SOIL SURVEY OF MUSCOGEE COUNTY, GEORGIA

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DESCRIPTION OF THE AREA

Muscogee County is situated on the western edge of the State of Georgia, at the head of navigation on the Chattahoochee River. It is irregular in outline; the boundaries on the north and northeast are formed by survey lines, while on the east, south, and west, Baker Creek, Upatoie Creek, and Chattahoochee River form natural boundaries. The county has an area of 223 square miles, or 142,720 acres.

Muscogee County is divided into two distinct parts by the fall line or line of demarcation between the Piedmont Plateau and the Coastal Plain. The latter, including the sand hills, covers the larger part of the county. It consists of a rolling to moderately hilly upland developed on a series of unconsolidated, essentially horizontal beds of sands, silts, and clays, of late geologic age. Erosion has been active throughout the uplands and has produced a series of ridges with a general north and south trend. In the northwestern part of the county bordering the river, and in the southern and southwestern parts overlooking the Upatoie valley, the ridges are narrow and in places hog-backed, with here and there peaks or knobs rising above the general elevation. Through the central and eastern parts of the county the ridges flatten out and the topography becomes rather steeply rolling.

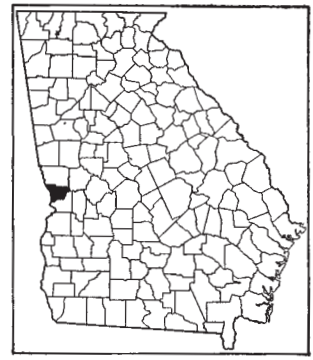

FIG. 33.—Sketch map showing location of the Muscogee County area, Georgia

The Chattahoochee valley is narrow, with little or no bottom land from the Harris County line south to Columbus, but below this point the softer Coastal Plain materials have offered little resistance to the cutting away processes of the river, and the valley floor is a mile or more wide, with broad, smooth terraces. Similar conditions prevail along the small streams in the county which rise in the Piedmont and flow across the Coastal Plain portion of the county. They have narrow bottoms until the fall line is crossed, after which they broaden out and generally have well-defined terraces along their lower courses. The Upatoie bottoms are generally wide and flat, since the adjacent uplands in Muscogee County are all of Coastal Plain materials.

The northern part of the county represents the southern border of the Piedmont region. It is underlain by ancient crystalline rocks

and varies in topography from scattered, fairly smooth, rolling areas with steep, eroded slopes near Nankipooh, Midland, and north of Upatoie, to severely dissected, deeply gullied, hilly areas west of Double Churches. Even where the hilltops or ridge crests are well rounded the slopes are generally steep and abrupt and in many cases severely eroded, with here and there outcrops of the underlying rocks or angular fragments strewn over the surface. The streams flow through narrow V-shaped valleys, over rocky beds, with little or no bottom land or terrace land.

South of the Piedmont section a sand-hill belt extends eastward from Columbus across the central part of the county. It is characterized by rolling to steeply rolling topography, with slopes varying from steep to gentle. It is crossed by Cooper, Bull, and Randall Creeks and has been worn down and severely dissected by these streams and their tributaries, which have developed broad, flat bottoms and terraces. The terraces occur at several different elevations below the general level of the uplands and in places are so old that their original terrace features have been changed and they now resemble the adjacent uplands in topography and physical characteristics.

The general elevation through the Piedmont section is 450 to 550 feet above sea level. The highest land is found along the Harris County line, with a few hilltops near Fortson of over 650 feet. There is a general slope to the south and southwest away from the Piedmont. The hilltops and ridge crests through the Coastal Plain range from 400 to 500 feet above sea level, with the stream valleys 150 to 200 feet lower. The main river terraces occur at elevations of 220 to 250 feet. Where the Upatoie Creek empties into the river the elevation is about 180 feet above sea level and is the lowest point in the county.

The whole of Muscogee County is drained into the Chattahoochee River through its tributaries, which extend into all parts of the county. The large creeks, with the exception of Upatoie Creek, flow in a southerly direction following the general slope of the country. The areas of bottom land classed as Meadow usually are deficient in drainage. Many of the stream channels have filled up or become so meandering that they lose much of the power developed in the drop from the Piedmont.

A number of cotton mills at Columbus are operated by power from the river, and electricity is transmitted for power and light to factories and towns within a radius of many miles. No power is developed at present from any of the smaller streams, as the water flow is too variable, although a number of mills and gins were formerly operated by water power.

Muscogee County was established in 1826 from Indian lands that had come under the control of the State of Georgia. The bottoms and terraces along the river and main creeks were first cleared and settled by colonists from other parts of Georgia, the Carolinas, and Virginia, who brought slaves with them to operate the farms. Most of the present inhabitants of the rural districts are descendants of these early settlers. Around Columbus and Bibb City, however, the cotton mills have attracted workers from outside points, and at present these constitute a large part of the urban population. With

the establishment of the Camp Benning Military Reservation, including the eastern and southern parts of Muscogee County, the included farms were vacated by the former occupants and are at present inhabited only by a small number of caretakers. The most densely settled portion of the county is that adjacent to Columbus in the western part. Through the northern and central parts of the county the farmers are concentrated near the main roads or in the villages. In the hilly section west of Double Churches and southeast of Columbus the population is sparse and a number of farms are unoccupied.

The population of Muscogee County was reported by the 1920 census as 44,195, of which 13,070 were classed as rural. This is not quite correct, however, as several thousand people live in Bibb City and in residential districts adjacent to but not included in the limits of Columbus. These are essentially urban, so that the strictly rural or farm population of the county is probably less than 10,000.

Columbus, the county seat, had a population in 1920 of 31,125. It is an important manufacturing center with a number of large cotton mills and iron foundries, owing in a large measure to the cheap power developed from the Chattahoochee River. Several fertilizer plants are located there. A number of people who work in Columbus live in Alabama towns, Phenix City and Girard, across the river, or in the outlying sections in Muscogee County. The population dependent upon Columbus totals around 40,000. Bibb City, adjoining Columbus on the north, has a population of 1,090.

Upatoie, Midland, and Nankipooh are locally important trading and shipping points. Columbus is the shipping point for near-by Alabama and Georgia points and has excellent railroad facilities in all directions over the Central of Georgia, Southern, and Seaboard Air Line Railways. A steamboat line plies between Columbus, the head of navigation on the Chattahoochee River, and Appalachicola, Fla., furnishing convenient and cheap freight transportation between these points.

The main county roads are constructed of a sand-clay mixture and are maintained in excellent condition. The secondary roads suffer from lack of attention and in places become nearly impassable in rainy seasons. In the sand hills during dry weather the sand beds in the roads become so deep and loose that it is almost impossible for motor cars to travel upon them. Telephone lines operate over most of the county and rural mail routes run within a short distance of every farmhouse.

Muscogee County has an excellent system of consolidated country schools to which the children are transported by bus, and in addition Columbus offers high school and industrial school advantages.

Columbus and Camp Benning afford excellent markets for all of the farm produce, vegetables, and fruit grown in the vicinity. The cotton produced locally is not sufficient to supply the needs of the large mills at Columbus.

CLIMATE

The climate of Muscogee County is mild and pleasant during fall, winter, and spring, but hot in summer. It is favorable to the pro-

duction of the farm crops most commonly grown in this section. The average yearly temperature is 65.2° F. The average summer temperature is 80.8°, July, with an average of 81.5°, and a maximum of 105°, being the warmest month of the year, although a temperature of 105° has been reached also in June. Some periods during the summer are very hot. The spring and fall months are usually warm during the day but pleasant and cool at night. The winters are mild, with cold spells of short duration, and the temperature does not frequently go below freezing. The average winter temperature is 47.7°, January being slightly below this average. The recorded minimum temperature was —3° in February. Snow is very rare.

The rainfall averages about 49 inches per year, being heaviest during the summer months, when growing crops are most in need of it, and lightest in the fall. The wettest year on record, 1906, had a total precipitation of 63.77 inches, and the driest year, 1904, 37.38 inches.

The average date of the first killing frost in the fall is November 13, and of the last in the spring, March 11, which gives an average growing season of about eight months. The latest recorded killing frost in spring occurred on April 10, and the earliest in the fall on October 21.

The following table gives the more important climatic data as recorded at the Weather Bureau station at Columbus:

Normal monthly, seasonal, and annual temperature and precipitation at Columbus

[Elevation, 262 feet]

Month	Temperature			Precipitation		
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1904)	Total amount for the wettest year (1906)
	°F.	°F.	°F.	Inches	Inches	Inches
December	47.8	81	11	4.67	6.25	4.15
January	47.1	80	9	3.54	5.10	5.86
February	48.3	83	—3	5.57	5.08	1.51
Winter	47.7	83	—3	13.78	16.43	11.52
March	58.0	92	23	5.25	1.93	6.43
April	64.5	95	31	3.39	.99	.75
May	73.9	100	42	3.05	2.58	2.99
Spring	65.5	100	23	11.69	5.50	10.17
June	79.9	105	49	3.93	1.98	7.38
July	81.5	105	60	6.29	3.25	10.36
August	81.0	103	61	4.81	8.15	4.84
Summer	80.8	105	49	15.03	13.38	22.58
September	77.3	100	46	3.14	.09	8.74
October	66.3	98	30	2.70	.06	8.34
November	55.8	86	19	2.67	1.92	2.42
Fall	66.5	100	19	8.51	2.07	19.50
Year	65.2	105	—3	49.01	37.38	63.77

AGRICULTURE

The earliest type of agriculture consisted chiefly of growing subsistence crops. Corn and oats were raised for use in the home in the forms of hominy grits, and meal, and for stock feed. A few cattle, sheep, and hogs were brought in by the pioneers, although they depended to a large extent upon wild game for their meats. Grazing was plentiful in the bottoms, where wild grasses and cane grew in abundance, so that little attention was necessary for the production of roughage and forage for cattle. Cotton growing was introduced very early. The cleaning and seeding of the cotton was a very laborious task for which the slaves were used. Later, with the perfection of the gin, cotton growing was given a strong impetus, and by 1860 had become the principal agricultural activity in Muscogee County. By that time settlers had spread into the uplands, the railroad to Macon had been completed, and Columbus had begun to develop the water-power resources of the Chattahoochee and was rapidly becoming an important cotton and iron manufacturing center. Land was plentiful and no attention was given to the care of the slopes to prevent washing. When a field became so badly gullied that cultivation was difficult, it was abandoned and new land cleared.

After the Civil War, the growing of cotton was reduced owing to lack of labor, much of the cotton land was turned out, and the growing of foodstuffs for subsistence was again the principal activity of the farmers for a number of years.

By 1879 cotton had again become the most important crop grown, with 11,625 acres planted and 3,268 bales picked. In the same year 8,263 acres of corn yielded 69,059 bushels, oats occupied 2,071 acres, sweet potatoes were grown on 394 acres, and wheat, rye, tobacco, and sugar cane were grown on many farms to supply home needs. The acreage in cotton has fluctuated, depending upon the financial and business conditions of the South. It was grown on 21,414 acres in 1889, on 17,214 acres in 1899, on 19,358 acres in 1909, and 11,304 acres in 1919. The production of corn materially increased up to 1899, when corn was planted on 13,808 acres. Since then the average planting has been around 11,000 acres annually.

The census data of total acreages and yields for 1919 are not entirely comparable to the data of the preceding censuses because the 28,160 acres included in the military reservation and withdrawn from cultivation since the 1910 census was made formerly produced large quantities of both cotton and corn.

The acreages of cotton and corn in 1919 were about equal, and since that time there has been a tendency to get away from depending upon cotton exclusively and to become self-supporting by growing sufficient feeds for home needs. Cowpeas, velvet beans, and peanuts are being grown extensively for feed for cattle and hogs. The excellent markets afforded by Columbus and the Army camp render the growing of vegetables, small fruits, and melons, and dairying the most profitable lines of farming, and a material change in the type of agriculture of the county has taken place since 1909.

