rises through the subsoil. Upon the subsidence of floods the surface water soon finds its way into the deep subsoil or into the numerous depressions and bayous, though in some places the movement of the ground water is retarded to some extent by the thin strata of clay and silt that are found interbedded with the fine sand.

The Miller fine sand is an alluvial deposit and has been laid down by the Red River during floods. Owing to its relatively high specific gravity, it was the first material to be dropped from the overflow waters, while the lighter and finer materials, such as silt and clay, were carried farther away and deposited in slower-moving waters. The fall of the river being about 6 inches to the mile, the current carries only the finer particles of earth, such as very fine sand, silt, and clay, and the irregularity of flow has caused the sandier types of soil to be built up in alternating strata of light and heavy material. Thus a section of the Miller fine sand shows here and there a thin stratum of clay or silt lying between thick beds of fine sand. This type of soil contains considerable lime carbonate in both soil and subsoil.

The Miller fine sand is a light, warm soil well adapted to early vegetables, especially to melons and other vine crops. The crops grown at present are cotton and corn. When first put under cultivation, this type produces about 1 bale of cotton and 40 bushels of corn to the acre, but after a few years the yields are much reduced, in many cases 50 per cent. An average yield on this type of soil would be about two-thirds bale of cotton and 20 bushels of corn to the acre. Shallow plowing and cultivation are generally practiced, and the plants are always grown in ridges.

Most of this type that has been long under cultivation is in need of humus, and some green crop should be turned under at least every four or five years. Some of the farmers are beginning to use commercial fertilizers on this soil, and when the season is not too wet good results are obtained. The fertilizer most commonly used is cotton-seed meal.[a]

[a] Samples of this soil type were collected in two localities in the area, from fields which have been under cultivation for many years. Shallow plowing and ridge cultivation is practiced, as is customary throughout the area, both fields being devoted to raising corn and cotton—in one case in alternate years, in the other one year of corn to six of cotton. No fertilizers of any kind have been applied. The yields are about equal in the two fields, averaging one-half to one-third bale of cotton and 20 to 25 bushels of corn to the acre.

The manurial requirements, as indicated by wire-basket tests, are as follows: The largest increase in plant growth resulted from the use of stable manure; next in order

Most of this type is fairly productive and until recently has been maintained in this state by annual inundations. At present land of this type of soil can be purchased for less than $30 an acre.

The results of mechanical analyses of samples of this type are given in the following table:

Mechanical analyses of Miller fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
14659	Soil	0.0	0.1	Tr.	18.7	62.8	13.9	4.6
14660	Subsoil	.0	Tr.	Tr.	21.4	57.3	16.3	5.0

MILLER FINE SANDY LOAM.

The soil of this type consists of very fine sand, silt, and clay, with little or no regularity in the distribution of the various grades of material. The type marks a transition from the Miller fine sand to the Miller silt loam, and is itself in many places almost a loam in texture. It has a loose, open structure, and is generally built up in layers, like the other types found in the valley. In color it grades from a dark brown in the depressed areas to a light salmon color in the more elevated parts, where the accumulation of organic matter has been less pronounced. The depth of this soil varies from 12 to 30 inches, with an average of about 20 inches. The subsoil is generally of a heavier texture than the soil and grades from a fine sandy loam to a clay. The color is usually brown or red.

The Miller fine sandy loam is found lying near the Miller fine sand, and is distributed over the whole length of the alluvial lands along the Red River. The surface is rather more regular than that of the Miller fine sand, being almost free from mounds and ridges, though sufficiently rolling to secure good drainage. The origin of this soil is similar to that of the Miller fine sand, namely, alluvial deposition. It has been modified since its deposition by the addition of a moderate quantity of organic matter and in small depressions by local wash, which has made patches slightly more loamy. This soil contains considerable lime carbonate. The native vegetation consists of ash, elm, oak, hackberry, and maple.

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that derived from cowpeas and lime, and both of these were greatly in excess of the increases derived from any other treatment. Nitrate of soda, sulphate of potash, and acid phosphate, used singly and in various combinations, were slightly beneficial. Lime gave a moderate increase in growth, both alone and in combination with a complete fertilizer.

The results indicate clearly the great importance of keeping up the supply of organic matter in this type of soil, and while strictly applicable only to the particular fields from which the samples are taken, may be assumed to indicate treatment beneficial to the type in general in this area.

Cotton and corn appear to be the crops best adapted to this soil, and these are the ones most generally grown. The maximum yields are about 1 bale of cotton and 40 bushels of corn to the acre. An average crop would be three-fourths of a bale of cotton and 25 bushels of corn.

