THE PURPOSE OF A SOIL SURVEY.

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INTRODUCTION.

SOIL SURVEY BASIS FOR IMPROVED AND INTENSIVE CULTIVATION.

At the close of the calendar year 1901 the Bureau of Soils had surveyed and mapped an area of 15,872 square miles, or 10,158,646 acres, of land in 21 States and Territories. This bare statement of fact carries with it no idea of the great variety of soil types that have been identified, the experience that has been gained by the soil survey parties in spending from two to eight months in a locality, nor of the many problems encountered in the selection of suitable crops and methods of cultivation for the different soils. In this field of research that has been developed in the Department of Agriculture there is the basis for improved and intensive cultivation, and information is being acquired of the possibilities of developing industries and improving conditions which is to be an important factor in the agricultural progress of the country.

KNOWLEDGE OF CONDITIONS NECESSARY FOR AGRICULTURAL SUCCESS.

There has never been a time in the history of the world when the different nations and communities have contended so strenuously for commercial supremacy, even for commercial existence, as they do to-day, when the markets of the world are brought close together by the enormously improved transportation facilities of recent years. The operation of the ordinary laws of trade and the relatively low transportation rates which prevail over the railroad and steamship lines have effected such economic changes as to render overproduction almost impossible. It is true that occasionally there will be an overproduction of certain articles, due to unusually favorable climatic conditions or to overconfidence of the people as to the future prices of the commodity; so occasionally there is a local shortage of production, due to unfavorable climatic or commercial conditions, and then potatoes and cabbages, for instance, may be sent with profit to America from Scotland, Ireland, Holland, and Denmark, as has been done this year, or foodstuffs may be sent from this country to the Orient to supply a local deficiency in that quarter.

Apart from these local or seasonal variations, there are in many
localities controlling factors that favor large yields or superior quality, or cheap production of certain articles against which it is difficult to compete in other less favored localities; and industries in such less favored localities are slowly built up and commercial success is only to be attained by the most careful methods and the most intelligent use of all natural advantages.

Individual effort, enthusiasm, training, and knowledge play as large a part in the successful management of agricultural affairs as in any other line of business. There are probably fewer notable successes in agriculture than in manufactures or trade, but this is because of the more complex nature of the problems—the uncertainty of the climatic conditions, not only in the immediate locality where the operations are being conducted, but in other parts of the world where the same commodities are being produced, the length of time required to mature and manipulate the crops, and the extreme difficulty on the part of growers of determining what are the real market demands. It takes more courage and keenness of perception to make a great success in agriculture than in most of the commercial industries. Given a tract of a thousand acres of land in any part of the country, even with unlimited capital for its cultivation, and, except in a very few localities, it requires rare business ability and judgment to make an unqualified commercial success in agricultural pursuits. Yet, there is hardly a portion of the United States at present in which there are not highly successful agricultural enterprises being carried on in which men of ability can command excellent salaries or make for themselves comfortable incomes. In the truck interests, the fruit interests, and the dairy and cattle interests salaries ranging from $5,000 to $6,000 to competent managers of estates are not uncommon, and incomes exceeding these by considerable amounts are frequently enjoyed by men who manage their own lands.

The majority of farmers are not so successful; neither are the majority of business men. The absolute failures in the business world are probably far more numerous than those in agricultural lines. If the worst comes to the farmer, retrenchments can always be made in agricultural pursuits, and a bare subsistence can always be had by a moderate expenditure of money and of labor. The land will at least feed the family, even if it does not clothe and educate them and give them the social advantages they would wish. This is not always so by any means with the business man, and often he has to give up the independent control of affairs and seek employment with others who have a better business capacity.

POSSIBILITIES OF UNPRODUCTIVE AREAS.

