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THE SOILS AND AGRICULTURE OF THE SOUTHERN STATES

BY

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PREFACE

The writer trusts this volume will be looked upon as Volume I in a series of books which it is hoped will be written to cover the soils of all sections of the United States and their relation to agriculture. At the present time much attention is being directed toward the Southern States on account of extensive areas of unused potential agricultural lands to be found there, and for this and for other reasons, particularly because of the need for more definite knowledge of the soils of the country, it is considered appropriate to present this volume at this time. The material has been prepared, it is believed, in a way that will make it useful not only to students, instructors and investigators in agricultural economics, but also to farmers and others interested in lands and farming.

It was the original intention to limit the area discussed in this volume to the region known as the Cotton Belt. As the work progressed, a number of reasons occurred for increasing the size of the territory included.

The soils of the Cotton Belt do not stop at the northern limit of cotton production, but they extend far north of that line. The type of agriculture practiced in the Cotton Belt grades into that practiced in the region to the north without any sharp regional division line. The eastern tobacco belt extends far down into the Cotton Belt, corn is grown through almost the whole of the Belt, as well as in the region to the north, and other staple crops of the more northerly regions are, also, staple crops in many parts of the South.

It was then decided to extend the area to the southern boundary of the region of glaciated soils. Again objections arose. Following this line the writer found himself all the way across central Pennsylvania into southern New York, and considering this too far removed from the original purpose of writing about the South, a compromise was made by fixing upon the northern line of Delaware, Maryland, West Virginia, Kentucky, Missouri, and Kansas as an arbitrary dividing line suitable to the purposes of this book.

It is hoped, also, that the farm methods referred to here will not be interpreted as representing fixed or final methods. It should be understood that methods of tillage, fertilizer usage, crop rotations, and so on, are constantly being improved upon—that from time to time old methods are abandoned and new or better ones adopted in their place, and that improved farm equipment, new crops and crop varieties may be expected to add still further to the efficiency of agriculture.

Making better use of the soils by using them more in accordance with their adaptations and requirements, a point too frequently overlooked or neglected in the agriculture of the past, both by practical farmers and by scientific agriculturists, is a means of improving agricultural efficiency which this volume attempts to emphasize and undertakes to encourage. Increased soil efficiency through a better understanding of the soils of the country—a better acquaintance with the geographic distribution of the soils, their physical and chemical properties, their drainage and topographic features, capabilities and limitations of crop production, and individual responsiveness to varied manurial, tillage and crop-rotation practices, as a means of marking the way toward a more intelligent and scientific use of them—is a field of large opportunity. In this field we may expect to have a new and important branch of professional engineering: soil engineering.

H. H. BENNETT.

Washington, D. C.,
December, 1920.

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SOILS AND AGRICULTURE OF THE SOUTHERN STATES

INTRODUCTION

It is the purpose of this volume to describe the important agricultural lands of the Southern States; to tell, in so far as space and the information at hand permit, what the soils are, where they occur, what crops they are used for, what crops they may be used for, what methods of soil treatment are employed on them, and what methods are essential to their most efficient use.

The more obvious characteristics of the different soils and the distribution of the more important types of soil are emphasized. It is believed that this will place the most important information within the reach of the farmer, the land buyer, the appraiser of farm land, the agricultural experimenter, and the general student of soils. Brief explanations only are given of the methods of gathering and classifying the data upon which the material presented here is based, and there is little discussion either of the complex problems of chemical changes that take place in soils, or of the more intricate problems and theories connected with soil fertility and infertility.

In the preparation of this material it has been the intention to avoid technical treatment in so far as has seemed compatible with a clear presentation of the subject matter, in order that it may be useful to the farmer and general reader as well as to the student and technical agriculturist.[1]

[1] Essential facts are often lost in attempts to present scientific data in what is sometimes called a "readable" or "popular" style. In all

At the same time a systematic plan has been adhered to, since any general or disconnected treatment which fails to bring out the relation of one group of soils to another, or the relation existing between soils and the broad physiographic regions, climatic zones, and agricultural districts of the country, can but lead to fragmentary and confused ideas of the subject.

The reader is referred to the bulletins of the Bureau of Soils and to those of the experiment stations, and to the many volumes that treat of soil physics and chemistry, for more detailed information relating to the physics, chemistry, and origin of soils. The publication of the Bureau of Soils—*Instruction to Field Parties*—gives the details of classifying and mapping soils.

The soil map accompanying this volume is a general soil map; it shows the main distribution, by regional divisions, of the principal agricultural lands. For more detailed soil maps and soil descriptions the maps and reports published by the Bureau of Soils and by the States should be consulted.

The writing of this volume was made possible through the results of investigations made by the Bureau of Soils

sciences technical terms are necessarily employed, and if other supposedly simpler terms are too freely substituted for these technical terms with their exact shades of meaning for the sake of avoiding so-called "dry scientific discussion," there is a danger of something being lost or obscured in the matter produced. Also, facts are frequently obscured or are not given in attempts to simplify by abridgment—the "least essentials" are left out and facts are overlooked in order to avoid repetition until only a skeleton of ideas is left and lucidity is lost in the quest of simplicity.

In discussing the large number of soils treated in this volume it has been found impossible to avoid a degree of sameness in the style of treatment. No attempt has been made to relieve the monotony by leaving out that which has been considered most important. Some space has been saved by briefer discussions of well-known farm methods, of the soils of lesser importance and of those that are not greatly different from related soils which have been given fuller treatment.

and information gathered by the author during a long period of service in this bureau, making detailed soil surveys and inspecting and supervising soil work in the field over a large part of the United States, and in carrying on soil and agricultural investigations outside the United States.

The plan of treatment followed is somewhat similar to that of a farmer who describes his farm as being made up of "wet clay bottoms, well-drained sandy loam second bottoms, hill slate land, red sandstone upland," etc. Agriculture and soils are discussed in their natural close relationships. The large natural soil divisions, whether determined by the character of the underlying rocks, the topography, or the climate, or all of these, are treated as subdivisions, the generalized soil map and the text showing the relation of these divisions and their included soils to each other.

There has been a general tendency to overlook differences in soils—to pass unnoticed soil features, which often have been found to have important bearing upon crop adaptations, tillage or manurial requirements, and the conservation of soil productivity. It has been assumed too often that all that it is necessary to consider in connection with soils is whether the land consists of "sandy land," "clay land," sandy loam, loam, or clay. The results of many experiments carried out upon a particular kind of clay, or sandy loam or other soil, frequently have been sent abroad among farmers cultivating clay, sandy loam, and other types of soil of many different kinds, on the assumption either that such soil differences are of no importance or that the advice given will at least apply to the soils of some farms. This may be well enough for the farmer who has land which is the same or similar to that on which the experiments were made, but it may entail an actual loss to the farmer who does not have such land, although his may be of the same texture. Suppose, for example, that a bulletin advising the use of potash for cotton and corn be sent to a farmer in the Piedmont region who is farming "red granite land" (Cecil soils), the bulletin may fail to state that other experiments and the experience of many good farmers indicate that potash is not required for either cotton or corn on these soils, since they are derived from rocks containing much potash and themselves contain sufficient potash. Yet upon the same farm there may be present "blackjack lands" (Iredell Soils), derived from diorite rock, on which potash has been found beneficial in preventing or minimizing the harmful effects of "frenching" and "rusting" of corn and cotton. Thus, the farmer on the diorite or Iredell soil may record a gain from the use of potash, as advised, while the one on the granite land may expect no benefit or a loss.

Why not carry such advice to the farmers in a scientific way—tell them what soil the advice may be expected to fit? Until soil peculiarities are considered, mistakes will continue to be made—the scientific agriculturist dealing with soils and crops cannot coöperate or advise with farmers to best advantage, for these soil problems will stand between them as a weak link in the chain or as an unbridged gap; and farmers often will not be able to adopt intelligently the successful methods of neighboring farms or those of other localities. In other words, the relationship existing between soils and crops and between soils and farm methods must be understood or there will continue to be misdirected effort in our agricultural practice through hit-or-miss, unscientific methods of dealing with the soil.

The materials from which soils are derived and the processes by which they have been formed from these parent materials are briefly treated in the chapters covering the soil provinces or regions. In describing the soil types,—that is, the individual soils—in the following chapters, the chief physical feature noted is the texture of the soil; that is, the relative abundance of sand, clay, and silt contained. Such other physical features as affect the agricultural value of the soil, notably the compactness of soil and subsoil, the friability or plasticity, are also brought out, since they have an important bearing upon the absorption, retention, and distribution of the moisture upon which the different crops depend, upon the erosion of fields in all sloping or hilly sections, and upon the preparation and tillage of soils. These latter factors in the physical conditions of soils are commonly grouped under the term, soil structure.

The most important physical feature of a soil is usually represented in its texture, its content of the various sizes of soil particles, as sand, clay, and silt. A number of soil classes have been established to designate the various textural grades of land (see Appendix A), following as closely as possible the usage of farmers. These classes have been given names according to the content of the several sizes of soil particles as determined by mechanical analysis. It has been found impractical to follow local usage in all cases in naming the various grades of land because local usage varies. In a section where the soils are predominantly clay, for example, a small content of sand in a soil is often sufficient for a fairly heavy soil to be wrongly designated as "sand." Similarly a silt loam is often incorrectly called "sandy loam" or even "clay."

According to the methods employed by the Bureau of Soils, the different kinds of soils found are given locality names—the names of towns, counties, or streams where the soils are first recognised and mapped, just as is done in the naming of geological formations. Thus, the Orangeburg soils were first mapped in Orangeburg County, South Carolina, the Amarillo soils were first mapped at Amarillo, Texas, the Congaree soils were first mapped along the Congaree River in South Carolina, and so on.

Those soils which have the same or similar origin, the same range of color in the soil and subsoil, the same range of structure in the subsoil, the same range in content of lime or magnesium carbonate or alkali salts, and which exist under similar conditions of topography and drainage are grouped in series. A soil series may include the whole range of textural classes—that is, sand, coarse sand, fine sand, very fine sand, loam, sandy loam, course sandy loam, fine sandy loam, very fine sandy loam, silt loam, clay, clay loam, silty clay loam, sandy clay loam, etc. In addition there are stony loams, stony sandy loams, shale loams, slate loams, etc. The class name is fixed by the texture of the surface material to the depth that may be affected by plowing, a depth of about 6 to 10 inches. Frequently there is a range of material within this depth; for example, the surface inch or so may be a sandy loam and the subsurface a heavy clay loam. Under these conditions the soil is named according to the texture of the material that will be produced by mixing the surface and subsurface layers by plowing. The shallower surface layer of sand, in the case referred to, when mixed with the heavy clay loam of the subsurface layer will produce a sandy clay loam or sandy loam.

To explain further what is meant by the soil groups or series, a few illustrations are given. In the Coastal Plain region three very extensive groups of soils are often found in close proximity: the Orangeburg, Norfolk, and Susquehanna soils. All of them are derived from unconsolidated sedimentary deposits of the Coastal Plain strata. The Orangeburg soils are gray to light brown in the surface and red in the subsoil, the subsoil is very friable and favorable to the movement of moisture, the drainage is very good, and the surface ranges from flat to rolling. There have been mapped, of this series, the Orangeburg coarse sand, the Orangeburg sand, the Orangeburg fine sand, the Orangeburg sandy loam, the Orangeburg fine sandy loam, and the Orangeburg gravelly sandy loam. These are all very easily tilled. The sands are excessively drained, but the sandy loams are retentive of moisture and produce well with moderate fertilization. The Norfolk soils are likewise gray to light brown in the surface; they are friable in both soil and subsoil, are well drained, and range from flat to rolling, but they are yellow in the subsoil. They are easily tilled, but with the same fertilizer treatment are not considered quite so productive as the Orangeburg soils. The principal types included in this group are the same types as those of the Orangeburg group. The surface material of the Susquehanna soils ranges from grayish or light brownish in case of the sandy and silty types to reddish in case of the clay loam and clay types; the subsoil is red, with mottlings of gray and yellow, and instead of a friable sandy clay subsoil like that of the Norfolk or Orangeburg, through which water and air move readily, the series has a dense, heavy, clay subsoil through which water and air move very slowly. The flat areas are poorly drained; the rolling areas have good surface drainage, but the unabsorptive clay subsoil causes serious washing of the looser surface material. The deeper sandy types are easily cultivated, but the clay loam and clay require heavy teams and implements, and they dry out to an intractible, hardened condition.

In the Appalachian Mountains are found soils which resemble the Orangeburg and Norfolk soils of the Coastal Plain: the Hanceville and Dekalb, respectively. But these exist under dissimilar climatic conditions, they are derived from consolidated material, as sandstone and shale, and the subsoils of the important types are more compact than the subsoils of the corresponding types of the Norfolk and Orangeburg. In southern Texas there are soils which also closely resemble the Orangeburg (Duvall soils); but in this region of lower rainfall there has been less leaching out of the water-soluble salts than in the humid region where the Orangeburg occurs; consequently these Duvall soils are distinctive in that they have a much higher water-soluble salt content. In addition they exist under different climatic conditions.

To sum up, then: Those soils possessing distinctive physical or chemical properties, topographic or drainage features that influence crop yield, crop adaptation, or the necessary cultural, drainage, or manurial treatment, are classified and mapped as separate and distinct soils.[1] Also,

[1] The following quotations relate to *land utilization* (*The American Economic Review*, vol. viii, No. 1, supplement, March, 1918, pp. 110-111):

"To classify soil as glacial soil or alluvial soil or pine land or grassland soil is of some value where no other data are available, but it tells us very little of the soil itself; while to classify it according to texture, color, profile, structure, chemical composition and reactions, and physical characteristics is classifying it on the basis of its own characteristics; and each fact is a soil fact and is of value in a final and fundamental characterization of the soil."

This soil survey work "consists of soil definition, identification and location, and the grouping of the soil units according to their characteristics. This is a classification of the fundamental features of the land. No final land classification is possible without this soil classification. It is the one factor that heretofore has been left out of consideration because it was not available. With a knowledge of the soil, topography, and climate we shall be in possession of the three fundamental factors that are necessary.

"The climate is already rather well known. The topography also in general terms and the details are being accumulated. The soil data, both general and detailed, were the last of the three to claim recognition, but they are now in process of accumulation."

". . . the soils of any area that has been covered (by soil surveys) can be grouped according to several characteristics: according to drainage, degree of oxidation and æration, presence or absence of hardpan, texture, intractability, productiveness, chemical characteristics, physical features, topography."

"Classification of the land, however, is not the final solution of the problem. . . . It expresses the result of the accumulation of the fundathose of widely different origin are mapped separately, even where they are of close resemblance, on the ground that they may have important properties which are not revealed in the ordinary tests applied to the classification of soils. It happens that usually some obvious soil distinction decides the question, but this does not hold in all cases. A notable example of soils of different origin having close resemblance but different values is that of the brown stream-bottom soils of the Appalachian Mountains and Limestone regions—the Huntington and Pope soils. The Huntington silt loam composed of first-bottom alluvium washed entirely from limestone soils or partly from limestone soils and partly from shale and sandstone soils is a duplicate in its apparent physical properties and drainage of the Pope silt loam, a first-bottom alluvial soil composed entirely of material washed from shale and sandstone soils; yet the former is more productuve than the latter. This is a case where productiveness points to the advisability of giving consideration to the source of material in deciding the correlation of soils.

The system of soil classification upon which the material in this volume is based is a simple one. It is a system which recognizes such soil differences as a farmer notices on his farm, and, in addition, other differences that he often does not notice, such as the character of the subsoil or deep substratum and its relation to such things as drainage. The farmer may know the soils of his own farm and yet have but vague knowledge regarding those of his neighbor's

mental information on which the work of the next phase must be based. The latter consists of the determination of the adaptabilities and capacities of the several kinds of land that have been defined, identified, and located. This must be done either by experiments carried on for the purpose on each kind of land, or by a determination and interpretation of the results of the unconscious experiments that farmers have made in their more or less blind efforts to adapt themselves to their natural environment."

farm, or those of the next township, or county; and this lack of knowledge may be the cause of his failing with certain crops or methods which have proved successful on other farms including other soils. The soil map, which is included, undertakes to help him in this—to show him wherein his acres are like or unlike those of his neighbor or of the next township or county or state.

All soil maps are not perfect—not all of them show every detail of soil difference. The degree of accuracy will depend much upon the scale used and the accuracy of the map maker himself. Less detail can be shown on maps of small scale than on maps of large scale. The scale commonly used on county soil maps, one inch to the mile, frequently does not permit the showing of the smaller patches of soil, even though these may have distinct characteristics unlike those of the predominant surrounding soil. Under ordinary conditions of soil occurrence this scale does permit the mapping of the important soil areas.

Again, sharp boundaries between soils by no means exist in all cases. Soils grade into each other so that the map maker often can show approximate boundaries only.

It would be difficult also to map accurately all chemical variations of the soil, not only for the reason that small soil areas not mapable on the scale used are likely to show differences in chemical composition, but also for the reason that chemical differences may be expected in the same kind of soil as a result of the varied past treatment and use to which different portions of the same soil may have been put.

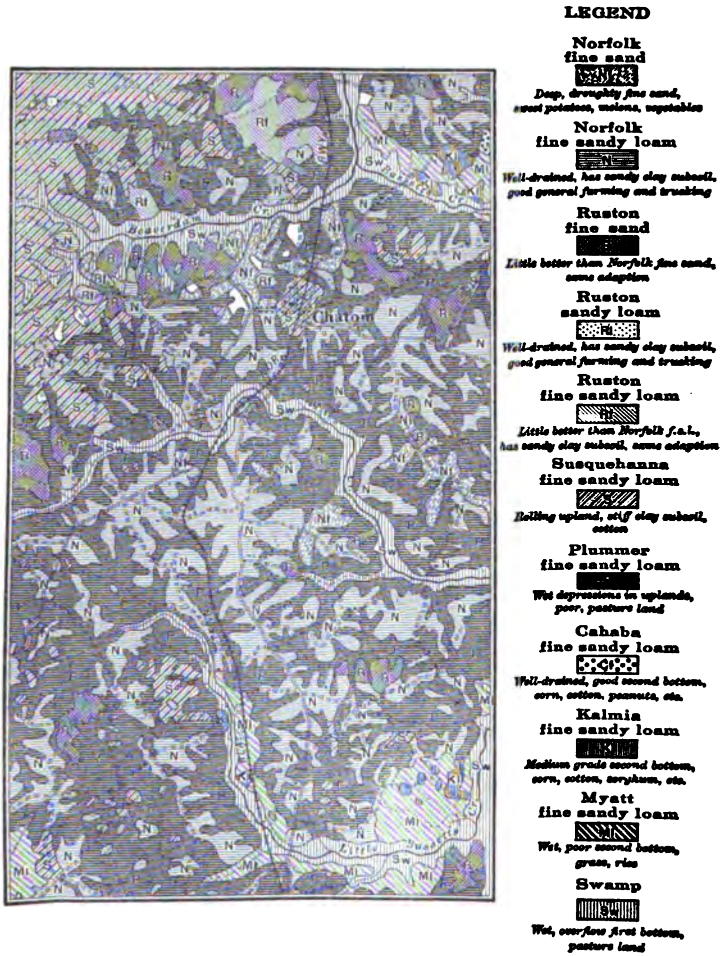
Many soil maps thus show only the average or predominant soil conditions. The report that accompanies the map should state what inclusions or variations one may expect to find when using the map in the field, under the descriptions of the several kinds of soil shown on the map.

In so far as the method of classification goes, it seems necessary only to follow some simple scheme which will show what the soil is from place to place—whether it is sand or clay, well drained or poorly drained, black or red, limestone soil or sandstone soil, and so on. This is precisely what the soil maps referred to in this volume attempt to show. The detail, of course, can be carried further. Large-scale maps can be made which will show every slight soil difference—even minor variations in the depth of the soil. Maps showing chemical composition from place to place can also be made, and even those that would show temporary bacteriological conditions. But it seems not a poor idea to ascertain first the more obvious characteristics and the main distribution of the principal kinds of farm lands. The more detailed maps can be made at the place and time they are needed.

Map 1 is a small section of the Washington County, Ala., detailed soil map, on a reduced scale. It is reproduced from a colored map, and is given as an illustration of how soil maps are made.

The agricultural data in this volume are based upon many sources of information. These include farm management and other investigations of the various Bureas of the U. S. Department of Agriculture; the work of experiment stations, and of specialists in varied lines of agricultural investigation; statistical data of the Census, the Bureau of Crop Estimates, State and other organizations; the work of the soil scientist who closely observes crops growing on different soils in many localities and who gets from the farmers their experience in handling the different soils and their estimates of yields.[1]

[1] Information obtained from farmers by soil men, who know how to correlate the varying results of farm practices, by a proper interpretation of the influences of the soil, is extremely valuable. There has been a tendency among some investigators along agricultural lines to minimize the value of farm information not based upon measured plats or



Map 1. A section of a detailed soil map, Washington County, Alabama. The detailed soil maps published by the Bureau of Soils are made on the scale of one inch to the mile; they show the soil areas in different colors. The solid double lines represent public roads; the broken double lines, second-class roads. Solid curved lines are permanent streams; broken curved lines are streams that flow intermittently; small square blocks show the location of residences. Section lines are left off in this map. Scale of this map—1 inch = 1.63 miles.

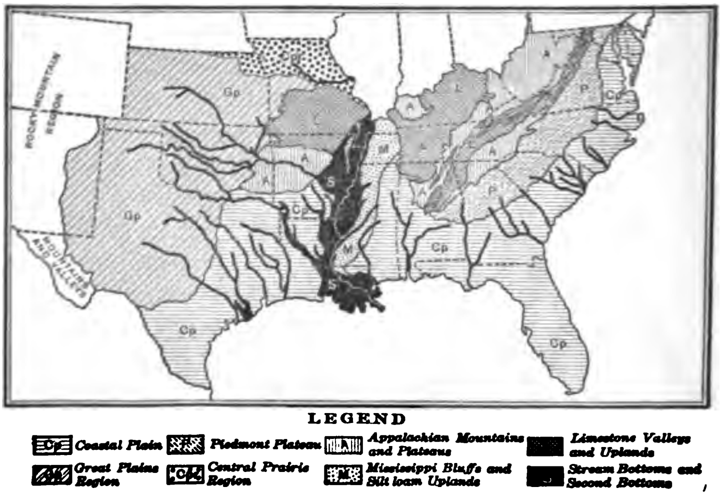
Results of cultural, fertilizer and other tests have been referred to when they have seemed particularly applicable. Space has permitted reference to a few of these only. The list of publications in Appendix C is intended to be suggestive rather than complete. It is simply a list from which helpful additional information may be secured. There is a vast amount of valuable data in the long list of bulletins published by the Government and by the State Agricultural Experiment Stations and Agricultural colleges, and in many standard books on agricultural subjects. The chemical analyses given in Appendix B represent but a small number of the analyses that have been made by the Government and the States.

The soil provinces or regions embraced in the States included in this publication are (see map 2): (1) the Atlantic and Gulf Coastal Plain, (2) the Piedmont Plateau, (3) the

the tabulated answers of a large number of farmers to questionnaires, regardless of the fact that the variations in the soils from one farm to another or from one field to another have not always been taken into consideration. These measured results are valuable—the more so when all modifying factors are duly considered. But the results of farm practices cannot be safely ignored or looked upon as valueless empirical information, particularly when the varying factors of soil, climate, etc., have been taken into account. The fact must not be lost sight of that the farmers themselves have been great experimenters in the field of agriculture. They were producing a large number of crops successfully in America before the scientific agriculturist became very active. Even in recent years it is not always the scientist who brings about large agricultural innovations. It was the experimental activities of farmers, not of technical agriculturists, that introduced rice production in the Louisiana and Arkansas prairies and the culture of bright tobacco into South Carolina and Spanish peanuts into the cornfields of Georgia.

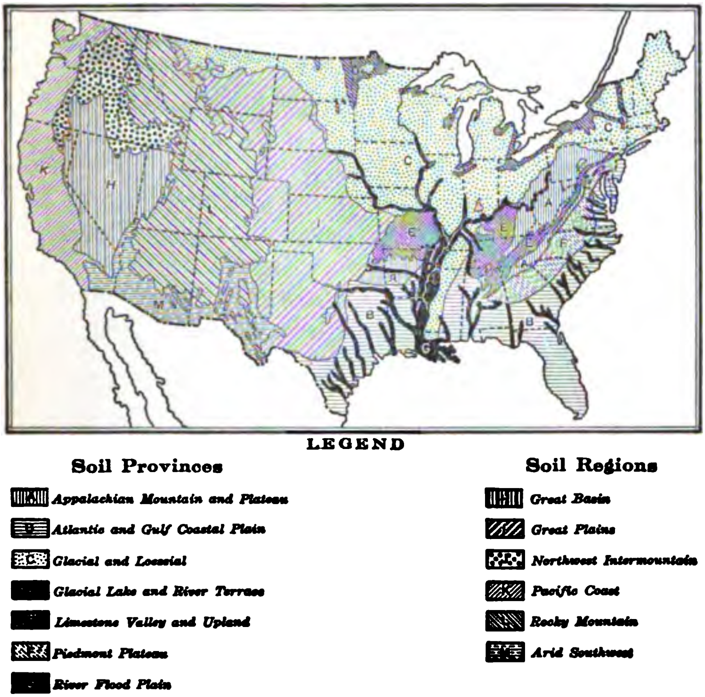
It is not meant by this to minimize the very great importance of the work of scientific agriculturists—the tremendous value of experimental work, the dissemination of new agricultural knowledge, the introduction of new economic plants, etc.; but simply to point to the value of experimental work accomplished by the farmers themselves, whether consciously or accidentally.

Appalachian Mountains and Plateaus, (4) the Limestone Valleys and Uplands, (5) the Great Plains, (6) the Central Prairies, (7) the Stream Bottoms and Second Bottoms, and (8) the Mississippi Bluffs and Silt Loam Uplands. These major divisions have been further divided into subordinate soil regions (see soil map), such as the Flatwoods, Middle Coastal Plain, Black Waxy Belt, Sand Hills, Bluegrass Region, High Plains, Red Prairies, etc., for the sake of convenient, systematic, and definite treatment.



Map 2. Soil provinces of the Southern States.

The soil province map of the United States (map 3) shows the geographic relation of the soil provinces of the Southern States to those of the United States.



MAP 3. Soil provinces of the United States. (The boundaries as shown on this map have been revised some in the province map of the Southern States).

PRINCIPAL AGRICULTURAL DISTRICTS OF THE SOUTHERN STATES.

The geographic distribution of the principal farm crops of the Southern States is briefly described below.[1] Brief reference is made here to some of the principal types of soil occurring in these districts.

Closer relationship between soils and crops is to be had by locating the regions described, and shown on the crop maps referred to, on the general soil map. These soil and crop relationships are brought out in detail under the soil discussions in subsequent chapters. This brief, preliminary description of the agricultural districts is given for the purpose both of showing how soil and climate influence agriculture and to avoid the necessity of repeatedly defining such terms as *the Cotton Belt, the Rice District, etc.*

Cotton—The Cotton Belt embraces that portion of the South, lying to the south of the 37th parallel and between the New Mexico line and the Atlantic Ocean, with the exception of the mountain and limestone lands of North Carolina, Tennessee, Kentucky, and Virginia, the Piedmont of Virginia and northern North Carolina, and the Ozarks of Missouri. Very little cotton is grown in the southern two thirds of the Florida Peninsula, and but little west of the central Panhandle region of Texas. Long-staple cotton is grown chiefly in the bottoms of the Mississippi, Red, and Arkansas rivers north of Natchez, in eastern and southeastern Georgia and contiguous northern Florida territory, in southeastern South Carolina, over a wide area surrounding Hartsville, South Carolina, and in northeastern Texas, as in the section about Clarksville.

[1] See acreage and production maps and tables, based upon data collected by the United States Census and by the Bureau of Crop Estimates, and, also, maps showing the acreage of improved farm land and the number of cattle and hogs, in the Yearbook, U. S. Department of Agriculture, 1915, pp. 335–403.

The crop is grown on nearly all of the soils occurring in the Cotton Belt, but the heaviest production is on the limy lands of the Black Waxy Belt of Texas, Houston soils, the gray and red lands of the Upper Coastal Plain (Norfolk, Tifton, and Orangeburg soils), the Piedmont soils (Cecil and Louisa) and in the Mississippi bottoms (Sharkey and Sarpy soils) and other stream bottoms, such as the Brazos, Red, Arkansas, etc., and on the Texas and Oklahoma Plains.

The boll weevil has proved extremely destructive to cotton in the areas invaded, particularly in wet years. Some localities suffer more than others. In stream bottoms, where the soils are heavy and the cotton late in fruiting, and on late upland soils, the weevils have been exceptionally destructive. Cotton continues to be grown, however, over the greater part of the infested area. Texas, for example, continues to be a very heavy producer of cotton despite the almost complete invasion of its cotton-producing area by the weevil.

While cotton has been grown too much under a one-crop system in the past, a comprehensive survey of the situation can but lead to the conclusion that its production should and will continue on a large scale, not entirely as an economic necessity, since other crops can be profitably grown in the Cotton Belt, but because cotton, when grown on the proper soil and with good management, is nearly always a profitable product. Some diversification of crops should usually accompany its production, certainly the occasional introduction of a soil-improving crop, such as cowpeas, lespedeza, alfalfa, or velvet beans into the rotations. A diversified system of agriculture may be expected in the long run to give higher average profits than a one-crop system.

The soils and climate of the Cotton Belt are so ideally suited to cotton, its production is so well understood, the demand for both seed and fiber is so permanent, good markets so immediate, and the profits, under good farming systems, so certain, that any advice favoring widespread cessation of cotton production can be based only upon ignorance of the subject.

Tobacco.—The Southern States—Virginia, Kentucky, and the Carolinas—produce the bulk of the tobacco crop of the United States.

Bright or yellow tobacco (used for cigarette, granulated smoking, and plug wrappers) is grown in southeastern Virginia and the eastern Carolinas on the sandy soils, with yellow subsoils, of the Coastal Plain and Piedmont regions (Norfolk, Granville, and Durham soils); dark and mahogany tobacco (much of which is used for plug chewing, plug wrappers, and pipe smoking) is the important leaf of the Virginia Piedmont section, and considerable is grown, also, in the contiguous Piedmont section of North Carolina, being chiefly grown on soils having red subsoils (Cecil and Louisa); sun-cured [1] tobacco comes mainly from Louisa, Gouchland, and Fluvanna counties, Virginia, and is grown on the same soils as dark tobacco; export, chewing, smoking and snuff are the principal types, such as the Clarksville and Hopkinsville, the Henderson or Stemming, the one-sucker, and the Paducah tobaccos, of the limestone, sandstone, and shale lands (Hagerstown, Clarksville, Decatur, Christian, and Dekalb soils) of the Highland Rim and adjacent country of northwestern Tennessee and southwestern Kentucky; burley tobacco (smoking, plug chewing, and plug wrappers) is grown extensively on the limestone

[1] This refers to the grade of tobacco known by the trade as sun-cured. Even this is not cured in the sun—the leaves after being harvested are simply left in the sun a few hours to wilt, when they are transferred to the barn to air cure. Often they are immediately hung in the barn. The main part of the curing process takes place in the barn. Much of the southern Kentucky tobacco after cutting is left on the ground or hung on poles in the field to wilt before going into the barn to be fire-cured. The latter tobacco, however, is not classed as sun-cured.

lands (Hagerstown, Shelbyville, and Clarksville soils) of the Kentucky, Bluegrass Region, and contiguous country and also on the sandstone and shale lands (Dekalb and Upshur soils) of western West Virginia; Maryland pipe-smoking, export and cigarette tobacco is produced on the sandy soils (Sassafras) of southern Maryland; and the Sumatra type of cigar-wrapper tobacco is grown on the sandy soils (Norfolk and Orangeburg) of western Florida, southwestern Georgia, and southeastern Alabama. Perique (a dark, strong smoking tobacco) comes from the Mississippi bottom land (Sharkey soil) near Baton Rouge, Louisiana. In 1919 yellow tobacco was commercially grown in a number of localities in the Coastal Plain of Georgia.

Corn.—This is an important crop throughout most of the area of the Southern States. The production is low in the lower Florida peninsula, and the crop gives way to the grain sorghums in the dry country of the western portions of Texas, Oklahoma, and Kansas. The regions of larger production are northern Missouri and eastern Kansas. In the Cotton Belt frequently not enough corn has been produced for home use and there have been large importations, but recently more attention is being given the crop, and a larger production is the result. North of the Cotton Belt the production has generally been sufficient for all requirements of the farm, and in many sections corn is sold or is fed to hogs and cattle raised for sale. It is an important money and feed crop for market stock in Kansas, Missouri, Kentucky, Maryland, and many localities in the other states.

The crop is produced on nearly all the soils found in the regions wherever it is grown. It succeeds best on the limestone lands, the brown and dark-colored soils of northern Missouri and eastern Kansas, the well-drained alluvial soils and the well-drained, clay loams, loams, and silt loams of a large variety of upland soils. With fertilizers, good yields are obtained on the sandy lands of the Coastal Plain, Piedmont, and Appalachians.

Wheat.—This is not a very important crop in the principal Cotton Belt States, with the exception of the Piedmont of North Carolina, the limestone lands of Central Tennessee, the Black Waxy lands of north-central Texas, the Texas Panhandle, and the prairies of western Oklahoma. It is in the Missouri River belt of Missouri and Kansas, central Kansas, northcentral Oklahoma, the Blue-grass region of Kentucky, central Tennessee, the valley of Virginia and east Tennessee, northern and eastern Maryland and Delaware that wheat is most importantly produced in the Southern States. The best wheat soils in these States correspond closely to the best corn soils.

Recently some very good results have been obtained in the production of wheat on the well-drained sandy loams of the Coastal Plain, such as the Norfolk, Orangeburg, and Ruston soils. In the eastern parts of the Carolinas and in Georgia and other parts of the Coastal Plain from twenty to thirty bushels of wheat per acre have been produced on these lands with moderate fertilization.

Oats.—This crop is grown to some extent throughout the Southern States, except in southern Florida and west Texas; but it is of greatest importance in Missouri, Kansas, and Oklahoma. In the Cotton Belt it is largely fed in the sheaf to the stock on the farm. In some localities, notably in Texas, considerable quantities of oats are thrashed, and much of this sold for seed, as in case of the Texas Rust Proof variety. The crop succeeds and is grown on a large variety of well-drained soils ranging from loam to sandy loam. It seems to prefer somewhat lighter textured soils than wheat.

Timothy, clover, and alfalfa.—Timothy production in the Southern States is largely confined to Maryland, Missouri, Kentucky, West Virginia, western and northern Virginia, eastern Kansas, and east and central Tennessee. Some is produced in the mountains of western North Carolina, but it is a crop of no great importance within the limits of the Cotton Belt. Red clover is grown importantly only in the same sections where timothy is produced. Alfalfa is a highly important crop in Kansas and western Oklahoma, and considerable is grown in some localities elsewhere, chiefly in northern and south-central Texas, in the Red River bottoms, the Black Prairies of Alabama and Mississippi, northwestern Missouri, and northern Kentucky. The crop succeeds on soils rich in lime, such as the Houston, Summit, and Miller and most of the first and second bottom soils of the Great Plains streams. Recently successful results have been had on the deep red soils derived from the tough block rocks of the Piedmont (Davidson and Mecklenburg soils), as in the Rock Hill, South Carolina section. With lime and inoculation the crop could be much more extensively grown.

Other feed and grazing crops.—Cowpeas succeed throughout the Southern States. In some localities they do not fruit well, and disease, the wilt particularly, does some damage. Wilt-resistant varieties, however, such as the Iron cowpea, are used with good results in the disease-infested fields. The importance of cowpeas as a soil-improving crop and forage crop is very great. It fits into many good rotations; it is one of the most valuable soil builders that has been used in the Cotton Belt and in the sugarcane districts, and its importance is generally recognized elsewhere.

The velvet bean is a forage and feed crop of increasing importance in the Cotton Belt, succeeding as far north as North Carolina, here the earlier varieties mature their seed. It produces a large amount of field forage, and the seed is being converted into meal for stock feed on an increasing scale. It is a crop of great importance to the South, both as a soil builder and producer of forage and feed. It succeeds on a wide range of well-drained soils, even on deep sands.

The soy bean is another crop of importance in the Southern States. In some localities within the Cotton Belt it is being crushed for oil and meal. The crop is most extensively grown in eastern North Carolina.

Still another highly valuable crop is lespedeza, or Japan clover. This grows wild through the humid portion of the South as far north as Virginia, and offers excellent grazing. Farther south it is being sown and cut for hay, producing on both well drained and poorly drained silt loams, fine sandy loams, clays and other types of the stream bottoms and uplands, from 1 to 2 tons of splendid hay per acre, being cut twice in some localities. It is an important hay crop in Louisiana and Mississippi.

Sweet clover or mellilotus gives splendid yields on the limestone soils, but as yet its production is limited to small fields and scattered localities. It is rapidly gaining ground in Mississippi, Alabama, and Kentucky. Crimson clover is a valuable soil-improving crop in eastern Virginia and the Chesapeake Bay region, and it is grown scatteringly and increasingly over much of the other territory of the Southern States east of the dry belt. It does not seem to require as much lime as red clover. Bur clover, alsike clover, other varieties of clover, and vetch are also grown scatteringly on a variety of soils ranging from heavy to sandy. Alsike clover succeeds on soil of poorer drainage and lower lime content than those best suited to red clover. Considerable alsike clover is grown in the Chesapeake Bay region.

Next to timothy and red clover the prairie grasses, such as blue stem, of Kansas, Missouri, and Oklahoma probably yield more hay than any other grass. These are also valuable grazing grasses. Mesquite, buffalo, and other short grasses of the dryer western country afford the principal grazing for the cattle herds of central and western Texas. Bermuda grass, (frequently called "wire grass") one of the most valuable plants in the South, succeeds on both well drained and poorly drained soils from the Atlantic to the dry portions of Texas and Oklahoma, and affords excellent grazing and produces splendid hay. It is a persistent grass, but can be eradicated by shading and shallow plowing in summer and winter.[1] Johnson grass does well on the prairie soils from Alabama westward, and also on alluvial soils. It produces an abundance of good hay, but on account of its tendency to spread and its tenacity of growth it is not everywhere looked upon with favor.[2] Sudan grass [3] is much like Johnson grass, but it is not difficult to eradicate. It is being grown to an increasing extent, especially in Oklahoma and Texas. It is grown scatteringly on most of the well-drained soils of the Cotton Belt, succeeding even in the Atlantic seaboard. In the humid portion or the South, orchard grass is grown for hay and pasturage on well-drained heavy soils and redtop (herd's grass) on poorly drained soils. These grasses are grown chiefly north of the southern boundaries of Virginia and Kentucky. Crab grass, crowfoot, broom sedge, Colorado grass, and a number of other wild grasses are cut for hay in the Cotton Belt. In Florida and along the southern Texas coast, Rhodes grass,[4] a perennial of slender stems two to five feet high, is being grown to some extent, succeeding best on heavy soils, reclaimed peaty soils, and soils

[1] See Farmers' Bulletin No. 945, U. S. Department of Agriculture: Eradication of Bermuda Grass.

[2] See Farmers' Bulletin No. 279, U. S. Department of Agriculture: A Method of Eradicating Johnson Grass.

[3] See Department Circular No. 50, U. S. Department of Agriculture: Sudan Grass.

[4] See Farmers' Bulletin No. 1048, U. S. Department of Agriculture: Rhodes Grass.

with clay subsoils, such as the hammock lands. It makes good hay and is said to be well adapted to the heavy soils and peaty soils of the Louisiana and Texas coast, where there is sufficient rainfall or where irrigation is available. It rarely survives temperatures below 15° or 18° F. Beggarweed produces excellent hay on the well-drained soils of Florida and Georgia. Carpet grass is valuable in the Gulf States. It is occasionally cut for hay. Natal grass [1] has the reputation of doing well on the well-drained sandy soils of the extreme South, as in Florida. Like Rhodes grass it is a perennial introduced from South Africa. It grows in tufts 3 to 4 feet high, and makes a good hay. Para grass [2] is a perennial, which does well in the warmer Gulf country on moist or wet soils. It is a good hay and grazing grass, but is said to be difficult to eradicate. It succeeds as far north as Charleston, S. C., producing one to three tons of hay per acre per cutting. Guinea grass does especially well on the heavier soils of the Gulf region, preferring well-drained land; it is a heavy producer of good forage. Napier grass, a native of tropical Africa, where it is called elephant grass or Napier's fodder grass, is a canelike perennial, growing to a height of from 6 to 12 feet or more, depending upon the fertility of the soil, which succeeds in Florida and a strip along the Gulf through Alabama, Mississippi, Louisiana, and Texas. The Florida Experiment Station [3] says: "Napier grass was found to succeed in all parts of the State when planted on a reasonably fertile soil and given good care and cultivation. It has done well on good pine land, flatwoods soil, and on rich muck land it makes remarkable

[1] See Farmers' Bulletin, U. S. Department of Agriculture, No. 726: Natal Grass, A Southern Perennial Hay Crop.

[2] See Department Circular, U. S. Department of Agriculture, No. 45: Para Grass.

[3] Napier and Merker grasses: Bulletin Fla. Experiment Station, No. 153.

vigorous growth. In nutritive value and palatability Napier grass is probably not excelled by any similar non-leguminous feed." Merker grass is a rank-growing, cane-like grass of the millet group, much like Napier grass, and having about the same value and regional and soil adaptation. Italian rye grass,[2] closely related to perennial rye grass, is an annual which succeeds on a wide range of well-drained soils. It is valuable in the South Atlantic States as a winter and spring lawn and grazing grass, and will produce a very early crop of hay, if seeded in the fall.

The frequent burning over of uncultivated land tends to increase broom sedge, at the expense of the more valuable wild grazing plants, such as carpet grass and lespedeza.

Peanuts.—The large or jumbo variety of peanuts—market peanuts—is chiefly grown on the gray, sandy land of southeastern Virginia and northeastern North Carolina, while the small or Spanish variety is extensively grown as a field-forage crop for hogs and for oil on a variety of sandy soils in the Coastal Plain of Georgia, Florida, Alabama, Texas, and on the sandy soils of the Cross Timbers regions and adjacent country in Texas and Oklahoma. Recently there has been a large increase in the production of peanuts, especially on the sandy lands of central and northern Texas and southern Oklahoma, for oil and meal. The crop is grown alone and between rows of corn.

Sugar cane and the sorghums.—Sugar cane is widely grown through the South Atlantic and Gulf seaboard, especially on the sandy lands, for the production of sirup; but its production for the manufacture of sugar is confined to the silty, fine sandy, and clay alluvial soils of the lower Mississippi bottoms and second bottoms in southern Louisiana and the bottoms of some of the other streams

[1] Italian rye grass: Department Circular, U. S. Department of Agriculture, No. 44.

of that region, notably the Red River. Some is grown also on the Gulf prairies of western Louisiana and southern Texas. Sorghum is grown for sirup and for forage much farther north than sugar cane. It is grown on a large variety of soils, succeeding best on moderately moist bottom soils, but doing very well, also, on uplands which are not too soggy or too sandy.

The non-saccharine sorghums—that is, the grain sorghums (Milo maize, Kafir corn, feterita, darso, and others)—constitute the principal crop of the dry country of western Texas and Oklahoma. These sorghums are also grown farther north, in Kansas, and farther east, but they are of little importance east of central Missouri. Japanese cane, a true sugar cane, is being extensively grown in Florida, Texas, and other Gulf States, both for forage and sirup. It produces a very heavy yield of forage of about the same value as sorghum. To feed it to best advantage the plant should be run through a feed cutter, or chopped into pieces.[1] The sirup is not considered so good as that of ribbon cane.

Rice.—Production of rice is now confined to the silty and clayey soils of the southern Mississippi bottoms in Louisiana, the flat lands of southwestern Louisiana, and the coastal prairies of Texas, and of the prairies of east-central Arkansas, the principal types used being the Sharkey clay, Crowley silt loam, Lintonia silt loam, Calhoun silt loam, and Lake Charles silt loam and clay. The crop was formerly important along the lower courses of the principal rivers entering the Atlantic from the Cape Fear in North Carolina to the Altamaha in Georgia.

Potatoes.—The sweet potato is a southern crop. It is grown chiefly on the well-drained sandy lands of the Atlantic and Gulf States from New Jersey to central Texas.

[1] Japanese Sugar Cane as a Forage Crop: Bulletin Texas Experimental Station, No. 195.

The Irish potato is more of a northern crop, yet the total production in the South is important. Small fields of the latter are planted throughout the Southern States for home use, and there are some very important market producing potato districts, such as the Eastern Shore, Virginia, district, and the Hastings, Florida, winter district. Nevertheless, Irish potato production is of more importance in the Northern States. While the sandy soils are very successfully used for early Irish potatoes, it is on the well-drained silt loams and loams that the heaviest yields and largest production are recorded. The sweet potato has long been an important market product in New Jersey and the Chesapeake region. Recently it has become an important sale and shipping crop in many localities farther south, in fact, in all the Cotton Belt states, the use of potato drying houses having stimulated the industry greatly.[1]

In the eastern Carolinas the growing of Irish potatoes between rows of cotton, corn, and beans has begun to be practiced recently by a considerable number of farmers.

In the following table are given the carload shipments and dates of shipment of Irish potatoes from representative potato-growing States of the South[2] for the 1917 and 1918 seasons.

[1] See Farmers' Bulletins U. S. Department of Agriculture, No. 970: Sweet Potato Storage, and No. 847: Potato Storage and Storage Houses.

[2] Farmers' Bulletin No. 1050, U. S. Department of Agriculture—Handling and Loading Southern New Potatoes.

CARLOAD SHIPMENTS OF SOUTHERN POTATOES

State	*Season*	*1916 season*	*1917 season*
Alabama	May 1–July 31	574	633
Arkansas	May 25–July 15	277	334
Delaware	June 1–Sept. 30	52	52
Florida	Apr. 1–July 15	4,834	4,284
Georgia	May 1–July 15	267	182
Louisiana	May 1–July 31	3,863	1,042
Maryland (Eastern Shore)	June 1–Sept. 30	706	2,286
Mississippi	May 1–June 30	307	160
North Carolina	May 15–Aug. 31	5,543	4,700
Oklahoma	May 25–July 15	349	625
South Carolina	May 1–July 15	2,812	2,440
Tennessee	June 15–Sept. 15	18	64
Texas	Apr. 25–July 15	2,312	1,671
Virginia (Eastern Shore)	June 1–Sept. 30	8,385	14,123
Virginia (Norfolk)	May 25–Sept. 30	2,485	5,003
Total		32,784	37,599

Vegetables.—A large number of vegetables are grown in garden patches for home use throughout the Southern States; but it is only in rather restricted districts that commercial production of vegetables and berries is carried on. Market gardening is important about many of the cities on a large variety of soils. The most important trucking (vegetables grown for shipment) is carried on upon the sandy soils of the Coastal Plain region—soils that are either naturally well drained, such as the Norfolk and Orangeburg, or soils that have been drained artificially such as the Portsmouth.

Celery production in the south is largely confined to the sandy soils in the vicinity of Sanford, Florida, and in Manatee County, Florida; asparagus, on the well-drained sandy lands of South Carolina and Maryland; string (or snap) beans, on the well-drained sandy soils of Florida and the Atlantic Coast States, eastern Kentucky, and southern West Virginia; cabbage, on both the sandy lands of the Atlantic and Gulf seaboard, and on heavier soils, such as the limestone soils of southwest Virginia and the silt loams and clay loams of southern Texas and southeastern Mississippi, the sandy lands giving the earlier crop. Lettuce is grown importantly in various trucking districts in Florida, in the eastern Carolinas, Virginia, Maryland, about New Orleans, and elsewhere. Sandy soil and drained muck lands are those most used for lettuce in the eastern districts, while alluvial soil, often clay, is used about New Orleans.

Watermelons are widely grown, but their heaviest production is concentrated on the well-drained sandy soils of the Atlantic Coastal Plain, such soils as the Norfolk, Orangeburg, and Sassafras sands and sandy loams. Cantaloupes and musk melons are chiefly grown in the important watermelon districts, and on the same soils.

The principal onion producing district in the South is the Bermuda district of south Texas. Southern tomato production is carried on mainly on the well-drained silt loam, sandy loam, and loams of eastern Maryland, Delaware, eastern and southwestern Virginia, the Florida Peninsula, west Tennessee, southwestern Missouri, western Kentucky, east Texas, and southwestern Mississippi. A large part of the Delaware and Maryland crop is canned, but most of that from the other districts is shipped fresh.

Tropical and subtropical products.—The commercial production of citrus fruits (oranges and grapefruit) in the Southern States is chiefly confined to the Florida peninsula, but some commercial orchards have been established along the coast of Texas, and in southern Louisiana, Mississippi, and Alabama. Satsuma oranges have been extensively planted in recent years in a number of localities near the

Gulf. Among the tropical fruits[1] that are being grown in Florida are avocados (alligator pear), mangoes, and papayas. A few coconuts are grown in parts of the southern Florida peninsula, the crop having attained a place of some small commercial importance. The same is true of bananas, which are successfully grown occasionally in a very small way here and there along the Gulf coast. Dasheens and chayotes do well in Florida and elsewhere along the Gulf. Figs succeed with but little attention as far north as North Carolina.

Berries and fruit.—The strawberry is grown for market in the Southern states mainly in eastern Maryland, Delaware, southeastern North Carolina, southwestern Missouri, Northwestern Arkansas, west and east Tennessee, and eastern Louisiana. This crop is grown on practically all varieties of soil, ranging from poorly drained, gray clay loam (Myatt clay loam in the Sanford, Mississippi, district) to the thoroughly drained, very gravelly limestone soils of southeastern Missouri. It is not improbable, however, that quality varies some with the soil. Dewberries and blackberries are commercially grown in a number of localities, as in some of the sandy districts of the Eastern shore of Maryland.

Apple production is insignificant in the south Atlantic and Gulf seaboard, but is of much importance in the country to the rear of this, particularly in the Blue Ridge Mountain belt, in the Appalachian plateau, in the limestone valleys of the Virginias and Maryland, in the Ozarks of northern Arkansas and southern Missouri, and on the silty soils of northern Missouri. The crop succeeds on a large variety of well-drained soils, ranging from sandy loam to silt loam and stony land, but some varieties seem to show special preference for particular soils. The York Imperial, for

[1] Bulletins describing these tropical crops can be had from the U. S. Department of Agriculture.

example, seems to prefer limestone soils, such as the Hagerstown silt loam and clay loam, while the Winesap appears to attain greatest production on the red lands of the Piedmont, the Cecil sandy loam and clay loam.

The growing of peaches in commercial orchards is especially important on the sandy lands (Orangeburg and Greenville) of central Georgia, eastern Texas, and southwestern Arkansas, on the brown loams and sandy loams (Sassafras) of eastern Maryland, on the gravelly limestone lands (Clarksville) of northwestern Georgia, on the gravelly limestone lands (Baxter) and red sandstone lands (Hanceville) of northwestern Arkansas, on the red lands of the Georgia Peidmont, and on the shale and limestone lands (Dekalb, Berks, and Hagerstown) of western Maryland and contiguous territory in West Virginia. The quality of the peach varies some with the soil.

Grapes are produced scatteringly through the Southern States. The scuppernong is the most common grape of the Cotton Belt. It has been grown commercially for wine, and is being extensively shipped from eastern North Carolina for the manufacture of grape juice.

Pecans.—This nut is chiefly grown on the well-drained sandy uplands of southwestern Georgia, northern Florida, southern Alabama, and Mississippi, in the Mississippi River bottoms, and on the sandy, silty, and clay alluvial soils of the streams of central Texas and Oklahoma. A large percentage of those in the stream bottoms are native, while those of the uplands have been set out.

STOCK

Cattle and hogs.—The raising of beef cattle in the Southern States is most important in Texas, Oklahoma, Kansas, Missouri, and in the blue-grass regions of Kentucky, Tennessee, West Virginia, and Virginia. In recent years beef cattle have become of much greater importance in some sections of the South, notably in Mississippi, Alabama, and Georgia, as a result of the diminished returns from cotton since the bollweevil invasion. Also the industry has made marked advance in localities outside the Cotton Belt, as on the Eastern Shore of Maryland.

Most farms throughout the South raise a few hogs for home use and a large number sell a few head occasionally. Yet large quantities of pork have been shipped annually into the Cotton Belt from the great pork-producing sections of Iowa, Nebraska, Illinois, Indiana, Ohio, Missouri, and Kansas. Recently the raising of pork has increased greatly in many sections, particularly in those sections where peanuts are grown as a field-forage crop, as in southern Georgia and Alabama. Mississippi is also raising an increasing number of hogs. Packing houses have been established within the last few years in a number of localities in the Cotton Belt.

With the increasing recognition of the South's adaptability to cheap production of pork and beef by means of the easily produced feed and forage, the abundance of valuable grazing plants, and the mild climate, it may be expected that the Cotton Belt and other southern sections will in the near future produce a very much more important part of the meat output of the nation than they have in the past. Some regions, such as Texas, Oklahoma, Kansas, and Missouri, and the limestone regions north of the Cotton Belt have long been important producers of these products for market, but much of the other part of the territory has raised only about enough meat for home consumption, while even a larger proportion has depended on other sections for its supply. This is being changed. Mississippi, for example, so long a State where cotton was practically the sole money crop, is rapidly becoming a stock producing State. There are large areas of available cheap land in the cut-over pine

PLATE 1.—Longleaf pine flatwoods of southern Louisiana (Caddo very fine sandy loam soil), Rapides Parish, La. There is much of this imperfectly drained land through the cut-over pine country of the Gulf region. It is valuable for stock. With ditching, cotton, corn, sugar cane, oats, and velvet beans succeed.

PLATE 2.—Dome-shaped mounds on Caddo fine sandy loam soil, Harrison County, Tex. These mounds constitute a distinctive feature of the uplands of Louisiana, east Texas, and southern Arkansas, often giving the surface a billowy character, and interfering some with cultivation. They are usually more sandy or the sand is deeper than is the soil between the mounds, and lighter yields come from them. (Photo. by Van Duyne, collection, Bureau of Soils.)

Plate 3.—Longleaf pine (southern yellow pine), standing and cut, southern Louisiana. The valuable forests of longleaf pine are being rapidly cut for lumber, leaving immense areas of cut-over land on which there is but little reproduction of this tree, owing to fires. Much of this land, including extensive tracts of good farm land, is unused except for some grazing. (Photo. by the Author.)

Plate 4.—Cut-over pine land, southern Louisiana (Ruston fine sandy loam). This is typical cut-over pine land, of which many millions of acres await agricultural occupation in the South. A large proportion is good land adapted to cotton, corn, peanuts, velvet beans, potatoes, hogs, cattle, etc. Some will require drainage. Some of the rougher areas and heavy clay land (Susquehanna clay) will be best suited to reforestation. There are stumps to remove, but many crops can be and are grown between the stumps, which can be removed gradually when other farm work is not pressing. (Photo. by the Author, collection Bureau of Soils.)

lands and stream bottoms of the South and in the mountainous areas of both the Ozarks and Appalachians that are capable of profitable use for cattle and hogs.

Other stock.—Mules and horses are raised for market on an important scale in many localities in Missouri, Kansas, Kentucky, Tennessee, and Texas. The raising of sheep and goats has not been of very great importance in the Southern States, although a considerable number are raised in the bluegrass region of Kentucky, in central Tennessee, northern Missouri, western Virginia, and northern West Virginia. Goats are of some importance in southwest Texas.

A very large area in the dry portion of Texas is splendidly adapted to the raising of goats, and it is not unlikely that the industry will become important here. The Appalachian Mountains and Ozarks are regions of much promise for sheep and goats. The cut-over pine lands, also, afford good opportunity for the raising of sheep and goats. Small flocks are now being raised in some localities of the pine lands, where no feeding or housing is done either in summer or winter.

AVAILABILITY OF SOUTHERN FARM LAND

Of the 658,410,880 acres representing the land area of eighteen southern States the Census of 1910 classed 205,176,105 acres, or approximately 31.25 per cent, as *improved land.* The figures for the States referred to are given in the table below. *Improved land in farms* is thus defined by the Census: "Farm land is divided into (1) *improved land,* (2) *woodland,* and (3) *all other unimproved land. Improved land,* includes all land regularly tilled or mowed, land pastured and cropped in rotation, land lying fallow, land in gardens, orchards, vineyards, and nurseries, and land covered with natural or planted forest trees, which produce, or later may produce, firewood or other forest products.

All other unimproved land includes brush land, rough or stony land, swamp land, and any other land which is not improved or in forests."

These classes of land refer to land classified as *in farms*, and does not embrace areas "held solely for speculation purposes and not actually utilized for agricultural production," "land owned by states or by the United States," "land occupied by forests if not in the same tract as land used for agriculture," or the "vacant lots or parts of residence lots" of cities, towns, and villages, and many "small tracts outside of such places similarly used."

A *farm* as defined by the Census, is "any tract of 3 or more acres used for agricultural operations, no matter what the value of the product raised upon the land or the amount of labor involved in operating the same in 1909." In addition there was reported as *farms* "all tracts containing less than 3 acres which either produced at least $250 worth of farm products in the year 1909 or required for their agricultural operations the continuous service of at least one person."

The large area of land not classed by the Census as *improved farm land* does not entirely represent land that cannot be farmed. As a matter of fact, much of that so classed is exactly like that which is now in cultivation. Especially is this true in the Cotton Belt States, outside the limits of the Appalachian and Ozark Mountains. It is simply awaiting development—the clearing away of timber and stumps, and the installation of drainage canals. It is true that in this unused area there is a considerable total area which is nontillable or essentially so, owing to its rough topography or stony character or both, but the information gained through soil surveys indicates that fully 75 per cent of it is susceptible of cultivation, and that most of it is the same soil that is being elsewhere cultivated at the present time, that is, outside of the mountain districts.

Area of States, Acres *in Farms*, *Acres of Improved Land in Farms*, and Per Cent of Total Land Area Classified as *Improved Land in Farms* (census 1910)

State	*Land area of State* acres	*Land in Farms* acres	*Improved land in farms* acres	*Per cent of Improved Land in farms*
Tex.........	167,934,720	112,435,067	27,360,666	16.3
Kans........	52,335,360	43,384,799	29,904,067	57.1
Mo..........	43,985,280	34,591,248	24,581,186	55.9
Okla........	44,424,960	28,859,353	17,551,337	39.5
Ga..........	37,584,000	26,953,413	12,298,017	32.7
N. C.	31,193,600	22,439,129	8,813,056	28.3
Ky..........	25,715,840	22,189,127	14,354,471	55.8
Ala.........	32,818,560	20,732,312	9,693,581	29.5
Tenn........	26,679,680	20,041,657	10,890,484	40.8
Va..........	25,767,680	19,495,636	9,870,058	38.3
Miss........	29,671,680	18,557,533	9,008,310	30.4
Ark.........	33,616,000	17,416,075	8,076,254	24.0
S. C........	19,516,800	13,512,028	6,097,999	31.2
La..........	29,061,760	10,439,481	5,276,016	18.2
W. Va.......	15,374,080	10,026,442	5,521,757	35.9
Fla.........	35,111,040	5,253,538	1,805,408	5.1
Md..........	6,362,240	5,063,203	3,359,900	52.8
Del.........	1,257,600	443,308	713,538	56.7
Total.......	658,410,880	431,833,349	205,176,105	31.25

There are many millions of areas of cut-over pine land in the Gulf States, most of which is good farm land, the same as that now being successfully used in that region for cotton, corn, forage crops, sugar cane, rice, hogs, sheep, and beef cattle. The removal of the stumps from this land will entail much work; but most of the land can be used for stock without removing the stumps, and even for cotton, corn, and forage production. The stumps can be removed gradually as the farms are developed.

There is very little stream bottom land, even in the Mississippi bottoms, that cannot be reclaimed for cultivated crops by canalizing, while a very large proportion can be used in its present state for hay and grazing crops like Bermuda grass and lespedeza simply by clearing and seeding. Practically all of it can be used for cattle and hogs. Similarly, most of the stream-bottom soils throughout the South can be utilized for pasture, hay or cultivated crops. Much of the tidal marsh and swamp lands near the Gulf and Atlantic by dyking can be drained and used. This has been done in places, notably in the marshes of Louisiana and in portions of swamps such as the Dismal Swamp.

In the dry western country irrigation is necessary for continuous crop production, but a large proportion, even of the mountainous country west of the Pecos River, supports nutritious short grasses valuable for cattle and goats.

Some of the rougher and more stony lands of the Appalachian and Ozark mountain regions which cannot be readily used for the ordinary crops can be used for peaches and apples. Practically all of it can be used for pasture land, and there is throughout these regions much unused land that can be cultivated.

Thus, while there is much "waste land," as measured by present extent of agricultural utilization, within the area not classified by the Census as *improved land in farms*, practically none is waste land from the standpoint of possible agricultural utilization; and within this area many millions of acres of potential farm land are simply awaiting the coming of farmers or the digging of canals and the removal of timber. Of course there are large forested areas in the mountains that should be left in forest for the reason that the timber has a strong influence in governing the flow of streams, along which there are valuable water-power sites and valuable alluvial farm lands. It is also advisable to leave much of the rougher country in timber as a means of conserving and preserving timber resources, and, further, because there are many steep slopes here which, although they can be farmed, will suffer serious deterioration under cultivation through increased erosion.

The relatively larger area of unimproved farm lands in many of the States is accounted for by the larger included area of hilly, mountainous, and stony land, unreclaimed poorly drained land, and dry land.

USE OF COMMERCIAL FERTILIZERS

Commerical fertilizers are most extensively used in the Cotton Belt and in the region about the Chesapeake Bay and Delaware River. These artificial manures are almost invariably applied to cotton and usually to corn in the region east of the belt of loessial soils in Mississippi (the Mississippi bluffs and silt loam upland region). They are also applied to tobacco generally and are used to an important extent for the general-farm crops through Virginia, Maryland, and in parts of Kentucky and Tennessee. Vegetables are heavily fertilized in the eastern States and even the citrus fruits of Florida are fertilized.

West of the Mississippi, commercial fertilizers are very much more sparingly employed, except in the sugar cane and trucking sections of southern Louisiana. A considerable number of farmers make light to moderate applications for cotton and sometimes corn through Louisiana, the uplands of southern Arkansas, and east Texas. Some fertilizers are used in east-central and southwestern Missouri for wheat, and a little in southeastern Kansas for the same crop. The use of fertilizers is of negligible importance in the Great Plains, the Central Prairie region, and in a considerable strip of country bordering these regions on the east.

The heaviest applications, aside from those made for special crops, such as vegetables, are made in the great cotton-producing belt of the upper Coastal Plain from central North Carolina across South Carolina and Georgia to southeastern Alabama. Some of the highest average yields obtained in the Cotton Belt come from this section, where without fertilization ordinary yields are light. In the section surrounding Marlboro County, South Carolina, it is not uncommon to apply 1,000 pounds or more of fertilizer per acre for cotton. Heavy fertilizer treatment is also practiced in the Piedmont. Even heavier additions are made for certain vegetables in some of the highly developed trucking sections. Acreage applications of 2 or more tons are usually made in the Sanford, Florida, celery and lettuce district. In addition, commercial fertilizers are often supplemented by manure, especially in the sections about large cities, as in New Jersey, Delaware, and eastern Maryland. At the present time much manure is being wasted in the large stockyards west of the Mississippi. A large quantity of fertilizer, however, is used in light to moderate applications on cotton, corn, wheat, and tobacco, in amounts ranging from about 200 to 400 pounds per acre. In some sections fertilizers are applied sparingly, as for example, acreage additions of 50 to 100 pounds are common in some of the Kentucky tobacco districts.

The contents of these mixtures vary widely. Before the potash scarcity caused by the European war, much of the fertilizer used was in mixtures, the formulæ of which ranged from about 8 per cent phosphoric acid, 2 per cent nitrogen, and 2 per cent potash (an 8-2-2 mixture) to mixtures in which the proportion of these ingredients was about 10-4-4. Often the potash content was increased for crops such as potatoes and tobacco, and again some farmers used mixtures without nitrogen, depending on the legumes grown in rotation for the supply of nitrogen. A large number of farmers also use acid phosphate, cottonseed meal, nitrate of soda, tankage, fish scrap, and other carriers of the common plant foods (phosphorous, nitrogen, and potassium) alone and in varying homemade mixtures.

Lime[1] is in general use in some localities, especially in the Chesapeake Bay region and northern limestone regions. It is applied there usually in the form of burnt lime at the rate of from 1,000 to 2,000 pounds or more per acre, about every 6 to 10 years. Ground limestone is being used to an increasing extent in many parts of the Southern States. The use of lime alone has not generally been followed with any marked increase of yield in the case of cotton, but some of the legumes have given much better results after liming, notably the clovers, soy beans, peanuts, and alfalfa. The prairie soils, with the exception of a few like the gray hardpan land of the Ozarks country (Lebanon soils), usually are well supplied with lime.

Burnt lime (from limestone, dolomite or oyster shells) is used in the (1) quicklime, "lump lime" or oxide form, (2) as air-slaked lime or lime carbonate, and (3) as hydrated lime or what might be termed water-slaked quick lime. Some investigators have claimed that quick lime and hydrated lime should not be used on the soil because of a reduction of the humus supply through the caustic action of such forms of lime. They have argued from this premise that either the carbonated form of burnt lime (air-slaked) or ground limestone, which chemically is the same, should

[1] See Farmers' Bulletin No. 921, U. S. Department of Agriculture: The Principles of the Liming of Soils; Bulletin No. 119, University of Tennessee: Ground Limestone and Prosperity on the Farm; Bulletin No. 146, University of Missouri, Agricultural Lime; and Bulletin No. 152, Pennsylvania State College: The Value of Limestone of Different Degrees of Fineness.

be used. But some recent investigations[1] do not support this claim. It appears that burnt lime does not long remain in the caustic form in the soil, but that it quickly reverts to the carbonate form. It appears also that organic matter in the soil is not destroyed chemically by caustic lime, but that lime promotes the growth of bacteria and fungi in the soil which feed upon the vegetable and animal matter contained therein, resulting in a process of normal decay of such material—a beneficial process which develops active humus. Lime seems to promote a sanitary condition or condition favoring plant growth in sour and poorly-drained, soggy soils after they have been drained, and in the more or less inert or "raw" material of the freshly turned-up subsoil of those soils of low lime content.

Lime improves the texture of some types of soil, at least, burnt lime has a tendency to make stiff clay soils more granular, that is, where the drainage is good.

The legumes and various humus-supplying crops are being grown more widely as soil improvers. Among these crops are the clovers, cowpeas, velvet beans, soy beans, lespedeza, alfalfa, and rye. These fit well into rotation schemes that can be variously arranged to fit the conditions.

SOME SIGNIFICANT SOIL FEATURES, UNFAVORABLE SOIL CONDITIONS, AND REMEDIAL METHODS

In the humid region the brown, red, yellow, and well-drained dark colored soils (such as frequently occur in the Blue Ridge Mountains) and the limestone lands generally represent the better class of soils. These are soils which ordinarily contain a good supply of humus, and which are well oxidized, friable, and less inclined to clod and bake. The gray, pale yellow, and mottled soils, on the other hand,

[1] See The Carbonation of Burnt Lime in Soils, by MacIntire, W. H. Soil Science, V. 7, No. 5, 1919.

usually represent poorly drained soils, often having an impervious subsoil, hardpan, or claypan, and which are imperfectly oxidized and strongly inclined to bake and clod. There is also much gray land which owes its light color to a low content of organic matter, representing either a natural condition or the result of long cultivation without replenishment of the humus supply. Much of the sandy Norfolk soil, for example, which in well manured or fertilized fields is brown or light brown in color, is light gray in fields which have been long used with little or no manurial treatment. The gray and pale-yellow sandy lands are naturally deficient in organic matter, and to obtain good yields from them an application of manure or fertilizer, or the liberal incorporation of vegetable matter, preferably of the legumes, is necessary.

Wet bottom lands and soggy flats and depressions in the uplands often have an impervious hardpan or compact layer in the subsoil, which retards underdrainage and internal movement of moisture and air. In the prairie regions a very tough claypan is found under many areas of flat land. This dense clay not only impedes the movement of moisture in the soil and causes crops to suffer in dry weather, but it also hinders development of the root system of the deep-rooted crops, such as alfalfa. Artificial drainage and the growing of the shallow-rooted crops, particularly small grain and grass, seem to be the means of making the best use of such lands.

In the dry western country the brown, black, and reddish soils are also usually the better lands. There is comparatively little wet gray or mottled soil in this region. There is, however, considerable gray soil which is rated as fair to good land in the localities where found, such as the smoother areas of the limy Bracket soils of the Edwards Plateau region and the light-colored grazing land of the southwestern part of the Great Plains.

An unfavorable soil condition sometimes follows the growth of certain crops usually described as crops which are "hard on the land." The reduced yields of such crops as cotton and corn frequently following a crop of sorghum cane is a striking example of this. In this case (sorghum as ordinarily grown for sirup removes very little plant food) the lowered yields seem to be due to a poisoned or toxic condition in the soil—a condition which ordinary manurial and tillage treatment does not improve for some years sufficiently for the production of crops as good as those obtained immediately preceding the sorghum. A crop of cowpeas, however, following the sorghum will correct or greatly improve this condition. This is an instance where the introduction of a particular kind of crop at a particular stage in the scheme of crop succession is essential to good soil management.

Another kind of unfavorable soil condition is encountered in the common "alkali spots" and "buffalo wallows" of some parts of the plains and prairie regions. Here a very marked degree of unproductiveness obtains, which appears to be due to the presence of an intractable, puttylike clay lying near the surface, the peculiar physical nature of which favors accumulation of a harmful excess of salts in the soil. These spots are difficult to plow, they are generally moist immediately beneath the surface even in long dry seasons, and crops are exceedingly poor on them. They can be improved by plowing under coarse barnyard manure.

In the drier western country accumulation of alkali in amounts harmful to crops frequently takes place in areas of flat land where the underdrainage is slow and where the excess of moisture disappears largely by evaporation. This is notably true is those situations where water accumulates from adjacent slopes by seepage or run off. A harmful concentration of alkali sometimes takes place in irrigated lands where the topography or nature of the subsoil retards proper underdrainage, and where there is much seepage from irrigation ditches to lower fields. Some soils in the desert region are naturally rich in salts, containing the water-soluble salts in amounts unfavorable to crop production.

The "hardpan" sandy soil of the southeastern Coastal Plain (Leon sand and St. Johns sand) when plowed deep enough to cause the very acid brown hardpan material to be turned to the surface gives very poor yields. Liberal fertilization is necessary under all conditions for all crops on these lands, but even with this the fresh soil is not likely to give satisfactory yields of some crops. The virgin land is generally used the first year or two after being brought into cultivation for such acid-tolerant crops as Irish potatoes and tomatoes. Liberal use of lime hastens the attainment of a good soil condition on such land.

Similar treatment, liming, is generally advisable for drained muck lands and for all the grayish and mottled poorly drained soils of the humid regions which are not naturally rich in lime, that is, after artificial drainage.

The plowing up of a large amount of subsurface soil from the layers beneath the ordinary plow depth is generally not advisable in the uplands of the humid region, especially in the case of soils not derived from limestone or marl. Such freshly upturned material is usually not in a good condition with respect to crop production—it is in an unsanitary or "raw" condition, apparently, and for this reason it is usually unsafe to increase the depth of plowing in any one season more than 1 or 2 inches over the plowed depths of preceding years. The raw, freshly exposed material improves by weathering and by application of lime and manure, and if the plowing is done in the fall ameliorative effects may be expected to result from freezing and thawing through winter.[1]

[1] "Vegetation experiments,—at the Minnesota Experiment Station—

An increased depth of plowing is very essential on those lands in which a compact layer is developed just below the ordinary depth of plowing, so that such a layer or "plowsole" may be broken up and normal circulation of air and moisture between soil and subsoil restored.

No comprehensive discussion of the numerous plant diseases, harmful insects, and other crop pests is given in this volume, since these are not generally soil problems, though the soil often has some bearing on plant disease, especially the virulency of the disease. Potatoes, for example, seem to be more susceptible to scab on some soils than on others, at least this appears to be true in the Aroostook (Maine) district.

Plant diseases caused by fungi sometimes necessitate a change to some other crop or disease-resistant variety in fields that have become infested with the troublesome organisms. In the watermelon districts of the South, for example, a second crop of melons is seldom grown in the same field oftener than eight years or longer, for the reason that the second crop is very liable to injury from wilt. Wilt diseases sometimes do serious damage to cotton [1] and cowpeas also, especially on sandy lands. Here, too, the remedy is to change to some other crop not susceptible to wilt, as corn or oats, or to grow wilt-resistant varieties, such as the Dillon variety of cotton and the Iron and Brabham varieties of cowpeas. These diseases can be transmitted from one field to another by any means that will permit soil particles

with certain Minnesota prairie subsoils, previously found "raw" toward inoculated legumes, showed that an application of soluble potash and phosphoric acid fertilizers removed this infertility, rendering the subsoils as productive as the corresponding surface soils. This is considered as evidence that rawness in these soils is due to a lack of readily available mineral nutrients." Experiment Station Record, vol. xli, No. 4.

[1] See Farmers' Bulletin, U. S. Department of Agriculture, No. 625: Cotton Wilt and Root Knot.

to be transferred from the infested ground, as on the feet of animals and on plows.

Dieback [1] is a disease of citrus fruits the absolute cause of which is not known. Certain soil conditions, however, are known to be favorable for the development of the disease, such as "the presence of excessive quantities of organic ammoniates, a lack of drainage, hardpan too near the soil surface, excessive cultivation, and irregular moisture conditions."

"The disease is more prevalent in trees planted in certain locations, such as near stables . . . on slopes, and sand-soaked areas, and on spruce, pine, shell, coquina, and rocky lands."

What has been said shows that drainage, seasonable and judicious plowing, crop rotations, manurial treatment, use of lime, the fitting of crops to soil conditions, and the growing of disease-resistant varieties are among the principal methods of farm practice for combating the more common soil problems related to plant diseases. The methods of controlling plant diseases and insects by spraying and dusting with poisons, by cutting out affected plants and branches, destroying the nearby host plants of harmful plant life, by treating seed with immunizing solutions, etc., are discussed in many bulletins issued by the Experiment Stations and by the U. S. department of Agriculture.

CLIMATE

The large area discussed in this volume covers a wide range in climate—a range from a humid climate in the eastern part, with an annual rainfall of from 40 to 80 inches, to a desert climate in the extreme western part, with 15 inches or less of rainfall, and from subtropical in the southern-

[1] Bulletin University of Florida, No. 140: Dieback or Exanthema of Citrus Trees.

most part to a severe or continental type of climate in the Great Plains region.

Measured by precipitation, the southern part of the United States may be considered as including four climatic divisions or types. These, roughly defined, are: (1) the humid or timbered division, comprising the area east of the 40-inch annual precipitation line (see precipitation map—map 4); (2) the subhumid or prairie division, comprising the area between the 30-inch and 40-inch precipitation lines; (3) the semiarid or plains division, comprising the area between the 15-inch and 30-inch precipitation lines; and (4) the desert or arid division, comprising the area (not including the higher mountains) west of the 15-inch precipitation line. The humid division is mainly a region of timber; the prairie division is essentially a treeless, heavily grassed region (with scattered timber along the eastern border and along streams); the plains division is also essentially a treeless, grassed region, but the grass is shorter and of sparser growth, and yucca and scrubby growths of such plants as mesquite and catclaw are more plentiful; while the desert division is a very thinly grassed, treeless region, with an abundance of cacti, greasewood, and other desert plants. These divisions are not separated by sharp lines; they are climatic zones, which grade into each other.

There are still other climatic zones—those dependent upon temperature. Aside from temperature differences due to latitude and elevation, there are zones in which the climate is modified by proximity to water, and vice versa. Along the coast there is a maritime or oceanic zone in which a more equable climate prevails than over the more interior areas. This is due to the influence of the ocean, which absorbs heat and gives it off again three times slower than land (on account of differences in the specific heat of water and land). Here the climate is characterized by moderate temperature changes between night and day and between winter and summer. On the other hand, the winters farther inland are more severe, the increased coldness being greater than is accounted for by the increased elevation.

In the Great Plains a continental climate dominates. This is a severe climate of hot summer and cold winter extremes, and of relatively rapid changes between the temperature of day and night. It is in this region and the adjacent prairie country that "northers" are so characteristic—those sudden and rapid drops in temperature, accompanied by winds from the north.

Thus we have the anomaly of higher temperatures in parts of the north than occur in the extreme south. The summers of the more southerly latitudes are longer, however, than in the plains region, and the means are not always cooler.

The table of temperatures below gives some idea of the warmer temperatures prevailing at the coast as compared with those of interior land areas.

TEMPERATURE AND ELEVATION ABOVE SEA LEVEL AT CORPUS CHRISTI, TEXAS, DODGE CITY, KANSAS, SPRINGFIELD, MISSOURI AND NORFOLK AND LYNCHBURG, VIRGINIA

Station	*Elevation of station*	*Temperature*			
		Mean summer	*Maximum summer*	*Mean winter*	*Minimum winter*
	ft.	°F	°F	°F	°F
Corpus Christi, Texas	20	81.8	100	55.9	11
Dodge City, Kansas	2,513	75.8	108	30.0	−26
Norfolk, Virginia	91	76.5	102	41.8	1
Springfield, Missouri	1,350	74.5	106	33.5	−29
Lynchburg, Virginia	685	75.2	102	37.5	− 7

Dodge City is about 1100 miles north of Corpus Christi, yet its maximum summer temperature is 8 degrees higher than that of the latter station. The winter minimum of Springfield, Missouri, is 30 degrees lower than of Norfolk, Virginia, although it is only 1259 feet higher. Springfield is approximately 1300 miles west of Norfolk. Lynchburg, 270 miles west of Norfolk and only 594 feet higher, has a winter record 8 degrees colder than Norfolk. The climate of Dodge City and Springfield can be classed as continental and that of Corpus Christi and Norfolk as maritime. That of Lynchburg is of an intermediate nature, but still possessing the character of a maritime climate.

The influence of climate on crop distribution and character of soils is too varied for discussion in detail here; it is brought out in the chapters following. Some of the more striking effects, however, will be mentioned, by way of illustration.

The higher content of water-soluble salts and frequency of alkali in the dry western areas, as compared with the humid region, where alkali is practically unknown, is a direct resultant of the low rainfall of the west, meaning a minimum of soil leaching. For the same reason the drought-resistant plants—the grain sorghums—dominate the crops grown.

An effect of temperature on soil and land utilization is seen in the more friable character of the soil and subsoil of many northern soils, as compared with similar soils in the south, caused by the deeper freezing of the soil material in the north. With soil and subsoil thus made porous, larger amounts of rainfall are absorbed and greater immunity from erosion is insured, so that a more general use is made of hillsides, without terracing, than in the South.