The following table shows the comparative value of the principal crops in this county as reported by the census for the years 1909 and 1919:

Comparison of relative values of crops, by classes, in 1909 and 1919

Year	Value of all crops	Cereals	Vegetables	Poultry	Dairy products	Hay, fruits, etc.	All other crops (chiefly cotton)
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
1909	$923,577	14.6	8.6	3.4	8.6	6.9	57.9
1919	1,057,136	18.4	13.4	5.9	12.8	6.6	42.9

The table shows that the relative values of the cereals, vegetables, poultry products, and dairy products have increased considerably, whereas the value of the cotton crop has decreased during the decade from 1909 to 1919. Although the value of the cotton crop in 1919 was 85 per cent of the value of the crop produced in 1909, the 1919 acreage was 41.6 per cent smaller, the yield per acre was reduced from one-third bale per acre in 1909 to one-fifth bale per acre in 1919, and the total yield was only one-third as great. The relative value of cotton was maintained by the fact that its price in 1919 was practically three times what it was in 1909, while the prices of the other agricultural products had not increased in proportion. At present cotton and corn occupy approximately equal acreages in the county, but the cotton crop has a much greater value and is still the most important single crop grown, although no longer the only cash crop, and among farmers close to Columbus it has been almost entirely superseded by corn, vegetables, and dairying. In 1909 feed was purchased by 44 per cent of the farmers, while in 1919 only 23 per cent had to depend upon feeds other than those produced on their farms, and these were principally farmers engaged in dairying who buy considerable quantities of concentrated feeds for the milk cows.

The census reports reveal the fact that the growing of fruit, peaches in particular, formerly was important in Muscogee County. From 1890 to 1900 the number of trees had increased from 17,347 to 74,480. The difficulty of marketing the fruit, with resultant losses, and a better cotton market, induced most of the growers to do away with their trees and get back to growing cotton, and in 1920 there were only 2,141 peach trees in the county in home orchards. There are no commercial fruit or nut orchards in the county at present. A number of farmers have small quantities of fruit, berries, and nuts in excess of their home needs, for which they find a ready market in Columbus. In 1919 this surplus yielded a return of $9,797.

Oats and rye are grown in a small way, being cut with a mowing machine and fed in bulk instead of threshing out the grain. Peas were grown on 929 acres in 1919, yielding 4,240 bushels. They are used for table food and cattle feed. During the last few years quantities of peas have been sold at very good prices for seed to farmers in other sections of the South. Velvet beans are gaining in popularity. Potatoes and sweet potatoes sufficient for home needs,

small fields of sugar cane for sirup, vegetable gardens, and a few fruit trees are grown on most farms. A few commercial truck gardens are located near Columbus and along the principal county roads within a radius of 8 to 10 miles, and many farmers make a practice of raising more vegetables than needed for home use and selling the surplus in Columbus.

A few hogs are raised by most farmers to supply meat for home use. A cow and a few chickens are usually kept, but stock raising is not important except for dairy purposes. Cattle or hogs are usually butchered at home, any surplus meat being sold in Columbus.

The relationship between soils and crops is recognized by the farmers. The well-drained sandy loams of the terraces and uplands are devoted to cotton, sweet potatoes, peanuts, and truck crops; the less well-drained terrace soils are used for grass, corn, sugar cane, and oats; the heavier soils of the Piedmont are best suited to general crops such as corn, oats, and grass; whereas the bottoms have been found better adapted to grass and corn than to cotton under boll-weevil conditions.

On the small farms one-horse plows and cultivators are in general use and the land is broken to shallow depths, but on the large farms, and particularly those used for dairying, heavier equipment is used, including a number of farm tractors, disk harrows, and two-horse cultivators. The farm homes for the most part are comfortable, with small barns and outbuildings. The negro tenant houses are similar to those found throughout the Cotton Belt. Mules are generally used for work stock.

The bottoms are usually reserved for corn, grass, and cane. Land is usually broken in ridges or "bedded." Cotton is planted on the ridges or beds, whereas corn is usually planted in the furrows. On slopes the fields are terraced, or at least the rows are run with the contours. Velvet beans are frequently seeded in the cornfields, usually in April, with the second cultivation. Cowpeas are planted in May, in the same row with the corn, or the corn rows are spaced about 6 feet apart and rows of cowpeas put between. Beans and cowpeas are picked by hand, or they are allowed to remain after the corn is gathered, when cows and hogs are turned into the fields.

There is no definitely recognized rotation in use. Cotton or corn is grown for several years in succession, after which the field may be allowed to lie idle for a while before again being brought into cultivation. Oats are frequently seeded in the fall and harvested in May, followed by cowpeas or potatoes.

In 1919 the fertilizer used in the county cost $113,484, with an average of $154.40 per farm reporting. Its use was reported on 90 per cent of the farms. In growing cotton and corn, fertilizer is used at a rate of about 200 to 400 pounds per acre. At present the common practice is to purchase the ingredients and mix the fertilizers on the farm. The mixtures commonly used are in the proportions of 9–3–3[1] for clay soils such as found in the Piedmont, and 8–4–5 for the sandy soils. The lighter, sandy soils require heavier applications than the clay soils. Barnyard manure is available only on

[1] Percentages respectively of phosphoric acid, ammonia, and potash.

farms devoted to dairying. The practice of turning under cover crops such as oats, rye, or cowpeas, is coming into favor.

Most of the farm work is done by the farmer and his family, extra help being hired on only one-third of the farms in 1919. The laborers are mainly negroes; in the main they are not very efficient and require constant supervision. The labor expense in 1919 was $60,657, or $223 per farm where hired help was employed. Wages vary from $20 to $30 a month with board and housing.

The 1920 census reports 817 farms in the county, averaging 84.2 acres each, of which 48.7 acres are improved land. Of the total number, 72.5 per cent are operated by tenants, 26.3 per cent by owners, and 1.2 per cent by managers. Rents are either on a cash or share basis. The cash rent averages about $3 to $5 an acre. Under the share system the owner receives one-third to one-half the crop, depending upon his proportion of the expenses for seed and fertilizers.

Prices of farm lands vary from $10 to $12 an acre for land in the more broken sections or in the sand hills, to $75 to $100 for the better terrace and bottom lands. The red soils of the Piedmont and the best of the sandy loam uplands average about $45 an acre. According to the census of 1920 the average value of the land alone was $33.70 an acre.

SOILS

The soils of Muscogee County are prevailingly light in color, the surface soils ranging from gray to red. The darkest-colored soils are found in depressions that occur through the uplands. The soils of the county are dominantly low in organic matter, as no grass or prairie areas exist, except in some of the swamps or ponds. This area was in forest until opened up for agriculture, and consequently there has been little chance for the accumulation of organic matter in the soil. In the wooded areas there is a noticeable accumulation of coarse, partly decomposed vegetable matter in the surface inch or two of the soil, but this has not become incorporated in the soil as is the case in areas covered with grass.

Active leaching has been and still is going on, owing to the heavy rainfall, warm temperature, and the fact that clean cultivation has been the general farm practice. Not only has carbonate of lime not accumulated in these soils, but the original carbonates in the parent geological formations from which many of the soils have been derived have been entirely removed from the soil profile. Few of the soils are decidedly acid in character, though practically all of them respond to the liberal application of lime, particularly the Cecil sandy clay loam, Greenville clay loam, Wickham clay loam, Roanoke silt loam, Augusta sandy loam, Congaree silt loam and Ochlockonee silt loam.

Muscogee County lies along the fall line, part of the county being within the Piedmont Plateau and part within the Coastal Plain province. The Piedmont Plateau province includes the northern part, approximately one-third the area of the county, and is called the "red clay" section, as distinguished from the "sand hills" and the Coastal Plain province. The line of separation is very irregular,

as there is considerable overlapping of the materials of the two provinces. The line runs in a general northeasterly direction from north of Bibb City through Flatrock and north of Upatoie into Talbot County. In places the lower slopes far down into the Coastal Plain are derived from Piedmont material, and remnants of Coastal Plain material cap some of the hills in the Piedmont country.

The Piedmont soils are residual soils derived from the weathering of igneous and metamorphic rocks, mainly granite, schist, gneiss, and aplitic granite cut by dikes of diorite and gabbro, with veins of quartz that break up into fragments such as are so frequently seen on slopes in this section. The soils derived from these rocks belong in the Cecil, Appling, Davidson, and Wilkes series. These soils are micaceous. Their color is derived mainly from the oxidation of the iron contained in the parent rocks and depends upon the amount of iron present and the degree of its oxidation.

The soils in the southern two-thirds of the county are derived from the unconsolidated sand and clay beds of the Coastal Plain. They include the Norfolk, Ruston, Greenville, and Susquehanna series. The materials may, in part, be traced to the Piedmont Plateau, from which they were largely transported by streams and deposited in the ocean while the region was submerged. This relationship is readily seen in the sand and clay deposits in the Hoffman soil along the border between the two provinces.

The second-bottom and flood-plain soils of the county have been formed from reworked material transported from the surrounding uplands by streams, and deposited in the valleys. The second-bottom soils are included in the Wickham, Roanoke, Kalmia, Cahaba, and Augusta series, and the flood-plain soils in the Ochlockonee and Congaree series.

Grouped on the basis of general features of the soil profile, the soils of the county fall into two main groups. In one of these, which includes by far the greater number of the soils of the county, the soils have attained a stage in their development that may be considered the normal or mature stage of development of the general region in which they lie.

The most striking feature of the texture profile of the well-developed soils in the county is the presence in all of them of a relatively light-textured surface layer or horizon overlying a deeper horizon with a heavier texture, in many cases much heavier, and a third still deeper horizon, which may vary considerably in texture but which is prevailingly lighter than the second horizon and in most places heavier than the first. The textures of these layers vary greatly in the soils of the region, the surface layers (horizon A) ranging from clay loams to sands, and the second or B horizon ranging from clays to very light sandy loams or sands. The third or C horizon consists of unconsolidated geological materials lying beneath the B horizon, and may be composed of material that is extremely variable in texture, structure, and color.

The thickness of these layers also varies widely, the surface layers ranging from a few inches in the case of the clay loams to a maximum of 2 feet or more in the most sandy soils.

Mechanical analyses of samples collected from this county have not been made, but the textures of the several types mapped were determined by field methods while the work was in progress, and these determinations were confirmed by inspection of samples sent to the laboratories in Washington. Mechanical analyses have been made of samples of some of the same types collected from near-by areas, and these are introduced into the following table to illustrate the differences in texture in the three soil horizons of these soils.

Mechanical analyses of Cecil sandy loam, Appling sandy loam, and Greenville clay loam

Number	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		CECIL SANDY LOAM						
	Inches	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
27917	0 to 4	3.5	15.2	11.8	14.6	10.8	30.3	14.0
28918	6 to 30	3.2	9.2	5.5	16.3	5.6	21.5	38.8
28919	40 to 65	.4	9.8	11.4	37.6	10.8	22.4	7.8
		APPLING SANDY LOAM						
236515	0 to 2	14.8	26.0	8.4	23.4	8.4	12.3	6.9
236516	2 to 8	21.2	21.4	6.7	18.8	8.2	15.4	8.5
236517	8 to 18	6.8	7.6	2.2	6.2	3.0	13.4	61.0
236518	18 to 40	5.0	7.4	2.3	7.0	3.6	14.8	60.0
236519	40 to 72	12.1	12.2	3.6	13.0	6.3	18.5	34.3
236520	72	9.2	16.4	4.7	18.0	10.4	27.4	13.9
		GREENVILLE CLAY LOAM						
32313	0 to 2	0.5	3.6	2.2	16.8	13.0	41.9	21.7
32314	3 to 6	.6	5.2	2.4	18.0	15.2	36.8	21.8
32315	7 to 30	.2	1.8	1.1	9.7	5.7	24.9	56.4
32316	31 to 48	.0	.8	.4	37.7	29.4	8.4	23.2
32317	49 to 70	.9	20.7	13.0	43.8	4.2	15.5	2.0

In Muscogee County the soils of this well-developed group include all the types of the Cecil, Appling, Davidson, Norfolk, Ruston, Greenville, Wickham, Cahaba, and Kalmia series. These soils possess the three textural horizons as above described.

The soils of Group 1 may be subdivided into two subgroups on the basis of the general features of the color profile or the successive color layers or horizons in the soil section. The first subgroup, including the soils of the Cecil, Davidson, Appling, Greenville, and Wickham series, is marked by a color profile, in the uncultivated soils, about as follows:

1. A layer of leaf mold mixed with the clay or sand of the soil. If it be mainly sand, the grains will be gray or brown as a rule, but if it be silt or clay, it will usually be rather well mixed with the organic matter of the leaf mold and will be dark in color. This layer ranges from a mere film to a maximum of about 3 inches. It is usually thickest in the sandy soils.

2. A pale-yellow or grayish-yellow layer, showing very little evidence of the presence of organic matter. In the heavy soils of the Cecil, Davidson, and Greenville series this layer is not present. Even when present it is often modified by the reddish color of the

next horizon as though it had formerly had a red color. In the sandy soils it will range up to 2 feet in thickness, or in extreme cases a little more. These two layers constitute part of the relatively light-textured surface layer of the texture profile.