There are many areas of our own country in which the soils are too poor or are in such wretched condition that they can not be profitably
farmed to our ordinary crops, and these areas are awaiting special industries or different methods of cultivation. Examples of this kind are numerous. The truck interests have been developed upon a class of soils along the Atlantic seaboard which thirty years ago had merely a nominal value. The pineapple industry of Florida has been developed on what appears to be an absolutely barren quartz sand. The grape and fruit interests now occupy many rough, stony, and mountainous areas that formerly had no more value than the market price of the timber they supported. The development of the arid West through irrigation and the specialization of crops is too well known to require more than passing notice. The introduction of Kiushu rice has enormously increased the value of large tracts of former waste areas of Louisiana and Texas. The introduction of Sumatra tobacco in the Connecticut Valley has augmented the value of the light sandy lands at least 200 or 300 per cent. The introduction of a desirable filler leaf is confidently expected to increase in much the same ratio the price of land in localities where it can be grown. The extension of the fruit orchards on the slopes of the Blue Ridge and Alleghenies is giving a fair commercial value to lands which were formerly almost worthless. What may be done with the vast areas of our Coast and Gulf States, which have been worn out by the exclusive cultivation of cotton or the superficial methods employed, or which have always been unproductive, is a great problem for the future to solve. That some use shall be made of them, that some crop shall be found adapted to them, there is no reason to doubt.

The commercial supremacy of America can have no safer basis than agricultural independence, and with the fierce competition of the present day it is essential that advantage be taken of every natural condition and of the most accurate scientific knowledge. Chief among these natural conditions are the soil and climatic conditions, for it is upon these mainly that agriculture depends. It is for this reason that the soil survey is bound to take a prominent part in the development of this country, serving as a basis for the introduction of new crops imported from other countries, the creation of new industries, and the improvement of the agricultural methods already in use.

THE OLDER METHODS OF SOIL INVESTIGATIONS NOT SATISFACTORY.

For sixty or seventy years agricultural chemists and physicists have tried to work out the basis of the fertility of soils and a practical method of soil classification. The soil is in itself a very complex material, and added to this the constant changes of climatic conditions, the constant factor of weathering influences, and the extremely complicated physiological functions of the plant have made a problem too difficult for solution. Chemical methods are not sufficiently refined,
and the physical problems are too numerous and involved for the scientist to explain satisfactorily even the simplest relation of the soil to the plant. Advances have been made both in chemical and physical lines, and our knowledge of soil phenomena has been greatly extended, but the basis of the relation of soil to plant production is still seemingly far from a satisfactory solution.

While this is so, it has been found possible to use certain methods, both physical and chemical, added to the observation of trained experts in the field, in making a practical classification of soils—a classification based not only upon texture and composition, but upon vegetation as well, which makes it possible to predict safely the extension of industries from one area to another possessing the same character of soil. Thus, while it is impossible to advise definitely from a chemical analysis of a sample of soil sent in to the laboratory as to the kind of crop it will produce or as to the fertilizer requirements, yet as a result of a soil survey it can be determined what new crops can be introduced and what methods are necessary to accomplish desired results.

The soil survey has been developed within the last five or six years by the Bureau (formerly the Division) of Soils, and so much of positive good has resulted that in spite of the liberality of Congress the demands for extension of the survey are far greater than the Department has been able to satisfy.

METHODS OF THE SOIL SURVEY.

THE SURVEY PARTY AND COST OF WORK.

When an area has been selected, a party of from two to four men is sent out and remains in the area from two to eight months, according to the size of the district, the reliability of the maps, the character of the country, the condition of the roads, and the complexity of the soil types. The average rate at which the work has been done heretofore is about 4 square miles per day, or 100 square miles per month (for a party of two men), varying greatly, however, with the conditions, as stated above. The average cost of the work has been $2 a square mile for the survey alone, or $3.50 including the preparation of reports and maps and the salaries of men during the winter, when the field operations can not be carried on. This amounts to about 56 cents per 100 acres.

RELIABLE BASE MAP ESSENTIAL FOR SURVEY WORK.

The first essential for the survey is a reliable base map; if possible, on a scale of 1 inch to the mile, which is the scale of the soil map. This base map should show all the roads, with every turn and angle accurately reproduced, the streams and towns properly located, and, if possible, most of the houses and also contour lines indicating the elevation and position of hills, plains, and valleys. This detail is necessary
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in order that the soil experts may constantly know where they are, so that they may draw their boundary lines between the soil types with exactness. In Western areas, where the lands are reasonably level, where the roads follow section lines, and the country is unwooded, the absence of a suitable base map is not a matter of much moment, as a traverse map may be constructed by the soil-survey party almost as rapidly as the soil work progresses. In hilly or wooded areas, however, the absence of a base map necessitates an actual survey of the area, and this is not considered a proper function of the Bureau of Soils. Wherever possible the topographic sheets of the United States Geological Survey are used, as these indicate accurately the streams and roads, the contour lines, and frequently the houses. In areas where the Geological Survey has done no work reliable county maps may be used, as they are often found to be satisfactory. Where there are neither Geological Survey sheets nor accurate county maps it is almost impossible to carry on the soil survey except through the cooperation of State institutions which will undertake to make a traverse map. Such cooperation has been secured in at least one instance, and the results have been extremely satisfactory. A satisfactory traverse map was made for the Bureau by the North Carolina department of agriculture of the area from Raleigh to Newbern, showing the streams, roads, and houses, embracing 1,000 square miles, at a cost of about $1,000, or at the rate of $1 per square mile.