Shallow plowing and cultivation are generally practiced. An occasional deep plowing with a share plow is recommended in order to clear the land of weeds and vines. A large proportion of this type is cultivated, and none of it has yet been abandoned on account of unprofitable yields. Most of it can be bought for less than $35 an acre.

The following table gives the results of mechanical analyses of samples of this type:

Mechanical analyses of Miller fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
14657	Soil	0.1	0.4	0.1	0.3	47.1	47.0	4.8
14658	Subsoil	.2	.5	.1	.2	23.9	66.6	8.2

MILLER SILT LOAM.

This is a transitional type lying between the Miller fine sandy loam and the Miller clay. The soil in its typical condition is composed of silt, with a sufficient admixture of very fine sand and clay to make it a silt loam. The structure is much closer and more compact than that of the other types, and for this reason its relation to crop production is somewhat different. In color it varies from yellow to dark brown or reddish brown. The depth of the soil ranges from 10 to 20 inches, with an average of about 15 inches. The subsoil is generally heavier than the soil, but is frequently underlain at from 15 to 30 inches by fine sand or fine sandy loam. The color is similar to that of the soil, but may be a little lighter, owing to the smaller content of organic matter. The type is not so easily cultivated as the sandy types, and is liable to bake quickly after a heavy rain. More frequent cultivation is required on this than on the more sandy types, which have a tendency to form a mulch when the surface becomes dry.

The Miller silt loam is found in narrow strips and patches lying in the bottom lands parallel to the Red River and the principal bayous. There are no very large areas. The surface is undulating and the slopes are sufficiently steep to permit the surface water to flow into the bayous, and yet the drainage of this soil is not so pronounced as that of the more sandy types, because the depth to standing water

is not so great and the structural drainage is not so good. While crops are not generally damaged by excessive rains, yet with a moderately wet season and high water in the river seepage waters come in under the levees and waterlog the sandy subsoils, and the crops often "scald" before the water can drain off. Much damage is done in this way. Such conditions are especially unfavorable where alfalfa is the crop to be grown. The surface drainage of much of this soil could be improved by cutting ditches leading into the bayous.

The Miller silt loam, like the other soils in the bottoms, has been deposited by the overflow of the Red River and owes its fine, close texture to the sorting action of the water at the time of deposition. Its position with reference to the other types shows it to have been next to the last material to be dropped from suspension by the flood waters as they flowed from the river bed back toward the bluffs. Since its deposition, cultivation and the growth of vegetable matter have changed the texture of the surface slightly. This type contains considerable lime carbonate.

The native vegetation consists of box elder, hackberry, ash, and tulip poplar. Of cultivated plants, cotton and corn seem to thrive, and these are practically the only crops that have ever been grown on this soil. When first cultivated the land yields about 1¼ bales of cotton and 45 bushels of corn to the acre. In an average year it will produce about three-fourths bale of cotton and 35 bushels of corn.

Shallow plowing and cultivation are generally practiced on this type and the plants are grown in ridges. On the poorly drained areas of this soil the ridge method is perhaps the best one to use, but level cultivation should be tried wherever there is no danger from seepage. An occasional deep plowing as in the other bottom soils is advised, in order to clean the land of weeds and vines that grow very rapidly on these rich alluvial soils. No fertilizers have yet been used on this type, since it produces good crops without them, and none of it has yet decreased in productiveness to the point where cultivation without manuring is unprofitable. This land could hardly be purchased for less than $35 an acre.

The following table gives the results of mechanical analyses of samples of this type:

Mechanical analyses of Miller silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
14663	Soil	0.0	0.2	0.1	0.3	6.4	82.2	10.3
14664	Subsoil	Tr.	.4	.2	.3	15.4	72.8	10.2

The above samples contained calcium carbonate ($CaCO_3$) as follows: No. 16663, 5.20 per cent; No. 16664, 6.66 per cent.

MILLER CLAY.

The Miller clay is a very uniform type. The soil is a heavy clay with an average depth of 10 inches and containing very little material of grades coarser than silt. The structure is close, but the soil is not so impervious as the texture would seem to indicate. The color of the soil is prevailingly reddish brown, though small areas occur here and there that have a somewhat darker color. There are also some other modifications where at some period during the process of formation there existed depressions or narrow, shallow lakes, in which much organic matter accumulated, in some cases forming a layer 6 or 8 inches thick, usually from 6 to 12 inches below the surface. The areas where this variation occurs are quite restricted, and there are usually no surface indications of their presence, the former depressions having been completely filled by the deposition of clay.