3. A red layer ranging from deep, almost blood red, through crimson, to yellowish red. The soils of the Davidson series have the darkest-red color of this group and those of the Appling series usually are the most nearly yellowish red. This horizon is usually the same as the heavy intermediate horizon of the texture profile.

4. A reddish, grayish, yellowish, or mottled horizon corresponding to the third horizon of the texture profile. Where reddish, the color is less strong than that of the third layer. Since this layer is part of the parent material, its color varies not merely from type to type, but somewhat from place to place in the same type.

The second subgroup of soils differentiated on the basis of the color of the several layers includes the members of the Norfolk, Kalmia, Augusta, and Ruston series. These are characterized by a series of color layers in which the two upper layers are identical with the corresponding layers in the first subgroup, but the third layer, in its upper and by far larger part, is yellow in color. In its lower part, however, there is usually a thin red layer, sometimes so thin that it is difficult to detect. This is true of the Norfolk, Hoffman and apparently of the Augusta series; in the case of the Ruston series the reddish color, though it is not strongly red, is present throughout the whole horizon. The fourth horizon or color layer in these soils varies, like the corresponding layer in the first subgroup.

The soils of the first or normally developed group may also be subdivided into two subgroups according to the character of the intermediate, relatively heavy horizon. In one of these, which will include the soils of the Cecil, Davidson, and Appling series, this horizon is a heavy but brittle clay, the difference between the texture of the surface light-textured horizon and the heavy intermediate horizon being very wide in the sandy types. The soils having the heaviest intermediate horizon, though not usually those with the widest difference between the upper and intermediate horizons, are those of the Davidson series, while the sandy loam and sandy clay loam types of the Cecil series are of much the same character.

The other subgroup of these soils includes the types of the Norfolk, Ruston, Greenville, Kalmia, Wickham, and Cahaba series, in all of which the intermediate or relatively heavy layer is a sandy clay. The surface soils in this subgroup are generally very light in texture, usually sands or light loamy sands.

The second main group includes soils in which the three texture horizons are not present. These soils, consisting of the Susquehanna, Hoffman, Roanoke, Augusta, Ochlockonee, and Congaree soils and Meadow, are characterized by the absence of any definite horizon development.

In the soils of the Wilkes series the surface horizon has a relatively light texture, but the second horizon is heavy, tough, and plastic, and extends downward to the parent schist, gneiss, and diorite or aplitic granite from which the material was derived.

In the Susquehanna profile the surface layer may be either light or heavy, and this grades into mottled, heavy, plastic clays, which are in many places underlain by still heavier material at variable depths. The Hoffman soils have no systematic profile development, as the surface layer of sandy, loose material overlies the parent material consisting of a mottled pinkish, reddish, purplish, yellowish, grayish, and whitish, hard but brittle sandy material.

There is a close relationship in many places between the color and structure of the subsoil of the Augusta to that of the Hoffman soils, whereas the sandy surface layers of the Augusta are not essentially different from those of the Kalmia soils. In the Roanoke series there is not much change in the color or structure of the heavy mottled clays or silty clays of the subsoil for several feet down. The surface material is silty, and single grained in structure. The Ochlockonee soils, like the Congaree, present no horizon development, as the relationship of heavy to light-textured material is not systematic; the surface layers may be heavy or light, and the same may be true of any other part of the profile.

Chemical analyses of soils similar to these in other parts of the South have been made, and the results show that the Norfolk, Ruston, and Kalmia soils are prevailingly low in nitrogen, phosphoric acid, potash, and lime. The Cecil, Appling, and Wilkes soils are dominantly high in potash but comparatively low in the other elements of plant food, whereas the Davidson soils are higher in lime and somewhat lower in potash than the Cecil. The Wickham and Congaree types are considered fertile soils and the analyses show that they are high in potash and contain more nitrogen than the upland soils.

The following tables give the results of chemical analyses of samples of soil, collected in places outside of Muscogee County, which are similar to the soils of the same name in this county.

Chemical analyses of Cecil sandy loam

[Samples collected at Mount Airy, Habersham County, Ga.]

Chemical constituents	Sample No. 28917 0 to 4 inches	Sample No. 28918 6 to 30 inches	Sample No. 28919 40 to 65 inches	Sample No. 28920 900 inches
	Per cent	*Per cent*	*Per cent*	*Per cent*
SiO_2	83.19	57.58	74.59	75.41
TiO_2	.91	1.05	.68	.81
Fe_2O_3	2.58	9.51	4.18	3.87
Al_2O_3	6.91	21.53	14.66	12.60
MnO	.049	.040	.029	.084
CaO	.01	.01	.01	.01
MgO	.01	.09	.06	1.76
K_2O	.56	.80	.82	2.89
Na_2O	.06	.01	.06	.19
P_2O_5	.03	.07	.06	.04
SO_3	.04	.11	.04	.05
Ignition loss	5.82	8.99	5.01	2.71
Total	100.16	99.79	100.19	100.42
N	.079	.018	.005	.001
H_2O at 110° C	.80	1.08	.49	.61

Chemical analyses of Greenville clay loam

[Samples collected 7 miles west of Eufaula, Barbour County, Ala.]

Chemical constituents	Sample No. 32313, 0 to 2 inches	Sample No. 32314, 2 to 6 inches	Sample Nos. 32315 and 32316, 6 to 48 inches	Sample Nos. 32315 and 32318, 48 to 100 inches	Sample No. 32319, 100 to 114 inches
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*
SiO_2	72.52	70.72	69.00	94.57	75.16
TiO_2	.72	.72	.72	.29	.79
Fe_2O_3	8.13	9.07	12.76	1.88	6.84
Al_2O_3	6.82	9.05	11.57	2.07	12.17
MnO	.09	.07	.03	.078	.015
CaO	.34	.20	.26	.01	.01
MgO	.23	.16	.22	.01	.03
K_2O	.53	.63	.54	.09	.44
Na_2O	.53	.36	.42	.17	.18
P_2O_5	.23	.28	.33	.06	.03
SO_3	.06	.04	.02	.02	.03
Ignition loss	9.80	8.30	5.62	.73	4.40
Total	100.00	99.60	101.49	99.97	100.09
N	.16	.08	.008	.002	.001
H_2O at 110° C	1.55	1.35	.95	.12	.64

Chemical analyses of Davidson clay loam

[Samples collected 1 mile south of Cedar Grove, N. C.]

Chemical constituents	Sample No. H 33 0 to 10 inches	Sample No. H 34 10 to 36 inches	Chemical constituents	Sample No. H 33 0 to 10 inches	Sample No. H 34 10 to 36 inches
	Per cent	*Per cent*		*Per cent*	*Per cent*
Sio_2	60.47	51.12	Na_2O	0.10	0.10
Tio_2	1.49	1.45	P_2O_5	.23	.48
Fe_2O_3	6.97	10.12	SO_3	.04	.01
Al_2O_3	18.60	25.08	Ignition loss	11.00	10.27
MnO	.40	.076			
Cao	.23	.15	Total	100.31	99.40
MgO	.26	.20			
K_2O	.52	.34	N	.15	.03

Chemical analyses of Norfolk sandy loam

[Samples collected 4 miles east of Dothan, Houston County, Ala.]

Chemical constituents	Sample No. 32333, 0 to 6 inches	Sample No. 32334, 6 to 10 inches	Sample Nos. 32335 and 32336, 10 to 37 inches	Sample No. 32337, 37 to 49 inches	Sample No. 32338, 49 to 80 inches
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*
SiO_2	91.23	91.94	85.18	82.06	81.96
TiO_2	.40	.43	.60	.56	.66
Fe_2O_3	.48	.58	1.14	1.17	1.25
Al_2O_3	3.81	4.65	9.06	11.58	11.67
MnO	.015	.012	.008	.003	.008
CaO	.01	.01	.01	.01	.01
MgO	.01	.01	.01	.01	.01
K_2O	.10	.08	.13	.09	.09
Na_2O	.15	.17	.19	.17	.16
P_2O_5	.02	.02	.01	.01	.02
SO_3	.02	.03	.03	.05	.02
Ignition loss	3.88	2.56	3.65	4.26	4.17
Total	100.12	100.49	100.01	99.97	100.02
N	.035	.002	.008	.004	.002
H_2O at 110° C	.61	.42	.52	.55	.52

The various soils in Muscogee County are grouped into series on the basis of color, origin, and structural characteristics. The series are divided into types on the basis of difference in texture, or the proportion of sand, silt, and clay entering into their composition. The type is the unit of soil classification and mapping. Twenty-two types and three phases of types, representing 16 soil series, in addition to the miscellaneous classification, Meadow, are mapped in Muscogee County.

The sandy types of the Cecil series have a dark-gray to brown layer of an inch or two, passing into a pale-yellow, friable to loose layer of 4 to 6 inches, and then into a reddish-yellow friable layer for a few inches. In the heavier members there is usually a friable surface layer of a brown to reddish-brown color. The above layers constitute the surface soil or horizon A. The subsoil or horizon B is a bright-red to deep-red, hard, brittle clay, which breaks into irregular shaped lumps and extends to depths of 3 to 8 feet or more. Below this is encountered a light-red, friable, micaceous clay, which grades at 1 to 2 feet into a light-gray or yellowish, partially decomposed soft rock, and this passes into the light-gray disintegrated granites, gneisses, and schists from which the soils are derived. The Cecil sandy loam with a gravelly phase, and sandy clay loam with a hilly phase, are mapped in Muscogee County.

The Davidson soils, below a shallow covering of leaf mold, consist of reddish-brown to red, friable material to a depth of 5 to 15 inches. The subsoil is a dark-red to maroon-red, firm, stiff but brittle clay, comparatively free from quartz sand, having a smooth feel, and extending to depths of 3 to 10 feet. Lying immediately below the subsoil is a layer of yellowish-red or ocherous-colored, friable material; this passes into a yellowish, soft rock, which quickly grades into the solid rock. These soils are derived from dark-colored, basic igneous rocks, such as diorite, diabase, and hornblende schist. The Davidson clay loam is the only type mapped in the county.

The soils of the Appling series have a gray to brown surface layer of an inch or two, and a yellowish-gray or grayish-yellow layer, which grades at a depth of 5 to 8 inches into a yellow or reddish-yellow material. These layers are friable and sandy. The subsoil, beginning at 12 to 15 inches, is a reddish-yellow to yellowish-brown clay, rather stiff but friable. Usually at 24 to 30 inches a mottled or streaked light-red and yellow, stiff but brittle clay is encountered, and this grades at 4 to 6 feet into the partly weathered, mottled red, yellow, bluish, and light-gray material which overlies the hard rock. These soils are derived from the weathering of light-colored gneisses, granites, and schists. The Appling sandy loam is the only type mapped in the area.

The types of the Wilkes series have a gray to brownish-gray surface layer passing at 1 to 4 inches into a yellowish-gray to pale-yellow layer, which extends to a depth of 6 to 10 inches. These layers are friable and generally sandy. The subsoil consists of a yellow or reddish-yellow, or mottled red and yellow, friable sandy clay, which passes within a few inches into the heavy, tough, plastic clay, brownish yellow or brown to yellow in color. Below this at 24 to 30 inches is the disintegrated, greenish-yellow or mottled gray and whitish, soft, partly decomposed rock. These soils are derived

from laminated gneisses and aplitic granites cut by dikes of diorite or diabase. The Wilkes sandy loam is the only type mapped in Muscogee County.

The types of the Norfolk series are characterized by 2 to 4 inches of gray to brownish-gray, friable material, and below this to a depth of 12 to 16 inches by a pale-yellow or grayish-yellow, friable, single-grained, light-textured, sandy material, these constituting horizon A. The subsoil, or horizon B, to a depth of 30 to 50 inches, is a yellow, friable, sandy clay or sand. Beneath this is horizon C, which is a mottled brownish or light-red, yellow, and light-gray or whitish, brittle, sandy material. In places streakings and blotchings are very noticeable. Usually the redder coloration lies immediately below the subsoil. The Norfolk sand and sandy loam, and the sandy loam, deep phase, are mapped in Muscogee County.

The types of the Ruston series have 1 to 3 inches of gray or grayish-brown material and a layer of yellow or brownish-yellow, friable, single-grained material reaching downward to a depth of 10 to 18 inches. The subsoil, or horizon B, consists of reddish-yellow, yellowish-red, or yellowish-brown sandy clay of a crumbly structure extending to depths of 30 to 60 inches or more. This is underlain by a mottled, yellowish-red, yellow, and light-gray, hard but brittle material. Usually the red mottlings diminish and shades of gray increase with depth. The Ruston sand and sandy loam are mapped in the county.