EQUIPMENT OF THE SURVEY PARTY.

Having secured a base map, the party is provided with a horse and buggy for each two men, and supplied with a compass, an odometer for measuring distances, occasionally with a plane table to survey new roads, and with a soil auger, used to take samples to a depth of 3 feet in the Eastern States and 6 feet in the Western, and with additional lengths of pipe for occasional borings of 15 or 18 feet. Parties in the West, where alkali is likely to be encountered, are equipped with a trunkful of instruments for determining the total salt content of the soil down to a depth of 6 feet or more, and with an outfit for determining in the field the chemical composition of the alkali salts and of the irrigation waters.

It is a great advantage in the development of the work to have a thorough knowledge of the geology of the region; not that this is in itself a basis for soil mapping, but the character of the soil and its distribution is largely influenced in any region by its geology. The physiography or form of the country must also be studied, as this determines to a large extent the distribution of the soils.

SOIL-SURVEY WORK IN THE FIELD.

As an illustration of the way the soil-survey work is carried on, it may be supposed that a party starts out on a straight road 4 miles or
more in length. As they drive along the road one or both of the men go out on either side into the fields for a distance of half a mile, more or less, or halfway across to the next road, according to the character of the country and the position of other roads, and take frequent borings, examining the material carefully, noting the texture, whether sand, silt, or clay, the changes which take place at varying depths, the presence of gravel, the drainage conditions, and the character of the crops or native vegetation. If the boring shows a sandy loam to a depth of 6 or 8 inches and below this a loam grading into a clay at a depth of 24 to 30 inches, the soil will probably be called a sandy loam or a loam, according to the general character of the material as a whole. If these conditions are found to prevail over a considerable area this will be recognized as a soil type, and a local name will be adopted, so as to give it an identity. It may, for instance, be called Cecil sandy loam.

Moving forward with their work, if the party found that the material changed, either in the surface soil or in the subsoil, sufficiently to influence plant growth, the character of this change would be noted; and if it were of sufficient importance and covered an appreciable area, a new type would be established, designated by a different local name, and the characteristics of this soil would be described. The boundary between the two types would then be traced out, the character of the vegetation or crops and the physiography of the country frequently being an important aid in this work.

When the team has traveled 4 miles along the road and the men have worked out half a mile on either side, this constitutes an average day's work for two men, that is, an area of 4 square miles per day. If the soils are very complicated and the types occur in small areas, the progress is much slower; while if the types hold constant over a considerable area, more work can be accomplished. The next day a road parallel to the first road may be taken and the surveys connected.

The number of soil types in the areas that have been surveyed ranges from three to sixteen. In all of these there will be certain local variations, due to slight depressions or slopes or to methods of cultivation; but these variations are not recorded, and it has been found that the general types are quite persistent and the boundaries usually sharply defined. The smallest area which can be shown upon the map is 10 acres in a square tract, which covers an area one-eighth inch square on the map.

When the types have become well established in the minds of the soil experts a description of them is sent in to the Bureau, and this must be so clearly stated that the reason for establishing each type is plainly apparent; otherwise the matter is referred again to the party for more complete information or for possible merging into other types in the same or in other areas.
Separate samples of the soil and of the subsoil are sent in to the laboratory from a number of borings in each of the soil types, the number depending upon the extent and importance of the area or the agricultural problems presented therein. These samples are examined in the laboratory, a mechanical analysis is made to show the grade of material composing the soil, and such chemical work is done as experience may indicate will be of probable value in understanding the conditions encountered in the area.