A marked climatic influence on crop production is noted in the concentration of trucking in the Atlantic seaboard. This belt, with its equable climate resulting from both low altitude and proximity to the sea, furnishes fresh vegetables the year around, following the recession of the season, from the winter gardens of Florida to the early summer, late summer, and fall vegetable fields of the Middle and North-Atlantic Coastal Plain.[1]

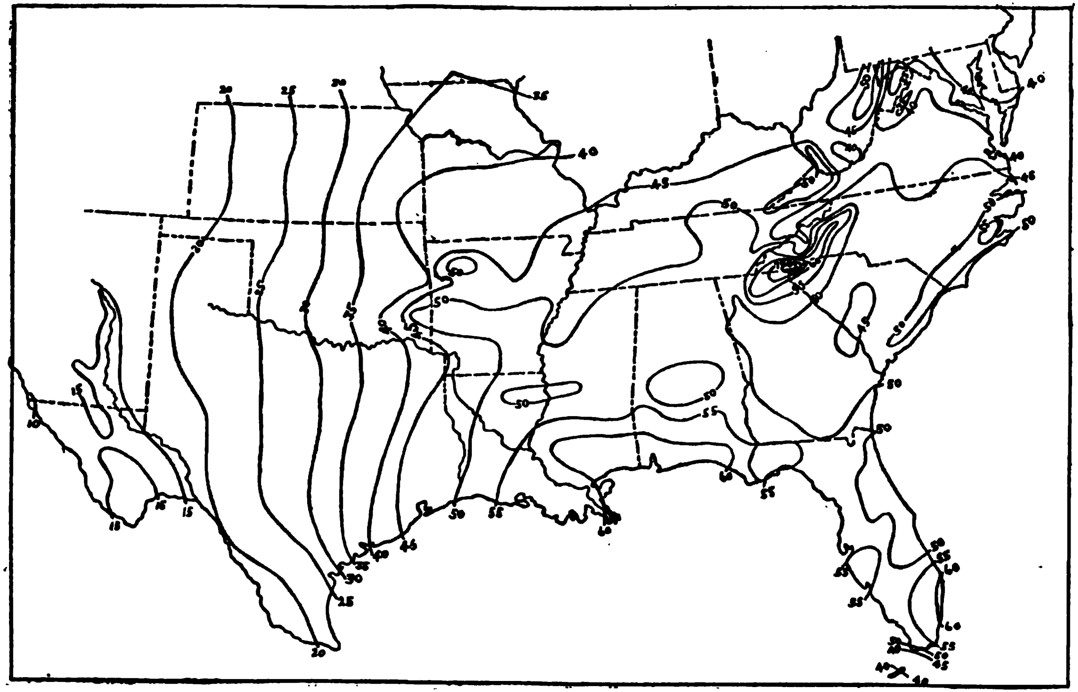
[1] See Yearbook, U. S. Department of Agriculture, 1912: Truck Soils of the Atlantic Coast Region.

PLATE 5.—White sand over a compact stratum of brown sand, known as "hardpan." This is the "hardpan land" (Leon sand) of the Florida peninsula. It is of low productivity, but will produce vegetables with liberal fertilization. It is used some for grazing cattle. (Photo. by the Author, collection, Bureau of Soils.)

PLATE 6.—Winter-grown Irish potatoes, Hastings, Fla. This is a deep fine sandy loam soil (Bladen)—some of the better grade of the sandy flatwoods. (Photo. by Latimer, collection, Bureau of Soils.)

PLATE 7.—String beans, with young cotton between the rows—on sandy loam soil near Mt. Olive, N. C. These sandy soils of the Coastal Plain are well adapted to a large variety of vegetables, producing an early crop. Cotton, corn, oats, tobacco (bright), peanuts, velvet beans, pecans, etc. also do well. The soil is easy to cultivate. Fertilizers increase the yields. (Photo. by Bonsteel, collection, Bureau of Soils.)

PLATE 8.—Beans and corn interplanted on fine sandy loam (Dunbar) near Mt. Pleasant, S. C. In this region it is a common practice to grow two crops together in the same field, one frequently being a soil-improving crop, as when velvet beans or cowpeas or peanuts are grown with corn. Also a succession of crops are secured from the same field the same year, as corn after oats, or an early vegetable, followed by a summer vegetable and then by fall potatoes or a crop of crab grass hay. (Photo. by Bonsteel, collection, Bureau of Soils.)



Map 4. Average Annual Precipitation in Inches. Based on records, U. S. Weather Bureau.

Climatic conditions resulting from local topography often influence agricultural practices. Shut-in valleys not having good air drainage are not considered favorable to fruit production, owing to uncertainty of frosts in such situations, more open ground being selected for the orchards. Southward and northward facing slopes in the Blue Ridge mountains often are given preference or are avoided for certain crops on account of the earliness or lateness of the position.

The following relates to influence of climate on vegetation: [1]

On the coastal plains everywhere there are regions of rich, abundant vegetation. This is directly related to the climate, the vegetation being a response to the presence of large amounts of moisture. Climate is also the cause of the Great Plains, with their sparse vegetation and dry, shifting soils. The prairie may be regarded as a transition from the forest conditions of the East to the arid conditions of the central plains. Climate is responsible for the origin of the prairies, but we must look to other factors to explain their persistence. The more abundant moisture of the prairies as compared with the plains has been attributed by Zon . . . to the forests of the southeastern United States. In his opinion land evaporation is more important than has usually been considered. Moisture does not take a single flight in land from the water areas, but is precipitated and reëvaporated in a series of short flights. The forests, utilizing the water in their own growth, again evaporate the larger portion of it, acting as a temporary deposit bank from which the moisture may be drawn into the air and redistributed for the use of plants in the path of this moisture-laden atmosphere. His argument has three steps: First, the coincidence of precipitation in eastern United States and the prevailing southerly winds. . . . Second, evaporation from the land constitutes seven ninths of the total precipitation, while evaporation from the oceans is only two ninths. Third, a cover of vegetation offers a better evaporating surface than a body of water and a forest evaporates more water than any less dense vegetative cover. There is abundant proof for each of these premises and one is compelled to accept the conclusion

[1] Waller, A. E., Journal, American Society of Agronomy, vol. x, No. 2: Crop Centers of the United States.

that the forests are an important factor in determining the humidity of the prairies.

To say that there is more abundant moisture in the prairies than in the plains is only another way of saying that there is more abundant vegetation. Many plant geographers. . . indicate or actually state that the forest is migrating across the prairie. If, then, the eastern prairie region is climatically a potential deciduous forest, it appears that the eastern forests in their spread can become moisture bearers and therefore equalizers of climate conditions farther and farther west. As the lands growing cultivated crops are, next to the forests, the most efficient evaporators, the intensive use of the level lands and the careful forestation of the parts not adapted to cultivation in these eastern States may make large areas of the country far inland from the primary sources of moisture more productive than has hitherto been imagined. The examination of the diminishing prairie areas in Ohio will doubtless throw light on this important problem.

THE ATLANTIC AND GULF COASTAL PLAINS

GEOGRAPHY

THE low country bordering the Atlantic Ocean and the Gulf of Mexico, and extending from the vicinity of New York City to the mouth of the Rio Grande and beyond into Mexico, is known as the Coastal Plain. This embraces (in the United States) an area of approximately 341,175 square miles or 218,352,000 acres, amounting to 11.4 per cent of the total land area of Continental United States. In 1910 this vast region supported an urban population of 3,047,599 and a rural population of 9,696,584, or 19.6 per cent of the total rural population of the country.

From a narrow strip in the northeastern extension, the province widens southward to a width of 200 miles in North Carolina. In Alabama it swings northward around the southern extremities of the Piedmont, the Appalachian Mountain, and the Limestone Valleys Provinces and extends through northeastern Mississippi and across Tennessee to southwestern Kentucky. Here the greatest width from the Gulf to the Kentucky line is about 450 miles. The distance to the northern or inland boundary of the province, in southern Oklahoma, from Galveston, Texas, is nearly 350 miles, and to the western boundary, about 225 miles.

Between New York City and Clanton, Ala., the inner boundary of the province is marked by the outer boundary of the Piedmont region. There is a broad gap in the Gulf portion of the province comprised in the Mississippi bottoms and the strip of silty loessial soils adjoining the bottoms on the east and extending from Baton Rouge, La., to southwestern Kentucky, the loessial deposits having covered the Coastal Plain beds here, which are exposed only where the loess has been removed by erosion.

West of the Mississippi the northern boundary of the region skirts the sandstone and shale hills of the southern Ozarks and extends westward into southwestern Oklahoma to the vicinity of Ardmore along the boundary of the Great Plains region. From here the boundary swings in a southerly direction approximately along a line through Fort Worth, Temple, Waco, and Austin to San Antonio and thence westward to the vicinity of Del Rio, on the Rio Grande.

Roughly, the Atlantic and Gulf Coastal Plains province comprises the southern two thirds of New Jersey, nearly all of Delaware, the eastern and southern two thirds of Maryland, the eastern thirds of Virginia and North Carolina, the eastern half of South Carolina, the eastern and southern three fifths of Georgia, all of Florida, the southern and western two thirds of Alabama, nearly all of the eastern half of Mississippi, a narrow strip in western Tennessee, the southern third of Arkansas, a narrow strip of east-southern Oklahoma, the western two thirds of Louisiana, and the eastern and southern two fifths of Texas.

TOPOGRAPHY

In its general aspect this region consists of a plainlike country, locally rolling to hilly, which rises gradually from the sea to the older inland regions—the regions of consolidated rocks: the Piedmont, Appalachian, and Great Plains region (see soil map).

The inner boundary varies in elevation above sea level from about 200 feet to 500 or 600 feet. The surface is characteristically much smoother than that of the Piedmont Plateau and Appalachian Mountains, yet much of it is rolling, especially the inner portion east of the Mississippi, and some areas are hilly and rough. There is a belt of conspicuously flat country along the Atlantic Coast from Delaware southward and along most of the Gulf Coast. The Atlantic and east Gulf flat belts are known as the flatwoods, and the west Gulf belt as the Coastal Prairies. The Arkansas, upper Louisiana, and northeast Texas parts are mostly rolling or gently rolling, but they include many flat and gently undulating areas. In the prairie regions of Texas, north of the low coastal prairie belt, the surface is mainly undulating to gently rolling.

In the main, the surface of the region is sufficiently smooth to be well suited to the use of all kinds of labor-saving farm machinery. There are, however, some eroded areas that require careful contour cultivation with one-furrow plows, and some that are too rolling and rough for cultivation at all. The principal subdivisions of the province, based on topography and soils, are described in the chapters following.

THE ATLANTIC AND GULF COASTAL FLATWOODS AND GULF COASTAL PRAIRIES

The Atlantic Coastal flatwoods belt begins as a narrow fringe in the southeastern parts of Delaware and Maryland, and widens southward, including the Virginia portion of the Maryland-Virginia peninsula and the country lying east of an irregular line passing southward somewhere near Suffolk, Va.; Winton, Kinston, and Elizabethtown, N. C.; Marion, Orangeburg, and Hampton, S. C.; Claxton and Waycross, Ga.; and Lake City and Palatka, Fla. This belt continues southward down the Florida peninsula between the sandridge strip skirting the east coast and the rolling sandy belt of the central peninsula to the Everglades and across the peninsula to the Gulf.

In places in North Carolina and Georgia this coastal strip approximates 75 miles in width, but the general width is about 25 to 50 miles. There is a considerable strip of the same character of country skirting the Gulf coast from a point northwest of Tampa, Fla., to a short distance west of Appalachicola River, and another beginning at Mobile, Ala., and extending westward to the Pearl River bottoms in Mississippi.

The flatwoods belt is a characteristically flat area, varied here and there slightly by low hillocks and ridges of sand, the shallow valleys of the streams rising within the belt, and the deeper valleys of the streams that cross the belt. Its surface rises inland with a gradient of about 1 to 2 feet per mile. Between the coast and the inland border of the flatwoods there is a rise in elevation of 50 to 150 feet. Along the Atlantic coast line a cordon of elongated islands, usually separated from the mainland by sounds and tidal marshes, front the ocean with generally a narrow ridge of dune sand 15 to 50 feet high near the beach. Coral keys take the place of these sandy barrier islands about the south coast of the Florida peninsula.

On account of the vary faint slope the lands of the flatwoods are generally poorly drained. With the exception of the larger streams crossing the belt, such as the Roanoke, Peedee, Santee, Savannah, Altamaha, and Appalachicola rivers, most of the drainage is by downward percolation and through the swampy depressions in which there is frequently no well-defined channel. In some sections, as in southeast Georgia, these shallow drainage depressions are numerous, winding in and out and often rejoining each other to form an interminable network of drainage ways. There are many areas without drainage outlets, where the rain water flows off or seeps down so slowly that the water table is maintained permanently near the surface. Some of these flat, poorly drained stretches on which there is only a sparse growth of trees are locally styled "savannas" and "prairies." Elsewhere there are flats and shallow depressions of very poor drainage which support a dense growth of a water-loving type of vegetation, such as bay, gallberry, highbush huckleberry, titi, myrtle, cypress, and tupelo. These are known as "pocosins," "bays," and "swamps." They constitute areas of upland swamp. Longleaf pine is the principal tree over the better drained areas from the Carolinas southward. Cabbage palmetto is a conspicuous plant in many parts of the Florida flatwoods. This plant is also abundant on the barrier islands along the coast to North Carolina. Saw palmetto is plentiful from southeastern South Carolina southward.

In the Gulf flatwoods east of the Mississippi the topographic, drainage, and vegetative features of the Atlantic flatwoods are essentially repeated, except in the strip between Pasco and Wakulla counties, Fla., in the lower part of which there is some hammock land.

The western Gulf (west of the Mississippi) equivalent of the flatwoods is known as the Coastal Prairies. This comprises a coastal strip 25 to 100 miles wide, beginning in central-southern Louisiana and continuing to the Mexican border. This is largely a treeless area (there are some pine and hardwood in Louisiana and southeast Texas and groves of mesquite further west, in Texas), whose surface is level to the eye, and without important topographic variation. Local areas are undulating as a result of wind-drifted sand. In Louisiana and east Texas there are dome-shaped mounds about 2 to 5 feet high and 50 feet or more in diameter, which are so close together in places as to give rise to a peculiar billowy or hummocky surface.

The regional drainage, even in the humid or eastern portion of the section, is prevailing better than that of the Atlantic and Gulf flatwoods. In the western extension semiarid conditions prevail. The marshes and semimarsh land immediately along the coast represent the most important areas of poorly established drainage. There are some imperfectly drained flats and depressions above the marshes.

The principal soils of the Atlantic and Gulf flatwoods east of the Mississippi are: the black wet lands with sandy clay subsoils (*Portsmouth* soils), the dark gray to black lands with mottled stiff clay subsoils (*Coxville* soils), the gray wet lands (*Plummer* soils), black lands with brown sandy "hardpan" (*St. Johns* soils), and the light gray to white lands with brown sandy "hardpan" (*Leon* soils). Along the ocean front there are beaches, ridges, and hillocks (dunes) of deep, loose sand.

In the Coastal Prairies of Louisiana and Texas the predominant soils above the marshes are the black calcareous lands (*Victoria* soils), the gray poorly drained lands of low lime content (*Edna* soils), the black lands of low lime content (*Lake Charles* soils), the brownish lands with mottled red, yellow, and gray stiff subsoils (*Crowley* soils), and the brown semimarsh land (*Lomalta* soils).

INNER COASTAL PLAIN

The higher, inner portion of the Coastal Plain, the interior division of the province, covers a very much larger area and is far more varied in its surface configuration than the flatwoods and Coastal prairies. Its surface ranges from flat to hilly; but the greater part is undulating and gently rolling. Some areas have been severely dissected by erosion. Generally, the surface is sufficiently smooth to allow the use of any kind of farm machinery. Along the boundary of the flatwoods and in those areas where the rolling lands touch the coast, as in Baldwin County, Ala., the elevation ranges from about 20 to 100 feet above sea level; along the inner boundary—that is, along the line of contact with the

Piedmont, Appalachian, and the other interior provinces—the elevation ranges from about 400 to 600 feet. There are some elevated sections that rise conspicuously above the surrounding country. The inner Coastal Plain really comprises several divisions that have distinctive topographic features or dominant soil characteristics or both. The most important of these will be called: (1) the Chesapeake Bay region; (2) the "Sand Hills"; (3) the Middle Coastal Plain; (4) the Upper Coastal Plain; (5) the Rolling Sandy Lands of the Florida peninsula; (6) the Clay Hills; (7) the interior Flatwoods of Mississippi and Alabama; (8) the Black Prairies of Alabama and Mississippi; (9) the Appalachian border region; (10) the interior Coastal Plain of northeast Texas, northwest Louisiana, and southwest Arkansas; (11) the interior Flatwoods of Texas and Louisiana; (12) the Black Waxy Belt or Black Belt; (13) the Rio Grande Plain; (14) the Red Lands of South Texas; and the East Cross Timbers.

Chesapeake Bay region.—From the vicinity of the James River northward the greater part of the Coastal Plain country is flat to gently rolling. There is a gradual rise toward the Piedmont boundary, but generally this is considerably accentuated at a short distance from the Piedmont, the country rising rather sharply to the much more rolling country of the Piedmont-Coastal Plain border zone. About the Chesapeake Bay there are many long, narrow, flat-topped strips of land, "river necks" or peninsulas, between the broad rivers and creeks (estuaries) entering the bay. Most of this country is of a terrace or benchlike character, with a rise to the west and north from the low flats or forelands to successively higher broad, flat belts in steplike fashion. The Delaware-Maryland-Virginia peninsula is of this kind, consisting of successively higher flat to gently rolling, broad terracelike plains practically to the Piedmont boundary in the northern part. Essentially the same surface features continue northward from Delaware Bay through New Jersey, although in the Highlands of Navesink, on Sandy Hook Bay, there is an elevation of 276 feet within a mile of the ocean. This is the highest point on the Atlantic Coast, south of Maine, in fact, the only conspicuous coast elevation along the entire middle and south Atlantic seaboard, with the exception of locally developed sand dunes.

Practically all of this country, below the rolling to hilly Piedmont border strip, is admirably suited to tillage, allowing the use of any kind of farm implement. Most of the higher rolling strip is cultivable, but there are many slopes here which are too steep for the satisfactory use of harvesters and similar labor-saving machinery, and erosion is a problem of some importance.

All the region is well drained, with the exception of the stream swamps, the tidal marshes, and the level or depressed areas back from the water front in which streams have not yet established themselves. There are many swampy areas in the depressions, and "white oak flats" on the level lands of the Delaware-Maryland-Virginia peninsula, and in the "necks" west of Chesapeake Bay. In southern New Jersey and Delaware there are many broad swamps along the drainage ways.

The well-drained brown lands with reddish-yellow friable subsoils and a gravelly substratum (*Sassafras* soils) and the poorly drained grayish lands with impervious subsoils, known as "white oak land" (*Elkton* soils) are the most extensive soils of this section. Locally the "greensand" soils, those containing considerable greenish glauconitic material (*Collington* soils) and dark-red lands (*Colts Neck* soils) are important.

The Sand Hills.—A long strip of moderately high, irregularly arranged hillocks and ridges borders the Piedmont from the vicinity of Sanford, N. C., to the vicinity of Auburn, Ala. This strip is continuous but for interruptions by stream bottoms. Its width ranges from about 5 to 30 miles. The peculiar hillocky and ridgy topography and the excessively sandy nature of the soil have given rise to the local designation, "the Sand Hills." The drainage is thorough to excessive, and the land supports a growth of scrub oak and longleaf pine.

Grayish loose sand passing below into pale yellowish loose sand extending to depths of more than 3 feet (*Norfolk* sand) is the principal soil of the sand hills.

Middle Coastal Plain.—This belt extends from Southeastern Virginia ("Tidewater Virginia") across the Carolinas and Georgia into Florida, and is bordered on the seaward side by the coast flatwoods. Its surface is flat, undulating, or gently rolling, and the elevation ranges from about 100 to 400 feet above sea level. From about Panama City to Mobile Bay the gently rolling to flat country touches the sea; but elsewhere flatwoods intervene, except for a narrow strip of the sandy rolling lands of Florida touching the Gulf west of Tampa. The surface is generally well suited to the use of farm machinery, in fact slopes steep enough to cause severe erosion are rare. The drainage is generally good, except for occasional seepy slopes and swales and wet flats of gray and black lands (*Plummer* and *Portsmouth* soils), which are usually not extensive.

The principal soils are the grayish to light brownish lands with yellow friable subsoils (*Norfolk* soils) and light brownish soils with yellow friable subsoils showing some reddish splotches and containing an abundance of iron concretions (*Tifton* soils), the latter group occurring most extensively in Georgia and western Florida.

This belt, together with the adjacent Upper Coastal Plain Belt, embraces the most important cotton farming section east of the Mississippi River. The proportion of improved farm land is very much greater than in the Flatwoods and Sand Hills. Longleaf pine and wire grass constitute the typical vegetation.

Upper Coastal Plain.—The Upper Coastal Plain Belt extends from central South Carolina across central Georgia and southern Alabama into central Mississippi, and includes a portion of northern Florida. The surface is prevailingly rolling, although not so rolling but that it is very largely well suited to cultivation. Slopes steep enough to be very susceptible to erosion are found mainly in the rolling redlands. The elevation ranges from about 200 to 500 feet above sea level. The drainage is well established practically everywhere. In southwest Georgia and in the Florida Panhandle much of the drainage enters underground passages through the common "sink holes" or "lime sinks" of this section. These sink holes are depressions or openings in the ground, which are generally connected with underground cavities in the basal limestone strata. Streams of considerable size rise and sink through such openings. The entrances to the underground passages have been filled in many of the sinks by the washing in of soil material, so that water stands in some of them for long periods.

The principal soils of this division of the Coastal Plain are the grayish to light brownish soils with deep red friable subsoils (*Orangeburg* soils) and similar soils with light-red or reddish-yellow friable subsoils, sometimes slightly mottled in the lower subsoils (*Ruston* soils). There are some important areas of red land—that is, red at the surface with subsoils like the Orangeburg (*Greenville* soils) and occasional bodies of gray land with stiff clay subsoil (*Susquehanna*). Gray soils with gray or mottled gray and yellow impervious clay subsoils (*Grady*) occur in the lime-sink depressions of southwest Georgia and northwest Florida, the individual areas being small.

Longleaf and shortleaf pine, with occasional areas of mixed forest, consisting of pine, oak, hickory, and dogwood, constitute the principal vegetation.

In northeastern Mississippi there is a long ridge (Pontotoc Ridge) on which red sandy land (*Orangeburg*, *Greenville*, and *Ruston*) predominates. This properly belongs with the Upper Coastal Plain Division on the basis of soils, as does also a strip of sandy country north of the Black Prairies of Alabama and Mississippi.

Rolling Sandy Lands of the Florida Peninsula.—Rolling, sandy lands occupy a large area of the interior of the northern Florida peninsula, extending from about the center of De Soto County to the Georgia line south of Valdosta. This area is widest about its center, being approximately 85 miles along the Deland parallel. The surface is gently rolling to hilly in places, the maximum elevation being about 220 feet above sea level. There are low, swampy flats, such as the broad belt along the Withlacoochee River, and also "saw palmetto" and "gallberry flatwoods."

The dominant soil of this region is the deep, grayish to light brownish sand (*Norfolk* sand). There are also important scattered bodies of reddish, grayish, brownish, and black "hammock" lands with red, yellow, bluish gray, and mottled clay subsoils overlying limestone (*Gainesville*, *Fellowship*, and *Hernando* soils). Longleaf pine is the principal tree on the deep, sandy soils, which are locally known as "rolling pine lands," and where there is no undergrowth of blackjack oak, as "open pine woods." There are areas of whitish sandy soil, known as "scrub land," which are covered with a thick growth of stunted evergreen oak and scrubby spruce pine. Saw palmetto is the most common undergrowth, with much gallberry on the less well drained flatwoods areas. The hammock areas support a forest growth including live oak, water oak, white oak, hickory, magnolia, sweet gum, black gum, ash, cabbage palmetto, and pine. In the swampy areas, such as on the lowlands along the Withlacoochee River, grassy, shallow ponds are interspersed with low hammocks of semiswampy character, and cypress swamps.

The Clay Hills.—The region designated as the Clay Hills comprises a curved belt extending from near Butler, Ga., southwesterly through Russell, Bullock, and Crenshaw counties, Ala., thence northwesterly through Butler, Conecuh, Wilcox, Clark, Marengo, and Choctaw counties into Mississippi through Clarke, Lauderdale, Kemper, Winston, Choctaw, Webster, and Calhoun counties. The widest part is along the Mississippi-Alabama line where the width is approximately 65 miles.

The surface of this belt is generally rolling; much of it is badly dissected, rough, and hilly, with many slopes too steep and too inclined to wash for easy or safe cultivation. There is a strip of especially rough country beginning west of Greenville, Ala., passing through Wilcox, Clarke, and Choctaw counties into Mississippi, then continuing northwesterly through Clarke, Lauderdale, and Kemper counties toward Kosciusko. In Lauderdale and Clarke counties, Mississippi and Clarke and Choctaw counties, Ala., the country associated with the "white hills" (*Lauderdale* soils) is not only very hilly, but there are many places where fragments of iron-cemented sandstone, quartzite, and a soft, whitish siliceous rock are abundant. This is the roughest part of the Coastal Plain, with the exception of the higher country along the border of the mountainous portion of northwestern Alabama. But for patches here and there, cultivation is impracticable through these rougher sections.

Since the surface is so generally rolling, the drainage of the region is good. Water does not pass rapidly through the heavy clay subsoil prevailing in this belt, where the soils are mainly the Susquehanna, and consequently erosion is a serious problem. The average slope will wash disastrously in a short time, if the fields are not carefully terraced. Much of the area is timbered with pine and some oak, hickory, and dogwood.

The Interior Flatwoods of Alabama and Mississippi.—On the east side of the Clay Hills in Mississippi and west-central Alabama there is a curved belt of dominantly flat country, locally styled "the Flatwoods." This extends northward to the Tennessee boundary. The soils are mostly the gray compact silt loam and clay of the *Lufkin* series. Much of these lands is so nearly level that water stands on the surface in many places for considerable periods after heavy rains and, in addition, the subsoils for the most part consist of heavy impervious clay which impedes underdrainage. Topographically the surface is well suited to cultivation.

The Black Prairies of Alabama and Mississippi.—North of the Clay Hills and Interior Flatwoods there is a broad crescentic belt of flat to undulating and gently rolling mixed "post oak" and prairie land extending from Bullock County, Ala., through Noxubee County, Miss., to the vicinity of Tupelo, Miss. This belt is about 30 miles wide in places.

Nearly all of the land is well drained and is well suited to cultivation. The dominant soils are the dark-colored, limy prairie lands (*Houston* soils) and the reddish "post oak" lands (*Oktibbeha* soils).

The Appalachian Border Region.—Between the Black Prairie Belt and the higher lands of the Piedmont and Appalachian to the north the Coastal Plain country becomes more rolling toward the line of contact with these interior soil provinces, the hills of the northern part rising to elevations of 500 or 600 feet. The lower part of this border zone is typically rolling, while the upper part, that overlapping the rocks of the Appalachian and Piedmont, is typically strongly rolling to hilly. There are throughout this border zone some flat and undulating areas, even at

PLATE 9.—Garden peas for canning, Seaford, Del. Grown on Sassafras sandy loam. The canning of peas, tomatoes, and corn is a very important industry in the Chesapeake Bay region. (Photo. by Bonsteel, collection, Bureau of Soils.)

PLATE 10.—Late tomatoes for canning, Kent County, Md. Grown on Sassafras silt loam. (Photo. by Bonsteel, collection, Bureau of Soils.)

PLATE 11.—Irish potatoes on Sassafras sandy loam, near Diamond Springs, Va. Showing also the flat topography of the lower "Tidewater" portion of the State. (Photo. by Bonsteel, collection, Bureau of Soils.)

PLATE 12.—Sweet potatoes on Norfolk fine sandy loam, near Shelton, Va., in the Tidewater Section. This is a crop of large importance through the South. The potato drying house has made this a commercial crop in many sections where it was formerly grown for home use only. An enormous quantity of potatoes was lost by decay under the old-fashioned method of storing in "potato hills," where they were stacked-up and covered with straw and soil. The light-colored sandy loams are ideally adapted to the crop. (Photo. by Bonsteel, collection, Bureau of Soils.)

the higher altitudes, but much of the country, most of the upper half in northwest Alabama and northeast Mississippi, is strongly rolling, with deep, steep-sloped valleys, along whose walls there are many stone areas and outcrops of sandstone and shale of the Appalachian platform rocks. Here a considerable percentage of the land is too steep or broken for satisfactory cultivation, more than 25 per cent in places.

The soils are prevailingly sandy, consisting of gray lands with yellow, light reddish, and deep red friable subsoils, representing the *Norfolk*, *Ruston*, and *Orangeburg* soils. Everywhere the drainage is good. Many of the slopes wash badly if carelessly cultivated. The area in cultivation and that capable of satisfactory cultivation is considerably less than in the smoother country to the south.

Much of the area is timbered with shortleaf pine, with some oak and hickory.

Interior Coastal Plain of Northeast Texas, Northwest Louisiana, and Southwest Arkansas.—This region comprises a large area of prevailingly rolling country lying to the north of the Texas-Louisiana Flatwoods, and extending from the Mississippi bottoms westward to the Black Waxy Belt. Its elevation ranges from about 100 to 500 feet above sea level, and the surface is moderately rolling, with here and there high red hills, and elsewhere level, poorly drained areas. Dome-shaped mounds like those of the Coastal Prairies to the south are of common occurrence, especially in the eastern part of the region, often giving the surface a peculiar billowy configuration. Nearly all of the region is topographically favorable to cultivation. The drainage of the rolling lands is generally good, but there are many flat and undulating areas that are imperfectly drained. The dominant soils are grayish and brownish fine sandy loams, silt loams, and clays (*Susquehanna* and *Caddo* soils). In a triangular area in Texas, with Hearne, Tyler, and San

Augustine near the angles, and in the northern part of the Louisiana-Arkansas area, there is relatively more soil with yellow and red friable subsoils (*Norfolk*, *Orangeburg*, *Ruston*, and *Greenville* soils). There are conspicuous ridges of deep gray sand in Robertson, Leon, Freestone, and Anderson counties, Texas, and red hills in Smith, Anderson, and Nacogdoches counties, Texas, and adjacent country, and in a strip of country bordering the Ozarks in southwestern Arkansas. There is much red land (*Orangeburg* and *Ruston*) in northwestern Louisiana and southwestern Arkansas, but probably more heavy clay subsoil land (*Susquehanna*) and wet, gray land (*Caddo*). In the eastern part of this belt pine predominates; in the western part oak is the principal tree. There are occasional prairie areas in the western part.

The Interior Flatwoods of Texas and Louisiana.—Between the Coastal prairies of Texas and the rolling lands to the north there is a broad belt of flatwoods country with flat to gently rolling surface, extending eastward into southern Louisiana and southwesterly to the Black Waxy Belt. In this flatwoods region there are many large, flat areas on which water stands after rainy seasons.

In some respects this area repeats the characteristics of the interior flatwoods of Mississippi. The principal soils are gray, compact, fine sandy loam, fine sand, silt loam and clay (*Lufkin* soils). The flat areas, which predominate, are known as "post oak flats" and "pin oak flats." There is also much gray soil with yellow, mottled yellow and gray and light reddish subsoils (*Norfolk*, *Caddo*, and *Ruston* soils) in the southeastern part where longleaf pine is a conspicuous tree. Also, there are scattered, small areas with red friable subsoil (*Orangeburg*), mottled red, stiff subsoils (*Susquehanna*), and some prairie areas consisting of mixed red and black land (*Crockett* soils). The Lufkin soils are generally timbered with oak.

The Black Waxy Belt.—The strip of flat, undulating, and gently rolling prairie country extending from the vicinity of Red River along a line between Clarksville and Denison, Texas, southwesterly to the vicinity of San Antonio is known as the Black Waxy Belt or Black Belt. There is a second important belt, having predominantly the same soils, which extends from Washington County, Texas, southwesterly into Webb County, near the Rio Grande.

These large areas are mainly occupied by the ashy colored and black, well-drained limy soils (the *Houston* clay and *Houston black* clay). Their surface is nearly everywhere topographically favorable to the use of all kinds of farm machinery. Practically all of the upper belt is cultivated and much of the lower one, although the less humid southwestern section is partly used for pasture land. The elevation above sea level ranges from about 100 to 500 feet.

The Rio Grande Plain.—This level to gently rolling belt comprises a rather indefinitely defined section bordering the Rio Grande from its mouth northwestward to the Edwards Plateau country, marked by the Balcones fault escarpment. The principal soils here are the gray limy land (*Brennan* soils), the black limy soils (*Maverick*), and the gray loose sands (*Nueces*).

Red Lands of South Texas.—There are two large bodies of these red lands, one lying between the southern extension of the lower Black Waxy Belt and the Edwards Plateau, and another lying between the same part of the lower Black Waxy Belt and the southern extension of the Coastal Prairies, extending from the vicinity of the Guadaloupe River to the Rio Grande Plain.

The principal soils are sandy loams, gravelly loams, and loams with red subsoils. Those with the red surface soils are the *Duvall* soils and those with dark surface soils are the *Goliad*.

East Cross Timbers.—This is a narrow belt of rolling to hilly country crossing Johnson, Tarrant, Denton, and Cooke counties, Texas, and extending into southern Oklahoma. There are many stony (sandstone) slopes, hills, and ridges, and at the same time, much smooth country, well suited to farming. There are even, low flats (occupied chiefly by *Wilson* and *Tabor* soils) that are imperfectly drained in places. The principal soils are the well-drained brown to reddish lands with stiff red subsoils (*Kirvin* soils). These are timbered with post oak. Some *Durant* soils occur within and near this belt. These are brown to dark-brown soils with mottled reddish, yellowish, and brownish subsoils, typically treeless.

GEOLOGY AND SOILS OF THE COASTAL PLAIN

The Atlantic and Gulf Coastal plains region is made up of waterlain material which was brought down by the regional drainage, the streams issuing from the higher and older land areas to the north and east—that is, from the Piedmont, the Appalachian Mountains, the limestone valleys and uplands and the Great Plains Region. Much of this stream-borne material was carried to the ocean where it was deposited. The finer sediments, which remained in suspension longest, were carried farthest out to sea, while the coarser particles were laid down near shore. The present areas of clay land probably represent those very fine particles that were carried out into deep water or deposited in the quiet sounds, while the deep sandy beds probably were formed near the coast line. The calcareous beds, which give rise to the limy soils, such as the Houston, were formed in those waters that were favorable to the development of that type of marine life whose remains contributed calcareous material to the deposits. Eventually these sedimentary deposits became land areas through processes of upbuilding and probably of upward movement of the strata of the region.

On their journey to the sea and probably also while in the agitated waters of the ocean, especially along the beach, the particles forming these beds were more or less altered by abrasion. The grains of sand and the chert and quartz gravel have been rounded by attrition, and probably a considerable percentage of mineral particles have been reduced to particles of clay and silt or dissolved. In many places the sands are made up almost wholly of quartz grains, being much simpler in mineralogical composition—that is, containing a much lower percentage of particles other than quartz—than the sandy soils of the stream bottoms and of the older land areas of residual soils lying farther from the coast.

Geological studies of the underlying beds of this region indicate that there were emergences and resubmergences of the sea floor during the formation of the Coastal Plain, and that there were variations, from time to time, in the source of the sediments and in the manner of, or conditions attending, their deposition. The province comprises a succession of belts representing geological formations of different age, in most of which, as now presented at the surface, there is some distinctive peculiarity of topography or of the component material. The older strata constitute the interior belts, which conform in direction with the rims of the older rear-land areas. Later deposits were laid down successively over the older ones, and each belt has a general slope, either toward the present coast or toward the coast as it existed immediately after the period of deposition. Thus, along the Atlantic Coast, the slope is to the east and South, in Alabama it is almost due south, along the Mississippi it is toward the bottoms of that stream on both sides, conforming with the shores of the ancient Mississippi embayment whose waters reached as far north as Missouri, and in Texas it is toward the shore of the Gulf of Mexico. All the formations represented in the Coastal Plain do not reach the surface everywhere, since in some instances they have been covered by later deposits and in others removed by erosion. The coastal sandy beds along the east side of the Mississippi bottoms have been buried by loessial material of the Memphis and Grenada soils or the Brown Loam consisting of wind-blown material with a thickness near the bottoms of 50 feet or more.

Many changes have taken place in the exposed materials of the Coastal Plain. Running water has altered the configuration of the surface considerably over the higher interior areas and to some extent over the lower coastal belts. It has also changed the texture of the surface soil over local areas of the slopes and ridges particularly, by washing out the finer particles, leaving the coarser sediments, the sands, as the surface covering. Also, water sinking downward probably has had some effect in carrying the finer particles from the surficial zone down to lower depths. There have been important modifications due to organic life and chemical changes. Oxidation, the principal effect of aëration, governed largely by drainage conditions and porosity of the materials, has been instrumental in the development of many shades of red, yellow, and brown in the varied soils of the region. Accumulated decaying vegetation accounts for much of the brown and black color of the surface soils, while the leaching effects of percolating and running water and the prevention of oxidation through the exclusion of air by the presence of excessive quantities of water or by the inperviousness of the heavy clays have been mainly responsible for the light gray, bluish, whitish, and mottled colors. Under certain conditions of drainage brownish and black concretions with a high content of iron have been formed in many places, particularly in the flat, imperfectly drained areas. Compact, impervious layers have also been formed in the subsoils of flat areas under certain conditions, generally associated with poor drainage. The presence of much lime in the exposed material has apparently been closely connected with the origin of the dark or black color in the surface soils of large areas—the black prairies of Texas, Alabama, and Mississippi.

There are many areas that probably have not been changed much since the uplift of the region. This seems to be particularly true in case of many of the sandy belts, which may conform rather closely with the original characteristics of the materials of old beach lines and sand dunes.

In the semiarid section of southern Texas, the low rainfall has not favored the leaching out of the soluble salts as in the humid country to the east, and, as a result, the soils contain more water-soluble salts, and in some places are alkali.

This semiarid or southwestern portion of the Province is considered a distinct sub-division—a region of different climate and different vegetation, and including, mainly, different soils. Some of the dark-colored soils, such as that mapped as Houston, are not so distinct, as compared with soils found farther east, and in reconnoissance work have been correlated with the more easterly equivalents. This has not been done, however, with many other important soils here, such as the red Duval soils, which in some respects resemble the red Greenville soils occurring farther east in the Coastal Plain.

Although most of the soils of the Coastal Plain apparently have been derived from unconsolidated sedimentary material, beds of sand, sandy clay, and heavy clay, there are many areas that are underlain by hard and soft limestone, from which the soils have been derived through decay. These limestones are extensively developed in central Texas, in Alabama, Mississippi, Florida, and southwest Georgia. In places there are strata of sandstone varying from soft to hard, and thin beds of rock formed by the precipitation of iron salts leached from the surface materials.

East of the Mississippi, sandy soils of a quartzose nature very largely predominate. Outside the Clay Hills, interior Flatwoods, and Black Prairie belts, where the soils are mostly of a heavy clay texture, at least in the subsoil, probably 90 per cent of the area consists of sandy loam and deep, loose sandy soils with sandy clay or sand subsoils. There are relatively large areas of loam and silt loam in the Chesapeake Bay section, but here there is little heavy clay in the subsoil.

West of the Mississippi there is relatively more of the silt loam and clay soils, but here, too, sandy soils are important, especially those that are sandy in the surface portion, east of the Black Waxy Belt and north of the Coastal Prairies and Flatwoods.

The table below, showing the areas of the more important Coastal Plain soils covered by detailed and reconnoissance soil surveys of the Bureau of Soils up to January 1, 1918, gives some idea of the relative importance, in area, of the principal soil groups of the Coastal Plain. When the entire province is surveyed there may be some change in the relative areas, as now shown. A revision of some of the older surveys will likely show that some of the soil mapped as Norfolk consists of Ruston, Tifton, and possibly other soils:

	Acres
Norfolk soils	20,440,860
Houston soils	7,059,072
Orangeburg soils	6,499,232
Susquehanna soils	5,447,896
Ruston soils	5,325,824
Victoria soils	4,724,608
Portsmouth soils	3,937,224
Duval soils	3,482,304
Sassafras soils	2,332,654
Lufkin soils	2,277,376
Nueces soils	2,210,240
Greenville soils	1,631,424
Edna soils	1,543.104
Brennan soils	1,405,504
Goliad soils	1,149,696
Tifton soils	1,138,496
Maverick soils	1,073,664
Coxville soils	1,001,280

GENERAL AGRICULTURE OF THE COASTAL PLAIN

The soils of the Atlantic and Gulf Coastal Plain are very diversified, comprising sufficient range in texture, and existing under sufficiently varied climatic conditions, to support a highly varied agriculture. There are extensive areas of excellent general-purpose and special-purpose soils adapted to most of the staple crops of the country, to crops that will not succeed in the northern part of the United States, and to tropical and subtropical crops.

The climate ranges from the subtropical immediately along the Gulf where sugar cane, rice, citrus fruits, mangoes, avocados, chayotes, pineapples, dasheens (tanier), and, in extreme cases, a few coconuts and bananas are grown, to the moderately temperate climatic conditions in the more northerly areas where such crops as buckwheat and the northern varieties of apples succeed. Between these extremes, cotton, corn, peanuts (for market and for oil and meal and field forage for hogs), tobacco, small grain, sorghum, cowpeas, velvet beans, and many other forage crops, various grasses, pecans, peaches, apples, strawberries, and a large number of vegetables thrive.

General farming is the prevailing type of agriculture over the greater part of the region, but specialized farming is the dominant industry in many localities, such as the growing of sugar cane, oranges, and grapefruit near the Gulf, and vegetables and strawberries along the coast and in some localities of the interior. Cotton, corn, and tobacco are the crops more generally grown; they are the great crops of the Coastal Plain. It is estimated that about 70 per cent of the cotton crop is produced on the soils of this region. In the drier, southwestern border of the province, the nonsaccharine sorghums ("grain sorghums") come in as crops of some importance, but cotton is an important crop here too. Alfalfa, also, succeeds in this southwestern region, especially on the limy uplands and on the alluvial soils. Cotton is the principal money crop, but tobacco, rice, sugar cane (for sirup and sugar), peanuts, citrus fruits, sweet potatoes, and vegetables are locally very important market crops. With the exception of the Chesapeake section and the northern part of the Texas black belt, grain farming is not important, although considerable oats are grown for use on the farm. Most of the corn is fed on the farm to the work stock, hogs and cattle, and used for meal.

Wheat, corn, clover, and grass are the important crops in the Chesapeake Bay region, and elsewhere north of the Cotton Belt, except in some localities where tobacco, sweet and Irish potatoes, vegetables, berries, peaches, and apples are the chief crops. Large yields of wheat and corn are made on the brown soils (*Sassafras* soils) of the upper Chesapeake Bay Country, and the clovers, alfalfa, and grass do very well on them.

The raising of live stock in the Coastal Plain, except in the Texas portion, until recently has not been carried on as the principal industry on many farms, and there have been relatively few exclusive stock farms. Nevertheless, most farms have raised a few hogs, chiefly for home use, and a great many have raised cattle, occasionally selling a few. Little imported beef is bought by the rural population, but the cities buy considerable quantities. Large quantities of pork are imported for both the rural and urban population. Recently the raising of hogs and beef cattle has increased, notably in southern Georgia, Alabama and in Mississippi, and in the Maryland Eastern Shore country, and an increasing number of farmers are specializing in hogs or cattle. In southern Georgia, where sweet potatoes and peanuts are grown between corn or cotton and alone as field-forage crops for hogs, packing houses are being established. In Texas live-stock farming is of large importance, there being many farms on which beef cattle constitute the chief product, and there are many large ranches devoted exclusively to the raising of cattle, particularly in the southwestern part of the region. In the Cotton Belt the raising of beef is favored not only by the mild climate, but by the locally produced valuable feeds, cottonseed meal and hulls, and the easy production of such excellent forage crops as velvet beans, sorghum, and Japanese cane. Sheep raising has not become very important, nor has dairying, except in a restricted way about some of the larger towns. Some sheep and goats are raised in occasional localities in the cut-over pine lands, notably in southern Mississippi, and in south Texas. The large area of unused cut-over lands offers good opportunities for sheep and goats. They can be raised here without feeding or housing in summer or winter. The principal enemy to sheep and goats is the dog.

Most farms produce their own milk and butter and raise some poultry, while many sell some turkeys, chickens, eggs, and butter. In the Chesapeake Bay section considerable cream is sold to creameries. Much butter is imported for the urban population.

Bermuda grass is the most valuable grass for the region as a whole. It is not grown nearly so extensively as it should be, but recently its worth has been more appreciated, and in some localities, notably in Texas and southern Arkansas, it is being grown on an increasingly large scale for hay and pasture. Lespedeza is a valuable grazing and hay plant through the Cotton Belt, growing wild over most of the region. Broom sedge and crab grass [1] are valuable for hay and grazing, and near the gulf carpet grass is an important wild pasture grass. Johnson grass thrives on the limy soils of the Gulf States. The "tame" grasses and clover are more important in the northern part of the province. Sweet clover will succeed on all the limy lands. Sorghum is a good forage crop and also makes good sirup. It succeeds throughout the belt. Japanese cane produces heavy yields of forage near the Gulf. Sudan grass succeeds throughout the Cotton Belt, and does especially well on the soils of the prairie regions.

A crop which promises to take a very much more important place in the agriculture of this region is the peanut as a producer of oil, peanut meal, and as a field-forage crop for hogs. It succeeds especially well on the well-drained sandy loam soils throughout the Coastal Plain. Still another crop of growing importance is the velvet bean, which is being largely used as field forage and for ground feed

[1] These two grasses have been considered by many as worthless plants. "Broom sedge land" has even been used as a designation for poor land, although it grows on nearly all abandoned fields just as does old field pine. Its presence is not an indication of poor land, it affords much good pasturage, and cut at the right time, before the stalks have become too old and woody, it makes fairly good hay. Crab grass is a troublesome plant in cultivated fields of the South; but it, also, makes fairly good hay, and is extensively used for hay, especially in Florida, Georgia and the Carolinas.

composed of the beans and hulls. This succeeds from North Carolina southward.

The production of vegetables by market gardeners is important about many of the cities of the Coastal Plain, while trucking and berry growing are the principal industries of many localities. As compared with the staple farm crops, the acreage devoted to vegetables and berries is small. These crops are treated intensively, and on favorable soil give heavy yields, so that a relatively small acreage suffices to meet the somewhat limited demand for some of the vegetables and for berries. Potatoes are grown on a much larger acreage than such vegetables as asparagus, celery, and lettuce; they are more of a staple or necessary product than are such vegetables. Proximity to large markets or favorable water and rail transportation facilities, good soil, and coöperative endeavor are among the principal requisites for the successful development of trucking districts.

Some of the most important trucking sections[1] of this region are scattered through southern New Jersey, Delaware, the Eastern Shore section of Maryland, the district south of Baltimore, the Norfolk and Eastern Shore sections of Virginia, Newbern and Wilmington, N. C., Beaufort, Charleston, and Barnwell counties, S. C., Chatham and Thomas counties, Ga., the Hastings, Sanford, Manatee, and other Florida peninsula districts, Mobile and Baldwin counties, Ala., the Biloxi and Crystal Springs, Miss., sections, Smith County, Texas, and the South Texas district. In many of these districts one to three or four crops often constitute the leading or dominating products. The Eastern Shore, Va., and Hastings, Fla., districts are known chiefly for their early potatoes;[2] the Charlestown District

[1] See Yearbook, U. S. Department of Agriculture, 1916, pp. 435–65: Development and Localization of Truck Crops in the United States.

[2] The Eastern Shore, Va., district shipped nearly 6,000,000 bushels

produces a large amount of cabbage and cabbage plants; asparagus, cucumbers, and string beans are the leading products of the Barnwell County, S. C., district; watermelons are the leading product of Thomas County, Ga., celery and lettuce of the Sanford and Manatee, Fla., districts; winter tomatoes, string beans, and cauliflower of the South Florida peninsula district; and Bermuda onions of the South Texas district. In New Jersey and the Delaware-Maryland peninsula district the canning of vegetables is very important, especially of tomatoes, corn, and garden peas.

There are numerous districts where the strawberry crop is either the leading or a very important crop, as in the Maurice River section of New Jersey; the Selbyville, Bridgeville, and Seaford sections of Delaware; the Marion, Pittsville, Fruitland, Princess Anne, Berlin, and Showell sections of Maryland; the Norfolk section of Virginia; the Chadbourn, Mount Tabor, Teacheys, Rose Hill, and Mount Olive sections of North Carolina; the Loris section of South Carolina; the Plant City, Lawtey, and Starke sections of Florida; the Castleberry and York sections of Alabama; the Sanford and Russell sections of Mississippi; Hammond, Lousiana, and the Deepwater and Alvin sections of Texas.

Peaches and apples are grown commercially in many parts of Southern New Jersey, Delaware, and the Eastern Shore of Maryland. The commercial production of peaches is important in many localities through the Coastal Plain east of the Black Waxy Belt of Texas, as in the Southern Pines, N. C., Fort Valley, Ga., Evergreen, Ala., Meridian, Miss., Howard County, Ark., and Smith County, Texas, sections. Pears are also important locally in eastern Maryland, southwest Georgia, and elsewhere. Blackberries and dewberries are commercial crops about Hammonton and

of Irish potatoes in 1917. This district also produces annually about 2,000,000 bushels of sweet potatoes.

other parts of southern New Jersey, in the vicinity of Denton and other parts of the Eastern Shore of Maryland, and elsewhere. The cranberry industry of the Coastal Plain is confined to the bogs of southern New Jersey, which are swampy lands ditched and usually surfaced with sand.

The most important tobacco sections of the Coastal Plain are the southern Maryland district, the bright tobacco (or yellow tobacco) districts of southeastern Virginia and the eastern Carolinas, and the cigar-wrapper district of western Florida, southwest Georgia, and southeast Alabama.

The prevailing type of farm equipment in the Coastal Plain consists of light plows, mules, and small barns. Most of the cotton, tobacco, and corn land is plowed with light one-horse, turning plows, while the cultivation is done chiefly with light-running plows of the shovel type. The plowing is prevailingly shallow—not more than about 4 to 6 inches deep. The use of heavier plows and deeper fall or winter plowing unquestionably would effect, generally, more efficient preparation of the seed bed, although deep plowing does not seem to be particularly necessary on the deep sandy soils, except where a compact subsurface or plowsole has been formed by long-continued plowing at a constant depth. Heavier plows drawn with two or more horses are in more general use on the heavy lands, such as those of the black prairie belts and of the Coastal Prairies rice lands. The sandy lands do not require heavy teams. As a rule the tillage methods are more efficient than those used in the preparation of the seed bed, at least, for cotton and tobacco. Many more labor-saving implements—plows, harrows, and cultivators carrying more than a single furrow—could be used to good advantage, permitting a more rapid rate of cultivation per man; in other words, increased productive power per unit of labor. The common practice of cultivating corn on ridges is less commendable than that of planting it in the water furrow and cultivating more nearly level, particularly on the sandy lands. In the trucking sections more intensive methods of tillage are employed. Recently, improved or labor-saving implements have begun to come into use in the region, including tractors and 2-row riding cultivators.

Commercial fertilizers are in general use east of the Mississippi River, and are beginning to be used in Louisiana, Arkansas, and east Texas. The acreage application for cotton varies from about 200 pounds to 1000 pounds or more in some localities, the heavier applications being made in such sections as Scotland County, N. C., and Marlboro County, S. C. Heavy applications of high-grade mixtures are made for tobacco and still heavier applications for vegetables. The well-drained sandy soils are nearly all naturally low in vegetable matter, and are much in need of the humus that would be added by growing and occasionally plowing under such crops as cowpeas, vetch, bur clover, rye, and oats. An increased supply of barnyard manure through an increased production of live stock would prove highly beneficial to these lands. Potash salts are more essential for the sandy lands, generally, than for the heavy types of soil. The soils of this region are generally low in lime, outside of the prairie regions, and some benefit may be expected from treatment with lime, particularly on the poorly drained soils after they have been drained. Experience and experiment station tests do not indicate much gain for crops such as cotton, corn, and grain by treatment with lime alone, but the legumes usually are benefited, the clovers, peanuts, and alfalfa especially.

The area of *improved land in farms* for the Coastal Plain province is given by the Census of 1910 as 59,639,903 acres. This amounted to 12.5 per cent of the total area of the *improved farm land* of the United States at that time and 27.3 per cent of the total area of the Coastal Plain province.

In the table below is given the estimated average acreage

PLATE 13.—Cabbage on limestone or marl (Parkwood) clay in Warm Springs Hammock near Coleman, Fla. This is a soil derived from marl. It is very productive, giving good yields of cabbage, tomatoes, onions, oranges and grape fruit. The quality of these products is exceptionally good on this soil. (Photo. by the Author, collection, Bureau of Soils.)

PLATE 14.—Winter-grown string beans on Palm Beach sand, east coast of Florida. These soils lie near the ocean. They are rich in humus, and are excellent for vegetables. This is hammock land, the principal virgin growth being live oak and cabbage palmetto. The paling serves as a windbreak. (Photo. by the Author, collection, Bureau of Soils.)

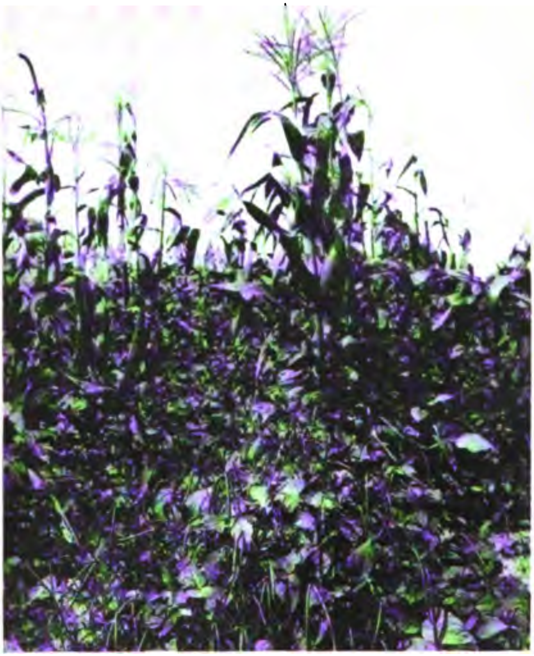


PLATE 15.—Cowpeas and corn on Sassafras sandy loam, near Onley, Va. When the corn is harvested, the pea vines are grazed off, cut for hay, or plowed under to improve the soil. The peas are frequently picked. They are used for seed and also on the table, being especially good for eating. (Photo. by Bonsteel, collection, Bureau of Soils.)

PLATE 16.—Crimson clover and wheat for field forage, Talbot County, Md. Grazed off and residue plowed under. This is a splendid soil-improving crop. (Photo. by Bonsteel, collection, Bureau of Soils.)

yield of cotton by decades for the principal Cotton States including Coastal Plain soils.

ESTIMATED AVERAGE PRODUCTION PER ACRE OF LINT COTTON [1] OF THE COTTON STATES INCLUDING MUCH COASTAL PLAIN SOIL

State	1866–1875	1876–1885	1886–1895	1896–1905	1906–1915
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
North Carolina	171	175	171	199	242
South Carolina	150	152	158	185	223
Georgia	150	147	152	171	194
Florida	140	107	109	122	123
Alabama	149	141	150	162	174
Mississippi	177	175	182	200	193
Louisiana	208	206	211	235	174
Arkansas	216	221	214	206	191
Texas	236	192	198	169	169
Tennessee [2]	170	188	165	182	198
Oklahoma [3]	—	—	—	246	186

[1] Data from the Bureau of Crop Estimates, U. S. Department of Agriculture.

[2] Tennessee includes but little Coastal Plain soil, most of the Coastal Plain beds having been covered by loessial deposits.

[3] Oklahoma includes but little Coastal Plain. This is largely used for cotton.

The table below gives the estimated average production and average yield of cotton for the principal cotton-producing soil regions of the Coastal Plain. The high average yield of the flatwoods is due to the fact that the better-drained lands of this region are selected for cotton and are heavily fertilized; the good yields of the Sand Hills Belt are due to very heavy fertilization; while those of the interior flatwoods are due to the selection of the better-drained areas for the crop. The low yields of the Black Prairies of Alabama and Mississippi are due to the use of considerable imperfectly drained "post oak flats" for cotton, and to the very light use of fertilizers on the long-used prairie soils.

ESTIMATED AVERAGE PRODUCTION AND ACREAGE YIELD OF COTTON FOR THE PRINCIPAL COTTON-PRODUCING SOIL REGIONS OF THE COASTAL PLAINS

Region	*Approximate average production for the five years, 1911–1915*	*Approximate average acreage yield of lint for the census years, 1879–89–99 and 1909*
	Bales	Pounds
Atlantic Coast Flatwoods	290,000	200
Middle Coastal Plain	1,140,000	205
Upper Coastal Plain	1,130,000	190
Clay Hills	820,000	145
Sand Hills	175,000	180
Black Prairies of Alabama and Mississippi	235,000	150
Interior Flatwoods of Louisiana, Texas, Alabama, and Mississippi	366,000	175
Interior Coastal Plain of northeast, Texas, northwest Louisiana, and southwest Arkansas	995,000	164
Black Waxy Belt	1,320,000	175

The table below gives the estimated average acreage yield of corn in the principal Coastal Plain States.

ESTIMATED AVERAGE PRODUCTION, BY DECADES, PER ACRE OF CORN [1]

State	*1866–1875*	*1876–1885*	*1886–1895*	*1896–1905*	*1906–1915*
	Bushels	Bushels	Bushels	Bushels	Bushels
North Carolina	14.3	13.3	12.4	13.4	18.3
South Carolina	9.7	8.8	10.2	9.5	16.7
Georgia	11.3	10.3	11.2	10.5	14.0
Florida	10.9	9.5	10.2	9.3	13.2
Alabama	14.0	12.4	12.8	12.6	16.4
Mississippi	16.0	14.2	14.7	14.7	18.3
Louisiana	18.2	16.3	16.2	16.3	19.9
Arkansas	25.7	21.4	19.2	17.8	20.4
Texas	23.7	19.8	19.0	17.7	20.2
Tennessee	22.9	21.4	21.5	21.9	25.2
Virginia	20.0	17.9	17.4	21.0	24.7
Maryland	24.7	26.0	23.0	32.0	34.9
Delaware	20.5	22.5	19.8	26.8	31.9
New Jersey	36.5	32.8	30.9	34.3	36.5

[1] Bulletin, Bureau of Crop Estimates, U. S. Department of Agriculture, No. 515.

The low yields of corn secured in the Cotton Belt States are due in a great measure to the fact that cotton has been the crop of prime importance—the crop that has received the best cultural and manurial treatment, while much of the corn has been grown more as a side crop, mainly for the work stock. Also, soils not well suited to the crop have been used for it, such as the deep sandy soils, soils with plastic, heavy clay near the surface, and thin mountain slope land. On the good corn soils much better average yields are had. In recent years more attention has been given the cultivation of corn, as the table above indicates.

The table below shows the estimated average acreage yield of wheat by decades for the States in which wheat has a very important place on the Coastal Plain soils.

ESTIMATED AVERAGE ACREAGE YIELDS, BY DECADES, OF WHEAT IN STATES WHERE COASTAL PLAIN SOILS ARE IMPORTANTLY USED FOR THIS CROP [1]

State	*1866–1875*	*1876–1885*	*1886–1895*	*1896–1905*	*1906–1915*
	Bushels	Bushels	Bushels	Bushels	Bushels
Delaware	10.9	12.5	12.1	16.0	16.7
Maryland	10.6	12.8	13.3	15.9	16.5
Virginia	8.3	8.3	8.8	10.3	12.6
Texas	12.8	10.8	10.4	12.3	12.4

[1] Bulletin, Bureau of Crop Estimates, U. S. Department of Agriculture, No. 514.

Delaware lies almost entirely in the Coastal Plain, and most of its wheat is grown on the brown (Sassafras) and gray (Elkton) soils. In both Maryland and Virginia some thin mountain land and rich limestone land in addition to a large area of Piedmont soils are used for wheat. Much of the Texas wheat is grown on the Great Plains soils lying to the west of the Coastal Plain, but it is an important crop in the northern part of the Black Waxy Belt.

DESCRIPTIONS AND AGRICULTURE, SOILS OF THE COASTAL PLAIN

The brown lands of the Chesapeake Bay section—Sassafras *soils.*—The brown well-drained lands (Sassafras soils) are the most extensive and most valuable soils of the Delaware-Maryland-Virginia Peninsula and they are also of very important occurrence along the west shore of Chesapeake Bay in Maryland and Virginia and through southern New Jersey. They consist of brown, mellow soils, chiefly loam, silt loam, and sandy loam, underlain at about 12 to 18 inches by reddish-yellow to light-red friable silty clay or sandy clay, which at depths of about 2½ to 5 feet passes into coarser, looser material containing considerable sand and gravel. There are also considerable areas of gravelly loam, large scattered areas of deep loamy sand, and some rather loose, deep sand. The heavier types are locally styled "red clay bottom[1] soil" and "medium loam," and the sandy types "medium light loam" and "sandy land."

These soils contain more organic matter than the gray soils of the Coastal Plain, such as the Norfolk soils; they are more retentive of moisture and naturally are more productive. Locally there are associated with the *Sassafras* soils, (1) the "marl lands" or "green soil" of the greensand marl or glauconitic formations (the *Collington* soils), occurring in southern New Jersey and parts of Maryland, as in Anne Arundel County; and (2) the red lands (*Colts Neck* soils) of southern New Jersey, as those in Monmouth County. These greensand marl soils are much less extensive than the Sassafras, but they are locally important, as they are good general farm, truck, and fruit soils, with crop values closely approximating those of the Sassafras.

In New Jersey there are, also, extensive areas of the white sandy lands, with orange-colored subsoils (the *Lakewood* soils) locally known as "scrub pine land." Practically all of this Lakewood soil consists of deep, loose, droughty sand of low agricultural value, now chiefly timbered with bushes and scrubby pine and oak. Heavy additions of manure and fertilizer are necessary to secure good yields

[1] The word bottom here refers to the subsoil.

of any crop on this sand. With such treatment asparagus, brier berries, sweet potatoes, and various vegetables succeed.

The Sassafras soils are well drained, remarkably retentive of moisture, and easy to plow and to keep in good condition of tilth. The underdrainage is favored by the relatively open structure of the substratum. The surface of the loam and silt loam is level to undulating and occasionally, gently rolling, while that of the sandy loam averages a little more rolling. The topography over practically the entire Sassafras area is such that any kind of farm machinery may be used.

On these soils there exists a very highly improved type of agriculture. The best average yields of wheat, clover, and timothy secured in the South are made on the Sassafras loam and silt loam. As a rule, the average yields of all the important crops are good. The general farm crops—wheat, corn, clover, and grass—are most extensively grown, but trucking is by far the most important industry in many localities, especially where there is considerable sandy land, as in the Camden and Freehold sections of New Jersey and in Queen Anne and Anne Arundel counties, Md. Peaches, apples, pears, dewberries, and blackberries are very important crops in many sections. The raising of hogs and beef cattle is also important over parts of the soils. There is probably no other section of the United States where so many crops are grown with such good average results as in the country occupied by these excellent soils, where more intensive methods of tillage and manurial treatment are employed, or where the system of farming accords better with the soil adaptations and the advantages offered by the transportation facilities and markets. Efficient implements, ample horse power, and good rotations are in general use. The farm buildings are generally substantial, and good roads and fences or hedges are maintained.

The loam and silt loam are most extensively used for wheat, clover, grass, corn, tomatoes for canning purposes, and Irish potatoes. There are also many good apple and peach orchards; hogs, beef cattle, and poultry are raised for home use and market, and dairying is successfully carried on in some localities. The sandy soils, although used to some extent for the same purposes as the loam and silt loam, are generally selected for the truck crops, and from them is secured a large production of sweet potatoes, peas, sugar corn, lima beans, and tomatoes (for sale and canning), peppers, asparagus, cantaloupes, and other vegetables, and dewberries and blackberries. Peaches and Kieffer pears seem to do better on the sandy soils than on the heavier types. There are some large districts where the principal efforts of the average farm are devoted to strawberries, practically all the soil types being used with good results for this crop.

While grain, corn, and hay are the main crops on a great many farms, trucking and fruit growing are frequently carried on as adjuncts. On most farms, over large areas, situated within 4 or 5 miles of a cannery, boat landing, or railway station, tomatoes are an important, often the most important, crop. Elsewhere potatoes are grown as the main crop or as the principal adjunct crop.

Alfalfa does well on the Sassafras soils, on the loam and silt loam especially, when limed, and there are a considerable number of small to fairly large alfalfa fields. Crimson clover, red clover, and cowpeas are important soil-improving crops. Rye, oats, and alsike and sapling clover are some of the other crops that succeed. The Winesap, Stayman Winesap, Ben Davis, and York Imperial are among the successful apples. The Elberta is the favorite peach, although several other varieties are grown. In some localities peach trees have suffered severely from the "yellows."

The prevailing schemes of crop succession with the general-farm crops are the 3 and 5 year systems, including corn, wheat, and "grass" (clover, timothy alone, or clover and timothy). Frequently grass remains for two years, and tomatoes, potatoes, and other crops are worked into the rotation. With the truck and berry crops the rotations are not so regular, but it is the usual plan to introduce a leguminous crop with them at rather frequent intervals. Often one crop is interplanted in another, so that a single field gives a succession of crops. Crimson clover is frequently seeded between corn and tomatoes in late summer to be plowed under in the spring for green manure.

Large quantities of commercial fertilizers and manure, much of which is shipped in from New York, Philadelphia, Baltimore, and other cities, are applied to the land. High-grade fertilizer mixtures are used, especially for vegetables, and the applications are usually heavy. A common application for corn, wheat, and tomatoes is 300 to 400 pounds an acre of a mixture containing 8 to 10 per cent phosphoric acid and 2 to 4 per cent of nitrogen. A common mixture for vegetables is one containing 10 per cent phosphoric acid and 8 per cent potash. Also, mixtures containing 8 to 10 per cent phosphoric acid, 2 to 4 per cent nitrogen, and 4 to 6 per cent of potash have given very good results with vegetables. Frequently 2 tons of manure are used per acre for corn and wheat and 8 to 10 tons for vegetables. Burnt lime is in general use, being applied usually at the rate of 1000 to 2000 pounds an acre. Wheat yields from about 18 to 35 bushels per acre, corn 40 to 75 bushels, hay 1 to 2½ tons, and potatoes 75 to 110 barrels, on the best soils, such as the Sassafras loam and silt loam. The deep sandy soils give lighter yields.

Gray lands of the Chesapeake Bay section—Elkton soils.— The gray lands of the Chesapeake Bay section, commonly known as "white oak land," are of important occurrence over the lower and the more nearly level, areas. There are many scattered areas, some of them of large extent, throughout the Delaware-Maryland portion of the peninsula and in the less rolling sections of southern New Jersey and on the west side of Chesapeake Bay. The silt loam is the most important type, but there are occasional bodies of sandy loam and loam. Sandy loam is more abundant from lower Delaware southward through the Peninsula.

The Elkton silt loam, consists of a gray silt loam surface soil, underlain at about 6 to 10 inches by light-gray silty clay loam, which passes quickly into mottled gray or drab plastic silty clay. In many places there is enough sand present at depths of about 28 to 36 inches to give this lower part of the subsoil a distinctly sandy character, although this stratum is rather compact. When dry the surface color is conspicuously white, and the tendency is for the soil to assume a compact structure favoring rapid evaporation of moisture. The immediate surface 2 or 3 inches often has a light brownish color when moist.

These gray lands occur over level areas and in slight depressions where there is little or no opportunity for the rainfall to run off. Drainage is further impeded by the imperviousness of the subsoil. In the original growth there is present much white oak, hence the name, "white oak land."

These soils occur in close association with the Sassafras soils. The water fronts are often occupied by a strip of brown Sassafras soil, with the gray Elkton soil occurring a short distance back over the level country where there is less opportunity for drainage. Among other associated soils are the black swampy land (*Portsmouth* soils) of the deeper depressions; the grayish soils with greenish, reddish, and yellowish mottled subsoils (*Shrewsbury* soils); and grayish to brownish soils with stiff mottled clay in the lower subsoil (*Keyport* soils). The last two are not extensive and have about the same value as the corresponding types of the Elkton series. There is considerable light brown to brown soil with a mottled gray and yellow lower subsoil (*Leonardtown* soils) in the Chesapeake Bay Region. The soil of this series is much like that of the Sassafras soils, while the lower subsoil resembles the lower subsoil of the Elkton series.

Owing to the difficulty of giving thorough preparation to the Elkton soils when there is much rain or when the season is very dry, planting is sometimes delayed. In addition, the silt loam is a late soil, slow to mature crops. Wheat and hay are the chief crops. Much of the type is used as pasture land.

In the best years wheat yields about 20 or 25 bushels per acre, hay 1½ tons, and corn 30 or 40 bushels, but the average yields, except that of grass, are considerably lower. Wheat gives much better average returns than corn, yields of the latter crop varying greatly with the season. For good corn crops the rainfall must be moderate and well distributed, since the crop suffers severely when the soil is wet and soggy as well as when it is dry and compact. Alsike clover and redtop grass do especially well on land of this kind.

Improvement of the drainage by ditching or tiling or both is the first step for the betterment of this land. The liberal incorporation of manure or of vegetation has a marked effect in opening up the soil to better aëration, and the liberal addition of lime, 1000 to 2000 pounds or more of burnt lime or twice this amount of ground limestone, at intervals of 4 or 5 years, has been followed by increased yields. Fertilizers containing high percentages of phosphoric acid and potash give good results, and are frequently used for wheat and corn at the rate of 300 to 400 pounds an acre.

Grayish to light brownish Coastal Plain lands with yellow, friable subsoils—Norfolk soils.—The light-colored lands with yellow friable subsoils are the most extensive and important soils of the Coastal Plain region. They occur throughout the region from southern New Jersey to central

Texas, but are most extensive in the section above the Atlantic and Gulf flatwoods, between the James River, in Virginia, and the region of the lœssial soils in Mississippi (see soil map). The sand and sandy loams are the important types. The sandy loams are the principal types below the Sand Hills and Clay Hill belts, with the sand largely predominating in the rolling lands of the northern Florida peninsula, in the Sand Hills and in the belt of rolling country between Tyler and Hearne, Texas.

These soils are characterized by the grayish to very light-brown color and loose nature of the soil and by the yellow color and friable structure of the subsoils. The sandy loams consist of grayish or very light-brown sand or loamy sand to fine sand or loamy fine sand, passing at an average depth of 4 or 5 inches into pale-yellow material of about the same texture, underlain usually at about 10 to 20 inches by yellow sandy clay of a decidedly crumbly nature. There are many areas where the texture ranges to coarse sandy loam, on the one side, and to fine sandy loam or even very fine sandy loam on the other side. Frequently there is considerable quartz and chert gravel on the slopes and ridges. In the sand type there is no important change from the surface down to a depth of 3 feet or more, the material changing only in color from grayish to yellowish. There are many areas of fine sand and coarse sand. In the more nearly level tracts, such as are of common occurrence within and near the Atlantic and Gulf flatwoods, the surface soil is frequently darker colored, owing to the higher content of organic matter, and there are in some of the less well-drained areas here slight mottlings of light gray in the lower subsoil of the sandy loams. Where there is much gray mottling in the lower subsoil the soil is classed as *Caddo,* and where there is much reddish mottling in the subsoil it is classed as *Bowie,* as in Bowie County, Texas.

The Norfolk soils are all thoroughly drained, with the rare exception of a slight excess of moisture in the lower subsoil of a few low-lying areas of the flatwoods country. The sand is excessively underdrained, water passes downward through the loose sand so rapidly with so little retained that crops suffer in dry seasons, unless the soil is well supplied with humus and is kept mulched by frequent shallow cultivation. In Texas the sand appears to hold more moisture than in the more easterly areas, probably because there is more wind to keep the soil mulched by blowing. These sandy soils are characteristically low in content of humus, and the little present is rapidly depleted where a cropping system is followed that does not provide for frequent incorporation of much vegetable matter or crop residues, as for example when light crops of cotton and corn are grown continuously with light fertilization. Where thus impoverished the soil has a leached or lifeless gray appearance and it crusts at the surface after rains. In this condition the soils are very irretentive of moisture. The coarse sandy soils are more droughty than the fine sand and sandy loam.

The Norfolk soils for the most part occupy flat, undulating, and gently rolling country well suited to use of all kinds of farm machinery. Some sections are rather rolling, but practically all the area can be cultivated, and there is generally little danger of erosion. A few slopes carelessly handled in cultivation have been gullied or have had the surface soil washed off down to the sandy clay. Being sandy and loose, good tillage is very easily performed with light horse power—one-horse plows are in general use, but an increasing number of farmers are using two-horse plows for breaking the sandy loams.

In general, the methods of cultivating cotton, the chief crop, are good. By operating more riding plows and other multi-toothed cultivators with increased horse power per man there would be an increased labor efficiency.

These soils are adapted to a wide range of crops, but they are of rather low natural productivity, so that liberal additions of manure or fertilizer are required for good yields of nearly all crops. The yields vary widely according to the type of soil and manurial treatment and, in some measure, the crop rotations practiced, especially those rotations including the legumes. The sandy loams are much better producers than the sand, and also, the productiveness of the soil increases to some extent as the depth to clay decreases.

Cotton yields from about one-fourth bale to 1½ or 2 bales an acre in highly fertilized fields, corn 12 to 50 bushels, oats 15 to 40 bushels, tobacco 800 to 1000 pounds or more, sweet potatoes 100 to 300 bushels, sugar cane 200 to 450 gallons of sirup, peanuts 30 to 100 bushels, cowpea hay 1 to 2 tons per acre, according to the soil treatment, the season, and the type of soil.

A large number of crops are grown on these soils. They produce more cotton than any other group of soils in the Cotton Belt, they are large producers of early vegetables from Florida to New Jersey and westward to Texas, they produce the greater part of the bright tobacco crop, a very large proportion of market peanuts and much of those grown as a field-forage crop for hogs, much of the sugar-cane sirup, large quantities of watermelons, cantaloupes, and very considerable crops of corn, cowpeas, and velvet beans. Scuppernong grapes, peaches, pecans, cigar-wrapper tobacco, sorghum, and oats are important crops locally. Cotton is the most important crop—the principal money crop—over practically all the area occupied by these soils southward from southeastern Virginia, except in the Florida peninsula and in some of the more important trucking sections. In southeastern Virginia and the eastern Carolinas bright tobacco ranks as a very important crop. Market peanuts (the large Virginia variety) are a valuable money crop in southeast Virginia and the adjoining territory in

North Carolina. Many farmers are growing the Spanish variety of peanut is southern Georgia, Alabama, and northeast Texas, as a forage crop for hogs. These peanuts are grown generally in rows between rows of corn and other crops, with but little extra cultivation. A large variety of early vegetables is grown on these sandy lands in Virginia, eastern North Carolina and South Carolina, about Savannah, Ga., in Florida, and in many scattered sections elsewhere.

Heavy shipments of watermelons are made from these lands in some localities, as in Thomas County, Ga., and cantaloupes are commercially grown in many localities. In their adaptation to sweet potatoes, watermelons, early cantaloupes, and cucumbers these soils could hardly be excelled. Sweet potatoes are grown on nearly every farm for home use and on some for sale. Sugar-cane sirup, which is commercially produced in large quantities on the Norfolk soils in southern Georgia, western Florida, and southern Alabama, is of a superior quality, possessing a desirable light color and good flavor. The best quality of the Sumatra type of cigar-wrapper tobacco grown in the western part of Florida and southwest Georgia section is secured from the Norfolk soils, the leaf being of a lighter and more desirable texture than that from the soils with red clay subsoils near the surface. Peaches are grown commercially in some sections, as in or near the Sand Hills Belt of the Carolinas. The Norfolk sand and fine sand are probably the most extensively used soils for citrus fruits in Florida. The velvet bean for field forage and for making ground feed of the seed and hulls is a crop of increasing importance on the more southerly areas of these and the associated soils.

Commercial fertilizers are in almost universal use for cotton everywhere, except in Texas, and some is used there. Tobacco, vegetables, and melons also are nearly always fertilized. The majority of farmers (east of the Mississippi

River) also use fertilizers for corn and oats. The applications for cotton vary from about 250 pounds an acre of low-grade mixtures analyzing 8-1.65-2 to 1000 pounds or more of high-grade mixtures, often made up on the farm of cottonseed meal or other nitrogen carriers, potash salts, and acid phosphate. The more common application consists of about 300 or 400 pounds an acre, and analyzes about 10-2-3. Light additions are generally made for corn and oats, and much heavier additions for tobacco and vegetables. Experiments made on lands of the North Carolina Test Station in Edgecomb County indicate that best results for cotton on the Norfolk sandy loams may be expected from a fertilizer containing a relatively high percentage of potash and nitrogen along with considerable phosphoric acid. Varying amounts of a mixture analyzing 7-2$^{1}/_{2}$-2$^{1}/_{2}$ gave progressively increased yields and profits as the amount was increased from applications of 200 pounds per acre to 1000 pounds per acre. On land very deficient in humus more potash and nitrogen are recommended.[1]

These loose sandy soils are so well drained and aërated that they warm up early and force crops to mature rapidly, so that phosphorus is not needed to hasten maturity. Bright tobacco receives frequently 1000 pounds an acre of a mixture analyzing 8-3-3 and, also, mixtures containing more potash. Some of the better cigar-wrapper tobacco growers of Georgia and Florida apply a mixture of 300 pounds of bonemeal, 400 pounds of potassium sulphate, and 1 ton of cottonseed meal per acre. For vegetables, such as asparagus, lettuce, and cantaloupes truckers sometimes use as much as 2 tons an acre of high-grade mixtures, frequently made up on the farm of cottonseed meal, acid phosphate, potash salts, fish scrap, and other fertilizer

[1] Fertilizer Experiments with Cotton on the Sandy Loam Soils (Norfolk Sandy Loams) of the Coastal Plain, Bulletin North Carolina Department of Agriculture, April, 1914.

ingredients. The best growers of sugar-cane sirup sometimes use as much as 1200 pounds or more per acre of a 10-3-5 fertilizer mixture or the equivalent of this in the several applications made. Cotton and oats, and to some extent other crops, occasionally receive a top dressing of sodium nitrate ("soda") during the growing period. The amount of fertilizer used, especially of nitrogen, can be materially reduced by growing the legumes, such as cowpeas, velvet beans, soy beans, crimson clover, and vetch, in rotation with the other crops.