The Greenville soils are brown to reddish brown in the surface portion, usually loamy and friable, the first inch or two in virgin areas containing some organic matter. The subsoil is composed of red, moderately friable clays, heavy sandy clays, or loamy sands. Usually at depths of 40 to 80 inches a mottled or blotched, purplish-red, gray, yellow, and whitish, hard but brittle clay is encountered. Small, rounded, brown to black iron accretions are present on the surface of the heavier types, and a concentration of these occurs locally where the subsoil grades into the unweathered parent material. Only one type, the Greenville clay loam, is developed in this area.

The Hoffman soils have a gray surface layer of 1 to 3 inches, grading into a pale-yellow or grayish-yellow layer extending to a depth ranging from 6 to 30 inches. These layers are sandy, friable, and of single-grained structure. Underlying this is a mottled pink, purplish, gray, reddish, and white, hard, compact but brittle sandy clay, without any definite color or texture. The Hoffman sandy loam is the only type mapped in Muscogee County.

In the sandy types of the Susquehanna series the A–1 layer consists of 2 or 3 inches of gray, friable material and the A–2 layer consists of a pale-yellow to grayish-yellow friable material. Horizon B–1 is a mottled light-red and yellow, heavy, sticky sandy clay, and B–2 is a mottled light-red, gray, and yellow clay, which is heavy, plastic and sticky. The C horizon consists of laminated clays. The clay type of this series has a shallow covering of loam and fine sandy loam which passes quickly into the heavy, dull-red clay. The Susquehanna clay occurs in this county.

The types of the Wickham series have grayish-brown to brown surface soils and a light-red to yellowish-brown, firm but brittle

clay subsoil. Usually at 4 to 6 feet this is underlain by a light reddish-yellow friable material. Small mica particles are common in the subsoil and lower substratum. The Wickham fine sandy loam and clay loam were mapped.

The soils of the Roanoke series have gray to dark-gray surface layers slightly mottled with brown, and subsoils of light-gray or bluish-gray, mottled yellowish-brown, tough, plastic clay. They are derived from the deposition of Piedmont material by the streams. They occupy second bottoms and are naturally poorly drained. The Roanoke silt loam is mapped in this area.

The surface soils of the Kalmia series consist of 3 or 4 inches of grayish-brown material, and below this to a depth of 14 to 18 inches of a pale-yellow, friable, mellow, single-grained material. These two layers constitute the A horizon. The subsoil or horizon B to a depth of 30 to 60 inches is a yellow, friable sandy clay or sand. Below this is a mottled purplish-red, yellow, and light-gray, friable material. These soils occur on second bottoms and terraces and represent material washed from Coastal Plain soils and redeposited. The Kalmia sand and sandy loam are mapped in this county.

The Cahaba series has an A–1 horizon of 3 or 4 inches of brown friable material, and an A–2 layer of reddish-yellow or brownish-yellow friable material. The B horizon is a reddish-yellow sandy clay or sand of a friable, crumbly structure, and the C horizon consists of more friable and lighter-colored material. The Cahaba sand occurs in this area.

The soils of the Augusta series have a gray layer of 1 to 4 inches passing into a pale-yellow layer extending to depths of 10 to 15 inches. These layers are friable, generally sandy, and of single-grained structure. The upper part of the subsoil is a yellowish, pinkish, or salmon-colored, friable sandy clay. This layer is only a few inches in thickness and is underlain by a mottled white, light-gray, yellow, and purplish-red friable sandy clay. Small scales of mica are present in the subsoil. The Augusta sandy loam is the only type mapped in the county.

The types of the Congaree series have brown to grayish-brown surface soils and light-brown subsoils. Both the soil and subsoil are friable, contain mica scales, and show very little difference in the soil section from the surface downward to a depth of several feet. The Congaree fine sandy loam and silt loam are mapped in the county.

The Ochlockonee series comprises first-bottom soils developed along streams that receive all or most of their wash from Coastal Plain uplands. They have light-brown to grayish-brown surface soils, with mottled brownish-yellow and light-gray subsoils. One type, the silt loam, occurs in this area.

Meadow includes material in stream bottoms so varied in texture that it can not be satisfactorily separated into types. This material includes wide variations in color and origin. It is subject to overflow, and much of it remains wet over a considerable part of the year.

In the following pages of this report the various soils are described in detail and their relation to agriculture is discussed; their distribu-

tion is shown on the accompanying soil map; and their actual and proportionate extent is given in the following table:

Areas of different soils

Soil	Acres	Per cent	Soil	Acres	Per cent
Norfolk sand	27,776	19.5	Augusta sandy loam	3,264	2.3
Cecil sandy clay loam	7,744	11.9	Ochlockonee silt loam	2,432	1.7
Hilly phase	9,216		Ruston sand	2,048	1.4
Norfolk sandy loam	9,216	10.9	Wickham fine sandy loam	1,984	1.4
Deep phase	6,336		Greenville clay loam	1,792	1.2
Hoffman sandy loam	14,400	10.1	Davidson clay loam	1,152	.8
Meadow	14,400	10.1	Congaree fine sandy loam	1,088	.8
Cecil sandy loam	7,488	6.0	Congaree silt loam	1,088	.8
Gravelly phase	1,152		Susquehanna clay	640	.4
Appling sandy loam	8,192	5.7	Roanoke silt loam	576	.4
Ruston sandy loam	6,720	4.7	Cahaba sand	448	.3
Wilkes sandy loam	6,400	4.5	Wickham clay loam	384	.3
Kalmia sandy loam	3,520	2.5			
Kalmia sand	3,264	2.3	Total	142,720	

CECIL SANDY LOAM

The surface soil of the Cecil sandy loam in virgin areas consists of about 1 to 3 inches of gray to brown sandy loam, passing into a yellow or brownish-yellow sandy loam and extending to a depth of about 6 to 10 inches. The subsoil begins as a reddish-yellow sandy clay, but in a few inches grades into the typical red, stiff but brittle clay, which breaks into irregular shaped lumps. This red clay subsoil varies in thickness from about 30 to 60 inches, and it is underlain by a yellowish-red, friable, and in places micaceous material, which grades into the rotten gneisses and granites from which it is derived. In cultivated fields the surface soil to a depth of 5 to 7 inches is grayish brown or slightly reddish brown, owing to the admixture of some of the red clay subsoil.

In places, particularly on slopes, some angular fragments of quartz and granite are scattered over the surface. Where this soil is developed near the fall line, rounded gravel is common, being a remnant of the Coastal Plain material once deposited over all of this region, but later was eroded. Locally the red subsoil is exposed. Much of the type has lost its sandy covering through erosion and approximates a loam in texture, and a few of the steeper slopes leading to small drainage ways have become badly gullied.

The presence of some mica flakes is common, but in a number of small areas the subsoil below 24 inches contains sufficient mica to make it friable, thus changing the physical character of the soil and tending to reduce its moisture-holding capacity. If this variation had been developed in large areas it would have been separated as Madison sandy loam. It occurs mainly along the river road, in the northwest part of the county, just north and west of Roaring Branch, and north of Heiferhorn Creek. Where the Cecil sandy loam is level or gently rolling, areas of Appling sandy loam are produced, and in slight depressions or swales spots of Davidson soils are developed, but such areas are too small to be mapped separately.

The Cecil sandy loam occurs only in the northern part of the county and is best developed between Nankipooh and Midland and

northwest of Upatoie. It occupies rolling to steeply rolling land and smooth, gently rolling ridge tops, and is well drained throughout.

About 85 per cent of this soil is in use, the smoother and better located areas being in cultivation. Practically all of it has been in cultivation, but the steeper slopes and gullied areas have been allowed to grow up in second-growth pine and oak, which together with some gum and dogwood, constitute the principal forest growth.

Cotton and corn are the principal crops, although since the advent of the boll weevil the cotton acreage has been somewhat reduced. At the present time one-eighth to one-fourth bale of cotton and 15 to 25 bushels of corn represent the range in yields. Velvet beans, cowpeas, and oats are the most important secondary crops, and Bermuda grass is the usual hay grass. This type was formerly used for peaches and is said to have produced fruit of superior quality and color, but marketing was difficult, and the increase in price of cotton was followed by the destruction of the orchards and a return to cotton production.

The Cecil sandy loam is recognized as being better adapted to cotton under present conditions than the sandy clay loam type, because it is more easily prepared and cultivated and is generally somewhat earlier. The use of commercial fertilizer is general. The construction of terraces on the slopes for prevention of erosion and washing is now customary, and if this policy had been adopted when the land was first cleared, many of the gullied fields that have since been turned out and allowed to grow up in pine and brush could be in use to-day. This type of soil ranges in price from $40 to $60 an acre.

The use of a winter cover crop, such as rye, is strongly recommended, and the growing of more velvet beans and cowpeas will increase the nitrogen content of the soil. This soil is usually high in potash, so that the application of that element in fertilizer may not be profitable. It is a strong soil and responds to careful management.

Cecil sandy loam, gravelly phase.—The gravelly phase of the Cecil sandy loam is of small extent, usually occupying the steeper slopes of ridges and hills whose crests are Cecil sandy loam or sandy clay loam. It differs from the typical soil in the quantity of angular gravel present on the surface and in the soil or sandy surface layer. Gravel is present in sufficient quantities to interfere somewhat with agricultural operations, and most of the phase has been abandoned and allowed to grow up in brush. The areas in cultivation are used principally for cotton and corn.

CECIL SANDY CLAY LOAM

The Cecil sandy clay loam has a light brownish-red sandy loam surface soil 4 to 8 inches deep. The subsoil is a red, stiff, but brittle clay extending to depths of 3 to 10 feet, and grading into reddish-yellow, friable material and finally into the rotten rock. The covering of sandy loam is usually so shallow that when plowed the red clay subsoil is brought to the surface. The land has a distinctly spotted appearance in a plowed field, as it includes small areas of red clay loam, with here and there small areas of light-brown or gray sandy loam. It is probable that much of this type has been

developed from the Cecil sandy loam by the erosion of the sandy surface layer, thus bringing the clay subsoil very near the surface.

Included in this type are areas in which the soil and upper subsoil are typical but the lower subsoil is more friable and contains fairly large quantities of mica flakes below 22 to 24 inches. If of greater extent, such areas would have been separated as Madison sandy clay loam. The principal occurrences of this variation are along the Central of Georgia Railway west of Fortson, and in the extreme northeast corner of the county along the county line east of Kendle Creek. A few small areas of Louisa clay loam, in which even the surface is highly micaceous and the soil and subsoil have a greasy feel when rubbed between thumb and finger, are also included in this type because of their small extent. The steep slopes of small drainage ways, in some cases somewhat eroded and gullied, included in this type, would have been separated as a hilly phase if of larger extent. Some of these slopes contain scattered fragments of quartz.

The Cecil sandy clay loam is best developed in the smoother part of the Piedmont section of Muscogee County, northwest of Heiferhorn Creek, close to the Harris County line, near Nankipooh and Midland, and north of Upatoie. It has a rolling to steeply rolling topography and occurs on ridges and upper slopes, although in many cases the ridge crests and lower slopes are occupied by the Cecil sandy loam. Drainage is well established.

This is a strong soil and is considered better fitted for heavy crop production and hay than the sandy loam, but since the advent of the boll weevil the sandy soils have become more popular. It has much the same crop adaptation and forest vegetation as the Cecil sandy loam. About 60 per cent of the type is in farms; over half of the farm land is in cultivation, the balance being in pasture and meadow. The steeper slopes and eroded patches remain in forest, consisting chiefly of short-leaf pine, red oak, scrub oak, and gum.

Corn and cotton are the principal crops. Yields range from 10 to 25 bushels of corn and one-eighth to one-fourth bale of cotton per acre. Oats, cowpeas, and velvet beans are grown chiefly for hay. Home-mixed fertilizers are in general use and are applied for both cotton and corn at a rate of about 200 to 300 pounds of a 9–3–3 grade per acre. Little stable manure is available and at present few farmers turn under any cover crops.

Farms consisting chiefly of this type of soil sell at $40 an acre or more, depending upon buildings and improvements.

Alfalfa can be successfully grown on the Cecil sandy clay loam if heavy applications of lime and manure are made, the soil plowed deeply, and the seed inoculated. By gradually increasing the depth of plowing and incorporating organic matter through the growing and turning under of leguminous crops or green cover crops, such as rye or oats, a better tilth and higher productiveness can be obtained. In addition, the water-holding capacity of the soil will be increased, with a consequent decrease in gullying and erosion.