During the months that the party is in the field they are careful to observe the character and yield of the crops. They are instructed to obtain all possible information from the farmers as to the methods of cultivation, the relation of the soils to drought and to drainage, and in general to acquire all knowledge possible in regard to the conditions existing in the area. As they become more experienced they are able to advise in their reports upon many practical questions and to judge by comparison with other districts which they have surveyed whether there is an opportunity of introducing new crops or improved methods of cultivation.

The party makes its temporary headquarters in one place for a week or two, sometimes extending this to a longer period and sometimes staying but a few days, according to the condition of the country as regards its roads and the possibility of obtaining accommodations near their field of work.

Requirements of the Bureau Regarding Soil Maps and Reports.

It is a requirement of the Bureau that the soil maps must be constructed in the field and must be completed in every detail before the party leaves the area. It is also urged that every party shall prepare at least the first draft of the report to accompany the map before they leave the area. If possible, the report must be completed in all details. In preparing their reports the parties are guided by a general schedule showing the subjects that must be treated and the order in which they should be taken up. The approximate space to be devoted to each subject is given as a guide, but this may be varied according to the necessities of the case. The subjects given for the report are: Location and boundary of the area; geology, physiography, and climate; history of the development of agricultural interests; description of each soil type; any special problems presented in the area; and a brief description of the conditions of agriculture. In the Western areas the subject of alkali, the improvement of alkali lands, drainage conditions and possibilities, and methods of irrigation are also included.

Owing to the number of field parties and the number of areas that are surveyed each year, in order to limit the size of the annual publication the reports on each area are limited as nearly as may be to 20
pages for the Eastern parties and 30 pages for the Western; yet even with this restriction the report on the soil survey for 1901 will exceed 600 pages.

The reports are required to be of a simple, practical nature, which can be read and understood by the large number of persons to whom the publications are distributed. Congress provides for an edition of 17,000 copies, and the report is sent to all classes of people; it is intended particularly to benefit farmers, to let them know what their soil conditions are, but it is also for the information of prospective purchasers and settlers.

**DEVELOPMENT OF THE SOIL SURVEY.**

The line of soil investigations which gradually developed into the present method of the survey was started for the purpose of tracing the relation between the soils and special crops (such as wheat, corn, grass, and truck) in the Atlantic coast States. The first specific authorization for a soil survey was made by Congress for the purpose of mapping the tobacco lands of the United States, and it was on this authorization that the work was started in the Connecticut Valley. Up to the present time this valley from Hartford, Conn., to some distance above Springfield, Mass., has been surveyed, and the relation of the various soils to tobacco and to other crops has been determined and described in a report.

**SOIL-SURVEY WORK IN TOBACCO REGIONS.**

Two seasons have been spent in the Lancaster and Lebanon Valley areas of Pennsylvania, the heart of the tobacco region of that State, and maps have been prepared covering nearly a thousand square miles.

The soil survey in Connecticut led to the successful attempt at the introduction of Sumatra tobacco on certain soils of the valley; while the work in Pennsylvania showed that the soils there are very different from those of Connecticut, and are adapted to the filler type of tobacco. The present grade of tobacco raised in the Pennsylvania area sells for about $1.5 cents a pound; the Zimmer Spanish, grown in Ohio, brings from 12 to 15 cents; while the Cuban filler imported into this country is worth from $1 to $1.20 a pound. This indicates the great difference in the quality of the leaf grown in this country and in Cuba. There is no question that the Cuban tobacco is and has always been a standard of excellence, and the Pennsylvania leaf can hardly be classed as a competitor. In other words, the market requires a different style and quality of leaf from that now produced in Pennsylvania, and the problem presented by the soil survey was: Are there soils in Pennsylvania and are there indications in the quality of the present crop which would offer reasonable assurance that a product could be grown approaching more nearly the ideal type from Cuba?
In the Lancaster area there are two types of tobacco soil which are important, two upon which tobacco is only occasionally grown, and one (lying adjacent to the Susquehanna River and occurring in a very narrow belt) which is adapted to a fine grade of wrapper. The tobacco experts of the Department believe that there is reasonable prospect of raising a much finer grade of filler leaf on some of these soils. Whether it will equal the average Cuban leaf is a question. It will certainly be better than the lowest grade of Cuban tobacco (grown at the eastern end of the island), which is not imported into this country at all, most of it being sent to Germany; and how near the product can be brought to the best Cuban leaf is of course a matter impossible to predict.