The heaviest yields of cotton are from those sections where intensive treatment is given the soil, especially with respect to fertilizers, as for example, in Scotland County, N. C., and Marlboro County, S. C. In these sections a common acreage application for cotton is 800 pounds of a mixture composed of 400 pounds of cottonseed meal, 200 pounds of acid phosphate, and 200 pounds of kainite, put in the bed at planting time, with a later side application of 100 pounds of sodium nitrate. In 1909 these counties produced approximately .8 of a bale of cotton an acre, while the average yield for the Cotton Belt is .32 of a bale.

The types of farming practiced on these lands with the exception of tobacco growing, are not those that require much barn space, so that the size of the farm buildings cannot be taken as a criterion of the farm prosperity as it frequently can in the dairying districts of the north, where the cows are carefully housed in winter in large, expensive barns.

Gray to red Coastal Plain lands with red, friable subsoils—Orangeburg and Greenville soils.—These grayish to reddish soils of the Coastal Plain, overlying red friable subsoils, are importantly developed in the Upper Coastal Plain from about Darlington County, S. C., through central Georgia, western Florida, and southern Alabama into Mississippi, and in parts of western Louisiana and east

Texas. The most extensive areas of the red soils, those that are red at the surface (*Greenville* soils) are found in southwest Georgia, extending from Sumter to Early County, and in southern Alabama. The gray soils with red subsoils (*Orangeburg*) are much more extensive than the red soils with red subsoils.

The sandy loams (including sandy loam and fine sandy loam) are, by far, the most extensive and important of the Orangeburg soils. These consist of a grayish to brownish loamy sand or loamy fine sand to sandy loam or fine sandy loam grading into reddish sandy loam or fine sandy loam, and underlain at depths ranging from about 8 to 15 or 20 inches by red friable sandy clay, which in some sections is rather compact and in others more sandy in the lower part of the 3-foot section. In case of the sand type, which occurs in rather small bodies, the sandy clay is not reached within less than about 3 feet of the surface, the soil consisting of loose grayish sand and the subsoil of red loamy sand. In many places small round pebbles, consisting mostly of concretions of a high iron content, are abundant. Such areas are known as "pimply land" or "pebble land." Quartz and chert gravel are also of common occurrence locally. Cultivation is very easily performed, requiring only light implements and horse power.

The principal difference between the Greenville and the Orangeburg soils is that the former have reddish to dark-red or deep-brown surface soils and contain more clay and are more loamy at the surface. The principal types are the clay loam, sandy loam, and gravelly sandy loam. There is also considerable loamy sand and loam. The gravelly areas (reddish-brown iron-cemented pebbles and fragments of rock of a similar nature) are known as "red pebbly land" and "red gravel land." The sandy soils and the loam are easy to plow, but the clay loam requires more power, and the gravelly areas assume a hardened condition in dry

PLATE 17.—Peanuts growing between corn. This crop is often planted between rows of corn, requiring but little additional cultivation. There are many millions of acres of ideal peanut soil through the Coastal Plain region, and also large areas in the sandy lands of the Great Plains, particularly in the West Cross Timbers of Texas, and in the Red Prairies. The production of peanuts in the South has extended rapidly in recent years, especially since its value for oil, meal and as a field-forage for hogs has been recognized. It is now established as a commercial crop of large and growing importance, having spread far from the former region of production in Virginia and North Carolina. (Photo. from collection, Bureau of Plant Industry.)

PLATE 18.—Alfalfa in the Black Prairies of Mississippi (on Houston clay), near West Point. This is an ideal soil for alfalfa. It is the typical lime prairie soil of the Black Prairies of Alabama and Mississippi, and is one of the richest upland soils in the United States. Fields which are said to have been in continuous cultivation to cotton and corn for 75 years without fertilizer or manure are still producing good crops. (Photo. from collection, Bureau of Soils.)

PLATE 19.—Cattle grazing in field of cowpeas on Coastal Plain sandy soil, near Newbern, N. C. Cowpeas succeed well on these sandy lands, and furnish excellent forage, at the same time improving the soil. (Photo. from collection, Bureau of Soils.)

PLATE 20.—Velvet beans and corn on sandy soil of the Coastal Plain, near Tifton, Ga. The velvet bean is one of the greatest forage crops known. It yields heavily, and can be grazed in the field through winter. It flourishes throughout the Cotton Belt, and is being extensively used on an increasing scale as a field-forage crop for cattle and hogs. It also improves the soil, adding humus and nitrogen. The vines have almost obscured the corn in this field. Some varieties grow to great height where there is something to support them; others are more dwarfed. (Photo. from collection, United States Department of Agriculture.)

weather that makes it difficult to force the plow into the soil.

In southwest Georgia, western Florida, and southern Alabama part of the Greenville soils is underlain by limestone, and there is some indication that the material is partly derived from the limestone strata. In Smith County, Texas, and near Nacogdoches, Texas, and in other localities greensand (glauconitic material) is present in the underlying beds, and the soil is much like the red greensand soils of the Red Banks section of New Jersey (Colts Neck soils).

The Orangeburg soils chiefly occupy gently rolling country, with a good many rolling areas toward the interior, including high ridges, some of which have been badly dissected by erosion since clearing, and also with many level and undulating areas nearer the coast. Originally, the surface was everywhere smooth, even on the steeper slopes of the more rolling areas, and favorable to cultivation, but erosion has cut deep gullies in many of the old fields, particularly of west central Alabama and Mississippi. The red Greenville soils occur as level, undulating, and gently rolling lands, admirably suited to tillage. Few areas have been seriously washed.

The Orangeburg soils everywhere have good drainage and yet conserve moisture in amounts usually adequate, except on the deep Orangeburg sand, for the needs of the crops adapted to them, throughout protracted droughts, especially if they are handled in the right way—plowed deeply in the winter or early in Spring, cultivated shallow and frequently and kept well supplied with humus. The red lands are much more inclined to compact or bake at the surface than the gray lands, and crops are more liable to suffer in dry spells, since the hardened surface favors more rapid loss of moisture.

All the sandy types can be cultivated within a few hours or a day after heavy rains, but the Greenville clay loam, especially the level tracts, require two or three day's drying out before plowing can be safely done.

Unfortunately, the sloping areas of these soils are peculiarly susceptible to ruinous erosion. If the slopes are not protected with substantial terraces and the rows run around the slopes with only a slight gradient, following the contour, gullies begin and extend rapidly into the ridges, soon rendering the field valueless for cultivation, if not checked. On many of the higher ridges the washing process has eaten out cañonlike hollows, extending even through timbered areas, toward the crest of the ridge. Frequently such gullies advançing from opposite directions have cut across high ridges, necessitating the building of bridges for the ridge roads. With each heavy rain masses of soil cave into the gullies from their heads and sides, leaving perpendicular walls, the process being more rapid about the heads, lateral encroachment being comparatively slow.

Once started the gullying extends rapidly and soon gets beyond easy means of control. The best plan, of course, is to keep up the terraces so as to prevent gullies from starting. To fill the gullies dams must be constructed or plants like honeysuckle, willow, and Bermuda grass started in the bottoms to serve as soil-catchment barriers. In some cases it may be advisable to cut down the slopes until a gradient is attained that will permit the growth of plants like Bermuda grass and lespedeza. The more severely gullied areas should be allowed to grow up to pine or used only for pasture land.

It is fortunate that much of these valuable lands is level or not so steep as to favor disastrous washing. Nearly all of the area of the smoother topographic features is in cultivation. The remainder is occupied with old field pine or a mixed pine and hardwood growth. In southern Georgia and west Florida that supporting a hardwood-pine growth (oak, dogwood, beech, maple, magnolia, and pine) is known as "hammock land."

These are very valuable farming soils used extensively in the production of cotton and corn and locally for tobacco, peaches, strawberries, sugar cane (for sirup), watermelons, and vegetables. They are also used for oats, cowpeas, soy beans, velvet beans, and all the crops grown in the region of their occurrence. The gray and red lands with red subsoils are used for the same crops as the Norfolk and are handled the same way. Vegetables are perhaps less extensively grown than on the Norfolk, but commercial peach production is much more important. These are the principal lands used for peaches in districts like Fort Valley, Ga., and those of east Texas. They are stronger soils than the Norfolk, requiring less fertilizer for the same yields; some farmers claim from one-fourth to one-third less fertilizer is required to equal the production of the corresponding Norfolk types. The quality of sugar-cane sirup is inferior to that from the Norfolk soils—it is darker colored, especially where the red clay is near the surface; but the yields are heavier. Bright tobacco is said to be inferior in burning and curing qualities, while wrapper tobacco is likely to be rather heavy and gummy, although there is some compensation in the larger yield. It is believed that cigar-filler tobacco of the Cuban type would succeed. These lands are considered splendid peach soils, producing well-colored fruit. The lint of cotton is apt to be stained in stormy, rainy weather by the red soil of the Greenville types to the extent of lowering the price some.

Near the cities and where the transportation facilities are favorable dairying could be successfully carried on, since hay, forage, and grazing crops, such as cowpeas, vetch, velvet beans, sorghum, and Bermuda grass succeed so well. Hogs also can be profitably raised and are, by some farmers growing peanuts as a field forage. At the present time beef cattle are not raised on an important scale, except where some areas are used along with associated stream bottoms. The gullied and more rolling areas could be much more safely utilized for beef cattle than for crops like cotton and corn. Results with alfalfa, grown in an occasional small field, indicate that the Greenville loam, clay loam, and sandy loam can be successfully used for this crop, especially when lime is used, the soil inoculated, and the fields rid of crab grass and other troublesome plants, by preventing all such plants from going to seed during the preceding year or two.

Fertilizers are in general use east of the Mississippi River for all crops except the legumes, the methods of application and the mixtures being generally about the same as on the gray lands with yellow subsoils. Experience shows that 400 to 500 pounds an acre of a mixture analyzing something like 8-3-3 usually gives very satisfactory results with both cotton and corn on the gray sandy loam, particularly when cowpeas or other legumes have been grown at intervals. The red sandy loam, gravelly sandy loam, and clay loam do not need so much. Vegetables and melons require heavier additions of better grades, such as 8-3-4 and 8-4-6 mixtures.

Grayish Coastal Plain lands with light reddish friable subsoils—Ruston soils.—These soils represent an intermediate group between the Norfolk and the Orangeburg. The soil is the same, but the subsoil is more reddish and usually more compact than that of the Norfolk on the one hand, while on the other it is not so red as that of the Orangeburg soils and often has more yellowish and grayish mottling in the lower subsoil, although the mottling is not characteristic. The lower subsoil is often more sandy than the upper subsoil, and in places is slightly compact. These soils are the most extensive lands over large areas of southern Alabama and Mississippi and are important in Louisiana and Arkansas. They occur in the rolling country above the flat coastal areas. Much of these lands occur in close association with the Clay Hill lands (Susquehanna soils). The drainage is well established and the surface is prevailingly well suited to cultivation. The sandy loams (including sandy loam, fine sandy loam, and very fine sandy loam) are the principal types. A good many ridges and hillocks contain large quantities of well-rounded gravel of quartz and chert.

These gray sandy soils are easy to cultivate. They are extensively used for cotton and corn, and the usual regional crops of less importance. They are fertilized and cultivated in the same way as the Norfolk. They apparently require about the same treatment and are adapted to the same crops, and with the same treatment yield about the same.

Grayish Coastal Plain lands with compact, mottled lower subsoils—Caddo soils.—This is another group of soils that resembles the Norfolk soils, the chief difference consisting of the more compact lower subsoil, which is mottled yellow and gray. The upper subsoil is usually yellow and friable like that of the Norfolk. Another difference consists of the more nearly level or depressed surface and the poorer drainage. The drainage generally is not poor enough to prevent cultivation, but without ditching or tiling excessively moist conditions persist for considerable periods after heavy rainfall, causing late planting or injuring growing crops. Small dark-colored pebbles or concretions are of common occurrence in these soils. A very large proportion of the Caddo soils has the dome-shaped mounds, so characteristic of the Louisiana and east Texas country, scattered about over the surface. The principal types are the fine sandy loam, very fine sandy loam, and silt loam.

The Caddo soils are very largely confined to southern Mississippi, southern Arkansas, western Louisiana, and that part of east Texas situated above the Coastal prairies.

A much smaller proportion of these lands is in cultivation than of the Norfolk or Ruston. Much of the region in which they occur has been held as timber tracts for the valuable longleaf and shortleaf pine, and lumbering has been the chief industry. A considerable area, however, is farmed, usually in small fields. Corn, cotton, and sugar cane (for sirup) are the chief crops. Fertilizers are used only sparingly and many of the fields have not been given proper drainage, consequently the yields are usually rather small. Grass does well on these lands. Bermuda grass and lespedeza afford splendid summer pasturage, and can be cut for hay.

There are large areas of these gray lands in the cut-over pine country of Arkansas, Louisiana, and Texas that could be used for raising beef cattle and hogs. By growing Bermuda, lespedeza, cowpeas, sorghum, oats, and corn, and raising beef cattle and hogs on these soils, much of which has never been plowed, there is every indication that numerous successful farms could be established here. The land is simply awaiting farmers to take it up.

In addition to draining the lower lying and level areas, additions of manure and fertilizers would increase the yields. Treatment with lime or ground limestone probably would benefit the soil.

In northeast Texas there is much soil that closely resembles the Caddo, differing in having better drainage and red mottling in the subsoil. This has been given the name *Bowie.* Fine sandy loam and very fine sandy loam are the principal types. Cotton and corn are the main crops. Some peanuts are grown. The yields average better than on the Caddo—they correspond closer with those of the Norfolk soils, and the crop adaptations are about the same as those of the Norfolk. A little fertilizer is used. Post oak and hickory are the principal trees. Dome-shaped mounds are very common. There has been very little erosion.

Light brownish, pebbly Coastal Plain lands with yellow, friable subsoils—Tifton soils.—These soils are very closely related to the Norfolk. They average more brownish in the soil and contain much more of the brownish iron-cemented pebbles (concretions or accretions). Locally, they are known as "pebbly land" and as "pimply land." The sandy loam (including fine sandy loam) is the main type. This consists of a light brownish sandy loam, passing at about 6 to 12 inches into yellow crumbly sandy clay and containing in the soil or subsoil or both, numerous small pebbles. The lower subsoil often shows some reddish color.

This land is found for the most part in eastern and southern Georgia, western Florida and southeastern Alabama, and occupies gently rolling country, with broad, rounded ridges and gentle slopes. It has good surface and underdrainage, and conserves moisture in sufficient quantity for all the crops grown through the average dry season. It is one of the best upland cotton soils. A very large part of it is used for this crop. Corn, peanuts, velvet beans, sweet potatoes, cowpeas, sugar cane (for sirup), and pecans are grown in an important way. A good many hogs are raised for market, and nearly every farm produces all the pork required. The importance of both hogs and cattle is increasing. Well-improved farms, good sand-clay roads, and ample buildings are common on these soils.

These pebbly lands are cultivated and fertilized in the same way as the associated Norfolk soils. They are considered a little more productive than the Norfolk soils.

Grayish to reddish Coastal Plain lands with stiff, mottled red clay subsoils—Susquehanna soils.—These soils predominate over all others in northeast Texas and in the Clay Hill Belt extending from west-central Georgia through southern Alabama into central-eastern Mississippi (see soil map), and are very important in southwestern Arkansas and in western Louisiana above the Coastal Prairie section.

The fine sandy loam and clay are the principal types. These are grayish (in the sandy types) to red (in the clay), with stiff, plastic, red clay subsoils, mottled in the lower part with gray or bluish gray and yellow. Often the mottling begins just beneath the soil. The soil of the fine sandy loam is about 6 to 15 inches deep as a rule. Some scattered areas contain gravel in plentiful quantities, while over some of the rougher tracts sandstone ("iron rock") fragments are abundant.

The surface of these stiff lands is characteristically rolling to hilly, but there are many flat and undulating areas. Frequently the lower slopes along streams are occupied by these soils, while the upper slopes and ridges are covered with more friable soils, such as the Ruston and Orangeburg. There are numerous sections, particularly in the Clay Hills Belt where the country is so deeply dissected and rolling that cultivation is impracticable or impossible. West of the Mississippi River the topography is usually more subdued, and much of the land is cultivated.

The surface drainage is nearly everywhere good; the stiff clay subsoil is rather impervious to movement of moisture and air. The soil washes on the steeper slopes, but gullies do not develop so rapidly as on the Orangeburg soils—there is not the same melting away of the soil during heavy rains as with the much more friable Orangeburg. However, the surface soil of the sandy types, where the depth to clay is shallow, is readily swept from the steeper slopes during heavy rains. Gullies do form, however, in many places.

With the usual shallow plowing practiced, the fine sandy loam is easy to handle, since the plow seldom reaches down to the heavy clay. One-horse plows are the kind commonly used. The clay type is very difficult to plow, so much so that but little of it is farmed. It hardens on drying and sometimes cracks. In some localities it is designated "cowhide land" and "pipe clay land." It is also referred to as "limestone land" in some sections, and again as "soapstone land."

The principal timber growth east of Texas is shortleaf and longleaf pine with some blackjack oak and post oak. Post oak is the principal tree in Texas.

These heavy lands are rather sparingly cultivated for crops other than cotton and corn. Some of the rougher areas are used for pasturing beef cattle. Cotton seems to do better than any other crop grown, and the sandy types constitute very important cotton soils, in Texas especially. Yields of one-half bale per acre are secured with the ordinary treatment, in good years. In Texas where little fertilizer is used and where the boll weevil is intermittently destructive to the crop, the average yield for the large area in the northeastern part of the State dominated by these soils was approximately one-third of a bale per acre for the period 1911–1915. Oats and cowpeas give fair returns, and corn succeeds fairly well where the clay is not too near the surface. Lespedeza has spread over most of these lands. It would afford a large amount of pasturage if all the idle lands were used for cattle. Bermuda also succeeds, and various other plants, such as carpet grass and wild legumes, are abundant. The best use that could be made of much of these soils would be for pasturing beef cattle. With peanuts and sweet potatoes grown on the sandy types for field forage, hogs can be easily raised. Cotton is probably the best crop for the smoother tracts, although with a sandy surface soil 8 or 10 inches deep peanuts can be successfully grown for oil or for hogs. These are not good fruit or alfalfa soils, and they can scarcely be said to be generally well suited to corn. Corn yields vary widely with variations in the rainfall. The clay is valuable only for pasture land and for hay and timber.

Fertilizers of the low grades are frequently used for cotton at the rate of 200 to 350 pounds an acre. With deeper plowing, the growing of legumes in rotation, and moderate addition of fertilizer analyzing about 10-2-3, from one-half bale to three-fourths of a bale of cotton may be expected on the fine sandy loam, 30 to 40 bushels of oats, and 30 bushels of corn or more per acre. It is believed liming would prove beneficial, although it may not be profitable unless used in connection with rotations including the leguminous crops. Ground phosphate rock also possibly could be used to good advantage.

Reddish to brown Coastal Plain lands with stiff red clay subsoils—Kirvin soils.—These soils differ from the Susquehanna [1] soils chiefly in the red to brown color of the surface material, the deeper red color of the upper subsoil, the less mottling present in the subsoil, and in the greater abundance of small and large fragments of iron sandstone and iron-ore rock. They are related to the Susquehanna in about the same way as the Greenville soils are related to the Orangeburg. They are generally rolling to hilly, and are well drained. They occur as the principal soils in the East Cross Timbers of Texas, and in many localities of eastern Texas above the Flatwoods, and also extend over into Arkansas and Louisiana. Scattered bodies are found in Mississippi. Post oak, hickory, and pine are the principal trees.

These soils average more productive than the Susquehanna. They produce good cotton, often one-half bale or more per acre without fertilization. Peanuts do very well on the sandy types, and are being grown in the Cross Timbers Region for oil. Oats do well and corn fairly well. Some peaches are grown on this land in east Texas and southwestern Arkansas. The soil is held in somewhat higher esteem than the Susquehanna, although there are rough, stony areas valuable for pasture land, and timber only.

[1] Considerable tracts of this soil were included with the Susquehanna in the earlier classification.

Black, wet lands of the Atlantic and Gulf Flatwoods—Portsmouth soils.—These black, wet lands are of wide occurrence throughout the Flatwoods from Delaware southward to the Everglades of Florida, along most of the Gulf coast from the Everglades to Panama City, Fla., and from Mobile to the Pearl River bottoms in Mississippi.

They are dark gray to black soils, with a high content of decaying vegetable matter, overlying light gray or mottled grayish and yellowish sand or sandy clay subsoils. The content of organic matter incompletely decomposed is often so great as to make the surface soil mucky, giving the material a fluff feel, referred to in some localities as "chaffy" land. In places there is a rather compact layer of brown sand with a high organic content beneath the dark-colored soil, especially in the sand types of southern Georgia and of Florida. Such land in the more recent classification is called *St. Johns.* In some of the more swampy areas the black material extends downward to a depth of 3 feet, such soil being classed as *Hyde.* There is more of the sand than of any of the other types, although there is considerable sandy loam and fine sandy loam, and some loam.

These soils occur over poorly drained flats and depressions, where there is not sufficient slope or drainage outlets to carry off excess water. Existing under permanently moist conditions, the remains of plants have accumulated in the soil as dark-colored decaying matter. Most of these lands are covered with a thick growth of vegetation, including bay, pine, swamp huckleberry, smilax vines ("cat brier" or "bamboo"), and, farther south, cabbage palmetto. Sphagnum moss, ferns, azalea, white maple, white cedar, and numerous moisture-loving bushes are abundant in the more swampy areas from New Jersey south. Cranberry is plentiful in southern New Jersey. The abundance of bay trees in the Carolinas and Georgia has given rise to the local name "bays" for these upland swamps. In Florida these soils usually are incorrectly called "muck lands." Muck contains much more vegetable matter and less mineral matter than the Portsmouth soils. Where cabbage palmetto is plentiful the land is known as "hammock land." These soils are also found in the pocosins (upland swamps) of the eastern Carolinas.

Many tracts have been cleared, ditched, and put into cultivation. Among the crops that succeed best are corn, strawberries, cabbage, eggplant, and onions. Additions of lime have given good results. Commercial fertilizers appear to be needed for all crops, and barnyard manure is effective. The loam, under proper conditions of drainage, yields very well without much manure, producing 40 bushels of corn or more per acre. Unfortunately there is not much of the loam. The sand is of low productivity and the sandy loam only moderately productive. Cotton frequently does not produce good yields. Applications of a ton or more burnt lime per acre or twice the amount of ground limestone would likely prove of much benefit. Liberal treatment with ground phosphate rock also may result in profitable benefit. Those areas having a clay or sandy clay subsoil will prove more durable under cultivation than those with the common white sand or "quick sand" subsoil.

There are large areas of the sand types in some localities, without suitable transportation facilities, for which the best use seems to be for grazing and forestry. It is, however, only fair grazing land, good native grasses being rather scarce.

The St. Johns soils are associated in occurrence and appearance with the Portsmouth soils. They are extensive in the Florida flatwoods and are found all the way along the coast to east-central New Jersey. They occur in wet flats such as are commonly occupied by the Portsmouth soils. The soil is black with a high content of organic matter;

the subsoil is like that of the Leon soils, having a compact layer of brown sand resembling coffee grounds, this often passing down into lighter-colored material. In places the hardpan is consolidated. In southern Delaware soil of this kind is referred to as "iron mine" land. Ditched, some bodies of this land are being successfully used for corn, lettuce and strawberries.

Gray, wet lands of the Atlantic and Gulf Flatwoods—Plummer soils.—These gray flatwoods soils are most extensive in southeastern Georgia and in the Florida flatwoods. There are also considerable areas in some localities above the flatwoods country, as those in Washington County, Ala., and Ben Hill County, Ga. The true flatwoods soil occupies level areas, while the other variety frequently extends up gentle slopes for a considerable distance.

The fine sand is the principal type. This is a light-gray fine sand with faint light brownish or rusty-brown mottling. This shows little change within the 3-foot section. There are some areas of silt loam. That of the more interior portion of the Coastal Plain, the slope and swale phase, is underlain by an impervious mottled heavy clay, like the Susquehanna, at depths of about 3 to 4 feet.

These are very poorly drained soils through the greater part of the year, but in long rainless seasons, they dry out and harden. The flat areas have poor drainage apparently on account of their level surface just as the Portsmouth, although there may be an impervious substratum; the swale and slope areas have poor drainage because of the impervious substratum, which prevents underdrainage, allowing the water to seep down and saturate the slopes and swales below. Tiling, perhaps, would effect good drainage. Ditches tend to fill up by caving, the saturated sand tending to flow from beneath the top soil, where exposed in the banks of ditches.

Very little of this gray soil has been cultivated. It supports a sparse tree growth and is frequently treeless in the natural condition, and for this reason is locally styled "savanna land," "prairie flatwoods," "grassy flatwoods," and "prairie." It is also locally called "crawfish land," on account of the abundance of crawfish holes. In the spring and early summer there is an abundance of grass which affords fairly good grazing. In dry seasons the grass is likely to die down. Pitcher plants, generally called "bugles" or "trumpets," are a characteristic growth, giving rise to the common local designation "bugle land" and "trumpet land."

A few patches of rice are sometimes grown, but the greater part of the land is not used or is used only for grazing. Some attempt has been made by land development companies to establish groves of satsuma oranges. This is a very poor, undesirable soil. There is little question but that its best use is for pasture land.

Light gray to white Atlantic and Gulf Flatwoods lands with brown sandy "hardpan"—Leon soils.—"Hardpan land" occurs in large and small bodies through the flatwoods of southeast Georgia and of the Florida peninsula. Practically all of it consists of deep sand (including fine sand). This consists of light gray to white, loose sand overlying a "hardpan" stratum of compact brown sand encountered at depths ranging from about 12 to 24 inches. This layer averages about 8 to 10 or 12 inches in thickness. In the upper part the material is black to dark rusty brown, the loosened material resembling coffee grounds. In places it is quite compact. Below it shades off into lighter brown, or orange colored sand, and becomes less compact, frequently passing into whitish sand at 3 or 4 feet. This layer contains a relatively high percentage of organic matter, while the overlying whitish sand contains very little, except in the darker-colored thin layer frequently found at the surface. In places the brown stratum is near enough the surface to be plowed up. It is said crops do not thrive in such exposed material, which is very acid, particularly those which are not exceptionally tolerant of acidity.

The surface of the typical soil is level. It loses its moisture rapidly in dry seasons. In wet seasons it is generally saturated to the surface. The hardpan layer apparently retards internal movement of moisture.

The soil supports a growth of pine, saw palmetto, and gall berry. It is often referred to locally as "palmetto flatwoods." It ranks as an inferior agricultural soil, and very little of it is in cultivation. Deep-rooted crops as oranges and grapefruit do not thrive on such land. In some localities, however, this soil is considered valuable for truck crops, as in the celery and lettuce trucking section about Sanford, Fla. The hardpan layer is said to be looked upon as a favorable feature here, where sub-irrigation is practiced. It is claimed that it prevents much of the water from sinking below the root-zone level and assists in spreading it latterly beneath the plants from one tile to another. Very heavy applications of high-grade fertilizer mixtures or of the separate fertilizer ingredients are made for vegetables, as much as 4 tons an acre by some of the celery and lettuce growers. Where the brownish hardpan material is plowed up treatment with lime is said to assist in getting it into healthful condition for plant growth. The material has a strong acid reaction upon litmus paper. Acid-tolerant plants [1] such as Irish potatoes and tomatoes are commonly grown on the freshly cleared land for a year or two before using it for other vegetables.

Although this soil can be used for vegetables under favorable conditions with respect to overhead or underground irrigation possibilities and transportation facilities, with very heavy manurial treatment, there is so much of it in

[1] See Bulletin No. 6, U. S. Department of Agriculture: The Agricultural Utilization of Acid Lands By means of Acid-Tolerant Crops.

some sections that it is difficult to see just what use can be made of large areas, other than for pine forests. It is not a good pasture soil; that is, the native grasses do not afford much grazing. It may be possible to introduce some valuable grazing grass that would succeed on the type.

Many tracts of this soil have been sold to those unfamiliar with its agricultural value, for good farming land, being represented as good soil with a wide range of adaptation. Some of the buyers cannot but be disappointed, since it is out of the question to carry on profitable trucking on all of these tracts, under present conditions. Some of this soil is found in small bodies in the lower coastal country from Florida and Georgia almost to the northern extension of the Coastal Plain in New Jersey. In the northern areas the lower subsoil is often a yellowish sandy clay, but clay is seldom found in the 3-foot section of the southern areas.

Dark gray to black Atlantic and Gulf Flatwoods lands with mottled heavy clay subsoils—Coxville soils.—These dark-colored soils with mottled, plastic clay subsoils are quite extensive in the Atlantic flatwoods from southeastern Virginia to southeastern Georgia. They are most extensive near the coast. These soils have dark gray to black soils, underlain at about 6 to 15 inches by rather impervious, plastic clay, mottled gray, drab, yellow and red, and resembling the subsoil of the stiff Clay Hills (*Susquehanna*) soils. There is much less sand than in the subsoil of the associated Portsmouth soils and more of the red color. There are associated poorly drained areas where there is no red and much yellow in the subsoil and where the surface is lighter colored (the *Bladen* soils), and other better drained areas with much red, the subsoil approaching the characteristic of the Orangeburg subsoil (*Dunbar* soils). The fine sandy loam is the principal type, with some areas ranging to very fine sandy loam. There are some scattered

PLATE 21.—Johnson grass hay in the Black Prairie Belt of Alabama, near Montgomery. This grass makes very nutritious hay and gives large yields. It is unpopular with many farmers on account of the difficulty of eradication. Close grazing, then shallow summer plowing are effective in killing it. (Photo. from collection, Bureau of Soils.)

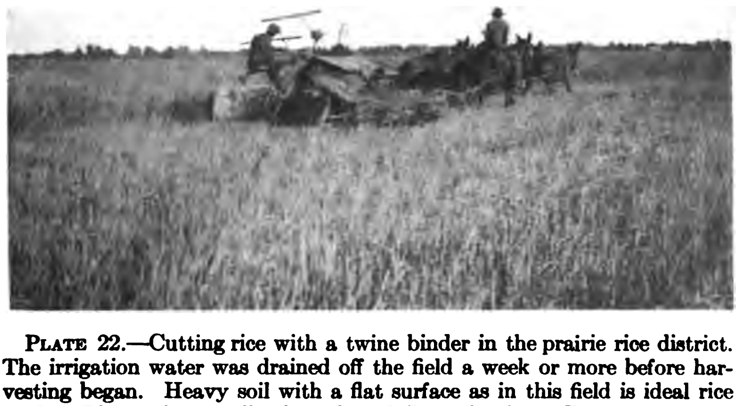


PLATE 22.—Cutting rice with a twine binder in the prairie rice district. The irrigation water was drained off the field a week or more before harvesting began. Heavy soil with a flat surface as in this field is ideal rice land. (Photo. from collection, Cereal Investigations, Bureau of Plant Industry.)

PLATE 23.—Showing topography of good Coastal Plain farm land, buildings and beef cattle on a modern farm of south Georgia—(on Ruston sandy loam soil). The raising of hogs and cattle has recently become an important industry in this region. Many millions of acres of unused land through the cut-over pine lands in the Southern States consist of the same or similar soil, and can be successfully used for beef cattle, sheep, and hogs. Their utilization is simply awaiting occupation and capital. (Photo. by Sweet, collection, Bureau of Soils.)

PLATE 24.—Showing topography of good farm land in the Chesapeake Bay section. Plowing for corn on Sassafras loam soil, Charles County, Md., in the "necks" of the Chesapeake Bay region. The soils in this region have been under cultivation since colonial days. They are still producing high average yields, showing no signs of lessened productivity in the average well-managed fields. (Photo. by Bonsteel, collection, Bureau of Soils.)

small bodies of clay loam, silt loam, and clay. In northeastern North Carolina there is considerable silt loam.

The surface is nearly level and the drainage rather poor. Owing to the infrequency of streams and the imperviousness of the subsoil, much of the rainfall disappears by evaporation. In many places the water table stands within a foot or so of the surface the year round. The original forest growth consisted largely of longleaf pine. The bulk of this has been removed and much of the land now represents idle cut-over land covered with pine stumps. Some true prairie areas and sparsely timbered tracts are called "savanna land," "prairie flatwoods," and "grassy flatwoods."

Part of the Coxville is used for pasturing cattle, the principal grass being broom sedge and wire grass. An increasing area is being ditched and cultivated. Cotton and strawberries are the principal crops. In South Carolina and Georgia the long staple Sea-island cotton is grown with good results. Short staple cotton tends to produce excessive foliage, unless the drainage has been thoroughly established, under which conditions yields of one-fourth to 1 bale per acre are made with fertilization. Corn and oats succeed, especially on the clay loam. Strawberries give good yields of fruit of excellent quality. They are grown for market in the Carolinas. Those areas of fine sandy loam having the yellow and drab-colored subsoil (*Bladen*) are used with much success for extra early Irish potatoes (April crop), as in the Hastings, Fla., district. The yields of potatoes range from about 30 to 60 barrels an acre.

Ordinary grades of fertilizer are used for cotton, corn, and oats in moderate applications. Heavier applications of better grades are made for strawberries and potatoes. In the Hastings district as much as a ton per acre of mixtures containing something like 6 per cent phosphoric acid, 4 per cent nitrogen, and 7 per cent potash, are applied. Treatment with lime, it is believed, would help increase the yields of crops, as the legumes, corn, and oats. The sandy land is very easy to cultivate, the heavier types are more difficult to handle.

The unused stump and pine land could be used for cattle. If seeded to Bermuda and lespedeza both hogs and beef cattle could be raised, especially with the other forage crops that succeed, such as cowpeas, velvet beans, soy beans, sorghum, and peanuts (on the well drained sandy types).

Atlantic and Gulf seacoast sands (beach sand, dune sand), St. Lucie sand, Palm Beach sand.—Along and near the beaches and the line of juncture of the mainland with the tidal marshes deep, loose sands are nearly everywhere present as dunes or flats along the Atlantic coast and to a less extent along the Gulf. In many places the surface of the dunes is constantly changing from the drifting of the sands by wind. Conspicuous dunes occur along much of the coast, such as those on Cape Henry, Va., on Hatteras Island, N. C., and along the east coast of Florida.

The beach sand is a whitish, loose sand, containing fragments of sea shells. This is swept by the ocean waves, and is free of vegetation. Much of the dune sand occurring to the rear of the beach sand, is slightly darker, or grayish, owing to the presence of vegetable matter from plants such as live oak, scrub oak, Spanish dagger, and saw palmetto. That along the Florida coast is often brown, and contains usually fragments of sea shells (*Palm Beach* sand). This supports a dense "hammock" growth of saw palmetto, cabbage palmetto, sea grape, rubber trees, cocoanut, and live oak. Some areas of this brown sand are used with good results for early string beans and other vegetables. The deep almost pure white sand occurring as ridges and flats chiefly along the Florida coast (*St. Lucie* sand) supports a growth of evergreen scrub oak and spruce pine, with some "hammock" areas covered with live oak, magnolia, cabbage palmetto, and hickory. In places the subsoil is of a golden or orange color. In St. Lucie and Palm Beach counties, Fla., this white sand is used for pineapples, heavy applications of fertilizers being used. Grapefruit, oranges, and various ornamentals are grown to some extent, with liberal manurial treatment.

The bulk of the material consists of quartz sand. Except in the areas with a hammock growth, the content of organic matter is extremely low and the sand is loose and very irretentive of moisture. The greater part of these sands can be classed as practically valueless for agriculture.

Hammock lands of Florida and Georgia—Gainesville, Parkwood, and related soils.—This group of soils does not comprise all the lands that are classed as hammock lands, but they represent some of the most important hammock soils.[1] The clay material of the soils of this group is residual

[1] The term hammock in Florida and adjacent Georgia territory primarily refers to timber growth—to those lands supporting hardwoods and trees other than pine, these being chiefly oak, hickory, dogwood, magnolia, and cabbage palmetto. The term is a sort of designation for the better lands. Where there is a hammock growth the soils are usually better, there is more vegetable matter in the soil and often clay or marl lies nearer the surface than in the deep sandy soils of the "piney woods" lands. Nearly every soil of the southeastern Atlantic country locally supports a hammock growth, and always the native population designates these areas as "hammock land." There are a number of terms used to define certain striking features of the hammock soils, with reference to the predominant trees, the topography, color of the soil, texture, etc. Thus we hear the terms "hickory hammock," "oak hammock," "clay hammock," or "chocolate hammock," "red hammock," "river hammock," "low hammock," "high hammock," and "rolling hammock land." Some of the terms have a double meaning, as for example "light hammock" indicates sandy hammock land or hammock land with a light timber growth. "Heavy hammock" generally refers to the heavy hardwood growth, and "mixed hammock" to a hardwood growth interspersed with pine. In southern Alabama and certain localities elsewhere in the Gulf States, the term hammock does not generally carry as definite a meaning as in Florida and Georgia, but usually applies to low-lying productive soils, as the better drained second bottom soils. The term

from the underlying marl beds and siliceous and cherty limestone, including some sandstone.

The principal soils of this group are: (1) the brown to reddish brown, well drained, undulating, and gently rolling lands with red or mottled reddish and yellowish subsoils ranging from loamy sand to rather stiff clay (*Gainesville* soils); (2) brownish to black flat soils overlying whitish and yellowish highly calcareous or marly subsoils, and having fair to poor drainage (*Parkwood* soils); (3) light brown, dark gray, and black soils overlying mottled yellowish, grayish, and reddish impervious, stiff clay subsoils, and occupying poorly drained to fairly well drained flats and gentle slopes (*Fellowship* and *Hernando* soils, the former being dark and the latter light colored in the soil).

The red hammock lands of the Gainesville character are most extensive in the northern Florida peninsula, in the Ocala and Gainesville sections. They occur in rather small areas. There are scattered areas along the east coast as far south as the Homestead section. The loamy sand and sandy loam are the principal types. These are the most productive upland soils of the Florida peninsula. They are used chiefly for Sea-island cotton and trucking. Corn does fairly well and velvet beans, pecans, cabbage, cucumbers, cantaloupes, tomatoes, and string beans succeed especially well. Citrus fruits also do well. Liberal applications of fertilizers and manure are used for all crops.

The dark soils overlying whitish subsoils (Parkwood soils) are only locally important. They occur in small bodies widely separated through the Florida peninsula and, also, northward into North Carolina. When properly drained they produce well, especially the clay loam. Cabbage, onion, tomatoes, and various vegetables give good yields.

is nowhere used with reference to a hummocky surface, as many writers say or infer; at least, it is the experience of the author that no such meaning is ever carried in the term.

Oranges, grapefruit, and tangerines are successfully grown, as for example, in the large grove near Coleman, Fla. Fertilizers are liberally used for vegetables.

The light brown to black hammock soils over mottled stiff clay subsoils of the Fellowship and Hernando series are also widely scattered and not extensive in the total. The largest bodies of these are in Hernando, Pasco, and Citrus counties, running through Brooksville and including Annutteliga and Chocachattee Hammocks and Armstead Prairie in Hernando County. There are locally important bodies between Ocala and Gainesville. The hammock areas are heavily timbered with oak, maple, sweet gum, holly-wood, ash, hickory, cedar, ironwood, and magnolia, but a considerable part supports only pine forest with some scattered sweet gum and oak. The black soils are imperfectly drained and are not cultivated. Considerable wild grass flourishes on them. The better drained light brownish and grayish lands are used with good results for citrus fruits, velvet beans, sugar cane, vegetables, and peanuts for hogs. Dasheens and Rhodes grass thrive on this land. At the plant introduction station near Brooksville commercial fertilizers are used for citrus fruits, sugar cane, and vegetables.

In the lower coastal strip of the flat country between Pasco and Wakulla counties, Florida, there are areas of hammock land, including considerable cabbage palmetto hammock on Parkwood soil. This strip is referred to by the Florida Geological Survey (Annual Report, 1909-10) as the *Gulf Hammock Region*. There is considerable flat soil with whitish limestone material in the subsoil in the section between Alachua County and Live Oak in Suwanee County. Part of this is covered with hardwood or mixed hardwood and pine, and part supports pine only. This latter is a good farming section.

The Everglades.—The large area of treeless marsh near the southern end of the Florida peninsula is known as the Everglades or "glades." To the eye this area appears as a dead-level plain, but there is a faint slope from about 21 feet at Lake Okechobee, the highest part, to about 4 to 8 feet along the eastern edge near the Atlantic Ocean. This area is covered with saw grass, and resembles a vast field of grain. Around the edges there are scattering cypress trees and clumps of myrtle. Toward the southwest the area is bordered by what is known as Big Cypress Swamp. Myrtle, fennel, maiden cane, careless weed, and willow tend to cover the areas that have had the drainage improved by canals, which have been cut through the 'glades from Lake Okechobee to tide water.

The material of the greater part of the Everglades consists of brown, fibrous peat of a felty or spongy character. This is composed mainly of the partially decomposed remains of saw grass.[1] In the natural state the peat was covered with water or remained saturated at all times.[2]

Some strips of the Everglades now dry out in dry seasons, as the result of the drainage canals which have been constructed between Lake Okechobee and the Atlantic Ocean. The area is underlain by a platform of limestone at a depth ranging from about 3 to 12 feet. In many places the limestone is covered with a thin layer of sand or marl.

There is a narrow rim of muck around Lake Okechobee, consisting of black finely divided and well-decomposed vegetable matter, containing considerably more mineral material, including fine sand, than the peat.[3] The material

[1] The loss on ignition of a large number of dry samples collected by the Bureau of Soils ranged from 80 per cent to 93.9 per cent. See Report, Fort Lauderdale Area, Fla., Field Operations, Bureau of Soils, 1915.

[2] In Alaska and Canada such land is called muskeg.

[3] The average loss by ignition of the dry material of samples collected by the Bureau of Soils was 60 per cent.

is practically uniform to about 3 to 6 feet, where the color changes to brown.

This strip of muck varies from about 1 to 2 miles in width. Its surface is nearly flat, with a gentle slope away from the lake. This area has sufficiently good drainage, at least in the higher part, to be farmed, although it has been overflowed by water from the lake during storms. At the present time the water table stands at about 20 to 40 inches below the surface. The natural vegetation consists of thick groves of custard apple covered with the vines of moonflower, and with elderberry and ferns. Areas of shallower muck occur about the outer edges of the Everglades.

The natural drainage of the Everglades was through the sloughs, which carried the water out through breaks in the "rock rim" near the Atlantic Ocean, and through the Caloosahatchee River flowing westward to the Gulf. The limestone rim is a slightly elevated ridge of limestone rock, locally covered with sand, lying between the Everglades and the Atlantic Ocean. Large quantities of water overflowing from Lake Okechobee and from rains have caused frequent overflows of the Everglades. The drainage canals appear to be lessening the extent and depth of the inundations.

Patches of the Everglades peat near the drainage canals recently have been used for vegetables such as cabbage, beans, lettuce, potatoes, and radishes. The muck land about Lake Okechobee has given good results with cabbage, onions, tomatoes, and beans. Among the other crops grown to some extent are strawberries, Irish potatoes, eggplant, peppers, cabbage, and sugar cane. Of the tropical fruits, bananas, avocados, guavos, and papayas have succeeded. The muck along the eastern edge is also used to some extent for vegetables, but most of it is forested with swamp maple, willow, cypress, and myrtle. It may be, if satisfactory drainage is established by the canals, the productiveness of the material could be improved by scattering over the surface crushed limestone from the local beds. Fertilizers undoubtedly will be required for the continuous production of good yields on the peat deposits. In this connection, Sellards says (1909-10 Annual Report, Florida Geological Survey): ". . . peat, unlike humus or ordinary soil, contains very little plant food. Its nitrogen is largely inert, . . . and it is usually sour and very deficient in other ingredients which nearly all crops need, such as lime, phosphoric acid, and potash." If a few inches of the surface material should be burned, the resultant ashes likely would increase the productiveness for a time, as has been found true of the peat deposits of Finland. Manure, fertilizers, lime, and drainage, however, probably will afford the most economic means of immediate and long-continued utilization of peat.

The area of the everglades is estimated at something like 5,000,000 acres.

Bays, pocosins, savannas, upland swamp, tidal marsh, and mangrove swamp.—These designations represent different types of swamp and wet lands. *Bays* and *pocosins* represent areas of flat to slightly depressed land having very poor drainage, and covered with a dense swampy growth including bay, tupelo, sweet gum, swamp pine ("slash" or "pond" pine), highbush huckleberries, gall berry, smilax vines, white cedar, azalea, cypress, myrtle, and titi. These are really *upland swamps*—areas without sufficient natural drainage outlets to provide good drainage. The soil consists mostly of black sand and sandy loam (Portsmouth), with areas of muck and some peat. Notable examples of such swamps are Big Pocosin north of Newbern, N. C., Angola Bay in Pender County, N. C., and Okefenokee Swamp south of Waycross, Ga. Portions of these upland swamps are being canaled and cleared for cultivation. Corn and vegetables are the most promising crops.

Tidal marsh comprises the low marshes occurring along the coast of the Atlantic Ocean and the Gulf. These are covered with salt grasses and sedges and are subject to inundation by salt water of the ocean. The material consists of dark colored and mottled brownish and bluish, oozy, silty, and clayey sediments of a high salt content, and containing much decaying vegetable matter and a mass of living marsh-grass roots. The salt marshes grade into fresh-water marsh up some of the tidal streams. In places these marshes have been reclaimed by diking or by diking and pumping. Along the Delaware River a number of areas were diked many years ago, and are still being used to some extent for corn, strawberries, hay, and pasture land. Strips of tidal marsh and of the adjacent river bottoms about the mouths of some of the south Atlantic rivers, as the Cape Fear in North Carolina and the Santee, Savannah, and Altamaha to the south, were diked and used for rice long before the Civil War. These old rice plantations at one time comprised a highly developed type of agriculture, supporting many prosperous and cultured families with palatial residences. Since the war the industry has declined, especially since rice growing was taken up in Louisiana, Arkansas, and Texas. The dikes have been neglected and the fields gradually turned out until the Carolina-Georgia rice industry has declined almost to the point of disappearance. Recent higher prices for rice have induced a limited revival of the industry on some of these rice lands.

In Louisiana the marshes are being reclaimed and used for corn, rice, and sugar cane. In southern Louisiana, in Iberia Parish, reclaimed tidal marsh produced over 50 bushels of corn per acre the first year after reclaiming by diking and pumping. Sugar cane made a large stalk on the fresh soil, but the content of sucrose was low and that of glucose high. After the third crop, sugar cane has done well. In Texas, and to a less extent elsewhere, the marshes, the higher, better drained portions, are used for pasture land and for cutting coarse hay. The inner higher marshes of the Texas Coastal prairie country (*Lomalta* clay), which are inundated only by high-wind tides from the Gulf, are pastured to a considerable extent. Such higher marsh or semi-marsh land does not contain so much salt as the lower areas which are overflowed daily, and they can be reclaimed much more easily.

About the south coast of the Florida peninsula there are strips of marsh upon which mangrove grows in abundance. Such marsh is called *mangrove swamp*. No attempt has been made to drain these areas. Such swamp is partly or wholly subject to tidal inundation.

Savanna is a designation applied to treeless areas and those supporting only a scattering growth of trees. It carries a meaning opposite to that of pocosin. The term is most frequently used in the flatwoods country along the South Atlantic coast. In Florida such land is usually known as prairie, "prairie flatwoods," and "grassy flatwoods." Generally the soil of the savannas consists of imperfectly drained gray or black land, with light-colored friable to mottled, stiff subsoils (*Portsmouth*, *Plummer*, and *Coxville* soils). Many areas have been taken into cultivation.

Muck and peat.—These terms are applied to the areas of accumulated vegetable matter—the decaying remains of plants—occurring as turf or bog in low, wet situations. Many of the areas are old lakes which have been filled in with plant remains.

Peat usually contains 90 per cent or more of vegetable matter. Characteristically the color is brown, and the texture fibrous, preserving much of the original structure of the plant parts. Frequently the trunks of trees are buried in it. These are softened with decay, but apparently are not changed physically in other respects. The material is of a felty or spongy character, and absorbs large quantities of moisture. It shrinks greatly upon drying, and will burn readily.

Muck represents material of the same source, more thoroughly decomposed and containing more mineral matter. The color is black. When wet the material is pasty, when dry it is granular, with some tendency to compact and crack. The average content of vegetable matter is about 60 per cent. This material represents a closer approach to a true soil than peat—it is the transitional stage between peat and black soils, such as the Portsmouth.

Areas of muck and peat occur throughout the flatwoods from New Jersey southward. The individual areas are generally small and widely scattered. They are found in the swamps, with a growth of bay, tupelo, cypress, swamp pine, myrtle, highbush huckleberries, titi, azalea, white cedar, maple, a variety of holly, sphagnum moss, and other water-loving vegetation. Some areas of peat support only a growth of saw grass or saw grass with scattering cypress and myrtle. The Everglades is a notable example of this variety. In Florida the black sandy Portsmouth soils, which are far more extensive, are often mistaken for muck.

Areas of muck have been ditched and put into cultivation in many parts of the flatwoods. They are used chiefly for corn, strawberries, and vegetables. Cabbage, onions, celery, and lettuce succeed especially well. Experience indicates that a complete commercial fertilizer is necessary for the maintenance of good yields. Those mixtures containing a relatively high percentage of potash appear to be the best. Heavy applications of lime have given good results. Ground limestone and phosphate rock may be expected to prove very beneficial.

Peat has not been used so much as muck. In Putnam County, Fla., fair crops of corn and potatoes have been obtained from reclaimed areas of the prairie or saw grass variety of peat.

The limy lands of the Black Prairie Belt—Houston, Victoria, and Maverick soils.—The ashy brown and black prairie limy lands of the Black Prairie Belt of central Alabama and northeast Mississippi and of the much larger areas constituting the Black Waxy Belt (or Black Belt) of Texas (*Houston* soils) comprise very valuable farming soils. These occupy undulating to gently rolling country, have good drainage, and are nearly all in cultivation. In places the virgin soil is characterized by a hummocky surface, referred to as "hog wallow" land. In Alabama and Mississippi there are about 1,000,000 acres. In Texas there are about 8,700,000 acres in the upper or western Black Waxy Belt alone, and probably about 2,500,000 acres in the lower belt. Small detached bodies occur in other parts of Texas and in southern Oklahoma, southwestern Arkansas, and central Louisiana.

The main types are the clay and black clay, with considerable areas ranging to the texture of a loam. The clay is a rather dark-gray soil in the surface, passing at depths of about 5 to 15 inches into yellowish brown or greenish yellow rather plastic clay, often containing in the lower part of the 3-foot section enough whitish, chalky, limy material to make the clay distinctly friable. On drying, the surface, especially of eroded areas, assumes an ashy-gray color that gives rise to the local name "ash prairie" and "gray prairie." The black clay is black or nearly black at the surface, but usually passes into dark brown or yellowish clay in the lower subsoil, often containing whitish, chalky, lime material. In places, especially in swales and along the lower slopes, the black material extends to a depth of 3 feet with very little change. The typical soils are highly calcareous.[1]

[1] An interesting chemical feature sometimes encountered in the Black Waxy Belt clay classed as Houston black clay is that some areas con-

When wet the soil is very sticky, but in the dry condition it granulates or flocculates, crumbling to a desirable pulverulent tilth. Even the clods turned up when the soil is plowed wet crumble down with the first rain.

These soils are derived from the underlying lime beds, consisting mainly of whitish and bluish soft chalky limestone, "rotten limestone." In places the limestone is hard. In washed areas, especially along stream slopes, the soft rock has been exposed at the surface. These washes are known as "bald prairie" and "white prairie."

Both the surface and underdrainage are good, with the

tain but little lime in either soil or subsoil and most of this is in combinations other than the carbonate, no effervescence being noted with hydrochloric acid, whereas the typical soil is very limy and most of the lime is present in the carbonate form, the material effervescing freely with hydrochloric acid. The soil in both cases is identical in other visible respects, both crumbling on drying to a desirable pulverulent condition; but the subsoil of that with low lime content does not contain the whitish lime material or the greenish-yellow clay so common in the typical black clay, but has a black, brown, or brownish-yellow subsoil. With respect to cotton production there is no apparent difference in the two kinds of soil, both producing in a good year splendid yields—a bale or more per acre—without fertilization.

This phase of the Houston black clay is very similar to the black soil of low lime carbonate content found on flats in association with the Houston black clay—the Wilson clay. This latter soil has the distinction of baking, or of crumbling only to shallow depths in dry weather, and crops suffer on it from the effects of drought very much more than on either the Houston black clay or the phase of low lime content.

Representative samples of the typical Houston black clay and the phase of low lime content gave the following results on analysis:

Sample No.	*Location*	*Section*	*Total CaO*	*Total MgO*	*Organic carbon*	*CaO as Carbonate*	*CaO in other combinations*
			P. ct	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
445306	2½ mi. E.	0–20 in.	9.38	0.60	2.20	7.48	1.90
445307	Clarksville, Texas	20–36 in.	11.70	0.73	0.97	10.37	1.33
445308	3 mi. S.	0–20 in.	1.20	0.90	1.91	0.01	1.19
445309	Clarksville, Texas	10–40 in.	1.15	0.93	1.46	0.08	1.07

exception of occasional level tracts. In these the water table stands well below the surface, yet near enough for crawfish to thrive. The soil washes some, but this can be easily prevented or checked by growing crops like sweet clover (melilotus). Even when chalk is exposed the washing can be stopped by seeding to sweet clover and lespedeza.

In breaking the land good plows drawn with at least two horses are needed for efficient work. The cultivation of crops is easily performed with light horse power.

These are strong, durable soils, producing good yields without manure or fertilizer, when the seasons are good and the tillage thorough. They are probably as productive as any upland soils of the world existing under similar climatic conditions. Cotton is the main crop. Considerable corn, oats, and alfalfa are grown. Such land is naturally well adapted to alfalfa, and the acreage of this crop is being extended. The crop is sometimes injured in Texas by the cracking of the soil in dry seasons. Sweet clover is another crop that gives splendid results, and it, also, is becoming increasingly important for hay. Johnson and Bermuda grass, lespedeza, vetch, cowpeas, soy beans, bur clover, sorghum, and velvet beans are among the grass and forage crops that do well. Johnson grass spreads and maintains itself persistently, and in some sections farmers have abandoned the fields over which it has gradually spread to hay lots and pastures. It can be eradicated by close grazing and shallow plowing in summer. Some wheat is grown.

Usually corn yields from 20 to 60 bushels an acre, cotton one-third to 1 bale, Johnson grass 1 to 2 tons of hay, and alfalfa 4 or 5 cuttings a year of one-half to 1 ton each, depending on the season and cultivation. There are fields on the soils that have been in cultivation 50 to 75 years or more to cotton and corn, without the addition of any kind of manure or fertilizer, that now produce three-fourths and sometimes a bale of cotton an acre, when the boll weevil is not active. The land does become somewhat impoverished, however, with such continuous cultivation, especially on slopes where there is some erosion. By including the legumes occasionally in the rotation, and by preventing erosion through contour cultivation or terracing, and with deep, thorough plowing, good yields can be maintained almost indefinitely, probably without fertilizers.

These soils offer excellent opportunities for the raising of beef cattle and hogs and for dairying. The raising of hogs in connection with the growing of alfalfa and other forage crops can be made a profitable industry, as shown by the experience of a number of farmers.

The Houston soils are prairie soils. In the virgin state they were covered with grasses, including, in Texas, much mesquite grass. In some parts of Texas mesquite trees flourish. In southern Texas some tracts support a growth of mesquite trees or bushes, chaparral, and prickly pear.

The *Victoria* soils are very similar to the Houston. They are the black limy lands of the Gulf Coastal prairies, occurring in large areas. The clay is the most extensive type. There is considerable loam and fine sandy loam.

The Victoria clay closely resembles the Houston black clay. Its surface is more nearly level, and the drainage is not so good on this account. It consists of black or very dark-brown clay, which passes beneath into lighter-colored clay, frequently becoming gray or drab at about 3 feet. The surface of much of it is of a "hog-wallow" nature—that is, a surface of associated small irregularly shaped hummocks and shallow intervening depressions. Such areas are called "hog-wallow land." In places the soil on hummocks is grayish or brownish clay, while that in the depressions is black. This has the effect of giving plowed fields a spotted brownish and black appearance. The soil is not so limy as the Houston clay and black clay, at least in the eastern part of the Coastal Prairies and compacts and cracks more when dry. Heavy plows and teams are required to break the land efficiently.

This is a productive soil, giving good yields without fertilizer, when properly tilled. Large tracts of it are used for grazing beef cattle, but much of it is used, also, for cotton, corn, and rice. Cabbage and onions are, also, grown commercially with good results. Cotton and corn yield about the same as on the Houston clay, though the boll weevil probably does more damage than on the northern areas of the Houston soils.

The greater proportion of the land was originally open prairie, covered with a heavy growth of grasses. West of the Guadaloupe River there is some chaparral, mesquite, huisache trees, and cacti, including prickly pear.

The *Maverick* soils in some respects represent the western or semiarid equivalent of the Houston. They occur on the Rio Grande plain in the extreme western part of the Coastal Plain, mainly in Maverick, Dimmit, Zavalla, Kinney, and Uvalde counties, Texas.

The clay loam is the principal type. This is an ashy gray to brownish clay loam passing beneath into light yellowish brown or drab-colored clay. The material contains a high percentage of lime. The surface is gently rolling to level. A small proportion of the land is used for onions, corn, and cotton, with irrigation. In seasons of plentiful rainfall large yields of cotton, corn, and forage crops are made without irrigation, but in dry weather poor yields are made. Much of the area is covered with mesquite, prickly pear, and chaparral. Grasses are found in the valleys, but are not so plentiful on the higher areas.

"Post oak" lands of the Black Belt—Oktibbeha soils.—These "post oak" lands, sometimes locally miscalled "red prairie" and "post oak prairie," are important soils in the Black Prairie Belt of Alabama and Mississippi. They are also developed to some extent in the Black Waxy Belt of

PLATE 25.—A Florida orange grove. . Pine forest in the background. The fine quality of the Florida orange and grapefruit is well known. These citrus fruits succeed best on the well-drained sandy soils (Norfolk) and hammock lands (Parkwood and Gainsville). (Photo. from collection, Pomological Investigations, Bureau of Plant Industry.)

PLATE 26.—Peach orchard in the Fort Valley, Ga., peach district—on red, friable coastal plain land (Orangeburg and Greenville soils). This is one of the great peach districts of the United States. (Photo. from collection, Pomological Investigations, Bureau of Plant Industry.)

[illegible] near Statesboro, Ga. [illegible] easy to culti- [illegible] Photo by the Author. collection, [illegible]

[illegible] Such marsh [illegible] agriculture [illegible] be diked and [illegible] may be required for [illegible] sea water. Land of [illegible] and used for [illegible] the Author. [illegible] collection, Texas. They have dull brown to reddish brown soils overlying mottled yellowish, reddish, and grayish heavy clay subsoils. At about 3 to 5 or 6 feet the limy beds from which the typical black prairie soils (*Houston*) are derived are reached on slopes. This limy material is occasionally reached within the 3-foot section.

These lands resemble the Clay Hills soils (the *Susquehanna*), but they are considerably more productive. The surface is nearly level to gently sloping. Some of the more nearly level tracts are imperfectly drained, but in the main, the drainage is adequate. The original growth consists mostly of post oak.

Much of these soils is in cultivation. Cotton is the principal crop grown. Cowpeas, soy beans, velvet beans, lespedeza, sweet clover, bur clover, and vetch are among the crops that succeed. Corn and oats are grown in a small way. With moderate fertilization cotton yields from one-half to three-fourths of a bale per acre on either the fine sandy loam or clay, which are the principal types. By growing the legumes in rotation with other crops and with deep seasonable plowing these soils can be maintained in good productive condition.

Black Coastal Prairie lands of low lime content—Lake Charles soils.—The less calcareous lands of the Coastal Prairies are found in southwestern Louisiana and southeastern Texas; that is, in the rice-growing district. Superficially they resemble the black Victoria and Houston soils, but characteristically they are not so high in lime content. These are not soils of exceptionally low lime content, but of relatively low lime content as compared with the associated black prairie lands. The clay is the important type. This is a dark gray to black clay overlying slightly lighter-colored clay, generally bluish gray. Small iron and lime concretions are common in the lower subsoil. The surface is level and the natural drainage rather poor, both on account of lack of surface relief and the imperviousness of the subsoil. Much of the surplus rainfall finds its way off through the slight drainage-way depressions and small intermittent streams. Drainage can be improved by deepening and straightening the natural drainage ways. There is an occasional dome-shaped mound of very fine sandy loam.

Although the soil is very sticky when wet, it tends to crumble on drying, even where the soil is plowed in a saturated condition. Consequently the soil works readily into a desirable tilth. Most of the type is used for rice. When fresh, yields upwards of 75 bushels an acre are secured with irrigation, but the average yield is much lower, and with several years of successive cropping the yields fall off. Light treatment with phosphatic and potash fertilizers are frequently used with good results. Some corn is grown on the drained areas, yielding from 20 to 50 bushels an acre. This land is naturally fertile, and with adequate drainage, such as can be secured by ditching or tiling, it can be used for many other crops, such as sugar cane, corn, cabbage, onions, and forage crops. The legumes, such as cowpeas, velvet beans, and soy beans should be grown in rotation with the other crops.

Most of these soils consist of prairie land, but there are some timbered strips near the streams and elsewhere, supporting chiefly shortleaf pine, pin oak, water oak, black gum, sweet gum, holly, maple, and magnolia.

There are some important bodies of very fine sandy loam. On this the dome-shaped mounds are generally abundant. This type is not so well suited to rice as the clay, being more difficult to irrigate, the water passing downward more rapidly. It gives good returns with corn, sweet potatoes, Irish potatoes, cabbage, strawberries, melons, peanuts, beans, and various vegetables.

Brown Coastal Prairie lands of low lime content—Crowley soils.—These brown soils are importantly developed in the Louisiana-Texas rice district. They have light brown, friable soils and mottled brownish, yellowish, and red stiff, impervious clay subsoils, frequently containing small iron and lime concretions. Most of the land of this character is included in the silt loam type. This is used extensively in Louisiana and to some extent in southeastern Texas for rice, giving good yields—50 bushels or more per acre (for details of rice growing see page 291). With improved drainage cotton, corn and forage crops succeed. There is a good natural growth of grasses. Some of the land is used for pasturing cattle. The heavy clay subsoil favors irrigation by checking percolation, thus favoring rice production.

Soil mapped as Crowley silt loam in the prairies of Arkansas occurs on old river terraces, and although practically identical with the Crowley of southern Louisiana, it may be well to hold it, as found in Arkansas, as a closely related type of another soil province.

Poorly drained gray lands of the Coastal Prairies—Edna soils.—These gray lands occupy poorly drained level areas in the Coastal Prairies. They are strikingly like the Lufkin soils of the interior flatwoods, being deficient in lime and humus and strongly inclined to bake on drying out. The fine sandy loam is the principal type. Typically, this is a gray, fine sandy loam, underlain at about 8 to 20 inches by mottled gray and yellow clay of an impervious nature. There are some small bodies of silty clay loam.

The greater proportion of the area is used for pasturing cattle on the native grasses. Some cotton, corn, rice, and sorghum are grown. The yields secured are low. With better drainage and the use of lime and fertilizers or manure, much better crops could be made.

Gray limy lands of the Rio Grande plain—Brennan soils.—In color these soils closely resemble the gray soils of the Coastal Prairie to the east (the Edna soils), but differ materially in containing much more lime and sand in the subsoil, and also, in existing in a drier climate. They are developed chiefly in south Texas, in Hidalgo, Starr, Zapatta, and Webb counties, in a broad belt paralleling the Rio Grande. The fine sandy loam is the important type. This is a gray to light brown, fine sandy loam, overlying compact, heavy, fine sandy loam, or sandy clay. The surface is level to gently rolling. It is used chiefly as grazing land for cattle. Prickly pear, chaparral, mesquite, and grasses constitute the principal growth.

Gray lands of the interior Flatwoods—Lufkin soils.— These interior flatwoods gray lands are very similar to the gray soils of the Coastal Prairies (the Edna soils). The surface is gray or ashy gray, while the subsoils are gray or mottled grayish and yellowish, ranging in texture from compact sand to tough, impervious clay. The principal types are the fine sand, sandy loam, fine sandy loam, silt loam, and clay. They are extensively developed in the interior flatwoods of Mississippi, Texas, and Louisiana. The surface is level to undulating or gently rolling in case of the sandy types, and the drainage is imperfect to poor, water standing on the surface of the level areas after heavy rains. In dry weather they dry out and compact, causing crops to suffer. Originally most of these lands supported a growth consisting chiefly of post oak and other oaks, with some black gum. Occasional small bodies known as "glades" were treeless. Common local names are "flatwoods land," "pin oak flats," and "post oak flatwoods," the "pin oak flats" being the poorest drained.

The Lufkin soils are not very productive. The content of lime and organic matter is low, and it is difficult to maintain the soil in a well-pulverized condition, as it runs together when wet and dries out hard. The more rolling and better-drained sandy types are used to a considerable extent for cotton and some for corn. Little of the clay is in cultivation. Manure or commercial fertilizers are required to produce good yields. Cotton seldom runs over half a bale to the acre. The heavier types, the clay and silt loam, and the level areas of the sandy loam could be used for rice, provided irrigation water can be had at reasonable cost. In some localities these soils have been used for this crop, giving good yields. A considerable part of the soils could probably best be used as pasture land. Lespedeza and various forage crops succeed. The good yields are had in years of equably distributed rainfall only. Crops suffer on all the types in both wet and dry years. Even the intractable Lufkin clay produces rather good crops if the seasons are just right.

Black prairie lands of low lime content—Wilson soils.—These are dark gray to black soils, with black to mottled grayish and yellowish stiff clay subsoils. Superficially they resemble the limy black belt soils (Houston), but contain much less lime, and harden rather than crumble on drying, or do not crumble so deeply as the Houston. Locally the soils are called "pancake land," on account of the tendency to bake. Cultivation of the clay and clay loam, the principal types, is limited to a narrow range of moisture conditions. If plowed when wet enough to be sticky the upturned soil hardens on drying to intractable clods difficult to pulverize; on the other hand, if breaking is delayed until the soil dries out it is difficult to plow at all, and rough clods are turned up. The surface is level, or nearly so, and the drainage rather poor. These soils occur through central Texas east of the Black Waxy Belt, and also within the Black Waxy Belt, as in Grayson and Denton counties. They are used mainly for cotton, the crop to which they appear best adapted. The yields are lower than on the black limy soils. With favorable seasons, however, good yields, especially of cotton are made.

Mixed grayish, brown, and black prairie lands, with reddish and mottled or black, stiff subsoils—Crockett soils.—These soils are importantly developed in and east of the lower Black Waxy Belt of Texas, and along the border of the timbered soils. They seem to represent a gradation between the timbered and prairie lands. The fine sandy loam, loam, and clay loam are the principal types. The fine sandy loam is grayish brown to dark brown in the soil and dull red to mottled red and yellowish in the clay subsoil. The topography is gently rolling. It is sometimes called "yeopon land," owing to the abundance of yeopon bush. The heavier soils are of a spotted brownish to black color in the soil, with mottled reddish, yellowish, and grayish to black subsoils. The black spots resemble the Wilson soils, while the lighter-colored ones resemble the Susquehanna or its prairie equivalent, the *Durant* (dark-brown prairie soils with mottled yellowish and reddish stiff clay subsoil). In places the subsoil is somewhat calcareous. These are considered fairly good soils. They are used chiefly for cotton. The sandy lands are locally used for vegetables. Average yields on these lands are better than those on the Wilson soils.

Red sandy lands of south Texas—Duval soils.—These red soils occur in south Texas chiefly in Duval, Frio, La Salle, Zavalla, Medina, Atascosa, Hidalgo, Zapatta, and Webb counties. They resemble the red sandy soils of the more eastern part of the Coastal Plain (the Greenville soils). The soils are reddish brown to red and friable, while the subsoils are bright red and compact. They occupy level, undulating, and gently rolling country and are well drained. In places the material is calcareous (*Webb* soils). The most important types are the fine sandy loam and fine sand.

These lands are used for cotton, melons, vegetables, corn, sorghum, and oats. Melons, sweet and Irish potatoes, cantaloupes, beans, peas, and tomatoes do especially well, when the rainfall is adequate or irrigation is practiced. Much of the land is pastured to cattle. Mesquite, chaparral, prickly pear, catclaw, and guajillo, and native grasses are principal forms of natural vegetation.

Under the description of the Duval fine sand we find in the Soil Survey Report of South Texas (Field Operations, Bureau of Soils, 1909) the following remarks relative to the vegetation:

A large proportion of the type consists of rather open prairie, with a scattering growth of mesquite and some cactus. Where the limestone comes near the surface, or in the slight depressions where the soil is heavier, the growth is much more profuse. The mesquite is rather small—very small in fact when compared with that on some of the heavier types—and not much of it becomes of sufficient size to be of economic importance. The presence of mesquite and the practical absence of chaparral gives a very striking difference to the appearance of the country as compared with areas where the fine sandy loams occur. Several varieties of native grasses were seen growing upon it.

Under the description of the Duval fine sandy loam the following statements are given:

The type supports a heavy growth of scrubby chaparral, guajillo, and various species of thorny brush and cactus. The amount of mesquite is small, especially where the rock is near the surface. The scrubby brush upon the rocky hills is in very striking contrast to the heavy growth of mesquite on the Victoria fine sandy loam and loam of the valleys. The course of the latter may be easily traced by the difference in the vegetation. The guajillo is very characteristic of this type and furnishes a valuable food for stock, especially during the dry seasons. Several species of grass furnish good grazing and greatly increase its value for pasture.

Dark lands with red subsoils of south Texas—Goliad soils.— These lands are confined to south Texas, occurring chiefly in Goliad, Dewitt, Karnes, Victoria, Bee, and Live Oak counties. Predominantly the soils are sandy, the principal type being the sandy loam and fine sandy loam. The soil is dark gray to black and friable, while the subsoil consists of red or reddish brown sandy clay. The surface is rolling, with usually gentle slopes. These lands are used for cotton, corn, sorghum, broom corn, and vegetables, giving good yields when the supply of moisture is sufficient. Some oranges and figs are grown. Alfalfa should succeed. In places post oak, mesquite, and chaparral are plentiful.

Gray sand over clay—Nueces soils.—In south Texas along the coast, and extending back from 50 to 60 miles, is a large area of gray, loose, fine sand usually several feet in depth, underlain with stiff, mottled gray, and yellowish clay. The depth to clay ranges from 2 or 3 feet to many feet, in most places it is over 5 feet. When the clay comes near the surface the soil is more retentive of moisture and consequently of greater agricultural value. The surface varies from almost level to duney or hillocky. Some of the dunes are 50 feet or more in height, many of them have been covered with vegetation and no longer are drifted about by the wind. In many places the sand is being shifted by the wind.

A large part of the type represents rolling prairie covered with grass and dotted here and there with live oak. There are also large areas covered with live oak. There are occasional low areas where there is considerable salt in the soil. Here sacahuista grass is present.

Most of this land is in pasture, to which it is best suited. Grass does well on much of it, remaining green when it is parched on the heavier soils of the region. The porous soil absorbs rainfall readily, and the constant movement of the loose sand at the surface by wind retards its loss by evaporation. The principal area is the large body in Starr, Hiladgo, and Cameron counties.

THE PIEDMONT PLATEAU

GEOGRAPHY

The Piedmont Plateau comprises the moderately elevated region between the eastern foot of the Appalachian Mountains (the Blue Ridge Chain) and the Atlantic Coastal Plain. Beginning in northeastern New Jersey it extends southwesterly as a narrow strip through that State, thence across southeastern Pennsylvania, the extreme northern part of Delaware, and central Maryland into central Virginia, where it widens and continues southwesterly through central North Carolina, western South Carolina, and northern Georgia to central Alabama. From New Jersey to central Virginia the width ranges from about 15 to 65 miles; southward the average width is about 115 miles, the widest place being approximately 200 miles along an east-west line through Raleigh, N. C. The length of the Piedmont is about 900 miles. The region comprises approximately 47,214,000 acres, and at the last census had a population of 3,451,592 urban and 3,966,191 rural. That portion of the region lying to the south of Pennsylvania has an area of 60,321 square miles or 39,605,440 acres.

TOPOGRAPHY AND DRAINAGE

The Piedmont Plateau is a rolling to hilly region, which rises gradually from an elevation along the outer edge, the seaward margin, of about 100 feet, in the northern part, and 500 feet, in the southern part, to an elevation along the inner edge ranging from about 700 to 1500 feet. In one sense the region might be considered as the foothills of the Appalachian Mountains. The outer edge, the line of junction with the Coastal Plain, is sharply defined in places by a "fall line" or border zone through which the waters of the Piedmont streams flow swiftly over the locally accentuated slope into the more sluggishly flowing waters of the Coastal Plain streams. The Delaware, Susquehanna, Potomac, Rappahannock, and James rivers cascade over rocky bottoms directly into tidal water at the lower edge of the Piedmont. But the boundary is not everywhere so distinct, either as regards topography or soil, and in many places the Coastal Plain passes so imperceptibly into the Piedmont, the material of the former division having been spread out like an apron over the edge of the latter, that it is difficult to locate the boundaries.

Usually the inner boundary is marked by an abrupt rise to the higher elevation of the Blue Ridge, but here, too, there are many places where there is no distinct line of division. At some distance back, however, the foot of the Blue Ridge is distinctly discernible nearly everywhere. In Alabama and Pennsylvania, the Piedmont locally abuts low areas of the limestone valleys. In most places a panoramic view of the country shows an even sky line, indicating that formerly the surface was level or much more nearly so than at present. There are, however, occasional hills (monadnocks) which rise conspicuously above the general upland level, marking the location of rocks which have proved exceptionally resistant to weathering. The entire region has been so completely invaded by streams and their tributaries, such as the small intermittent drainage ways, that there are now no large areas without drainage outlets, or slopes which quickly lead to drainage ways. There are numerous deep erosional valleys with frequent steep slopes, through which the creeks and rivers flow, and, locally, gullies—narrow, freshly cut ravines with precipitous slopes—are abundant; but the prevailing slopes of the region are sufficiently gentle and smooth to admit of cultivation. Erosion over cultivated areas and abandoned fields, however, is very active, so that the slopes must be carefully handled, terraced, or used only for soil-binding crops, if wasteful washing is to be prevented. There are, especially in the southern part of the region, areas where inefficient management and ill-advised use of the slopes has been followed by disastrous gullying. Over the broader stream divides there are many plateau areas of undulating to gently rolling topography, and along the Coastal Plain border considerable areas are smoother than is characteristic of the region as a whole. Level surfaces over large areas are rare, but there are isolated examples, particularly in those areas where the soils are derived from rocks such as diorite, sandstone, and shale. The drainage of the region is almost universally good, in fact, the run off is so rapid that much soil material is carried away on many of the tilled slopes. The control of erosion is the most difficult problem confronting the farmer in this region—the conservation of the soil itself is a larger problem than the conservation of soil fertility. Hillside terraces and the growing of grass are the principal means of controlling erosion. Much of the land, however, the smoother portion, can be cultivated without danger of erosion.

GENERAL AGRICULTURE OF THE PIEDMONT

The Piedmont is a region of general farming. In the southern portion cotton dominates the agriculture; in the central part dark tobacco is a very important crop; and in the northern part wheat, corn, timothy, and clover are the principal farm products. Locally, apples and peaches are grown commercially, the former mainly north of the Cotton Belt. Dairying and market gardening are important near the large cities. Future development will probably include a large extension of livestock industries—the raising of beef cattle and hogs particularly and the growing of more subsistence crops in the southern portion.

The average annual production of cotton in the Piedmont for the five years, 1911–1915, was 1,860,000 bales or approximately 15 per cent of the total cotton crop. The average yield of lint cotton per acre for the census years of 1879 to 1909 was 180 pounds.

On the basis of the census figures, the Piedmont includes 21,274,985 acres of improved farm land, which is about 45 per cent of the total land area of this province. The proportion of improved farm land is greatest in the northern part. In Maryland and Pennsylvania about 65 to 80 per cent is classed as improved; while in the Cotton Belt about 30 to 55 per cent is classed as improved. The uncultivated areas are largely timbered, the timber consisting mostly of old field pine, particularly in the southern part, the remainder including virgin timber of shortleaf pine, oak, hickory, and dogwood, with considerable chestnut in the northern part. South of Maryland there is on land formerly cultivated much old field pine that is now merchantable.

In the northern part the farms are mostly self-sustaining with respect to production of pork, meal, flour, and feed for the work stock, hogs, and cattle, but in the Cotton Belt the average farmer buys pork, meal, flour, and considerable corn and some hay for the work stock and other farm animals. The region is about self-supporting with respect to beef production, except for the larger towns and cities. Most farms produce the home supply of milk, butter, poultry, eggs, and vegetables, and north of the Cotton Belt milk and butter are sold from many farms situated near the railroads and cities. Large quantities of vegetables are shipped into the larger cities and many of the smaller towns buy vegetables grown outside the Piedmont.

It is safe to say that nearly every farmer in the region could easily produce all the meat, meal, flour, and hay required, and most of them should do this. This would be the means of reducing farm expenditures immensely, in the Cotton Belt particularly, indeed, it would be the means of improving many impoverished farms, and of substituting a more balanced and profitable type of agriculture. It would not be necessary to reduce the cotton acreage; in fact, by practicing more intensive methods, including deeper plowing and better crop rotations, all these necessary foodstuffs could be produced without a very large increase in the area cultivated.

In general, the agricultural practices are better in the northern part; deeper plowing is practiced, heavier teams and implements are used, crop rotations are more generally followed, more lime is used, and more live stock is raised. This partly explains the higher average yields of grain, corn, and hay in the northern part, but this part of the Piedmont has some advantage in the prevailingly more permeable character of the soils and the consequent fact that they are generally less susceptible to erosion. Better methods are being introduced in the southern part. For example, terracing of slopes susceptible to washing is general now rather than exceptional; in fact, this important practice is more prevalent in the southern part than in the north, even where danger of erosion is about the same.

Fertilizers are in general use. The applications are usually moderate to heavy, ranging from about 300 to 800 pounds per acre. The heaviest additions are usually made for tobacco and cotton. Mixtures containing phosphoric acid, potash, and nitrogen have been generally employed. Potash in relatively large quantities has been used in the fertilizers for tobacco. Much potash has been needlessly used on those soils derived from the granitic rocks—the Cecil soils—apparently. These do not seem to need potash, at least not for cotton or corn. Some other soils do need potash, while all of them generally need nitrogen and phosphoric acid.[1] Lime is probably not much needed on the more extensive soils, except for the clovers and other legumes.