Cecil sandy clay loam, hilly phase.—The hilly phase includes the areas of Cecil sandy clay loam that are so badly eroded, gullied, and stony, and so rough in topography as to be of little or no agri-

cultural value except for the pasturage afforded. Most of this phase was originally cleared but little of it was terraced or protected from erosion. Some of it had a sandy loam covering that was subsequently removed and carried into the stream bottoms below. In color and texture the greater part of this phase is typical, although it includes small areas, or "galls," of Wilkes material on slopes and outcrops of the underlying crystalline rocks. Included also are small eroded areas of Appling and Louisa soils too small to be separated.

The Cecil sandy clay loam, hilly phase, is developed chiefly in the northwestern part of the county along the drainage basins of Standing Boy, Douglas, and Heiferhorn Creeks, and on slopes and ridges overlooking Chattahoochee River. Other small areas are mapped on slopes of streams in the northeastern part of the county. It occurs in close association with the Wilkes sandy loam.

Practically none of this phase is used for farming, and most of it has been allowed to revert to forest. Farms which include this phase range in price from $10 to $25 an acre, depending upon the nature of the associated soils and the quantity and quality of the merchantable timber. The phase is best suited to forestry, as it produces little pasturage and is too rough and irregular to be farmed.

DAVIDSON CLAY LOAM

The surface soil of the Davidson clay loam in virgin areas has a slight covering of dark-brown clay loam, the dark color being due to the presence of organic matter. In cultivated fields the surface is a dark reddish-brown, friable clay loam to a depth of 5 to 8 inches. The subsoil is a dark-red or maroon-red clay, moderately stiff but brittle, and yet having a smooth feel. It extends to a depth of 4 to 10 feet and passes into a few inches of yellow, friable material overlying the bedrock. Black specks and the absence of any large amounts of quartz sand are characteristic of the clay subsoil.

The Davidson clay loam generally occurs in slightly depressed or almost level areas or on gentle slopes within bodies of the Cecil soils. This soil is derived from the dark-colored crystalline rocks, diorite and diabase, as distinguished from the acid rocks or rocks high in quartz which produce the Cecil soils. Its dark color in slight depressions is due partly to accumulations of organic matter.

This type is mapped in the northern part of the county in the vicinity of Flatrock, with scattered areas east of Midland and north of Upatoie.

Practically all of it is cleared and in cultivation, as its smooth topography renders it well adapted to tillage operations. Although not of large extent, it is recognized by farmers as the most productive of the upland Piedmont soils in Muscogee County. It is farmed principally to cotton and corn, yields of one-half to three-fourths bale of cotton and 20 to 35 bushels of corn per acre being obtained. Where planted to velvet beans, oats, and cowpeas for hay, heavy yields of forage have been obtained. This soil is usually higher in lime than the Cecil soils, and in some sections of the Carolinas it is used extensively for clovers and alfalfa. It ranges in price from $50 to $60 an acre.

APPLING SANDY LOAM

The surface soil of the Appling sandy loam in wooded areas consists of 1 to 3 inches of gray or brownish-gray loamy sand passing into a pale-yellow or yellowish-gray loamy sand or light sandy loam extending to a depth of 6 to 8 inches. It is underlain by a yellow to brownish-yellow heavy sandy loam to friable sandy clay, grading at 12 to 18 inches into a reddish-yellow friable clay, which in a few inches passes into a mottled, blotched, or streaked light-red and yellow, rather compact but brittle and gritty clay; this extends downward to depths of 3 to 6 feet, where the rotten rock is generally reached. In cultivated fields the surface soil is light gray or grayish yellow.

Included with this type are small areas in which the soil is red, resembling the Cecil soil, but with the characteristic mottled yellow and red subsoil. Areas of this variation are mapped along the road north from Upatoie. On the steeper slopes galls of exposed subsoil or outcrops of the parent rock similar to those on the Wilkes soils are included. In places considerable quantities of angular rock fragments, largely quartz, are strewn over the surface.

The Appling sandy loam is found mainly in the northern and northeastern parts of the county from the vicinity of Double Churches eastward toward Flatrock and Upatoie. It occupies rolling, gently sloping to steeply rolling areas, heads of streams, and flats or saddles between drainage ways, and includes considerable areas of badly eroded and gullied hillsides. Drainage is generally well established, and on slopes that were not terraced when first cleared the drainage has been excessive. On lower slopes there are local seepy spots where drainage water from the upper slopes and small underground streams and springs come to the surface. In other places where the subsoil is rather impervious, or in flats around the small stream heads, drainage may be deficient.

About 60 per cent of this type is used for agricultural purposes, including pasture; the balance, consisting of steep, gullied hillsides or severely eroded areas, remains in forest consisting of short-leaf and loblolly pines, blackjack oak, sweet gum, and dogwood.

The Appling sandy loam is not as productive as the Cecil and Davidson soils of the county and usually requires heavier applications of fertilizers. Cotton and corn are the principal crops, yielding from one-eighth to one-half bale of cotton and 15 to 25 bushels of corn per acre. Cowpeas, velvet beans, and peanuts, are grown to some extent, chiefly for forage and hay. Sweet potatoes and oats are being introduced into this section and seem to be well adapted to this type of soil. Some small areas are used for growing truck crops, such as onions, peas, lettuce, cabbage, watermelons, and cantaloupes for the Columbus markets. Dairying is carried on to some extent, the farmers depending to a large extent upon imported feedstuffs for their cows. Cane is grown for the production of sirup for home needs.

This soil is rather easily worked and responds well to the use of fertilizers. The wider use of legumes, such as cowpeas and velvet beans, and the growing of sweet potatoes and peanuts instead of the constant cropping to cotton and corn, are recommended for this soil.

WILKES SANDY LOAM

The surface soil of the Wilkes sandy loam in forested areas has a gray to brownish-gray layer of sandy loam passing at 1 to 4 inches into a pale-yellow or grayish-yellow sandy loam extending to depths of 6 to 8 inches. This is underlain by a mottled yellow and reddish-brown clay loam which grades at about 10 to 15 inches into a heavy, plastic clay, mottled light gray, yellow, and reddish brown. Usually below 20 to 30 inches the rotten light-colored rock and dikes of dark-colored rocks are encountered. In places the rotten rock joins the surface soil. In cultivated fields the surface soil is light gray. In many places the heavy subsoil layer is a yellowish-brown plastic clay.

This soil is extremely variable in depth, structure, and texture. It occupies fairly smooth to deeply eroded and dissected, steep and broken areas, and is for the most part nonagricultural. In many places it consists of a shallow covering of soil or partly weathered rock material over the parent rocks, which here and there are exposed in badly eroded slopes or galls. In some places large granite bowlders and considerable quantities of angular rock fragments are encountered. Included in this type are small areas of soil which have the characteristic Cecil, Appling, or Madison surface color and general appearance, but the subsoil consists of the typical Wilkes material or partly weathered parent rock material.

The Wilkes sandy loam is developed chiefly in the northwestern part of the county. The largest area lies west of Double Churches. Other areas are mapped in the northeastern part of the county close to the Harris County line, and small areas are scattered over the Piedmont portion of the county. Much of this type was cleared by the early settlers, but because of its thin and unproductive soil, together with its unfavorable topography and tendency to wash and erode, practically all of it has been abandoned and allowed to revert to forest. With the exception of a few small areas along Tar River in the extreme northeastern part of the county and along the northern edge of the county east of Pierce Chapel, and some garden patches around tenant houses, this land is not used for crops. This type is of little agricultural value, being unsuited to crop production and affording but scant pasture, and practically all of it could be most profitably devoted to forestry.

NORFOLK SAND

The surface soil of the Norfolk sand in wooded areas has from 2 to 4 inches of gray to grayish-brown sand. This is underlain by a yellow to pale-yellow sand, which ranges in depth from 3 to 10 feet or more and has a loose open structure. Usually at depths of 3 feet there are slight mottlings of reddish-yellow in the form of soft iron accretions or stains. Underlying this sand is a mottled light-red and yellow, friable, sandy material. In cultivated fields the color of the surface soil ranges from light gray to grayish brown.

In the southern part of the county small areas of fine sand and loamy sand are included, and in the vicinity of areas of Ruston sand and sandy loam the subsoil of the Norfolk sand is somewhat brownish or brownish yellow. On ridges or steep slopes the subsoil

is gray, there being but little difference in color and texture between soil and subsoil.

The Norfolk sand is the most extensive soil in the county and occurs throughout the southern or Coastal Plain section. Its principal development is in the eastern and southeastern parts, particularly on the military reservation, where it occurs in large bodies. It occupies tops of ridges and smooth gentle slopes. It is also commonly found around the heads of small drainage ways and on lower slopes, where, in some places, the surface soil is somewhat darker and its formation seems to have been due in part to colluvial action. Continued cultivation and the action of rain water has a tendency to work the sand from ridge tops and upper slopes to lower levels. In places, particularly on slopes, waterworn gravel is present in noticeable quantities.

In dry weather this soil becomes very loose and incoherent and roads across it become well-nigh impassable because of the depth of loose sand. The porous structure of the soil and subsoil insures good to excessive drainage.

Most of this type was formerly cleared and farmed for a time because of its easy cultivation, but yields were small, and erosion was so excessive that much of it was abandoned and allowed to grow up in long-leaf and loblolly pines and blackjack and other oaks.

About 10 per cent of the type outside the military reservation is in cultivation. Corn and cotton are the principal crops, but yields are low, corn yielding 8 to 15 bushels and cotton one-eighth to one-fourth bale per acre. Near Columbus this soil is used for sweet potatoes and peanuts, and several truck farms are established on it. A few small peach orchards and pecan groves have been set out. This type supports some Bermuda grass and wire grass, and broom grass affords some pasture in early spring before it becomes too tough.

The Norfolk sand can be worked with light tillage tools. Shallow and frequent cultivations are necessary. Heavy applications of complete fertilizers are needed for cotton and corn. Very little barnyard manure is available and turning under cover crops is seldom practiced.

The Norfolk sand is used in parts of the Carolinas for growing peaches commercially, and they are said to mature earlier than on heavier soils. It is well suited for trucking, as it warms up early in the spring and is easy to cultivate. Application of large quantities of manure and fertilizer or the turning under of green-manuring crops are necessary to build up and maintain the productiveness of this soil. Slopes should be carefully terraced and frequent shallow cultivation given to crops to conserve the moisture supply.

This type ranges in selling price from $12 to $25 an acre, depending upon improvements and the nearness to the principal county roads.

NORFOLK SANDY LOAM

The surface soil of the Norfolk sandy loam in virgin areas, to a depth of 2 to 4 inches, is a gray loamy sand, the dark color being due to the presence of organic matter. The subsurface or main part of the soil is a pale-yellow to grayish-yellow loamy sand extending to depths of 12 to 16 inches. The true subsoil is a yellow sandy

clay of a crumbly, granular structure. This is underlain at 34 to 48 inches by a mottled brownish-red, light-gray and yellow, friable material. In places a thin red or mottled red and yellow layer underlies the subsoil. On cultivated fields the surface soil of 5 to 7 inches is a light-gray to yellowish-gray loamy sand, the color depending on the content of organic matter and how the soil has been handled.

Where this soil occurs close to the Piedmont soils the surface layer has some sharp, medium to coarse sand and approaches a coarse sandy loam, and the subsoil is a brownish-yellow sandy clay which is decidedly more sticky than typical. Farther south in the county there are small areas of Norfolk fine sandy loam, and locally on slopes small spots of gravelly sandy loam. In places where surface drainage has been excessive on slopes, erosion has exposed the underlying yellow sandy clay. On flats and in depressions small circular spots, one-fourth to one-half acre in extent, consisting of gray sandy loam with a gray heavy clay subsoil have been included. Such areas would have been mapped as Plummer sandy loam if of greater extent. These variations are of such small area and low agricultural value that they have not been separated on the map.

The Norfolk sandy loam is mapped throughout the Coastal Plain in the southern and central parts of the county. The largest bodies are in the region between Columbus and Midland. Small detached areas are also found capping low hummocks or ridges in the Piedmont section, evidence that this material once covered this whole region. The type is best developed on long gentle slopes and smooth ridges and on the lower borders of steep slopes where the upper parts are covered with Norfolk sand, or Ruston or Hoffman soils. Broken or very steep areas within bodies of Norfolk sandy loam are usually occupied by Hoffman sandy loam.

This is one of the most extensively farmed soils in the county, about 75 per cent of it, with the exception of areas included in the military reservation, being in cultivation. The steeper, eroded portions are allowed to remain in brush and pine and furnish some pasture in early spring.