During the summer of 1900 a soil survey was made of the whole of Montgomery County, Ohio, the center of the Zimmer Spanish district of the Miami Valley. This district furnishes what is held to be the finest grade of filler in this country, at least before the introduction of the Cuban crop of Florida three or four years ago. There are fewer soils here to experiment upon, but the character of the Zimmer Spanish tobacco more nearly approaches that of the Cuban leaf than does the Pennsylvania product, and there is reasonable hope of improving the Ohio crop.

A soil survey was made during the summer of 1901 in a portion of Montgomery County, Tex., as tobacco had been grown there for several years, some part of which possessed admirable quality, occasional leaves having the most desirable characteristics of the Cuban leaf. The crop as a whole, however, did not maintain this high degree of excellence, and in the last year or two the industry has been almost abandoned. This failure is believed to be due to a number of causes, chief among which is the fact that the product has not been handled as it should have been. The indications of good quality furnished by portions of the crop warrant a thorough investigation of the possibility of raising Cuban filler in that locality.

Cigar leaf of promising character from portions of California has also been examined by the Department experts. Here again the handling of the crop has been unskillful, and the product as a whole is not particularly good, but there is sufficient promise to warrant the belief that a desirable leaf can be grown on certain soils in that State. Large areas have been surveyed in California, and the soil maps which have been constructed will serve as a basis for future tobacco investigations.

During the summer of 1900 and again in 1901 extensive soil surveys were made in North Carolina in the bright-tobacco belt and in the manufacturing tobacco districts of Virginia.

In 1901 Montgomery County, Tenn., the center of the export tobacco region of that State, was surveyed as a preliminary to investigations.
which will be taken up later, looking to the improvement of these heavy export types of leaf.

A large part of the present tobacco district in Maryland, embracing three counties in the southern part of the State, has been surveyed and the foundation laid for possible improvement in the type of tobacco produced—a type which has so long held its own as a light, free-burning smoking tobacco, but which is now being crowded out by the Burley of Kentucky on account of the adaptability of the latter to other uses which the Maryland leaf can not successfully fill.

EXTENSION OF THE SOIL SURVEY TO GENERAL CROPS.

In March, 1900, Congress specifically provided for a much wider scope of the tobacco investigations and authorized in general terms the mapping of the soils of the United States. It has never been the intention of the Department, and was probably not intended by Congress, that any systematic plan should be adopted of preparing soil maps of the entire country. On the contrary, it is the purpose of the Department to investigate and map the soils of certain agricultural districts which may be noted for the excellence of their products or which lack remunerative crops.

During the summer of 1901 soil surveys were made in different portions of the Piedmont Plateau, including areas in Maryland, Virginia, North Carolina, and Georgia. The mapping of the soils (having the same character, derived from the same class of rocks, occurring in this widely separated distribution under the range of climatic conditions that prevail within this distance of 900 miles) and the study of the methods and habits of the people have resulted in throwing new light upon the problems of agriculture in these several States.

During the summer of 1901 a survey was made in Virginia along the Blue Ridge Mountains, where the apple and peach industries are developing; and the relation of the soils to these crops was studied and valuable information acquired which will offer a basis for the more intelligent development of the industries. The demand for such work has been very great, and it is probable that the survey will be extended to other areas of this mountainous region in the interest of the fruit growers.

Many urgent requests have come to the Bureau of Soils for the extension of the soil survey into the rice lands of the coast regions of Louisiana and Texas. The introduction of the Kiushu rice by the Department, already mentioned, has built up an industry estimated to be worth $1,000,000 a year to the State of Texas alone. This industry is confined to the coast country, and it has been found that the types of soil have a considerable influence upon the yield of rice. One of the most prominent growers, a man who probably knows more about the
industry than anyone else, has stated that the yield of rice varies on the
different soils from about 8 barrels to 20 barrels per acre. If these very
productive soils can be outlined on maps, so that the main energies of
the planters can be devoted to their cultivation and not to the less pro-
ductive soils, great good will naturally accrue to the rice interests.
During the fall of 1901 a beginning was made in the survey of about
260 square miles in the rice country between Lake Charles and Crow-
ley, La. This work will probably be continued and extended into the
rice belt of Texas.