Cow peas have long been grown in the southern Piedmont as a hay and soil-improving crop, and continue to hold an important place. These peas are also used considerably on the table. Recently velvet beans have been taken up, and they are being grown by an increasing number of farmers, the early varieties succeeding as far north as North Carolina. Red clover is quite extensively grown from central North Carolina northward, with timothy coming in as an important crop in Maryland and to some extent in northern Virginia. Red clover can be successfully grown on the deep red clay and clay loam derived from the tough igneous rocks, diorite and diabase, locally known as "iron" rock and "nigger-head" rock (the Davidson and Mecklenberg soils) through-

[1] The following is based on fertility experiments made by the North Carolina Experiment Station (Experiment Station Record, Vol. XXXVII, No. 7, 1917, pp. 625–6): field tests of Piedmont soils, Cecil clay near Charlotte, Cecil clay loam near Statesville, and Cecil sandy loam near Gastonia, all show phosphoric acid to be the limiting constituent of plant food, with nitrogen second. Very little benefit is derived from potash, except where used in a complete fertilizer. The tests on the Iredell loam near Charlotte show that nitrogen is the first element of plant food needed, with potash and lime next. Although a complete fertilizer with lime gives best returns, where phosphoric acid alone is used, no increase is secured. Alamance silt loam near Monroe, Durham sandy loam near Oxford, and Norfolk coarse sand near Hoffman all show nitrogen to be the most needed element of plant food, with phosphoric acid and potash giving good yields when used with . . . . nitrogen. For large crops a good supply of all of the plant food constituents with lime is needed, as well as an increased supply of vegetable matter. On the Cecil clay soils potash either gives no gain or depresses the yields. On other phases of the Cecil series of soils experiments show that nitrogen is the chief limiting element of plant food for large yields of crops, with additions of phosphoric acid needed for best crops. Potash is of least importance.

out the Piedmont, even as far south as Alabama. The same is true of alfalfa.

Alfalfa is now being grown importantly in some sections on these heavy red Piedmont soils, as about Rock Hill, South Carolina, and patches of it are to be seen in many localities through the South. With lime and inoculation this crop can be successfully grown also on the clay loam and the shallow phases of the sandy loam of the granitic (Cecil) Piedmont soils, and possibly also on similar soils derived from schist rocks (Louisa soils). It is predicted that alfalfa will find an important place in the agriculture of the Piedmont down to the southern extremity of this region, within the next decade. Crabgrass gives some trouble in getting a stand, but by previous clean cultivation—the scrupulous destruction of all the grass before seeding—alfalfa can be grown.

Vetch, bur clover, crimson clover, rape, millet, Bermuda grass, and sorghum are some of the other crops that succeed in the Piedmont.

GEOLOGY AND SOILS OF THE PIEDMONT

The Piedmont is a very old region geologically. It was a land area when the present regions to the east and west (except the Blue Ridge Mountain belt) were covered by ancient seas. It is a region of complex rocks including (1) crystalline igneous rocks, such as granite, diorite, and gabbro; (2) highly metamorphosed crystalline, imperfectly crystalline, and sedimentary rocks, such as gneiss, schist, phyllite, slate, and quartzite; (3) partially metamorphosed sandstone and shale; and (4) unmetamorphosed sandstone and shale. The igneous rocks appear as thin and thick dikes and as extrusives; the metamorphosed rocks in many cases have been warped and tilted out of all semblance to their former attitude or position, and in other instances they appear with regular bedding and joint planes. The sandstones and shales of the Triassic (Newark formation) basins are the youngest and least changed. They constitute a distinct group of rocks, just as do the outliers of limestone in the northern part of the region. They are relatively young sedimentary rocks which have not been metamorphosed, except immediately along the contact with the igneous rocks that have been forced up through fractures or openings.

The soils of the Piedmont consist of the products—the residuum—left upon the decay of the underlying rocks. The thickness of this mantle of residual material varies from an inch or so to 50 feet or more, being deepest over the smoother portion where there has been less removal of the material by erosion. There has been little or no mixing of the material, aside from that brought about over slopes by gravitational creep and running water, and this has been of local importance only, as evidenced by the fact that the soils generally bear a close relationship to the rocks lying immediately beneath. On the lower, gentler slopes colluvial material has accumulated in places.

The most effective work of running water in the matter of soil differentiation in the Piedmont has been: (1) the bodily removal of the surface material by rapid erosion, leaving freshly exposed subsoil material or bed rock, and (2) the washing out of the finer soil particles through slow sheet erosion, leaving coarser-textured surface soils.

The chief factors that have controlled the soil differentiation in this province have been: (1) the character of the parent rock, and (2) erosion. A given rock gives rise to material of a definite character over wide areas, except in so far as changes in the residual material have resulted from aëration (oxidation) and erosion. It appears that the color of the subsoil of some important types is due to retarded or advanced oxidation, as the case may be, the more thoroughly oxidized soils being red and the less well oxidized yellow or mottled.

PLATE 29.—Showing the smoothly rolling surface of the northern Piedmont, Howard County, Md.—Manor stony loam soil. (Photo. from collection, Bureau of Soils.)

PLATE 30.—Characteristic topography of good farm land in the southern Piedmont, Iredell County, N. C. Terraces are laid out to follow around the slopes at nearly the same level, having just enough fall to permit rain-water to flow along them slowly. They are invaluable in the prevention of erosion, and permit cultivation on slopes which otherwise could be safely used only for grass, pasture and forestry. (Photo. from collection, Bureau of Soils.)

PLATE 31.—Dark fire-cured tobacco on red clay loam of the Piedmont (Cecil clay loam), Appamattox County, Va. Yields of over 1,200 pounds an acre are frequently grown on this land. (Photo. from collection, Bureau of Soils.)

PLATE 32.—Alfalfa on red clay loam of the Piedmont (diorite or "iron-rock" land—Davidson clay loam), near Rock Hill, S. C. Stand four weeks old. This soil is well adapted to alfalfa, and also to grain, corn, cotton, grass and a number of forage crops. It is a productive soil easily maintained in good condition. Land of this kind is found in many parts of the Piedmont country. (Photo. from Bureau of Plant Industry.)

The dominant soil material of the region is a brittle or only moderately friable, gritty clay; that is, in the subsoil. The surface material varies from clay to sandy loam. Deep sandy soils are of very limited extent in the Piedmont. There are comparatively few places where clay is not reached within 6 to 12 inches of the surface. The loams, clay loams, sandy loams, and clays are the important types, with some stony soils.

In their distribution the soils of the Piedmont show some restriction, resulting, apparently, from difference in climatic influences. In the northern Piedmont the soils with yellow subsoils (*Chester*) are of greater extent than those having red subsoils; in the southern part, the converse is true. The subsoils in the northern part are also more friable than in the southern part. From Maryland south, soils with a very plastic, sticky clay subsoil (*Iredell*) are locally important, but these have not been found in Pennsylvania or New Jersey. Indian-red or chocolate-red sandstone and shale soils (*Penn*) occur throughout the Triassic belt, but these are relatively less extensive in the southern part, giving way to the *Granville* and *Wadesboro* soils, which are derived from the same general class of rocks, but which have differently colored subsoils. The *White Store* soils, which are also derived from Triassic rocks, are important in the southern extension of the Triassic region, but they do not occur in the northern part, the converse being true with the *Lansdale* series.

Of the soils derived from the Piedmont granitic rocks, there are two extensive series, the *Cecil* and *Chester*, and two others of less extent, the *Durham* and *Appling*. The Cecil soils predominate over all other soils of the region, occupying about 60 per cent of the entire province. This series is largely restricted in occurrence to the southern portion—from the vicinity of Culpepper, Va., southward. The Chester soils dominate in the northern Piedmont. The Durham soils are fairly extensive in Virginia, North Carolina, and South Carolina. The Appling soils are of moderate importance in Georgia.

The *Louisa* and *Manor* are the chief soils of the Piedmont derived from schists. The former is the more extensive, occurring through the southern Piedmont where the underlying rocks are of a highly schistose character, and ranking next to the Cecil in point of extent. The Manor is of extensive occurrence in Maryland and Pennsylvania. The York series is found in association with the Louisa, but it is much less extensive.

Soils derived from the group of dark colored, tough igneous rocks, mainly diorite and diabase, usually described as trap rocks, dike rocks, "iron rock," and "niggerheads," are found throughout the Piedmont in scattered areas. The *Iredell* and *Davidson* series are the most extensive of these in the southern part, and the *Montalto* in the northern part, occurring in isolated bodies, usually rather small. Some of the most important areas of Iredell soils encountered are those in the vicinity of Chester, Calhoun Falls, and Winnsboro, S. C., Culpepper and Farmville, Va., Wadesboro, Statesville, and Oxford, N. C., and Talbot County, Ga. Some of the most important bodies of the Davidson soils include the belt extending through Orange County and Charlottesville, Va., and areas near Monroe, Va., Salisbury, Hillsboro, Linwood, Greensboro, and Graham, N. C., Rock Hill, S. C., and in Gwinnett, Green, Jasper, Morgan, Madison, Putnam Talbot and some of the other nearby counties in Georgia. The *Mecklenburg* series occurs in rather small areas in association with the Iredell. Some of the principal areas are those in Cabarrus and Mecklenburg counties, N. C., and York County, S. C. The Montalto series occurs in Maryland and Pennsylvania. In some measure it resembles the Mecklenburg, but the lower subsoil is different.

Soils derived from sandstone and shale are extensively developed in the area of Triassic (Newark) rocks extending interruptedly through the Piedmont from the vicinity of New York City through New Jersey, eastern Pennsylvania, central Maryland, central Virginia, and central North Carolina to South Carolina through Anson County, N. C. The principal series are: The *Penn*, which occurs throughout the areas of these rocks, being most extensive north of central Virginia; the *Granville* in the Virginia and North Carolina areas, the *White Store* and *Wadesboro* in the southern areas, and the *Lansdale* and *Lehigh* (metamorphosed sandstone and shale) from Virginia northward. Soils derived from slates are very extensive over the Carolina slate belt in central North Carolina, extending into South Carolina on the one side, and into Virginia on the other. The *Alamance* and *Georgeville* are the series derived from the slates of the Carolina Slate Belt.

DESCRIPTION AND AGRICULTURE, SOILS OF THE PIEDMONT

Gray to red granitic lands with red clay subsoils—Cecil soils.—The Cecil soils occur chiefly south of Maryland with the larger area in southern Virginia, in the Carolinas, and in Georgia. They are characterized by the red color and brittle or moderately stiff structure of the clay subsoil. The sandy types are grayish in the surface; the loam, yellowish to reddish; and the clay loam and the clay, reddish. Fragments of quartz are usually present in both the surface and subsoil, and veins of this rock often cut through from the surface downward. Large fragments of the parent rocks together with fragments of quartz are abundant over many of the steeper slopes and sharper ridges. Predominately the material is derived from granite and gneiss. The coarse sandy loam is derived from the coarser-textured rock, while the fine sandy loam and loam are from finer-grained rock. The clay loam and clay are derived from granite and gneiss of all textures. These heavier soils generally occupy sloping positions, where erosion does not favor the development of the coarser, looser surface soil, such as exists in the lighter-textured types. Apparently the formation of this sandy surface layer has been accomplished by the gradual washing out of the clay in the surficial layer. Much of the clay and clay loam represents former areas of sandy loam and other types from which the surface material has been washed off.

These soils are gently rolling to strongly rolling and hilly. There are a few level areas. Probably 90 per cent of the land is sufficiently smooth for cultivation, although a fourth or more of this is of such a sloping character that washing will follow the continued growing of clean-cultivated crops and injure or ruin the land if the fields are not terraced, kept in a well-pulverized condition by deep plowing and incorporation of vegetable matter, or used largely for soil-binding crops. The sandy loams and loam generally occupy the smoother, less sloping areas; while the clay loam and clay occupy the slopes; and the stony types, the steepest slopes, strongly rolling, and hilly areas.

The under drainage of these soils is everywhere good, and they conserve moisture well where they are properly handled; that is, plowed deeply, cultivated shallow and frequently, and kept well supplied with humus. The sandy loam, clay loam, and clay are by far the most extensive of the Cecil soils. They are the important farming types. All of these are extensive in occurrence throughout the region.

From central North Carolina, southward, cotton is the principal crop on these lands, although about half the corn needed for work stock and the small amount of live stock is produced. On the coarse-grained Cecil soils it is said that cotton of extra good quality is obtained.

Another crop of increasing importance is cowpeas, which is grown both as a soil improver and for forage and seed. Peaches are locally grown on a commercial scale in Georgia, and to some extent farther north. North of the Cotton Belt dark or export tobacco is an important product, and small grain, corn, and clover find important places in the agriculture. Apples, chiefly the Winesap, are of some importance. There are some commercial orchards in Virginia and North Carolina, but few south of this.

The most promising lines for increased diversification on these lands is an increased production of live stock, beef cattle, hogs, and sheep, dairying in the vicinity of the cities and along the railways, and market gardening on the sandy types near the cities or convenient shipping points. The soils are capable of producing an abundance of stock feed, cowpeas, vetch, and oats, sorghum, soy beans, and Bermuda grass, while the native grasses afford considerable pasturage, and the hardwood forests acorns and nuts for hogs. The sandy loam is not injured by moderate grazing. The clay lands also can be safely grazed when the ground is not wet enough to be sticky. The increased production of legumes for forage will increase the productiveness of the land. With lime and inoculation alfalfa, and probably sweet clover can be successful grown on the clay, clay loam, and the shallow phases of the sandy loams, but at the present time this crop is seen only in an occasional small field.

The sandy soils are much easier plowed than the clay lands; but they do not produce so heavily—that is, where the clay lands are deeply and thoroughly plowed. The former can be plowed over a much wider range of moisture conditions than the latter. If the clay lands are plowed or grazed when wet enough to be very sticky, the soil on drying assumes a very unfavorable hardened structure and forms clods.

Among the drawbacks to the present system of agriculture is the prevailing shallowness of plowing, failure to maintain the humus supply, and the growing of too few winter cover crops. Deep fall plowing is highly efficacious. It is not advisible to turn up more than one or two inches of the fresh subsoil clay in one season, but the plowing should be gradually deepened to at least 8 or 10 inches. Applications of lime at the rate of a ton per acre following fall plowing has been followed with splendid results with the legumes, especially on the clay type; but the practice is not common, at least not south of Virginia. Lime is not particularly needed for cotton and probably not for corn or small grain. Fertilizers are in common use, the applications ranging from about 300 to 600 or 800 pounds per acre for cotton and about 250 to 350 pounds for corn. These mixtures generally carry about 8 to 10 per cent phosphoric acid, 2 to 3 per cent nitrogen, and 2 per cent potash. In many sections farmers recently have not used potash. These soils do not seem to need much potash, at least for cotton and corn.[1] These are durable soils. Once put into good productive condition they are easily maintained in such condition; they "hold improvement" well and are easily improved.

Brownish granitic lands with yellowish, friable subsoils—Chester soils.—The soils of the Chester series have grayish to brown surface soils and yellow, moderately friable, gritty clay subsoils. Occasionally the lower subsoil has a slight reddish cast. The material is largely derived from granite and gneiss, but to some extent from schist. The subsoil is more friable and contains more mica and gritty material than that of the Cecil. The topography is rolling to hilly, and the drainage conditions are excellent; the soils conserve moisture in adequate quantity for crops through dry seasons, and they are sufficiently permeable to absorb rainfall rapidly, thus holding erosion to a minimum. As

[1] See Reports on the Piedmont Soils, N. C. Department of Agriculture.

compared with the Cecil, these soils are much less inclined to wash owing to the more porous nature of the soil and subsoil.

The Chester is the most extensive series in the northern Piedmont, predominating over all other soils in northern Virginia, in Maryland, and in Pennsylvania. The loam is the dominant type, there being little of the sandy classes or clay. Some of the steeper areas are of a stony or gravelly nature. The Chester loam is largely under cultivation. It is a valuable soil, used for general farming, the production of corn, wheat, clover, and timothy. Some beef cattle are raised and fattened for market, and dairying is important in the vicinity of the larger cities, such as Wilmington, Del., and Philadelphia. Locally, canning crops, chiefly sugar corn and tomatoes, are grown. In Pennsylvania some tobacco of the Pennsylvania seedleaf is grown for cigar binder and filler. In Maryland some tobacco of the pipe-smoking type is grown.

Certain varieties of apples, such as the Mammoth Black Twig, Stayman Winesap, and York Imperial succeed. Peaches and other fruits also are grown with good results. Alfalfa has been successfully grown, but it is not an important crop. This soil gives good yields under the prevailing efficient farm methods. Corn frequently yields 50 bushels per acre, wheat 25 bushels, and clover-timothy hay 1 to 2 tons, in the best seasons and with good treatment. In Pennsylvania[1] on the highly improved farms corn yields 40 to 75 bushels per acre, wheat 20 to 35 bushels, Irish potatoes 150 bushels or more, hay 1 to 2½ tons, and tobacco 1200 to 1600 pounds.

Deep plowing is easily performed with two-horse teams, such as are in common use. Commercial fertilizers, usually 8-2-2 and 10-2-3 mixtures, are frequently used. The best

[1] See Soil Survey report of Lancaster County, Pa.: Field Operations, Bureau of Soils, 1914.

farmers apply 300 to 500 pounds an acre for corn and wheat, a little more for tobacco, and 500 to 1000 pounds for potatoes. Considerable barnyard manure is used. Applications of burnt lime at the rate of 1000 to 3000 pounds an acre are made by many farmers at intervals of about 8 to 12 years. The crops are generally rotated, the 5-year system being in general use; that is, corn 1 year, followed by oats, tobacco, or potatoes 1 year, then wheat 1 year, and timothy-clover sod 2 years. Another rotation is corn 1 year, wheat 1 or 2 years, timothy and clover 2 years.

The type of agriculture now practiced on the Chester soils is well suited to the land and the economic conditions. Some improvement would come from a more general use of the steeper slopes for grazing and fruit, since with clean cultivation, erosion does some damage. These are productive, durable soils, easy to cultivate, and easy to improve.

Gray granitic lands with yellow, friable subsoils—Durham soils.—The Durham soils, occurring in the southern Piedmont, from Virginia southward, have grayish surface soils and yellow friable sandy clay subsoils. They are much more sandy and friable in the subsoil than the corresponding types of the associated Cecil soils and are more sandy and grayish (in the surface soil) than the Chester. They are very similar in color, structure, and crop adaptation to the Norfolk soils of the Coastal Plain. The material is derived mostly from coarse-grained, light-colored granite and gneiss of a high quartz and feldspar content. The cause of the yellow color in the subsoil of these well-drained lands is not understood; it may be connected with a low iron content. Topographically, these soils are gently rolling. The drainage is thorough to excessive, owing to the porous nature of the subsoils. The sandy types only are of important extent. The coarse sandy loam and sandy loam are the principal types. These are loose in structure and deficient in organic matter. They can be efficiently tilled with a light equipment of teams and tools, and can be cultivated a few hours after heavy rains.

The Durham soils are largely under cultivation. They are used for bright tobacco, peanuts, cotton, and corn. Their crop adaptation is strikingly different from that of the Cecil soils, and the yields average lighter. An excellent type of bright tobacco is obtained; while on the Cecil soils this type of tobacco cannot be successfully grown.

Commercial fertilizers are in general use. Results show that heavier applications are necessary to secure yields equal to those on the corrresponding Cecil types. Applications of 500 to 1000 pounds per acre of mixtures analyzing about 8-3-3 usually give about 800 to 1000 pounds of tobacco. Peanuts, sweet potatoes, Irish potatoes, and cowpeas do well and cotton and corn fairly well. Grass gives rather poor returns, as does also small grain. The raising of beef cattle does not appear to be promising, but more hogs could be raised to advantage by growing peanuts, sweet potatoes, and other field-forage crops. These soils are well suited to raising poultry.

In order to bring agriculture to the highest point of development on the Durham soils, it will be necessary to use them more generally for the special crops to which they are peculiarly adapted; that is, for bright tobacco, market peanuts, sweet potatoes, vegetables, and poultry. By introducing the legumes and other organic-supplying crops in rotations the deficiency in humus can be effectively remedied. Crimson clover and cowpeas are well suited for this purpose. Barnyard manure is peculiarly efficacious on these light sandy lands.

Gray granitic lands with mottled clay subsoils—Appling soils.—These gray soils hold an intermediate place between the Durham and Cecil series, resembling most the Durham. The soils are grayish and the subsoils yellow with red mottlings or streaks, and more friable than the subsoils of the Cecil, but not so sandy and friable as the subsoils of the Durham. The material is residual, chiefly from granite and gneissoid rocks. In topography and drainage they resemble the Durham, being a little more retentive of moisture. They are adapted to about the same crops as the Durham, averaging a little more productive. Cotton, the chief crop grown, seems to yield better on the Appling soils. About the same treatment is required as with the Durham. They are not quite so productive as the Cecil. These soils have been found only in the southern Piedmont. They are only locally important.

Gray to red "slate" (schist) lands with red clay subsoils—Louisa soils.—These soils are the same as the Cecil in color, topography, and drainage, the chief physical difference consisting of the greasy feel of the subsoil resulting from the presence of mica flakes, and, in places, graphitic and talcose material. They have red clay subsoils, and grayish to yellowish soils in case of the lighter-textured types and reddish soils in case of the heavier types. They are derived from metamorphosed rocks, chiefly micaceous, sericitic, and graphitic schists, talcose rocks and phyllites. The Louisa soils occur through the same region as the Cecil, and they are used for the same crops and are cultivated and fertilized in the same way. They are not ranked as the equal of the Cecil in productiveness, being much poorer yielders, especially where the parent rocks are of a sericitic or talcose character. They are, however, capable of being improved and made to give as good or nearly as good results by the same treatment as that required with the Cecil. The soils seem to be more in need of potash than the Cecil soil.

There is relatively more of the loam and stony land in this series than in the Cecil series. These soils are inclined to compact unfavorably, when they are not well supplied with humus and plowed deeply and seasonably. Cotton is the principal crop. Corn is an important crop, but not every farm produces enough to meet the requirements of the work stock. Some farmers raise a small amount of beef cattle for market. Generally the farms on these soils produce the pork needed for home use, and occasionally some hogs are sold. Oats, cowpeas, and sorghum are grown to some extent. In Virginia grass, wheat, and tobacco of the dark export and sun-cured types are grown.

The principal types are the loam, clay loam, and slate loam. The slate loam occupies rather steep slopes and sharp ridges, and much less of it is in cultivation than of the loam and clay loam. Of the whole series, probably 40 to 50 per cent is in cultivation.

Brownish "slate" (schist) lands with light-red subsoils—Manor soils.—The Manor series may be considered as the northern equivalent of the Louisa. The soils are characterized by the brownish to yellowish color of the surface material and the yellowish-red or dull-red color and greasy feel of the clay subsoil. The upper subsoil is often yellowish, but reddish clay is always found in the lower part of the 3-foot section. The schist rocks, including phyllite, mica schists, and chloritic schist, are the important underlying or parent rocks. Locally the Manor soils are known as "slate land." Mica flakes and other partially weathered particles of the parent rocks contribute the greasy feel to the subsoil. Bedrock is reached nearer the surface, usually, than in the Louisa soils. The topography is smoothly rolling to hilly, and the drainage is good.

The Manor soils are more susceptible to erosion than any of the other northern Piedmont soils. On the steeper slopes where the general farm crops have been grown for considerable periods gullied areas and bedrock exposures are of rather common occurrence. The loam is the principal type, but there are some important bodies of stony loam and slate loam. The last two differ from the loam chiefly in their steeper topography, in the presence of large and small platy rock fragments and the shallower depth to bedrock.

The Manor soils are extensively used for general farming, and, to some extent, they are used for the production of Irish potatoes, brier berries, and apples. They give higher average yields than the Louisa, partly because they receive a more intensive treatment in the way of deep plowing, rotation of crops, and application of barnyard manure, and partly because the soil and subsoil are more friable. They do not yield quite so well as the corresponding Chester types, with which they are closely associated. Corn, wheat, oats, clover, and timothy are the principal crops grown. In the vicinity of towns market gardening is carried on. Some farmers raise veal and some beef cattle for market, and dairying is carried on in some localities in Maryland and Pennsylvania.

Increased production of live stock and dairying by pasturing more of the steeper slopes, rather than encouraging erosion on them by the growing of clean-cultivated crops, is the most promising means of improving the general condition of agriculture on these lands. Aside from this, the soils are used in rather close accordance with their adaptation. They are also generally handled in an efficient manner. Deep plowing is the general practice, the legumes are included in the rotations at rather frequent intervals, and lime and fertilizers are in common use. The soils are handled in about the same way as the Chester.

Gray "slate" (schist) lands with yellow subsoils—York soils.—The York series represents the yellow subsoil equivalent of the Louisa and occurs in the southern Piedmont in association with the Louisa over areas of smooth topography. Only small areas have been found.

These are grayish soils with yellow, compact clay subsoils. The content of organic matter is low and the soils are inclined to assume an undesirable compact condition on drying. They are derived from metamorphosed rocks, mainly micaceous schists. Owing to the compact subsoils, internal circulation of moisture and air is imperfect. The level areas are rather poorly drained. The fine sandy loam and the silt loam are the important types.

These soils are of rather low productive capacity, and they are not so largely used as the Louisa. Cotton is the principal product. Crops are rather late in maturing, and unless commercial fertilizer or barnyard manure is used liberally low yields are obtained. Deep plowing, liberal addition of organic matter, barnyard or vegetable matter plowed under, and liming are the best means of increasing yields. Phosphatic fertilizers will hasten the maturity of cotton. Grass, lespedeza, sorghum, and other forage crops are likely to give best results.

"Iron rock land" or "blackjack land"—Iredell soils.—These soils vary in the surface from light brown in the sandy types to brown, dark brown, and occasionally black in the clay types. The subsoils consist of an extremely plastic or waxy, sticky, heavy clay of yellowish-brown to greenish-yellow color. Greenish and brownish soft, partly decomposed rock is frequently reached at about 20 to 30 inches below the surface. Small black concretions are generally plentiful on the surface and throughout the soil section, giving rise to the local name "shot land" or "buckshot land." A characteristic growth of blackjack oak accounts for the common designation "blackjack land," while the waxy character of the subsoil is responsible for the other common names, such as "bull tallow land," "beeswax land," and "pipe clay." Diorite is the chief parent rock. Well water is usually hard, and for this reason the diorite soils are sometimes referred to as "lime land." Although derived chiefly from a lime-bearing (lime-soda feldspar) rock the soil does not crumble on drying like the highly calcareous

soils. This may be because most of the lime is not in the carbonate form. The surface is characteristically level to undulating, and is often lower than the surrounding granite and schist lands, constituting basin areas. Also, these soils are of common occurrence on slopes, where they are subject to ruinous erosion, if used for other than soil-binding crops. Many of the areas represent long, narrow strips, often several miles long and less than one-eighth of a mile wide.[1] The principal type is the clay loam. Sandy loams and loam are the other important types. A large proportion of these soils is in cultivation, notwithstanding the fact that crops on them are very sensitive to seasonal conditions, and that the most extensive type, the clay loam, is an intractable soil, difficult to plow. Wet seasons alternating with dry periods cause corn and cotton to "french" and cotton to rust badly; continual wet weather makes cultivation impossible, since the soil bakes and clods if disturbed when even slightly sticky; while with continual dry weather undesirable hardness ensues, which causes a rapid loss of moisture by surface evaporation. Such characteristics are not so marked on the loam and sandy types. If the seasons are just right good crops of cotton, corn, and small grain are obtained. In years of well-distributed rainfall cotton gives as much as a bale of cotton an acre, or even more, with intensive treatment. Tobacco of the dark type is grown to some extent in North Carolina and Virginia. The leaf is not so gummy and heavy as that from the Cecil soils. Wheat, alsike clover, redtop, Bermuda grass, lespedeza, and cotton are the crops which appear to give best average results. It is likely that close pasturing will cause unfavorable puddling and hardening. Probably the best method of improving the Iredell soils is to plow under manure and vegetable matter such as clover, melilotus, and cowpeas at frequent intervals.

[1] See Soil Map Anson Co., N. C., U. S. Department of Agriculture.

Potash salts, usually kainit, are added with good results in retarding the frenching of corn and cotton and the rusting of cotton. Bermuda grass could be employed to good advantage in stopping erosion and for utilizing areas already seriously washed. Such eroded lands seeded to Bermuda grass would contribute good pasturage, and this is the only apparent means of profitably using such areas.

Reddish soils with yellowish to red subsoils—Mecklenburg and Davidson soils.—The Mecklenburg soils have reddish brown to red friable surface soils and reddish to yellowish, stiff clay subsoils, grading into yellowish disintegrated rock or very plastic clay at a depth of 3 feet or less. These soils appear to represent an advanced stage in the weathering of Iredell material, having a soil resembling that of the Cecil and subsoil with a yellowish color like that of the Iredell. Diorite is the principal underlying rock. The surface is undulating and the drainage is good. The clay loam is the principal type. These soils have been found mainly in Mecklenburg, Cabarrus, Rowan, and Davidson counties, N. C. They are productive, being adapted to cotton, corn, cowpeas, red clover, oats, and wheat. More potash and less lime are probably needed than in the case of the Cecil clay loam, but the tillage requirements are about the same. There are many areas of reddish to brown loam, clay loam, and stony clay loam through the Piedmont from Maryland southward, which have moderately stiff, red clay subsoils (*Davidson*) soils. These are productive soils, well suited to red clover, vetch, orchard grass, corn, cotton, and small grain. In the vicinity of Rock Hill, S. C., alfalfa is being successfully grown on these lands. These Davidson soils closely resemble the Cecil soils, and were included with them in the earlier classification and mapping, but they are derived from diorite and diabase, contain more lime and less potash, and are more productive. They are better suited to the lime-loving plants, such as red clover and

PLATE 35.—Showing unequal depth of weathering of limestone, at railroad tunnel through Indian Ridge, west of Johnson City, Tenn. The soil resulting from the decay of the limestone lies directly over the hard, unweathered limestone rock. In the decay of such rock a large proportion of the parent rock, the lime and magnesium carbonates, is dissolved and removed in solution, leaving the rock impurities to form this residual soil. (Photo. by Bonsteel, collection, Bureau of Soils.)

PLATE 36.—Bluegrass pasture on stony limestone land (Hagerstown stony clay) in limestone valley region, Frederick County, Va. Even the roughest stony areas of these limestone soils constitute fine pasture lands for all kinds of stock. (Photo. from collection, Bureau of Soils.)

many of the steeper slopes are strewn with large fragments. These soils occupy level to rolling country. The loam, the most extensive type, is level to undulating, while the shale loam, the next most extensive member of the series, is generally sloping to rolling, representing areas where erosion has removed much of the fine material. The stony loam, sandy loam, and silt loam are fairly important, but the other types, the clay loam, gravelly loam, and clay, are unimportant. Everywhere the drainage is good, even in the level areas, and the soils in all cases are sufficiently retentive of moisture to insure success with crops, even through long periods of dry weather, provided good, deep preparation of the seed bed and frequent shallow cultivation are practiced. Erosion is of little importance. The Penn soils are almost entirely in cultivation. In the northern areas, wheat, corn, timothy, and clover are the chief crops. Under good management wheat yields upwards of 30 bushels per acre, corn 40 to 60 bushels, and hay 1 to 1½ tons on the loam and silt loam, the most productive types. Lower yields are obtained from other types. Alfalfa and sweet clover succeed, especially where lime has been applied, but the crop is not extensively grown. Locally, peaches, apples, brier berries, Irish potatoes, and buckwheat are successfully produced, and stock raising and dairying are of some importance. Cigar tobacco is grown in Pennsylvania. In the southern areas dark tobacco, corn, small grain, and some cotton are grown. Efficient cultivation is performed with moderately heavy teams over a fairly wide range of moisture conditions. The yields compare favorably with those of the Manor series. Commercial fertilizers and barnyard manure are in general use.

Brown shale and sandstone lands—Lansdale soils.—This group of soils occurs in close association with the Penn in Pennsylvania and Virginia. The material is derived from the brownish and yellowish Triassic rocks. The soils are brown and mellow and the subsoils yellowish brown or light brown and more friable than those of the Penn. The drainage conditions, topography, and tillage characteristics are practically the same as those of the Penn; and the soils are used for the same crops. Corn seems to give better results than on the Penn.

Gray shale and sandstone lands—Lehigh soils.—These are ashy-gray to light-gray rather compact soils overlying stiff clay subsoils of a grayish or mottled grayish and yellowish color. In places both soil and subsoil are bluish, such areas being known as "bluestone land." The Lehigh soils occur in rather small bodies adjacent to soils derived from igneous rocks, such as the Montalto and Iredell. They are derived from light-gray and bluish Triassic shale, mudstone, and sandstone, which rocks have been altered by contact metamorphism, as a result of the intrusion of dikes. They are principally developed in Pennsylvania, Maryland, and northern Virginia. Collectively these lands are of little importance, both on account of their small extent and low productivity. They are much inferior in crop value to the associated Penn and Iredell. The structural conditions are unfavorable, the soils having a strong tendency to compact. Wheat and grass are the crops to which they are best adapted. They are only moderately productive.

Gray shale and sandstone lands with yellow, friable subsoils—Granville soils.—This is a group of grayish soils overlying yellow friable subsoils, which in the lower part of the 3-foot section or in the substratum usually show the presence of drab and red material like that of the Penn. The soil and upper subsoil are almost identical in color and structure with the Norfolk and Durham soils. Triassic sandstone and shale are the rocks which have contributed the soil material. On the gently rolling areas the sandy soils predominate; over the lower situations the silt loam predominates.

The drainage is good, except in case of the level areas of silt loam, where underdrainage would be beneficial.

In Virginia and North Carolina, where these soils occur, bright tobacco, sweet potatoes, and early vegetables give splendid results on the sandy types, about the same as on the Durham and Norfolk sandy soils. These sandy soils are used principally for bright tobacco, cotton, corn, market peanuts, and cowpeas. The silt loam is better suited to corn, wheat, oats, and forage crops, but some cotton is grown on it with fair success. Moderately heavy additions of manure or fertilizer are necessary for good yields. Lime and phosphatic fertilizers will increase yields on the silt loam. Fertilizers relatively high in nitrogen and potash give best returns on the sandy types. Vegetable matter turned under and legumes grown in rotation with other crops go far toward improving these soils.

Grayish to red shale and sandstone lands with red, stiff clay subsoils—White Store soils.—The soils of this series are of only local importance, but they are distinctly different from any of the other soils of the Triassic belt. They occur in the southern portion of the Triassic belt, having been identified only in North Carolina, mainly in Anson County. The soils are dull red in case of the heavy types, and grayish in the sandy types; while the subsoils consist of red or chocolate-red plastic clay with frequent gray and yellow mottlings. The material, especially in the subsoil, rather closely resembles that of the extensive Susquehamna soils of the Coastal Plain region. Bedrock is reached usually at about 3 to 6 or 8 feet, being much shallower on the slopes, where the soil erodes rapidly if carelessly cultivated. These soils have fairly good drainage in spite of the dense character of the subsoil. The clay loam is the most important type, but there is considerable sandy loam. The surface is gently rolling to rolling. Much of this soil is under cultivation, cotton being the principal crop grown, with some corn and oats for the work stock and for meal. Wheat, cowpeas, and various forage crops give fair returns in seasonable years. Efficient breaking of the land requires the use of heavy implements and two-horse teams, but most of the work is now done with light plows and a single mule. The land is easy to improve by gradually building up the organic supply and deepening the seed bed with fall and winter plowing, done when the soil is not wet enough to be sticky. Once built up to a good productive condition these lands prove durable; that is, where protected against wasteful washing, and they give good yields of cotton and corn. Moderate applications of fertilizers are made for cotton and generally for corn. Mixtures relatively high in phosphorus give best results. Applications of lime are helpful, but little is used. Some farmers believe the soil is rich in lime, but the average content is probably not much greater than that of other clay land of the humid region derived from non-lime-bearing material or rock.

Gray Slate land—Alamance soils.—The Alamance soils are light gray, silty, and compact in the surface, which is usually about 6 to 10 inches deep, and yellow and compact in the subsoil which consists of silty clay. Fine-grained, bluish slates (Carolina slates) containing very little mica give rise to these soils. The surface is prevailingly undulating to level, and the drainage is fairly good to good, according to the slope. These soils are rather difficult to keep in a good condition of tilth, as they are so silty and low in organic matter that they run together with soaking rains and harden with subsequent dry weather. The silt loam is by far the most extensive type. There are scattered areas of slate loam on the slopes, but no other types are found to any very important extent. The Alamance soils along with the Georgeville occupy the greater part of the slate belt of central North Carolina.

The Alamance soils are of moderate or rather low productivity, and crops grow slowly on them. They are best suited to wheat, lespedeza, and grass. Cotton yields about one-fourth to one-third bale, with the ordinary treatment. Deeper plowing, incorporation of organic matter, the growing of the legumes in rotation with other crops, applications of manure and phosphatic fertilizer seem to be the best means of building up the Alamance soils. By practicing these methods yields of over 40 bushels of corn per acre and 20 to 25 bushels of wheat have been obtained by some of the best farmers. Lime probably would prove beneficial. Level areas should be ditched or tiled.

Gray to red slate lands with red clay subsoils—Georgeville soils.—These soils occur in intimate association with the Alamance, occurring on the slopes and more rolling areas. The material is derived from the same slate rocks. The soils are grayish to reddish (in case of the eroded or clay areas), while the subsoils consist of rather stiff red clay. The red color appears to be due to more complete oxidation resulting from the better drainage. The silt loam, clay loam, and slate loam are the chief types. The slate loam, clay loam, and clay occur mainly on the steeper slopes and sharper ridges where the grayish soil of the silt loam has been completely or partly washed off. These soils are earlier and more productive than the Alamance, yielding about 15 to 30 per cent better under similar conditions of treatment. Manure or fertilizer is required for heavy yields, but not so heavy applications are necessary as on the Alamance soils. Wheat, oats, corn, and cotton are the principal crops grown. Red clover succeeds on these lands. Deeper plowing, growing the legumes, and the incorporation of vegetable matter are methods of improving the Georgeville soils. Owing to susceptibility to erosion the steeper slopes should be used for grass and forage crops. Beef cattle can be successfully raised on these soils, as they are good producers of grass and forage crops. Fertilizers relatively high in phosphorus give good results.

With lime and inoculation the clay and clay loam should produce alfalfa and sweet clover.

THE APPALACHIAN MOUNTAIN PROVINCE

GEOGRAPHY

The Appalachian Mountains, comprising the great mountain system of eastern United States, extends from the Canadian boundary along the New York-Vermont line southeasterly to central Alabama. With the Cumberland-Allegheny Plateau, this region comprises the greater part of Pennsylvania west of the Piedmont region (the northern part of the Appalachian, from the northern part of Pennsylvania northward, is glaciated), a part of eastern Ohio, the western parts of Maryland, Virginia, and the Carolinas, all of West Virginia, eastern Kentucky, and eastern Tennessee, northwestern Georgia, and northern Alabama. The region of sandstone and shale rocks in western Kentucky and the mountainous portion of Arkansas (the Boston and Ouachita mountains) and of eastern Oklahoma are included in the soil province of the Appalachian Mountains and Plateau, while the included limestone valleys (the Appalachian Valley) and ridges, the Highland Rim regions of Tennessee and Kentucky, the Blue-grass region of Kentucky, the Central Basin of Tennessee, and the northern Ozarks are discussed under the Limestone Valleys and Uplands soil province. The Appalachian province, as thus defined, embraces an area of about 84,837,000 acres, with an urban population of 2,622,802 and a rural population of 5,622,221. The principal area, that from northern Pennsylvania to central Alabama, is about 900 miles long and 250 to 270 miles broad in the widest place—east and west across central Virginia and West Virginia. There is a gradual narrowing of the region southward from this broadest belt. The southern boundary in Alabama is about 100 miles across.

The principal divisions of this greater part of this soil province are: (1) The Blue Ridge belt on the east; (2) the Cumberland-Allegheny Plateau on the west; and (3) the ridges between the Plateau and the Blue Ridge (called in the northern part the Allegheny Ridges or Mountains.

TOPOGRAPHY

The highest altitudes of the eastern United States are attained in the Blue Ridge Mountains, the culminating elevation being that of Mount Mitchell in North Carolina, which rises to 6711 feet. Along the eastern margin of the Cumberland-Allegheny Plateau elevations of 2500 to 3000 are not uncommon, and the highest elevation, something over 4000 feet, is reached in West Virginia. Elevations of approximately 4000 feet are attained in the Big Black Mountains of Kentucky and Virginia. Southward from Virginia the Plateau surface falls gradually to about 500 feet in central Alabama. From the Plateau front westward the surface declines gradually until it merges with the Mississippi Plain region at elevations of 1000 feet or less. The Allegheny ridges rise to altitudes of 1800 feet and occasionally, in the northern part, to 2500 feet.

The Blue Ridge chain or belt is represented by a comparatively narrow ridge from northeastern Pennyslvania to southern Virginia, where it spreads out into a broad mountainous belt with many high peaks, reaching its maximum width in North Carolina. The southern extension in Alabama is also represented by a narrow ridge. The prevailing slopes are too steep for easy cultivation, but there are many saddles, slopes and shoulders that can be safely plowed or at least cultivated sufficiently for fruit, and there are comparatively smooth valley areas which, with the associated stream bottoms, constitute good farm land. Most of the Blue Ridge region is covered with soil, and originally supported an unbroken forest of hardwood and some pine, with a dense undergrowth of rhododendron and mountain laurel. Much of the forest remains, although a considerable part of the merchantable timber has been cut in many localities. There are surprisingly few rock outcrops or very stony areas.

The Cumberland and Allegheny Plateau comprises, respectively, the southern and northern portions of the western slopes of the Appalachian System. This division of the Appalachian Province is sharply defined along the greater part of its eastern boundary, from the glaciated region in northeastern Pennsylvania to the Coastal Plain in central Alabama, by the steep escarpment marking the western border of the Appalachian Valley and Ridges, which is known as the Allegheny Front in Pennsylvania, Maryland, and West Virginia, and as the Cumberland Escarpment in Kentucky, Virginia, Tennessee, Georgia, and Alabama. In most places this front is steep to cliff-like, but locally it is not so well defined. In Georgia and Alabama it is fairly distinct along the eastern side of Lookout Mountain, and from there southward the front is gradually obscured, the Cumberland Plateau passing beneath the Coastal Plain deposits in the central and northwestern parts of the State.

A panoramic view across this plateau country reveals an even sky line, indicating the original smooth character of the land. There are now some almost level areas, but the region in general has been so altered by erosion that its surface is dominantly strongly rolling and hilly. There are many deep valleys with slopes too steep for cultivation. New River (Kanawa in West Virginia) enters the Plateau in a cañon 1500 feet deep and flows across it to the Ohio in a deeply intrenched valley with steep rock walls. In addition to the level tracts, there are distributed throughout the region gentle slopes and rounded ridges and hills that can be safely cultivated, but the greater proportion of the slopes is too steep or too rocky for plowing.

The long parallel ridges between the Blue Ridge belt and the plateau are prevailingly narrow, and rise to elevations of a few hundred feet above the associated valleys, and to 2500 feet or more above seal evel. These ridges have steep slopes, often rocky, and unsuited generally for cultivation. Some of them are flat-topped and well suited to cultivation.

The Ouachita-Boston Mountain region of the Ozarks embraces a large part of Arkansas—the mountainous region west of Little Rock—and extends for a considerable distance into Oklahoma. That portion of the region south of the Arkansas River is known as the Ouachita Mountains, and that north, as the Boston Mountains. The region is prevailingly rough, with steep and unusually stony slopes, yet there are scattered level and gently rolling mountain-tops and shoulders that are arable. There are also many wide and narrow valleys between the ridges containing cultivable land. The altitude ranges from about 500 feet to 2900 feet (in Magazine Mountain) above sea level. The area of this southern Ozark region is 23,596 square miles or 15,101,440 acres.

The area of Appalachian country in western Kentucky (between Hopkinsville and Owensboro) is low as compared with the main portion of the province. It is rolling to hilly, with a relatively high proportion of the land suited to cultivation.

The entire Appalachian Province is well drained with the exception of an occasional unimportant flat or depression where all the drainage is downward through the soil, and strips of slope kept wet by seepage. The probem of drainage is of practically no importance, but erosion is of considerable importance on the steeper slopes. Steep areas, where used for the clean-cultivated crops, are susceptible to ruinous washing. They should generally be used for pasture or as hay land or else left in forest.

GENERAL AGRICULTURE OF THE APPALACHIAN REGION

General farming, the raising of beef cattle, and fruit farming are the dominant types of agriculture in the Appalachian Province. In Alabama and Georgia cotton is grown, along with corn, cowpeas, and oats, cotton representing the money crop. Northward, general farming, the production of corn, wheat, oats, and hay predominates, but there are many localities where the raising of beef cattle, largely upon pasture, is of more importance. The beef cattle industry is of considerable importance in those regions where mixed grayish and red shale lands and the mixed limestone, shale, and sandstone lands (the *Meigs* and *Westmoreland* soils) occur. Apples are grown commercially in many localities, especially in the northern part of the province. There are also commercial peach orchards here and there throughout the province. Some burley tobacco is grown in West Virginia and Kentucky.

Methods of tillage are much the same as those practiced in the adjacent regions of lower altitudes, except on some of the very steep slopes where most of the work is accomplished with hand hoes. Some cultivated slopes in West Virginia and elsewhere are so steep that the crops cannot be removed by wagon—they are carried down into the valleys by hand on sleds and even on wire trolleys. It would seem remarkable that the soil from these declivities is not bodily swept away by the rains. The reason this has not generally been the result is that these soils are open-natured—gravelly, shaly, stony, sandy, and loamy soils—which readily absorb large quantities of water. Still there are frequent occurrences of patches and entire slopes where the greater part of the soil material has disappeared, leaving largely rock fragments and exposures of bedrock. Where the soil is inclined to wash badly the land should, of course, be used only for grass, pasture, and forestry. Terracing is practiced in some localities, as for example, on the slopes of Sand Mountain, Alabama. The steeper slopes cannot everywhere be protected by terraces, since these embankments frequently are incapable of resisting the rushing water, and for the reason that many slopes are so steep that terrace construction is not feasible.

Some idea of the wide variation in the character and value of the soil is suggested in the wide range of land values. There are isolated sections and areas of very rough topography where land can be bought at $5 an acre or less, whereas some of the better cotton lands sell for more than $50, while some of the good limestone and red lands of the stock-raising sections cannot be bought for less than $100 to $150 an acre, even where it is hilly.

In general, the farms produce the required supplies of corn meal, flour, and pork and the feed needed for the work stock and cattle. Light implements drawn with one and two horses are in common use, performing generally satisfactory tillage, as the prevailing soils are easy to handle. Rotations including clover and often blue grass are practiced to some extent on most of the northern farms, and cowpeas are frequently grown in the southern part. As a rule, however, not enough of the legumes and humus-supplying crops are grown to keep the soils in the best condition.

In some of the mountainous country of West Virginia and Kentucky much upland is used for "permanent" pasture for cattle and sheep, remaining in grass often 10 to 20 years or more or until weeds and brush have largely crowded out the grass. This is particularly true in those sections where blue grass succeeds; that is, in those sections where limestone and the chocolate-red soils (*Westmoreland*, *Meigs*, and *Upshur soils*) occur.

When sod land is broken here it is frequently planted to corn, which is followed by wheat and then by grass or in some sections by buckwheat, then wheat again and then grass.

Fertilizers are in general use. In the southern part, the acreage applications range up to about 500 pounds an acre for cotton and less for corn, commercial mixtures being most frequently used. In the plateau country, as in West Virginia, acid phosphate and bone meal are the common fertilizers. These are applied usually at the rate of 100 to 250 pounds per acre for corn and 250 to 300 pounds for small grain and buckwheat. Blue grass sod is sometimes given light additions. In the tobacco-growing sections heavier additions are made, and prepared "complete" mixtures are generally used. Lime is frequently used in the northern part. It is not uncommon to apply 500 to 1000 pounds or more of burnt lime per acre at intervals of 4 to 6 years. This is usually applied to sod, broken sod, or corn stubble, preceding grass, wheat, timothy, and clover.

The most promising outlook for agriculture in this province is to enlarge the fruit and live stock industries, the raising of beef cattle and sheep particularly.

In the Appalachian Province 29,457,347 acres were classified as improved farm land by the Census of 1910, which is 34.7 per cent of the total area of the province.

GEOLOGY AND SOILS OF THE APPALACHIAN REGION

The rocks of the Blue Ridge region are closely related to those of the Piedmont, consisting mainly of granite, gneiss, schist, and quartzite. There are also local developments of dark-colored and greenish igneous rocks. In the remainder of the province, that west of the Blue Ridge belt, the principal rocks are sandstone, conglomerate, and shale; in fact, these occur almost to the exclusion of others, with the exception of occasional beds of limestone.

The soils are derived from these rocks. Where the surface is level or nearly so the soil material lies directly over the parent rocks; on the slopes there has been some movement of the material to lower levels through creep, slides, and the action of rain water, so that there are many slope strips and pockets of colluvial and partly colluvial soils; that is, soil washed and fallen from higher slopes. Also, there is a considerable total acreage of slope land over which rocks have fallen from above or have been exposed by erosion in such quantity as seriously to interfere with or to preclude tillage operations. Rocky talus material has accumulated along the lower slopes, especially of the plateau and ridges, in places to a depth of 15 feet or more. Some of these consist of nothing but loose rock fragments, and, of course, support no vegetation. Outcrops of bedrock and stony cliffs and escarpments that are unfit for the growth of vegetation are not uncommon, especially on the valley walls of those streams of the plateau that have cut their beds deeply. The greater part of the province, however, is mantled with enough soil to support a heavy growth of timber and probably 40 to 50 per cent of the total area can be tilled, although some of this has such slope as to necessitate the growing of soil-binding crops, chiefly grass, if destructive washing is to be avoided. A large part of the province is well suited to apple and peach culture, while most of it constitutes good forestry land and fair to good grazing land.

Aside from the large area of rough, stony land which is suited only for forestry and pasture, and rock outcrop, which has no value, the principal soils are the stony loams, silt loams, shale loams, slate loams, clay loams, loams, and sandy loams. The most extensive soil groups are the gray sandstone and shale lands (*Dekalb* soils); mixed gray and heavy red shale lands (*Meigs*); mixed limestone, shale, and sandstone lands (*Westmoreland*); red granitic lands (*Porters*); red sandstone and shale lands (*Hanceville*); heavy red shale lands (*Upshur*); and gray slate lands with red subsoils (*Talladega*). The Porters and Talladega dominate in the Blue Ridge, the Dekalb, Meigs, Westmoreland, and Upshur in the plateau, while the Hanceville occurs almost to the exclusion of other soils in the Ozark region. The Appalachian Ridges are occupied chiefly by the Dekalb and Upshur and the western Kentucky area by the Dekalb and *Christian*. Of the areas covered by detailed and reconnoissance soil surveys in this province up to 1917, the areas of the principal series were as follows:

	Acres
Dekalb soils	26,816,700
Meigs soils	4,447,808
Westmoreland soils	3,742,720
Porters soils	1,891,216
Hanceville soils	1,247,296
Upshur soils	1,797,440
Talladega soils	514,432

DESCRIPTION AND AGRICULTURE, SOILS OF THE APPALACHIAN MOUNTAIN PROVINCE

Gray sandstone and shale land—Dekalb soils.—The Dekalb soils known as "gray shale lands" and "gray sandstone lands" predominate throughout the Cumberland-Allegheny Plateau and in the ridges lying east of the plateau and west of the Blue Ridge region, occurring extensively from northern Pennsylvania to the vicinity of Tuscaloosa, Ala. The most important associated soils are the Westmoreland, Meigs, and Upshur, occurring in West Virginia, Pennsylvania, and Ohio.

The Dekalb soils are made up of the products resulting from the decay of the sandstone, shale and conglomerate of the Coal Measures. They have grayish to pale-yellow surface soils and yellow subsoils, which in the sandy types are quite friable and in the heavier types moderately friable to slightly compact. In all the types, except those on slopes, where material has washed or fallen from above, the content of organic matter is low, and the silt loam and silty clay loam are inclined in dry weather to assume a compact condition unfavorable to tillage and the retention of moisture. These soils occur over all the varying topographic conditions existing in the Appalachian region, from level plateaus to rough mountainous areas impossible of cultivation. Most of the stony soils occupy the steeper slopes and strongly rolling country, the topography of the less stony types being more subdued, although varying considerably.

Drainage is everywhere good, with the exception of a few level areas and seepage slopes of the stiffer types. The steeper slopes often wash severely under clean cultivation. Properly supplied with humus, plowed deeply, and cultivated shallow the deep, heavier types hold moisture well, but those areas having bedrock within the 3-foot section, and the sandy types and all areas that have been impoverished through improvident methods are not very retentive of moisture. Cultivation is very easy on the sandy lands; on the finer-textured silty soils two-horse teams and moderately heavy plows are necessary for efficient plowing.

The principal types are the silt loam, including silty clay loam, stony loam, stony silt loam, shale loam, and sandy loams. There are a good many small areas of deep, loose sand and stony sand.

A rather light type of general farming prevails over the Dekalb soils; that is, the growing of small grain, corn, and, in the southern extension, cotton. Some beef cattle are raised, many farms raising a few head. There are few

PLATE 37.—Export tobacco of the Clarksville, Tenn., district (Highland Rim country of Kentucky and Tennessee). This field is on the Clarksville and Hagerstown soils of Montgomery County, Tenn. This is one of the leading tobacco districts of the country. The view is characteristic of the surface configuration of this part of the limestone region. (Photo. by Lapham, collection, Bureau of Soils.)

PLATE 38.—Apple orchard (chiefly York Imperials) on limestone soil (Hagerstown loam), near Kernstown, Va. This is near the famous Apple Pie Ridge on which some of the best apple orchards of eastern United States are established. The "apple pie land" of this ridge is a gray gravelly soil, with yellow subsoil, the gravel consisting of chert and soft weathered siliceous limestone, called "soapstone." This soil (Frankstown gravelly loam) extends from northwestern Virginia across West Virginia and occurs in western Maryland extending into Pennsylvania. (Photo. from collection, Bureau of Soils.)

PLATE 39.—Forty-year old apple orchard of mixed varieties on limestone soil, near Martinsburg, W. Va. (Photo. from collection, Bureau of Soils.)

PLATE 40.—Valley and stream bottoms in the Black Mountains of North Carolina—Blue Ridge region. These valley and bottom lands are valuable for corn, sorghum, grain, forage crops, vegetables and grass. The mountains are covered with soil in this region, with relatively little rough stony land as compared with the Appalachian Plateau region. The Porters and Ashe soils predominate here. They are valuable for fruit, stock raising and forestry purposes, with frequent shelving situations, valleys and slopes suitable for the cultivated crops. (Photo. by Lapham from collection, Bureau of Soils.)

large stock farms. Locally, in West Virginia, southwestern Pennsylvania, and Ohio cattle raising is the most important industry, but here the Dekalb soils are used generally along with the better grass soils of the Upshur, Westmoreland, and Meigs series. The Dekalb soils are only fair grass lands; in fact, they are, in the natural condition, light producers of all crops. By increasing the stock of humus, by growing, and turning under occasionally, the legumes in rotation with other crops, and by manuring or fertilizing liberally, these lands can be built up to produce good yields, the effects of such treatment being fairly lasting, where there is not too much erosion. The farms are small, the farm equipment light, and generally the type of farming is mediocre; but there are good farms throughout the region, producing profitable yields of cotton, grain crops, hay, sorghum and many good beef cattle. Considerable clover and timothy are produced from Tennessee northward on the silt loam, chiefly for hay and pasturage. Blue grass does not succeed nearly so well as on the red shale and the limestone soils. There are some highly developed farms including dairy farms in Pennsylvania, for instance, in Cambria County, and in West Virginia, on which intensive methods are employed, such as deep plowing, heavy manuring, and regular rotations with the legumes. Generally, the farms are self-supporting, producing all the meal, flour, meat, milk, and butter required, except in the southern part, where flour is commonly bought.

Commercial apple orchards are of some importance north of Tennessee. The principal varieties of apples are the Ben Davis, Rome Beauty, York Imperial, and Wealthy. Some peaches are grown for market. Plums and cherries do well, but these are not important. Burley tobacco is grown locally in West Virginia, Kentucky, and Ohio with fairly good results. Buckwheat does well in the northern part and on the higher elevations in the central part. Cotton is grown with fair to good results, according to treatment, in Alabama, on the silty and sandy soils, the latter giving best results, possibly because they are earlier and favor maturity before frost. As much as a bale of cotton an acre is obtained on the Dekalb fine sandy loam of the better farms in such sections as Sand Mountain in Alabama, with applications of 300 to 400 pounds of 8-2-2 fertilizer per acre.

The yields of wheat range from about 8 to 20 or 25 bushels an acre, corn 10 to 35 bushels, oats 15 to 40 bushels, tobacco 1000 pounds, and hay three-fourths to 1½ tons an acre, according to treatment. The better yields of grain are obtained only on the best farms where either manure or commercial fertilizer is used and where the legumes are grown in the rotations. From 200 to 300 pounds of fertilizer is the usual acreage application, and the mixtures generally analyze about 8-2-2. Some farmers use only acid phosphate. Better grades of fertilizers, with a higher content of potash, are applied for tobacco, and in heavier applications. Liberal additions of phosphorus appear to be desirable for those crops that are susceptible to damage by early frosts, such as cotton in the south and corn in the north. It is also advisable to grow the early or hardy varieties. Lime is frequently used in the more northern States, in application of a ton or more per acre (burnt lime). Ground limestone and raw ground phosphate rock should benefit these soils.

Vegetables are grown on the market-garden basis near the cities. The sandy types have been found desirable for the earlier vegetables, but the silt loam is most commonly used, mainly because it happens to be an available type in most of the favorable localities. Irish potatoes, cabbage, turnips, and lima beans give good results on the silt loam. In some localities Irish potatoes are grown as an important crop. In localities reasonably near markets or shipping points the sandy types could be used profitably for cantaloupes, cucumbers, sweet potatoes, and various other vegetables.

Dairying is of little importance except near the larger towns, such as Pittsburgh, Pa., and Charleston, W. Va. A good many farms, probably the majority, produce the needed home supplies of pork, but few of them sell hogs.

Improvement in the agricultural conditions over these soils probably will be greatly enhanced through an increase in the number of live stock raised, growing more forage crops, and pasturing more of the stony and steep land, through better farming, including deeper plowing, the incorporating of more vegetable matter in the soil, and the growing of more legumes, and through increased production of special crops, such as apples and vegetables, where the economic conditions are favorable. Cowpeas, Canada field peas, clover, and buckwheat are crops that can be used for building up these lands. More sheep should be raised, especially on the rougher and stony areas.

Light-brown shale land—Berks soils.—These soils closely resemble the Dekalb soils; the soils are browner but the subsoils are much the same. They produce better average yields than the Dekalb. They are used chiefly for potatoes, corn, small grain, and hay. They are largely confined to the rounded ridges and hills east of the Allegheny front, occurring principally in Pennsylvania and Maryland.

Mixed red and gray land—Meigs soils.—Large areas of Meigs clay loam occur in northwestern West Virginia, southwestern Pennsylvania, and southeastern Ohio.

The land classified under this name is very variable, including, in reality, a number of soils, chiefly the silty clay loam, silt loam, and clay loam of the Upshur and Dekalb series occurring in intimately associated areas. The soil has a predominant texture of clay loam or silty clay loam, and is underlain at 5 to 10 inches by Indian-red, rather stiff clay to yellow, moderately friable clay. There are also many patches of clay and silt loam. Shale fragments are of common occurrence in the soil and subsoil. Rain water, creep, and slides have caused considerable mixing of the materials of all of these soils. Bedrock is reached at depths ranging from 15 to 50 inches, averaging about 3 feet. In view of the very rolling to hilly topography there are surprisingly few rock outcrops, except along steeper walls and cliffs of the larger streams. So rolling is the topography in most places that probably not over 25 per cent of the area can be classed as good cultivable land, the prevailing slopes being too steep for safe plowing. Practically all of the land, however, makes fine blue grass pastures, and much of it is used for raising and fattening beef cattle. Some sheep are raised. Good two-horse teams and heavy plows are necessary to plow this soil properly. The soil holds moisture well and is well drained. If plowed when wet enough to be sticky, intractable clods are formed.

The raising of beef cattle, frequently in conjunction with general farming, is the principal industry on the greater part of this soil. General farming is important, but the output of individual farms is not large, owing to the relatively small area of land suitable for tillage, this being confined to the smooth ridge tops, shoulder situations, and the occasional gentler slopes. Wheat, oats, hay, buckwheat, and corn are the principal crops. Clover and timothy are usually grown together for hay. Some bright burley tobacco is grown.

The yields of crops on the smoother areas averages higher than on the Dekalb soils, but on account of the rough topography the general yields are about the same as on the Dekalb silt loam, corn giving 15 to 45 bushels, wheat 10 to 25 bushels, hay 1 to 1½ tons, and tobacco 800 to 1500 pounds an acre. Acreage applications of 250 to 300 pounds of acid phosphate or bone meal, or of mixtures analyzing about 8-2-2 are frequently used for wheat, and 400 to 500 pounds of about an 8-2-5 mixture for tobacco. Newly cleared land is seldom fertilized. Burnt lime and ground limestone are used by some farmers in rather light applications. Blue grass comes in naturally on the Meigs clay loam, but when sowed with a nurse crop it gives a better stand. A good sod of this grass will last 10 to 15 years under ordinary methods of management, if not too closely and constantly grazed, and if kept free from brush the sod will last almost indefinitely. Apples, peaches, Irish potatoes, soy beans, Canada field peas, and buckwheat are among the other crops that are grown in a small way. Dairying is carried on near the cities.

Decidedly the best use for this soil is the raising of beef cattle and sheep on blue grass pasure. Cultivated crops should be confined to the smoother portions. Clover or some other legume should be included in the rotation with the clean cultivated crops and small grain. It would seem that sweet clover and alfalfa could be grown profitably on these soils.

Red shale land—Upshur soils.—In the same region as that embracing the Meigs clay loam, and also in the plateau and ridges farther north and east, there are small and large areas of the Upshur soils—the "red shale lands" or "red shell lands" of the northern Appalachian. These are Indian-red or chocolate-red soils overlying Indian-red or chocolate-red stiff clay. These soils are very similar to the Penn soils of the Piedmont Plateau. They occupy the crests and slopes of ridges and strongly rolling areas. The drainage is well established, and the soils hold moisture well. When wet the clay is sticky and on drying it compacts and cracks unless well supplied with humus. The clay loam, silt loam, and loam are more friable and easier to keep in good tilth. Much of these lands is too steep for safe cultivation, since the soil washes rapidly. The clay, stony loam, and shale loam ("red shell land") are the principal types. The material is derived from Indian-red or chocolate-red shales.

These are good blue grass soils, and for this reason and because of the rough topography the raising and fattening of beef cattle is the principal industry, especially in West Virginia. The soils are used for the general farm crops, chiefly clover-timothy hay, wheat, and corn. Much of the stony loam is too steep and stony for other uses than for pasture land and forestry. Locally these soils, including the stony loam, are used for peaches and apples.

Fruit does well on these lands. On new land corn yields 20 to 50 bushels an acre, and where clover is introduced into the rotation good yields can be maintained, particularly when moderate applications of manure or fertilizer are made. Wheat yields from 15 to 25 bushels and hay 1 to 2 tons an acre. Buckwheat also succeeds. Blue grass affords much good pasturage, doing especially well with an occasional moderate dressing of phosphatic fertilizer or barnyard manure. Heavy teams and plows are needed to plow the clay type properly. Alfalfa and sweet clover probably can be successfully grown.

Mixed shale and limestone land—Westmoreland soils.—The Westmoreland soils are extensively developed in southwestern Pennsylvania, northwestern West Virginia, and southeastern Ohio. These are light-brown mellow soils, underlain at 8 to 12 inches by yellowish brown or yellow moderately friable silty clay to rather stiff clay subsoils. These soils occupy hills and slopes, but the surface is characteristically smooth and many of the slopes are sufficiently gentle for safe cultivation. These soils are derived principally from shales, but some of the material comes from associated beds of limestone and calcareous shale. Often there is only a thin bed of limestone on a slope, but the decayed products from this apparently have intermingled with the soil below, since the land averages much more productive than the Dekalb soils. In places the hills are capped with soil derived entirely from the underlying limestone, and strips or patches of such limestone land occur in places on the slope. There is some shale land (Dekalb soil) associated with the Westmoreland, but collectively these areas are known as "limestone land." The principal types are the silt loam and silty clay loam. The drainage is good, the soils conserve moisture and are easily kept in a good condition of tilth.

Blue grass succeeds so well and the sod is so lasting under almost continuous grazing that the type is largely used for pasture land. Corn, wheat, and timothy and clover hay also do well. These are valuable soils, in places held at over $100 an acre for pasture land, even where very rolling. Applications of ground phosphate rock probably will help to obtain high yields of all crops. Alfalfa and sweet clover should succeed on these lands.

Red sandstone and shale land—Hanceville soils.—The greater part of the mountainous country of Arkansas and of eastern Oklahoma as far north as the limestone region, which is about 15 to 40 or 50 miles south of the Missouri line, is occupied by the red sandstone and shale soils of the Hanceville series. These soils also have a fairly important representation in the southern part of the Appalachian, particularly in Alabama and Tennessee, and occur here and there throughout the sandstone and shale areas of the Appalachian region.

These are grayish, reddish, or light-brownish soils underlain, usually, at 8 to 15 or 20 inches, by brick-red to yellowish-red friable to moderately stiff clay. Most of the material is derived from sandstone or sandy shale, and contains enough sand to give the soil a permeable character favoring good drainage. Locally, shale constitutes the bulk of the soil material, and here the clay subsoil is stiffer and frequently shows yellowish or grayish mottling in the lower subsoil. The content of humus is rather low. Bedrock is commonly reached at depths ranging from about 15 to

40 inches, and there are many small areas of rock outcrop and much stony land on the slopes and sharper ridges. Small and large fragments of sandstone and shale outcrops are of common occurrence and in many areas are sufficiently abundant to unfit the land for cultivation.

In general the country occupied by these soils is mountainous, characterized by flat-topped and sharp ridges flanked with steep slopes. Areas smooth enough to cultivate are scattered throughout these lands, occurring chiefly on the flat-topped ridges and hills, the benchlike situations, and the less rolling portions of the occasional belts of relatively low country associated with stream valleys, such as that along the Arkansas River, northwest of Little Rock. Probably not over 40 per cent of these soils has the topography or is sufficiently free from rock to constitute good cultivable land. Cultivation of the steeper slopes, besides being difficult, is likely to be followed by destructive washing.

The principal types of this series are the stony loam and the sandy loams. Loam and silt loam are found, but the individual areas are generally small. Most of the stony loam is too rough and stony for cultivation, except to some extent for apples and peaches. The sandy loams are the chief farming soils. They are easy to till, but are only fairly productive, and much of the land lies in rather inaccessible mountainous country. It is estimated that less than 25 per cent of the area of the Hanceville soils is in cultivation, the remainder being timbered. In the Arkansas region a part of these lands lies within the National forest reservations.

Cotton and corn are the principal crops. There are a good many peach and apple orchards, particularly in Arkansas. Peaches succeed exceptionally well. Sweet and Irish potatoes, peanuts, various vegetables, strawberries, and some varieties of grapes give good results. Oats, cowpeas, sorghum, and wheat are grown in a small way.

Corn yields from 15 to 25 bushels, cotton one-fourth to three-fourths bale, and oats about 25 bushels per acre. Some beef cattle and hogs are raised. Most farmers produce their pork and some sell a few head of cattle at intervals. The cultivated area on the average farm is small and the prevailing agriculture, especially of the more hilly country, is not of a very efficient type, although most farms produce all the needed supplies of the ordinary farm products. Cotton and corn are the principal sale crops. The cutting of crossties is an important industry, many farmers spending a part of their time at this occupation.

In general, plowing is too shallow, the legumes are not given sufficiently important places in the rotations, and not enough vegetable matter is plowed under. Some use commercial fertilizers, for cotton chiefly, applying 200 to 300 pounds of low-grade mixtures to the acre. For good yields some fertilizer or manure must be used, especially in the older fields, or else clover, cowpeas, or other legumes must be grown at frequent intervals. At present little attention is given to crop rotation. More beef cattle, hogs, and sheep could be raised for market on these soils. The rough and more stony areas are available only for pasture land and forestry. Fruit growing, it is believed, will increase. Much of this land can be bought cheaply—for $10 to $20 an acre—and at such prices it represents land of especially attractive opportunities to the stock man. In some localities beef cattle are raised in considerable numbers by occasional farmers. The production of peanuts for oil and as a field-forage crop for hogs is of promising possibilities.

Brownish to reddish soils from crystalline rocks, with red clay subsoils—Porters soils.—These red mountain lands (Porters soils) are the most extensive and important soils in the Blue Ridge region, occurring throughout the belt from Pennsylvania to Georgia. These are the red granitic soils, corresponding to the red granitic soils (Cecil soils) of the Piedmont. They have grayish-brown to reddish-brown soils overlying red brittle clay, usually at depths of 5 to 12 inches. Some of the sandy types are grayish or yellowish in the soil, the loam is brown to dark brown ("black loam"), and the clay and clay loam are reddish brown to red. Small fragments from the disintegrated parent rocks are distributed through the soil and subsoil in many instances, and larger fragments of quartz and other rocks are not uncommon. The material comes chiefly from granite and gneiss, but materials from other metamorphic and igneous rocks, such as greenstone, locally have entered into the composition of these soils, as they have been mapped. Bedrock lies generally deeper than 3 feet, but in places on the steeper slopes disintegrated rock is encountered at depths of less than 3 feet. These soils generally contain more organic matter than the Cecil, except on the washed slopes, some areas (the black loam), having as a result a dark color and very mellow desirable structure in the soil. There has been considerable movement of the soil down the slopes, and on bench positions and the smoother slopes much colluvial material has accumulated, giving rise to very desirable loamy soils.

The drainage is good and the soils hold adequate supplies of moisture when proper tillage can be performed and bedrock or disintegrated rock is not near the surface. Plowing is impossible on the steepest slopes, and cultivation is likely to be followed with some washing on the average slope unless soil-binding crops are grown. Probably 20 per cent of these soils can be safely used for the intertilled crops. Some farmers use very steep areas by cultivating with hoes. Apples are successfully grown, frequently on slopes where, with the ordinary crops, the soil would wash away. A large part of these lands is timbered with oak, chestnut, maple, buckeye, and tulip-poplar. Rhododendron and mountain laurel are often found in thickets of almost impenetrable density.

The principal types are the loam, sandy loam, clay, clay loam, and stony loam. With the exception of the clay and clay loam the soils are easy to till; that is, where rocks are not too plentiful and the slopes not too steep.

Fruit growing and stock raising are important agricultural industries, but many small scattered fields are used for corn, grain, hay, sorghum, potatoes, vegetables, and buckwheat. Climate has a marked effect upon the crop adaptation. Buckwheat, timothy, and blue grass are successfully grown as far south as North Carolina on these lands, although on similar soils in the lower Piedmont country to the east these crops are not successfully grown. There are local conditions of climate also that influence the crops and agriculture. At certain elevations probably favored by good air drainage apples are said to give especially good results, being much less subject to damage by frost than in other situations. Such situations have sometimes been styled "frostless zones." Some discrimination is shown in selecting the north, southeast, and west slopes for certain crops. In North Carolina, "north land" and "west land" are often avoided for wheat and corn, the "south land" and "east land" being preferred for these crops. The northern and western-facing slopes appear to give better results with grass.

The Porters soils are productive and lasting, giving good average yields with very little or no fertilization. Corn yields from about 20 to 75 bushels per acre, the average, on the best land with good treatment, being about 35 bushels. Hay gives 1 to 2½ tons, buckwheat 12 to 40 bushels (as for South as North Carolina), and wheat 10 to 40 bushels, according to the type of soil, smoothness of the slope, the tillage, the rotations, and to some extent the manurial treatment. The loam and clay loam are the best types. Light applications of fertilizer mixtures, such as 10-2-2, 10-3-3, and 10-2, are occasionally made for wheat, buckwheat, and corn. Experiments indicate that phosphoric acid is needed first on these lands.[1] Irish potatoes, cabbage, and a number of other vegetables give excellent results on the loam and sandy loam, while sweet potatoes succeed on the sandy loam. Rye, cowpeas, and sorghum are grown to some extent. Apples do very well, and grapes also succeed. The Stayman Winesap, Winesap, Virginia Beauty, Limber Twig, Ben Davis, Albemarle Pippin, Rome Beauty, and Smokehouse are among the shipping varieties grown. There are many valuable commercial apple orchards on these soils, the Albemarle Pippin orchards in Virginia having a wide reputation for the excellence of the fruit.

Beef cattle are raised largely by pasturage in an important way on these lands, especially in the broad development of the Blue Ridge belt in southern Virginia and North Carolina. Most farmers produce all the pork required, and some sheep are raised for market. A large part of these mountainous lands, more than half of the area, is best suited for stock raising and forestry. One of the principal things that must be observed in the use of these lands is to avoid the growing of clean-cultivated crops on those slopes that are steep enough to wash badly, since the loosened soil is

[1] The following statement in regard to the fertilizer need of soils of the Blue Ridge Mountain region is based on tests made by the North Carolina Experiment Station (N. C. Sta., Rept. 1916): "Field tests with four distinct types of soil in the mountain sections; namely, Porters clay, Porters loam, Toxaway silty loam, and Toxaway loam, show that with all four types phosphoric acid is needed first, and potash shows no gain with different crops, except where complete fertilizer is used and large crops produced. Lime alone shows gains on leguminous crops, and when used with complete fertilizer a gain is made. On Porters clay and Porters loam nitrogen is second in importance to phosphoric acid, and has to be supplied to produce good crops. Toxaway loam and Toxaway silty loam needs nitrogen for best results, but not so much as the upland mountain soils to produce remunerative crops."

swept away at a rapid rate by heavy rains. Stock raising, fruit growing, and general farming on the more nearly level tracts, and stock raising, forestry, and fruit on steeper areas, are the best ways to use the Porters soils. Although the farms are small, good methods are practiced on many of them, at least the soil is occasionally refreshed by growing crops like red clover and cowpeas in the rotations, and many fields are seeded to grass at intervals. Some areas have recently been placed in National Forest reservations.

Brownish soils from crystalline rocks, with yellow, friable clay subsoils—Ashe soils.—The brownish mountain soils with yellow subsoils (Ashe soils) are associated with the red lands (Porters), occupying the same type of mountainous country and occurring extensively in southern Virginia, western North Carolina, and northwestern Georgia. They are also used for about the same crops and give very close to the same yields, although not ranking quite so strong. The soils are brown and the subsoils yellow, the latter consisting mostly of friable clay, containing some mica flakes. These are very similar to the Chester soils of the northern Piedmont. They are permeable throughout, easy to cultivate, well drained, and especially favorable to internal circulation of moisture and air. Erosion is not so serious as on the Porters and a relatively larger area can be plowed safely. The loam is the principal type. There is not much of the stony loam and very little of the clay and clay-loam types. There are some scattered areas of sandy loam. Stock raising and the growing of apples, grain, corn, hay, and buckwheat comprise the principal agricultural activities. The loam is peculiarly adapted to Irish potatoes and cabbage, and blue grass, clover, and timothy succeed. With favorable transportation facilities Irish potatoes and cabbage could, it seems, be made valuable crops. Grapes do well.

Slate land with red clay subsoils—Talladega soils.—These soils, representing the Appalachian Mountain equivalent of the slate lands (Louisa soils) of the Piedmont, have an extensive occurrence in the western part of the Blue Ridge belt in southern Virginia, North Carolina, and Georgia, and they are the principal soils in the hills and ridges of Alabama, representing the southern extension of the Blue Ridge, such as the high, rough ridges extending from Georgia by way of Talladega, Ala., to the northern part of Coosa County, Ala. Micaceous schists and phyllites are the principal underlying rocks. The soils are usually known as "slate lands." They are pale yellowish to red (in case of the clay loam) at the surface, the subsoils consisting of red clay containing mica flakes and having a distinctly greasy feel. Bedrock or disintegrated rock is frequently reached within the 3-foot section of the slate loam, which is the principal type. Rough topography characterizes these lands, there being many sharp-crested, steep-sloped ridges with many stony areas. A large part of the area occupied by the Talladega soils is too rough for cultivation. This is timbered with pine, oak, and chestnut, and is pastured in some localities. The cultivated areas are mostly on the clay-loam type. In Alabama some cotton is grown, with fair success. In North Carolina, as in Ashe County, the clay loam is used with fairly good results for corn, wheat, buckwheat, and oats and as pasture land. Some apples are grown.

The Talladega soils are not so valuable as the Porters. Their best utilization will be for the raising of beef cattle and sheep, with some general farming on the loam as an adjunct to the live stock feature of farming operations. The rough, sloping areas should not be cleared.

Mountain soils of minor importance.—In the Appalachian Province there are several other soil series, which are not nearly so extensive as those described above. These are principally valley soils derived mostly from shale.

The *Conway* soils occur as level lands in the valleys associated with the larger streams of the sandstone and shale region of Arkansas. They consist of pale-yellowish soils overlying yellowish silty clay mottled with grayish and rather compact at depths of about 24 to 30 inches. Small black pebbles—iron concretions—are generally present, and in the lower subsoil are so plentiful in some places as to constitute a hardpan. The compact subsoil is rather impervious to moisture and air and on this account and because of the flat surface, the drainage is deficient. The more poorly drained level bodies are known as "crawfish land." The silt loam is the main type.

A considerable part of this soil is being used for cotton and corn. Corn yields poorly on the wet flats, but 30 or 40 bushels an acre are sometimes made on the better drained, undulating fields. Cotton is inclined to produce a heavy vegetative growth and to fruit lightly, especially in the imperfectly drained areas. As much as two-thirds bale per acre are sometimes produced on the better drained places, with a moderate treatment of fertilizer. Lime undoubtedly would prove beneficial, but little is used. Bermuda grass, lespedeza, sorghum, and cowpeas give good yields of hay, and more of these crops should be grown along with an increased attention to the raising of beef cattle and hogs.

The *Conasauga* soils are light brown to yellowish in the surface and yellow in the subsoil, which usually consists of silty clay. These are found in rather small bodies in the limestone valleys, chiefly of Alabama, Georgia, and Tennessee. Shale is the rock from which most of this material is derived. The silt loam and shale loam are the principal types. The silt loam is level to undulating, while the shale loam occupies low ridges and hillocks. The silt loam is used for cotton, corn, and oats, giving rather low yields, unless liberally fertilized or manured. The shale loam is not much used, although it makes fair grazing land. These are soils of only moderate value. They are in need of vegetable matter, lime, and manure or fertilizers. Ground phosphate rock probably would help to build up these soils.