The crop adaptation is similar to that of the Norfolk sand, but the sandy loam is naturally a stronger soil, produces heavier yields, and holds fertilizers longer. Fertilizers are in general use, a 9–4–5 grade being recommended by the county agent for this type. Dairying is carried on to some extent in the vicinity of Columbus.

Corn yields from 15 to 25 bushels per acre, cotton one-eighth to three-fourths bale, and in a few instances, almost a bale per acre. Cowpeas and velvet beans are grown to a considerable extent, cowpeas in the last few years having been one of the important cash crops of this section. Watermelons and cantaloupes are grown extensively for local markets. Oats, peanuts, and sweet potatoes are also grown. Patches of Norfolk sandy loam around the heads of small drainage ways or draws, and at the base of slopes where moisture supply is sufficient, are devoted to the growing of cane for the home supply of sirup. A number of small truck farms are established on this type, producing lettuce, cabbage, cauliflower, peas, tomatoes, and strawberries for the local markets. The home orchards include peaches, plums, and pecans.

Farms on the Norfolk sandy loam sell for prices ranging from $20 to $50 an acre, depending on the location and improvements.

Like most of the upland sandy soils of Muscogee County, the Norfolk sandy loam is low in organic matter. This can be supplied by application of manure or by growing and plowing under crops of rye, oats, and cowpeas. Peaches produce well on this type of soil in other sections of Georgia and in the Carolinas, and where market conditions and transportation facilities are favorable, large areas are devoted to vegetables, particularly sweet potatoes, and to strawberries, and in some sections wrapper tobacco is an important crop. Cane sirup produced on the Norfolk soils is said to be of a superior quality and desirable light color. This type is highly regarded in North Carolina for the production of light tobacco.

Norfolk sandy loam, deep phase.—The Norfolk sandy loam, deep phase, differs from the typical soil mainly in the depth of the surface sand layer, which ranges from 18 to 30 inches. It occurs in close association with the typical soil and grades into it in many places. Locally it includes small areas of Norfolk sand and spots of gravelly sand. The deep phase is similar to the typical soil in topography and crop adaptation, but yields are lower. Most of it has at some time been cleared and farmed, but at present not over 60 per cent of it is used for farm crops. In price it ranges somewhat lower, and it does not respond to treatment as readily as does the typical soil.

RUSTON SAND

The surface soil of the Ruston sand consists of a light-brown or grayish-brown sand, which passes at 6 to 8 inches into a yellowish-brown to reddish-brown sand and extends to depths of 3 to 5 feet. It is generally underlain by mottled light-red, yellow and gray, sandy material. When dry the subsoil in places is brownish yellow, but the same material in a moist condition is decidedly reddish brown. In places the sand subsoil becomes slightly loamy at 30 to 40 inches.

As mapped the Ruston sand includes small areas that approach the Norfolk sand in color, and on a few ridge crests it is so red in color in the subsoil that it would have been mapped as Orangeburg sand if of sufficient extent. In places sandy loam or sandy clay is reached at 30 to 36 inches. Such areas might be classed as a deep phase of the sandy loam, but they are of the same agricultural value as the typical sand and were included with it. In a few places, notably 1 mile west of Midway Church, angular fragments of hard ferruginous hardpan are strewn over the surface, and outcrops of the same material on some slopes render cultivation impracticable. These fragments are used for chimneys and foundations in a number of houses. Small fragments of the same material occur on some of the cultivated fields.

The Ruston sand occupies the higher parts of ridges, knobs, and upper slopes, and drainage is good to excessive. It occurs in several areas near Midway Church, about 2 miles east of Midway Church, and in smaller areas scattered over the portion of the military reservation lying north of Upatoie Creek.

Since much of this type is on the military reservation and is not used, and much of the remainder is of little agricultural value because of hilly topography and the presence of rock fragments, it is not very important in Muscogee County. Much of it has been allowed to remain in short-leaf pine, and some fields that were cleared have gullied so badly that they were turned out and are now supporting a growth of short-leaf pine, blackjack oak, and some red oak.

Cotton and corn are the principal crops. Yields are slightly higher than on the Norfolk sand. Some cowpeas, velvet beans, and sweet potatoes of excellent quality are grown. Fertilizers must be applied heavily to assure good yields. This type of soil is generally lacking in organic matter. It is easily cultivated and is well adapted to peaches, pecans, and strawberries. It tends to be droughty in dry seasons and frequent shallow cultivations are necessary to conserve the soil moisture. It has a tendency to gully rather easily and most of it has been terraced.

During the winter season fields of Ruston sand should be protected by seeding to rye or oats, which will prevent much of the severe erosion that is so common. These cover crops should be plowed under in the spring to increase the organic-matter content. This soil ranges slightly higher in value than the Norfolk sand.

RUSTON SANDY LOAM

The surface soil of the Ruston sandy loam in virgin areas is a grayish-brown loamy sand, 2 to 4 inches deep, grading into a brownish-yellow loamy sand or light sandy loam and extending downward to a depth of 10 to 18 inches. The subsoil is a reddish-yellow or yellowish-red to yellowish-brown sandy clay, of a friable, crumbly structure, and has a thickness of 2 to 8 feet. Below this is a mottled red, yellow, and whitish, hard but brittle material; the upper part near the subsoil shows more red, while at 7 or 8 feet the gray and yellow colors predominate. On cultivated fields a brownish-gray to gray color prevails to the depth of cultivation.

Small angular fragments of a ferruginous hardpan are scattered over some of the steeper slopes, and the same material outcrops on a few slopes in the central and southern parts of the county and is encountered within the 3-foot section. In places the lower subsoil is somewhat compact and is slightly mottled with gray. There is some variation in texture. Areas near the Piedmont section contain some coarse sand, whereas in the southern and southwestern parts of the county some of the sand material is finer textured.

Included in this type are small areas in which the subsoil is a red friable sandy clay. Such areas, which would have been separated as Orangeburg sandy loam if of greater extent, are found on the river road in the vicinity of the Columbus waterworks reservoir, and on some of the high ridges and knobs southeast of Columbus. In the rougher, more broken section the subsoil somewhat resembles that of the Hoffman. The presence of rounded waterworn gravel is shown by gravel symbols. These variations are included with the Ruston sandy loam because of their small extent.

The Ruston sandy loam occupies rolling to hilly lands, ridge crests, knobs, and "peaks." It is widely distributed over the Coastal

Plain section of Muscogee County. It includes some badly eroded and broken hillsides. A considerable part of it occurs on the military reservation. Bare spots or galls exposing the sandy clay subsoil are common on the steeper slopes where terraces have not been properly maintained.

At present about 35 to 40 per cent of this type is in use, although at one time or another practically all of it has been cleared, and evidences of use can be seen in the remains of cotton rows in wooded areas. Such areas were not properly cared for and eroded rapidly until of little use for cultivation. They now support a growth of short-leaf and loblolly pines, sassafras, black oak and red oak.

Corn and cotton are the principal crops. The yields are about the same as on the Norfolk sandy loam and cultural methods and fertilizers used are similar. The soil responds well to fertilizers and manures and is considered excellent farm land where the topography is favorable. Oats, peanuts, and cowpeas are grown for forage. Bermuda grass and lespedeza are the principal hay grasses. Small patches of sugar cane for home supply of sirup are planted on most farms.

To increase and maintain the fertility of the Ruston sandy loam, methods similar to those recommended for the Norfolk sandy loam should be followed. The rougher areas should be left in forest. The ridges and knobs would probably furnish excellent sites for peach orchards. Sweet potatoes, melons, and truck crops of various kinds are grown commercially on this soil in various sections of the South.

Prices of this soil range from $20 to $50 an acre, depending upon the location, topography, and improvements.

GREENVILLE CLAY LOAM

The surface soil of the Greenville clay loam is a reddish-brown clay loam 4 to 8 inches deep, underlain by a dark-red, heavy, friable, slightly sticky clay extending to depths of 4 to 8 feet or more. It is underlain by a mottled light-gray, yellow and light-red, hard but brittle sandy material. Along the Chattahoochee River north of Bibb City a few areas on low terracelike positions resemble the typical soil in structure and characteristics and are included with this type. Around the edges of the main areas are small patches of Greenville sandy loam; also spots having a thin gray or light reddish-brown covering and a more friable subsoil, which resemble the Orangeburg soils. A few small areas of a dark reddish-brown clay loam resembling the Blakely soils are included, and here and there outcrops of rounded waterworn gravel occur.

This type occurs principally on ridge tops, hills, and knobs overlooking the Chattahoochee River valley. The principal areas are along the river road about 3 miles north of Bibb City, around Esquiline about 4 miles southeast of Columbus, and in and around Bibb City and north of Columbus. The topography is smooth to gently sloping.

The Greenville clay loam is not very extensive, but practically all of it is cleared and in cultivation; the few forested areas support a growth of pines, oaks, dogwood, and maple. It is the strongest of the upland Coastal Plain soils in Muscogee County and is well

suited to all of the general crops of the region. Cotton yields one-fourth to three-fourths bale and corn 20 to 40 bushels per acre. Oats do well and are usually cut for hay. Bermuda grass and lespedeza are the principal hay grasses. Some velvet beans and sweet potatoes are grown. This type requires more power to plow than do the lighter sandy soils and after rains must be allowed to dry out for several days before it can be worked.

Land of this type sells for $30 to $60 an acre and in a few cases for higher prices, depending on the improvements.

In various parts of Georgia this soil is extensively used commercially for peaches and pecans. When inoculated and limed, excellent stands of alfalfa have been obtained. Great care must be taken to prevent gullies from starting, for they quickly destroy valuable fields if allowed to go unchecked. Terracing and seeding to Bermuda grass, or encouraging honeysuckle and pine to grow in the eroded places, are excellent means of protecting the land.

HOFFMAN SANDY LOAM

The Hoffman sandy loam has a gray loamy sand surface soil, 4 to 5 inches deep, underlain by a pale-yellow loamy sand or sandy loam subsurface layer to a depth of 14 to 18 inches, below which is encountered a mottled light-gray, yellow, white and purplish-red, hard but brittle sandy clay, having no definite texture, structure, or coloration. The subsoil as exposed in road cuts has a distinctly spotted or calico appearance and splotches of purplish red are characteristic. In the upper part of the soil section the type resembles the Norfolk soils and here and there includes patches of them. Where it is associated with Ruston sandy loam the upper subsoil is frequently a rusty brown or brownish yellow. Much of it has a considerable quantity of mica flakes in the subsoil. On steep slopes and at the edge of hilltops outcrops of a brittle hardpan and patches of waterworn gravel occur. On the lower parts of some of the slopes south of Bull Creek near Schatulga the subsoil is a mottled red and gray clay, tough and plastic, resembling the Susquehanna soils. Several small areas are included which have a yellow sticky clay or sandy clay subsoil, rather highly micaceous. Altogether the Hoffman sandy loam is an extremely variable soil and fields of it frequently have a spotted or patchy appearance.

This type occupies rolling to hilly and broken areas, knobs, and isolated points where conditions have favored the removal of the surface covering and exposure of the subsoil. Galls or bare patches are numerous. It seems to be derived, in part, from a mixture of Piedmont and Coastal Plain material and in places resembles the Appling sandy loam. It occurs widely over Muscogee County, occupying most of the rougher drainage ways and slopes of hills and ridges whose crests are covered with Norfolk, Ruston, and Greenville soils. In the hilly section southeast of Columbus it is associated with the Susquehanna clay.

Very little of this type is used except as pasture; the greater part is in forest and much that was formerly cleared has been abandoned and now supports a growth of scrub oak, gum, and sassafras. In dry weather this type becomes hard and difficult to cultivate and crops suffer from drought, particularly where the compact, con-

solidated hardpan lies close to the surface. It has a lower crop value than either the Ruston or Norfolk sandy loam, and its selling price varies over a wide range, depending upon its topography and convenience to roads.

In farming this type of soil care must be taken to terrace the slopes. Seeding of rye and winter oats aids in preventing washing during the winter season. Heavy fertilization is necessary to obtain good yields. The growing of cowpeas and velvet beans will increase the content of nitrogen and humus. All of this type should remain in forest.

SUSQUEHANNA CLAY

The surface soil of the Susquehanna clay in virgin areas consists of 2 to 4 inches of yellowish to reddish-brown loam to clay loam, grading into a dull-red, heavy, stiff, plastic clay, extending to depths of 6 to 10 inches. This is underlain by an intensely mottled light-gray, yellow, and red, heavy, tough, plastic, and sticky clay subsoil which extends to depths of 4 or 5 feet and is underlain by laminated light-gray clays, streaked with yellow or brownish yellow. Small patches of Susquehanna fine sandy loam occur on the less dissected parts, and in places the subsoil is more friable, approaching that of the Hoffman soils. Small areas with a yellowish-brown, heavy, tenacious clay subsoil that is highly micaceous are included with the type as mapped.