During the summer of 1901 a soil survey was made of Allegan
County, Mich., which lies in the center of the peach belt of that State.
Sixteen types of soil were mapped in this area, and their relation to
crops was studied and described in the report which will accompany
the map when published. Some of these soils are adapted to peach
culture, others to sugar beets, others to peppermint, and others to
general farm crops. The adaptation of each type is pointed out in
the report.

During the same time a soil survey was made in the center of the
grape belt of Chautauqua County, N. Y., and the relation of the
various soils to the grape industry and to general farming was
pointed out.

One of the most interesting areas surveyed in the season of 1901
was one of about 600 square miles in the southwestern part of New
Jersey, including some of the finest truck lands and general farming
country of that State. The region was found to be in a very pros-
perous condition, and special attention had already been given by the
farmers to the proper adaptation of the soils to different crops. An
interesting feature of this work was that many of the soils were found
to be identical with those of southern Maryland, where, through a
lack of such adaptation of soils to crops, the communities are far less
prosperous than those in New Jersey. The contrast and the remedy
for the Maryland area are clearly shown in the report.

SOIL SURVEY FOR DEVELOPMENT OF A MISSISSIPPI AREA.

During the fall of 1901 a survey was made of an area in Mississippi
extending from a point about 12 miles east of Yazoo City and taking
in this breadth of upland, and from thence 30 miles across the Yazoo
and Mississippi Delta to the Mississippi River. The upland soil was
readily identified as a loess, and it has been confidently predicted that
alfalfa could be introduced upon it and the cattle industry built up.

The delta proved one of the most interesting areas that has been sur-
veyed. The cultivated soils of the delta region follow the rivers and
bayous, having been built up from the annual overflow of the rivers.
These soils have an average width rarely exceeding a mile on either
side of the streams. They are formed of the coarser fragments of silt and sand deposited by the waters, while the finer material has been carried farther inland and finally deposited by the quiet waters in the large areas known locally as "open swamps." These lands are not swamps in the ordinary sense of the term. They have no cypress, except in the occasional bayous or true swamp areas, but are covered with a dense growth of hard wood. They are overflowed every year, the water subsiding about the first of June and the lands becoming cultivable too late for any of the ordinary crops. Throughout the remainder of the year, however, the lands are dry.

The cultivated lands along the rivers have been built up somewhat higher than the open swamps and are only subject to occasional overflow in the very highest freshets, which occur once in twenty years or so. Three grades of soil are recognized in these areas—a sandy loam, which produces from one-half to three-fourths of a bale of cotton to the acre; a loam, producing from three-fourths to one bale; and a clay, producing from 1½ to 1¾ bales. Of the entire area surveyed, about 10 per cent is covered with the sandy loam, 8 per cent with the loam, 16 per cent with the productive clay, and 65 per cent with the open swamp or "Sharkey clay," which is not cultivated. This Sharkey clay, composed of the very finest sediment of the rivers, is a stiff, tenacious clay, exceedingly fertile, as shown by the dense forest growth of hard woods, and the problem of cultivating this large area of what is at present waste land can be solved either by finding short-lived crops which can be planted after the floods subside and mature within the growing season, or by diking the lands off and preventing the annual overflow. This latter method appears to be a possible engineering feat which would not be particularly expensive, in comparison with the wonderful fertility of the lands and their probable high productivity if protected by suitable dikes.

The sandy loam along the rivers is a fine type of early truck soil, and with the direct communication which is maintained with the Chicago markets, this industry could be profitably introduced. Truck crops with an intensive method of cultivation should yield ten times the profit on this soil that is now obtained from cotton. It is proposed to extend this Mississippi survey to include a much larger area, so that the possibilities of developing this important country may be more clearly seen.

VALUE OF THE SOIL SURVEY WORK.

No better illustration of the value and use of a soil survey can be given than in a brief description1 of 16 types of soil in the area mapped between Raleigh and Newbern, N. C., in 1900. This area extends entirely across the coastal plains.