The *Armuchee* soils comprise the red soils derived from shale occurring on the gently rolling valley areas hillocks and ridges associated with the Conasauga. They are a little stronger than Conasauga, but require similar treatment for the maintenance of their productiveness. Cotton is the principal crop. The rougher shale loam is best suited to live stock.

The *Chandler* soils occur in close association with the Talladega soils and differ from them in having a yellow instead of red subsoil. They are derived from schists and occupy mountainous country. Much of the area is too rough for cultivation. The slate loam and loam are the principal types. There is considerable loam in northwestern North Carolina. Part of this is used with fairly good results for wheat, corn, hay, and buckwheat. The yields are lower than those on the Ashe or Talladega soils.

THE LIMESTONE VALLEYS AND UPLANDS

GEOGRAPHY

The Limestone Valleys and Uplands soil province comprises the residual limestone soils lying east of the Great Plains region and north of the Atlantic and Gulf Coastal Plains. The province is closely associated with the Appalachian Mountain region; in fact, it represents the limestone lands of the Appalachian region. Most of the valleys consist of a part or parts of the Great Appalachian Valley extending from eastern Pennsylvania to central Alabama, and lying between the Blue Ridge belt on the east and the Cumberland-Allegheny Plateau and Allegheny Ridges on the west. The main valley or trough is narrow in the northern part, about 10 to 15 miles wide in Pennsylvania, and about 20 to 30 miles wide in Maryland and northern Virginia. In southern Virginia it widens out toward the south, reaching its maximum width of 40 to 60 miles in east Tennessee. Generally this great depressional belt is known as "the Valley," but in different localities it is known by different names. In eastern Pennsylvania it is known as the Lebanon Valley, in Maryland as the Cumberland Valley, in northern Virginia as the Shenandoah Valley, farther south as the Valley of East Tennessee, and in Alabama as Coosa Valley.

There are within the main valley both low and high ridges that divide it into what might be considered subordinate valleys. There are several separate limestone valleys within the Allegheny Ridges of Pennsylvania, west of the main Cumberland-Lebanon Valley, the principal one being Nittany Valley in Center and Blair counties. Another important detached valley is the Sequatchie Valley of Tennessee, with its Alabama extension known as Brown's Valley. This is separated from the major valley on the east by a fairly wide strip of mountain plateau country. There is also an extensive valley area of irregular outline along the Tennessee River in northern Alabama. The valley areas in the vicinity of Frederick, Md., and York and Lancaster, Pa., lie east of the Appalachian Mountains.

Two large areas not associated in occurrence with the Appalachian Valley, yet having a physiographic relationship in occupying relatively low or basin country, are the Central Basin or Nashville Basin of Tennessee and the Blue-grass Region of central and northern Kentucky. The Blue-grass Region is about 100 miles across from east to west and 125 miles from north to south, while the Central Basin embraces several thousand square miles in central Tennessee. These areas have very irregular outlines, with tongues reaching up the streams flowing into and out of the regions.

The uplands division of the province embraces a large area including: (1) The Highland Rim region of northern Alabama and middle Tennessee extending northward to and partly around the Blue-grass Region of Kentucky, and (2) the Ozark Border Region of southern Missouri, northern Arkansas, and northeastern Oklahoma. Many of the gravelly and stony limestone ridges lying in the southern part of the Appalachian Valley properly belong with the uplands division. More than 50 per cent of the province belongs in the uplands division.

The estimated area of this province is 67,870,000 acres and its population in 1910 was 1,461,459 urban, and 4,227,864 rural. There are about 17,000,000 acres in the Ozarks Region alone.

TOPOGRAPHY

The great Appalachian Valley and the outlying valleys and basins are lowland areas whose surface has been lowered below that of the adjacent country, owing to the fact that the underlying limestone has decayed more rapidly than the more resistant rocks of the bordering highlands. In other words they are not valleys that have been cut down gradually by streams, but valleys which have resulted from the more rapid decay and removal of the original rocks by erosional and underground waters than has taken place in the rocks on each side of the valleys.

The surface of these lands is characteristically undulating to gently rolling, and admirably suited to tillage. The floors of the valleys range from about 500 to 3000 feet below the crests of the bordering mountains. In the Appalachian Valley the average altitude above sea level ranges from about 500 to 1000 feet in Pennsylvania, Maryland, and northern Virginia. To the south there is a gradual ascent to about 2700 feet at the Virginia-Tennessee line, and a gradual slope thence southward to 500 feet or less in central Alabama. In places the streams have cut valleys within the Valley to 250 feet or more below the general level of the lowland country. The Central Basin of Tennessee averages about 600 feet above sea level and about 400 feet below the adjacent Highland Rim. The Blue-grass Region is 500 to 1000 feet above sea level.

The Highland Rim Region of the Limestone uplands is mainly developed in Tennessee and Kentucky, but extends southward into northern Alabama. It has a generally even upland level of distinct plateau character and an elevation of about 1000 feet above sea level. There are many undulating and nearly level areas in this region, and there are also many included tracts of rolling and severely dissected country, where the streams have cut valleys back into the highlands. This region is bordered on the east by the Cumberland Plateau and strictly represents a lower plane of that plateau.

The limestone lands of the Ozark Region, comprising a large area south of the Missouri River, stretching from the Mississippi River bottoms in southeastern Missouri to the southwestern part of that State and for a short distance into northeastern Oklahoma and across the northern part of Arkansas, consists of a rolling to hilly country, with many slopes too steep for cultivation.

Both the Highland Rim and Ozark Region include a large area of land suitable for cultivation, the former having more smooth land and far less rocky land. A considerably larger proportion of the Highland Rim is cultivable than that of the Appalachian Plateau.

The Limestone Valleys and Uplands Province is a region of prevailingly good drainage, but there are flat and depressed areas of deficient drainage throughout. Such situations are occupied by distinct soils, such as the Guthrie and Clarksville silt loams.

GENERAL AGRICULTURE ON THE SOILS OF THE LIMESTONE VALLEYS AND UPLANDS

In the valleys the predominant soils are very productive and durable, giving good yields of the general farm crops—chiefly cotton and corn in Alabama and Georgia, and of wheat, corn, hay, and tobacco to the north. The best soils of Lancaster County, Pa., which ranks as one of the most highly developed agricultural counties in the United States, with land selling for $300 an acre or more for general farming purposes, are the limestone-valley soils—the Hagerstown soils. Here excellent cropping and tillage methods are employed, and the yields of all crops are high. In general the agricultural practices on these valley lands are of a higher type than on the inferior soils of the adjacent ridges and mountains. Locally, dairying is carried on, some cattle and hogs are raised, and beef cattle are fattened in winter for spring sale. Good teams and up-to-date farm implements are in general use. Little fertilizer is used; crop rotations, including the legumes, manure, and lime, are generally depended upon for the upkeep of the soil. Most of the land is in cultivation, except on the valley ridges, where there is still much virgin soil.

In the southern part of the Highland Rim country the type of farming does not average so good nor the yields so high as in the valleys, yet it is better, considerably, than that in the rougher Appalachian Plateau and there are some highly developed sections, as in the dark export and burley tobacco districts of Tennessee and Kentucky. General farming, with tobacco, wheat, corn, and hay as the principal crops, is the prevailing type of agriculture. Special crops, such as strawberries and peaches, are locally important, and stock raising by grazing the rougher lands and timbered areas is of moderate importance on some farms. Much attention is given to the rotation of crops in the better sections of Kentucky and northern Tennessee, and some fertilizers are used. Clover and cowpeas are frequently grown. Probably not more than 60 per cent of the Highland Rim region is cultivated.

In the Ozarks a still larger area is timbered, and the average type of general farming is inferior to that of the Highland Rim. But in this country fruit growing—apples, peaches, and strawberries—is very important, especially in the southwestern part. The fruit farms are handled in an intelligent manner, generally according to modern methods, and there are, also, many well-managed farms on which grain, hay, and clover are the principal crops. In the rougher part, as in southeastern Missouri and parts of northern Arkansas, the farms are small, and the cutting of crossties takes considerable of the farmer's efforts. The raising of beef cattle in this rougher country is of more importance in many sections than any other line of farm activity. They are raised chiefly by pasturing on the open range. Fertilizers are sparingly used. The soils produce satisfactorily with good seasons, particularly when clover or cowpeas are occasionally grown in rotation with the other crops. A large proportion of this country is very gravelly (cherty) and stony, many ridges and hills being too gravelly or stony to cultivate satisfactorily. Surprisingly good crops, however, are made in fields where the soil is so gravelly that it appears just after heavy rains as if no soil material were present. Strawberries, cantaloupes, peaches, and apples thrive throughout the region, even on the very gravelly and stony lands. Strips of stream bottoms, consisting of highly productive soil, add much to the value of many stony farms in the Ozarks.

In the more rolling parts of the limestone regions, particularly in the case of the less gravelly lands, erosion does much damage that could be largely avoided by terracing the slopes, as is so commonly done in the southern part of the Piedmont. In many parts of the Central Basin Region of Tennessee, in the valleys and in the Blue-grass Region neglected slopes have been gullied and had the soil washed off to the clay and even to bedrock, which could easily have been protected by terraces. Only in a few localities have terraces been built, and not all of these have been constructed with the proper gradient. Competent engineers should be employed to lay out terraces in these regions. Land that sells for $100 to $250 an acre is too valuable to be permitted to wash until it is fit for pasture only. There is no excuse for such economic waste. This refers to land that is suitable for cultivation, and not to those very steep slopes which obviously should be used only for pasture land and for hay and woodlots.

The Census of 1910 classified 30,843,124 acres in this province as *improved farm land;* that is, 45.4 per cent of the total area.

GEOLOGY AND SOILS OF THE LIMESTONE VALLEYS AND UPLANDS

The soils of this province are derived very largely from limestone. Some areas contain material from beds of sandstone and shale associated with the limestone and also material fallen from sandstone, shale, and other rocks occupying the higher slopes.

The reduction of the limestone or dolomite (magnesium carbonate) to soil has been accomplished by solution and removal of the carbonates of lime and of magnesia by water. In case of the purer limestones, which are composed largely of these carbonates, the present soil represents a very small proportion of the original rock—merely the accumulation of the impurities or less soluble portion. Many feet of rock thus were required to form a relatively thin layer of soil.

In case of the impure limestone, those containing more insoluble material as silica and chert, and interbedded layers of chert, less of the component materials of the original rock has been carried off in solution. The soils formed from the purer limestone are the more productive and are less gravelly and less generally stony. Of these the *Hagerstown* and *Decatur* series are the most important, and they are the most extensive soils of the valleys. The cherty and less pure beds have given rise chiefly to the *Clarksville* and *Baxter* soils, which predominate over the Highland Rim and Ozark Regions.

DESCRIPTION AND AGRICULTURE, SOILS OF THE LIMESTONE VALLEYS AND UPLANDS

Brown limestone land with reddish, friable subsoils—Hagerstown soils.—The Hagerstown soils are the principal soils of the limestone valleys of Pennsylvania, Maryland, and Virginia, and occur less importantly in the valleys of Tennessee, Georgia, and Alabama. There are considerable areas in the Highland Rim of Kentucky and northern Tennessee, and occasional small bodies in the Ozark Region, and some north of the Missouri River near the streams. In the Central Basin of Tennessee and in the Kentucky Blue-grass Region these are very important soils. They consist of brown, mellow soils overlying reddish brown to dull red friable subsoils, consisting usually of clay.

In places, especially where the drainage is not so good, the subsoil, the upper part particularly, is yellowish brown. Bedrock (limestone) is usually reached at depths of about 3 to 6 or 8 feet, but on the more rolling areas it may be encountered at less than 3 feet, and in places on the steeper slopes there is no soil covering over the rock. In some of the more rolling areas limestone fragments are plentifully strewn over the surface, and on many of the flat strips in the narrower valleys a scattering of fragments of sandstone and other rocks occurs. As a rule, however, the principal types, the loam and silt loam, are free or essentially free of stone and gravel. They are also level to undulating or gently rolling and admirably suited to cultivation. Their drainage is well established, the soils absorbing moisture rapidly so that erosion is not a very serious problem, and retaining it in quantities sufficient for crops through all average seasons. These soils are well supplied with humus, except in some fields impoverished through long-continued growing of the clean-cultivated crops without the addition of manure or other organic material. They are easy to plow and to keep in an excellent condition of tilth. Two-horse plows are commonly employed in breaking the ground. It is more difficult to keep the clay loam, which is of frequent occurrence in small bodies on slopes, in good pulverulent condition.

These brown limestone soils are among the most productive upland soils of eastern United States. They are highly prized for general farming, which is the prevailing type of agriculture. Their highest state of development is attained in the Blue-grass Region of Kentucky, the Central Basin of Tennessee, the Shenandoah Valley of Virginia and northward through Maryland and in Pennsylvania, where wheat, timothy, clover, and corn are the chief crops, with an important acreage of cigar tobacco in Pennsylvania and burley tobacco in Kentucky. Locally Irish potatoes and apples are important, and small fields of alfalfa are successfully grown. In the southern extension cotton is the chief crop, but even here relatively more corn, grain, and grass are produced than on the Appalachian Mountain, Piedmont, and Coastal Plain soils. Blue grass does well, and affords fine pasturage for all kinds of stock.

In the northern part, where clover has a regular place in the rotations followed on most farms, the yield of corn in the best years is from about 60 to 75 bushels an acre, wheat 25 to 45 bushels, tobacco (Pennsylvania seedleaf or broadleaf) 1000 to 2500 pounds (the Havana variety gives the highest yields), Irish potatoes 100 to 200 bushels, and hay (clover-timothy) 1½ to 4½ tons. Cotton gives about three-fourths to 1 bale an acre. The higher yields are made with the use of manure or fertilizer and the practice of intensive methods, such as those used in Lancaster County, Pa. Lower yields of crops are obtained in the more southerly portions of the valleys, on account of the less attention given to crop rotations and deep plowing; but, here, too, the yields are good. In the Central Basin of Tennessee and the Kentucky Blue-grass Region good yields are the rule. Good yields are also made in the Highland Rim and Ozark Regions.

Systematic rotations are in general use, the 3, 4, and 5-year systems prevailing in Pennsylvania and somewhat similar practices southward down into the Shenandoah Valley. In the 3-year rotation corn or tobacco is followed by wheat one year and then by grass (clover and timothy) one year. In the 4-year system the field is devoted to corn and tobacco one year each, then wheat one year and grass one year. The land remains in grass two years in the 5-year plan. Lime, manure, green-manuring crops, and occasionally commercial fertilizers are used. The best Pennsylvania farms apply burnt lime on the wheat land usually, at the rate of one-half ton to two and one-half tons an acre in the course of a 5-year rotation. Some use ground limestone. High-grade fertilizer mixtures are used in Lancaster County, Pa., for wheat, corn, and tobacco, 200 to 500 pounds an acre of 8-4-4 and 8-4-6 mixtures frequently being applied to wheat and corn. Heavier applications are used for tobacco, some farmers using 1000 pounds of a mixture consisting of one ton of cottonseed meal, one-half ton of sulphate of potash, and one-half ton of phosphate rock. Such intensive treatment is not in general use in the southern areas.

Apple orcharding is of importance on a good many farms, and there are farms on which this is the principal industry. The York Imperial, Black Twig, Baldwin, Jonathan, Stayman Winesap, Rome Beauty, Fallawater, Smokehouse, Grimes Golden, and Northern Spy are among the varieties most grown. Apple production is most important from southwestern Virginia northward.

Dairying is carried on to an important extent in some of the northerly localities, considerable milk being shipped. In Pennsylvania cattle are brought in and kept as winter feeders for sale in the spring. A large part of the corn and hay produced is used in fattening stock of this kind.

In southwest Virginia and in the Blue-grass Region some fine beef cattle are raised on the Hagerstown soils, being pastured on blue grass, which thrives on these lands. Thoroughbred horses have been very successfully raised in Virginia, Tennessee, and Kentucky. In the valleys cattle are prevailingly less important from Virginia southward.

Describing the Hagerstown loam, Snyder says (*Fights of the Farmer*, pp. 10–11):

> The Hagerstown loam is one of the most fertile of the eastern soils. Its long-sustained crop-producing power has given rise to the saying, "Limestone soil is a fertile soil. . ."
>
> Since early colonial days the Hagerstown loam has been highly prized as a general farming soil. Its principal crops for nearly 200 years have been corn, winter wheat, and hay. It has always maintained a profitable live-stock industry. . .
>
> Corn is the principal grain produced. Even after 200 years of cultivation in southeastern Pennsylvania the average corn yield upon the Hagerstown loam exceeds 50 bushels per acre, while yields of 75 to 80 bushels are nowise uncommon. The Hagerstown loam is a dominant wheat soil in the Eastern States, producing from 20 to 35 bushels of winter wheat per acre and maintaining an average yield in excess of 25 bushels.
>
> The grass-producing capacity of the type is, probably, its most widely known characteristic. The Kentucky blue grass is peculiarly adapted to this soil, and pastures seeded to this grass maintain a large number of grazing animals. The type is no less suited to the growing of mixed timothy and clover, while clover and alfalfa, seeded alone, are very productive. . .
>
> The uses of the Hagerstown loam are not confined to the practices of grass and grain growing and of dairying and stock raising. Fruit trees, particularly apples, are grown to advantage upon the type, and the extension of apple orcharding upon it has been marked during the last decade.
>
> The Hagerstown loam has dominated the crop-rotation practices of the region within which it occurs. Upon it the clovers and timothy have been grown in rotation with corn and wheat for upwards of two centuries. It was among the earliest of eastern soils to be tilled with the well-ordered and soil-sustaining rotation of an intertilled crop (corn), followed by a small grain (winter wheat), followed by two or more years in mixed timothy and clover. The success of this rotation, coupled with the manuring and liming, is attested by increased crop yields after 200 years of tillage.

In the Central Basin of Tennessee and in the Blue-grass Region of Kentucky much of the limestone giving rise to the Hagerstown soils (the Trenton limestone) runs relatively high in content of phosphorus, the rock being locally mined on a very important scale for the manufacture of commercial acid phosphate and ground "raw" phosphate rock. Even some of the thin beds of sandstone locally associated with limestone of the Central Basin, as in Maury County, Tenn., are high in content of phosphorus. Soils derived from these phosphatic rocks naturally run high in phosporus content. It is probable that they contain enough of this element to produce good crops for a great many years without addition of phosphatic fertilizers. The table below shows the high content of phosphorus (P_2O_5) in some representative areas of these soils, as determined by analyses of carefully selected samples from Maury County, Tenn.

PHOSPHORUS (P_2O_5) CONTENT OF SOME REPRESENTATIVE SAMPLES OF LIMESTONE SOIL (HAGERSTOWN) AND LIMESTONE-SANDSTONE SOIL (CHRISTIAN) FROM MAURY COUNTY, TENN.

Sample No.	*Location*	*Kind of soil*	*Section*	*Total P:O*
401718...	3 mi. S. W. Columbia	Hagerstown silt loam (from Trenton limestone)	0–8 in.	0.67
401719...	Subsoil of 401718	Same	8–36 in.	1.38
401720...	1 mi. S. Columbia	Hagerstown clay loam (from Trenton limestone)	0–6 in.	0.28
401721...	Subsoil of 401720	Same	6–36 in.	0.47
401729...	1 mi. E. Rochdale School	Christian loam (from sandstone and limestone)	0–8 in.	0.23
401730...	Subsoil of 401729	Same	8–36 in.	0.23
401731...	1¼ mi. S. E. Central Church	Christian very fine sandy loam (from sandstone and limestone)	0–6 in.	0.99
401732...	Subsoil of 401731	Same	6–36 in.	1.42

Red limestone land—Decatur soils.—These soils are most extensive in the limestone valleys of southwestern Virginia, eastern Tennessee, in Georgia and Alabama, and in the Highland Rim country of Kentucky and northern Tennessee. Over much of this country they are the principal soils. They are also present in smaller bodies in the Ozark Region and in the valleys from Virginia northward.

The Decatur soils represent the red equivalent of the Hagerstown or brown limestone soils. The typical surface is reddish brown to dark red, while the subsoil is a deep red, moderately stiff clay resembling the subsoil of the red granite lands of the Piedmont. In places the soil of the silt loam and loam is deep brown in color. Generally the underlying limestone lies at depths of 5 or 6 feet or more. Fragments of chert are present in places giving rise to gravelly and stony areas.

The drainage is good and the soils retain adequate supplies of moisture, crops seldom suffering from the effects of drought. The surface varies from level to rolling, the average surface condition being more rolling than that of the Hagerstown soils. According to the areas mapped in detail the clay loam is the most extensive type. This is mostly rolling with a good many slopes that are inclined to wash. The silt loam is next in importance, consisting of a reddish brown or deep brown mellow silt loam 10 to 15 inches or more deep over the red clay, and occupying the less rolling areas. As a rule the surface of the Decatur soils permits the use of any kind of farm implement. The silt loam is very easy to handle, but strong teams and heavy plows are necessary for breaking the clay loam to proper depths. Stone and gravel fragments interfere some with cultivation, but they have a compensating advantage in checking erosion.

The red limestone soils are used for general farming, the production of grain, corn, grass, and cotton chiefly. They rank as excellent soils, giving, with similar treatment, yields equal to these made on the Hagerstown soils. There are many excellent farms, giving high yields of grain, corn, timothy, clover, and cotton. Apples, peaches, strawberries, and nursery stock are grown commercially in places. The live-stock industries have not become important generally, but there is no reason why they should not, especially dairying and beef production, since good forage crops, such as cowpeas, clover, vetch, soy beans, and alfalfa succeed. Most of the Decatur soils are cultivated.

Brown limestone land with yellow subsoil—Shelbyville soils.—These brown limestone soils with yellow subsoils (Shelbyville) very closely resemble the Hagerstown soils on the surface, but the subsoil is yellow or yellowish brown and usually contains considerable dark-colored concretionary material in the lower part of the 3-foot profile. They do not have as good underdrainage as the Hagerstown, yet they are not poorly drained, with the exception of occasional seepy spots.

These lands are most extensively developed in the Bluegrass Region of Kentucky, in the country about the Hagerstown soils, the latter centering about Lexington. Shelby County, Ky., is the locality where they were originally mapped. Other areas occur in the Central Basin of Tennessee, and in some places through the limestone valleys.

In agricultural value these soils rank very close to the Hagerstown, giving very nearly as good yields. Wheat, corn, clover, timothy, tobacco, and hemp are the principal crops. Some beef cattle, hogs, horses, and mules are raised. Blue grass thrives, affording excellent pasturage. These are high-priced lands, supporting a good type of agriculture.

Grayish limestone land with yellow subsoil—Clarksville soils.—These soils are important or predominant through the Highland Rim country of northern Alabama and middle Tennessee, and are of important extent in central and southwestern Kentucky, in the Ozark border of southern Missouri, northern Arkansas, and northeastern Oklahoma, and also in the ridges in the southern part of the valleys of east Tennessee and of Georgia and Alabama.

The Clarksville soils, derived from limestone of a less pure or more cherty nature than these giving rise to the

PLATE 41.—Smooth plateau land of the southern Appalachian. Cotton and corn on sandstone land (Dekalb fine sandy loam) of the Cumberland Plateau Region, Sand Mountain, Ala. (Photo. by the Author, collection, Bureau of Soils.)

PLATE 42.—Irish potatoes on Memphis silt loam, near Natchez, Miss. This field is in the smoother country of the Mississippi Bluffs and Silt Loam Uplands region. This silty soil is well adapted to vegetables, as well as to grass, grain, corn, peanuts, lespedeza, and forage crops. (Photo. by the Author, collection, Bureau of Soils.)

Hagerstown and Decatur soils, are characterized by the grayish color of the surface soil and the pale-yellow color of the subsoils. In the more nearly level and less cherty areas, as in much of the silt loam type, the lower subsoil is often compact and mottled with gray. In the surface the material is prevailingly silty, while in the subsoil it usually consists of silty clay loam or silty clay. Fragments of chert from the size of small chips to large stones are typically abundant over the rougher areas. The principal types are the silt loam, stony loam, and gravelly loam.

The Clarksville silt loam is a gray silt loam of floury feel, underlain at about 5 inches by pale-yellow silt loam which quickly passes into silty clay loam of slightly deeper yellow color. In places this yellow subsoil is uniform to a depth of 3 feet, especially where the topography is moderately undulating, but many areas of level surface features have a compact stratum at about 20 to 30 inches, in which gray mottling is conspicuous and dark concretions are common. This soil resembles "hardpan" soil, *Lebanon*, found in some of the prairies of the Missouri Ozark country. That with the compact lower subsoil has inadequate surface and underdrainage and must be ditched or tiled for its most efficient use. That with the uniform yellow subsoil has adequate drainage.

This soil is deficient in organic matter and compacts to an undesirable structure in dry weather. By growing the humus-supplying crops, preferably cowpeas, clover, vetch, soy beans, and lespedeza, and occasionally turning under a covering of vegetation, as cowpeas or rye, the soil can be put into a much more productive condition. By such treatment the soil assumes a brownish color and more mellow tilth. Applications of both burnt lime and ground limestone have been followed by increased yields. Deeper plowing than the average, which is only 4 or 5 inches, is especially needed. The soil is very responsive to applications of commercial fertilizers and manures. Those fertilizers containing a relatively high percentage of phosphoric acid seem to be desirable. Crops are rather late on the Clarksville silt loam, particularly on that having a compact lower subsoil.

At present, hardly more than 25 per cent of this land is in cultivation. It is most extensively used in the dark tobacco districts of north-central Tennessee, as in Montgomery and Robertson counties, and in southern Kentucky. Here tobacco is the chief money crop, although corn, grain, and grass are important. In northern Alabama cotton is the principal crop, and in the Ozark Region grain, corn, and grass. This type ranks as a soil of only moderate productiveness, but one that can be improved. It is a fairly good grass and tobacco soil, and under proper management wheat does well. It is not naturally so productive as either the Hagerstown or Decatur. Wheat yields range from about 10 to 25 bushels, oats 15 to 40 bushels, corn 20 to 35 bushels, tobacco from 500 to 1000 pounds, and hay (timothy, redtop, and clover) averages about 1 ton an acre, according to the drainage and treatment given. That with the compact mottled subsoil is less productive. It is in the tobacco districts that the best methods are followed. Here rotations are practiced by the best farmers, which tend to maintain productivity. It is a common practice to follow tobacco with wheat and then clover and grass for 1 or 2 years, or with cowpeas, or corn and cowpeas, for one year. In some localities beef cattle are raised by pasturing in the native hardwood (oak and hickory) timber.

There are good opportunities for increasing the value of this land; chiefly by (1) increasing its productiveness as pointed out above, by (2) raising more cattle and hogs, and by (3) dairying. Among the crops that do well but are now unimportant are strawberries and lespedeza.

PLATE 43.—Showing how unchecked erosion ruins good farm land in the Mississippi Bluffs and Silt Loam Uplands region (Memphis silt loam). Such wasteful erosion can be largely avoided by timely construction of efficient terraces or by using the steeper slopes for grass and trees only. Honeysuckle, Bermuda grass, artificial dams, and growing trees are possible means of checking the waste and of restoring the washed land to some degree of value, as for pastures and second-growth timber. The same holds true for other kinds of soil susceptible to ruinous washing. (Photo. by the Author, collection, Bureau of Soils.)

PLATE 44.—Showing the gently rolling topography and large proportion of cultivated land of the rolling limestone and loessial soils of northeastern Missouri (Pike County). These lands produce good yields of wheat, corn, timothy, clover, and bluegrass, and are highly adapted to the raising of stock. (Photo. from collection, Bureau of Soils.)

The Clarksville gravelly (cherty) loam is extensively developed through the Ozarks of southern Missouri and northern Arkansas and on the valley ridges of east Tennessee, northwest Georgia, and northern Alabama. Much of this land is timbered, and is too gravelly and steep for satisfactory cultivation, but there are many small farms and some large ones on it. In Missouri considerable areas are used with good results for apples, peaches, and strawberries, and with fair results for grass, clover, corn, and grain. In Georgia and Alabama cotton is grown and some corn, and in some localities there are commercial orchards of peaches. The type yields surprisingly well for such gravelly land. It is really an excellent fruit, strawberry, cowpea, and cantaloupe soil. Fertilizers and manure are used sparingly. The soil needs humus, and the legumes should be grown in the rotations. Considerable beef cattle and some hogs are raised, chiefly on the open range—the timbered areas.

The stony loam is mostly forested. It is valuable for pasture land and for its hardwood timber. The cutting of crossties is an important industry on this stony land. Peaches and apples will succeed, but the land is generally too stony and rolling for ordinary crops.

Grayish limestone land with mottled yellow and grayish, compact subsoils—Lebanon soils.— There are many scattered areas of these soils of small to large size through the limestone portion of the Ozark Region, mainly in southern Missouri. They were originally prairie lands, but timber, chiefly oak, has encroached upon some of the areas.

These are grayish soils overlying mottled yellow and grayish compact subsoils, with frequently many chert fragments in the lower subsoil. The silt loam and gravelly (cherty) silt loam are the principal types. They occupy flat and gently sloping areas, the associated steeper slopes being occupied usually by the Baxter soils.

These lands are used principally for wheat, corn, and grass, giving best average yields probably with wheat and grass. The grain sorghums do very well. The compact subsoil seems to interfere with internal circulation of moisture and air, and in long, dry seasons crops, corn particularly, suffer considerably, while in wet seasons planting is delayed or cultivation is seriously retarded. The growing of clover and cowpeas in rotation with other crops is very helpful, and applications of manure and fertilizer are followed with increased yields. Additions of lime also are probably advisable. The flat areas should have ditches or tile drains. These soils closely resemble the Clarksville soils, and have not very different crop values.

In some of the prairie areas there are some dark-colored soils, silt loam and silty clay loam chiefly, with mottled yellowish, grayish, and reddish plastic subsoils (*Eldon* soils). These are rather more productive than the Lebanon soils. They are used mostly for grain and corn.

Brownish to grayish limestone land with red subsoil—Baxter soils.—These soils occur in the same localities as the Clarksville; in fact, they are very closely related to the Clarksville in topography, origin of material, crop adaptation, and requisite methods of management. The chief difference is that the subsoil or lower subsoil consists of red clay, much like that of the Decatur. In much of the Ozark Region these soils are very largely in the predominance. These lands may be expected to give somewhat better yields than the Clarksville soils. They are used for the same crops. The larger part of the stony loam and gravelly loam is timbered, but there are many farms that include chiefly the latter soil. The timber consists mainly of oak. The silt loam and clay loam are productive soils. Wheat, corn, grain, clover, grain sorghum, cowpeas, strawberries, potatoes, tomatoes, peaches, apples, beef cattle, poultry, and mules are the principal products.

Soils of minor importance in the Limestone Province.— In the Limestone valleys of Alabama, Georgia, and Tennessee there are scattered bodies of a limestone soil classified as *Colbert* soils, which have a sticky or waxy heavy clay subsoil that retards drainage. The flat areas are poorly drained and are called "crawfish land" and "buckshot land" (where the black iron pebbles are abundant). They are best suited to lespedeza and redtop. With improved drainage corn, grain, cotton, and various forage crops succeed. There are strips of the stony clay on the lower slopes of the mountains that support a valuable growth of red cedar and afford good grazing.

A closely related group of soils, the *Cincinnati* soils, occurring in the Blue-grass Region of Kentucky, in southern Ohio, and in other parts of the limestone region, has light brownish soils with plastic, heavy clay subsoils. These are moderately productive and are used for corn, grain, tobacco, and to a considerable extent for pasturing cattle. Blue grass does well.

There are also in the valley, from Alabama to Pennsylvania, occasional strips of brown soil along the slopes that consist of mixed soil material fallen and washed from the slopes above. These are the *Murrill* soils. They are well drained and productive, being adapted to the general farm crops and fruit.

In the areas of Clarksville silt loam there are, here and there, poorly drained depressions (or sink holes) and flats of a light-gray silty soil overlying mottled grayish, bluish, and yellowish clay. Land of this kind has been classified as the *Guthrie* soils. In the natural undrained condition such land is valuable for pasture land and for lespedeza and redtop.

There are scattered areas through the limestone valleys and uplands where sandstone interbedded with limestone has contributed enough material to give the soil and subsoil a friable sandy character. These areas having a brownish soil and red subsoil (*Christian* soils) resemble the Hagerstown, but are not so productive. They are, nevertheless, good general farming soils. These have been found in southern Kentucky, as in Christian and Logan counties and the adjacent counties, and to some extent in the limestone valleys of Georgia and other States.

The *Conestoga* soils occurring chiefly in the limestone valleys of Pennsylvania, as in Lancaster County, are derived from schistose or marbleized limestone. They are brown in the soil and greenish brown in the subsoil and have a greasy feel. The surface is undulating to gently rolling, the drainage is good, and the soils, consisting of loam and silt loam mainly, are easy to cultivate. These lands are handled about the same as the Hagerstown, and are used for the same crops. They give about the same yields, perhaps a little lighter.

The *Frankstown* soils are locally very important. On them are some of the best apple orchards in the East, as on Apple Pie Ridge of Frederick County, Virginia, and Berkeley County, West Virginia. They occur chiefly as rounded ridges and hills. The principal type is an open-natured gravelly loam, gray in the surface and yellow below. The gravel consists of chert and soft decayed siliceous limestone, incorrectly called "soapstone." This soil is known as "apple pie land" and "soapstone land." It has been found in the Virginias, in western Maryland and in Pennsylvania. Wheat and clover do well.

MISSISSIPPI BLUFFS AND SILT LOAM UPLANDS

GEOGRAPHY

The Mississippi Bluffs and Silt Loam Uplands Region comprises a long belt of silty upland soils extending along the east side of the Mississippi River bottoms from southwestern Kentucky to the vicinity of Baton Rouge, La. The belt is broadest in western Tennessee and southwestern Mississippi, where it is about 75 to 80 miles wide. The main belt terminates in a narrow strip in Kentucky, but has a broad front along the southern extremity, where it falls off gradually to the flatlands of the Lake Pontchartrain country. Narrow strips extend up the Mississippi River along the bluffs, passing northward into closely related loessial soil (*Knox* soils) of the Central Prairie Region.

A narrow belt including the same soils occurs in northeastern Arkansas and southwestern Missouri, and is known as Crowley's Ridge. This extends from the vicinity of Forest City in east-central Arkansas to the vicinity of Bloomfield in southeastern Missouri. In places this ridge is about 10 miles wide, but it averages narrower.

The Mississippi Bluffs and Silt Loam Uplands region covers about 20,979 square miles or 13,426,560 acres including the smaller associated stream bottoms and second bottoms.

TOPOGRAPHY

The topography of the region varies from gently rolling and undulating to severely dissected or rough and hilly. The western part, a strip of varying width along the bluffs fronting on the Mississippi bottoms, is comparatively rough. Toward the east the surface is generally smoother, but this is not everywhere true, for some very hilly and broken areas occur along the eastern border from the northeastern part of Madison County, Miss., northward through Leake, Attala, Montgomery, Grenada, Calhoun, Yalobusha, Lafayette, and Marshall counties into Tennessee. On the other hand, there is much gently rolling and undulating land along the Mississippi bluffs, especially in northern Mississippi and in Tennessee. The greater part of a strip ranging from very narrow to about 15 miles in width and extending along the Mississippi bluffs from Grenada County, Miss., to the southern extremity of the region in Louisiana, is predominantly rough, very rolling with numerous ridges and subsidiary ridges separated by the valleys of the larger streams, often 100 to 150 feet below the upland level, and by short, shallow valleys and gullies of tributary streams and wet-weather drainage ways. These valleys are flanked with steep walls generally, but many of the ridges are rounded over the top, and have gradual slopes along their longitudinal axes down to the stream bottoms. The tops of many of these ridges or divides expand into comparatively flat to gently rolling areas.

Considerable farming in fields of irregular distribution, shape, and size is carried on in this dissected strip of country, locally known as the "cane hills" and "hills," but there are sections where the slopes are prevailingly too steep, the ridges too narrow, and the occasional smooth areas of farming size too inaccessible for any other use but grazing and forestry. Also there are sections in the hilly northeastern portion of the region which are but poorly suited or altogether unsuited for farming on account of the unfavorable topography.

But the greater part of this region has an undulating to gently rolling surface, with many level areas admirably suited to farming operations, including the use of improved machinery. From central Mississippi southward most of the country, back from the strip of rough lands immediately along the Mississippi bluffs, possesses smooth surface features, and a very large proportion in west Tennessee and the adjacent part of Mississippi, even much of that along the bluffs, is similarly smooth in its surface configuration.

The boundary between this upland or "hills" country and the Mississippi bottoms is marked by a sharp bluff (the Mississippi Bluffs) rising 75 to 200 feet above the bottoms. At Memphis and other places in Tennessee and southern Mississippi, the bluffs constitute the eastern banks of the Mississippi River, rising perpendicularly from the water or from a very narrow intervening strip of alluvium. In places the river is gradually cutting back the perpendicular bluffs. Great masses of land fall into the river at frequent intervals during high water. The elevation of the region varies from about 100 feet above sea level in Louisiana to about 500 or 600 feet in Kentucky.

Crowley's Ridge is gently rolling to rolling in the main portion. It falls off to the bottoms or second bottoms on both sides through slopes which in most places are gentle. The higher part is about 250 feet above the surrounding bottoms, the average being less than 150 feet above the bottoms. Nearly all of this area is topographically suited to farming.

GEOLOGY AND SOILS OF THE MISSISSIPPI BLUFFS AND SILT LOAM UPLANDS

The Mississippi Bluffs and Silt Loam Uplands Region is underlain by yellowish brown silty material, which is believed to consist of wind-blown particles, or loess. If one stands on the banks of the Mississippi River on a windy day in dry weather clouds of dust will be seen blowing up from the bars and floating out over the adjacent bottoms and uplands. Acting through ages wind could have in this manner built up such deposits as constitute these silty beds. It is possible that preëxisting conditions of climate and other conditions were favorable to a more rapid transposition of dust from the associated bottoms than is now going on. Formerly this loessial uplands country extended farther west. The area has been cut back, as is now being done, by the erosive action of the Mississippi River. It is not improbable that the present area east of the Mississippi was at one time continuous with Crowley's Ridge, a detached area of soil material identical with that of the eastern or major area. These deposits are underlain abruptly by distinctly different material—beds of red, yellowish, grayish, and mottled Coastal Plain material consisting of heavy clay, sandy clay, and gravel. The silty beds are deepest in the western part of the region, often 40 or 50 feet deep along the bluffs. Toward the east they become thinner, changing to only a thin veneer over the Coastal Plain deposits and finally disappearing, giving way to the sandy soils of the Coastal Plain material in central Mississippi and near the Tennessee River in Tennessee.

The loess shows some changes of texture and color through the vertical section. Uneroded areas have a light brownish silt-loam surface layer ranging from about 8 to 14 inches deep and containing in places nearly 90 per cent of silt and averaging about 75 or 80 per cent. Immediately beneath this layer is a stratum of dull-red to reddish-yellow silty clay loam or silty clay (locally yellowish in the poorer drained situations), which becomes more silty below, passing within a range of about 3 to 5 feet into yellowish-brown silt loam or first into a compact mottled grayish and yellowish layer containing dark-colored ferruginous concretionary material and then into yellowish-brown silt loam. The clay layer may be due to a concentration of clay resulting from a downward transposition of the finer or clay particles of the original surface layer by percolating water. The grayish and yellowish color in the subsoil of many areas is the result of imperfect drainage. In places the clay layer has been exposed by erosion. The yellowish-brown substratum is generally neutral to litmus and frequently contains some nodules of lime and snail shells, but the surface soil is characteristically acid in reaction.

There are two principal kinds of soils in the uplands of this region: the brown silt loam with reddish clay subsoil passing beneath into yellowish-brown silt loam (*Memphis* silt loam), and brown silt loam with yellowish to reddish clay subsoil passing beneath into mottled yellowish and grayish compact silty clay loam containing dark-colored concretionary material consisting mainly of oxides of iron (*Grenada* silt loam). On the slopes a former surface covering of silt loam has been removed by erosion in many areas, giving rise to a clayey soil. Some land in the eastern part of the belt has sandy clay material of the Coastal Plains beds in the lower subsoil (*Lexington* silt loam).

GENERAL AGRICULTURE ON THE SOILS OF THE MISSISSIPPI BLUFFS AND SILT LOAM UPLANDS

The Mississippi Bluffs and Silt Loam Uplands belt is a very important agricultural region. In addition to the large area now in cultivation, there is an immense total unused area of good potential agricultural value, including cleared land abandoned following the invasion of the boll weevil, virgin timber land, cut-over virgin land, and rough or hilly land valuable for pasturage. In the northern part a much larger proportion of land is in cultivation than in the southern part, where there is much cut-over pine land, and land "turned out" owing to the reduced cotton yields occasioned by the boll weevil. Considerable timber is still standing throughout the belt. The northern part is a hardwoods region, including chiefly white oak, red oak, tulip-poplar, sweet gum, hickory, and elm, while the southern part is mainly a longleaf and shortleaf pine region, although including some oak, hickory, and sweet gum.

The dominating industry continues to be cotton production, but within the limits of the boll-weevil invasion (from north Mississippi southward) cotton production has decreased, and recently the raising of live stock, mainly cattle and hogs, and the production of lespedeza hay have increased. Gradually the raising of stock is increasing and spreading, the industry being favored by the excellent adaptation of the soils to grass and forage crops, such as Bermuda grass, lespedeza, velvet beans, cowpeas, bur clover, and soy beans. In some sections white clover is plentiful, and nearly everywhere lespedeza flourishes, growing in abandoned fields, on well-drained and poorly-drained uplands and bottom lands. This belt is the best large area of grass land (grass, lespedeza, etc.) east of the great "mesquite grass" ranching sections of central Texas, and it is believed it will steadily advance to the point of being one of the principal stock-raising sections of the United States. The increasing importance of this industry is the outstanding feature in the agriculture of the region to-day.

Cotton production has not decreased in the section north of the boll-weevil area. Shelby County, Tenn., for example, whose uplands consist entirely of the typical soils of the region, produces 40,000 to 50,000 bales of cotton annually. The crop of 1913 in this county alone amounted to 57,820 bales. In 1909, 57 per cent of the cultivated area of Shelby County was devoted to cotton, the remainder being used largely for corn (32 per cent).

The corn produced in the northern part about meets the demand for the work stock and other farm animals;

in the southern part an incr asing amount of corn is being grown, both by means of increased acreage and improved methods

The table below gives the average acreage yield[1] of lint-cotton and corn in Mississippi for five decades:

	Corn Bushels	*Lint Cotton* Pounds
1866–1875	16.0	177
1876–1885	14.2	175
1886–1895	14.7	182
1896–1905	14.7	200
1906–1915	18.3	193

The raising of vegetables for shipment and for local markets constitutes an important industry in some localities, such as Crystal Springs and Natchez, Miss., and Wilson, La. Tomatoes, potatoes, cabbage, garden peas, and sweet potatoes are among the vegetables grown. These give good yields. Strawberries also are grown commercially in some sections, as in the Crystal Springs, Miss., section and in the Humboldt, Medina, Dyer, and Sharon sections of Tennessee, the soil being ideally suited to the crop. Limited areas are devoted to the production of tabasco peppers on Avery Island, La. (and on similar soil of the Mississippi River terraces in St. Martin's Parish, La.). These peppers are used for making tabasco sauce.

Peanuts do well, and are grown in a small way in some localities. Probably this could be made a very important crop for the production of peanut oil and meal and as a field-forage crop for hogs. An increasing number of farmers

[1] These yields are for the whole State and for all soils, seasonal conditions, and good and poor methods of farming. The Bluffs and Silt Loam Uplands Region constitutes approximately one-third of the area of the State.

are sowing lespedeza for hay, many of those in Mississippi and Louisiana growing both hay and seed for sale. A few farmers grow enough wheat for their own use, and most of them grow some oats, which usually are fed in the sheaf to the stock on the farm. Alfalfa, vetch, bur clover, crimson clover, and red clover are grown by some farmers.

In northwestern Tennessee and southwestern Kentucky red clover, wheat, dark fire-cured tobacco, sweet potatoes, and corn are the important crops, with some cotton. This is a good stock section also.

While farm methods are gradually improving, much improvement can be accomplished by earlier and deeper plowing, by introducing the legumes more generally into rotations with cotton, corn, and other crops, and by increasing the supply of barnyard manure through the raising of more cattle and hogs. Much idle land of the rough and hilly areas and of the cut-over lands and stream bottoms could be brought into profitable use for pasturing cattle, hogs, sheep, goats, horses, and mules.

Many farmers plow cotton and corn ground in late winter and spring, and it is too often plowed with light one-horse turning plows and "middle busters" to a depth of only about 4 inches. Cotton and corn ground frequently is simply rebedded over the old "middles" or water furrow, in many cases without a preliminary furrow to break the middle. The cultivation of these crops is performed in a more efficient manner, cultivators and shallow-running sweeps being in common use. The better farmers flat-break the ground as soon as possible after the harvest, using heavy turning plows and disks drawn by two or three mules, plowing to a depth of about 7 or 8 inches. After this the land is usually harrowed once or twice. Yields are markedly increased on these silty lands simply by the use of these better methods of tillage. Instances have been noted in this region where certain sections locally described as being poor farming neighborhoods because of the abundance of so-called "poor land" or "worn-out land," and other near-by sections described as neighborhoods of good farming because of the better grade of land, have been found upon examination to have exactly the same soils. The poor farming sections were "poor" because the methods of farming were poor—continuous shallow cultivation had formed an undesirable compact subsurface or plow sole and diminution of the soil humus had caused the land to harden in dry weather to a condition unfavorable to the retention of moisture. In other words the soil was impoverished by injudicious farm methods, but it was not "worn out."

Erosion is a very serious problem in this region. Gullies once started cut back rapidly and ruin the land for cultivation, if means are not taken quickly to check the washing. Many areas have been ruined in so far as having value for cultivated crops, and some have been rendered almost worthless for grass by cutting down to unproductive stiff clay. Gullies should be filled with brush, or by planting soil-binding plants, such as honeysuckle, as soon as they show signs of getting beyond ordinary control. Carefully laid out hillside terraces should be constructed and the rows made to follow the contours on cultivated slopes steep enough to favor erosion, or else such slopes should be used only for grass land and woodlots. Vertical walls of this material, such as those along many of the highways, stand for long periods with practically no change by erosion.

Commercial fertilizers are used to a considerable extent for cotton, corn, vegetables, and berries. Cotton and corn are frequently given an acreage application of about 200 to 300 pounds of commercial mixtures, and of cottonseed meal and acid phosphate at the ratio of 1 to 2 by weight. Vegetables are grown with heavier applications. Additions of ground limestone have proved especially helpful in getting satisfactory stands of clover and alfalfa. Probably lime could be used to good advantage on all of the soils of the region, inasmuch as they are all acid. Rock phosphate also probably would prove profitable, especially if the soil is kept supplied with humus. The leguminous crops should be grown more extensively to supply nitrogen and humus and to permit the raising of more live stock.

DESCRIPTION AND AGRICULTURE, SOILS OF THE MISSISSIPPI BLUFFS AND SILT LOAM UPLANDS

Brown to light-brown lands—Memphis, Grenada, and Lexington soils.— The brown silt loam with red clay subsoil (Memphis silt loam) is derived directly from the loessial material described above. It is the weathered loess, consisting in its typical development of 8 to 14 inches of brown silt loam, underlain abruptly by reddish brown, dull red, or reddish yellow, moderately stiff silty clay loam or silty clay, which grades beneath into more silty, yellowish brown material, passing usually at depths of about 3 to 5 feet into silt loam. In fields that have had the organic matter of the soil considerably reduced by severe cropping, the soil has a lighter color, is less mellow, and more inclined to compact. In places there is some grayish mottling in the lower subsoil, but not so much as there is in the Grenada silt loam, and there is not the compactness that is common to the subsoil of the Grenada. There usually is less gray mottling in the areas near the Mississippi Bluffs, and it is in a strip about 10 to 20 miles wide along the bluff that the main portion of this soil type occurs. On many slopes the silty surface soil has been partly or wholly removed, giving rise to patchy bodies of clay and silty clay loam. These areas of heavier soil are more difficult to plow, they clod more, and crops on them suffer more in dry weather than on the more friable silt loam, as the soil is much more susceptible to baking.

The silt loam is easy to cultivate, and if enough vegetable matter is incorporated with the soil a desirable mellow tilth is maintained. Continuous shallow plowing is apt to cause the formation of a compact subsurface or plow-sole "hardpan," which seems to impede the proper movement of moisture and air in the soil. Crops suffer more from drought where this compact layer exists, and lower yields are obtained. Plowing should be done at least 6 to 10 inches deep, and as soon as possible after crops are harvested.

The agriculture of the region as summarized above applies to this soil. It is used mainly for cotton and corn, but other crops are successfully grown for use on the farm, for sale, and as soil improvers. Among these are oats, cowpeas, velvet beans, soy beans, lespedeza, Bermuda grass, clover, alfalfa, wheat, sorghum, sugar cane (for sirup) strawberries, and a variety of vegetables, including sweet and Irish potatoes, cabbage, and tomatoes. Vegetables for sale are grown extensively in some localities by truckers, and in the vicinity of cities, such as Memphis, by market gardeners. Johnson grass does well, but it is avoided owing to its tendency to spread and become troublesome in cultivated fields.

The live-stock industry is increasing; a large number of farmers, particularly south of Tennessee, are raising beef cattle and hogs for sale. The land is ideally adapted to the raising of cattle and hogs. This is due to the ease with which splendid grazing, hay, and forage crops are produced in large amounts. There is probably no soil better adapted to Bermuda grass, which is an excellent pasture grass for both cattle and hogs, and also a good hay grass, especially on the alluvial soils of the region. In the dissected country near the bluffs along the Mississippi bottoms Bermuda grass has spread over much of the land, where it makes an unusually heavy growth. Long pendants of this grass are often seen here suspended from the edge of gullies, and many areas, both eroded and uneroded, are covered with it. Hence the roughest of this dissected country constitutes good grazing land.

Lespedeza is another grazing and hay plant that takes possession of all uncultivated cleared land. In seeded fields it gives 1 to 2 tons of high-grade hay per acre, and it has spread well over the whole region, affording the best kind of pasturage. Two cuttings are obtained in the more southerly portions.

Velvet beans succeed nearly everywhere. In the southern part they produce a remarkably luxuriant growth, affording a tremendous amount of field forage, and 1500 to 2000 pounds of seed in the pods to the acre. Red clover seems to do best in the section near the bluffs, perhaps on account of a higher content of lime in the soil there. This crop persists for several years once a good stand is obtained. Bur clover does very well. Some crimson clover is grown, but it appears to be more difficult to get a satisfactory stand than with bur clover. White clover grows wild in many places. Vetch does well, and is occasionally grown with oats for forage. Occasional fields of alfalfa are seen on this soil. With lime this can be made a valuable crop.

Red clover is extensively grown on this soil in northwestern Tennessee, as in Henry County, and in southwestern Kentucky producing good, crops. Dark fire-cured tobacco is also a successful and important crop in this northern portion of the belt. Yields of 800 to 1400 pounds of tobacco an acre are obtained here. Wheat, sweet potatoes, and corn are grown in an important way too, with relatively less cotton than is produced farther south although cotton is an important crop also. This northern section is fine for stock.

Cotton gives an average yield of about one-third bale per acre, when not damaged by the boll weevil. The range

PLATE 45.—Showing sharp line of contact between the soil and claypan subsoil of the Oswego silt loam, Barton County, Missouri. The claypan soils are of important extent in the Great Plains. Generally the deep-rooted crops, such as alfalfa, do not succeed on them as well as on soils having less dense clay in the subsoil, and crops suffer more from drought on them. Usually they are best suited to the grain sorghums, grass and wheat. (Photo. by the Author, collection, Bureau of Soils.)

PLATE 46.—Cattle at watering place in dry country of the Pecos River region, Reeves County, Tex. Background shows the smooth surface of this High Plains region (elevation something over 2,500 feet.) This is a dry country, situated near the 15-inch rainfall zone. There is considerable available grazing, and the large ranches of this "Trans-Pecos" country support an important cattle industry. In rainy seasons grass is plentiful. Some grain sorghum and alfalfa are grown under irrigation. (Photo. by the Author, collection, Bureau of Soils.)

PLATE 47.—Harvesting wheat on the High Plains of western Kansas. (Photo. from collection, Bureau of Soils.)

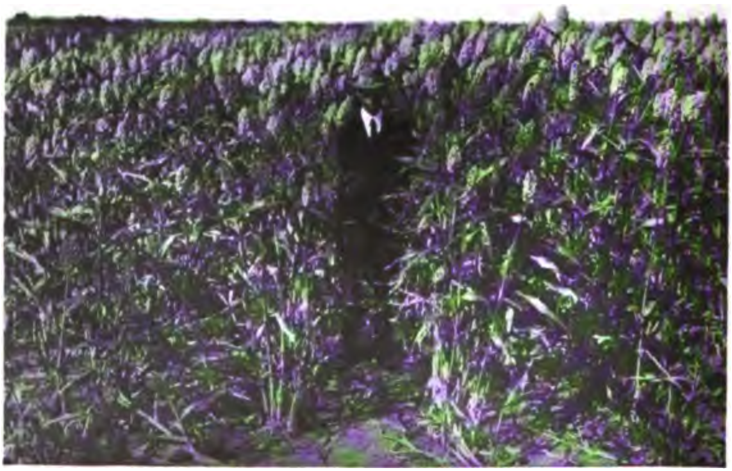


PLATE 48.—Grain sorghum (feteritá) in the Great Plains region, near Chillicothe, Tex. The grain sorghums constitute the most suitable crop for average results on the uplands of the western part of the Great Plains. Sorghum, feteritá, Milo maize, Kafir corn, sweet sorghum, and Sudan grass are the chief forage and feed crops now grown, but others are being adapted from time to time. (Photo. from collection, Bureau of Plant Industry.)

of yield is from about one-fourth to three-fourths bale, according to season, past rotations, and fertilization. A bale per acre is occasionally obtained on the best farms. Corn is not given as good average treatment as cotton, and the yields vary widely. In normal seasons 25 to 40 bushels per acre should be obtained on the uneroded land by careful treatment; even better yields are sometimes had where legumes have been grown in the rotations, and when fertilizer is used. On the other hand, yields of only 10 or 15 bushels are obtained where the less improved methods are employed. Some fertilizer is used for cotton, but probably on the larger number of farms it is not used. Mixtures of acid phosphate and cottonseed meal, and mixtures analyzing about 8-2-2 have been the usual kinds applied, and the applications have generally been about 200 to 300 pounds an acre. Fertilizers are used in the northern part for tobacco and other crops. Marked improvement of the soil results from growing clover, lespedeza, velvet beans, cowpeas, and alfalfa.

In the Natchez section yields of 150 to 300 bushels of potatoes and of 125 to 175 crates, 100 pounds each, of cabbage have been obtained with applications of 800 to 1200 pounds per acre of an acid phosphate-cottonseed meal mixture (in the ratio of about 1 to 2 by weight).[1]

The soil almost invariably gives an acid reaction to litmus indicating need of lime. Acreage additions of 1000 to 2000 pounds of ground limestone may be expected to give increased yields, and to assist in the successful production of alfalfa and clover. It is not improbable that heavier additions are needed. Burnt lime also will be beneficial.

The *Grenada* silt loam resembles the Memphis silt loam in its surface soil, averaging perhaps a slightly lighter shade of brown, but it differs markedly in the subsoil, the lower subsoil particularly. The subsoil is a silty clay loam to

[1] See Field Operations, Bureau of Soils, 1910, p. 712.

silty clay, of yellowish-brown to reddish-yellow color in the upper part, passing beneath into mottled rayish and yellowish compact silty clay loam, containing dark-colored (black or rusty brown) concretionary material of a ferruginous character. This compact stratum acts somewhat as a hardpan. In road cuts water is often seen seeping out along the upper part of the compact layer, indicating its impervious nature.

The soil occupies level and sloping areas. It is found as the predominate type in the eastern portion of the region, having apparently a somewhat larger extent for the whole region than the Memphis silt loam. Not so much of it is in cultivation as of the Memphis, but it is an important farming soil. It is used for the same crops as the Memphis, but does not give on the average as good yields. It is a little later and is not so well suited to vegetables. Among the crops that give especially good results are lespedeza, Bermuda grass, and white clover. It is all acid and would be benefited by moderately heavy liming. There are some occasional whitish patches of little importance, which have a very impervious clay subsoil, and which are extremely unproductive. About the same treatment as that stated for the Memphis silt loam should apply to this type.

The *Pheba* soils, chiefly the silt loam, have been mapped in considerable areas just east of the main loessial belt. They are similar to the Grenada soils, but are more grayish in the surface and contain more sand in the lower subsoil. There is often much dark concretionary material in the lower subsoil which is compact when dry. The surface is rolling and the surface drainage is good. They produce about the same as the Grenada soils.

The *Lexington* silt loam is not so extensive as the Grenada silt loam. It occurs in the more rolling and hilly sections, chiefly in the eastern part of the region. Much of it is rolling and best suited to stock. Cotton and corn are the principal crops. Its requirements of tillage, manurial treatment, and rotations do not differ essentially from those of the Memphis silt loam. Its chief distinction from the other upland soils of the loessial region is the presence of sandy clay at depths of about 3 feet.

THE GREAT PLAINS REGION

GEOGRAPHY

The Great Plains Region embraces the vast area of plains and prairies lying between the Rocky Mountains on the west, and the Ozarks Region and Central Prairie Region on the east. It extends from Mexico across the Mexican boundary in southwest Texas northward beyond the Canadian line. Its western boundary through southwest Texas and eastern New Mexico is nearly coincident with the western edge of the Pecos River valley; its eastern boundary follows along the western boundary of the Gulf Coastal Plains through central Texas, thence along the Ozarks across eastern Oklahoma and southwest Missouri to the Central Prairie Region near the Missouri River.

The southern extension of the Great Plains includes approximately three-fifths of Texas (the western part), three-fourths of Oklahoma, all of Kansas except the northeastern part, and a considerable area in west central Missouri south of the Missouri River.

TOPOGRAPHY

The surface of the Great Plains is prevailingly level to undulating and gently rolling over the less eroded portion of the region, undulating to hillocky over the wind-blown sandy areas, and rough to hilly over the more eroded country. The smoother and most extensive portion is well suited to the use of improved farm machinery, but there are many badly washed areas, especially along the larger streams in the western part of the region and over the "breaks" of the southwestern part, where cultivation is impracticable, much of the land being precipitous or of a rough "bad land" character, suitable only for grazing.

There are six principal topographic divisions of the Great Plains Region: (1) The High Plains; (2) the Low Plains (including the Red Prairies and the Edwards Plateau); (3) the "breaks"; (4) the "Sand Hills"; (5) the rolling "Cross Timbers," and (6) the Eastern Prairies (or plains).

High Plains.—The High Plains of the southern Great Plains Region comprises the high, smooth country of the Texas Panhandle region and of western Kansas. This area extends westward into New Mexico and Colorado to the foot of the Rocky Mountains, and eastward to (1) the Red Prairies and the associated "Breaks," along an irregular line through the southeastern Panhandle country from Reeves County, Texas, to the vicinity of Ashland, Kan., and to (2) the indistinct line marking the western boundary of the Eastern Prairies, extending from the vicinity of Garden City, Kan., northeasterly to the Nebraska line.

The High Plains of Texas are frequently called The Staked Plains or *Llano Estacado.* The southern part is locally known as the South Plains. The elevation of this area ranges from about 2500 to 6000 feet, rising imperceptibly toward the west. In western Kansas the elevation along the Colorado line is 4000 feet above sea level; along the Oklahoma-New Mexico line it is 5000 feet. So smooth is the surface and so gentle the slope that the treeless High Plains country appears to the eye a limitless expanse of uninterrupted level country. Along the larger streams, however, such as the Canadian and Arkansas rivers, and also along the line separating the High Plains from the Low Plains to the east, in the southwestern part, there are both narrow and broad belts of severely eroded country known as the "Breaks"; but back from these dissected areas the surface has been little affected by erosion, and since the breaks lie below the level of the High Plains they are invisible, from the upland level, at relatively short distances. Here and there slight depressions occur, some of which hold water after heavy rains ("*playa* lakes"), and much of the country is faintly undulating, with occasional billowy and gently rolling lands, especially where the soils are sandy. Occasional small drains, the sources of streams that become important farther east, extend through the High Plains, but these are not numerous, the region being one with but few streams. In the upper parts they are but slight drainageway depressions without channels or only shallow channels; they deepen as they extend toward the Low Plains, and the country along them becomes more rolling until the rough lands or breaks are developed. Near the outer edge of the High Plains, in that part south of the Arkansas River, many of the streams flow in cañons. Much of the rainfall enters the ground on the level plains.

The High Plains once extended considerably farther to the east south of the Arkansas River, but erosion has removed much of the material, having graded back the plains along the edges.

Low Plains, and "*Breaks*".—These lands lie between the High Plains and the Gulf Coastal Plain and Eastern Prairies. This broad belt comprises: (1) the "breaks" or zone of rough land along the streams and the boundary between the High Plains and the Low Plains; (2) the adjacent Red Prairies (or Red Plains) and the Edwards Plateau to the east and south. The Red Prairies Region comprises an approximate area of 30,120,000 acres, and the Edwards Plateau (including the Fort Worth Prairie Region) an approximate area of 30,090,000 acres.

The descent from the High Plains to the Low Plains is generally rapid in Texas, Oklahoma, and southwest Kansas; in many places it is precipitous. Along much of the boundary there is an escarpment several hundred feet high, visible many miles from the lower country. In places the escarpment is a zone of rough land, often stony, 2 or 3 miles wide, being abrupt along the upper part, near the "cap rock," at the border of the High Plains and less steep along the lower part. Tongues of these rough lands or "breaks" extend far back into the High Plains, along drainage lines, representing areas over which erosion has advanced. Along the Arkansas and Canadian rivers, the breaks are 25 miles wide or more in places.

The greater part of the Low Plains is undulating and gently rolling, but here, too, there are many areas of moderately and severely eroded lands along the streams and some back from the streams. The sides of the occasional mesas or buttes are always precipitous or very rough. These isolated mesas are conspicuous features of the eroded plains. They are the remnants of a former higher surface, their flat tops preserving the surface features that characterized the tableland country before erosion had graded down so much of the land. The elevation ranges from about 1000 feet above sea level on the east side to about 3000 feet on the west.

The Edwards Plateau division of the eroded or Low Plains, including the northern extension or Fort Worth Prairie Region, comprises the eastern and southern portions—the country bordering the Red Prairies on the south and the West Cross Timbers on the west. This plateau extends to the East Cross Timbers and Black Waxy Belt on the east and to the Rio Grande Plain on the south. Its former smooth surface has been disfigured by erosion over a large proportion of its area, yet there remain many areas having a relatively uneroded nearly flat surface. In the southern part there are large bodies of rough, stony land having essentially the characteristics of the breaks. There are also some conspicuous mesas. A severely eroded scarp (the

Balcones Fault) separates the region on the south from the Rio Grande Plain, rising 300 to 1000 feet above the level of the plain.

Considerably more than half of the Red Prairies and Edwards Plateau is cultivatable, but the combined area of the breaks and of the rougher portions of the Red Prairies and Edwards Plateau constitute a very large area of nonarable or grazing land. There are scattered bodies of post oak and cedar through the Edwards Plateau country.

The broad belt of rolling timbered country extending from the vicinity of San Angelo, Texas, to the vicinity of Tishomingo, Okla., is known as the West Cross Timbers.

Sand Hills.—There are some extensive "Sand Hills" areas in southwestern Kansas, western Oklahoma, in the Texas Panhandle, and in the southern part of the High Plains. These have an undulating and gently rolling to hillocky or dune topography. These sandy lands occur usually near the streams, the surface becoming smoother back from the streams. In places the sand is still drifting, but generally vegetation, such as scrub oak and bear grass in the northern areas and yucca and greasewood in the southern areas, has established itself upon the soil, giving it a temporary fixed topography. When put into cultivation, however, the sand begins to drift again, except where the soil has been made coherent by the incorporation of vegetation, or by surface deposit of wind-blown silt.

West Cross Timbers.—The West Cross Timbers is a broad belt of rolling to hilly and broken timbered country extending from the vicinity of Brady, Texas, into south-central Oklahoma, lying between the Red Prairies and the Fort Worth Prairie Region.[1]

[1] The East Cross Timbers is a much narrower belt of similar country extending from the vicinity of Hillsboro, Texas, into southern Oklahoma, and lying between the Fort Worth Prairies and the Black Waxy Belt. This belt marks the boundary between the Black Waxy Belt and

The surface of this belt is characteristically rolling to hilly, with many stony slopes unsuitable for cultivation. The greater part of the country, however, can be cultivated, there being many gently rolling areas and almost level inter-ridge and valleylike areas which are susceptible of easy cultivation. The uncultivatable rough areas constitute fairly good grazing lands.

Eastern Prairies (or Plains).—That portion of the Great Plains lying east of the Red Prairies of Oklahoma and the High Plains of Kansas, or roughly east of a line crossing Kansas and Oklahoma near their centers, will be designated the Eastern Prairies. This division includes about one third of Oklahoma (the country between the Red Prairies and the Ozarks), approximately the eastern half of Kansas and a part of west-central Missouri, or roughly, 66,756 square miles or 42,723,840 acres.

Much of the surface of this division is level to undulating, but there are gently rolling and rolling areas, the roughest of which usually occur in strips along the large streams. Probably 90 per cent of the land in this division possesses surface features well suited to cultivation, generally admitting the use of all kinds of farm implements. There are some rough areas including nonarable land along some of the streams and in some instances back from the more important streams, as in the Flint Hills of southern Kansas. The elevation of this region ranges from about 800 to 1200 feet above sea level.

GEOLOGY AND SOILS OF THE GREAT PLAINS

The Great Plains region is underlain by limestone, shale, sandstone, unconsolidated wind-blown material, and by unconsolidated and consolidated water-transported material (outwash-plain and filled-in valley material).

the Great Plains. It is considered a part of the Coastal Plain, and is discussed under that province.

The surface material of the High Plains, south of the Arkansas River, in the uneroded areas consists of outwash material which in past geologic time was transported from the Rocky Mountains and spread out over a wide area by shifting streams. This outwash is composed largely of silt and clay, with considerable sand locally, and gravel of crystalline rocks in the substratum. The subsoil or deep substratum is composed of limy material, either of a marly or "mortar beds" nature.

The principal soils of the High Plains are derived from the outwash-plain material. These are: (1) The chocolate-brown to reddish soils overlying whitish to pinkish highly calcareous material which is either of a chalky nature (marl) or consolidated material known as "cement," "mortar beds," or conglomerate (the *Amarillo* soils), and (2) the brown to dark-brown soils overlying similar calcareous material (*Richfield* soils). The silt loams, silty clay loams, loams, and fine sandy loams are the principal types. In the wet depressions mottled brown and gray soils are found (*Randall* soils). In the southern extension of the High Plains as in Reeves County, Tex., the soils contain much more carbonates in the surface and are locally modified by gypsum. Here there are soils that resemble the Amarillo (*Verhalen* soils), and also much soil that resembles the Richfield, except that the surface color is lighter brown (*Reeves* soils).

Almost the whole of the High Plains north of the Arkansas River is occupied by transported material, possibly of wind-blown origin. This has given rise largely to the ashy-brown or ashy-gray soil overlying brownish and somewhat compact heavier material which passes beneath into lighter brown friable silty material (*Colby* soils). The silt loam is the predominate type.

Filled-in valley and outwashed-plain deposits occur extensively in the eroded plains east of the High Plains, in both the Red Prairies, southern part, and in the Edwards

Plateau. Here the material represents products derived from sandstone, shale, and limestone, spread out by shifting streams over the eroded or cut-down country of the valleys and broad lowlands between the mesas. Three important groups of soil are derived from this material. These differ in the color of the soil and subsoil, but have similar material in the deep subsoil or substratum, which consists of: (1) consolidated to semi-hardened whitish carbonate of lime frequently containing gravel and known as "concrete" or hardpan, or (2) whitish to pinkish chalky calcareous material known as marl. Beneath the hardpan or marl layer, sandstone, shale, and limestone of the kind that had been graded down by erosion and weathering before the present surficial deposits were placed are encountered. The reddish lands of this nature have been given the name *Miles* soils, the brown lands, *Abiline* soils, and the black, poorly drained lands, *Simmons* soils. The Miles soils are much like the Amarillo soils of the High Plains, and the Abiline much like the Richfield. The clays, clay loams, and loams are largely in the predominance.

In the Red Prairies the soils are chiefly residual from chocolate-red sandstone and shale of the Permian Red Beds. There are associated with these rocks, beds which contain a high percentage of gypsum, and these have locally modified the soil. The chocolate-red lands have been classified as the *Vernon* soils, and the brown to dark-brown lands, with tough claypan subsoils, as the *Kirkland* soils. Clay loam, silt loam, and fine sandy loam are the main soil types.

The Edwards Plateau soils, aside from the included outwash plains and filled-in valleys, described above, represent, in the main, residual products from the underlying limestone. Four principal groups of soils occur over this region: (1) The reddish-brown to dark-brown soils with red subsoils (*Crawford* soils); (2) the light-gray to ashy-gray soils with whitish to yellowish, chalky, highly calcareous subsoils (*Brackett* soils), (3) brown soils (*Denton*) and (4) the dark-brown to black soils (*San Saba* soils). The clays, stony clays, clay loams, loams, gravelly loams, and stony loams are the most extensive soils, with some large areas of rough stony land in the southern part.

In the West Cross Timbers the principal soils are residual from sandstone and consist mainly of brownish to grayish sandy and stony soil over reddish sandy clay (*Windthorst* soils) and grayish sandy soil over yellow clay (*Nimrod* soils). These soils are lower in lime content than the soils occurring to the west and the limestone soils to the east.

There are three isolated areas of igneous rocks, chiefly of a granitic nature, in the Great Plains Region. These are the areas in Llano County, Texas, and Johnston and Comanche counties, Okla., and adjoining country. They are residual from the underlying rocks, and consist mainly of reddish-brown material over red clay (*Tishomingo* soils).

Isolated areas of wind-blown sand-hill soils are scattered through southwestern Kansas, western Oklahoma, the Texas Panhandle, and the southern High Plains. The material of these lands was probably blown up from the stream bottoms and from the outwash-plains material. The principal soils of these sandy belts belong with the Amarillo and Richfield groups, with some narrow strips of reddish-brown soils of the *Derby* series occurring along the streams. Some areas are nothing more than the loose sand of sand dunes.

In the level to gently rolling Eastern Prairies east of the High Plains and Red Prairies are found little but residual soils. These are derived from the underlying limestones, shales, and sandstones. The most important soils here are: The dark-brown to black lands with yellowish clay subsoils (*Summit* soils), the brown soils with brownish, tough clay subsoils (*Gerald* soils), the black lands with dark brown to black, tough clay subsoils (*Oswego* soils), the reddish-brown Crawford soils, the dark-gray to brownish lands with mottled yellowish and reddish friable subsoils (*Bates* soils), and the gray "white ash" lands with brownish, tough clay subsoils (the *Cherokee* soils). The Gerald, Oswego, and Cherokee soils are derived mainly from shale, although limestone probably contributes some of the material. The material of the Bates comes from sandstone and shale. The Crawford soils are derived from limestone, the Summit principally from limestone and calcareous shale, and the Bates from sandstone and shale. The Summit series is probably the most extensive group in this division of the Great Plains in that part occurring in Kansas, while the Gerald and Bates are probably the most extensive in Oklahoma. The Bates is also important in Missouri and Kansas, and the Cherokee and Oswego are important in southeastern Kansas and north-central Oklahoma. The principal types are silt loams, silty clay loams, and loams, with some bodies of stony land in the rougher sections, and fine sandy loams over many of the sandstone beds.

There are in north-central Kansas important areas of light-brown to grayish lands overlying light-colored subsoil containing much partly decayed shale and limestone fragments. These lands have been given the name *Benton*.

GENERAL AGRICULTURE OF THE GREAT PLAINS

In the main, the Great Plains is a region of fertile soils, although some of the claypan (locally known as hardpan) types, such as the Cherokee silt loam, are less productive and less well suited to deep-rooted crops than those having subsoils of less density or stiffness, such as the Crawford and Summit soils. There are also scattered areas of badly eroded lands, especially in the western part, that have value for grazing only. In the western part rainfall is the limiting factor in crop production in case of the better lands. In Missouri, eastern Kansas, and eastern Oklahoma there is usually enough rain; but with the decreasing precipitation toward the west crop susceptibility to damage by drought increases.

In the table below are shown average acreage yields of wheat and corn for Kansas and Oklahoma, which States are occupied mainly by soils of the Great Plains.

ESTIMATED AVERAGE ACREAGE YIELD OF WHEAT AND CORN FOR KANSAS AND OKLAHOMA, BY DECADES [1]

State	*1866–1875 wheat—corn*	*1876–1885 wheat—corn*	*1886–1895 wheat—corn*	*1896–1905 wheat—corn*	*1906–1915 wheat—corn*
	Bushels	Bushels	Bushels	Bushels	Bushels
Kansas.....	15.7—33.5	13.9—33.4	12.8—22.2	13.7—22.0	13.9—20.2 [2]
Oklahoma...				14.1—23.0 [3]	12.5—19.4 [2]

[1] Bulletins Bureau of Crop Estimates, U. S. Department of Agriculture, Nos. 514 and 515.

[2] It is probable that the extension of the corn farming area farther west into the dryer country has had considerable to do with the lower average yields of the later periods.

[3] 7-year average.

In the eastern portion of the Great Plains, particularly the northeastern part, agriculture is highly developed, and a large proportion of the land is in cultivation. In southern Kansas and in Oklahoma there is a larger area of native sod which is used for grazing and hay. Corn, small grain, hay, grain sorghums (the nonsaccharine sorghums, such as milo maize, kafir corn, darso, and feterità) and hogs are the principal products of the eastern part. Also, an important number of beef cattle, some mules and horses are raised in many localities. Alfalfa is important, especially on the stream bottoms and second bottoms.

In the middle section of the Great Plains, roughly defined by the area lying between the 97th and 100th meridians, the rainfall ranges from annual means of about 34 inches, in the eastern part, to about 22 inches in the western part, and droughts here are more frequent and more serious, and crops, especially corn, are oftener damaged by hot winds than in the eastern part of the Great Plains. Small grain and corn farming continue to be important in this middle division, but relatively more native hay and grain sorghums are grown, and more beef cattle are raised. Alfalfa is a very important crop on the alluvial soils, giving heavy yields and curing nicely. Considerable cotton is grown in the southern part; that is, in Texas and southern Oklahoma, with the yields averaging somewhat lighter than those secured farther east, owing to greater frequency of droughts. In Texas the raising of beef cattle is a very important industry, particularly in the more southerly portion. Here there are many cattle ranches, including moderate sized to very large tracts of land, and the raising of cattle, sheep, and goats is more important than farming in many localities. Much of the cultivated land here is used for the production of grain sorghums for winter feed. The cattle are grazed without protection throughout the year in the Texas and Oklahoma sections, mesquite and buffalo grasses supplying good winter pasturage. The leaves of live oak and both the leaves and beans of the mesquite trees afford considerable browsing. Bluestem is abundant in Oklahoma and Kansas, where also the raising of stock is important. In the colder northern part more winter feeding is necessary.

The native spiny variety of prickly pear is abundant over much of the southern part of the Edwards Plateau, and southward across the Rio Grande plain country into Mexico. Griffiths says:[1] "The prickly-pear region par excellence is in Texas, from the Edwards Plateau southward. . . . The greatest prickly-pear region in the world extends over the plateau and the Gulf coastal plain of Mexico."

[1] Farmers' Bulletin, U. S. Department of Agriculture, No. 1072: Prickly Pear as Stock Feed.

This plant affords much succulent feed to stock through the Edwards Plateau and the southwestern portion of the Gulf coastal plain in Texas. For best results with stock the spines should be singed with a gasoline torch, but cattle often browse on the spiny prickly pear in the natural condition, especially in dry seasons when grass is scarce, frequently injuring their tongues by accumulations of the spines, which possess extraordinary sticking qualities.

Writing of the economic importance of this plant, Griffiths says:

Live stock values are large, and droughty seasons are certain to occur in our southwestern "cow country," from the vicinity of the ninety-ninth meridian westward, and the resulting disaster has frequently wiped out savings and even fortunes. In such emergencies a store of reserve feed is needed which will carry stock through the period of shortage until rains come again and the normal supply of forage is restored. In southern Texas, and similar regions where prickly-pear is native and rampant, fortunately the reserve is always ready. All that is necessary is to "limber up" the prickly-pear torch, destroy the spiny armature of the plant which has protected it from destruction by live stock even in seasons of plenty, and the herd is saved from the effects of a moderate drought. If the lean season is more pronounced a pound or two of concentrates a day will be necessary in addition, so that the cattle may be kept in good condition until the season of plenty again arrives.

The prickly pear is a decided asset to southern Texas, which is especially mentioned because it is the leading prickly-pear region of the United States. Probably 50 per cent more cattle are marketed over a term of years than could be produced were it not for this reserve supply of feed, which up to the present has been rather overabundant. This wild crop has enabled the rancher to keep his herd intact through droughty periods ranging from three months to three years.

This forage, though utilized in the past as an emergency feed, is capable of being made a farm crop of no mean value for more or less continuous use. It can be cultivated at a minimum of expense, fed continuously with good effect, and with profit made a main roughage in the dairy ration.

The spines of prickly pear are indeed objectionable, but these have enabled it to persist in grazed areas. They also permit the plant to be grown as a farm crop without fence protection. On the other hand, forms of prickly pear are available in which the spines are mostly eliminated. These forms, while requiring protection from stock until needed, are just as serviceable a reserve forage as the spiny natives, and when they can be grown are much more easily handled and more acceptable generally. The planting of these spineless forms should be intelligently done, as only one species, the Ellis cactus (*Opuntia ellisiana*), is known to be hardy throughout the native prickly-pear region of Texas. This can be utilized as a reserve forage in the way recommended for the native sorts, but it will require the protection of fences.

The recent three-year period of drought in the Southwest (1916–1918) emphasized the necessity for the native-pasture stockman to make provision for lean years. In the prickly-pear region such an insurance of the forage supply will entail only the cost of selecting native stocks of prickly pear, distributing them in the field, and giving them ordinary horse cultivation. In pastures where the plants already grow the husbanding of this resource is all that is required to provide against an ordinary drought, although cultivation will improve the quality of the feed and make it more valuable in time of need.