The Susquehanna clay is not very extensive and occurs only on the steep slopes and in the draws in the southwestern part of the county, most of it within the boundaries of the military reservation. Much of the type in this area is badly eroded and gullied and the heavy clay is exposed in many places.

None of the type is used agriculturally except for the small quantity of pasturage it affords. A large part of it was originally cleared and was considered excellent cotton soil, but erosion quickly made it of little value and it was abandoned. Most of it at present supports a growth of scrub oak and short-leaf pine. The type is best suited to forestry and pasture.

WICKHAM FINE SANDY LOAM

The surface soil of the Wickham fine sandy loam is a light-brown loamy fine sand or fine sandy loam, 6 to 8 inches deep, which is underlain by a brownish-red friable fine sandy clay subsoil containing a noticeable amount of small mica scales. At a depth of 4 to 5 feet the material generally is a reddish-yellow fine sandy loam. The surface color varies from reddish brown to light brown or grayish brown. Included with this type as mapped are some small areas of reddish-brown heavy sandy loam or loam with a red friable sandy clay subsoil, corresponding to the Amite sandy loam mapped farther south along the river. Some small areas have a grayish sandy surface covering resembling Chattahoochee soils. Along the edges of the terraces the surface covering is thin in spots, and here and there outcrops of the sandy clay subsoil occur. In low depressions and in places adjoining the Roanoke silt loam the subsoil is slightly mottled with gray. In some places the subsoil is

rather variable in texture, containing sand or sandy loam pockets or lenses, which tend to make such areas somewhat droughty.

The Wickham fine sandy loam occupies second-bottom or terrace positions along the Chattahoochee River and consists of material brought down by the river from the Piedmont Plateau. Most of the city of Columbus is situated on this type of soil. It has a nearly level to gently undulating topography, with slight ridges and depressions or swales here and there giving it a billowy appearance. It is generally well drained.

Practically all of the type is cleared and devoted principally to corn and cotton. Under boll-weevil conditions cotton yields are low, averaging around one-eighth bale per acre. Corn yields 15 to 35 bushels per acre and even higher when fertilized. The soil is easily handled and can be cultivated soon after rains. Some of the type is in grass, principally Bermuda grass, with some carpet grass and dallis grass (large water grass). A few patches are used for oats, which produce a good stand.

The price of this soil ranges from $75 to $100 an acre for farm land, the relatively high price being due in part to its location near Columbus.

In other sections of Georgia, in Virginia, and in North Carolina, this soil is successfully used for alfalfa. It is well adapted to oats, corn and grasses, and, with such a good market as Columbus affords, might well be utilized for truck crops, melons, and such small fruits as strawberries and blackberries.

WICKHAM CLAY LOAM

The Wickham clay loam is a brown to yellowish-brown clay loam, 5 to 6 inches deep, underlain by a reddish or reddish-brown, stiff but brittle, silty clay. This extends to depths of 3 to 6 feet and grades into a friable material of a reddish-brown color. In places the subsoil is rather compact. The surface covering varies considerably in texture, in places being a silt loam and in others a silty clay loam. A thin film of sandy loam is present in a few places.

The type is of very small extent and occurs in close association with the Wickham fine sandy loam and Roanoke silt loam on the terraces of the Chattahoochee River south of Columbus. It has a flat to gently undulating topography, but is uniformly well drained.

This type has all been cleared and put into cultivation, principally to cotton and corn. It is a strong soil well suited to corn, oats, and grasses, and elsewhere has been successfully seeded to alfalfa after being limed and inoculated. It is farmed in conjunction with the Wickham fine sandy loam and has about the same selling price. It is usually fertilized at a rate of 200 to 400 pounds of a 9–3–3 fertilizer. Cotton is badly infested with the boll weevil and yields are low, ranging from one-tenth to one-fourth bale per acre. Corn yields 20 to 40 bushels per acre.

Since this soil is particularly suited to grasses and corn, it should be reserved for these crops, as they will be much more profitable under present conditions, because cotton on this type is late maturing and suffers very much from boll weevils.

ROANOKE SILT LOAM

The surface soil of the Roanoke silt loam, 4 to 6 inches deep, is a gray heavy silt loam with slight brown mottlings, underlain by a mottled light-gray and yellowish-brown, tough, plastic clay subsoil extending to a depth of several feet. In places it contains some red mottlings, resembling the Leaf silt loam.

The type occupies poorly drained areas on the Chattahoochee River terraces. It has a small total extent, occurring in two main areas, one along Werocoda Creek at the southeast edge of Columbus and the other an irregular area near the confluence of Upatoie Creek and Chattahoochee River. Practically none of this type is in cultivation, a few fields being in grass and pasture, but the larger part remaining in forest consisting of bay, magnolia, hickory, several varieties of oaks, hawthorn, and a few pine.

This type of soil could be brought under cultivation only at considerable expense, and owing to its tough plastic subsoil, low fertility, and intractable nature, it can be more profitably devoted to grasses, which consist of Bermuda, Johnson and some carpet grass. It is best suited for pasturage or forestry.

KALMIA SAND

The Kalmia sand is the terrace equivalent of the Norfolk sand of the uplands. It is a light-gray sand to a depth of 6 to 8 inches, passing into a pale-yellow sand subsoil which is unchanged to depths of 3 to 6 feet or more. In depressions, on low ridges, and along drainage ways it loses much of the yellow color in the subsoil, and in places it is a light-gray to almost white sand which changes very little through the 3-foot section. Along the outer edge of the terraces and along drainage ways Augusta or Kalmia sandy loam is usually found outcropping. The inner portion of the terrace is in places partly of colluvial origin, representing material washed down from the adjacent sand hills.

The Kalmia sand has a flat to gently undulating or billowy topography. Its largest areas are in the southern and southeastern parts of the county along Upatoie Creek. Other important areas are located on Bull Creek between Schatulga and the mouth of Mill Branch. Small areas occur on Wolf Creek and Randall Creek. Drainage is excellent owing to the porous nature of the subsoil.

Most of this type lies within the military reservation and is not farmed at present. The areas along Bull Creek and Wolf Creek are about 75 per cent in use for crops and pasture, the balance remaining in long-leaf and loblolly pines, blackjack oak, plum bushes, and bamboo rice. Cotton and corn are the principal crops grown, but yields are low. Crop adaptations and methods of culture are similar to those on the Norfolk sand.

This type of soil is low in natural fertility and consists chiefly of quartz sand. In certain sections, with heavy fertilization, it produces good crops of melons, cantaloupes, sweet potatoes, and peanuts. It will not stand heavy cropping unless heavily fertilized or manured. It is well suited to early truck crops which need an early, warm soil, and to forestry.

KALMIA SANDY LOAM

The surface soil of the Kalmia sandy loam in virgin or old-field areas is a grayish-brown to light-brown loamy sand for 2 to 4 inches, where it grades into a pale-yellow loamy sand which extends to a depth of 14 to 18 inches. The subsoil to a depth of 40 to 60 inches is a yellow sandy clay of a friable, crummy structure. Below this is a mottled purplish-red, yellow, and whitish, very friable sandy clay, containing a few soft iron accretions. Where cultivated the upper layers of the loamy sand are mixed to a depth of about 6 inches, thus producing a light-gray to brownish-gray color.

The surface soil varies somewhat in texture, being in places a loamy fine sand or fine sandy loam. Several such areas are located near and east of Willett on both sides of Bull Creek. A few small areas along Bull Creek near Muscogee, and others widely scattered on the Upatoie Creek terraces, which have a brown or grayish-brown sandy surface and a yellowish-brown or slightly reddish-yellow sandy clay subsoil, really represent Cahaba sandy loam, but have been included with this type on account of their small extent. The subsoil in a few places is slightly mottled with gray and is rather compact.

The Kalmia sandy loam occurs principally on the terraces of Upatoie and Bull Creeks. About half of the type lies along Upatoie Creek and tributary streams within the military reservation and is not farmed. The largest development which is being farmed at present is in the vicinity of Willett, southeast of Columbus. About 90 per cent of the type has been cleared. The small areas of forest consist principally of gum, ash, elm, oak, and pine. The topography is level to undulating, with here and there slight elevations and depressions. As a whole the type is well drained, the subsoil structure being sufficiently open to permit the rapid percolation of excess water.

Corn and cotton are the most important crops, with yields of one-sixth to one-half bale of cotton and 15 to 30 bushels of corn per acre. Smaller areas are devoted to truck crops, melons, sweet potatoes, and oats. This is one of the best cotton soils in Muscogee County under boll-weevil conditions. On the lower terrace levels and slopes and in the rather moist depressions, hay yields three-fourths ton to 2 tons per acre. Hay grasses consist of Bermuda grass, lespedeza, some bur clover, and dallis grass (large water grass). A few fields of hairy vetch and one of kudzu were noted on this soil near Bull Creek. Cowpeas, peanuts, and velvet beans are grown chiefly for forage. Several small pecan and peach orchards are located on this soil.

Farm land on this type ranges in price from $50 to $60 an acre, although near Columbus, where it is becoming valuable for building purposes, it sells for much higher prices.

This soil is very similar to the Norfolk sandy loam in its crop adaptations. Its productiveness can be improved, the most important means being to increase the organic-matter content by growing more legumes and plowing under an occasional cover crop of oats, rye, or cowpeas. A fertilizer analyzing about 8–4–5 is considered best for this soil. The Kalmia sandy loam is well suited to truck crops requiring an early soil. Sweet potatoes, peanuts,

melons, and strawberries are grown commercially on this type in other sections, and it is also well suited to the growing of peaches, figs, and pecans.

CAHABA SAND

The surface soil of the Cahaba sand consists of a grayish-brown sand 4 to 6 inches deep, underlain by a brown or light-brown sand; this passes at 8 to 10 inches into a brownish-yellow or reddish-brown sand, which continues to a depth of 3 to 6 feet. In places it approaches the Kalmia sand in color of the upper portion of the soil section, and the characteristic red or brown color is lacking or found only at depths of 30 inches or more.

The type is not agriculturally important in Muscogee County, since most of it lies within the military reservation, and at present very little of it is farmed. All of it is cleared and a few acres are planted to cotton and corn. It is found only along Upatoie Creek, its largest development lying east of the confluence of Randall and Upatoie Creeks. It has a flat to gently undulating topography and is uniformly well drained.

This type is generally somewhat more productive than the Kalmia sand. In other localities it is devoted to cotton, melons, sugar cane, peanuts, sweet potatoes, and truck crops. It requires heavy applications of fertilizer and increase in the content of organic matter for successful crop production.

AUGUSTA SANDY LOAM

The surface soil of the Augusta sandy loam is a light-gray to yellowish-gray loamy sand, underlain by a pale-yellow heavy sandy loam which extends to a depth of 15 to 18 inches. The subsoil consists of a variegated yellow, light-gray, and reddish-brown, friable, crummy, sandy clay, which in places is highly micaceous. This type corresponds to the Hoffman sandy loam of the uplands in color and structure. Included areas have a heavy, rather sticky subsoil corresponding to the Leaf subsoil, such areas occurring in close proximity to the Susquehanna clay west of Esquiline and along Bull Creek west of the county farm. Along drainage ways and small flats or depressions small areas occur with gray surface soil and subsoil, the subsoil being rather heavy and compact, resembling the Roanoke and Myatt soils. Some included low ridges or mounds consist of Kalmia sandy loam. Numerous eroded spots or galls are found in which the subsoil is exposed.

The Augusta sandy loam occurs along most of the principal streams of the Coastal Plain section of Muscogee County. Its largest developments are on Bull Creek near Muscogee and southeast of Columbus; other areas lie along Randall and Upatoie Creeks in the southern and southeastern parts of the county. It also occurs on slopes of slight depressions or drainage ways within bodies of other terrace soils or outcropping along the outer edge of the terraces.

The topography is undulating to nearly level. The drainage is fair over most of the type, but is somewhat deficient in depressions. On some of the flats and at the base of slopes there are seepy or springy spots.

About 85 per cent of the type is cleared land, the greater part of which is in cultivation or used for the production of hay. The forest growth consists of pine, gum, water oak, and hawthorn. Cotton, corn, and oats are the principal crops. Cotton yields about one-sixth bale and corn 15 to 25 bushels per acre. Cowpeas and velvet beans are grown for forage, and oats are cut for hay. Several dairies are located on this type of soil. The pasture and hay grasses consist of Bermuda grass, lespedeza, carpet grass, and dallis grass (large water grass).