1 Field Operations of the Division of Soils, 1900, pp. 36–39.
The Cecil clay, is the product of disintegration of the crystalline rocks of the Piedmont Plateau. The soil is a red clay, 6 inches deep, resting on a stiff, tenacious red clay. Both the soil and subsoil contain considerable quartz and rock fragments, sufficient to be very wearing upon implements. These fragments insure good drainage, however, especially as the broken quartz is arranged in perpendicular veins in the subsoil. The soil when well tilled makes the best wheat and grass land of the locality, and is also an excellent cotton and corn land. It is decidedly the strongest and best soil for general farming and stock raising in the area.

The Cecil sandy loam has the same origin as the Cecil clay, but differs from it in having from 6 to 10 inches of a brown sandy loam overlying the stiff red clay. Both soil and subsoil contain the same quartz and rock fragments as the Cecil clay. The red clay subsoil insures a uniform moisture content, and the land withstands drought well. The soil is adapted to cotton and grain, and some bright tobacco is raised on it.

The Durham sandy loam is closely related to the two preceding types, being composed of the same material, although partly of sedimentary origin. It has the same quartz and rock fragments, although the quartz veins do not occur in the subsoil, and the subsoil clay is of somewhat different character. The soil also contains more sand than the Cecil sandy loam. It is better adapted to corn, bright tobacco, and truck than to cotton or small grain. All three of these types are quite rolling or even hilly.

The Norfolk sandy soil is a coarse, sharp sand or sandy loam, 10 to 20 inches deep, resting on yellow clay. The surface is generally level. It is not adapted to small grain, is fairly well adapted to cotton, but is well suited to corn, bright tobacco, and truck.

The Norfolk fine sandy loam differs from the above only in the character of the soil. It consists of a fine-grained sandy loam, 10 to 15 inches deep, resting on a rather stiff yellow clay. The surface is generally level. It forms a large and important type in the area surveyed. The clay subsoil holds fertilizers and maintains moisture, so that the soil withstands droughts well. It is an excellent cotton soil, and is well adapted to corn, bright tobacco, and truck.

The Selma silt loam is a gray silt, 18 inches deep, overlying a mottled yellow clay subsoil containing some fine sand and small gravel. The surface is gently rolling and the drainage is good, except in a few low places. This is a fine cotton soil, and one of the most valuable soils for bright tobacco especially, as occasionally happens when the silt contains an admixture of fine sand, permitting more perfect drainage—a condition which renders the soil less fit for cotton.

The Selma heavy silt loam consists of a heavy, compact silt 10 to 20 inches deep, overlying a stiff mottled clay. It occurs generally in flat, level areas, poorly drained,
and generally requiring artificial drainage. When drained it is well suited to cotton, much better, in fact, than to any other crops of the locality. It is not at all suited to bright tobacco.

The sand hill soil is a coarse, loose, incoherent sand, 10 feet or more in depth, little adapted to any agricultural crop, owing to the small water-holding power of the soil. It occurs generally as low hills, and the sand is often from 20 to 60 feet deep. Recently peaches have been tried with some success. The fruit has a rich color. The soil is generally uncultivated, and supports a growth of scrub oak and pine.

The Neuse clay is a stiff, silty or fine sandy loam, 10 to 20 inches deep, underlaid by a stiff mottled-clay subsoil. It is generally subject to overflow in time of freshets, and is used mainly for pasture or left to forest growth. It is difficult to till in wet or in dry seasons, and is little esteemed for farm purposes.

The Garner stony loam consists of a sandy loam 6 to 15 inches deep, containing from 40 to 60 per cent of rock fragments and gravel, often of considerable size, underlaid by a stiff red brick clay. The soil packs firmly over the clay subsoil, affording firm roads almost equal to macadam. The surface is quite rolling, and this thin veneer extends over the whole area, rendering it exceedingly difficult to till and almost valueless for agricultural purposes. It supports a forest growth, however, containing good merchantable timber, principally pine.

The Susquehanna gravel is a very gravelly soil of small extent and of little agricultural value.

The Savanna is a physiographic type rather than a soil type. It is a low flat area with poor drainage. The country is often flooded for considerable periods from the ordinary rainfall of the locality. It is generally sparsely wooded, but supports an abundant growth of cane and coarse grass, which afford good pasturage. It can nearly always be drained, but on account of the level surface and broad extent this is a difficult and costly operation. When drained it is adapted to cotton and corn. It is, however, seldom cultivated.