The subsoil, as shown by the sample analyzed, has about the same texture as the soil, but areas are found where it is much lighter than the soil, frequently being a very fine sandy loam or a silty clay loam. The depth of the layer of clay from which this type is derived ranges from a few inches to several feet. It is everywhere underlain by a very fine gray sand. The deep and shallow areas are quite irregular, corresponding to the surface of the old bottom lands over which the clay was deposited. The subsoil has a gradual transition downward from very heavy clay to very fine sand.

This soil is rather difficult to cultivate and the term "stiff land" is always applied to it. If not plowed and cultivated at the proper time, it is liable to puddle, and subsequent cultivation reduces it to a mass of cuboidal fragments popularly known as "buckshot."

The Miller clay is located along the Red River, but farther from the channel than any other of the bottomland types. It is generally bounded on the side next the river by lighter soils of the bottomlands, and on the side away from the river by the bluff line marking the highlands. This is the most extensive of the alluvial types and is uniformly distributed throughout the bottom lands.

The surface is generally smooth, but is sufficiently rolling to insure fairly good drainage. There are found very few of the small irregularities such as the ridges and mounds seen in the lighter types of lowland soil.

This type as a whole is not so well drained as the other alluvial soils. The depth to the water table is not so great and much of the type is now in need of deep, open ditches. Large areas lie in close proximity to swamps, and others are subject to inundation during very wet seasons. The element of risk in putting crops on these low-lying areas is very great, though in general artificial drainage is feasible.

The Miller clay has been built up during floods by the slow deposition of the red clay held in suspension by the waters of the Red River.

The slope of the river bottom is from the channel toward the bluffs, but the overflow currents become less and less swift until the bluffs are reached, where ponds and lakes are formed by the clay-laden waters and the clayey material slowly deposited. There have been slight changes in the level of the river bottoms since some of this material was laid down, causing fairly large tracts to be very well drained and adapted to a large range of crops. This soil has a high content of lime carbonate, and it is believed to be largely due to this that the soil breaks up into the small cuboidal aggregations. It is possible that the lime also causes the comparatively open structure of the subsoil.

The native vegetation consists of oak, hickory, ash, elm, hackberry, and walnut.

The most of this type, having the water table permanently near the surface, is adapted only to shallow-rooted crops, such as corn and some of the grasses, but on the better drained areas alfalfa will grow successfully, and where the water table can be kept at least 10 feet below the surface there is little risk in planting alfalfa on this soil. There has been some loss in attempting to grow this crop, owing largely to a lack of familiarity with its habits of growth and requirements. It seems that most of the failures may be traced to spring sowing and in less degree to choosing lands subject to seepage during high water or affected by poor surface drainage or a permanently high-water table. The best authorities agree that the seed should be sown in the fall, say in October, thus allowing the young alfalfa plants to get ahead of the grasses and weeds that prevent the growth of the spring-sown alfalfa. When sown on land that has poor surface drainage some arrangement should be made to carry the surplus rain water from the surface very quickly, since water standing but a few hours on an alfalfa field exposed to the hot sun will kill the plants. Broad open ditches would perhaps be of most service for this purpose on the Miller clay. In case of seepage water there is probably no remedy except the selection of land where the water table is maintained at a depth of from 6 to 10 feet. Indeed, standing water is so near the surface throughout the bottom lands generally that alfalfa should not be expected to produce good crops for more than six years in succession. Great care must always be taken when seeding alfalfa on the clay soils to get the land in fine tilth, as otherwise the young plants will have difficulty in becoming well established.

The principal crops grown at present on this soil are cotton and corn. When at its best the Miller clay will produce 1½ bales of cotton to the acre. It is relatively not so good for corn, though it produces under the present cultural methods about 40 bushels to the acre. As these yields would indicate, this is the strongest land in the parish, though with the present practices even this type is deteriorating in productiveness. Some of it will now yield but three-fourths bale of cotton

and 25 bushels of corn to the acre. An average yield on the older land is about 1 bale of cotton and 30 bushels of corn to the acre.

The Miller clay has always had shallow plowing and cultivation, and no attempt to keep the store of organic matter is made, the old stalks and trash being generally burned. It is stated by some of the farmers that the fields are much more productive after alfalfa has been grown for a few years. This suggests that the soil is benefited by the addition of organic matter, by the increased aeration promoted by deep-root growth and by increased store of nitrogen. It is the opinion, too, that it should be plowed deeply once every second or third year when not in alfalfa or other permanent crops and that an occasional green crop should be turned under. This soil contains much lime, which accelerates the oxidation of organic matter, hence the supply should be added to frequently.