This soil ranges in price from $50 to $60 an acre, depending on the location and improvements.

Improved drainage through surface ditches or underdrainage, the increasing of the organic-matter content of the soil through wider use of cowpeas and other legumes, and the plowing under of an occasional cover crop, would result in larger yields.

CONGAREE FINE SANDY LOAM

The Congaree fine sandy loam is a light-brown loamy sand, about 10 to 12 inches deep, underlain by a light-brown silty clay loam subsoil, usually highly micaceous. It is variable in texture, ranging from a sand or fine sand on the slightly higher parts near the river to a silt loam in the lower parts next to the terraces or uplands, and includes some small areas of very fine sandy loam. A few areas of loose sand, similar to material mapped as Riverwash in other areas, are also included. This type is a river-bottom soil subject to periodical overflow. It occurs only on the western edge of the county along the Chattahoochee River and is not extensive. The larger part of it is north of Columbus.

About 50 per cent of the Congaree fine sandy loam is farmed, the balance being used for pasture or covered by a forest growth of willow, ash, gum, soft maple, sycamore, cottonwood, and tulip poplar. Corn is the principal crop and yields 20 to 30 bushels per acre on the more uniform areas of the type. Some hay of mixed Bermuda, Johnson, carpet, and wild swamp grasses is cut. Sugar cane is grown in a few fields. In the rough and broken northwest section of the county this is an important soil because the hills are of little value for cultivated crops. No fertilizer is used on this type. As it occurs in small areas it is sold only in connection with areas of other soils, but where sold with the Congaree silt loam it brings $50 to $75 an acre.

CONGAREE SILT LOAM

The Congaree silt loam is a brown mellow silt loam, 18 to 20 inches deep, underlain by a brown or light-brown heavy silt loam or silty clay loam extending to a depth of several feet. Much of it has a fairly deep soil and in places there is not much variation throughout the 3-foot section. The soil varies considerably in texture; on low hummocks or ridges it often consists of a heavy fine sandy loam, while in depressions or swales where the backwater from the river stands for a period after overflows, it consists of silty clay loam. The subsoil varies somewhat in texture. In places, particularly along old stream channels, pockets of sand are present at varying depths. In the sags, where drainage is not perfect, some

slight mottlings of grayish brown are found at 20 to 40 inches. New depositions of silt are added to this soil with each overflow, sometimes as much as one-fourth to one-half inch of rich alluvium being left on this land as the waters recede. All of the type is more or less micaceous.

The Congaree silt loam is mapped chiefly in one large body about 5 miles south of Columbus along the Chattahoochee River. A few small detached areas are found farther up the river, near the Harris County line, at the back edge of fine sandy loam bottoms. The topography is flat, with slight undulations and a slight dip away from the river. Drainage is naturally good except in the depressions or sloughs.

Practically all of this type is farmed except narrow strips along the bank of the river, which have been allowed to remain in willow, cottonwood, sycamore, gum, and oaks. A few of the sloughs support a dense growth of cane and bamboo vine.

Corn and hay are the chief crops. Oats have a tendency to grow rank and lodge, but produce excellent forage if cut for hay. This type of soil is very well adapted to corn and yields of 30 to 50 bushels per acre without fertilizers are reported. Johnson grass and Bermuda grass produce a heavy tonnage of hay. The Johnson grass can be cut four or five times during the season and yields 3 to 4 tons per acre. If cut before it becomes too mature and coarse, and cured in piles or under cover, it makes a bright palatable hay. Johnson grass hay that contains much of the mature seed is discriminated against by buyers to the extent of $3 to $5 a ton. No fertilizers are used or needed. Land of this type sells for $75 to $100 an acre.

If protected from overflow this soil would probably give good returns of alfalfa.

OCHLOCKONEE SILT LOAM

The Ochlockonee silt loam consists of a brown silt loam surface soil, 10 to 12 inches deep, underlain by a mottled brownish-yellow and light-gray silty clay loam subsoil containing some dark-brown or black, soft concretions. It includes small areas of the sandy loam, particularly along the stream banks and in low mounds or strips, while in the low areas some silty clay loam is developed. This soil is subject to frequent overflow in the winter and spring, and receives new deposits of alluvium. It is influenced somewhat in places by wash from Piedmont upland soils, but for the most part is derived from the local upland soils of the Norfolk, Ruston, and Hoffman series.

This type occupies flat or nearly level stream bottoms which have a slight dip away from the stream. Drainage is usually only fairly well developed, and wet spots or sloughs are found particularly at the back edges of the bottoms away from the main channels. It occurs in several areas in the Upatoie Creek bottoms southeast of Upatoie, on Randall Creek southeast of Commonwealth, along Bull Creek east and southwest of Schatulga, and in several smaller areas farther downstream. Where this soil is extensively developed it is of considerable agricultural importance, particularly where the adjacent uplands are eroded or badly washed and of low agricultural value.

About 75 per cent of it is used for corn and grass and a few small fields of cotton. The balance is forested with the typical bottom-land growth, including short-leaf pine, sweet gum, black gum, swamp maple, sycamore, cottonwood, hickory, dogwood, persimmon, willow, hawthorn, magnolia, and a dense growth of alder, ferns, and cane in the lower places.

The Ochlockonee silt loam is best suited for corn, grass, and cane. Cotton produces a too heavy growth of stalk and leaves and is severely affected by the boll weevil. Corn yields 20 to 40 bushels per acre. The grass consists of Bermuda grass, some carpet grass, and lespedeza, much of it being cut for hay and the balance being devoted to pasture. No fertilizers are applied on the Ochlockonee silt loam, since overflows from time to time enrich the soil with depositions of alluvium. This soil is sold only in connection with the adjacent uplands, which range in price from $20 to $50 an acre. It furnishes excellent pasture for cattle.

MEADOW

Meadow includes material in the stream bottoms which is so varied in texture that it can not be separated into soil types. It varies considerably in color, ranging from brown to dark gray, and includes some swampy patches that are heavy textured. It occurs as narrow strips along the banks of the larger streams and in places occupies the entire bottom land. It is subject to frequent overflows which leave additional depositions of material washed from the uplands. The streams along which Meadow is developed rise either in the Piedmont or Coastal Plains sections, and although the materials from these sources are distinctly different, they are so lacking in uniformity and of such little agricultural value that separation would serve no practical purpose.

Meadow supports a growth of broom sedge, Bermuda grass, lespedeza, and cane, which afford fairly good pasturage for cattle; and in forested areas acorns and nuts furnish abundant mast for hogs. Practically none of it is cultivated. Forested areas support a growth of trees and bushes commonly found on the bottom soils of the region.

Along Lindsey and Cooper Creeks there are a few spots of grayish-brown sandy loam which are really Ochlockonee sandy loam, but owing to small extent they were included with Meadow. Such areas are used for the production of corn, oats, and grasses, chiefly Bermuda grass and lespedeza.

All of the Meadow should be used for summer pasturage or kept in forest.

SUMMARY

Muscogee County is situated on the western edge of the State, at the head of navigation on the Chattahoochee River. It has an area of 223 square miles, of which 44 square miles are included in the military reservation.

The topography of the county ranges from smooth and gently rolling to steep and broken. The smoother areas are on the ridge crests and on the river and creek terraces. The streams flow in a general southerly direction following the general slope from the

Piedmont. The range in elevation is from over 650 feet above sea level near Fortson, to about 180 feet at the point where Upatoie Creek empties into the river. The county as a whole is well drained, the only exceptions being along some of the stream bottoms, on a few of the terraces, and in scattered depressed areas in the uplands. The entire county is drained into the Chattahoochee River.

The population of the county in 1920 was 44,195. Columbus, the largest town and county seat, is an important cotton and iron manufacturing center and railroad point with a population of 31,125 in 1920.

Railroad facilities are excellent in all directions and all of the main county roads are improved. A steamboat line plies the Chattahoochee River between Columbus and Appalachicola, Fla. Columbus and Camp Benning afford excellent markets for surplus farm produce, meats, and fruits.

The average annual temperature in Muscogee County is 65.2° F., the summer average being 80.8° , and the winter average 47.7°. The average annual rainfall is 49 inches, 15 inches falling during the summer months. Snow is rare, and periods of freezing weather are short. The average length of the growing season is about eight months.

Settlement in Muscogee County began early in the nineteenth century and the county was established in 1826. The growing of corn and other subsistence crops engaged the attention of the early settlers, but cotton was soon introduced and became the most important crop, and subsistence crops were brought in from the West. At the present time cotton is the leading cash crop, but trucking and dairying have largely supplanted it in the vicinity of Columbus. With the exception of those engaged in dairying, the farmers of Muscogee County are now producing sufficient feed for their needs. Corn, oats, sweet potatoes, peanuts, melons, garden vegetables, cowpeas, and velvet beans are the principal crops grown at present. Poultry raising is a profitable side line on a number of farms.

No definite crop rotation is practiced in the county. The use of fertilizer is general, and most of the farmers prefer home-mixed goods. The mixtures commonly used are 9–3–3 in the Piedmont and 8–4–5 for the sandy lands in the Coastal Plains.

Most of the farm work is done by the farmer and his family. There were 817 farms in the county in 1920, averaging 84.2 acres each, of which 48.7 acres were improved. Tenants operate 72.5 per cent of the farms. The price of farm land ranges from $10 to $100 an acre, the average being between $40 and $50.

Muscogee County is located on the fall line. One-third of it lies within the borders of the Piedmont Plateau and the rest lies in the Coastal Plain. The first bottoms and terraces contain alluvial soils consisting of materials from both provinces.

The soils of Muscogee County are separated into 16 soil series, which are represented by 22 types and 3 phases, in addition to Meadow. The Cecil and Appling soils in the Piedmont, the Norfolk and Ruston in the Coastal Plain, the Kalmia and Wickham on the terraces, and the Ochlockonee and Congaree in the bottoms are the principal agricultural soils of the county.

In the Piedmont Plateau the Wilkes sandy loam includes the extensive broken areas which have a grayish-brown to yellow

surface soil and a mottled yellow and gray, tough sticky clay subsoil.

The Davidson series includes the dark reddish-brown soils with dark-red, smooth, moderately stiff clay subsoil. The Davidson clay loam is considered the strongest soil in the Piedmont and is highly prized for all crops.

The Cecil sandy loam is an excellent soil for cotton and corn. The Cecil sandy clay loam is better adapted to corn, oats, and grass.

The Appling sandy loam is less productive than the Cecil or Davidson soils.

The Norfolk sandy loam, together with the deep phase, is the most extensively farmed soil in Muscogee County. It is adapted to cotton, vegetables, melons, fruit, and peanuts. The Norfolk sand is adapted to the same crops but is less productive.

The Ruston sandy loam and sand are similar in crop adaptation to the Norfolk soils, although they have a rougher topography, and a smaller proportion is farmed.

The Greenville clay loam is not extensive but is recognized as the strongest and most productive of the upland Coastal Plain soils and is practically all farmed.

The Hoffman sandy loam occupies the slopes and hillsides in the Coastal Plain portion of the county and only a small part of it is cultivated. The Susquehanna clay is of small extent, occurring only on steep slopes, and none of it is cultivated.

The Wickham fine sandy loam and clay loam occur on the Chattahoochee River terraces and consist of materials transported from the Piedmont uplands. These soils are well drained and are devoted chiefly to corn and cotton. The Roanoke silt loam is a poorly drained terrace soil, developed in close association with the Wickham soils. It is devoted to pasture and forestry.

The Kalmia sandy loam and sand are terrace equivalents of the corresponding types of the Norfolk series, and have much the same crop adaptations and yields. Near Columbus these soils are used to some extent for vegetables and melons. The Cahaba sand is found on terraces of streams flowing through the Coastal Plain and has the same adaptations as the Kalmia sand, but at present little of it is farmed. The Augusta sandy loam is the terrace equivalent of the Hoffman sandy loam in the uplands. It is less productive than the Kalmia and Wickham soils.

The Congaree fine sandy loam and silt loam are devoted principally to corn and hay. They are composed of Piedmont material transported and deposited by the Chattahoochee River.

The Ochlockonee silt loam is developed along streams rising in or flowing through the Coastal Plain. These soils are used chiefly for corn, cotton, oats, and grass.

Meadow includes miscellaneous material along stream courses of such varied texture that it could not be separated into types. It is generally poorly drained and very little of it is in cultivation.

In general the soils of Muscogee County are deficient in organic matter. This can be supplied by turning under green-manuring crops, such as oats, rye, vetch, cowpeas, or clover. Applications of lime would be beneficial in most cases.

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