It is probable that although all prickly-pear varieties are useful continuously in the roughage ration, their greatest value is as an emergency feed to tide over a drought and to furnish succulence for dairy cows during the short cold winter and dry summer. A few stockmen, however, already are learning in various ways to place more and more dependence upon this crop and are adopting measures to increase its production. A sufficient acreage of prickly pear to provide a partial ration for the herd during a drought is a cheap insurance.

. . . .

Prickly pear can be most advantageously and economically fed in the green, fresh state. In this condition the plant is to be compared with root crops and immature green-corn fodder, and it should be fed in much the same manner.

Being bulky and containing much water, it can never be transported far with profit, but should be grown close to the feeding place, so that either the cattle can be turned on it to graze or the haul to the feed lot will be short. . . .

Although practical dairymen have used the native prickly pear successfully for months at a time, with almost no other roughage, the best results are to be secured by using some dry roughage in connection with it, feeding the prickly pear in a manner comparable to silage as commonly employed—as a part of the roughage in a dairy ration. This conclusion is based upon its chemical composition, upon the experience of some of the best posted feeders, and upon carefully controlled tests, conducted by the United States Department of Agriculture. On the other hand, some of the best herds in southern Texas have thrived on a continuous roughage ration of prickly pears and have kept in the best of condition with a rather heavy concentrate ration of cottonseed meal and rice bran. In one instance, a herd of 80 to 100 cows had no other roughage for nearly two years. No injury was apparent, and the milk flow was good. Although the feed had a tendency to scour, it was the opinion of the dairymen that no injury resulted.

. . . .

No plants are more easily grown than prickly pears. They are usually propagated from cuttings, which start readily. They must be in firm contact with the soil, but if the soil is moist the cuttings will usually grow, even though they are not inserted into the ground, provided, of course, the weather is not too hot, in which case scalding of the joints occurs, resulting in their destruction. . . .

It will often be advantageous to plant this crop in uncultivated pastures, especially in many portions of the Southwest. In such situations it is only possible to utilize the spiny forms, mainly on account of the danger from cold weather. The spineless forms are also excluded because they would soon be exterminated under open pasture conditions. The spineless species can be considered as a cultivated crop only. If the work is done while there is moisture in the ground all that is necessary is to distribute the cuttings on the surface without covering at all. In a month they are all rooted. Crops grown in this way are slow, but they produce, at a minimum expense, a reserve supply of stock feed which is invaluable when the inevitable drought comes. A method a little more certain is to open up furrows in the pastures with a plow, distribute cuttings on the land side, and then turn the furrow slice back on the bases of the cuttings. Waste land, stony ridges, etc., can be profitably utilized in this way, especially in southern Texas.

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Though both spineless and spiny prickly pears can be used continuously as roughage, it is likely that they will be more extensively used during the drier portions of the year when succulent feed is scarce. It can be said that as a general rule in regions well adapted to grow prickly pears the crop can be harvested at any time of the year. Certain conditions, however, modify this practice somewhat.

Cattle do not like the young joints for some time after they first form. Up to the time when they swell out and become in appearance more like mature joints they do not appear to be palatable. Considerable waste in feeding young joints occurs, and economy would suggest that it may be well not to harvest and feed until later in the season.

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In the work of the United States Department of Agriculture at San Antonio, Tex., an average yield of (the spiny natives) nearly 24 tons to the acre was obtained under moderately good cultural conditions, while without cultivation in ungrazed pastures the yield was only one-eighth of that quantity. At Brownsville, Tex., with more prolific varieties and more fertile soil, a yield of 32 to 50 tons per acre, depending upon the variety, was secured at the first biennial harvesting, while at the second the phenomenal average yield for all varieties was 106 tons per acre.

. . . .

In the feeding of the spineless forms no previous preparation is necessary. Stock can be turned into small fenced-off portions of the area to graze the plants where they grow, but unless the areas eaten off at one time are small this method entails a great deal of waste. It is doubtless much more economical to haul the material into a feed lot. Again, if the plants are grazed off where they stand there is danger that they will be cropped too closely. It is never well with either spineless or spiny forms to harvest lower than the joint attached to the cutting planted, and the older the plant the larger should be the stump left from which new growth is to start.

In feeding the spiny crop two general methods have been employed. The more economical method, all things considered, has been to singe the plants with a gasoline torch and allow the live stock to graze them where they stand. The other method is to put the unsinged plants through a chopper. The rough treatment which the material gets in passing by the strong, rapidly revolving knives results in breaking most of the spines, and the centrifugal force with which the chop is thrown out of the machine results in winnowing out many of them, so that cattle experience little difficulty with the feed thus prepared. Occasionally however, an animal gets a spine into its mouth and suffers until it is pulled out. This pulling out must be done. Cattle handle pretty rough materials normally and can eat prickly pear, spines and all, if only the tips are broken off. Camels are reported to eat the spiniest varieties of prickly pears with impunity. Much of the native crop in the region from Texas to Arizona is grazed by cattle throughout the year to a limited extent with no preparation. It is a common practice for the herders in the prickly-pear region to assist the sheep and goats to get a start at a limb of the pear. They cut off the spiny edge of the joint with their machetes, and the animals do the rest. A start is all they need. After this they can nibble away at the succulent tissues between the spines on either side.

In the western division, including largely the High Plains and "breaks," with some of the Low Plains of southwest Texas, semiarid conditions prevail, and dry-farming methods are employed to a considerable extent. The mean annual rainfall here ranges from about 21 or 22 inches, in the eastern part to about 16 or 17 inches in the western part. The rainfall is of a decidedly fluctuating nature, years of relatively heavy precipitation following years when the rains are deficient, or a succession of comparatively wet years following comparatively dry years.

In this western division considerable wheat is grown, especially in western Kansas, and the grain sorghums are very important, giving best average yields of all the crops.[1] Wheat and beef cattle are the principal products of the western Great Plains. In the early days stock raising constituted the only industry. The nutritious prairie grasses of the native sod covering a vast open range made the section well suited to cattle raising. The industry

[1] Earliness and dwarfness are said to be very important factors in selecting the varieties of the grain sorghums for this region. "Dwarf milo, Dawn Kafir (dwarf), and Sunrise Kafir (early) are shown to be well adapted varieties. Dwarf milo and Dawn Kafir are meeting with wide approval on the farms of the high, dry plains."—Grain-Sorghum Experiments in the Panhandle of Texas, Bulletin U. S. Department of Agriculture, No. 698.

continues to be important. In the breaks it is the only possible efficient industry. Much of the smooth High Plains land, however, has been divided into farms, and is now used chiefly for the grain sorghums, wheat, corn, and oats. When the rainfall is satisfactory, the yields of all crops are good, but dry seasons sometimes reduce the production below the point of profitableness or cause complete crop failures. It is believed that the raising of cattle in conjunction with the growing of limited areas of feed crops, the grain sorghums mainly, is the best type of farming, on the average, for the southern portion of the High Plains, and much of the Low Plains to the east. But there are many small farms, particularly in western Oklahoma and Texas, on which there is insufficient land for the most satisfactory results with cattle raising on an important scale. On these small farms much of the more nutritious virgin sod grasses has been killed out by cultivation. There are sections where it seems that it would have been the wiser plan not to have divided the land for small-farm operations, but rather to have left it in the native sod in tracts large enough for ranching, particularly as relating to the western part.

Making use of these plains lands in this fashion has proceeded too far probably for anything to be gained by lamenting the past, nor can the mistake of breaking up so much of the soil, if it was a mistake, be held up as a valuable guidepost in connection with future use of similar lands, for the reason that so much of the virgin plains of this kind has already undergone this treatment. It can scarcely be asserted at this stage that it would be economically wise to seek any wholesale rejuvenation of the original sod by a process of abandonment of cultivation to permit reversion to the former condition, although on some of the larger holdings such procedure might be practiced to a limited extent. A considerable area of native virgin sod even now is included in some of the larger ranches. The owners of these it would seem should be cautious about breaking up the sod, but there can be no assurance that the course that will be pursued will be different from that which has been followed over so much of this country in the past. From time to time under the stimulation of periodic good crops and good profits therefrom, parcels of these remaining virgin lands are likely to come under the plow, permitting destruction of the growth of nutritious native grasses upon which a short time ago great herds of buffalo grazed, and which is so peculiarly suitable for the raising of stock. No final statement can be made, however, in the absence of comprehensive statistical data, as to the relative profitableness of the different ways of utilizing these soils—whether it would be best to use them strictly for grazing, or for cultivated crops only, or for a combination of the two. The last named plan probably is the best under existing conditions.

The soils are extremely fertile, and with an assured rainfall or with economically available irrigation water, there would be no question as to the soundness of using them very extensively for the cultivated crops.

Some millet, Sudan grass, emmer, barley, broom corn, cowpeas, cotton (in the southern part) and alfalfa (in the valleys) are grown. Northern Kansas is about the southern limit of extensive spring wheat and oat production. Sheep, hogs, mules, and horses are raised, but cattle dominate the live-stock farming in the southern Great Plains. Winter feeding is necessary, especially in the northern part during the severe northers that sweep over the plains. The raising of stock is relatively of less importance in northern Kansas. The growing of peanuts on the sandy soils of the East and West Cross Timbers and of other sections—as, for example, in Comanche County, Texas—is becoming an important industry. Considerable oil is being manufactured from this product. Bermuda grass does well.

Something can be accomplished in the matter of conserving moisture in the western and central Great Plains by the practice of dry-farming methods, such as summer tillage without crops and frequent shallow stirring or mulching of the surface; but some seasons will be so unfavorable that there will be crop failures regardless of the methods employed. The sandy lands of the western Great Plains especially hold moisture better than the heavy or clay soils ("tight lands"), probably because the wind keeps the surface mulched by continually shifting the sand.

In regard to the Great Plain region, with reference to the western part, Chilcott makes the following statements:[1]

The soils of the Plains are generally rich. Fertilizers are never used. The broad level or rolling fields of the prairie lend themselves to an extensive agriculture in which large machinery can be used to advantage and a minimum of man labor be made to cover effectively a maximum acreage. Winter wheat is naturally adapted to such an agriculture.

The results of the experiments of the Department of Agriculture show that the most profitable and greatest returns per unit of labor are obtained by expending the labor on as large an acreage as can be efficiently covered rather than by attempting to obtain increased yields from a given acreage by concentrating a greater amount of labor upon it.

The factor that determines and controls the agriculture of the region is the limited rainfall and its uncertain distribution. The uncertainty of the distribution of the rainfall rather than the total average quantity received is the factor that makes crop production hazardous. Over the greater portion of the Great Plains the average rainfall is sufficient to insure the production of crops, but the rainfall in any given year may be either above or below the average. When above the average the production of good crops is assured unless the distribution of the rainfall is very unfavorable. . . . When the rainfall is much below normal it may not be sufficient to produce a crop. Under such conditions the greater the amount of water in storage in the soil at seeding time the greater is the chance

[1] Farmers' Bulletin, U. S. Department of Agriculture, No. 895: Growing Winter Wheat on the Great Plains.

of making a crop. Water so stored is of advantage in supplementing the rainfall, but nowhere on the Great Plains can much more than a crop of straw be produced from the water in the soil alone.

With the decreasing rainfall from east to west in western Kansas, there is a decreasing certainty as to the production of a crop. The northwestern portion of the State shows a better adaptation to winter wheat than the southwestern or Arkansas Valley section. Winter wheat is so much more successful than spring wheat that it is grown almost exclusively. Only in emergency is it replaced with spring wheat, and then with a much lower expectation of a profitable crop.

The early harvest and long season here gives a very marked advantage to earliness in fall plowing or listing. While corn ground has an advantage over late-prepared land, it does not have such an advantage over land prepared immediately after harvest. The latter is in turn exceeded in yield but not in profit per acre by land that is summer tilled. The beneficial effects of summer tillage may be realized in some cases and at the same time a crop of corn may be produced by leaving every other row of corn blank and maintaining clean cultivation. At Hays the average yields per acre for the 9-year period, 1907 to 1916, exclusive of 1912, when the crop was destroyed by hail, were as follows: Summer tilled, 22.7 bushels; listed after winter wheat, 19.2 bushels; early fall plowed after winter wheat, 17.6 bushels; disked corn ground, 15.4 bushels; and late fall plowed after winter wheat, 11 bushels. Where there is greater danger from blowing, both blowing and winterkilling are sometimes successfully guarded against by seeding directly in stubble without preparation. Such crops are likely to be more weedy than cultivated land and to suffer more quickly from drought. But as a successful general crop in the western counties, to which this practice is confined, is dependent upon an unusually favorable rainfall during the growing season, this latter objection may not be as vital as might at first appear.

Kafir or other sorghum ground is very poor preparation for wheat in this section. This is contrary to the results farther north, where sorghum ground may be as productive as corn ground.

Of all the small grains, winter wheat is by far the best adapted to this region (western Oklahoma). In case of failure it can not be successfully replaced with spring wheat. In this area, the winter pasturage furnished by winter wheat is an important consideration in determining the acreage it occupies. Pasturing is necessary in some seasons to prevent too great a growth.

Summer tillage is not practiced to any great extent, partly perhaps on account of the long season. Where the crop follows small grain, early preparation is essential to the best results. Several months elapse between harvest and seeding. If the ground is plowed or otherwise cultivated during this period, there is a chance for the storage of water which would otherwise be used by weeds.

Unless pasture is a prime consideration, seeding should be late. It is necessary that the plants start growth and become established before winter, but any growth in excess of this uses water during the fall, winter, and early spring that may be needed in drought protection during a later critical period. Corn, bean, and cowpea land is a much better preparation than any of the sorghums, including broom corn.

Panhandle conditions are represented by the Dalhart and Amarillo Field stations. The sandy soil on which the Dalhart station is located is not at all adapted to the growth of wheat or any other small grains except winter rye. A good crop of winter wheat may be produced occasionally, but no dependence is to be placed on it.

On the heavier soil represented by the Amarillo substation, the winter-wheat crop is more reliable. An 8-year average of yields at Amarillo varied from 7.1 to 10.6 bushels per acre according to tillage methods. In half the years the yields were fair and in half they were poor. The difference in yields resulting from different methods of preparation was not great in either the good or the poor years. The highest yield, 10.6 bushels, was from summer tillage, but this is less than a bushel more than the yield on early fall plowing of winter-wheat stubble. Small-grain stubble, no matter how treated, was more productive than corn ground.

Late seeding is advisable. This lengthens the period of water storage and reduces the amount of water used by the crop in the fall, winter, and early spring. Farther south, in the region locally known as the South Plains, wheat is more extensively grown than it is in the Panhandle. Presumably this is because it is more successful and more profitable, but no comparative data can be given.

In the territory represented by the Big Spring Field station, winter wheat is grown to a limited extent. Success with it here is dependent on a season better than the average.

From the standpoint of winter-wheat production, the Great Plains region divides rather naturally into three sections, merging, of course, rather gradually into each other—the northern, the central, and the southern sections. The northern section includes the Plains portion of Montana and Wyoming, western South Dakota, and a portion of western Nebraska. In this section the average yield of winter wheat is little above that of spring wheat. When it fails to start growth or to survive the winter, its place may be taken by spring wheat without serious loss. The response of the two to cultural methods is generally about the same.

Harvest is late and seeding early. In the northern portion of this area and in the higher altitudes, harvest and seeding time are so near together that old wheat is generally in demand for early seeding. Under these conditions there is no chance to distinguish between early and late plowing or preparation. In the sections where winterkilling is the worst, it is necessary to resort to extreme measures of protection, such as seeding in standing cornstalks or in small-grain stubble without preparation. Corn or other cultivated ground is one of the best preparations in this section.

In the central section, winter wheat is primarily the most important grain crop. It can be replaced with spring wheat only at a decided loss in yield, quality, and certainty of crop. Here there is greater response to cultural conditions. This response being greater for winter wheat than for other grains, that crop should be seeded on the best-prepared land. The season being longer, there is more time between harvest and seeding and consequently a decidedly favorable response to earliness of preparation. Early fall plowing or listing may be exceeded in yield, but generally not in profit per acre by summer tillage. While corn or other cultivated ground is a good preparation in this section, it has not the unqualified superiority over other methods that it has farther north. . . .

Neither corn ground nor the sorghums, which are grown so extensively here, make a good preparation, although corn ground is much better than sorghum ground. Early preparation is important. Seeding should be late, unless pasture is a prime consideration.

Experiments [1] indicate that ridging (or listing) the land with a lister, and leaving it in this shape during the winter gives better yields of spring wheat than flat breaking, that the average yields following fall plowing and spring plowing are about the same, that subsoiling is of doubtful utility, and that summer tillage without crops gives the highest, although not necessarily the most profitable, average yields.

[1] See Bulletin, U. S. Department of Agriculture, No. 214: Spring Wheat in the Great Plains Area.

Disked corn ground gives good yields, and seems to be the most profitable method.

Drilling the grain east and west lessens injury from blowing the finely pulverized soil. In northern Kansas spring plowing has been more productive of oats generally than fall plowing, the reverse being true south of this. Generally, disking corn ground and previous summer tillage without crops have given the best yields.

On the Texas High Plains much of the land is broken in late winter or early spring, generally with a broad, flat-turning plow with a rod-mold board drawn by three horses or mules. Some gang tractors are used. Plowing here is usually 2 to 4 inches deep, the tractors sometimes going an inch or two deeper. Following the breaking the ground is harrowed. Intertilled crops are generally grown on ridges thrown up with middle busters (lister).

In the Great Plains Region, especially the western part, planting of intertilled crops in the depression between ridges is the common practice, the soil being worked gradually toward the plants by cultivation as they grow, so that the surface is usually nearly level at the time of the last cultivation. Generally good implements and teams are in use throughout the region. With reference to the effect of subsoiling, deep tilling, and soil dynamiting in the Great Plains, Chilcott and Cole [1] have the following to say:

> Recognizing the fact that there may be times and places giving results favorable to subsoiling or other methods of deep tilling, the average yields obtained in the extensive experiments here reported seem to warrant the conclusion that as a general practice for the Great Plains as a whole no increase of yields or amelioration of conditions can be expected from the practice. In their relative response to deep tillage there is no marked difference to be observed between crops. Subsoiling and deep tilling have been of no value in overcoming drought. The effect, on the contrary, apparently has

[1] Experiment Station Record, U. S. Department of Agriculture, vol. xxxix, no. 9, p. 812.

been to reduce the yields in those seasons that are below the average in production. Experiments have been conducted with the subsoil plow, the Spalding deep-tillage machine, and dynamite. The effect or lack of effect of deep tillage appears to be essentially the same, irrespective of the means by which it is accomplished.

These conclusions are the result of extensive experiments covering a wide range of crops, soils, and conditions in the Great Plains. Experiments conducted in the Great Basin under semiarid conditions with the greater part of the precipitation occurring in the winter, under humid conditions in the States of Illinois, Pennsylvania, and Mississippi, under semiarid conditions at San Antonio, Texas, and under semiarid conditions on the black soil of southern Russia have all led to the same conclusion—that yields can not be increased nor the effects of drought mitigated by tillage below the depth of ordinary plowing. The quite general popular belief in the efficiency of deep tillage as a means of overcoming drought or of increasing yields has little foundation of fact, but is based on misconceptions and lack of knowledge of the form and extent of the root systems of plants and of the behavior and movement of water in the soil.

Not much commercial fertilizer is used in the Great Plains; much of the manure is wasted and grain straw burned.

Writing of experiments and experience in Kansas, most of which lies in the Great Plains (see soil map), Call and Throckmorton [1] have the following to say:

As an average of 15 tests in the eastern one fourth of Kansas, extending from 1914 to 1917, inclusive, manured wheat made an average yield of 23.2 bushels per acre, unmanured wheat 17.4 bushels. . . . In the central one half of Kansas as an average of 11 tests for the same seasons manured wheat produced 24.4 bushels per acre, unmanured wheat 20.8 bushels. . . . These tests show that manure when properly applied as a top dressing on wheat is of value in central Kansas as well as in eastern sections of the State.

The effect of manure on alfalfa at this station has been even more pronounced than on wheat. . . . The average yield of alfalfa for the past seven years has been 3324 pounds per acre on the unma-

[1] Bulletin, Kansas Agricultural Experiment Station, No. 220: Soil Fertility.

nured ground, while ground manured at the rate of 5 tons annually produced an average yield of 7169 pounds. . . .

Many farmers in central and western Kansas are not using the barnyard manure produced on their farms. They feel that manure is not needed and that there is danger of reducing the yield of crops if it is used. In this section of Kansas it is necessary to use manure with greater caution than in the eastern section of the State. It should be applied in small quantities at a time, and usually as a top dressing so that it will not interfere with the moisture supply of the plants. Manure may be applied on ground that is to be listed to corn or Kafir, or it may be applied as a top dressing on winter wheat in the fall or winter. . . . The supply of organic matter in the soils of western Kansas must be conserved if they are to retain their present high state of productivity.

. . . At the present time a large quantity of straw is burned or otherwise destroyed. This practice results in a loss that neither the individual farmer nor the State as a whole can afford. . . . The most economical way of handling straw is to utilize as much of it as possible for feed and bedding, applying the manure produced therefrom to the soil . . . the straw can be applied as a surface dressing on wheat during the winter or as a top dressing on corn or sorghum ground at the rate of 1 to 1.5 tons to the acre. Heavier applications are not advisable on growing wheat. When top dressings of this kind are made the straw acts as a surface mulch and aids in the conservation of moisture. Later, it becomes incorporated in the soil mass and supplies organic matter and plant food.

Cowpeas make an excellent green-manuring crop in the eastern half of Kansas where they can be grown successfully. . . . Sweet clover is one of the most valuable of the green-manuring crops. . . . In the western part of the State, where moisture is the limiting factor in crop production, it is not usually advisable to grow green-manuring crops because of the large amount of moisture they remove from the soil in their growth. In this section of the State all other sources of organic matter should be utilized before resorting to green-manuring crops.

. . . the soils of eastern and southeastern Kansas have a lower phosphorous content than any others in the State. Fertilizer experiments have also demonstrated that in this section of the State, especially on residual soils derived from sandstone and shale, a commercial fertilizer supplying phosphorus can frequently be used with profit . . . fertilizers have generally given paying returns on wheat only in the two or three eastern tiers of counties. Better returns have been secured in the southern portion of this area than in the northern portion, and in the southern portion the best returns have been secured on the sandstone and shale soils.

The soils of Kansas vary greatly in their content of lime. Those in the western part of the State . . . have a very high lime content. In eastern Kansas the rainfall is high, much more leaching has occured and acid soils have developed. . . . Not all the soils in the area where lime is generally deficient are in need of lime. Some soils, especially those formed from limestone, have sufficient lime for the present needs of all crops. There may also be areas west of the area indicated . . . (approximately the eastern four tiers of counties) where lime will be needed for alfalfa. But such areas will be rare and of limited extent, consisting largely of sandy soil or soil that has been subjected to excessive leaching.

DESCRIPTION AND AGRICULTURE, SOILS OF THE GREAT PLAINS REGION

Red and brown lands of the High Plains—Amarillo and Richfield soils.—These are the two most important groups of soils in that portion of the High Plains occurring south of the Arkansas River. The Amarillo soils are chocolate-brown to reddish in the surface and upper subsoil, passing down into more reddish material and beneath this, at depths ranging from about 2 to 8 feet, into whitish to pinkish soft or hard highly calcareous material (marl or "concrete"); while the Richfield soils have brown to dark-brown soils and upper subsoils, passing into lighter brown material and beneath this into the same character of material that underlies the Amarillo soils. All but the sandy land, and much of that, is characterized by level to undulating surface features, adapted to the use of all kinds of farm machinery. The dark-colored soils occupy the more nearly level areas and do not drain out so quickly after rains as the red lands, a fact which probably accounts for their darker color. The country is treeless, but there is much short grass—buffalo, blue grama, and curly mesquite grasses, and in places an abundance of scrub mesquite. In the southern part of the

High Plains, where the soils are much the same physically, except that there is much more light brownish land and but little dark brown, mesquite and greasewood (*Covillea tridentata*) are plentiful and there are short grazing grasses. Among the grazing grasses here "salt grass" (*Sporobolus airoides*) and "tabosa grass" are common.

Fine sandy loam, loam, clay loam, and silt loam are the important types. The sandy soils hold moisture well and seem to give best results with corn and cotton. Small grain is liable to injury by blowing of the sand. In the southern part of the High Plains there is relatively little farming on these upland soils, the land being used largely for cattle, the bottom lands being used for crops—chiefly for alfalfa grown under irrigation. There is considerable hummocky or hillocky Sand Hills east of the Pecos River.

The table below shows the relative importance of the principal High Plain soils mapped in detailed and reconnoissance soil surveys—covering, chiefly, the northern Panhandle of Texas:

Type	*Amarillo soils* *Acres*	*Richfield soils* *Acres*
Clay loam and silty clay loam	6,485,824	1,708,880
Silt loam		3,452,480
Sandy loam, and sandy loams and loams undifferentiated	3,712,064	17,728
Loam	1,294,848	239,616
Fine sandy loam		878,080
Sand and sands undifferentiated	460,800	45,508
Fine sand		27,264
Loamy fine sand	4,544	14,272

In the northern part, that lying roughly north of Bigspring, Texas, there is much more farming, although cattle raising is very important, and much virgin land is included in pastures. The "tight lands" (heavy or clay soils), particularly of the dark soils, are less frequently selected for cropping than the sandy land, loam, and silt loam, but the grain sorghums and small grains are grown on these lands with good results when the seasons are favorable. The sorghums are the surest crops. Irrigation is being practiced in some localities, with good results, where the water doesn't have to be pumped from a greater depth than about 50 feet. Alfalfa does well under irrigation, except on some of the soils in the southwestern part of the region where the content of carbonates and other salts is much higher than in the northern part.

Sorghum yields about 5 to 10 tons of cured fodder per acre, and from 15 to 25 bushels of seed. Kafir, milo, and feteritá yield from about 20 to 40 bushels of grain. Feteritá is popular owing to its drought-resistant qualities. In favorable seasons wheat gives from about 10 to 25 bushels per acre and oats from 25 to 50 bushels. The dark soils produce somewhat heavier yields of wheat than the red lands. Millet in good years produce 1 to 3 tons of hay per acre and 20 to 30 bushels of seed. Alfalfa succeeds when there is sufficient rainfall, giving in the best years 3 or 4 cuttings of fine hay. Many small fields are used in the northern part for pasturing cattle, hogs, and horses. Vegetables, apples, pears, peaches, plums, grapes, and brier berries succeed, but are not grown importantly. No fertilizers are used. This is a treeless country, but much grubbing is necessary in places to remove the roots of mesquite, catclaw, greasewood, and other shrubs.

In the Sand Hills section where light sandy loams and deep sands predominate the native vegetation consists of bear grass, yucca, scrub oak or "shin oak," and broom sedge. The sorghums are the principal crops, but some oats, corn, and cotton are grown. The best yields are lighter than the best yields on the heavier soils, but the crops are probably surer on these sandy lands, owing to their good moisture-holding qualities. Cotton averages about one-third bale per acre, and frequently produces more on the sandy loams. Sweet potatoes and melons do well. These soils are easily cultivated, but are subject to undesirable drifting by the wind. Planting is sometimes delayed until the winds moderate. The addition of manure or green vegetation plowed under will make the soils more coherent and more productive.

Ashy-brown lands of the northern High Plains—Colby soils.—These ashy-brown colored soils are very largely in the predominance over a large part of the High Plains north of the Arkansas River, extending northeasterly to the Nebraska line near central Kansas. When wet the color is quite dark. They are characterized by a level to rolling surface, and an ashy-brown or ashy-gray surface soil overlying brownish, heavier, more compact material which passes beneath into lighter colored, more friable calcareous material. The silt loam is the principal type. When moderately moist this soil is easy to work into a desirable condition, but it is inclined to compact if allowed to dry out before breaking. In northern Kansas wheat is by far the most important crop; toward the south corn and the grain sorghums come in as important crops along with wheat. In good years wheat yields 25 to 35 bushels per acre. The average yield of corn is probably about 15 bushels an acre, but much higher yields are frequently obtained. Dry weather does great damage in some years. Stock raising is important in some localities. In this region the soil varies to less productive gray land in some sections.

Red and brown lands of the Red Prairie (or Red Plains) Region—Vernon and Kirkland soils.—These soils dominate the Red Prairies Region, which lies east of the High Plains in Texas and Oklahoma. The red soils (Vernon) are of a purplish or chocolate-red cast and have moderately stiff clay to friable sandy clay subsoils, while the darker-colored soils (Kirkland) occupying the more nearly level areas range from brown to nearly black in color, and have stiff, heavy clay (claypan) subsoils. The red soils contain more carbonate of lime than the dark soils, often effervescing in the subsoil with acid. Of the former group, fine sandy loam and clay loam are the most important; of the latter the silt loam and loam are the most important. Near the streams there are frequently badly washed areas chiefly valuable for pasture land.

The red sandy soils are more generally selected for cotton and corn, the red clay loam and the dark-colored soils being considered better for grain sorghum, wheat, and hay, although all these crops are grown to some extent on all of these soils. Alfalfa does much better on the red land than on the darker soils, for the reason that the brown claypan subsoil of the latter is unfavorable to the best growth of alfalfa. Most of the alfalfa of this region, however, is grown on the alluvial lands. Cotton yields from about one third to three fourths of a bale per acre in good years on the sandy red land, and corn up to 30 bushels or more. On the red clay loam and dark loam and silt loam wheat yields from about 10 to 20 bushels per acre up to 30 bushels or more. On these soils, the yields vary more with the seasons than on the sandy lands, except in case of the grain sorghums, which usually give good yields.

In some years corn is seriously damaged or ruined by hot winds on all the types. The hot August winds of 1917 almost destroyed the corn throughout the Red Prairies of Oklahoma and Kansas, and did serious damage far east of this region in these States. Good yields of native-grass hay are usually secured from all the soils, except the deeper sandy land. These grasses include bluestem, buffalo, and mesquite. They afford excellent pasturage, and the raising of cattle is important. Peaches, sweet potatoes, watermelons, and vegetables do well on the red sandy land, and are grown on a commercial scale in some localities. Peanuts also will succeed. The sandy land is easily tilled with light implements and plows, but the clay loam requires a heavier equipment. Clods are often troublesome on this soil. The silt loam and loam do not give much trouble if not allowed to dry out too long before being well broken. No fertilizers are used.

In the southern part of the Red Prairies there are some important areas of red land (*Miles*), brown land (*Abiline*), and black land (*Simmons*), which closely resemble the High Plains soils in that they have a highly calcareous deep subsoil or substratum of marl or "concrete." The red soils are well suited to cotton, and corn does well when the seasons are right. The dark soils are used for cotton also, but probably not so much relatively as the red; while the black soils are used mainly for pasture land, hay, and the grain sorghums. The grain sorghums do well on the soils of all these groups, but yield heavier on the darker types. These same soils occur also in the Edwards Plateau.

There is considerable mesquite in the Texas portion of the Red Prairies, while scrub blackjack oak is common on the deeper sandy soils throughout the entire region. With these exceptions this is a treeless region.

Red, dark, and light-colored lands of the Edwards Plateau and Fort Worth Prairie Regions—Crawford, San Saba, and Brackett soils.—These are the principal soils of this region, aside from the Miles, Alibine, and Simmons soils, which are important in many parts of the Edwards Plateau. There is considerable rough stony land, especially in the southern part. The red lands (Crawford soils) range from dark brown to reddish-brown in the surface; the subsoils consist of red, rather stiff clay or gravelly clay. The gravelly and stony loam, loam, clay loam, and stony clay are the principal types. The gravel and stone consist of angular chert and limestone fragments from the parent rock. These gravelly and stony lands are rolling in topography, are difficult to plow, and are used mainly for the raising of cattle. The other types, however, are used with very good results in the production of the grain sorghums, cotton, grass, and small grains, while corn does well in the more easterly areas. Alfalfa succeeds, but not much is grown. Bluestem and the short grasses of the buffalo and mesquite order afford good pasturage. There is considerable small and scrub post oak and mesquite, and some cedar. The mesquite and oak afford valuable browsing.

The brown and black limestone lands (San Saba and Denton soils) are used for about the same purpose as the red lands, with probably relatively more grain sorghum grown. The clay, clay loam, and stony clay are the principal types. These are productive soils rich in lime, and closely resembling the Houston clay and black clay of the Black Waxy Belt, but having, characteristically, shallower depth to bed rock and less chalky limy material in the subsoil. They are the semiarid correlatives of the brown and black Houston soils.

The light-colored to gray lands with whitish or yellowish, highly calcareous, chalky material in the subsoil (Brackett soils) occupy the rougher areas, such as the steeper slopes along streams, the flanks of ridges, and the sides of mesas. Land of this kind, often having the character of "bad land," is very largely used for pasturage. Aside from the short grasses, mesquite, and catclaw (*Acacia gregii*) are abundant. The pasturage is not so good as that afforded by the red and dark lands of this region. The shrubs growing on the more stony soils make such land better suited to goats than to cattle.

All of the important soils of the Edwards Plateau Region have either a good or a very high content of lime. They are fertile soils that require only sufficient rainfall to produce good crops.

Probably 85 to 90 per cent of the Edwards Plateau Region is used for grazing live stock, chiefly cattle, sheep, and goats. The cattle are often sent farther north to be finished-up by feeding before being put on the market.

There is much rough, stony land in the southern part of the region, which has no value except for pasturage, being too stony and rugged for cultivation. The rocks of this badly eroded land consist mainly of limestone. The native vegetation includes valuable grasses which occur plentifully in the valleys, but are less abundant on the rougher upland areas. The shrubs most commonly found are huisache, guajillo, catclaw, and chaparral.

Writing of this land, Kocher says:[1]

> Although the rough, stony land is unsuited to agricultural purposes, it is fairly well adapted to ranching. The few small areas which can be cultivated in the valleys give excellent yields of oats, sorghum, and other forage crops which are of especial value in raising stock. Many of the drainage ways in this section are favored with running water the year round, as the stream beds, cut to the solid rock, do not absorb the flow. . . . This constant flow is of great value to the rancher in caring for the goats, sheep, cattle, horses, and mules that range on the hills. The land is especially adapted to goats, as these animals live mainly on shrubs and weeds, which form the greater part of the vegetation. It is claimed . . . that about 1 acre is sufficient to support each goat, while from 20 to 30 acres are required on an average to furnish grazing for a cow. The average returns from the goats is about 3 to 4 pounds of mohair per year. . . .

Brown and gray lands of the West Cross Timbers—Windthorst, Stephenville, and Nimrod soils.—The West Cross Timbers Region is occupied chiefly by light brownish soils with red or mottled red and yellow clay or sandy clay subsoils which are moderately to very stiff (Windthorst soils). There are some calcareous strata in the parent sandstone rocks locally. These are mainly sandy soils, fine sandy loam occurring over the smoother country, and stony sandy loams over the rougher areas. Most of the stony land is

[1] Kocher, A. E., Field Operations, Bulletin of Soils, 1911, pp. 1218–19.

covered with post oak and is used as pasture land or is not used at all. Considerable cotton and some corn and grain sorghum are grown on the fine sandy loam, and in some localities peanuts are becoming increasingly important, being grown for oil, for market, and for field forage. This is an ideal peanut soil, and with the larger available area of such land the opportunities for furthering peanut production as an important agricultural product is very promising. Some objection to peanuts is caused by blowing of the sandy soils on which they are grown after the vines are removed, thus leaving the bare ground completely exposed to the impact of the wind.

On some of the slopes and ridges and in some places on flats there are found in this region light brown to reddish brown soils, mainly fine sandy loam (Stephenville), which have relatively friable sandy clay subsoils, as compared with the much stiffer subsoils of the Windthorst series, and which are red in the subsoil, showing little or no mottling. These produce well, being adapted to cotton, peanuts, grass, and forage crops.

There are some flat areas of light gray very sandy soil overlying yellow clay (Nimrod soils). These soils are not so productive as those with the more brownish soil, but are used for cotton, corn, oats, grain sorghum, peas, and peanuts.

Dark colored and brown sandstone, shale and limestone lands of the Eastern Prairies (or Eastern Plains)—Summit, Bates, Gerald, and Oswego soils.—These are the chief soils in the eastern prairies of Oklahoma and Kansas, and they occupy a considerable area in west-central Missouri. The very dark brown to black limestone and shale land (Summit soils) are very extensive and important in this region, especially in Kansas and west-central Missouri. They have yellowish clay subsoils, which, although plastic when moist, do not have the tough claypan nature characterizing the subsoils of the Gerald and Oswego soils. The silty clay loam and silt loam are the principal types. On these a good type of agriculture prevails, corn and wheat being the principal crops. Some alfalfa is grown. A good many hogs are raised, and on the shallower soil, such as that in the Flint Hills of Kansas, the raising of beef cattle is the most important industry. Almost all of the farms on these soils are well equipped with modern farm machinery, such as 2 to 5 horse turning plows, disk plows, harrows, riding cultivators, manure spreaders, hay loaders and stackers, and often gang plows operated by tractors. The surface is flat to undulating, and gently rolling so that all kinds of farm machinery can be efficiently employed.

Wheat yields about 15 to 30 bushels per acre on the silt loam and silty clay loam, corn about 25 to 50 bushels—that is, on the average farm. Alfalfa gives four cuttings in Kansas, amounting to about 4 tons per acre. The silt loam is easier to cultivate than the silty clay loam, and usually gives better yields of corn. Probably 75 per cent of the area of these soils, or more, is used for cultivated crops, the remainder being used as hay lots and pasture land. The grain sorghums are important on many farms. It has been estimated by the Bureau of Soils that the Summit soils (or the Summit and closely related soils) produced in Kansas about 28 per cent of the corn crop and about 34 per cent of the wheat crop of that State in 1909. Comparatively little fertilizer is used. Wheat land is broken about 4 to 8 inches and harrowed well before seeding. Much of the corn land is ridged (listed). Not much attention has been given to the rotation of crops on many farms, but rotations and other advanced farm practices are being introduced gradually. The essential feature of a good rotation on land of this kind is to change occasionally from a clean, cultivated, or a grain crop to a legume, such as alfalfa or clover.

The Oswego and Gerald soils are important series. They frequently occur in close association with the Summit soils. Both have tough clay subsoils—brown, dark brown, or black claypan. The Oswego is black, and the Gerald brown in the surface. Shale is the principal parent rock, but undoubtedly limestone locally contributes some of the material.

The silt loam is the main type of the Oswego series. Its surface is characteristically level, and in places the drainage is slow, with respect both to surface flow-off and under drainage. A large proportion of it, however, is in cultivation, chiefly to wheat. Corn, the grain sorghums, and hay are also important, and some cattle and hogs are raised. Wheat yields about 15 to 25 bushels an acre, and corn averages about 25 or 30 bushels. If plowed while wet the soil bakes to an undesirable condition. It should be plowed when the content of moisture is such that the soil has a mellow structure. Some alfalfa is grown. Fertilizers are not in common use.

The silt loam is also the principal type of the Gerald series. This usually lies a little higher than the Oswego silt loam and does not average quite so nearly level, ranging from nearly level to undulating. Wheat yields from about 10 to 30 bushels and corn 20 to 40 bushels per acre, depending on the seasons and soil management. The grain sorghums give good yields of both grain and fodder. Little fertilizer is used. Some cotton and hogs are raised, and butter and cream are produced on many farms. In the southern area a considerable part of the land is used for hay and pasturage. As a whole, this is an important farming soil. If the land is dry at the time of breaking, the plowing is usually shallow on account of the hardness of the ground. The type is handled about the same as the Summit, but the farms are usually not so highly developed as those on the more productive Summit.

In southeastern Kansas, and here and there elsewhere in the eastern prairies, there are some areas of "white ash land" (*Cherokee* soils) which have an ashy-brown or gray surface soil, with a light-gray silty subsurface layer overlying brown claypan subsoil, which is about like the subsoil of the Gerald. Such land does not rank as very productive soil. It has imperfect drainage and the tough subsoil is not favorable to good circulation of moisture and air. Wheat and grass seem to be the best crops for it. Phosphatic fertilizers and manure are said to be beneficial on these soils.

The Bates soils are derived from shale and sandstone. They are brown in the surface, and red to mottled reddish and brownish in the subsoil, and are not so tough as the Gerald or Oswego in the subsoil. The surface varies from undulating to moderately rolling, and the drainage is good. The silt loam is the principal type, but there is considerable loam. These are important farming soils. They are used for wheat, corn, hay, and to some extent for raising cattle and hogs. In productivity they rank next to the Summit. Cultivation is easy, and by introducing a legume into rotations, satisfactory yields can be maintained. Manure and phosphatic fertilizers may be expected to increase yields of most crops. They can be profitably used in the easterly areas.

There are scattered areas of red limestone lands (*Crawford*) and of brownish wind-blown soils with red subsoils along some of the streams (*Derby*). Of the former the silt loam is the main type in this region, and of the latter sandy loam, loam, and silt loam. All of them are highly valuable, productive lands well adapted to corn, small grains, and alfalfa. The Derby soils also extend along some of the streams, such as the Canadian River, back into the Red Prairies.

In north-central Kansas light-brown to grayish soil, with light-gray subsoils, often containing fragments of the parent shale and limestone rock (*Benton* soils) occur in important areas. Over a large part of this soil the surface is rough, representing eroded plains country. The smoother bodies are devoted chiefly to forage crops for stock, together with some wheat; but the rough land is used for grazing cattle.

Reddish-brown soils from crystalline rocks—Tishomingo soils.—These soils occur in three isolated areas of hilly country in Llano County, Texas, and in Johnston and Comanche counties, Okla. They are reddish brown and have red clay subsoils, and are derived from several kinds of crystalline rocks, mainly of a granitic nature. There is much gravelly and stony land which is chiefly valuable for pasturing stock. Some of the less stony land is used for cotton and corn with fair to good results. Owing to the relatively small area, these lands are not of great importance in the agriculture of the Southern States.

Post oak is present in scattering growth.

THE CENTRAL PRAIRIE REGION [1]

GEOGRAPHY

THE Central Prairie Region embraces the predominantly prairie country lying north of the Ozarks and eastern Great Plains, including mainly northern Missouri, northeastern Kansas, Illinois, Iowa, southern Minnesota, eastern Nebraska, and a strip across the eastern parts of the Dakotas. In this volume, only the Kansas and Missouri portions will be discussed. This southern part, however, includes much of the dominant soils of the whole region. That part of Missouri to the north of the Missouri River together with a narrow strip along the south side of the river and another extending along the Mississippi Bluffs south of St. Louis constitute the Missouri portion of the region. The Kansas area extends southward to about the vicinity of Lawrence and westward to about the 97th meridian.

The Central Prairie Region is not wholly a region of prairies. It is predominantly prairie country, but there are important timbered areas, especially in strips along the streams.

TOPOGRAPHY

The surface features of the region are not unlike those

[1] Inasmuch as only a relatively small portion of the Central Prairie Region is included in this volume, not as much space is devoted to it as to the other soil provinces. Further information can be had from the reports and bulletins of the Missouri and Kansas Experiment Stations, and from soil-survey reports on Nodaway, Buchanan, Callaway, Cass, Pike, Ralls, Knox, and Lincoln counties, Missouri and Shawnee and Leavenworth counties, Kansas. See, also, The Soils of Missouri, Bulletin, University of Missouri, No. 153.

of the adjacent Great Plains Region, and the boundary between the two is indistinct, except as marked by soil differences. It is a country of level, undulating, and rolling lands, with rough, eroded areas here and there, chiefly near the larger streams. In northern Missouri there are some large bodies of badly dissected country which are best suited to grazing and orcharding. By far the greater part, however, is smooth and admirably suited to the use of all kinds of farm machinery, and a very large proportion of the land is in cultivation.

GEOLOGY AND SOILS OF THE CENTRAL PRAIRIE REGION

The Central Prairie Region is underlain predominantly by loessial and glacial soils. The origin of the loess, which is composed mainly of fine particles of silt, has never been satisfactorily explained; but the uniformity of the fine dust-like silt composing the body of the material occurring at varying altitudes and extending down to basal beds of entirely different character, such as that which is obviously residual from the underlying rocks or which represents gritty glacial drift material; the lack of stratification; the variety of fresh-water fossils and absence of marine fossils lends strong evidence of an Eolian (wind-blown) origin. The glacial material consists of drift material which was laid down when ice sheets covered the area. This is made up of detritus formed by the abrading action of moving ice sheets over the underlying rocks of limestone, sandstone, and shale, and of foreign material transported by the ice. This foreign material in many instances was transported long distances from the north. Boulders, cobbles, and gravel of granitic rocks, quartz, diabase, chert, limestone, and other rocks are often found in localities where such rocks do not occur in the underlying strata.

Much of the glacial material is distinctly gritty, containing medium and large rock particles, with gravel, cobbles, and boulders in some places. This is not true of the loess, which is a smooth mass of fine particles, without any large grit particles, gravel, etc., except where they have been washed down upon the loess from exposed higher areas of glacial or residual soil. Heavy clay beds of glacial origin occur in places.

In places, the covering of loessial and glacial deposits has been washed from the underlying rocks, and these since their exposure have decayed to give rise to purely residual soils. Among these residual soils are light-colored soils derived from sandstone and shale (*Boone* soils) and brown soils with reddish subsoils, derived from limestone (*Hagerstown* soils).

The principal soils of the southern Central Prairie Region are the black loessial soils with lighter-colored friable subsoils (*Marshall* soils); brown loessial soils with yellowish friable subsoils (*Knox* soils); dark-colored soils with mottled brownish and drab impervious clay subsoils, probably of loessial origin (*Grundy* soils); grayish soils with drab or brownish, stiff, impervious clay subsoils, probably of loessial origin (*Putnam* soils); and grayish to brownish glacial soils with yellowish gritty clay subsoil (*Shelby* soils). There are other kinds of soils, differing chiefly in color of the soil and subsoil, but they are either relatively unimportant in extent or are so closely related to the soils named that it is not considered necessary to discuss them in this volume. The silt loam types are very largely in the predominance. There is considerable loam derived from glacial material.

GENERAL AGRICULTURE IN THE CENTRAL PRAIRIE REGION

The Central Prairie Region is characterized by a highly developed type of agriculture and a large proportion of land in cultivation, the chief industry being the production of corn, winter wheat, oats, timothy, and clover, often in conjunction with the raising of live stock. In 1909, Illinois, Iowa, Missouri, and Nebraska produced 1,103,529,030 bushels of corn; the total production of the United States for that year being 2,552,189,630 bushels. The same States produced that year 123,409,850 bushels of wheat, while the United States produced 683,379,259 bushels.

Timothy, clover, oats, and alfalfa are important crops. A great many farmers raise and sell hogs and beef cattle and some buy cattle to fatten on the farm for sale. Blue grass affords much fine pasturage in this region. Live-stock farming is the principal industry on much of the eroded, rougher land. Butter and milk also constitute an important source of income on many farms. Commercial apple orchards are important in some localities, particularly on soils like the Knox silt loam. Potatoes and various vegetables do well on the well-drained soils with friable subsoils, and are grown for market in some localities.

The black silt loam (Marshall silt loam) is the leading corn soil of the corn belt, and it also produces much wheat. Excellent yields of both corn and wheat are secured from this extensive soil type, as well as from other important soils of the region, such as the Knox, Shelby, and Grundy. The other soils do not, as a rule, give quite so good yields as the Marshall. The gray soils with an impervious clay subsoil, such as the Putnam silt loam, are considerably less productive, and are best suited to grass and wheat, although a large amount of corn is grown on it, due to the large area used for the crop. It is estimated that 40 per cent of the Missouri corn crop of 1909 was produced on five soil types occurring in the Central Prairie portion of the State (the uplands occurring mainly north of the Missouri River)—on the Marshall, Putnam, Knox, and Grundy silt loams, and Shelby loam, the Putnam silt loam leading on account of its more extensive area. The 10-year average yields per acre of corn and wheat in Missouri for five decades are as follows:[1]

	Corn Bushels	*Wheat* Bushels
1866–1875	30.1	12.8
1876–1885	28.6	11.4
1886–1895	27.7	12.8
1896–1905	27.4	12.2
1906–1915	27.7	14.1

These yields represent the average for the whole State, covering poor as well as good corn and wheat soils, bad years and good years, poor soil management and good soil management.

Blue grass thrives on the better soils of the region and affords excellent pasturage. Redtop finds the gray lands especially suited to its requirements.

Efficient farm machinery and teams are in general use throughout the belt, except on some of the poorer gray land, with impervious clay subsoil. Buildings and other farm improvements indicate a prevailingly prosperous condition. Deep seasonable preparation of the seed bed, with sufficient harrowing to effect an excellent state of tilth, is the general practice. Some farmers do not grow the legumes with sufficient frequency in rotation with other crops for best results, but a great many are growing them—alfalfa and clover chiefly—and by their use are maintaining a high state of soil productivity. Much barnyard manure also is being used and some commercial fertilizers are applied, especially for wheat on the older fields. Lime is helpful on the gray soils with heavy clay subsoil such as the Putnam silt loam. Much more lime could be used to advantage. An increased content of organic matter,

[1] Bulletins, Nos. 514 and 515, U. S. Department of Agriculture, Bureau of Crop Estimates.

such as can be supplied by additions of barnyard manure and by growing crops like cowpeas and clover, is especially desirable on such light-colored soil.

On the whole, the most extensive soils of the region are so inherently productive that good yields have generally been secured with the methods employed. There has been some soil depreciation by long cropping without rotation, but this is being remedied by the gradual adoption of better farming systems, so that this will continue to be a country of big crop production and high-priced land. Erosion is one of the most serious problems to deal with. Certain lands, such as the more sloping areas of the brown silt loam (*Knox* silt loam), are particularly susceptible to damage by washing. Apparently the best way to handle this is to use the steeper areas for hay and pasture land, or to keep the soil liberally supplied with humus where it is cultivated.

DESCRIPTION AND AGRICULTURE, SOILS OF THE CENTRAL PRAIRIE REGION

Black, brown, dark brown and gray lands of the Central Prairie Region—Marshall, Knox, Shelby, Putnam, and Grundy soils.—In northeastern Missouri there is much light-brownish to grayish silt loam with a subsurface of gray or mottled grayish and yellowish silt loam, underlain abruptly at about 15 to 20 inches with a heavy impervious clay (claypan) of a drab to brown color (Putnam silt loam). This soil is best adapted to grass such as timothy and red-top. Wheat does better than corn. The land is used for corn, wheat, and clover, but the average yields are not high. It can be improved by liming and growing clover and peas. It occupies level to undulating country and has poor under-drainage. The material is derived from what appears to be loess. Crops are susceptible to injury by drought.

In northwestern Missouri there is a dark-gray to black

PLATE 49.—Breaking raw (virgin) land with traction engine and gang plow in the High Plains of the Texas Panhandle. Much of the raw prairie of the High Plains land is broken by tractors. (Photo. from collection, Bureau of Soils.)

PLATE 50.—Prickly-pear and mesquite trees in the Rio Grande plain country, Cameron County, Texas. This native cactus affords valuable grazing for cattle in South Texas, the section being highly adapted to prickly-pear. The spines are frequently singed with a gasolene torch to enable stock to eat the plant more readily. Cattle also browse on mesquite trees and eat the beans of the tree. (Photo. from collection, Bureau of Soils.)

PLATE 51.—Corn and cotton on rich alluvial soil, Arkansas County, Ark. These alluvial soils, including the Mississippi bottoms (Mississippi Delta) and contiguous bottoms of streams tributary to the Mississippi, constitute one of the most productive agricultural regions in the world. The great area of these lands already in cultivation is being rapidly added to by the reclamation of swampy lands and the clearing off of the timber. Much of the soil consists of "buckshot land" (Sharkey clay), the productiveness of which probably is not exceeded by any soil anywhere. Cotton, corn, wheat, oats, alfalfa, lespedeza, clover, sugar cane, rice, and pecans are some of the successful crops. (Photo. courtesy, Southern Alluvial Land Association.)

PLATE 52.—Cotton on the rich level alluvial soil of the Yazoo Delta, a [illegible]on of the Mississippi River bottoms. "Buckshot" soil (Sharkey clay), [illegible] the most productive soils known. (Photo. from collection, Bureau

silt loam which passes beneath into light-colored silty clay loam, which is underlain at about 18 inches by heavy plastic clay, mottled dark drab and yellowish-brown (Grundy soils). The material of this is also derived from what appears to be loess and it occupies nearly level to gently rolling country. Serious erosion occurs on the more sloping areas frequently unless the land is carefully handled. This is a good corn soil and wheat and oats do very well. Corn yields from 25 to 60 bushels an acre, wheat 15 to 25 bushels, and oats 25 to 50 bushels. Red clover and timothy are frequently grown. On most farms some hogs and cattle are raised. Fertilizers are used for wheat by some farmers.

Both the Putnam and Grundy are mainly prairie soils.

The Marshall silt loam is very important in northwestern and north-central Missouri and occurs also in northeastern Kansas. The Knox silt loam is important in northern Missouri. These are derived from material that appears to be of wind-blown origin, that is, loess. They occupy level to gently rolling country, and have good drainage.

The principal types are the silt loams. The Marshall silt loam is a black or nearly black, deep, mellow silt loam passing beneath into lighter colored silty clay loam, while the Knox silt loam is a brown, deep, mellow, friable silt loam which passes beneath into yellowish-brown silt loam or silty clay loam.

The Marshall silt loam is the great corn soil of the corn belt. A highly developed type of agriculture exists on it. Corn, the principal crop, yields up to about 80 bushels an acre, under good farming systems, the average yield being about 40 or 45 bushels probably. Oats yield 20 to 50 bushels per acre; wheat about 18 to 35 bushels; clover-timothy hay 1 to 2 tons; and alfalfa about 6 tons.

Considerable mixed clover and timothy are grown. Blue grass does well. In some localities, as in Buchanan County, Mo., there are successful commercial apple orchards. Beef cattle, hogs, and dairy cattle are important on many farms. In many cases, live stock and dairy products constitute the important sources of income, most of the corn being fed on the farm. Many farmers bring in cattle for fattening. The soil is easy to cultivate as is also the Knox silt loam.

The Knox silt loam also gives good yields of wheat, corn, alfalfa, clover, and timothy. Orchard fruits and vegetables, including potatoes, do very well. The yields of corn probably do not average quite so high as on the Marshall, but they are good, as are also the yields of other crops. Commercial apple orchards are important in some localities.

This land is inclined to wash badly on slopes if neglected. Some of the type has a rather rough topography which makes the land best suited to grazing and to fruit. Most of it is rolling. It occurs largely in belts along streams. Originally the soil was timbered, chiefly with oak, walnut, hackberry, wild cherry, elm, and basswood.

The Knox silt loam in its surface soil closely resembles the Memphis silt loam, which is an extensive soil along the east side of the Mississippi River bottoms from southwestern Kentucky to Louisiana, and which occurs also on the west side of the river. But the Memphis is underlain by Coastal Plain material, mainly sandy clay and gravelly beds, whereas the Knox is underlain by sandstone, shale, and limestone or by glacial material.

In northern Missouri, there is much rolling to broken brown to dark-brown loam, overlying yellow or yellowish-brown gritty clay, frequently mottled with drab and reddish-brown (Shelby loam), the material of which is derived from the glacial deposits geologically classed as the Kansan drift. Locally, loessial material probably enters into the composition of the areas of more silty surface soil. The subsoil often contains sand and gravel of quartzite, gneiss, granite, diabase and limestone, and both iron and lime concretions. In places, ridges occur with such regularity as to give the surface a billowy appearance, locally characterized by the name "washboard country." Drainage is good, the run-off often causing harmful erosion on cultivated slopes.

Much of this land was originally timbered with oak and hickory. Both general farming and stock farming are important.

Corn yields 25 to 60 bushels per acre, according to season and soil management; wheat 15 to 30 bushels; oats 20 to 40 bushels or more, and timothy-clover hay 1 to 2 tons. Alfalfa, when tried, has generally succeeded. Blue grass does particularly well.

Being susceptible to erosion, much of the rougher areas are used as pasture and hay land. Considerable manure is used and some commercial fertilizer for wheat. Good implements and teams are generally employed. The soil is easy to cultivate.

The residual limestone land, mainly the Hagerstown soils, and the residual shale and sandstone lands, such as the Boone and Bates soils, occurring largely as sloping and rolling areas in the eroded country along the Missouri and Mississippi rivers and other streams, are extensively cultivated to the general crops grown in the region, mainly wheat, corn, oats, timothy, and clover. The limestone lands produce excellent crops and afford good blue grass pasturage. The sandstone and shale soils are not so productive, yet they generally give good results, especially with small grain and corn. The rougher lands are devoted to live stock and timber lots.

THE STREAM BOTTOM AND SECOND BOTTOM (ALLUVIAL) SOILS

GENERAL DESCRIPTION

The alluvial soils include the vast number of stream flood plains (first bottoms) and old flood plains (second bottoms, terraces, or benches) occurring along the intricate network of streams that ramify all the soil regions of the country. Nearly every stream has a strip of bottom land and often a strip of second bottom somewhere along its course. These bottoms usually begin near the headwaters of the streams and follow their courses, on one side or the other, to the larger streams into which they flow and along these finally to the sea. Often the bottoms are not continuous; for example, there may be no development of bottom land whatever where the stream has cut its channel through belts of very hard rocks, while above and below such belts, in areas of softer rocks or strata, the same stream meanders through broad flood plains. In mountainous country where the fall is rapid and in regions of very hard rocks the streams spend their energy deepening their channels, cutting steep-walled valleys, gorges, and cañons, and accomplishing little in the way of lateral planation or cutting back of the banks. It is in regions of comparatively soft strata and moderate surface relief that broad bottoms are developed, such, for example, as the Coastal Plain Region, where the dominant soft, unconsolidated materials, sand and clay, have been less resistant to the cutting back of the flanking bluffs by overflows, and where the gradual slope toward the sea causes the currents to flow relatively sluggishly and the channels to meander over a wider area. Here the bottoms average much broader and are more continuous than in the adjacent Piedmont Region, where hard rocks resist the erosive effects of running water and where the more rapid fall of the streams tends to direct the cutting force of the water downward rather than outward.

In regions of low rainfall there are fewer streams than in the more humid regions. In the western Great Plains there are many large counties which do not have any streams, not even well-defined drainage-way depressions. In the Piedmont Region, on the other hand, the whole country is so thoroughly ramified by streams and by depressions and slopes leading to streams that practically the entire area has good surface drainage. The primary waterways of such regions divide in the direction of their sources into secondary streams, which in turn divide into smaller brooks or branches that dwindle to mere wet-weather drainage ways, swales, and gullies.

During heavy rains such rolling country as the Piedmont is practically covered with a sheet of running water which picks up particles of soil, and sweeps them down the slope, carrying large amounts into the streams below, thus converting the entire surface of the land into what constitutes essentially a temporary flood plain. The alluvial soils, however, are confined to the stream bottoms and second bottoms or terraces.

The width of the bottom lands varies generally with the size of the stream and the hardness of the rocks or deposits through which the stream flows. Many small streams have flood plains only a few yards across; the width of the Mississippi River bottoms, on the other hand, as an extreme example, at a point near its confluence with the Red River is about 75 miles. The bottoms and benches average broadest in the Coastal Plain Region, and there is a much larger total area of alluvial land within this region than in an equivalent area of the other soil regions treated in this volume, except, possibly in portions of the eastern Great Plains and of the Central Prairie regions. The western Great Plains has the least area of alluvial soil and the Appalachian Mountains come next in order in relative total area.

The first bottoms compose the lowest lying and most recently formed areas of the alluvial soils—those which are still subject to submergence by overflow waters from the stream. Abnormally high water occasionally covers the lower second bottoms or benches which stand above those bottom lands subject to inundation by normal overflows.

The bottoms are characteristically flat, but there are occasional depressions, including abandoned channels or "cut-offs" and swales scooped out during overflows, together with hummocks and faint ridges, consisting usually of sandy material. In the bottoms of some of the Great Plains streams, as the Arkansas and Canadian rivers, there are more conspicuous surface inequalities represented by strips of dune sand which rise abruptly from the level bottoms, often to a height of 20 feet or more. These dunes, of course, do not constitute bottom land proper—they represent the work of wind, and in a strict sense are nothing more than areas of upland. There are also, here and there in the bottoms, islandlike areas of high ground apparently representing remnants of a former flood plain which for some reason was not completely cut down to the level of the present flood plain.

Aside from these minor surface inequalities, the bottoms are usually level or essentially so from one side to the other, but in many places they sink imperceptibly away from the stream banks, being lowest along the outer margin, while again they rise imperceptibly toward the foot of the uplands or second bottoms, a condition often due to the washing down of material from the adjacent slopes. Immediately along the banks there is frequently a narrow strip which is slightly higher than the main portion of the bottoms to the rear. These are natural levees, and usually are of a sandy character.

The second bottoms, often called terraces and benches, include old flood plains which now stand above the influence of stream water. These were the earlier flood plains—the flood plains that existed when the waters flowed at higher levels, the streams having cut their channels to lower levels and formed new and lower first bottoms. Some streams have no overflowed bottoms at all, or only high bottoms subject to overflow only during very high floods. In such instances the channels have been cut out sufficiently deep and large to carry all normal flood water within their immediate banks.

In their height above the first bottoms the second bottoms vary from a few feet to 100 feet or more. There are often third bottoms, and occasionally even fourth, fifth, and still higher terraces, rising one above another in steplike succession. The lower terraces are usually flat, and many of the higher ones are also, but many of the higher, older ones, have had their original flat surface disturbed by erosion, some having been so dissected by streams, gullies, and drainage-way depressions that they have a rolling topography, preserving nothing of the original terrace surface configuration except an even crest level as seen in perspective.

The better developed terraces are separated from the first bottoms by distinct scarp lines or steep slopes, and the successively higher ones are similarly separated from their lower counterparts. On the outer or upland side the terrace boundaries are marked by steep slopes or bluff lines. In places these scarp lines and steep slopes have been effaced by the leveling effect of erosion, or else they never existed, the rise from one level to another having been originally through gentle slopes. Similarly, the outer escarpments or steep slopes have been obliterated by erosion, having been replaced by gentle slopes. In some places (as along Cowhouse Creek in Bell County, Texas) the uplands have been eroded down to the level and even below the level of the terraces, leaving terrace remnants as a kind of table-land between the adjacent upland and the stream bottoms.

GEOLOGY AND SOILS OF THE STREAM BOTTOMS AND SECOND BOTTOMS

The stream bottoms and second bottoms are built up of alluvium, that is, material that has been washed from the uplands and deposited downstream by overflow waters.

This material varies in character from simple deposits derived from drainage basins comprising soils of uniform texture and character, laid down before the transporting water had been contaminated by water of other streams carrying in suspension material from different sources and of unlike character, to extremely heterogeneous deposits derived from drainage basins or several drainage basins including soils widely variant in texture and character.

Since increased velocity increases the carrying power of water, the texture of the alluvial deposits varies markedly according to the swiftness of the current by which the material is laid down. Accordingly coarse material is much more in evidence along the smaller, swifter headwater streams and near the banks of the larger streams than in the broader bottoms along the lower courses, and away from the banks, where velocity is checked by trees and increased friction from shallower depth. The alluvium of the smaller drainage ways of the Appalachian Province and the higher portions of the Piedmont frequently contains large quantities of sand, gravel, and boulders, whereas that of the broad-bottomed major streams, particularly in regions of lower relief, such as the Atlantic and Gulf Coastal Plains, seldom carries material coarser than medium sand, the greater part, especially of the first bottoms, consisting of silt and clay. The older alluvium of the terraces along many of these larger streams, however, even near the coast, carries much gravel, particularly in the substratum. This coarse material was deposited when the streams were flowing at higher levels and at a time when the currents were undoubtedly much swifter than under present conditions of streams flowing more nearly at base level.

While there has been considerable assorting of stream-carried material by variations of current and some wearing down of the coarser particles swept along the bottoms of channels, the streams have done much less of this work than have the waters of the ocean.

In the narrow bottoms the alluvium averages far more variable in texture than in the broad bottoms, for the reason that the narrow strips are more generally developed along shallow streams having a steeper gradient and greater current velocity, and for the additional reason that their smaller area is necessarily affected more completely by the variable material washed down from adjacent slopes and brought in by smaller tributaries.

Over the bottoms of the smaller streams heavy overflows deposit sand and gravel in those places where the current is suddenly checked by such obstructions as vegetation and hummocks, while finer material is laid down close by from the water thus relieved of its coarser burden. As the flood subsides, still finer grains settle out in the lower position from the slackened current and clay and silt are deposited from the pools of water left in depressions. Again the entire flood plain may be inundated by the water of a tributary carrying material from a different source and of entirely different character. Thus the smaller bottoms usually comprise many textural grades and variable material within restricted areas. The deposits are also extremely variable in texture and character from the surface downward.[1]

In the bottoms of the larger streams silt loam, silty clay loam, clay, and very fine sandy loam are the principal soils, particularly at a short distance back from the banks. In the Mississippi bottoms, for example, very little but clay is found back of a narrow strip of sandy soil immediately along the river front, the banks of abandoned river channels (oxbow cut-offs) and streams crossing the bottoms. Obviously this is due to the fact that the overflow water has dropped its coarser particles in the faster moving water nearer the banks, retaining the finer silt and clay to be

[1] Quotation from the author, Soils of The United States, Bulletin, Bureau of Soils, U. S. Department of Agriculture, No. 96, pp. 304–5.

laid down in the more sluggish current farther back from the streams. The author has seen overflow water from the Mississippi River which some miles back from the bank was almost clear. A sample collected by the writer at Portland, Ark., after a great spring rise of the river had broken the levees and caused a destructive overflow, contained only a trace of sediment, aside from a little organic material, yet this was from overflow water 4 feet deep near the outer edge of a continuous sheet of deep overflow water 20 miles wide at this point. Proceeding toward the river the water, 3 or 4 miles from the banks, began to show increasing turbidity; in mid channel (at the highest flood stage known in the Mississippi) the water had a yellowish-brown or dun color, and a sample collected from the surface contained a relatively large quantity of suspended matter consisting of silt, clay, and some very fine sand.

Both the texture and character of stream bottom soils are strongly influenced by the texture and character of the prevailing soils of the regional uplands; often the character, particularly color and lime content, are markedly influenced by soils which are not necessarily largely predominant in the uplands from which the alluvium is derived. In the Mississippi Bluffs and Silt Loam Uplands Region the alluvial soils, both of the first and second bottoms, are very largely silt loams, a fact obviously due to the presence of little but silt loam soils in the regional uplands. Bottom lands subject to overflow by streams carrying drainage from the chocolate-red soils of the Red Prairies or Red Beds of western Texas and Oklahoma usually have the same chocolate-reddish color, even at long distances from the source of the material. For example, the bottom soils of the Red River have a chocolate-reddish color unmistakably due to Red Prairie material washed from the Vernon soils almost to its point of confluence with the Mississippi River, about 500 miles, by the stream, east of the red uplands from which the material comes, and this regardless of the fact that a large proportion of the material transported by the waters of this river comes from affluents entering the river east of the Red Prairies, and having along their courses only soils of brownish, gray, and dark colors. Bottom lands in the prairies of Mississippi, Alabama, and Texas having in the drainage basins of their streams only small areas of calcareous soil and much noncalcareous soil often are richly charged with lime carbonate, and have that nature peculiar to alluvial soils rich in lime, a granular or "buckshot" structure at the surface when dry.

Some bottom soils in sections including much cultivated uplands frequently show such marked and abrupt differences between the soil and subsoil material as to indicate that there has been increased deposition of alluvium due to increased removal of upland soil by erosional water, resulting from the cultivation of the soil. It is not uncommon to find recently deposited sandy surface soils overlying very silty or clayey subsoils, and brown mellow soils overlying compact gray subsoils in bottoms where there is no explanation of such abrupt changes through the vertical section except by a greatly accelerated deposition of material washed from the neighboring uplands since they have been brought into cultivation. Not infrequently such sandy deposits are laid down by floods to such a depth as to cause much depreciation in the value of alluvial soils which previously were highly productive.

In much of the alluvial soils of the first bottoms there has not been the opportunity for weathering and alteration of the soil texture through the vertical section by washing out of fine particles from the surface layer by erosional water or by translocation of fine particles from the surface to the subsurface by downward-moving water, that obtains in upland soils and high-terrace soils, for the reason that fresh deposits are continually being added. In much of the alluvium, also, oxidation has been retarded by the continuous or nearly continuous presence of an excess of moisture serving to inhibit air penetration and to encourage thereby chemical alteration opposite to that of oxidation such as goes on in well-drained soils, with the effect of producing grayish, pale-yellow, and rusty-brown colors in the material rather than the reddish, brownish, and deep yellow colors characterizing most well-drained, well-oxidized soils. Hence the presence of so much gray and mottled grayish, pale-yellowish and rusty-brown soils or soils having subsoils with these colors in the bottoms of the humid regions.

On the better drained, older terraces chemical changes and alteration by erosional and percolating water have accomplished more work, and for this reason many of the older second bottom soils have characteristics similar to the soils of the neighboring uplands. It may not be a safe assumption, however, to say that these alluvial soils are the same as the soils of the near-by uplands which they may resemble, especially where the drainage waters of the streams flow in part from regions having different upland soils. Chemical and mineralogical analyses may show important dissimilarity between such alluvium and near-by upland types, even though their apparent physical features are identical.

The principal soils of the stream bottoms and terraces consist of silt loams, clays, silty clay loams, loams, fine sandy loams, and very fine sandy loams, together with swamp or very wet bottoms of variable soil texture. The source, color, and age of the material have been taken as important criteria in the classification of alluvial soils. The source of the material often has a direct bearing upon the inherent nature of the soil, as, for example, well-drained alluvial soils containing much wash from limestone soils are inherently more productive than alluvium containing principally wash from noncalcareous shale and sandstone soils, even though the two kinds may be very similar in color and other visible properties.

The age of the alluvium, as measured by position, whether occurring in overflowed bottoms of recent deposition or on older, higher terraces standing above overflow, often has much to do with the physical features and productiveness of the soils.

It has been found impossible to determine the exact source of all the material, or even the greater part in many cases, because the deposits from varied sources have been so intimately mixed as frequently to lose any individual characteristics the particles from a definite region may have possessed. In the case of those streams which rise and have their courses entirely within areas completely occupied by definite or related soils, as is true, for example, of many Coastal Plain streams, the exact source of the material is at once obvious. But with streams traversing regions of unrelated soils and receiving the waters of tributaries flowing from still other soil provinces, as in the case of the Mississippi River, as an extreme example, it can be safely assumed only that the greater part or at least a large part of the material is derived from the region affording the greater part or a considerable part of the drainage waters.

In the case of many streams embracing several soil regions within their drainage basins, the source of a considerable part of the alluvium can be readily fixed by certain unmistakable inherent properties of the material, the identity of which has been preserved with sufficient distinctness to dominate the physical qualities even where representing an intimate mixture of a variety of dissimilar materials. This is particularly true of materials washed from red soils and calcareous soils.[1]

On the basis of color the alluvial soils are easily classified in distinct groups of black, brown, gray, yellow, mottled, and red soils or soils with such colors in the subsoils. The color of the material points either to some important soil condition, as drainage, content of organic matter, degree of oxidation, or source of material. The black alluvial

[1] Quotation from the author, Soils of the United States, Bulletin, Bureau of Soils, U. S. Department of Agriculture, No. 96, p. 306.

soils of the streams in the humid regions are usually imperfectly drained and rich in organic matter, the gray and the mottled gray and yellow soils are usually very poorly drained, the brown soils usually have good drainage, at least between periods of overflow, and the red soils either have very good drainage or owe their red color to wash from red upland soils. Alluvial soils which crumble readily on drying may generally be assumed to contain considerable lime and to be very productive. Soils having lighter-textured subsoils than surface soils are considered distinct for the reason that they have exceptionally good under-drainage, and may be expected to be particularly well suited to deep-rooted crops as alfalfa. In the dry western country the alluvial soils are largely brown or black. Both are productive, where there is not too much alkali, the brown soils usually having better drainage.

The general soil map accompanying this volume shows only the larger strip of alluvial soils—those of the larger streams. Thousands of narrow areas along the smaller streams are not shown.

GENERAL AGRICULTURE ON THE ALLUVIAL SOILS

The alluvial soils constitute very important agricultural lands. They are much more extensively used relatively in the Great Plains, Central Prairie, Limestone, Appalachian, and Piedmont regions than through the Coastal Plain Region, where there is a large proportion of swampy bottoms. Also, much of the Mississippi River bottoms is of such a swampy nature that canals must be dug before it can be cultivated.

These bottom soils prevailingly are extremely fertile. The well drained alluvial lands are the richest of soils. They represent accumulations of soil particles washed down from all varieties of uplands, intimately mixed with one another in a fluid (floodwater) which itself contains in suspension and solution nutritious organic and mineral substances, and deposited in deep beds of rich potential agricultural land, generally mellow and easily tilled. Wet, soggy alluvial soil, "crawfishy bottom," is not as productive, but very little even of this can be said to represent a poor grade of land, since with drainage there is little bottom land outside of alkali regions which will fail to produce pretty good yields, at least of grass or some such crop as lespedeza. So, the alluvial lands of the country represent a resource of almost incalculable value, particularly when the vast total area of these lands which has never been used is considered, coupled with their wide distribution—through regions of highly developed farms over both uplands and lowlands and through hilly, mountainous and rocky country where the strips of bottom land constitute the principal arable soil.

Occasionally unseasonable overflows do much damage, but the crops of the good seasons hold the average yields up to a good standard. In the western Great Plains the crops, especially corn, occasionally are severely damaged by droughts, but the average crops here are far superior to those of the uplands. In some parts of southwestern Texas only the alluvial soils are used for crops to any important degree, the uplands being used for grazing. Alkali does some damage in places in the western Great Plains, particularly in the southwestern part.

In the humid region there are, in addition to the very swampy bottoms, which are unusable in their present condition, except for hay and pasturing, imperfectly drained gray soils, both in the first bottoms and on the second bottoms, such as the Bibb, Myatt, Atkins, Holly, and Calhoun soils, which are much less productive than the better drained brown, red, and black lands. These gray lands are inclined to bake to an undesirable compact condition in dry weather and to clod when plowed in such condition, and it is often impossible to get crops in early on them. They need ditching or tiling, and will be benefited by liberal treatment with lime.

The swampy bottoms, so abundant in the lower Coastal Plain, east of the Brazos River and in the Mississippi bottoms, generally cannot be safely used for crops other than rice and grass, until protected from heavy overflows by enlarging the stream channels with dredges or by the construction of levees. Levees and canals have been the means of bringing into use millions of acres of highly productive land in the Mississippi, Arkansas, and Red River bottoms, and the area is being added to steadily, especially by the dredging out of channels and construction of canals. In southeastern Missouri, Arkansas, Louisiana, and western and northeastern Mississippi very extensive drainage operations have been carried out and are being extended. A very large area of swamp land has been reclaimed in the St. Francis River section of Missouri and Arkansas. In some of the Mississippi counties, as in Chickasaw and Lee, a large area of productive creek bottoms has been opened recently to safe cultivation by enlarging and straightening the creek channels with dredges. When the land is sufficiently canaled the trees are removed or deadened by girdling, and corn or cotton is planted, giving good crops the first year as a rule.

But without expensive drainage expenditures millions of acres of swampy bottom land throughout southeastern United States, including the Mississippi bottoms and the bottoms of streams west of the Mississippi, could be brought into valuable use for the production of hay and rice and for grazing cattle and hogs, simply by cutting off the timber, which is chiefly hardwood. At first this land could be used for grazing, and after the stumps have rotted (hardwood stumps decay rapidly on wet alluvial lands) it could be used for rice and hay. By cutting stumps low enough to

PLATE 53.—Sugar cane on alluvial soil, southern Alabama. Sugar cane is grown for sugar chiefly on the alluvial soils of southern La. Some is also grown on the coastal prairies of that State and Texas. Molasses is a by-product from the manufacture of cane sugar. The crop is grown for sirup principally on the sandy soils of Ga., Fla., Ala., Miss., La., and Texas. On light-colored sandy land, such as the Norfolk and Kalmia soils, sugar cane makes a table sirup of very excellent quality.

PLATE 54.—Fattening beef cattle on lespedeza growing on Mississippi alluvial soil. This is a very valuable hay and grazing crop in the South. It succeeds on almost all soils, but produces best hay on the stream bottom and second-bottom soils, doing well even on imperfectly drained types of a very acid nature. (Photo. courtesy, Southern Alluvial Land Association.)

Plate 55.—Oats on Mississippi alluvial land. (Photo. courtesy, Southern Alluvial Land Association.)

Plate 56.—Showing the level surface of the Shenandoah River terrace (second bottom), near Waynesboro, Va. Waynesboro gravelly loam. Blue Ridge Mountains in background. This is old alluvial material, deposited when the waters of the stream were flowing at a higher level than at present. (Photo. by the Author, collection, Bureau of Soils.)

allow the use of machinery, rice and hay could be produced from the start. Of course the extremely swampy land, that which is covered with water or remains marshy through the summer, can not be used except for pasture land until canals are opened to give surface drainage. Land of this kind occurs in large tracts in the lower Mississippi bottoms, as along the Atchafalaya River, and along other streams such as the lower Alabama River. The simple fact that the land overflows by no means precludes its use for pasture and hay, and in many instances for rice. Heavy overflows would likely destroy some hay and rice, but little damage would be done meadows of lespedeza, Bermuda, and other grasses in so far as affecting their value for grazing.

Along the lower courses of the Cape Fear, Santee, Savannah, and Altamaha rivers and other streams of eastern North Carolina, South Carolina, and Georgia, a very important agriculture existed prior to the Civil War, which had for its basis the production of rice on the bottoms. Here the rice lands were protected from overflow and the necessary irrigation controlled by levees built along the banks of the streams. Since the war these diked rice lands have been gradually abandoned, following the development of rice production in Arkansas, Louisiana, and southeastern Texas. The most important rice district of Arkansas is on the old, broad terraces of Lonoke, Prairie, and Arkansas counties. Rice production is also important in the Mississippi bottoms of Louisiana.

Corn is the principal crop grown on the first bottom soils. On a great many farms the uplands are utilized for grain, grass, cotton, etc., while the bottoms are reserved for the corn crop. However, considerable cotton, sorghum, oats, and hay are grown in the bottoms of the humid region. The early varieties of cotton are frequently selected for the bottoms, for the reason that the crop is often late to mature in the bottoms. Much alfalfa is produced both in the bottoms and on the terraces of the Central Prairie and eastern Great Plains regions, and in the bottoms of streams like the Red and Arkansas rivers where soils admirably adapted to this crop occur. Some alfalfa is also grown on terraces of streams farther east, as on those of the Rappahannock in eastern Virginia, and considerable is grown in the bottoms of streams in the Black Prairie sections of Alabama, Mississippi, and Texas, where excellent alfalfa soils occur. Well-drained areas of Mississippi bottom soils are also being very successfully used for this crop. In the central and western parts of the Great Plains alfalfa and the grain sorghums are the principal crops of both the bottoms and second bottoms, although corn and cotton are grown here. The sugar cane crop of the United States is grown largely on the bottoms and associated second bottoms of the lower Mississippi and Red rivers.