A large proportion of this type is under cultivation, and when the season is not too wet excellent yields are obtained. It is the highest-priced land in the parish, and can not be purchased for less than $40 or $50 an acre.

The following table gives the results of mechanical analyses of samples of this type:

Mechanical analyses of Miller clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
14661	Soil	0.0	0.3	Tr.	0.7	2.4	51.3	45.3
14662	Subsoil	.0	Tr.	Tr.	.5	1.1	51.2	47.2

The following sample contained more than one-half of 1 per cent calcium carbonate ($CaCO_3$); No. 14662, 4.32 per cent.

MEADOW.

The term "Meadow" has been applied to the low-lying land found along the smaller streams flowing out of the uplands. These strips of land are generally forested, sometimes swampy, always subject to overflow, and are used principally as pasture. The soil is generally a clay or a clay loam and would make excellent hay land if it were cleared and drained.

SWAMP.

At several points in the bottoms along the Red River the land is so low and flat that water stands on it a part of the year and sometimes all the year. These areas generally lie back from the river and are found near the hills and around the lakes. They are usually covered with cypress and other water-loving plants and trees. During abnormally dry years some of this low land can be farmed, and an occasional crop is gathered from it; but the element of risk is so great that the

owners are generally content to let it lie idle. The soil in these swampy areas would in most cases be mapped as the Miller clay, if they should be reclaimed.

SUMMARY.

Caddo Parish lies in the extreme northwestern part of Louisiana, adjoining Arkansas on the north and Texas on the west. It is divided into three general physiographic divisions—the Red River bottom, the Lake region, and the uplands. Drainage is effected almost wholly by the Red River and its tributaries.

The greater part of the population is colored, the descendants of antebellum slaves. The white population is almost wholly southern in origin. The rural population is concentrated in the river bottom, the uplands being sparsely settled. The Twelfth Census gives about 66 per cent of the parish as uncleared land.

The chief town and trading center is Shreveport. The parish has excellent transportation facilities, being traversed by six different lines of railroads. The principal markets are St.Louis and Chicago.

The climate is mild, and the region has a growing season of more than eight months.

Cotton has always been the staple crop. It is grown under the "one-crop" system without rotation with other crops. Not enough forage is grown to supply the home demand. Besides cotton, some corn, potatoes, and vegetables are grown.

The agricultural methods are largely those in use before the war. Very little modern farm machinery is used. A large part of the land is farmed by negro tenants, who depend upon the landlord for their seed, stock, and household supplies.

Fifteen types of soil were recognized and mapped in the parish. Nearly all of them are fine sands or fine sandy loams. Most of them belong in the Norfolk, the Susquehanna, the Orangeburg, or the Miller series—four important soil series of the Atlantic and Gulf Coastal Plains. The soils of the Norfolk, Orangeburg, and Susquehanna series are found on the uplands, while those of the Miller series occur in the Red River bottom.

The sandy soils of the uplands—the Norfolk fine sand, Norfolk fine sandy loam, Orangeburg fine sandy loam, Orangeburg fine sand, Orangeburg sandy loam, Susquehanna fine sandy loam, and Caddo fine sandy loam—are generally well suited to vegetables and truck crops, and the better drained areas will produce peaches of good flavor and shipping qualities. Most of them can be made to produce good yields of cotton. On some of these lighter soils a fine grade of cigar-wrapper tobacco can be grown. It is on the same types of soils that the Cuban cigar-wrapper tobacco is being grown in Texas. Corn is

not recommended as a crop on any of the upland soils, except to supply enough for home consumption, although it may be best to include it in rotation with other crops.

On the bottom lands the water table is generally too high for deep-rooted plants to live very long. Alfalfa thrives at first, but dies after the sixth year from seeding. These soils are well suited to cotton and corn, but even these crops are sometimes damaged by seepage water.

There is need of a change in the methods used in cultivating the soils. More diversification should be practiced and more stock, preferably hogs, should be raised. A systematic rotation of crops should be followed on all the soils of the area. On the upland sandy soils a three-year rotation of corn, cotton, and cowpeas, and on the sandy bottom-land soils a four-year rotation of corn, cotton, oats, and cowpeas are suggested. On the heavier types of the area deep plowing and some five-year rotation would doubtless prove best. In all the rotations cowpeas should figure largely, and sufficient quantities should be grown and plowed under to increase the humus content of the soils. Level cultivation on the well-drained lands, the use of the check-row system in growing cotton, the use of improved farm machinery, the topping of cotton, and the growing of more forage are all recommended.

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