The Pocoson is also a low-lying area, generally swampy, and having a black, spongy, mucky soil. It supports a sparse growth of scrub pine and a very thick growth of grass, bushes, and vines. In dry seasons it affords good grazing. In such seasons there is danger from fire, which burns not only the grass but also the mucky soil itself, ruining the pasturage for some time. When cleared and drained the land is excellent for cotton and corn, but only small areas have been so reclaimed.

A few areas of muck are found in the area surveyed, but these are usually of small extent, and make fertile corn lands when drained. Few areas of cypress swamp were encountered, and these were of small extent.

It is thus seen that, although a large number of soil types was encountered in the area, they all have quite distinctive characteristics, and are adapted to different interests or have different crop values and require different treatment.

SOIL WORK IN IRRIGATED REGIONS.

A large amount of work has been done in the irrigated regions of the West. These surveys have been made in the principal irrigated districts in New Mexico, Arizona, California, Utah, Idaho, and Washington. About 2,200,000 acres have been surveyed in irrigated areas, presenting a great variety of agricultural conditions. The fruit districts around Hanford and Fresno, Cal., have been studied, and the grain, fruit, and sugar-beet lands of Ventura and Monterey counties have been mapped. Three areas in southern California have been surveyed, one on the Coastal Plain around Santa Ana, and one in the
The purpose of a soil survey.

San Gabriel Valley, and the third in the untried desert lands lying east of the Colorado River. In Arizona the lands lying along the Colorado River and in the Salt River Valley have been mapped. In New Mexico, the Pecos Valley has been surveyed; in Utah a portion of the Jordan Valley near Salt Lake City, the Sevier Valley, and the country around Ogden. The surveys in Washington and Idaho were confined to the Yakima and Boise valleys. In some of these the work has been simply a soil survey; in others, where the alkali problem has been encountered, a thorough study has been made of the character of the salts, the extent to which they have injured or are likely to injure the lands, and consideration has been given to methods of reclamation and drainage.

In the Salt Lake district mapped it was found that about one-fifth of the lands which have been successfully irrigated have been ruined by an accumulation of seepage waters and alkali. This injury is entirely unnecessary if proper precautions are taken, which can be economically applied to the lands. In the level stretch between Salt Lake City and the Great Salt Lake, where many unsuccessful attempts have been made to farm the lands, it was found that about 60,000 acres of now practically worthless land can be reclaimed at an estimated cost of $20 an acre through drainage and proper methods of irrigation, after which the lands will have an estimated value of about $75 or $100 an acre. The systematic reclamation of alkali lands has never been attempted in this country. There are in the irrigated districts probably more than a million acres of lands which can be profitably brought back into fertility. These lands are usually favorably situated for cultivation and lie below present canal systems. In order to encourage their reclamation the Bureau is carrying on reclamation experiments at various points in the West. These will show to the farmer the results and necessities of drainage, and will demonstrate the feasibility of this method of reclamation. In Egypt over 2,500,000 acres have been reclaimed, and about 800,000 acres are in process of reclamation. It is believed that in a short while drainage will become a more common practice in the West, just as it has in other irrigated countries throughout the world.

Equally striking and valuable possibilities have been pointed out in other areas in the West as a result of the soil survey, and if the suggestions made by the Bureau reports are carried out larger areas may be irrigated with the available water supply and larger crops secured than at present.

Soil Management.

Reference has already been made to the successful introduction of Sumatra tobacco on certain soils in the Connecticut Valley, and to the possibility of developing the agricultural interests of southern
Maryland through the adoption of the crops and methods which have proved successful on the same soils in southern New Jersey under practically the same climatic conditions. In all the areas such possibilities of improvement and progress are constantly presenting themselves to the parties who make the soil surveys, their experience in other areas enabling them to appreciate readily the needs and opportunities of the country; but with their rapid movement from place to place, necessitated by the widespread demand for the soil-survey work, they are often unable to impress the lessons of their discoveries upon the people with sufficient force to induce them to apply the knowledge in actual practice. It requires so long a time and such constant attention to establish and develop agricultural industries that it has seemed advisable to organize in the Bureau of Soils a division of soil management to work out the various problems presented in the areas surveyed. Such a division has now been established, and it is confidently believed that many of the lessons gained in the course of the survey can be applied in a practical manner to the benefit of the agricultural community.