The well-drained silt loams, loams, and sandy soils of the stream bottoms and terraces are easy to plow and keep in good condition of tilth. The clays require heavier teams and plows. Those rich in lime, such as the "buckshot" clay (Sharkey clay) of the Mississippi bottoms and the red and black soils of rivers like the Red, Brazos, and Arkansas can be plowed while wet, since the clods, on drying, crumble to a desirable pulverulent condition, owing probably to a high content of lime and organic matter.

Generally the intertilled crops are grown on ridges, especially in case of the wet lands, in order to bring the root zone of plants above the surface waters that accumulate in wet seasons. Cultivation is usually performed in about the same manner as for the same crops grown on the neighboring uplands. Some land is irrigated in the western Great Plains, particularly in southwest Texas.

Fertilizers are used lightly on many bottom farms east of the Mississippi for cotton and to some extent for corn and grain, but the applications are lighter than on the uplands.

Fertilizers are not especially needed on much of the alluvial soils, even in sections where it is profitably used on the uplands. As a rule, also, lime is not needed, except, perhaps, on the gray soils. The brown, black, and red alluvial soils are seldom acid to any considerable degree, even where there is little or no wash from limy uplands.

The ordinary crops grown on the alluvial soils are usually handled in about the same way as on the uplands. Sugar cane and rice, which are crops extensively grown on these lands, are handled in a very different manner from that characterising the culture of such crops as corn, grain, and cotton, and the methods employed will, therefore, be given in some detail below.

Rice is sown on land which is flat-broken in fall or late winter to a depth of about 3 to 5 inches, and subsequently harrowed. Small levees 2 feet high or less are built at intervals of about 100 feet to several hundred feet in order to hold irrigation water at the requisite depth over the subfields into which the rice fields are thus divided. When the rice is 4 to 6 inches high water is let on it, and kept there, the depth being gradually increased until the water is 6 or 7 inches deep, until a short time before harvesting, usually about 2 weeks. The crop is harvested like wheat, with machines and, in the Iberia Parish, La., section, with hand scythes. The irrigation water is pumped from wells and streams.

This applies to the Louisiana-Texas prairie district. In the Arkansas district enough water is let on at first barely to cover the ground. This is permitted to dry off, when again it is turned on a little deeper, and allowed to remain on about three weeks, when it is shut off a second time. As soon as the soil begins to dry out, flooding is resumed, and the water is kept on the field until about two weeks of harvesting time. It is then finally turned off. It is claimed this turning the water off at intervals diminishes damage by the rice root

[illegible]

[illegible]

[illegible] or [illegible] or [illegible] years, or the land is [illegible] "rested" for a time. [illegible] [illegible] years, [illegible] more than two [illegible] up [illegible]. [illegible] destroyed by [illegible]. [illegible] weeds. [illegible] bushels per acre. [illegible] and [illegible] has been "rested" or rotated with a [illegible]. [illegible] applications of fertilizers are [illegible] made. [illegible] can be introduced into the [illegible] with good results.

Soils best suited to rice are those having a clay subsoil to prevent too rapid downward movement of the water, and a nearly flat surface allowing easy control of irrigation water. Fuller details of rice production are given in the footnote below.[1]

[1] Rice is grown usually two or three successive years on the same land, sometimes longer, and is followed by corn, sugar cane, soybeans, with cotton, or potatoes, or the land is "rested" one or more years, frequently being grazed by cattle. In the Louisiana district, where rice follows another crop, plowing is generally done in February, and following this harrowing is done, the object being to seed the crop before weeds appear. Many growers plow in November and December, especially for the second or third crop, disk and harrow and replow, and harrow in the spring. Some wait until seeding time before plowing. For the first two years that land is in rice a second plowing is not necessary, and after that the spring plowing may give a $33\frac{1}{3}$ per cent

Sugar cane is planted in the fall, winter, and spring in beds about 6 feet apart. The plants are cultivated until early July, and harvesting begins in October. The stalks

increase in yield over land plowed in the fall only," (Soil Survey Report, Iberia Parish, La.). Rice land is frequently plowed while wet, especially the black Coastal Prairie lands, with 2 or 4 horse turning plows, subsequent rains being depended upon to "slacken" or crumble the clods.

The grain is seeded both by drill and by hand. After seeding the land is often harrowed; it is sometimes rolled or flooded to prevent birds from destroying the seed. Some "mud-in" the seed on wet ground with a broad drag. For an early crop seeding is often done in February, the crop maturing in July. A second crop is secured with some varieties, as the Honduras, being cut in September or October. The late varieties, as the Japan type, are seeded from March to May, maturing in August or September.

When the plants are 4 to 6 inches high water is let into the field from the irrigation ditches to a depth of about two inches; later, at a height of about one foot, the flood water is deepened to something near four inches; then again when the grain becomes taller the water is deepened until the capacity of the levees is reached. One man to 75 acres is said to be sufficient to maintain the levees, if crawfish are not too troublesome.

In the Arkansas district land is broken for the next crop as soon as possible after harvesting is over. Usually this is done in the fall, but sometimes unseasonable weather forces later preparation of the seed bed. The average depth of plowing here is about 3 or 3½ inches. Deep plowing is objected to because, as claimed, the harvesting machinery sinks to the depth of plowing. Most of the breaking is done with three-horse riding plows and two-horse walking plows, carrying a single turning plow, and with tractors pulling a gang of such plows. These cut a 14-inch furrow-slice. Plowing is done over the small irrigation levees, and the crop is planted over these as well as elsewhere. The usual practice is to disk once and harrow twice just before seeding, and to roll the field once after seeding. The seed are drilled in during April and May.

Harvesting is done by hand and with machines. In the Iberia Parish, La., region most of the grain is cut with a scythe. That cut by hand is said to bring a little higher price than the machine-cut rice.

Many growers in the Louisiana-Texas district use commercial fertilizers—some the first year, others only for the second, third, or fourth are cut, topped, and stripped of their leaves, and piled to be transported to the local sugar mills. If freezing weather threatens the cane is "windrowed", that is, cut without re-

crop. In the western part of the Gulf belt, as in Jefferson County, Texas, 80 to 100 pounds or more per acre of a mixture containing 10 to 12 per cent of phosphoric acid and 2 to 4 per cent of potash have been applied with drills at the time of seeding. Some growers here claim that fertilizer is of greater benefit on new land than on land that has been in cultivation for some time. The sandy soils of Jefferson County are said by some to respond to fertilizer treatment more readily than the heavy soils. "According to the rice experiment station at Crowley, La., this soil (the Crowley silt loam—one of the principal rice soils) is largely in need of organic matter and phosphatic fertilizer"—(Soil Survey Report, Lafayette Parish, La.). Rice is said to be less exhausting on land than sugar cane. Most of the rice straw is burned, a practice that leads to exhaustion of the humus supply.

Chambliss says: "The rice soils of the prairies are, as a rule, deficient in phosphorus, but in most of them there is enough potash. When absent, these plant foods can be restored to the soil in the form of commercial fertilizers. Even when they are present they are not always available, though a good supply of decaying vegetable matter in the soil tends to make them so. . . . A large part of the nitrogen and potash consumed by the rice is stored in the straw and is saved if the straw is plowed under. The burning of straw piles and stubble, therefore, is wasteful, so far as nitrogen is concerned. The potash is not completely lost, however, if the ashes of the burned straw are returned to the soil." (Farmers' Bulletin, U. S. Department of Agriculture, No. 1092: Prairie Rice Culture).

At the present time commercial fertilizers are not used in the Arkansas prairie district, but it is believed they will be after the comparatively fresh soils of this new and very productive rice district have been used continuously for this crop some years longer.

With water standing in the rice fields 75 to 90 days, and leaving the land wet for some time after it is withdrawn, it is believed that some cultivated crop should be rotated with rice at intervals of not more than three or four years, in order to give the soil a chance to aërate. Insufficient aëration probably is secured under the system of "resting" the land. If cultivated during this fallow period, it would seem much benefit would result from the aëration thus induced.

Until recently the varieties grown were the Japan and Honduras. Now other varieties, as the Blue Rose, are important. Three types moving leaves and tops, and piled in furrows so that the stalks are protected by the foliage.

The best sugar cane soils range from well drained, fine sandy loam to clay. The product of the lighter soils usually has a higher sugar content, but the clay lands give heavier yields. Yields range from about 12 tons of cane per acre to as high as 50 tons on the best land, fertilized, rotated, and cultivated according to the best methods. A ton of cane yields from about 145 to 185 pounds of commercial sugar, depending on the variety, degree of ripeness, weather conditions, and efficiency of the manufacturing processes, and from 4½ to about 5 gallons of molasses.

The principal varieties of cane are the "native" red or purple and striped or ribbon cane, and the D-74 and D-75 introduced from Demerara. The so-called native varieties were carried to Louisiana from Georgia, or have been evolved from the Georgia Strain.[1] The D-74 seems to be adapted to a wider range of soils. On hard-used or thin soil the native varieties are given preference on account of greater tonnage and a more certain stubble crop from this variety. The purple cane is said to offer greater resistance to frost. It is probably grown more than other varieties.

Cane for spring planting is laid, at harvest time, in furrows and covered several inches deep with soil to protect from frost. Fall-planted cane is taken directly from the standing cane. About 3 tons of stalks are required to plant one acre. Two crops and often three are made from one planting, the second and third crops sprouting from the stubble. Fertilizers are generally used, 400 to 600 pounds per acre

of rice are grown in Louisiana, the writer was recently informed: (1) The Japan type, including long-straw, medium-straw, and short-straw strains or varieties; (2) the Honduras type, including Carolina, Edith and Storm Proof; and (3) the Blue Rose type, including Blue Rose, Louisiana and Early Prolific.

[1] Bulletin 127, Louisiana Experiment Station.

of tankage, distributed below the cane at planting time, and 300 to 500 pounds of cottonseed meal in drills on both sides the row in spring, being considered a good manurial treatment by many growers. Cowpeas are almost universally grown, being sown with corn, after cane, every 2 or 3 years. The peas do not fruit well in this section, but produce an abundance of vegetation to be plowed under, and supply much nitrogen.

DESCRIPTIONS AND AGRICULTURE, SOILS OF THE STREAM BOTTOMS AND SECOND BOTTOMS

Principal alluvial soils of the Piedmont Region: Brown, reddish, and grayish lands—Congaree, Wickham, Altavista, and Bermudian soils.—Bottom lands in the Piedmont are comparatively narrow, except along the larger streams, near the Coastal Plain boundary. Seldom is the width greater than about one mile, and there are many places where the bottoms narrow to insignificant proportions or disappear altogether in steep-sloped, narrow valleys of a gorgelike character. The most extensive bottoms are found along large streams, such as the Chattahoochee, Savannah, Saluda, Catawba, Roanoke, and James rivers. There are occasional creeks that have important strips of alluvium along their courses, frequently as broad or broader than those of some of the larger rivers; for example, Brown Creek of Anson County, North Carolina, an affluent of Peedee River has in places along its course bottoms something more than a mile wide, while the Peedee at no place along its lengthy course in this county has bottoms so wide as this, and they average much narrower and far less continuous than along the tributary stream.

The table below gives the area of alluvial soil in several representative Piedmont counties from Alabama to Pennsylvania:

AREA [1] OF ALLUVIAL SOILS OF SOME REPRESENTATIVE PIEDMONT COUNTIES

County	*Dominant upland soils*	*Area of county*	*Area of alluvial soils*	*Per cent alluvial soil*
		Acres	*Acres*	
Chambers, Alabama	Gray sandy loam and red clay loam (Cecil)	380,160	53,504	14.1
Franklin, Georgia	Red clay loam and gray sandy loam (Cecil)	172,800	5,376	3.1
Troup, Georgia	Red clay loam and gray sandy loam (Cecil)	278,400	24,064	8.7
Union, South Carolina	Gray sandy loam and fine sandy loam and red clay loam (Cecil)	327,680	24,768	7.5
Union, North Carolina	Gray silt loam and gravelly loam and red clay loam (slate land)	403,200	24,256	6.0
Anson, North Carolina	Gray silt loam and gravelly loam (slate land), gray sandy loam and red clay loam (granite and sandstone) lands	344,960	39,828	11.4
Rowan, North Carolina	Red clay loam and gray fine sandy loam (Cecil) and brown fine sandy loam (Iredell)	330,240	15,232	4.9
Louisa, Virginia	Gray sandy loam (Cecil) and yellowish loam and fine sandy loam (Louisa)	323,008	11,520	3.6
Montgomery, Maryland	Brown loam (Chester)	309,760	29,184	9.4
Adams, Pennsylvania	Red shale loam and loam (Penn)	341.888	3,648	1.0

[1] These areas fall a little short of the whole amount of alluvial soil in these counties, because some of the narrower strips were too small to show on the soil maps from which the measurements are taken.

There are broad strips of alluvium, both first bottom and second bottom, along many of the streams issuing from the Piedmont and flowing across the adjacent Coastal Plain Region, which consist largely of material washed from the Piedmont uplands. In origin these are Piedmont alluvial soils, but geographically they are alluvial soils of the Coastal Plain Region. Large areas of these occur along such streams as the Pamunkey, James, Roanoke, Cape Fear, Peedee, Santee, Congaree, Savannah, Altamaha, and Chattahoochee rivers. These are chiefly reddish and brownish silty clay loam, loam, silt loam, and fine sandy loam in the first bottoms (*Congaree* soils) and brownish sand, sandy loam, and loam over reddish subsoils on the second bottoms (*Wickham* soils), with much very swampy land along the lower courses, including fresh water, and finally salt water marsh in the lower tidal reaches, where the streams are broad estuaries and the current sluggish.

The brown to reddish soils, usually containing mica flakes (*Congaree* soils), are the principal bottom soils of the Piedmont, the main types being silt loam, loam, and fine sandy loam. There are some poorly drained areas of gray bottom land with gray or mottled gray and yellow subsoils, containing black concretions (*Wehadkee* soils); and occasional areas of dark-colored to black bottoms (*Toxaway* soils). The brown and red bottoms produce excellent yields of corn with but little or no fertilizer, often 40 bushels per acre, and occasionally as high as 75 bushels. Cotton also does well, especially in years of moderate rainfall, there being a tendency in wet seasons toward too much vegetative growth at the expense of fruiting. From three-fourths to one bale per acre is a common yield, and occasionally more than a bale is made. Oats, wheat, sorghum, cowpeas, lespedeza, and a number of wild grasses also do well. A relatively larger acreage is devoted to corn than on the uplands. Some commercial fertilizer is used, especially for cotton, the application being lighter than on the neighboring upland soils. Mixtures relatively high in phosphorus seem to have good effect in forcing cotton to open before the bolls are injured by frost. The soils are easy to cultivate and to keep in good condition. Some damage is done by unseasonable overflows. Between overflows the drainage is good. The gray bottom soils are usually heavy and difficult to maintain in good tilth. They are less productive, being suited best to grain and grasses.

The dark-colored bottom land when properly drained is a splendid corn soil.

There are red bottom soils along streams rising in the red lands of the Triassic sandstone and shale belt (*Bermudian* soils), chiefly silt loam and silty clay loam, which have about the same value as the Congaree soils, being, where not too frequently overflowed, highly adapted to cotton, corn, oats, grass, and forage crops, including alfalfa. These soils produce as much as 1½ bales of cotton and 60 bushels of corn or more an acre with only moderate fertilization.

The principal second bottom soils of the Piedmont are: (1) the well-drained brown to reddish soils with reddish subsoils and a gravelly substratum, containing considerable mica flakes (*Wickham* soils), and (2) the poorly drained gray soils with compact gray or mottled gray and yellow subsoils, often containing black concretions (*Altavista* soils). The brown and reddish land, chiefly sandy loams, sands, and loam, are usually in cultivation, giving good results, except on the droughty, deep, sandy areas, with cotton, corn, oats, wheat, alfalfa, and a large number of forage crops. Alfalfa has become an important crop in some localities, as along the Rappahannock River in Virginia. These are easy soils to cultivate. Fertilizers are used to some extent, especially on the more sandy types. The gray terrace land is not cultivated much. It is best suited to grass, being late land that compacts in dry weather.

Principal alluvial soils of the Appalachian Mountains: Brown, black, gray, and red lands—Pope, Atkins, Moshannon, Holston, Tyler, and Waynesboro soils.—There are some very important bottoms along many of the larger streams of the Appalachian Mountains, and, in places, important second bottoms. In the Blue Ridge division of the region the bottom lands are like those of the Piedmont, chiefly brown and dark-colored silt loams, loams, and fine sandy loams (*Congaree* and *Toxaway*). These are largely used for corn and oats, giving excellent yields. In the sandstone and shale regions—that is, in the Cumberland and Allegheny Plateaus and ridges and the southern Ozarks—the bottoms average broader than in the Blue Ridge area, or region of crystalline rocks. Here the important soils are the brown (*Pope*), gray (*Atkins*), and red (*Moshannon*) lands, the chief types being silt loam, loam, and fine sandy loam. The gray bottoms, like those of the Piedmont and other regions, are poorly drained, difficult to maintain in good condition of tilth, and of low productivity, being best adapted to grass, lespedeza, and wheat. The brown bottoms are the most extensive. They are easy to till and produce good yields of corn, 40 to 50 bushels an acre, and also good crops of grass, oats, and wheat. In the southern area cotton is grown with good results. Fertilizer is occasionally used, especially for cotton. The chocolate red bottoms (the red being due to material from red uplands—Upshur soils) have about the same crop value as the brown soils. In the Ozarks (southern part) some of the bottom soil is reddish brown and very productive (*Casa* soils).

On the second bottoms of the sandstone and shale regions the principal soils are the brown lands with yellow subsoils (*Holston*). The silt loam, fine sandy loam, and loam are the principal types. All of these give fair to good results with corn, cotton, oats, wheat, and forage crops. They are not quite so productive as the brown bottom lands, but have the advantage of not being subject to overflow. Fertilizers are profitably used for cotton, to some extent for corn and grain, and, near the cities, for vegetables. Cultivation is easily performed with light teams and plows. There are some second bottom areas of brown soils with reddish subsoils (*Waynesboro*) which are used for the same crops as the Holston, giving better average yields, and also gray soils (*Tyler*) which, like the Atkins, are of low productivity, being imperfectly drained. Alfalfa can be grown on the brown and reddish soils by liming.

Principal alluvial soils of the limestone regions: Brown, gray, and black lands—Huntington, Holly, Dunning, Elk, Robertsville, and Cumberland soils.—The bottom lands are very important in the limestone regions, occurring chiefly in the valleys of the Appalachian Mountains from Alabama to Pennsylvania, in the Central Basin of Tennessee, the Highland Rim, and Kentucky Blue-grass regions and in the northern Ozarks from Northwestern Arkansas nearly to the Missouri River. Through all these regions the main bottom soil is a brown mellow silt loam, often gravelly and possessing easy working quality (*Huntington*). Containing material washed entirely or largely from productive limestone soils and being refreshed at intervals by additional deposits from overflows, this soil, as might be expected, is one of exceptional productivity and durability. It is used chiefly for corn, giving yields as high as 75 bushels per acre without fertilization. Oats, wheat, clover, timothy, and in the southern areas cotton give good yields. Alfalfa will do well if protected from long periods of overflow. Cotton is inclined to produce too much stalk growth in wet years. These rich bottoms are used for hay and for pasturing cattle, chiefly dairy cattle.

The gray bottoms (*Holly*), are poorly drained and of much lower value than the brown bottoms, but the black bottoms (*Dunning*), also poorly drained naturally, can be ditched or tiled and used to produce very heavy crops of corn.

The principal second bottom soil of the limestone region is a brown silt loam with yellowish subsoil closely resembling the Huntington (*Elk*). This is also an excellent soil, which produces fine crops of corn, oats, wheat, clover, grass, alfalfa, and, in the southern part, cotton. Second bottom soil resembling the Elk in the surface portion, but having a reddish subsoil (*Cumberland*), is even more productive but not so extensive, although occurring in some quite important areas of undulating and flat surface along the Cumberland, Tennessee, and other streams of the limestone regions. The poorly drained gray terrace soil (*Robertsville*) has about the same value as the gray first bottom soil.

Principal alluvial soils of the Coastal Plain Region: Brown, gray, and black lands—Ochlockonee, Bibb, Trinity, Cahaba, Kalmia, and Myatt soils.—It is in the Coastal Plains that the most extensive areas of alluvial soils occur. There are found here not only soils derived from the uplands of the region, but very important areas composed of foreign material, occurring along streams that issue from the regions to the rear and traversing the Coastal Plains, such, for example, as the chocolate-red *Miller* soils along streams like the Brazos River and the brown to reddish Congaree soils along streams like the Altamaha River.

There are streams in the Coastal Plains, especially in the sandy regions, which have very little or no bottom land, as for example the St. Johns River of Florida. Here the uplands are flat and very sandy, absorbing a very large proportion of the rainfall, so that transportation of soil particles by water is of negligible importance. Streams of this kind carry very little sediment. Many of the streams of the lower Coastal Plain, east of the Mississippi, carry but little sediment and frequently have dark-colored, or "inky" water, due to drainage from swampy areas. Among such streams are the Lumber River in North Carolina, the Ochlockonee in Georgia, and the Suwanee in Florida.

The table below gives the area of alluvial soils in some representative Coastal Plain counties from Texas to North Carolina:

Area of Alluvial Soils in Some Representative Coastal Plain Counties [1]

County	Dominant upland soils	Area of county	Area of alluvial soil	Per cent alluvial soil
		Acres	Acres	
Scotland, North Carolina	Gray sandy loam and sand (Norfolk)	205,440	28,480	13.8
Robeson, North Carolina	Gray sandy loam (Norfolk)	677,120	108,800	16.1
Orangeburg, South Carolina	Gray sand and sandy loam (Norfolk), black sandy loam (Portsmouth) and gray sandy loam with red subsoil (Orangeburg)	702,720	118,300	16.8
Chatham, Georgia	Gray fine sand (Norfolk)	273,280	25,472	9.3
Dougherty, Georgia	Grayish and red sandy loam with red subsoil (Orangeburg and Greenville)	219,520	36,800	16.7
Bradford, Florida	Black sands and fine sandy loam (Portsmouth) and gray sands (Norfolk)	344,960	15,296	4.4
Leon, Florida	Gray sand and fine sandy loam (Norfolk) gray fine sandy loam with red subsoil (Orangeburg)	431,872	2,816	.7
Coffee, Alabama	Gray sand and sandy loam (Norfolk), fine sandy loam with heavy clay subsoil (Susquehanna), and red sand and sandy loam (Greenville)	439,680	56,000	12.7
Hale, Alabama	Gray fine sandy loam with red subsoil (Orangeburg) and dark limy clay (Houston)	418,560	153,856	36.8
Lowndes, Mississippi	Reddish clay (Oktibbeha) and dark limy clay (Houston)	326,400	158,454 [2]	48.5
Chickasaw, Mississippi	Gray flatwoods silt loam and clay (Lufkin), reddish clay (Oktibbeha) and gray fine sandy loam (Ruston)	320,640	97,344	30.4
Webster Parish, Louisiana	Gray fine sandy loam (Ruston) and fine sandy loam with heavy clay subsoil (Susquehanna)	389,760	94,016	24.3
Robertson, Texas	Fine sandy loam with heavy clay subsoil (Susquehanna) and gray fine sand (Norfolk)	545,600	111,360	20.4
Harrison, Texas	Fine sandy loam with heavy clay subsoil (Susquehanna)	558,080	60,352	10.8

[1] From soil surveys by the Bureau of Soils, U. S. Department of Agriculture.
[2] 49,820 acres first bottom, 108,634 acres second bottom.

It is noted in the above table that in counties including mainly very sandy flatwoods soils like Bradford and Leon counties, Fla., the area of bottom land is comparatively very small. The large area of stream bottoms in Robeson County, N. C., is mainly swamp, about 80 per cent of that in Dougherty County, Ga., is swamp, and all of that of Chatham, Ga., was classed as swamp, as was also that of Leon County, Fla. Little of the other alluvium in the counties given, however, is swamp.

The principal first bottom soils of the Coastal Plain Region, aside from that derived from interior soil regions, such as the Congaree from the Piedmont and the Miller from the Red Prairies, are swamp, occurring chiefly along the lower courses of streams entering the Atlantic Ocean and Gulf of Mexico; brown and mottled gray and yellow soils along streams not receiving wash from limy uplands; and brown and black soils along streams receiving wash from limy uplands, such as those of the black prairie regions of Alabama, Mississippi, and Texas; while the principal second bottom soils are the grayish to reddish soils with red subsoils and grayish soils with yellow and mottled gray and yellow subsoils. Second bottoms are more extensive in Mississippi and southern Alabama than in any other part of the Coastal Plain.

The brown soils washed from the noncalcareous uplands of the Coastal Plain (*Ochlockonee* soils) and the gray or mottled gray and yellow soils of the same origin (*Bibb* soils) are the most extensive first bottom soils of the region east of the Mississippi bottoms and in the region west of the Mississippi bottoms between the Black Waxy Belt of Texas and the Mississippi bottoms. The brown bottoms have the better drainage, while the gray bottoms have the poorest drainage. There is also considerable black bottom land (*Johnston*) particularly in the Atlantic and Gulf Flatwoods. Along the lower courses of the streams, within the flatwoods country where the currents are less swift, a large proportion of these lands exists under very swampy conditions, and is little used. Farther up stream, there is still much swampy land, but relatively more of that which has better drainage between periods of overflow, and relatively much more is in cultivation, or is used more for pasturing cattle and hogs. Probably 75 per cent of these soils is in timber, the growth including water oak, willow oak, overcup oak (or swamp white oak), sweet gum, tupelo, cypress, swamp pine, titi, swamp maple, ironwood, holly, beech, hickory, magnolia, bay, star anise, red haw, and many wet-land shrubs and vines.

The silt loam, fine sandy loam, and very fine sandy loam are the principal types. The brown silt loam will produce 40 to 50 bushels of corn, 1 bale of cotton per acre, and heavy yields of sorghum, sugar cane, and oats in the best years. The lighter sandy soils generally give somewhat lighter yields, although cotton does very well on them. Some fertilizer is used. The gray lands do not yield nearly so well. Lespedeza does well on both the gray and brown types.

A very large proportion of the area of these soils now unused, except in a small way for pasturing cattle and hogs, could be brought into use for the production of Bermuda grass and lespedeza hay, rice, and for more intensive grazing, by cutting off the timber low so that mowing machines could be used. The most swampy areas could be utilized to advantage, at least for pasturing hogs and cattle.

Much of the stream swamp land of the eastern Carolinas, eastern Georgia, and Florida includes considerable black mucky soil, mucky loam, and sandy loam, with a clay foundation, which, when reclaimed, will give especially good results with corn, oats, and vegetables; but in many places the subsoil consists of sand ("quick sand") of a nature that makes it difficult to keep ditches open and which will not prove so productive or so durable.

In some localities, as in Lee and Chickasaw counties, Miss., large areas of brown bottom lands have been brought into safe and profitable use by dredging out the stream channels, straightening and enlarging them so that they carry within their banks all normal flood waters. These operations have added enormously to local agricultural development.

The second bottoms associated with these brown, gray, and black first bottoms are occupied chiefly by well-drained grayish to brown soils with red, friable subsoils (*Cahaba* soils), moderately well-drained gray soils with yellow subsoils (*Kalmia* soils) and poorly drained, light-gray soils with gray or mottled gray and yellow impervious subsoils (*Myatt* soils). These soils are very extensive in Mississippi, Alabama, and are important in parts of Georgia and the Carolinas. Some of the stream benches in Mississippi occupied by these lands, as for example, in Lowndes County, Miss., along the Tombigbee and Luxapalila rivers, are 3 miles or more in width.

The Cahaba soils, chiefly the sandy loams, are ideally suited to cotton, producing a bale per acre in good years with moderate fertilization. Those areas having a red surface soil (*Amite* soils) are even more productive. Corn, oats, velvet beans, cowpeas, peanuts, sorghum, and sugar cane (for sirup) are among the other crops that yield well. Alfalfa can be grown with liming. The gray wet second bottoms, however, are not nearly so productive. They are good rice, lespedeza, and grass lands, but are not likely to give good average results with other crops. Somewhat better drained second bottom land with brownish soil and mottled yellow and red stiff clay subsoil (*Leaf* soils), occurring in fairly large areas in some localities, as in Russell County, Ala., gives good crops of cotton.

The grayish second bottoms with yellow subsoils (*Kalmia*), chiefly the fine sandy loam and fine sand, occupy an intermediate position between the well drained and poorly drained terrace soils in productiveness. They are used principally for cotton and corn, being fertilized generally. They are not so productive as the Cahaba. Some of this needs drainage.

The black (*Trinity*) and brown (*Catalpa*) first bottom soils containing wash in part or entirely from the Black Prairie limy soils of Alabama, Mississippi, Texas, south-central Oklahoma, and southwestern Arkansas, are rich in lime and are highly productive. They are very largely cultivated, giving excellent results with alfalfa, sweet clover, corn, cotton, grass, and a variety of forage crops. They are durable soils that may be counted on to give heavy yields almost continuously without fertilization, especially where occasionally overflowed. The clay is the principal type. Good teams and plows are essential for efficient tillage. These soils on drying crumble at the surface to a desirable condition.

Some second bottom areas of black, limy soil (*Bell*) and brown, limy soil (*Lewisville*) occur in Texas, extensively in Dallas and Denton counties, but very little has been seen elsewhere. These have about the same value as the first bottom soils of the lime prairie regions, and have the additional advantage of not being overflowed.

In the bottoms of the Rio Grande there are valuable alluvial soils, such as the brown silt loam (*Laredo* silt loam) near Laredo, Texas, which is so successfully used for the production of Bermuda onions. With irrigation from 18,000 to 25,000 pounds of onions per acre are grown on this soil. Cotton, sweet potatoes, and vegetables are grown here.

Principal alluvial soils of the Mississippi Bluffs and Silt Loam Uplands: Brown and gray lands—Vicksburg, Collins, Lintonia, Crowley, and Oliver soils.—The main first bottom soils of this region are the brown soils, mainly silt loam, with light-brown subsoils (*Vicksburg* soils) and brown soils, mainly silt loam, with gray compact subsoils (*Collins*). There are some poorly drained areas of gray soils with impervious gray subsoils, containing many black concretions the size of buckshot, and locally called "buckshot" and "crawfish" land (*Waverly* soils). The brown soils are well drained between overflows, at least in the surface soil, and produce good crops of corn, oats, and cotton, and splendid yields of lespedeza and Bermuda grass hay. The last two crops also do well on the gray land.

On the second bottoms soils similar to those in the first bottoms are found in both small and large strips. Here there are well-drained brown soils, mainly silt loam, with reddish to yellowish-brown silty clay loam or silty clay subsoils (*Lintonia* soils); light-brown soils, mainly silt loam, with gray compact subsoils, well drained in the surface and imperfectly drained in the subsoil (*Olivier* soils), and poorly drained silt loam, silty clay loam, and clay, with impervious clay subsoil, containing usually many small black concretions (*Calhoun* soils, locally known as "buckshot" and "crawfish" land). The brown soils are good corn, oat, lespedeza, and grass lands, while the gray soils are adapted to lespedeza, rice and grass. White clover succeeds on all these soils, those of the first bottoms as well as those of the second bottoms. Bur clover succeeds on the brown soils, and probably sweet clover will also do well. Some wheat is grown, giving fair crops on the silt loams, silty clay loams, and fine sandy loams. Cowpeas produce a heavy growth of vines, and fruit well on the sandy types. They do not fruit well generally in the more southerly areas. Soy beans do well on the well-drained types, and velvet beans grow luxuriantly, especially in southern Mississippi and in Louisiana. Rice is the leading crop on the brown and gray terrace lands in east-central Arkansas (chiefly *Crowley* silt loam or *Lonoke* silt loam) [1]—in the Lonoke and Prairie county sec-

[1] "This soil (Crowley silt loam or Lonoke silt loam) yields from 1 to

tion—a very important industry having been established here with this crop as its basis. Water for irrigating the rice is pumped from wells and streams.

The Crowley silt loam (since this is strictly an old second-bottom soil, as developed in Arkansas, Lonoke, and Prairie counties, Arkansas, it is suggested that it might be given some other name, as *Lonoke*, to distinguish it from the soil along the Gulf Coast from the vicinity of Crowley, La., westward, although being very much the same in all apparent characteristics) of this section consists of a brown silt loam faintly mottled with rusty brown or dark bluish gray and passing at about 6 to 8 or 10 inches into gray silty clay loam mottled more or less with pale yellow, this passing down into gray or bluish gray silty clay more or less mottled with yellow or pale yellow and in many places being slightly compact, although usually friable when mashed between the fingers. The lower subsoil beginning at depths ranging usually from about 18 to 30 inches is a mottled bright red and bluish gray, moderately plastic to quite plastic and rather stiff silty clay. There are some small black and brownish iron concretions through the soil and upper subsoil, but the mottled red and gray plastic lower subsoil seldom contains any considerable amount of concretions; but there is a phase occurring in rather excessively wet situations where there is little or no red mottling within the 3-foot section but yellowish and grayish mottling instead, in which concretions are present throughout the 3-foot section. There is less yellow and more gray in the upper subsoil of the less well-drained flat areas, while on some of the better-drained slightly higher lying areas and gentle slopes red mottling is encountered

2 tons per acre of native prairie hay. Oats yield in ordinary seasons from 30 to 50 bushels per acre, and under especially favorable conditions they sometimes yield as high as 60 or 70 bushels. Corn yields from 15 to 40 bushels per acre"—(Soil Survey Report, Prairie County, Ark., Field Operations, Bureau of Soils, 1906).

much nearer the surface than in the average of the type. In the rice fields which are almost permanently wet by rainfall and irrigated water, there is a tendency for the soil to be more mottled with dark bluish gray and rusty brown. There are some flats of very poor natural drainage where the soil is lighter brown or grayish brown and where the subsoil is light gray or bluish gray with very little yellow, but with bright red mottling in the lower subsoil, which approaches the characteristics of the associated Calhoun soil.

The surface soil of the Crowley silt loam dries out to a grayish color, but the brown material is encountered in the moist layer immediately beneath. This soil occupies level to nearly level prairie areas; the gently sloping associated areas between stream bottoms and the level prairies, and between different levels of the prairies are usually occupied by the better-drained phase of the type. This is not a soil of good natural drainage, although much of it has good enough drainage for the growing of corn, cotton, and oats. The under drainage is rather slow, but not so slow as in soils like the Calhoun which have a more impervious compact silty clay containing more concretions or a tougher clay in the lower subsoil.

For rice this soil is often plowed in a wet condition, subsequent rains being depended upon to "slacken" or crumble the clods.

Cattle and hogs are being raised on these lands on an important scale in some localities, particularly in Mississippi. These soils are ideally suited to these industries, owing to the ease with which lespedeza, Bermuda grass, velvet beans, and other hay and forage crops are grown.

These soils are easy to cultivate, except the gray lands, which are inclined to bake and compact. They are all acid, and probably can be limed profitably.

The table on page 311, for a representative county in this region, shows how extensive the alluvial soils are here.

The proportion of alluvial soils may not be so great for the entire belt as in Hinds County, but nearly everywhere there is a comparatively large area of alluvium in this region.

AREA OF ALLUVIAL SOILS IN A REPRESENTATIVE COUNTY OF THE MISSISSIPPI BLUFFS AND SILT LOAM UPLANDS

County	*Dominant upland soils*	*Area of county*	*Area of alluvial soils*	*Per cent alluvial soils*
		Acres	*Acres*	
Hinds, Mississippi............	Brown silt loam, loessial soil (Memphis and Grenada)	558,080	210,816 [1]	37.8

[1] First bottom, 113,344 acres; second bottom, 97,472 acres.

Principal alluvial soils of the Great Plains Region: Brown, black, and red lands—Osage, Frio, Miller, Yaholo, Arkansas, Bastrop, Reinach, and Muskogee soils.—The alluvial soils are nearly as extensive in that portion of the Great Plains east of the High Plains as in the Coastal Plain Region. They are relatively far more important, for the reason that a very much larger proportion is in cultivation; in fact, nearly all of them are cultivated with the exception of the rather inextensive poorly drained types and the drifting sands.

In the eastern portion of the Great Plains the first bottoms of streams, other than those like the Arkansas, Red, and Canadian rivers, which receive wash from the Red Prairies or the Rocky Mountains, are chiefly occupied by dark-brown to black loam, silt loam, and clay (*Osage* soils). These are extensively used for corn, producing sometimes 75 bushels per acre, without fertilization. Grain sorghums, oats, wheat, clover, timothy, and alfalfa are grown with very good results.

In the western Great Plain similar soils dominate the first bottoms outside the Red Prairies, but they are more calcareous (*Frio* soils). These are very successfully used for the grain sorghums and alfalfa.

Brown to dark-brown second bottom soils (*Canadian*), associated chiefly with the streams on which the brown and dark-colored sands occur, are quite extensive in Kansas and Oklahoma. They are among the best alfalfa soils in the United States. It is easy to get a stand and to produce heavy yields continuously for many years. They also produce very good yields of wheat, grain sorghum, and corn. There are some terrace lands, however, in this region, both gray (*Neosho*) and brown (*Calumet*), with heavy clay (claypan) subsoils that do not give good results with alfalfa, although wheat and grass succeed on them.

The principal bottom soils of the Red Prairies and of the streams carrying drainage waters from this region, such as the Brazos, Red, Canadian, and Cimarron rivers, and the Arkansas River below the mouth of the Cimarron, are the chocolate-red silt loams, fine sandy loams, and clays (*Miller* and *Yohola* soils, the latter having sandy subsoils). In places the soil is brown and the subsoil red (*Portland*), such soil being abundant in the bottoms of the Arkansas, Red, and Atchafalaya, and the outer edge of the Mississippi bottoms below the mouth of the Arkansas River.

On the second bottoms there are soils which correspond to these (*Bastrop* and *Reinach* soils, the latter having sandy subsoils) and some poorly drained grayish soil (*Muskogee* soils) along the lower courses of the streams named.

The red and brown lands of the first bottoms are usually quite calcareous especially in the subsoil. They are very productive, being ideally suited to alfalfa, cotton, grain sorghum, corn, and grasses, such as Bermuda and Johnson grass. Lespedeza and sugar cane are also successfully grown along the lower courses, as in Louisiana. Cotton of especially good quality, known as "benders," is grown in the Arkansas River bottoms. Originally these soils were timbered with elm, hackberry, cottonwood, ash, and other trees, but a very large proportion has been cleared and put into cultivation. Levees have been built in places, as along the lower Arkansas and Red rivers. The red and brown soils of the second bottoms, also, are highly productive, producing alfalfa, corn, cotton, grain sorghums, etc.

The Arkansas River above the Cimarron has in its bottoms principally brown to dark-brown soil with a yellowish subsoil, usually coarser textured in the lower part. Part of the material of these *Arkansas* soils is derived from the Rocky Mountain region. These are productive soils, valuable for corn, small grain, grain sorghum, and alfalfa. They are naturally subirrigated in places, and on this account generally produce good crops, even when drought has ruined the crops on the neighboring uplands.

In the bottoms of such westerly streams as the Pecos and the Rio Grande there are rich brown, black, and reddish alluvial soils which are successfully used under irrigation for alfalfa and other crops. In places alkali gives trouble here.

Principal alluvial soils of the Missouri River and other Central Prairie streams: Brown and black lands—Wabash, Sarpy, and Vicksburg soils.—Black silt loam, silty clay loam, and clay (*Wabash* soils) are very important bottom lands on the Missouri River and other Central Prairie Region streams. Also brown soils (*Vicksburg*) and brown soils with lighter textured subsoils (*Sarpy*) are important here. All of these are very productive, highly prized soils, which are largely in cultivation. Very heavy yields of corn, the chief crop, are obtained from them. In addition, wheat, oats, clover, timothy, and alfalfa are successfully grown. Wheat produces so much straw on the black lands in some years that the crop is damaged somewhat by lodging. There is some poorly drained and less productive gray bottom land (Waverly), and well-drained, productive brown second bottom soil (Lintonia).

Principal soils of the Mississippi River bottoms:—Brown *and mottled lands—Sharkey and Sarpy soils.*— The Mississippi bottoms or "delta" embraces the largest continuous body of alluvial land on the continent, even exceeding in area the great alluvial "flats" of the Yukon and Kuskokwin rivers of Alaska. From Cape Girardeau to the Gulf of Mexico the Mississippi bottoms, including the associated second bottoms and the bottoms of the lower Arkansas and Red rivers, comprise an area of approximately 45,862 square miles or 29,351,680 acres.

Much of this has been reclaimed by the construction of levees along the Mississippi and some of its tributaries, and additional areas are being rapidly brought into cultivation by the dredging of large drainage canals; but there still remains a very large area of wet, swampy, timbered land, used only partially as pastures for cattle and hogs.

The alluvial lands comprising the Mississippi bottoms, frequently known as the Mississippi Delta, together with those of the tributaries, such as the Arkansas, Red, and Yazoo rivers, represent one of the richest and most important bodies of land in the world. Probably no land used by man exceeds this in fertility and productiveness. In that part of the region extending from southern Missouri down through Arkansas, west Tennessee, and Mississippi, into Louisiana, a large part of this rich alluvium is being farmed with a very high degree of success. The profitableness of farming in some portions of this "delta" country probably is not exceeded by any important area of cultivated land anywhere in the world.[1]

[1] "A few years ago I received a visit at South Bend, Ark., from a gentleman who had traveled all over the earth, especially interested in lands. In coöperation with an English syndicate he opened the first tract of land on the Upper Nile for the cultivation of cotton. Just before he visited me he had been employed by a great syndicate controlling the railroads of Brazil, which had a concession of many million acres of land, to go over that country and make recommendations for its development. He had been interested in enterprises in the Orient. He

The most extensive soil of the Mississippi bottoms is the Sharkey clay. This is a brown or mottled grayish and rusty-brown clay which passes beneath into mottled gray or bluish gray and yellowish sticky clay. Much of it is still subject to overflow, and is occupied by over-cup oak, willow oak, red oak, water oak, pecan, hackberry, cypress, tupelo, pin oak, honey locust, sweet gum, maple, ash, red haw, sycamore, hickory, box elder, swamp palmetto, and cane brakes. The surface of the slowly flowing streams of the lower Mississippi bottoms is often covered with water hyacinths, which interfere with or stop navigation until they are removed. There are relatively high and better drained areas in the bottoms known as "ridges," "dog wood ridges" and "gum ridges." The higher areas and those protected by levees are extensively cultivated, being used chiefly for cotton, frequently yielding a bale per acre. The cotton lint is of good quality, much of it being recognized in the trade as "benders" cotton. The average annual production of cotton on the Mississippi bottom lands for the five years, 1911–1915, was approximately 940,000 bales. Alfalfa, corn, oats, lespedeza, Bermuda and Johnson grass, sugar cane, sorghum, and rice yield well. On this soil a large part of the sugar cane of Louisiana is grown, the yields being 25 to 50 tons of cane per acre, according to season and treatment. Considerable rice also is grown, and it is on this land in southeastern Louisiana that the perique tobacco industry has been established. Vegetables, such as onions, cabbage, beans, and Irish potatoes, are grown for market in a number of localities, particularly about New Orleans. Vegetables

visited me for a week in the Arkansas Valley and told me at the conclusion of that visit that the only lands he believed on the face of the globe that were at all comparable with the alluvial lands in this section were a small portion of the Valley of the Nile." From a speech by Frank O. Lowden before the Southern Alluvial Land Association at Memphis, Tenn., 1919.

succeed much better on this soil than they generally do on such heavy clay land. This is probably due to the fact that the soil upon drying breaks into small aggregates, effecting a granular structure. It is locally known as "buckshot land" owing to this characteristic. While in an intermediate wet condition the soil is extremely adhesive, for which reason plowing is often done when the soil is very wet, even while water stands in the furrows, since the clay is soft in this condition and turns easily. On drying the clods crumble instead of baking, as do clays not containing much lime. Little fertilizer is used except for sugar cane, vegetables, and to some extent for cotton.

Hutton describes this soil in the soil survey report on Coahoma County, Miss. (Field Operations, Bureau of Soils, 1915) as follows:

The typical Sharkey clay is a mottled dark-brown and dark-drab clay, 4 to 6 inches deep, becoming somewhat lighter in color with increase in depth, but otherwise showing no important difference from the surface downward, except that in dry weather the subsoil, being more moist, is more plastic than the surface material. The subsoil shows considerable variation in color, ranging from dark brown, yellowish brown, rusty brown, dark drab, and light drab, to blue. When wet the soil is very sticky, but when dry the material crumbles in a manner similar to the slaking of lime, although the particles, or soil aggregates, are angular. Roads soon become impassable on this soil in wet weather, but upon drying they quickly become smooth and compact.

This soil can be plowed when in a saturated condition, and any clods which may form invariably crumble down to a desirable tilth after intermittent periods of rainy and dry weather. The land is generally plowed when wet enough to turn easily with the ordinary plow. This soil is known throughout the Mississippi bottoms as "buckshot land."

The Sharkey clay is the most extensive soil of the county. It is distributed through all sections, occurring in relatively low situations, and much of it, where unprotected from floods, is covered with water during a large part of the year. In some places drainage ditches have been constructed to remove the excess water. The surface is characteristically level, but the drainage is ordinarily good where the type is protected from overflow.

Large areas of this type occur outside the levees, especially west of Sherard. The land outside the levees is subject to deep overflows, and the type in such situations is forested with a heavy growth of cypress, sweet gum, hackberry, hickory, and pecan, with an undergrowth of blue cane. Much of this type originally was covered with cypress, sweet gum, water oak, overcup oak, honey locust, and ironwood. With the construction of drainage ditches more of the type is brought under cultivation each year. . . . Cotton is the principal crop, occupying a much larger area than all the other crops combined. Considerable corn is grown. . . . Alfalfa is a crop of increasing importance, being grown both for use on the farm and for sale.

The type is of high natural productiveness, and where properly drained gives good results with cotton, alfalfa, and corn. Cotton yields from one-half to 1 bale per acre without fertilizer. The soil seems especially suited to alfalfa. Where the seed bed is properly prepared and the seed sown in the early fall, about October 1 to 15, a good stand of alfalfa is obtained without liming or inoculation. In some instances three cuttings are made the first year after seeding. After the first year alfalfa can be cut from four to six times, the first cutting usually being made about May 15. In exceptional years the first cutting has been made as early as April 25. Planters estimate the average yield of alfalfa as about 5 tons per acre. Corn does fairly well on the Sharkey clay, provided the rainfall is sufficient. In some years, however, the soil cracks and dries out badly, diminishing the yield. Cowpeas do well, making a strong growth of vine.

Crop rotations are not regularly practiced on this type. In many instances, however, cowpeas are sown with corn, and after the corn is harvested the stalks and pea vines are turned under to improve the physical condition of the soil. Where this practice is followed the yield of cotton is considerably increased.

The type requires strong implements and heavy teams for breaking and cultivating. In a few cases gas tractors with disk plows are used with good results. The soil has the advantage of crumbling down to a good structural condition if plowed when wet, and breaking is done mainly when the land is saturated. It plows more easily at this time than with a moderate content of moisture, when the material is more plastic. In general this soil is plowed fairly deep, and cultivation is shallow. The present methods of preparing the seed bed and of cultivating the crops are well suited to the soil. No commercial fertilizers are used on this type.

This is inherently a rich, durable soil, and it apparently will not require much fertilization, if any, for a long time. There would probably be some improvement in the moisture-holding properties if occasional additions of vegetable matter were made, as by plowing under some such crop as cowpeas or bur clover, adding barnyard manure or growing legumes more frequently in rotation with the clean-cultivated crops. It apparently would be profitable to devote a larger area to alfalfa. Beef cattle and hogs can be raised with profit, but whether such industries would prove more profitable than the present form of agriculture is problematical. Additional areas of the type are being brought into cultivation with the extension of drainage systems.

Sharkey clay, better drained phase.—The better drained phase differs from the typical Sharkey clay in having a higher position, and consequently more efficient drainage. Much of it is cultivated without ditching. In some areas sandy material is encountered at a depth of about 3 feet, and in such places the drainage is somewhat better than is true of the average of the phase. Generally the surface soil is more uniformly brown than in the typical soil, and there is less mottling, though little other color difference in the subsoil, which is perhaps a slightly more yellowish brown. The original forest growth consists of overcup oak, elm, sweet gum, hickory, hackberry, ironwood, and red oak, with some pecan.

The surface is prevailingly level, and though in some cases it is ridgy, the ridges are of slight elevation and easily cultivated. Owing to better drainage, a larger proportion of the phase than of the typical Sharkey clay is farmed.

Where cleared the land of this phase is devoted to cotton, alfalfa, and corn. Cotton yields from one-half to three-fourths bale per acre. In some cases yields of 1¼ bales per acre have been obtained. The soil is especially suited to the production of alfalfa, and a relatively large acreage is devoted to this crop. As the planters become more familiar with the handling of the crop the acreage is being extended. Best results are obtained where alfalfa is sown early in the fall, with or without a nurse crop. The crop usually is cut five times during the growing season. In some cases it is cut as many as seven times, the first cutting being made in April. The average yield is about 1 ton to the acre at each cutting.

Corn does better on the better drained phase than on the typical Sharkey clay, because it can be planted earlier in the spring, insuring a better growth before dry weather affects it. Approximately 30 per cent of the phase is devoted to the production of corn, with an average yield of about 40 bushels per acre.

Where alfalfa is grown some cattle and hogs are kept and pastured on the alfalfa at certain times of the year.

The table below shows the content of phosphoric acid, potash, lime, and magnesia in Mississippi alluvial soils (analyses by Hilgard—in Mississippi: Its Geology, Geography, Soil and Mineral Resources, Bulletin, Mississippi Geological Survey, No. 14, p. 298—E. N. Lowe):

Locality	*Soil*	*Phosphoric acid Per ct.*	*Potash Per ct.*	*Lime Per ct.*	*Magnesia Per ct.*
Coahoma County	Dogwood ridge soil	.14	.39	.25	.59
Coahoma County	Light colored buckshot clay	.27	.60	.38	.97
Tallahatchie Co.	Tallahatchie bottom soil.	.11	.30	.30	.38
Sunflower County	Indian Bayou front land soil	.16	.22	.15	.25
Sunflower County	Same: subsoil	.28	.30	.14	.39
Issaquena County	Sunflower River front land soil	.16	.40	.40	.69
Issaquena County	Deer Creek buckshot land	.30	1.10	1.34	1.66

Other important soils of the Mississippi bottoms are the brown silt loam, silty clay loam, and very fine sandy loam, having subsoils which are lighter textured than the surface soils (*Sarpy* soils). These occur in strips near the banks of the streams and abandoned stream channels. They are extensively used for cotton, corn, alfalfa, and oats, giving good yields.

There is some gray silt loam, silty clay loam, and clay (Waverly), which has imperfect drainage but which gives fairly good crops of corn in seasons of moderate and well-distributed rainfall. These gray lands are extensively developed along and near the St. Francis River.

In southern Louisiana, particularly in Iberia, St. Martin, and St. Mary parishes, there is a considerable area of dark gray to black silt loam, silty clay loam, and clay with lighter colored clay subsoils often containing lime concretions

(*Iberia* soils). The clay is black and very sticky when wet. It is locally known as "black waxy land," "terre gras," and "blackjack land," the last name referring to the character of the soil and not to timber, as there is no blackjack oak on it. This soil is difficult to work unless plowed early while wet so that it may subsequently granulate to a good tilth. If there is not too much rain, good crops of corn and sugar cane are secured, yielding under best conditions 25 tons or more of sugar cane and 25 to 35 bushels of corn per acre. Rice also does well. The lighter types are also used for sugar cane and corn chiefly, giving frequently better yields of corn than the clay.

Practically all of the swampy land of the Mississippi bottoms could be used for hay (Bermuda grass and lespedeza especially) or for grazing even without ditching. Through the woods cows and hogs now find much feed, but if cleared it could be made to support a much larger number of cattle and hogs. Overflows would do some damage occasionally, but provision could be made for getting the stock out during floods to upland country of which there is much that can be bought cheaply.

There is much brown silt loam and sandy second bottom soil (Lintonia and Olivier) and gray, poorly drained second bottom silt loam, silty clay loam, and clay (Calhoun) in Arkansas north of the Arkansas River and east of the Ozark uplands, extending into southeastern Missouri. The well-drained soils here are extensively used in the production of cotton and corn, and part of the gray land is so used, although it is better suited to grass, wheat, and rice.

There are occasional bodies of these terrace soils elsewhere along the outer bottoms of the Mississippi, as in southern Louisiana on both sides of the river. The Lintonia silt loam is the chief sugar cane soil in Lafayette Parish, La., and is an important producer of this crop in adjacent territory, yielding with ordinary methods 12 to 20 tons of cane per acre, and more with better fertilization and cultivation. The Olivier silt loam is also used for sugar cane, but does not yield so well. Lespedeza is grown on these soils, giving here two cuttings annually, amounting ordinarily to 2 to 4 tons per acre, in some localities in southern Louisiana. Tabasco pepper is an important crop on these soils in southern Louisiana.

North of Lake Pontchartrain there is much second bottom land of fair to poor drainage, consisting of mottled grayish and yellowish silt loam, overlying bluish-gray impervious clay (*Hammond*). In the vicinity of Hammond, La., this soil supports a very important strawberry industry.

There are some very fertile high bottoms along the Arkansas River below the point where this stream debouches from the Ozarks at Little Rock, mainly the Portland very fine sandy loam, clay, and silt loam. These produce three-quarters of a bale to 1½ bales of cotton per acre without fertilizers in the best years. Alfalfa, corn, oats, lespedeza, and Bermuda grass also give very heavy yields. There are low wet areas, including much clay, that are being drained by canals, which probably will yield as well as the higher bottoms. In Lonoke County, Ark., this strip of rich land is known as "the rich wood lands." Some of the largest cotton farms in the country are located in this region.

The rice lands of the Lonoke-Prairie County district (Crowley silt loam) lie east of these high bottoms and represent old, weathered alluvium of the same source as the lower bottoms.

APPENDIX A

Definition of Soil.—Soil, as commonly understood, consists of a layer of unconsolidated materials at the earth's surface, which has been derived from rocks and organic matter through agencies of decay and disintegration. Soil, in a sense, is the antithesis of rock—not in the sense that freshly pulverized rock would constitute true soil, but in the sense that the fine materials left when rocks decay do constitute true soils, even though such material may be of low productivity. Some plants will grow after a fashion in freshly pulverized rock material, if watered; but anything approximating normal plant growth may not be expected in such inert material, especially if it be of such rocks as quartz and obsidian. Normal soils are inhabited by microörganisms; they contain varying amounts of decaying organic matter, and represent material in which plants can grow when the climatic environment is favorable.

Soils become what may be termed mature soils after the constituent materials have passed through all changes of oxidation, leaching, etc., normal to the climatic environment. This they can do in well-drained situations only. With such thorough weathering their characteristics have become fixed, and any further important natural change would require a change of the climate.

All soils, as they exist in nature, are not necessarily productive. Some are potentially productive, containing all the necessary elements of fertility for normal plant growth, but are still unproductive because of some abnormal condition, not necessarily unchangeable, such as the presence of alkali salts in amounts sufficient to be toxic to plants, the presence of excessive amounts of water, or the absence of sufficient moisture to sustain plants.

The term, *surface soil,* as used in this volume, designates the surficial portion of a soil—the layer extending from the surface down to some decided change in the texture, color, or structure of the material. It may be only a few inches deep, or it may be a foot or more. Frequently this surface layer is referred to simply as *the soil.*

The *subsoil* is that part of the material lying beneath the surface soil. A soil really is made up of two parts, the surface soil and the subsoil. In soil-survey work, the material below a depth of 3 feet of fine material is referred to as the *substratum*. If such material as bedrock or loose gravel underlying fine-soil material should be reached at depths of less than 3 feet of the surface, it also, properly speaking, should be spoken of as the substratum. The term *subsurface* is sometimes used to designate the lower portion of the surface soil, when there is some slight difference in color or texture between the two layers.

In classifying soils, it is sometimes necessary to give the surface soil a textural name not corresponding with the texture of the material at the immediate surface. As, for example, in the case where a few inches of fine sandy loam overlie a clayey layer so that ordinary plowing would mix the two layers and form a clay loam, the soil would be called a clay loam rather than a fine sandy loam. The textural name of the soil type is determined by the texture of the surface soil. If the surface soil is a loam and the subsoil a clay, the name loam and not clay is given to the type, the descriptions in the soil-survey report bringing out the character of the subsoil and such other features as cannot be described in the name of the soil type.

It sometimes happens that soils of very different character occur in patches so small and intimately associated that it is impracticable to plot out all the spots of different soil on a map of convenient scale. In this case the predominant soil determines the name on the map, the other variations being described in the report.

Soil texture.—The texture of a soil refers to its content of the various constituent grades of gravel and sand and of clay and silt. A soil composed largely of coarse sand is called coarse sand, one composed largely of fine sand is called fine sand, those composed of various percentages of coarse sand, medium sand, fine sand, very fine sand, silt, and clay are variously called sand, fine sand, very fine sand, coarse sandy loam, sandy loam, fine sandy loam, very fine sandy loam, loam, silt loam, clay loam, silty clay loam, sandy clay loam, clay, and silty clay. Also those having an abundance of gravel and of slate, shale, and other rock fragments are classified as gravelly soils (of the various textural grades), slate loams, shale loams, stony loams, stony sandy loams, and so on. Some very rough areas are called rough stony land, steep broken land, etc.

The table below gives the range of content of the various sizes of soil particles in the more important classes of soil as defined by the Bureau of Soils. The figures represent per cent, the minus sign (—) and the plus sign (+) represent less or more, and the sign (-) when used between two figures represents range of content; thus, 20-50 should be read from 20 per cent to 50 per cent.

CLASSIFICATION OF SOIL MATERIAL BY TEXTURE

Soils containing —20 silt and clay:

Coarse sand	25+ fine gravel and coarse sand, and less than 50 any other grade.
Sand	25+ fine gravel, coarse and medium sand and less than 50 fine sand.
Fine sand	50+ fine sand or —25 fine gravel, coarse and medium sand.
Very fine sand	50+ very fine sand.

Soils containing 20-50 silt and clay:

Sandy loam	25+ fine gravel, coarse and medium sand.
Fine sandy loam	50+ fine sand or —25 fine gravel, coarse and medium sand.
Very fine sandy loam	35+ very fine sand.

Soils containing 50+ silt and clay:

Loam	—20 clay, —50 silt.
Silt loam	—20 clay, 50+ silt.
Clay loam	20-30 clay, —50 silt, —20 sand.
Silty clay loam	20-30 clay, 50+ silt.
Sandy clay loam	20-30 clay, —50 silt, 20+ sand.
Clay	30+ clay, —45 silt.
Si[illegible]	30+ clay, 45+ silt.

The sizes of the particles of these different grades of material are as follows:

Grade	*Millimeter*
Fine gravel	2 to 1
Coarse sand	1 to 0.5
Sand	0.5 to .25
Fine sand	.25 to .1
Very fine sand	.1 to .05
Silt	.05 to .005
Clay	.005 to .0001

The table below shows the results of mechanical analyses of soils collected in different parts of the country, covering most of the textural classes. This gives the per cent (by weight) of the different sizes of particles in the same types, as actually determined by mechanical analyses.

MECHANICAL ANALYSES OF SOIL TYPES REPRESENTATIVE OF THE MOST IMPORTANT TEXTURAL CLASSES OF SOIL MATERIAL (FINE EARTH) [1]

Locality	*Name*	*Fine gravel 2 to 1 mm.*	*Coarse sand 1 to 0.5 mm.*	*Medium sand 0.5 to 0.25 mm.*	*Fine sand 0.25 to .1 mm.*	*Very fine sand 0.1 to 0.05 mm.*	*Silt 0.05 to 0.005*	*Clay 0.005 to 0 mm.*
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Jasper County, Miss.	Norfolk coarse sand	6.4	61.1	18.4	5.9	1.8	3.4	3.3
Jasper County, Miss.	Norfolk sand	.3	8.2	48.1	36.5	1.4	3.2	2.9
East coast of Florida	Palm Beach fine sand	.0	1.2	11.0	78.4	7.6	.7	.4
Bryan County, Okla.	Miller very fine sand	.0	.0	.2	13.9	69.4	13.6	2.8
Anne Arundel County, Md.	Sassafras loamy sand	2.6	18.9	30.9	18.6	7.6	14.7	6.6
Granville County, N. C.	Granville coarse sandy loam	13.2	21.2	9.7	14.2	5.1	27.0	9.2
Escambia County, Ala.	Greenville sandy loam	1.7	13.3	15.2	22.6	10.2	27.5	10.1
Wayne County, Miss.	Cahaba fine sandy loam	.1	1.5	12.2	49.5	2.4	22.9	11.2
Russell County, Ala.	Susquehanna very fine sandy loam	1.0	1.1	.5	1.8	54.8	31.2	9.1
Jefferson County, Ala.	Hagerstown loam	.3	2.9	2.3	11.7	24.8	42.3	15.9
Salem, New Jersey	Sassafras gravelly loam	30.1	24.3	11.5	6.3	1.6	17.9	5.9
Green County, Ind.	Marshall silt loam	.0	.3	.5	6.3	9.7	70.7	12.8
Montgomery County, Kan.	Osage silty clay loam	.1	.5	.6	2.2	5.9	64.7	26.0
Loudon County, Va.	Iredell clay loam	3.6	6.1	3.4	9.8	11.6	39.3	25.9
Ransom County, N. D.	Fargo clay	.1	1.4	3.5	19.9	9.2	24.7	41.2
Ashley County, Ark.	Portland clay	.0	.2	.2	.9	3.3	30.3	65.2
Mesilla Valley, N. M.	Gila clay adobe	.0	.0	.1	.6	1.1	27.5	70.6

[1] Material coarser than fine gravel excluded from the soil analysed.

Soil structure.—Structure, used in connection with soils, refers to the density or permeability of soil material and not to the percentage of the various sizes of soil particles. We may have two clay soils which are the same as regards the sizes of particles contained, or texture, but which may have very different structures. One may crumble on drying as does the "black waxy" clay of the Texas prairies, while the other may assume a very tough or compact structure on drying as the red clay of the Clay Hills of Alabama, Mississippi, Louisiana, southern Arkansas, and east Texas. Well-drained sandy soils usually have a loose or friable structure; loam soils, a mellow structure; and clay soils, a hard structure when dry, and a compact or miry to sticky, plastic structure when wet. Many silty soils and some sandy soils (as the Elkton sandy loam) have a peculiar way of baking and crusting on drying.

Soil color.—The color of soils is important, since it is usually associated with some distinctive property of a soil or some degree of crop productivity. In the humid region the light-gray soils usually have poor underdrainage with frequently an impervious claypan in the subsoil, and on drying they usually become hard and compact. The black soils of the humid region, when not of a very limy nature, generally represent wet land having poor drainage both at the surface and in the subsoil. The black limy soils are generally well drained, but in wet weather they are extremely sticky. The brown, reddish-brown, and brownish-gray soils usually have good surface drainage and underdrainage.

The paragraphs below relating to color are taken in the main from Instructions to Field Parties, published by the Bureau of Soils.

Color as used in classifying and describing soils does not refer merely to the surface coloration as viewed across a field but to the color of the soil as deep as it extends, and of the subsoil to a depth of 3 or 6 feet. What should be considered as the true color of the soil, or of the subsoil, is that which it possesses when bored out moist for examination, in other words, the color it has under normal field conditions.

As the color of the soil material is dependent upon or influenced by weathering, drainage, amount, and character of organic-matter content, exposure, and cultivation, besides the mixed origin of material and a slight predominance of one material in certain places, it is not to be expected that the color of a soil will be uniform throughout its whole expanse. It is to be expected, on the other hand, that variations will occur. An effort to show the true place of a soil in a color scheme is all that can be accomplished, but in doing this, if it is attempted to give all detailed variations, confusion results and no good is accomplished. The principal soil colors are: White, black, red, yellow, gray, and brown, with shades and variations produced by different combinations, particularly of the yellow and red. Other colors used are: Indian red, chocolate-red, pinkish-red, purplish-red, light-red, dark-red, brick-red, brown, light-brown, dark-brown, reddish-brown, and chocolate-brown. Such other colors as green and blue very rarely occur, although these and other colors and other shades are occasionally found, and when found should be stated.

In other words, it has been found sufficient for purposes of soil classification and as the result of a vast amount of work done to give certain distinctive class colors as the characteristic color of the type, and it has been found to be simpler and more satisfactory not to confuse this in the main color description by attempting to show the variations of color that may be exhibited by the soil type under different conditions of exposure and use. The Portsmouth series is properly described as a series of black soils, indicating that it belongs to a class of black soils. This distinguishes it at once from the associated Norfolk series, which is properly described as having a gray soil and a yellow subsoil. The Portsmouth series, however, throughout all its extent is not literally black. It may, under exposure and good drainage conditions, or when air dry, or with local accumulations of material, become much lighter and grayish in color. It must be remembered, however, that color is but one of the characteristics of a soil, and color may vary within limits without changing the ultimate classification of the soil material. The Cecil clay has a subsoil which is properly described as belonging to the class of red-soil material. It is not always the same shade of red, but it is never a decided Indian red, as in the subsoil of the associated Penn series, nor has it the yellow color of the subsoil of the associated York series.

The color of a soil type is usually made up of two parts, the color of the surface-soil material and the color of the subsoil material. Usually the color of the surface soil differs from the color of the subsoil material. Occasionally they are the same, and sometimes the subsoil is made up of layers of two or more differently colored materials. All such variations as this in the vertical section must be given, but each color so described must be a class color referring to that particular section of the profile as distinctive for the soil type as a whole.

As the samples sent in . . . are usually in an air-dry condition, imposing certain changes or modifications of color, it is important, to avoid misapprehension and confusion in comparing the color of the air-dry sample with the field color, for the field man to state the color of an air-dried sample in the condition it would be handled . . . to judge fairly of his interpretation of color in any particular case.

In other cases more frequently found, where drainage is deficient, the color, owing to slight differences in drainage and aëration, changes from red to yellow or gray in a single hand specimen. This condition is properly described in classification as mottled with red, yellow, or gray or other colors predominating, as the case may be.

Hardpan, claypan, gravel, and sand substrata.—A hardpan consists of a layer of very compact or consolidated material of varying thickness occurring at varying depths in soils. Some so-called hardpan consists of a compact layer of sandy material such as that found in the common "hardpan" soils of Florida and southeastern Georgia, while others consist of dense clay (claypan) such as that found in the "hardpan" soils so frequently occurring in the Central Prairie and Great Plains regions. These strata can be dug through easily, but they act much like true hardpan, that is very compact to rocklike layers, characterising many areas of soil in arid and semiarid regions, inasmuch as they are more or less impervious to water, controlling its movement to a large degree, and also offer resistance to healthful development of plant roots. Such hardpan frequently can be broken up only by the use of explosives.

A layer of compact subsurface material, sometimes called a plow sole, is frequently found in cultivated fields where plowing has been done to about the same depth for a long period of years. Such compact material usually interferes with proper internal circulation of moisture. It can be broken up by deep plowing.

Beds of gravel and sand in the subsoil are of much importance, not only from the fact that they can be excavated for use in the surfacing of highways, but because they generally denote the existence of ideal or excessive underdrainage. There are some gravel substrata with dense clay filling the interstitial space in such a way that the layer acts like an impervious hardpan layer. Such unfavorable substrata are common in the flat uplands of the cherty soils of the northern Ozark Region.

APPENDIX B

The table below gives the results of chemical analyses of some representative soils from widely separated localities in the Southern States. These analyses show the total content of the constituents determined. Other analyses can be had from the Agricultural Experiment Stations.

CHEMICAL ANALYSES (BY FUSION METHOD) OF SOME IMPORTANT SOUTHERN SOILS. ANALYSES MADE IN THE LABORATORY OF THE BUREAU OF SOILS, EXCEPT AS OTHERWISE STATED

Name of Soil	*Locality*	*Section*	*Origin*	% P_2O_5	% K_2O	% N	% CaO	% MgO	% SiO_2	% Al_2O_3	% Fe_2O_3	% TiO_2	% Na_2O	% MnO	% Organic carbon
Grenada silt loam	Grenada Co., Miss.	soil 0–7 in.	Loess	.04	2.10	—	.37	.02	78.57	8.92	3.93	1.06	1.03	—	
" " "	"	upper subsoil 7–30 in.	"	.02	1.99	—	.68	.02	76.03	10.85	4.84	1.03	.94	—	
" " "	"	compact layer 30–48 in.	"	.06	2.24	—	.42	.02	77.25	10.30	4.66	1.09	1.28	—	
" " "	"	substratum 48+in.	"	.03	2.33	—	1.20	1.18	76.78	9.72	4.65	.97	1.49	—	
" " "	"	soil 0–6 in.	"	.11	2.04	—	.62	.47	—	—	—	—	—	—	
" " "	"	subsoil 6–36 in.	"	.14	2.32	—	.60	.73	—	—	—	—	—	—	
Marshall silt loam	Pottawattamie, Co., Ia.	soil 0–20 in.	"	.23	2.40	.22	1.38	1.10	71.30	11.47	4.05	.60	1.95	.13	2.55
" " "	"	subsoil 20–36 in.	"	.15	2.17	.10	1.59	1.33	71.25	12.48	4.95	.63	2.06	.15	.98
Cherokee silt loam	Cherokee Co., Kan.	soil 0–6 in.	Shale	.07	.91	.11	.71	.43	86.96	4.69	2.86	.69	1.07	.07	1.11
" " "	"	subsurface 6–16 in.	"	.07	1.00	.09	.65	.49	85.13	5.84	3.49	.74	1.16	.09	.65
" " "	"	subsoil 16–28 in.	"	.10	1.20	.13	.77	1.07	69.30	15.06	4.65	.74	1.10	.02	.91
Muck [1]	Pender Co., N. C.	0–36 in.	Vegetable matter and soil	.32	.13	.48	.21	.27	—	—	—	—	—	—	—

[1] Average of analyses of 5 samples.

Chemical Analyses (by Fusion Method) of Some Important Southern Soils. Analyses Made in the Laboratory of the Bureau of Soils, Except as Otherwise Stated

Name of Soil	*Locality*	*Section*	*Origin*	% P_2O_5	% K_2O	% N	% CaO	% MgO	% SiO_2	% Al_2O_3	% Fe_2O_3	% TiO_2	% Na_2O	% MnO	% *Organic carbon*
Hyde silty clay loam	Hampton Co., S. C.	soil 0–6 in.	Mucky soil	.22	.36	.34	—	—	—	—	—	—	—	—	—
" " "	"	subsoil 6–36 in.	"	.32	.44	.17	—	—	—	—	—	—	—	—	—
Norfolk fine sand	Pender Co., N. C.	soil 0–8 in.	Coastal Plain	.14	.08	.08	.64	.33	—	—	—	—	—	—	—
" " "	"	subsoil 8–36 in.	"	.13	.08	.06	.33	.49	—	—	—	—	—	—	—
Coxville fine sandy loam	Georgetown Co., S. C.,	soil 0–8 in.	"	.17	.52	.08	.40	.22	—	—	—	—	—	—	—
" " "	"	subsoil 8–36 in.	"	.26	.72	.05	.21	.90	—	—	—	—	—	—	—
Cecil clay loam [2]	Gaston Co., N. C.	soil 0–6 2/3 in.	Granitic rocks	.03	.49	.06	.11	—	—	—	—	—	—	—	—
" " " [2]	"	subsoil 6 2/3–28 in.	"	.075	.33	.02	.08	—	—	—	—	—	—	—	—
Cecil fine sandy loam [2]	"	soil 0–6 2/3 in.	"	.015	.9	.04	.19	—	—	—	—	—	—	—	—
" " " [2]	"	subsoil 6 2/3–28 in.	"	.06	.79	.02	.06	—	—	—	—	—	—	—	—
Cecil loam [2]	"	soil 0–6 2/3 in.	"	.03	.98	.03	.14	—	—	—	—	—	—	—	—
" " [2]	"	subsoil 6 2/3–28 in.	"	.057	2.31	.016	.08	—	—	—	—	—	—	—	—
Cecil clay [2]	"	soil 0–6 2/3 in.	"	.085	.63	.09	.17	—	—	—	—	—	—	—	—
" " [2]	"	subsoil 6 2/3–28 in.	"	.106	.52	.03	.10	—	—	—	—	—	—	—	—
Durham coarse sandy loam [2]	"	soil 0–6 2/3 in.	"	.02	.47	.03	.11	—	—	—	—	—	—	—	—

[2] Average results of analyses by North Carolina Department of Agriculture, County Soil Survey Report No. 2.

CHEMICAL ANALYSES (BY FUSION METHOD) OF SOME IMPORTANT SOUTHERN SOILS. ANALYSES MADE IN THE LABORATORY OF THE BUREAU OF SOILS, EXCEPT AS OTHERWISE STATED

Name of Soil	*Locality*	*Section*	*Origin*	% P_2O_5	% K_2O	% N	% CaO	% MgO	% SiO_2	% Al_2O_3	% Fe_2O_3	% TiO_2	% Na_2O	% MnO	% Organic carbon
Durham coarse sandy loam [2]	Gaston Co., N. C.	subsoil 6²/₃–28 in.	Granitic rocks	.19	.54	.02	.10	—	—	—	—	—	—	—	—
Cecil sandy loam [2]	"	soil 0–6²/₃ in.	"	.035	3.15	.03	.10	—	—	—	—	—	—	—	—
" " " [2]	"	subsoil 6²/₃–28 in.	"	.08	1.79	.02	.06	—	—	—	—	—	—	—	—
Iredell clay loam [2]	"	soil 0–6²/₃ in.	Diorite	.042	.17	.06	3.29	—	—	—	—	—	—	—	—
" " " [2]	"	subsoil 6²/₃–28 in.	"	.099	.10	.05	2.66	—	—	—	—	—	—	—	—
Cecil clay loam [3]	Mecklenburg Co., N.C.	soil 0–6²/₃ in.	Granitic rocks	.05	.43	.05	.27	—	—	—	—	—	—	—	—
" " " [3]	"	subsoil 6²/₃–28 in.	"	.08	.34	.02	.19	—	—	—	—	—	—	—	—
Iredell loam [3]	"	soil 0–6²/₃ in.	Diorite	.26	.43	.05	3.01	—	—	—	—	—	—	—	—
" " [3]	"	subsoil 6²/₃–28 in.	"	.11	.30	.03	4.02	—	—	—	—	—	—	—	—
Mecklenburg clay loam [3]	"	soil 0–6²/₃ in.	"	.12	.65	.07	.32	—	—	—	—	—	—	—	—
" " [3]	"	subsoil 6²/₃–28 in.	"	.095	.47	.05	2.49	—	—	—	—	—	—	—	—
Alamance silt loam [3]	"	soil 0–6²/₃ in.	Slate	.06	.20	.03	.77	—	—	—	—	—	—	—	—
" " [3]	"	subsoil 6²/₃–28 in.	"	.039	.32	.02	.15	—	—	—	—	—	—	—	—

[2] Average results of analyses by North Carolina Department of Agriculture, County Soil Survey Report No. 2.
[3] Average results of analyses by North Carolina Department of Agriculture, County Soil Survey Report No. 1.

Chemical Analyses (by Fusion Method) of Some Important Southern Soils. Analyses Made in the Laboratory of the Bureau of Soils, Except as Otherwise Stated

Name of Soil	*Locality*	*Section*	*Origin*	% P_2O_5	% K_2O	% N	% CaO	% MgO	% SiO_2	% Al_2O_3	% Fe_2O_3	% TiO_2	% Na_2O	% MnO	% *Organic carbon*
Congaree fine sandy loam [3]	Mecklenburg Co., N. C.	soil 0–6$\frac{2}{3}$ in.	Alluvium	.15	2.04	.04	.92	—	—	—	—	—	—	—	—
" " " [3]	"	subsoil 6$\frac{2}{3}$–28 in.	"	.15	2.10	.02	.81	—	—	—	—	—	—	—	—
Cecil clay loam	Albemarle Co., Va.	soil 0–8 in.	Granite	.22	1.53	.10	.25	.31	—	—	—	—	—	—	—
" " "	"	subsoil 8–30 in.	"	.24	1.31	.06	.26	.39	—	—	—	—	—	—	—
Louisa loam [4]	"	soil 0–12 in.	Mica schist	.48	2.22	.09	.38	.58	—	—	—	—	—	—	—
" " [4]	"	subsoil 12–36 in.	"	.27	2.24	.04	.24	.61	—	—	—	—	—	—	—
Louisa clay loam	"	soil 0–6 in.	"	.55	.90	.14	.55	.55	—	—	—	—	—	—	—
" " "	"	subsoil 6–36 in.	"	.67	1.33	.06	.45	.77	—	—	—	—	—	—	—
Diorite rock	"	Gives rise to Davidson clay	—	.57	.54	—	6.25	.85	—	—	—	—	—	—	—
Davidson clay	"	soil 0–6 in.	Diorite	.17	.54	.07	.40	.86	—	—	—	—	—	—	—
" "	"	subsoil 6–36 in.	"	.14	1.13	.03	.35	.82	—	—	—	—	—	—	—
Cecil sandy loam	"	soil 0–10 in.	Granite	.10	3.82	.09	.54	.76	—	—	—	—	—	—	—
" " "	"	subsoil 10–30 in.	"	.13	5.05	.04	.55	1.01	—	—	—	—	—	—	—
Porters loam	"	soil 0–15 in.	Igneous rocks	.13	2.83	.15	.60	1.00	—	—	—	—	—	—	—
Diorite rock	"	Gives rise to Iredell loam	—	.07	2.26	—	12.45	3.23	—	—	—	—	—	—	—
Iredell loam	"	soil 0–8 in.	Diorite	.06	1.65	.11	2.76	.90	—	—	—	—	—	—	—

[3] Average results of analyses by North Carolina Department of Agriculture, County Soil Report No. 1.
[4] Average of analyses of 2 samples.

Chemical Analyses (by Fusion Method) of Some Important Southern Soils. Analyses Made in the Laboratory of the Bureau of Soils, Except as Otherwise Stated

Name of Soil	*Locality*	*Section*	*Origin*	% P_2O_5	% K_2O	% N	% CaO	% MgO	% SiO_2	% Al_2O_3	% Fe_2O_3	% TiO_2	% Na_2O	% MnO	% *Organic carbon*
Iredell loam	Albemarle Co., Va.	subsoil 8–30 in.	Diorite	.08	1.13	.05	3.44	1.63	—	—	—	—	—		
Penn silt loam	"	soil 0–10 in.	Triassic shale	.29	.90	.11	.50	.72	—	—	—	—	—		
" " "	"	subsoil 10–36 in.	"	.36	2.18	.08	.53	1.58	—	—	—	—	—		
Mecklenburg clay loam	Mecklenburg Co., N. C.	soil 0–4 in.	Diorite	.24	.48	.11	1.44	.93	46.41	21.85	17.14	3.68	1.20	.46	.53
" " "	"	subsoil 4–24 in.	"	.25	.41	.10	1.48	1.76	43.3	25.02	15.29	2.03	.89	.31	.41
" " "	"	Lower subsoil 24–36 in.	"	.23	.27	.06	3.09	2.04	46.7	25.21	12.87	2.03	2.04	.16	.3
Ruston fine sandy loam	Georgetown Co., S. C.	soil 0–12 in.	Coastal Plain	.10	.39	.08	.40	.22	—	—	—	—	—	—	—
" " "	"	subsoil 12–36 in.	"	.21	.45	.04	.26	.29	—	—	—	—	—	—	—
Georgetown clay[5]	"	soil	Alluvium	.23	.49	.53	1.04	.75	—	—	—	—	—	—	—
" "[5]	"	subsoil	"	.18	.57	.87	.84	.65	—	—	—	—	—	—	—
Orangeburg sandy loam	Calhoun Co., S. C.	soil 0–10 in	Coastal Plain	.22	.14	.07	.47	.28	—	—	—	—	—	—	—
" " "	"	subsoil 10–36 in.	"	.37	.17	.01	.48	.31	—	—	—	—	—	—	—
Greenville sandy loam	"	soil 0–8 in.	"	.37	.20	.04	.35	.41	—	—	—	—	—	—	—
" " "	"	subsoil 8–36 in.	"	.46	.22	.03	.58	.26	—	—	—	—	—	—	—
Central Basin Soil,[6] probably Hagerstown	Bedford Co., Tennessee	soil	Limestone	.15	1.07	.13	.27	—	—	—	—	—	—	—	—
" "[6]	Marshall Co., Tenn.	"	"	,30	.93	.11	.23	—	—	—	—	—	—	—	—

[5] Average of analyses of 5 samples.
[6] Analyses from Bulletin of the Agricu ltural Experiment Station of Tennessee: The Soils of Tennessee.

CHEMICAL ANALYSES (BY FUSION METHOD) OF SOME IMPORTANT SOUTHERN SOILS. ANALYSES MADE IN THE LABORATORY OF THE BUREAU OF SOILS, EXCEPT AS OTHERWISE STATED

Name of Soil	*Locality*	*Section*	*Origin*	% P_2O_5	% K_2O	% N	% CaO	% MgO	% SiO_2	% Al_2O_3	% Fe_2O_3	% TiO_2	% Na_2O	% MnO	% Organic carbon
Central Basin soil, probably Hagerstown [6]	Sumner Co., Tenn.	soil	Limestone	.24	1.27	—	.30	—	—	—	—	—	—	—	—
Highland Rim soil,[6] probably Clarksville	Stewart Co., Tenn.	"	"	.07	1.48	.10	.23	—	—	—	—	—	—	—	—
East Tenn. Valley soil,[6] probably Clarksville gravelly loam	Hamblen Co., Tenn.	"	Knox Dolomite	.06	.61	.11	.11	—	—	—	—	—	—	—	—
Stream bottom soil [6]	Knox Co., Tennessee	"	Alluvium	.21	2.05	.13	.69	—	—	—	—	—	—	—	—
Cumberland Plateau soil	Cumberland Co., Tennessee	"	Walden sandstone	.04	.47	.08	.07	—	—	—	—	—	—	—	—
Decatur clay loam [7]	Chattooga Co., Ga.	soil 0–7 in.	Limestone	.05	.56	.07	.22	—	—	—	—	—	—	—	—
" " " [7]	"	subsoil 7–21 in.	"	.03	.53	.02	.14	—	—	—	—	—	—	—	—
Colbert stony clay [7]	"	soil 0–7 in.	"	.03	1.11	.06	.18	—	—	—	—	—	—	—	—
" " " [7]	"	subsoil 7–21 in.	"	.03	1.95	.05	.30	—	—	—	—	—	—	—	—
Conasauga silt loam [7]	"	soil 0–7 in.	Shale	.04	.88	.05	.13	—	—	—	—	—	—	—	—
" " " [7]	"	subsoil 7–21 in.	"	.06	1.75	.02	.11	—	—	—	—	—	—	—	—
Armuchee silt loam [7]	"	soil 0–7 in.	"	.06	1.05	.08	.22	—	—	—	—	—	—	—	—
" " " [7]	"	subsoil 7–21 in.	"	.07	2.07	.03	.16	—	—	—	—	—	—	—	—
Dekalb fine sandy loam [7]	"	soil 0–7 in.	Sandstone & shale	.03	.58	.07	.09	—	—	—	—	—	—	—	—
" " " [7]	"	subsoil 7–21 in.	"	.02	.49	.03	.05	—	—	—	—	—	—	—	—
Hanceville fine sandy loam [7]	"	soil 0–7 in.	Sandstone	.015	.39	.05	.08	—	—	—	—	—	—	—	—

[6] Analyses from Bulletin of the Agricultural Experiment Station of Tennessee: The Soils of Tennessee.
[7] Analyses from Bulletin No. 80, Georgia State College of Agriculture. Percentages computed from results expressed in pounds per acre in the Georgia bulletins.

CHEMICAL ANALYSES (BY FUSION METHOD) OF SOME IMPORTANT SOUTHERN SOILS. ANALYSES MADE IN THE LABORATORY OF THE BUREAU OF SOILS, EXCEPT AS OTHERWISE STATED

Name of Soil	*Locality*	*Section*	*Origin*	% P_2O_5	% K_2O	% N	% CaO	% MgO	% SiO_2	% Al_2O_3	% Fe_2O_3	% TiO_2	% Na_2O	% MnO	% Organic carbon
Hanceville fine sandy loam [7]	Chattooga Co., Ga.	subsoil 7–21 in.	Sandstone	.03	.51	.05	.07	—	—	—	—	—	—	—	—
Clarksville gravelly loam [7]	"	soil 0–7 in.	Cherty limestone	.03	.30	.03	.08	—	—	—	—	—	—	—	—
" " " [7]	"	subsoil 7–21 in.	"	.02	.28	.03	.04	—	—	—	—	—	—	—	—
Hagerstown silt loam [7]	"	soil 0–7 in.	Limestone	.05	.73	.05	.14	—	—	—	—	—	—	—	—
" " " [7]	"	subsoil 7–21 in.	"	.06	1.21	.03	.12	—	—	—	—	—	—	—	—
Huntington silt loam [7]	"	soil 0–7 in.	Alluvium	.09	1.08	.10	.28	—	—	—	—	—	—	—	—
" " [7]	"	subsoil 7–21 in.	"	.08	1.10	.08	.25	—	—	—	—	—	—	—	—
Norfolk sandy loam [8]	Scotland Co., N. C.	soil 0–14 in.	Coastal Plain	.06	.10	—	.39	.09	94.50	2.07	.83	.71	.11	.007	—
" " [8]	"	subsoil 14–36 in.	"	.04	.12	—	.38	.19	85.30	8.82	1.91	.91	.07	.004	—
Decatur clay loam [8]	Jackson Co., Ala.	soil 0–4 in.	Limestone	.18	.67	—	.63	.39	79.35	8.89	4 44	1.15	.24	.07	—
" " [8]	" "	subsoil 4–15 in.	"	.15	.75	—	.40	.33	74.81	12.80	5.28	1.28	.16	.05	—
Hagerstown loam [8]	Montgomery Co., Ga.	soil 0–8 in.	"	.19	2.71	—	.93	1.08	70.99	11.39	4.23	1.01	.82	.18	—
" " [8]	"	subsoil 8–24 in.	"	.16	3.58	—	.35	1.93	66.49	14.80	5.99	1.01	.66	.10	—
Marshall silt loam [8]	Platte Co., Missouri	soil 0–15 in.	Loess	.22	2.28	—	1.08	.77	73.61	9.67	3.54	.71	1.03	.12	—
" " [8]	"	subsoil 15–36 in.	"	.16	2.03	—	1.40	1.28	71.43	13.44	4.28	.77	.63	.10	—

[7] Analyses from Bulletin No. 80, Georgia State College of Agriculture.
[8] Analyses from Bulletin, U. S. Department of Agriculture, No. 122: The Inorganic Composition of Some Important American Soils.

Chemical Analyses (by Fusion Method) of Some Important Southern Soils. Analyses Made in the Laboratory of the Bureau of Soils, Except as Otherwise Stated

Name of Soil	*Locality*	*Section*	*Origin*	% P_2O_5	% K_2O	% N	% CaO	% MgO	% SiO_2	% Al_2O_3	% Fe_2O_3	% TiO_2	% Na_2O	% MnO	% *Organic carbon*
Cecil clay [8]	Mecklenburg Co., N. C.	soil 0–6 in.	Granitic rocks	.20	.62	—	.36	.31	66.49	17.11	7.43	1.02	.16	.51	—
" " [8]	"	subsoil 6–36 in.	"	.17	.61	—	.44	.09	44.15	27.58	16.23	1.14	.15	.03	—
Durham sandy loam [8]	Johnson Co., N. C.	soil 0–10 in.	"	.12	3.96	—	.89	.19	80.79	10.55	1.61	.55	.87	.01	—
" " [8]	"	subsoil 10–36 in.	"	.12	3.34	—	.72	.29	69.35	18.04	3.42	.60	.89	.01	—
York silt loam [8]	York Co., S. C.	soil 0–10 in.	Schist	.05	3.26	—	.08	.29	76.71	12.85	2.81	.41	.39	.005	
" " " [8]	"	subsoil 10–22 in.	"	.05	4.07	—	.21	.38	74.38	16.31	2.56	.40	.30	.005	—
Louisa loam [8]	Louisa Co., Va.	soil 0–12 in.	"	.12	.74	—	.21	.25	84.58	5.54	3.30	1.51	.14	.04	—
" " [8]	"	subsoil 12–30 in.	"	.15	.97	—	.26	.32	74.99	10 90	6.75	1.59	.28	.03	—
Penn silt loam [8]	Montgomery Co., Pa.	soil 0–9 in.	Triassic sandstone	.16	1.57	—	1.13	.69	74.33	11.00	4.64	1.04	1.53	.13	—
" " " [8]	"	subsoil 9–24 in.	"	.10	1.50	—	1.73	1.06	71.76	14.36	5.82	1.06	1.54	.10	—
Cecil sandy loam [9]	Troup Co., Ga.	soil 0–7 in.	Granitic rocks	.03	.45	.03	.10	—	—	—	—	—	—	—	—
" " " [9]	"	subsoil 7-20 in.	"	.03	.53	.02	.06	—	—	—	—	—	—	—	—
" clay loam [9]	"	soil 0–7 in.	"	.05	.40	.05	.13	—	—	—	—	—	—	—	—
" " " [9]	"	subsoil 7–20 in.	"	.04	.37	.04	.12	—	—	—	—	—	—	—	—
Louisa loam [9]	"	soil 0–7 in.	Mica schist	.03	1.03	.02	.04	—	—	—	—	—	—	—	—
" " [9]	"	subsoil 7–20 in.	"	.04	1.30	.02	.09	—	—	—	—	—	—	—	—

[8] Analyses from Bulletin, U. S. Department of Agriculture, No. 122: The Inorganic Composition of Some Important American Soils.
[9] Analyses from Bulletin No. 92, Georgia State College of Agriculture.

Chemical Analyses (by Fusion Method) of Some Important Southern Soils. Analyses Made in the Laboratory of the Bureau of Soils, Except as Otherwise Stated

Name of Soil	*Locality*	*Section*	*Origin*	% P_2O_5	% K_2O	% *N*	% *CaO*	% *MgO*	% SiO_2	% Al_2O_3	% Fe_2O_3	% TiO_2	% Na_2O	% *MnO*	% *Organic carbon*
Iredell loam [9]	Troup Co., Ga.	soil 0–7 in.	Diorite	.07	.30	.04	1.02	—	—	—	—	—	—	—	—
" " [9]	"	subsoil 7–20 in.	"	.08	.25	.04	1.70	—	—	—	—	—	—	—	—
Congaree loam [9]	"	soil 0–7 in.	Alluvium	.10	2.17	.09	.37	—	—	—	—	—	—	—	—
" " [9]	"	subsoil 7–20 in.	"	.08	2.03	.07	.35	—	—	—	—	—	—	—	—
Oswego silt loam [10]	Riley Co., Kan.	soil 0–14 in.	Shale	.10	2.28	.20	1.09	.36	71.38	12.29	3.63	.68	1.14	.05	—
" " " [10]	"	subsoil 14–36 in.	"	.08	2.20	.13	.88	1.12	68.74	14.45	5.00	.70	1.12	.05	—
Knox silt loam [10]	Platte Co., Mo.	soil 0–14 in.	Loess	.12	2.10	.14	.92	.60	76.81	9.73	3.26	.70	1.74	.06	—
" " " [10]	"	subsoil 14–36 in.	"	.10	1.60	.06	.92	.74	75.95	11.16	3.99	.70	1.74	.06	—
Memphis silt loam [10]	Grenada Co., Miss.	soil 0–6 in.	"	.08	1.78	.11	.31	.39	81.13	8.52	2.92	.78	.52	.02	—
" " [10]	"	subsoil 6–36 in.	"	.14	2.14	.07	.36	.78	73.58	12.25	5.02	.80	.71	.06	—
" " smooth [10]	"	soil 0–6 in.	"	.10	1.84	.06	.27	.45	80.78	8.48	3.05	.86	.72	.03	—
Memphis silt loam smooth [10]	"	subsoil 6–36 in.	"	.13	2.08	.05	.26	.84	72.67	12.80	5.58	.79	.56	.05	—
Cahaba fine sandy loam [10]	Clay Co., Georgia	soil 0–12 in.	Coastal Plain Alluvium	.06	.90	.05	.21	.09	91.39	3.72	.97	.52	.12	.06	—
" " " [10]	"	subsoil 12–36 in.		.05	1.08	.10	.15	.34	73.25	13.79	4.88	.69	.10	.02	—
Cahaba very fine sandy loam [10]	Webster Parish, La.	soil 0–12 in.	"	.06	.45	.05	.15	.01	93.29	2.45	.78	.42	.03	.06	—
" " " [10]	"	subsoil 12–36 in.	"	.05	.58	.03	.12	.09	91.83	3.83	1.19	.46	.05	.07	—

[9] Analyses from Bulletin No. 92, Georgia State College of Agriculture.
[10] Analyses from Bulletin, U. S. Department of Agriculture, No. 551: Variation on the Chemical Composition of Soils.

CHEMICAL ANALYSES (BY FUSION METHOD) OF SOME IMPORTANT SOUTHERN SOILS. ANALYSES MADE IN THE LABORATORY OF THE BUREAU OF SOILS, EXCEPT AS OTHERWISE STATED

Name of Soil	*Locality*	*Section*	*Origin*	% P_2O_5	% K_2O	% N	% CaO	% MgO	% SiO_2	% Al_2O_3	% Fe_2O_3	% TiO_2	% Na_2O	% MnO	% Organic carbon
Norfolk sand [19]	Chesterfield Co., S. C.	soil 0–8 in.	Coastal Plain	.10	.08	.02	.03	.01	94.81	1.42	.60	.51	.08	.02	—
" " [19]	"	subsoil 8–36 in.	"	.03	.08	.06	.08	10	97.01	1.31	.52	.53	10	.005	—
Orangeburg sand [19]	Terrell Co., Ga.	soil 0–10 in.	"	.04	.08	.06	.08	10	96.18	1.70	.59	.35	10	.01	—
" " [19]	"	subsoil 10–36 in.	"	.04	.10	.02	.05	10	91.86	4.11	1.31	.41	10	.01	—
Orangeburg sandy loam [19]	Clay Co., Ga.	soil 0–12 in.	"	.05	.10	03	10.	10	94.32	2.13	.85	.40	.29	.05	—
" " [19]	"	subsoil 12–36 in.	"	.08	.14	.08	.08	.08	77.20	12.75	3.18	.66	.20	.09	—
Greenville sandy loam [19]	"	soil 0–10 in.	"	.05	.13	02	.01	10	92.42	2.78	1.55	.41	.26	.03	—
" " [19]	"	subsoil 10–36 in.	"	.06	.14	.03	.10	.23	73.03	16.11	5.11	.70	.26	.01	—
Norfolk fine sandy loam [19]	Colquitt Co., Ga.	soil 0–10 in.	"	.04	.05	.04	.03	10	92.87	2.75	1.17	.43	.01	.007	—
" " [19]	"	subsoil 10–36 in.	"	.03	.10	.05	.01	.07	89.04	5.36	2.04	.55	10	.003	—
Tifton fine sandy loam [19]	McIntosh Co., Ga.	soil 0–12 in.	"	.04	.10	.04	.05	10	94.15	1.67	.94	.41	10	.02	—
" " " [19]	"	subsoil 12–36 in.	"	.05	.12	.04	.07	.15	76.29	12.51	4.01	.78	10	.006	—
Ruston fine sandy loam [19]	Webster Parish, La.	soil 0–6 in.	"	.04	.16	.07	.12	10	95.51	1.70	.68	.36	.04	.01	—
" " " [19]	"	subsoil 6–36 in.	"	.05	.36	.03	.12	.18	85.95	6.75	2.65	.60	.04	.008	—
Susquehanna fine sandy loam [19]	Smith Co., Texas	soil 0–12 in.	"	.04	.28	.08	.11	.09	90.90	2.59	3.02	.57	10	.02	—
" " [19]	"	subsoil 12–36 in.	"	.05	.66	.05	.16	.60	67.55	16.08	7.52	.82	10	.008	—

[19] Analyses from Bulletin, U. S. Department of Agriculture, No. 551: Variation on the Chemical Composition of Soils. 10 Tr.

Chemical Analyses (by Fusion Method) of Some Important Southern Soils. Analyses Made in the Laboratory of the Bureau of Soils, Except as Otherwise Stated

Name of Soil	*Locality*	*Section*	*Origin*	% P_2O_5	% K_2O	% *N*	% *CaO*	% *MgO*	% SiO_2	% Al_2O_3	% Fe_2O_3	% TiO_2	% Na_2O	% *MnO*	% *Organic carbon*
Susquehanna fine sandy loam [19]	Colquitt Co., Ga.	soil 0–12 in.	Coastal Plain	.04	.12	.05	10	10	91.17	3.65	1.31	.42	10.	.008	—
" " " [19]	"	subsoil 12–36 in.	"	.10	.16	.01	10	10	75.04	13.38	5.04	.82	.01	.007	—
Portsmouth fine sandy loam [19]	"	soil 0–12 in.	"	.05	.06	.05	10	10	94.85	1.37	.41	.56	.06	.003	—
" " [19]	"	subsoil 12–36 in.	"	.06	.02	.03	10	10	94.61	2.97	.33	.56	.02	.002	—
Susquehanna clay [19]	Clarke Co., Miss.	soil 0–4 in.	"	.06	.56	.07	.40	.32	76.67	8.98	6.05	1.02	.01	.09	—
" " [19]	"	subsoil 4–36 in. gives rise to Dekalb	"	.05	.76	.05	.37	.67	62.97	18.45	8.42	1.00	.12	.01	—
Charleston sandstone	Logan Co., W. Va.	stony loam	—	.05	1.57	—	.19	.36	87.05	6.73	1.23	.27	.23	.004	—
Dekalb stony loam	"	soil	sandstone	.06	1.67	—	.20	.48	85.52	7.76	1.74	.50	.30	.003	—
Granville fine sandy loam	Anson Co., N. C.	soil 0–5 in.	Triassic sandstone	.11	.12	.06	.18	—	—	—	—	—	—	—	—
" " "	"	subsoil 5–15 in.	"	.11	.43	.04	.15	—	—	—	—	—	—	—	—
" " "	"	lower subsoil 15–36 in.	"	.12	.45	.06	.14	—	—	—	—	—	—	—	—
Granville silt loam	"	soil 0–5 in.	Triassic shale	.09	.61	.07	.13	—	—	—	—	—	—	—	—
" "	"	subsoil 5–12 in.	"	.08	.24	.04	.14	—	—	—	—	—	—	—	—
" "	"	lower subsoil 12–36 in.	"	.07	.35	.03	.08	—	—	—	—	—	—	—	—

[19] Analyses from Bulletin, U. S. Department of Agriculture, No. 551: Variation on the Chemical Composition of Soils. 10 Tr.

Chemical Analyses (by Fusion Method) of Some Important Southern Soils. Analyses Made in the Laboratory of the Bureau of Soils, Except as Otherwise Stated

Name of Soil	*Locality*	*Section*	*Origin*	% P_2O_5	% K_2O	% *N*	% *CaO*	% *MgO*	% SiO_2	% Al_2O_3	% Fe_2O_3	% TiO_2	% Na_2O	% *MnO*	% *Organic carbon*
Cecil gravelly loam	Anson Co., N. C.	soil 0–12 in.	Granite	.18	4.63	.04	.20	—	—	—	—	—	—	—	—
" "	"	subsoil 12–36 in.	"	.16	2.74	.06	.17	—	—	—	—	—	—	—	—
Iredell loam	"	soil 0–5 in.	Diorite	.13	.68	.13	.89	—	—	—	—	—	—	—	—
" "	"	subsoil 5–36 in.	"	.17	.22	.08	2.56	—	—	—	—	—	—	—	—
Wadesboro fine sandy loam	"	soil 0–10 in.	Triassic sandstone	.11	.40	.06	.12	—	—	—	—	—	—	—	—
" " "	"	subsoil 10–30 in.	"	.20	2.20	.07	.11	—	—	—	—	—	—	—	—
White Store clay loam	"	soil 0–4 in.	Triassic shale	.15	.84	.07	.51	—	—	—	—	—	—	—	—
" " "	"	subsoil 4–36 in.	"	.13	1.28	.07	.46	—	—	—	—	—	—	—	—
Ashe stony loam	Warren Co., Va.	soil	Igneous rocks	.17	.68	—	1.36	.82	—	—	—	—	—	—	—
" " "	"	subsoil	"	.15	.72	—	1.65	1.67	—	—	—	—	—	—	—
Porters loam	"	soil	"	.13	.45	—	.57	.47	—	—	—	—	—	—	—
" "	"	subsoil	"	.04	.38	—	.38	.56	—	—	—	—	—	—	—
Davidson stony loam	Talbot Co., Ga.	soil	Diorite	.21	.11	—	.18	.18	38.53	24.14	22.91	1.71	.03	.09	—
Unweathered diorite	"	Gives rise to Davidson stony loam	—	.16	.32	—	10.66	5.69	51.76	14.34	14.16	1.43	2.09	.19	—
Partly weathered diorite	"	"	—	.32	.08	—	.09	.37	24.30	11.93	49.75	4.49	.06	.04	—
Cecil clay loam	"	soil	Granite	.13	1.23	—	.20	.35	52.81	26.65	8.73	.96	.08	.01	—
Unweathered granite	"	Gives rise to Cecil stony loam	—	.15	5.30	—	1.32	.64	73.63	13.55	2.71	.46	2.12	.02	—
Partly weathered granite	"	"	—	.16	2.40	—	.30	.85	70.43	13.33	7.80	.95	.20	.01	—

CHEMICAL ANALYSES (BY FUSION METHOD) OF SOME IMPORTANT SOUTHERN SOILS. ANALYSES MADE IN THE LABORATORY OF THE BUREAU OF SOILS, EXCEPT AS OTHERWISE STATED

Name of Soil	*Locality*	*Section*	*Origin*	% P_2O_5	% K_2O	% N	% CaO	% MgO	% SiO_2	% Al_2O_3	% Fe_2O_3	% TiO_2	% Na_2O	% MnO	% Organic carbon
Lebanon silt loam [11]	Green Co., Mo.	soil 0–6 in.	Limestone	.05	1.35	.10	—	—	—	—	—	—	—	—	—
" " [11]	"	subsoil 6–34 in.	"	.06	1.11	.04	—	—	—	—	—	—	—	—	—
Putnam silt loam [11]	Macon Co., Mo.	soil 0–12 in.	Glacial material	.18	1.70	.16	—	—	—	—	—	—	—	—	—
" " [11]	"	subsoil 12–36 in.	"	.19	1.70	.08	—	—	—	—	—	—	—	—	—
Marshall silt loam [11]	Nodaway Co., Mo.	soil 0–16 in.	Loess	.14	2.15	.28	—	—	—	—	—	—	—	—	—
" " [11]	"	subsoil 16–40 in.	"	.11	1.92	.19	—	—	—	—	—	—	—	—	—
Shelby loam [11]	Pike Co., Mo.	soil 0–9 in.	Glacial material	.08	1.33	.08	—	—	—	—	—	—	—	—	—
" " [11]	"	subsoil 9–36 in.	"	.14	1.13	.06	—	—	—	—	—	—	—	—	—
Summit silt loam [11]	Cass Co., Mo.	soil 0–14 in.	Limestone and shale	.25	1.57	.17	—	—	—	—	—	—	—	—	—
" " [11]	"	subsoil 14–36 in	"	.18	1.33	.12	—	—	—	—	—	—	—	—	—
Wabash clay loam [11]	"	soil 0–9 in.	Alluvium	.19	1.39	.20	—	—	—	—	—	—	—	—	—
" " [11]	"	subsoil 9–36 in.	"	.14	1.73	.13	—	—	—	—	—	—	—	—	—
Waverly clay loam [11]	Stoddard Co., Mo.	soil 0–8 in.	"	.14	1.76	.14	—	—	—	—	—	—	—	—	—
" " [11]	"	subsoil 8–36 in.	"	.11	1.76	.03	—	—	—	—	—	—	—	—	—
Bates silt loam [11]	Barton Co., Mo.	soil 0–14 in.	Shale	.05	1.16	.18	—	—	—	—	—	—	—	—	—
" " " [11]	"	subsoil 14–36 in.	"	.04	1.20	.07	—	—	—	—	—	—	—	—	—

[11] Analyses by Missouri Agricultural College.

CHEMICAL ANALYSES (BY FUSION METHOD) OF SOME IMPORTANT SOUTHERN SOILS. ANALYSES MADE IN THE LABORATORY OF THE BUREAU OF SOILS, EXCEPT AS OTHERWISE STATED

Name of Soil	*Locality*	*Section*	*Origin*	% P_2O_5	% K_2O	% N	% CaO	% MgO	% SiO_2	% Al_2O_3	% Fe_2O_3	% TiO_2	% Na_2O	% MnO	% *Organic carbon*
Cherokee silt loam [11]	Barton Co., Mo.	soil 0–8 in.	Shale	.06	1.78	.13	—	—	—	—	—	—	—	—	—
" " [11]	"	Upper subsoil 8–20 in.	"	.12	1.58	.07	—	—	—	—	—	—	—	—	—
" " [11]	"	Lower subsoil 20–36 in.	"	.11	1.26	.08	—	—	—	—	—	—	—	—	—
Clarksville gravelly loam [11]	Laclede Co., Mo.	soil 0–5 in.	Lime-stone	.04	1.50	.05	—	—	—	—	—	—	—	—	—
" " [11]	"	subsoil 5–36 in.	"	.07	1.84	.02	—	—	—	—	—	—	—	—	—
Crawford silt loam [11]	Cass Co., Mo.	soil 0–15 in.	"	.24	—	.20	—	—	—	—	—	—	—	—	—
" " [11]	"	subsoil 15–36 in.	"	.13	—	.12	—	—	—	—	—	—	—	—	—
Gerald silt loam [11]	Barton Co., Mo.	soil 0–18 in.	Shale	.06	.70	.11	—	—	—	—	—	—	—	—	—
" " " [11]	"	subsoil 18–36 in.	"	.07	1.16	.07	—	—	—	—	—	—	—	—	—
Knox silt loam [11]	Carroll Co. Mo.,	soil 0-16 in.	Loess	.16	2.03	.15	—	—	—	—	—	—	—	—	—
" " " [11]	"	subsoil 16–36 in.	"	.12	1.70	.10	—	—	—	—	—	—	—	—	—
Osage clay [12]	Cherokee Co., Kan.	soil 0–7 in.	Allu-vium	.11	1.56	.20	1.06	—	—	—	—	—	—	—	2.23
" " [12]	"	Upper subsoil 7–20 in.	"	.08	1.47	.12	.98	—	—	—	—	—	—	—	1.18
" " [12]	"	Lower subsoil 20–40 in.	"	.05	1.39	.07	.96	—	—	—	—	—	—	—	.65

[11] Analyses by Missouri Agricultural College.
[12] Analyses from Bul. Agricultural Experiment Station, Kansas State Agricultural College, No. 207: Soil Survey of Cherokee County, Kan.

CHEMICAL ANALYSES (BY FUSION METHOD) OF SOME IMPORTANT SOUTHERN SOILS. ANALYSES MADE IN THE LABORATORY OF THE BUREAU OF SOILS, EXCEPT AS OTHERWISE STATED

Name of Soil	*Locality*	*Section*	*Origin*	% P_2O_5	% K_2O	% N	% CaO	% MgO	% SiO_2	% Al_2O_3	% Fe_2O_3	% TiO_2	% Na_2O	% MnO	% *Organic carbon*
Osage silt loam [12]	Cherokee Co., Kan.	soil 0–7 in.	Allu-vium	.07	1.39	.18	.30	—	—	—	—	—	—	—	1.67
" " " [12]	"	Upper subsoil 7–20 in.	"	.04	1.45	.09	.47	—	—	—	—	—	—	—	.88
" " " [12]	"	Lower subsoil 20–35 in.	"	.06	1.31	.08	.37	—	—	—	—	—	—	—	.60
Osage silty clay loam [12]	"	soil 0–7 in.	"	.09	1.29	.17	.56	—	—	—	—	—	—	—	1.79
" " " [12]	"	Upper subsoil 7–20 in.	"	.08	1.30	.09	.53	—	—	—	—	—	—	—	.87
" " " [12]	"	Lower subsoil 20–40 in.	"	.04	1.34	.08	.96	—	—	—	—	—	—	—	.81
Cherokee silt loam [12]	"	soil 0–7 in.	Shale	.05	.62	.10	.42	—	—	—	—	—	—	—	1.05
" " " [12]	"	Upper subsoil 7–20 in.	"	.07	.80	.09	.47	—	—	—	—	—	—	—	.87
" " " [12]	"	Lower subsoil 20–40 in.	"	.07	.92	.05	.56	—	—	—	—	—	—	—	.29
Summit silt loam [12]	"	soil 0–7 in.	Lime-stone and shale	.03	.99	.13	.71	—	—	—	—	—	—	—	1.38
" " " [12]	"	Upper subsoil 7–20 in.	"	.04	1.32	.12	.75	—	—	—	—	—	—	—	1.06
" " " [12]	"	Lower subsoil 20–40 in.	"	.04	1.36	.04	1.84	—	—	—	—	—	—	—	.43
Crawford silt loam [12]	"	soil 0–7 in.	Lime-stone	.02	.96	.15	.67	—	—	—	—	—	—	—	1.54

[12] Analyses from Bulletin Agricultural Experimental Station, Kansas State Agr. College, No. 207: Soil Survey of Cherokee County Kan.

Chemical Analyses (by Fusion Method) of Some Important Southern Soils. Analyses Made in the Laboratory of the Bureau of Soils, Except as Otherwise Stated

Name of Soil	*Locality*	*Section*	*Origin*	% P_2O_5	% K_2O	% *N*	% *CaO*	% *MgO*	% SiO_2	% Al_2O_3	% Fe_2O_3	% TiO_2	% Na_2O	% *MnO*	% *Organic carbon*
Crawford silt loam [12]	Cherokee Co., Kan.	Upper subsoil 7-20 in.	Limestone	.04	1.03	.12	.74	—	—	—	—	—	—	—	1.29
" " " [12]	"	Lower subsoil 20-40 in.	"	.05	1.03	.09	—	—	—	—	—	—	—	—	.87
Oswego clay [12]	"	soil 0-7 in.	Shale	.08	1.35	.22	1.07	—	—	—	—	—	—	—	2.42
" " [12]	"	Upper subsoil 7-20 in.	"	.07	1.40	.13	1.33	—	—	—	—	—	—	—	1.41
" " [12]	"	Lower subsoil 20-40 in.	"	.05	1.40	.06	1.65	—	—	—	—	—	—	—	.56
Oswego silty clay loam [12]	"	soil 0-7 in.	"	.08	.99	.14	.54	—	—	—	—	—	—	—	1.76
" " [12]	"	Upper subsoil 7-20 in.	"	.05	1.32	.10	.46	—	—	—	—	—	—	—	1.02
" " [12]	"	Lower subsoil 20-40 in.	"	.06	1.36	.07	.50	—	—	—	—	—	—	—	.76
Bates silt loam [12]	"	soil 0-7 in.	"	.08	.75	.14	.50	—	—	—	—	—	—	—	1.38
" " " [12]	"	Upper subsoil 7-20 in.	"	.08	.88	.09	.36	—	—	—	—	—	—	—	.79
" " " [12]	"	Lower subsoil 20-40 in.	"	.06	.94	.07	.47	—	—	—	—	—	—	—	.41
Kirkland clay [13]	Reno Co., Kan.	soil 0-7 in.	Shale	.09	2.42	.20	3.40	—	—	—	—	—	—	—	2.03
" " [13]	"	subsoil 7-16 in.	"	.09	1.98	.10	6.76	—	—	—	—	—	—	—	1.46

[12] Analyses from Bulletin Agricultural Experiment Station, Kansas State Agricultural College, No. 207: Soil Survey of Cherokee County, Kan.

[13] Analyses from Bulletin Agricultural Experiment Station, Kansas State Agricultural College, No. 208: Soil Survey of Reno County, Kan.

Chemical Analyses (by Fusion Method) of Some Important Southern Soils. Analyses Made in the Laboratory of the Bureau of Soils, Except as Otherwise Stated

Name of Soil	*Locality*	*Section*	*Origin*	% P_2O_5	% K_2O	% N	% CaO	% MgO	% SiO_2	% Al_2O_3	% Fe_2O_3	% TiO_2	% Na_2O	% MnO	% Organic carbon
Arkansas clay [13]	Reno Co., Kan.	soil 0–10 in.	Alluvium	.09	2.55	.12	.78	—	—	—	—	—	—	—	1.23
" " [13]	"	subsoil 10–20 in.	"	.09	2.83	.03	.58	—	—	—	—	—	—	—	.34
Arkansas clay loam [13]	"	soil 0–7 in.	"	.08	2.44	.18	1.20	—	—	—	—	—	—	—	2.08
" " [13]	"	Upper subsoil 7–20 in.	"	.07	2.29	.08	1.31	—	—	—	—	—	—	—	1.03
" " [13]	"	Lower subsoil 20–40 in.	"	.08	2.21	.05	5.02	—	—	—	—	—	—	—	.59
Pratt loam [13]	"	soil 0–7 in.	Outwash plain material	.10	2.52	.11	.58	—	—	—	—	—	—	—	1.05
" " [13]	"	Upper subsoil 7–20 in.	"	.11	2.44	.10	.61	—	—	—	—	—	—	—	.75
" " [13]	"	Lower subsoil 20–40 in.	"	.11	2.38	.05	.61	—	—	—	—	—	—	—	.32
Pratt silty clay loam [13]	"	soil 0–7 in.	"	.08	2.18	.16	.86	—	—	—	—	—	—	—	1.82
" " " [13]	"	Upper subsoil 7–20 in.	"	.07	2.18	.10	.86	—	—	—	—	—	—	—	1.01
" " " [13]	"	Lower subsoil 20–36 in.	"	.09	2.31	.06	1.40	—	—	—	—	—	—	—	.46
Pratt very fine sandy loam [13]	"	soil 0–7 in.	"	.07	2.73	.08	.77	—	—	—	—	—	—	—	.96
" " " [13]	"	Upper subsoil 7–20 in.	"	.04	2.61	.05	.72	—	—	—	—	—	—	—	.61
" " " [13]	"	Lower subsoil 20–40 in.	"	.04	2.67	.03	.57	—	—	—	—	—	—	—	.32

[13] Analyses from Bulletin Agricultural Experiment Station, Kansas State Agricultural College, No. 208: Soil Survey of Reno County, Kan.

Chemical Analyses (by Fusion Method) of Some Important Southern Soils. Analyses Made in the Laboratory of the Bureau of Soils, Except as Otherwise Stated

Name of Soil	*Locality*	*Section*	*Origin*	% P_2O_5	% K_2O	% N	% CaO	% MgO	% SiO_2	% Al_2O_3	% Fe_2O_3	% TiO_2	% Na_2O	% MnO	% *Organic carbon*
Vernon very fine sandy loam [13]	Reno Co., Kan.	soil 0–7 in.	Sandstone	.07	2.14	.11	.65	—	—	—	—	—	—	—	1.17
" " " [13]	"	Upper subsoil 7-20 in.	"	.07	2.12	.09	1.30	—	—	—	—	—	—	—	.84
" " " [13]	"	Lower subsoil 20–40 in.	"	.07	2.13	.06	1.52	—	—	—	—	—	—	—	.53
Arkansas fine sandy loam [13]	"	soil 0–7 in.	Alluvium	.10	3.16	.07	.71	—	—	—	—	—	—	—	.77
" " [13]	"	Upper subsoil 7–20 in.	"	.07	3.19	.04	.82	—	—	—	—	—	—	—	.40
" " [13]	"	Lower subsoil 20–36 in.	"	.06	2.52	.04	.81	—	—	—	—	—	—	—	.32
Arkansas fine sand [13]	"	soil 0–30 in.	"	.06	2.91	.03	.77	—	—	—	—	—	—	—	.28
Dune sand [13]	"	soil 1–10 in.	Wind-blown material	.04	2.42	.01	.50	—	—	—	—	—	—	—	—
Colby silt loam [14]	Jewell Co., Kan.	soil 0–7 in.	Loess	.09	2.44	.16	1.00	—	—	—	—	—	—	—	1.82
" " " [14]	"	Upper subsoil 7–20 in.	"	.10	2.52	.10	.67	—	—	—	—	—	—	—	1.04
" " " [14]	"	Lower subsoil 20–40 in.	"	.12	2.60	.06	1.48	—	—	—	—	—	—	—	.70
" " " [14]	"	soil 0–7 in.	"	.08	2.50	.14	1.55	—	—	—	—	—	—	—	1.77
" " " [14]	"	Upper subsoil 7–20 in.	"	.09	2.54	.10	1.05	—	—	—	—	—	—	—	1.05

[13] Analyses from Bulletin Agricultural Experiment Station, Kansas State Agricultural College, No. 208: Soil Survey of Reno County, Kan.

[14] Analyses from Bulletin Agricultural Experiment Station, Kansas State Agricultural College, No. 211: Soil Survey of Jewell County, Kan.

Chemical Analyses (by Fusion Method) of Some Important Southern Soils. Analyses Made in the Laboratory of the Bureau of Soils, Except as Otherwise Stated

Name of Soil	*Locality*	*Section*	*Origin*	% P_2O_5	% K_2O	% N	% CaO	% MgO	% SiO_2	% Al_2O_3	% Fe_2O_3	% TiO_2	% Na_2O	% MnO	% *Organic carbon*
Colby silt loam [14]	Jewell Co., Kan.	Lower subsoil 20–40 in.	Loess	.10	2.59	.05	1.12	—	—	—	—	—	—	—	.50
Colby very fine sandy loam [14]	"	soil 0–7 in.	"	.07	2.46	.09	.92	—	—	—	—	—	—	—	1.01
" " " [14]	"	Upper subsoil 7–20 in.	"	.06	2.52	.08	1.16	—	—	—	—	—	—	—	.91
" " " [14]	"	Lower subsoil 20–36 in.	"	.06	2.56	.06	.96	—	—	—	—	—	—	—	.59
Colby silty clay loam [14]	"	soil 0–5 in.	"	.10	2.50	.16	.90	—	—	—	—	—	—	—	1.56
" " " [14]	"	Upper subsoil 5–16 in.	"	.10	2.55	.09	1.16	—	—	—	—	—	—	—	.93
" " " [14]	"	Lower subsoil 16–40 in.	"	.12	2.55	.05	1.69	—	—	—	—	—	—	—	.22
" " " [14]	"	soil 0–7 in.	"	.09	2.37	.14	1.00	—	—	—	—	—	—	—	1.64
" " " [14]	"	Upper subsoil 7–20 in.	"	.09	2.35	.10	.89	—	—	—	—	—	—	—	1.10
" " " [14]	"	Lower subsoil 20–40 in.	"	.09	2.46	.06	1.20	—	—	—	—	—	—	—	.62
Benton silty clay loam [14]	"	soil 0–7 in.	Limestone and shale	.13	1.75	.24	6.67	—	—	—	—	—	—	—	2.79
" " " [14]	"	Upper subsoil 7–20 in.	"	.12	1.58	.19	7.29	—	—	—	—	—	—	—	2.11
" " " [14]	"	Lower subsoil 20–40 in.	"	.11	1.08	.08	7.43	—	—	—	—	—	—	—	1.05
Lincoln silty clay loam [14]	"	soil 0–7 in.	Alluvium	.12	2.55	.15	1.45	—	—	—	—	—	—	—	1.82

[14] Analyses from Bulletin Agricultural Experiment Station, Kansas State Agricultural College, No. 211: Soil Survey of Jewell County, Kan.

Chemical Analyses (by Fusion Method) of Some Important Southern Soils. Analyses Made in the Laboratory of the Bureau of Soils, Except as Otherwise Stated

Name of Soil	*Locality*	*Section*	*Origin*	% P_2O_5	% K_2O	% *N*	% *CaO*	% *MgO*	% SiO_2	% Al_2O_3	% Fe_2O_3	% TiO_2	% Na_2O	% *MnO*	% *Organic carbon*
Lincoln silty clay loam [14]	Jewell Co., Kan.	Upper subsoil 7–20 in.	Alluvium	.12	2.54	.12	1.58	—	—	—	—	—	—	—	1.37
" " " [14]	"	Lower subsoil 20–40 in.	"	.09	2.53	.08	1.23	—	—	—	—	—	—	—	.98
Lincoln silt loam [14]	"	soil 0–7 in.	"	.14	2.58	.21	3.23	—	—	—	—	—	—	—	2.23
" " " [14]	"	Upper subsoil 7–20 in.	"	.13	2.48	.14	3.56	—	—	—	—	—	—	—	1.37
" " " [14]	"	Lower subsoil 20–40 in.	"	.08	2.56	.09	2.25	—	—	—	—	—	—	—	1.19
Osage silt loam [15]	Shawnee Co., Kan.	soil 0–7 in.	"	.12	2.22	.16	.51	—	—	—	—	—	—	—	2.16
" " " [15]	"	Upper subsoil 7–20 in.	"	.10	2.14	.16	.71	—	—	—	—	—	—	—	1.82
" " " [15]	"	Lower subsoil 20–40 in.	"	.10	2.17	.11	1.05	—	—	—	—	—	—	—	1.10
Osage silty clay loam [15]	"	soil 0–7 in.	"	.15	2.48	.20	1.28	—	—	—	—	—	—	—	2.50
" " " [15]	"	Upper subsoil 7–20 in.	"	.13	2.58	.16	1.14	—	—	—	—	—	—	—	1.90
" " " [15]	"	Lower subsoil 20–40 in.	"	.09	2.67	.11	1.20	—	—	—	—	—	—	—	1.46
Osage very fine sandy loam [15]	"	soil 0–7 in.	"	.05	2.34	.12	1.13	—	—	—	—	—	—	—	1.55
" " " [15]	"	Upper subsoil 7–20 in.	"	.04	2.38	.08	1.02	—	—	—	—	—	—	—	.83

[14] Analyses from Bulletin Agricultural Experiment Station, Kansas State Agricultural College, No. 211: Soil Survey of Jewell County, Kan.

[15] Analyses from Bulletin Agricultural Experiment Station, Kansas State Agricultural College, No. 200: Soil Survey of Shawnee County, Kan.

Chemical Analyses (by Fusion Method) of Some Important Southern Soils. Analyses Made in the Laboratory of the Bureau of Soils, Except as Otherwise Stated

Name of Soil	Locality	Section	Origin	% P_2O_5	% K_2O	% N	% CaO	% MgO	% SiO_2	% Al_2O_3	% Fe_2O_3	% TiO_2	% Na_2O	% MnO	% Organic carbon
Osage very fine sandy loam [15]	Shawnee Co., Kan.	Lower subsoil 20–40 in.	Alluvium	.03	2.48	.05	1.17	—	—	—	—	—	—	—	.90
Osage very fine sand [15]	"	soil 1–12 in.	"	.05	2.47	.04	1.30	—	—	—	—	—	—	—	.26
" " " [15]	"	subsoil 12–40 in.	"	.09	2.44	.03	1.36	—	—	—	—	—	—	—	.21
Shelby loam [15]	"	soil 0–7 in.	Glacial material	.06	1.28	.13	.70	—	—	—	—	—	—	—	1.64
" " [15]	"	Upper subsoil 7–20 in.	"	.04	1.35	.09	1.05	—	—	—	—	—	—	—	1.08
" " [15]	"	Lower subsoil 20–30 in.	"	.05	1.38	.05	1.07	—	—	—	—	—	—	—	.50
" " [15]	"	soil 0–7 in.	"	.06	2.46	.13	.46	—	—	—	—	—	—	—	1.69
" " [15]	"	Upper subsoil 7–20 in.	"	.06	2.53	.09	.42	—	—	—	—	—	—	—	1.22
" " [15]	"	Lower subsoil 20–40 in.	"	.04	2.61	.06	.37	—	—	—	—	—	—	—	.71
Crawford silty clay loam [15]	"	soil 0–7 in.	Limestone	.09	1.88	.25	.54	—	—	—	—	—	—	—	2.73
" " [15]	"	Upper subsoil 7–20 in.	"	.07	1.78	.18	.68	—	—	—	—	—	—	—	1.85
" " [15]	"	Lower subsoil 20–30 in.	"	.08	1.92	.09	1.30	—	—	—	—	—	—	—	.70
Oswego silt loam [15]	"	soil 0–7 in.	Shale	.08	1.76	.21	.79	—	—	—	—	—	—	—	2.85

[15] Analyses from Bulletin Agricultural Experiment Station, Kansas State Agricultural College, No. 200: Soil Survey of Shawnee County, Kan.

CHEMICAL ANALYSES (BY FUSION METHOD) OF SOME IMPORTANT SOUTHERN SOILS. ANALYSES MADE IN THE LABORATORY OF THE BUREAU OF SOILS, EXCEPT AS OTHERWISE STATED

Name of Soil	*Locality*	*Section*	*Origin*	% P_2O_5	% K_2O	% N	% CaO	% MgO	% SiO_2	% Al_2O_3	% Fe_2O_3	% TiO_2	% Na_2O	% MnO	% Organic carbon
Oswego silt loam [15]	Shawnee Co., Kan.	Upper subsoil 7–20 in.	Shale	.06	1.72	.14	.78	—	—	—	—	—	—	—	1.69
" " " [15]	"	Lower subsoil 20–40 in.	"	.09	2.02	.07	1.34	—	—	—	—	—	—	—	.83
Summit silty clay loam [15]	"	soil 0–7 in.	Limestone and shale	.11	2.05	.30	.93	—	—	—	—	—	—	—	3.62
" " " [15]	"	Upper subsoil 7–20 in.	"	.10	2.28	.16	1.61	—	—	—	—	—	—	—	1.71
" " " [15]	"	Lower subsoil 20–40 in.	"	.05	2.55	.09	.65	—	—	—	—	—	—	—	.82
Richfield clay loam	Lubbock Co., Tex.	soil 0–10 in.	Outwash plain material	.10	1.83	.03	.63	.87	79.64	8.27	2.74	.52	1.12	.03	—
" "	"	Uppper subsoil 10–18 in.	"	.04	1.75	.02	.78	1.10	78.97	9.12	2.89	.46	.72	.02	—
" "	"	Lower subsoil 18–25 in.	"	.09	1.34	.03	14.09	1.67	56.66	8.45	2.72	.43	.30	.03	—
Decatur silt loam [16]	Logan Co., Ky.	soil 0–6 in.	Limestone	.09	1.61	—	.59	.50	84.08	7.49	1.28	1.12	—	—	—
" " " [16]	"	subsoil 6–18 in.	"	.06	1.72	—	.53	.53	80.74	9.80	2.40	1.30	—	—	—

[15] Analyses from Bulletin Agricultural Experiment Station, Kansas State Agricultural College, No. 200: Soil Survey of Shawnee County, Kan.

[16] Analyses by Kentucky Agricultural Experiment Station.

APPENDIX C

(Some valuable publications on soils, soil physics, soil chemistry, soil management, crops, live stock, etc.)

Field Operations, published annually by the Bureau of Soils, U. S. Department of Agriculture.

Separate Soil Survey reports, *Advanced Sheets—Field Operations*, published at frequent intervals by the Bureau of Soils, U. S. Department of Agriculture. Also bulletins and circulars.

Farmers' Bulletins covering a large variety of agricultural subjects, published by the U. S. Department of Agriculture.

Bulletins covering a wide range of agricultural subjects, published by the State Experiment Stations and Colleges of Agriculture.

Soils: Their Formation, Properties, Composition, and Relation to Plant Growth, Hilgard, E. W.

The Soil: Its Nature, Relations and Fundamental Principles of Management, King, F. H.

The Story of the Soil, Hopkins, C. G.

The Soil, Hall, A. D.

The Soil, King, F. H.

Soil Conditions and Plant Growth, Russell, E. J.

The Soils of the United States, Bulletin No. 96, Bureau of Soils, U. S. Department of Agriculture, Marbut, Bennett, Lapham, and Lapham.

A Study of the Soils of the United States, Bulletin No. 85, Bureau of Soils, U. S. Department of Agriculture, Coffey, G. N.

Instructions to Field Parties, published by the Bureau of Soils, U. S. Department of Agriculture.

Soils, Fletcher, S. W.

Rocks and Soils, Stockbridge, H. E.

Rocks, Rock Weathering, and Soils, Merrill, G. P.

Die Typen der Bodenbildung, Glinka, G. K.

Soil Physics, King, F. H.

Physical Properties of the Soil, Warrington, Robert.

Physical Properties of Soils, McCall, A. G.

The Soils of Missouri, Bulletin 153, College of Agriculture, University of Missouri, Miller and Krusekopf.

The Soils of Mississippi, Technical Bulletin, No. 7, Mississippi Agriculture College, Logan, W. N.
The Soils of Kentucky, Bulletin No. 193, Kentucky Agricultural Experiment Station, Averitt, S. D.
The Soils of Tennessee, Bulletin No. 3, University of Tennessee, Vanderford, C. F.
Mississippi: Its Geology, Geography, Soil, and Mineral Resources, Bulletin No. 14, Mississippi State Geological Survey, Lowe, E. N.
The Composition of the Soils of South Texas, Bulletin No. 161 (and other similar bulletins covering other parts of Texas), Texas Agricultural Experiment Station, Fraps, G. S.
Soils: Their Properties and Management, Lyon, Fippin, and Buckman.
Soil Management, King, F. H.
The Soil Solution, Cameron, F. K.
Soils and Fertilizers, Snyder, H.
Rothamstead Experiments, Hall, A. D.
How Crops Grow, Johnson, S. W.
How Crops Feed, Johnson, S. W.
Fertilizers and Crops, Van Slyke, L. L.
Fertilizers, Voorhees, E. B.
Fertilizers and Manures, Hall, A. D.
Soil Fertility and Permanent Agriculture, Hopkins, C. G.
The Fertility of the Land, Roberts, I. P.
Physiology of Plant Production, Duggar, B. M.
Principles of Agriculture, Bailey, L. H.
Cyclopedia of American Agriculture, Bailey, L. H.
Farm Management, Warren, G. F.
How to Choose a Farm, Hunt, T. F.
Soils and Crops of the Farm, Morrow and Hunt.
Successful Farming, Gardner, F. D.
Farm Development, Hays, W. M.
Principles of Rural Economics, Carver, T. N.
The Conservation of Natural Resources in the United States, Van Hise, C. R.
Agricultural Chemistry, Ince and Tottingham.
Crop Rotation and Field Management, Parker.
Crops and Methods of Soil Improvement, Agee.
Agricultural Bacteriology, Conn, H. W.
Dry Farming, Widtsoe, John.
The Water Requirements of Plants, Bulletin No. 284, Bureau

of Plant Industry, U. S. Department of Agriculture, Briggs and Shantz.
The Conquest of Arid America, Smythe, W. E.
Irrigation and Drainage, King.
Principles of Irrigation Practice, Widtsoe, J.
Irrigation Institutions, Mead, Elwood.
Engineering for Land Drainage, Elliott, C. G.
The Cereals in America, Hunt, T. F.
Farm Grasses of the United States of America, Spillman, W. J.
Field Crops, Wilson and Warburton.
Alfalfa, Wing, Joe.
The Book of Alfalfa, Coburn, F. D.
The Forage and Fiber Crops, Hunt, T. F.
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Clovers and How to Grow Them, Shaw, Thomas.
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Corn Book, Bowman and Crossley.
The Potato, Grubb, E. H.
Southern Field Crops, Duggar, J. F.
The American Apple Orchard, Waugh, F. A.
The American Peach Orchard, Waugh, F. A.
The Nursery Book, Bailey, L. H.
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Citrus Fruits and Their Culture, Hume, H. H.
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Tropical Agriculture, Wilcox, E. V.
Feeds and Feeding, Henry, W. A.
Beef Production, Mumford, H. W.
Types and Breeds of Farm Animals, Plumb, C. S.
Domesticated Animals and Plants, Davenport, Eugene.
Milk and Its Products, Wing, H. H.
Dairy Farming, Eckles and Warren.
Silos, Ensilage, and Silage, Miles, Manly.
Sheep Feeding and Farm Management, Doane, D. H.
Productive Poultry Husbandry, Lewis, H. R.
Productive Swine Husbandry, Day, G. E.
Swine, Dietrich, William.
Diseases of Economic Plants, Stevens and Hall.
Garden Farming, Lee, Cleavel, and Corbett.
The Principles of Handling Farm Woodlands, Graves, H. S.
Farm Science, Spillman, W. J.

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The Soy Bean: Its Culture and Uses, F. B. 973.
Sweet Clover: Growing the Crop, F. B. 797.
Bur Clover, F. B. 693.
Crimson Clover, F. B. 550.
Red Clover, F. B. 455.
Alfalfa, F. B. 339.
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Cowpeas, F. B. 318.
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Strawberry Culture, South Atlantic and Gulf Coast States, F. B. 1026.
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Fig Growing in the South Atlantic and Gulf States, F. B. 1031.
Growing Peaches, F. B. 917.
Preparation of Barreled Apples for Market, F. B. 1080.
Growing Fruit for Home Use, F. B. 1001.
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Insects of a Citrus Grove, Bulletin 148, University of Florida.
Fumigating Citrus Fruits, F. B. 923.
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Bermuda Grass, F. B. 814.
Wheat Growing in the Southeastern States, F. B. 885.
Spring Oat Production, F. B. 892.
Corn Culture in the Southeastern States, F. B. 729.
Rye Growing in the Southeastern States, F. B. 894.
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[1] F. B. = Farmers' Bulletin, published by the U. S. Department of Agriculture.

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Thirty-five Years' Results with Fertilizers, Bulletin 146, Pennsylvania State College.

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Systems of Hog Farming in the Southeastern States, F. B. 985.
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Surface Irrigation for Eastern Farms, F. B. 899.
Frost and the Growing Season, Atlas of American Agriculture, Part II, Section 1.
The Boll-Weevil Problem, F. B. 848.
How Insects Affect the Cotton Plant and Means of Combating Them, F. B. 890.
Farm Practices that Increase Crop Yields in the Gulf Coast Region, F. B. 986.
Prickly Pear as Stock Feed, F. B. 1072.
Growing Beef on the Farm, F. B. 1073.
Prairie Rice Culture, F. B. 1092.
Frost and the Prevention of Damage By It, F. B. 1096.
Soy Beans in Systems of Farming in the Cotton Belt, F. B. 931.
Classification of American Upland Cotton, F. B. 802.
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The Cost of Producing Cotton, Bul., U. S. Dept. Agr., No. 896.

APPENDIX D

The tables below give statistics bearing on some of the important farm products of the Southern States. The data are mainly from the estimates and statistics of the United States Department of Agriculture, Bureau of Crop Estimates.

TOBACCO: ACREAGE AND PRODUCTION, BY STATES, CROP OF 1918

State	Acreage[1]	Production	State	Acreage	Production
		Pounds			*Pounds*
Maryland........	32,000	26,560,000	Tennessee.....	77,800	62,240,000
Virginia..........	215,000	165,550,000	Alabama......	1,500	1,050,000
West Virginia.....	13,600	9,792,000	Louisiana.....	300	126,000
North Carolina...	468,000	329,940,000	Georgia........	4,500	3,600,000
South Carolina...	86,400	62,208,000			
Florida..........	4,600	4,416,000	Southern States	1,397,000	1,138,852,000
Missouri.........	3,300	2,970,000			
Kentucky........	490,000	470,400,000	United States	1,647,100	1,439,071,000

[1] It is estimated that for those States which grow more than one type of tobacco that the approximate acreage devoted to each type in 1918 was as follows:

Va.—Sun-cured, 7 per cent; Virginia Dark, 36 per cent; Old Bright belt, 57 per cent.

N. C.—Old Bright belt, 33 per cent; New Bright belt, 66 per cent, all others, 1 per cent.

W. Va.—Burley, 92 per cent; Export, 5 per cent; all other, 3 per cent.

Tenn.—Burley, 8 per cent; Paducah, 28 per cent; Clarksville and Hopkinsville, 47 per cent; One-sucker, 16 per cent; all other, 1 per cent.

Ky.—Burley, 45 per cent; Paducah, 15 per cent; Stemming, 18 per cent; One-sucker, 8 per cent; Clarksville and Hopkinsville, 13 per cent; all others, 1 per cent.

CANE SUGAR AND MOLASSES: ACREAGE AND PRODUCTION, CROP OF 1918

State	Acreage	Production	
		Sugar	Molasses
		Pounds	*Gallons*
Louisiana..........	231,200	561,800,000	30,724,000
Texas.............	5,500	7,000,000	

SUGAR CANE AND SORGHUM HARVESTED FOR SIRUP: ACREAGE AND PRODUCTION, CROP OF 1918

State	Sugar cane for sirup		Sorghum	
	Acreage	Gallons	Acreage	Gallons
Virginia			10,000	920,000
West Virginia			5,400	459,000
North Carolina	680	78,000	48,000	4,704,000
South Carolina	7,000	959,000	8,000	640,000
Georgia	50,000	8,500,000	15,000	1,365,000
Florida	13,000	2,800,000	600	72,000
Missouri			21,600	1,512,000
Kansas			10,000	470,000
Kentucky			33,200	2,822,000
Tennessee			22,500	2,070,000
Alabama	56,000	8,195,000	123,200	9,486,000
Mississippi	23,500	4,740,000	5,200	416,000
Louisiana	27,500	10,793,000	600	52,000
Texas	1,300	220,000 [1]	8,800	458,000 [1]
Oklahoma			7,600	251,000
Arkansas	1,700	170,000	16,000	960,000
Total:	180,680	36,455,000	335,700	26,657,000

[1] Texas made a poor crop in 1918 due to drought. The estimated production for that State in 1919 is more than 2,000,000 gals.

IRISH POTATOES: ACREAGE AND PRODUCTION, CROP OF 1918

State	Acreage	Production	State	Acreage	Production
		Bushels			Bushels
Delaware	12,000	1,044,000	Tennessee	50,000	3,500,000
Maryland	53,000	4,240,000	Alabama	60,000	4,800,000
Virginia	135,000	12,690,000	Mississippi	20,000	1,600,000
West Virginia	55,000	4,785,000	Louisiana	55,000	4,345,000
North Carolina	65,000	6,175,000	Texas	60,000	3,300,000
South Carolina	28,000	2,856,000	Oklahoma	50,000	1,700,000
Georgia	23,000	1,610,000	Arkansas	48,000	2,400,000
Florida	35,000	3,500,000			
Missouri	114,000	6,954,000	Southern States	1,018,000	75,364,000
Kansas	80,000	4,240,000			
Kentucky	75,000	5,625,000	United States	4,295,000	411,860,000

SWEET POTATOES: ACREAGE AND PRODUCTION, BY STATES, CROP OF 1918

State	Acreage	Production	State	Acreage	Production
		Bushels			Bushels
Delaware	6,000	720,000	Tennessee	35,000	3,430,000
Maryland	11,000	1,430,000	Alabama	148,000	14,208,000
Virginia	32,000	3,840,000	Mississippi	89,000	8,455,000
West Virginia	2,000	212,000	Louisiana	65,000	4,875,000
North Carolina	95,000	10,450,000	Texas	87,000	5,046,000
South Carolina	80,000	7,600,000	Oklahoma	20,000	1,300,000
Georgia	130,000	11,960,000	Arkansas	38,000	3,420,000
Florida	36,000	3,960,000			
Missouri	8,000	728,000	Southern States	901,000	83,379,000
Kansas	4,000	320,000			
Kentucky	15,000	1,425,000	United States	940,000	87,924,000

OATS: ACREAGE AND PRODUCTION, CROP OF 1918

State	Acreage	Production	State	Acreage	Production
		Bushels			Bushels
Delaware	5,000	175,000	Tennessee	325,000	8,125,000
Maryland	60,000	1,980,000	Alabama	428,000	8,132,000
Virginia	225,000	5,175,000	Mississippi	322,000	6,440,000
West Virginia	160,000	4,320,000	Louisiana	80,000	2,000,000
North Carolina	300,000	5,100,000	Texas	1,510,000	22,197,000 [1]
South Carolina	500,000	11,000,000	Oklahoma	1,300,000	31,200,000
Georgia	550,000	11,000,000	Arkansas	390,000	9,945,000
Florida	60,000	1,080,000			
Missouri	1,524,000	44,196,000	Southern States	10,468,000	232,903,000
Kansas	2,329,000	51,238,000			
Kentucky	400,000	9,600,000	United States	44,349,000	1,538,000,000

[1] The Texas crop of 1918 was injured by the big drought. That State produced 37,050,000 bu. of oats in 1917 on 1,425,000 acres.

HAY: ACREAGE AND PRODUCTION,[1] CROP OF 1918

State	Acreage	Production	State	Acreage	Production
		Tons			Tons
Delaware	75,000	94,000	Tennessee	1,240,000	1,674,000
Maryland	455,000	614,000	Alabama	1,243,000	1,007,000
Virginia	1,050,000	1,418,000	Mississippi	347,000	416,000
West Virginia	798,000	1,037,000	Louisiana	225,000	292,000
North Carolina	640,000	768,000	Texas	581,000	581,000
South Carolina	260,000	286,000	Oklahoma	580,000	696,000
Georgia	696,000	863,000	Arkansas	467,000	607,000
Florida	105,000	120,000			
Missouri	2,989,000	2,690,000	Southern States	14,692,000	17,790,000
Kansas	1,869,000	3,233,000			
Kentucky	1,072,000	1,394,000	United States	55,755,000	76,660,000

[1] These figures do not include a large production of hay cut in the Southern States from the voluntary growth of such grasses as crab and crowfoot appearing in fields of cotton, corn, vegetables, and other crops after the last cultivation of the planted crop. Hay, as here used, includes all cultivated grasses, grains cut green for hay, wild, salt, or prairie grasses, and coarse forage crops.

SOY BEANS: ACREAGE AND PRODUCTION (FOR GRAIN), CROP OF 1918

State	Acreage	Production	State	Acreage	Production
		Bushels			Bushels
Virginia	28,000	630,000	Tennessee	2,000	10,000
North Carolina	85,000	1,700,000	Alabama	22,000	240,000
South Carolina	1,000	6,000			
Georgia	1,000	11,000	Southern States	149,000	2,697,000
Missouri	5,000	40,000			
Kentucky	5,000	60,000	United States	180,000	3,041,000

VELVET BEANS: ACREAGE—PRINCIPAL STATES GROWING VELVET BEANS IN 1917

State	*Acreage*	*State*	*Acreage*
Alabama	2,334,000	South Carolina	188,000
Georgia	1,300,000	North Carolina	138,000
Mississippi	705,000		
Florida	500,000	Total	5,165,000

RICE: ACREAGE AND PRODUCTION, CROP OF 1918

State [1]	*Acreage*	*Production*	*State*	*Acreage*	*Production*
		Bushels			*Bushels*
North Carolina	500	10,000	Louisiana	580,000	16,704,000
South Carolina	4,500	104,000	Texas	245,000	7,840,000
Georgia	1,200	31,000	Arkansas	170,000	6,443,000
Florida	1,200	29,000			
Missouri	550	25,000	Southern States	1,006,550	31,270,000
Alabama	600	15,000			
Mississippi	3,000	69,000	United States	1,118,550	38,606,000

[1] California is the only other rice-producing State of any importance.

PEANUTS: ACREAGE AND PRODUCTION, CROP OF 1918

State [1]	*Acreage*	*Production*	*State*	*Acreage*	*Production*
		Bushels			*Bushels*
Virginia	140,000	5,775,000	Mississippi	5,000	160,000
North Carolina	145,000	5,800,000	Louisiana	4,000	108,000
South Carolina	14,000	630,000	Texas	488,000	5,368,000
Georgia	314,000	8,792,000	Oklahoma	20,000	440,000
Florida	153,000	5,202,000	Arkansas	21,000	546,000
Missouri	400	16,000			
Tennessee	18,000	684,000	Total	1,865,400	46,010,000
Alabama	543,000	12,489,000			

[1] These are the only states reported as producing peanuts.

GRAIN SORGHUMS [1] AND BROOM CORN: ACREAGE AND PRODUCTION, CROP OF 1918

State [2]	*Grain sorghums*		*Broom corn*	
	Acres	*Bushels*	*Acres*	*Tons*
Kansas	2,139,000	20,107,000	58,000	8,500
Texas	1,605,000	24,075,000	74,000	19,200
Oklahoma	1,800,000	18,000,000	140,000	16,100

[1] Kafirs, milo maize, feterita.

[2] These are the principal States producing these crops.

APPLES: PRODUCTION BY STATES, COMMERCIAL CROP OF 1918

State	*Barrels*	*State*	*Barrels*
Delaware	186,000	Tennessee	218,000
Maryland	315,000	Alabama	26,000
Virginia	1,766,000	Texas	11,000
West Virginia	1,092,000	Oklahoma	17,000
North Carolina	184,000	Arkansas	241,000
Georgia	117,000		
Missouri	735,000	Southern States	5,349,000
Kansas	333,000		
Kentucky	108,000	United States	24,743,000 [1]

[1] The total apple crop of the country for 1918 is estimated at 173,632,000 bushels.

APPROXIMATE RELATIVE PRODUCTION OF THE PRINCIPAL VARIETIES OF APPLES, EXPRESSED AS PERCENTAGES OF A NORMAL CROP OF APPLES

Variety	*Va.*	*W. Va.*	*Mo.*	*Ky.*	*Ark.*	*N. C.*	*Tenn.*	*Kan.*	*Md.*	*Okla.*	*Ga.*
	%	%	%	%	%	%	%	%	%	%	%
Arkansas (Mammoth Black Twig)	3.1	.7	1.1	.9	2.3				4.4		
Arkansas Black	.7	.8	1.5	3.0	3.0					5.6	1.6
Baldwin	2.8	5.8	1.5	2.9	.4				8.8		
Ben Davis	11.4	15.7	34.2	16.8	44.1	7.5	12.2	19.4	17.0	25.8	12.2
Early Harvest	4.7	3.9	2.0	6.4	2.0	7.2	8.4		4.2		6.1
Gano	.6	1.6	6.5	.2	6.6			6.0		4.0	
Grimes Golden	2.6	4.6	3.6	2.6	2.1						
Horse	1.0		.5	2.1	1.5	7.2	6.3				14.3
Jonathan	1.0	1.7	10.4	2.5	3.7			13.8		8.2	
Limbertwig	2.5	.8	1.5	4.0	5.8	14.3	12.1				8.8
Maiden Blush	1.5	2.5	2.8	4.5	1.0			4.3			
Missouri Pippin	.2	.1	3.0	.5	1.4			8.6		12.1	
Red June	1.8	1.3	1.9	4.3	2.7	5.9	5.4				10.0
Rome Beauty	1.2	18.7	1.7	9.6	1.8						
Stayman Winesap	5.3	1.9	1.8	1.9	1.7				7.0		
Winesap	20.7	1.8	6.8	14.0	8.4	12.2	14.1	15.3	7.6	8.1	7.6
Albemarle (Newtown) Pippin	7.0	.3	.1	.2							
Yellow Transparent	1.5	3.2	1.1	3.2	.4						
York Imperial	15.1	5.0	1.1	.1	.1				16.2		

PEACHES AND PEARS: PRODUCTION,[1] CROP OF 1917

State [2]	*Peaches*	*Pears*	*State*	*Peaches*	*Pears*
	Bushels	*Bushels*		*Bushels*	*Bushels*
Delaware.....	647,000	294,000	Tennessee.....	900,000	75,000
Maryland.....	975,000	525,000	Alabama......	1,830,000	80,000
Virginia.......	800,000	194,000	Mississippi.....	375,000	30,000
West Virginia.	608,000	33,000	Louisiana......	478,000	52,000
North Carolina	1,541,000	150,000	Texas.........	2,352,000	280,000
South Carolina	1,130,000	100,000	Oklahoma.....	1,150,000	45,000
Georgia.......	4,716,000	140,000	Arkansas......	840,000	102,000
Florida.......	122,000	46,000			
Missouri......	890,000	265,000	Southern States	20,409,000	2,755,000
Kansas.......	121,000	140,000			
Kentucky.....	1,034,000	204,000	United States..	45,066,000	13,281,000

[1] The proportion of the crop shipped was considerably less than the total production. The Department of Agriculture estimates that the 1917 commercial crop of peaches for the United States was 28,901,000 bushels or 64 per cent of the total crop.

[2] The commercial peach crop is highly centralized in many States. Washington County, Md., produces about 60 per cent of the Maryland commercial crop; Hampshire, Morgan, and Mineral counties produce 89 per cent of the West Virginia crop; Moore and Montgomery counties produce 60 per cent of the North Carolina crop; Crawford, Johnson, Polk, Sebastian, Franklin, Yell, and Logan counties produce 46 per cent of the commercial peaches of Arkansas; Cherokee, Wood, Smith, Hopkins, and Franklin counties produce 48 per cent of the Texas crop; and Houston and Macon counties produce 60 per cent of the Georgia crop.

ESTIMATED QUANTITY OF COTTONSEED AND COTTONSEED PRODUCTS,[1] CROP OF 1917

	Cottonseed		*Cottonseed products*		*Hulls*	*Linters*
	Produced	*Crushed*	*Oil*	*Cake and meal*		
	Tons	*Tons*	*Gallons*	*Tons*	*Tons*	*500 lb. bales*
Alabama........	230,000	180,118	7,512,000	84,000	43,000	47,540
Arkansas........	432,000	299,524	12,797,000	146,000	67,000	79,351
Georgia.........	847,000	764,457	32,599,000	366,000	180,000	186,655
Louisiana........	284,000	200,712	8,330,000	105,000	37,000	49,623
Mississippi.......	402,000	426,432	18,828,000	216,000	88,000	116,982
North Carolina...	273,000	262,330	11,046,000	124,000	62,000	58,658
Oklahoma.......	426,000	304,946	11,765,000	152,000	70,000	77,889
South Carolina...	550,000	338,443	14,420,000	161,000	77,000	80,918
Tennessee.......	107,000	234,856	10,215,000	109,000	59,000	68,400
Texas...........	1,390,000	1,121,339	42,590,000	545,000	286,000	284,065
Other States.....	99,000	118,523	4,894,000	60,000	27,000	30,721
	5,040,000	4,251,680	174,996,000	2,068,000	996,000	1,080,802

[1] Bulletin 137, Department of Commerce, Bureau of the Census: Cotton Production and Distribution.

CATTLE AND HOGS: NUMBER ON FARMS JANUARY 1, 1919

State	*Cattle*	*Hogs*	*State*	*Cattle*	*Hogs*
	Number	*Number*		*Number*	*Number*
Delaware........	69,000	71,000	Tennessee.....	967,000	1,965,000
Maryland.......	312,000	434,000	Alabama.......	1,345,000	2,223,000
Virginia.........	991,000	1,134,000	Mississippi.....	1,257,000	2,282,000
West Virginia....	609,000	439,000	Louisiana......	1,053,000	1,599,000
North Carolina..	694,000	1,546,000	Texas.........	5,021,000	2,320,000
South Carolina...	447,000	1,056,000	Oklahoma.....	2,005,000	1,036,000
Georgia..........	1,215,000	3,043,000	Arkansas......	1,121,000	1,725,000
Florida..........	1,085,000	1,512,000			
Missouri.........	2,701,000	4,943,000	Southern States	25,300,000	31,477,000
Kansas..........	3,365,000	2,381,000			
Kentucky.......	1,043,000	1,768,000	United States	67,866,000	75,587,000

Farm value of all cattle of Southern States, Jan. 1, 1919......	$1,219,012,000
" " " " " " " United States, " " "	3,796,725,000
" " " " hogs " Southern States, " " "	547,704,000
" " " " " " United States " " "	1,665,987,000

SHEEP: NUMBER ON FARMS JANUARY 1, 1919

State	*Number*	*State*	*Number*
Delaware............	10,000	Tennessee...........	556,000
Maryland............	246,000	Alabama............	140,000
Virginia............	700,000	Mississippi..........	180,000
West Virginia.........	766,000	Louisiana...........	230,000
North Carolina.......	138,000	Texas...............	2,232,000
South Carolina.......	29,000	Oklahoma...........	125,000
Georgia.............	135,000	Arkansas...........	161,000
Florida.............	105,000		
Missouri............	1,495,000	Southern States......	8,982,000
Kansas..............	460,000		
Kentucky............	1,274,000	United States........	48,866,000

ACREAGE OF PASTURE LAND IN 1910 AND CARRYING CAPACITY PER 100 ACRES

State	*Pasture land acreage*	*Carrying capacity, cattle per 100 acres*
Delaware................	103,679	35
Maryland................	800,450	35
Virginia................	4,428,410	28
West Virginia............	3,484,060	28
North Carolina...........	2,056,413	27
South Carolina...........	1,286,912	30
Georgia.................	2,537,399	33
Florida.................	578,742	35
Missouri................	10,781,515	40
Kansas..................	17,115,638	31
Kentucky................	5,810,535	39
Tennessee...............	3,664,451	50
Alabama.................	2,550,100	35
Mississippi..............	3,392,156	35
Louisiana...............	1,348,664	45
Texas...................	63,523,701	20
Oklahoma................	10,013,450	30
Arkansas................	1,716,950	33

VALUE OF PRINCIPAL CROPS AND HYPOTHETICAL VALUE OF ALL CROPS, 1918

State	*Value thirteen principal crops* [1]	*Hypothetical value, all crops* [2]	*States*	*Value thirteen principal crops*	*Hypothetical value, all crops*
	Dollars	*Dollars*		*Dollars*	*Dollars*
Del.......	18,907,000	26,260,000	Tenn.....	245,637,000	319,009,000
Md.......	92,132,000	127,961,000	Ala.......	260,878,000	347,837,000
Va.......	209,147,000	294,573,000	Miss......	297,896,000	408,077,000
W. Va....	94,946,000	137,603,000	La........	180,762,000	291,552,000
N. C.....	407,238,000	565,608,000	Tex.......	580,001,000	707,318,000
S. C.....	351,508,000	456,504,000	Okla......	224,496,000	267,257,000
Ga.......	466,592,000	598,195,000	Ark.......	248,164,000	339,951,000
Fla.......	41,472,000	101,151,000			
Mo.......	409,354,000	481,593,000	So. States.	4,852,224,000	6,320,222,000
Kan......	385,452,000	438,014,000			
Ky.......	337,642,000	411,759,000	U. S......	11,127,953,000	14,094,384,000 [3]

[1] Corn, wheat, oats, barley, rye, buckwheat, flaxseed, rice, potatoes, sweet potatoes, tame hay, tobacco, and lint cotton.

[2] Based upon the ratio of the thirteen crops to all crops produced in the census year 1909.

[3] The estimated (preliminary) value of animals and animal products in the United States for 1918 is $7,164,000,000. This value is not included with the value of crops.

ESTIMATED ACREAGE OF ALL CROPS, 1918

State	*Acres*	*State*	*Acres*
Delaware...........	526,000	Tennessee..........	7,252,000
Maryland...........	2,254,000	Alabama...........	10,569,000
Virginia............	5,577,000	Mississippi.........	8,089,000
West Virginia........	2,351,000	Louisiana..........	4,981,000
North Carolina......	7,832,000	Oklahoma..........	13,744,000
South Carolina......	6,992,000	Texas..............	25,328,000
Georgia............	12,624,000	Arkansas...........	7,399,000
Florida............	1,563,000		
Missouri...........	15,232,000	Southern States.....	161,823,000
Kansas............	22,588,000		
Kentucky...........	6,922,000	United States.......	367,738,000

CONSUMPTION OF COMMERCIAL FERTILIZERS, 1917

(THE AMERICAN FERTILIZER HANDBOOK)

State	*Tons*	*Per cent of total*	*State*	*Tons*	*Per cent of total*
Delaware..........	50,000	.8	Tennessee........	99,584	1.6
Maryland..........	191,900	2.9	Alabama.........	210,000	3.3
Virginia...........	496,217	7.8	Mississippi.......	76,717	1.2
West Virginia.......	41,000	.6	Louisiana........	98,264	1.5
North Carolina.....	849,728	13.2	Texas...........	40,500	.6
South Carolina.....	850,790	13.3	Oklahoma........	21,000	.3
Georgia...........	895,897	14.0	Arkansas.........	58,000	.9
Florida...........	214,068	3.3			
Missouri..........	65,000	1.1	Southern States...	4,359,285	67.9
Kansas...........	7,600	.1			
Kentucky.........	93,000	1.4	United States.....	6,423,043	

ACREAGE VALUE OF ALL CROPS FOR 1918

State	Acreage crop value
	Dollars
Maryland	56
Delaware	50
Virginia	53
West Virginia	58
North Carolina	72
South Carolina	65
Georgia	48
Florida	65
Missouri	32
Kansas	19
Kentucky	49
Tennessee	44
Alabama	33
Mississippi	50
Louisiana	59
Texas	28
Oklahoma	20
Arkansas	46
Southern States	39.66
United States	38.33

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