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# SOILS OF THE SASSAFRAS SERIES.

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## DEFINITION OF THE SERIES.

The soils of the Sassafras series are distinguished by the characteristic brown or yellowish-brown color of the surface soils and by the yellow or reddish-yellow color of the subsoil. At depths ranging from 2 to 3 feet the deeper subsoil is frequently sufficiently tinged with red to become a pale orange. In the dry condition both the surface soils and subsoils of the more sandy members of the series are decidedly yellow, but when moist the deeper brown shade is usually developed. A fresh cut in the subsoil of practically every member of the series will usually show a distinct reddish coloration below a depth of 2 feet.

Practically all of the typical occurrences of the soils of the Sassafras series show the existence either of a distinct bed of medium to coarse gravel or of fine gravel mixed with coarse and medium sand at depths which range from 2½ to 5 feet. In the case of large areas of the Sassafras silt loam the underlying gravel bed is covered to a depth of 8 to 10 feet by the heavy, compact, silty loam soil and subsoil. It is generally true that the gravel is coarser and the beds are more continuous and thicker near the inland border of the region where these soils are found, becoming thinner and grading into fine gravel and coarse sand as the seaward margin of the various types is approached.

In certain localities, as on Long Island, along the lower courses of the Delaware River, and opposite the mouth of the Susquehanna River, large blocks of stone or bowlders derived from various formations of the Appalachian and Piedmont regions are found within the underlying gravels or scattered sparingly over the surface of the different soil types. Otherwise the different soils of the series are characteristically stone-free.

All of the different types consist of water-laid materials, chiefly formed as marine, estuarine, and fluvial terraces, although some of

the areas consist of closely related outwash material deposited in connection with the glaciation of the Long Island area and others seem to be derived from older coastal plain deposits. The materials entering into the formation of the soils of the Sassafras series have been derived from the Appalachian Region, the Piedmont Plateau, from glaciated areas immediately to the north of the principal areas of their occurrence, and from the underlying Coastal Plain deposits reworked in some cases. The latter materials are dominant in the sections nearest to tidewater while the mingling of materials from other sources is more pronounced along the inland border of the general region in which these soils occur.

The soils of the Sassafras series are distinguished from those of the Norfolk series by the predominant gray color of the surface soils and the yellow color of the subsoils of the latter series and by the reddish color and presence of the underlying beds of gravel or coarse sand in the case of practically all areas of the Sassafras soils.

The soils of the Elkton series, which are found closely associated with those of the Sassafras series, are marked by the gray color of the surface soils and the mottling of yellow and gray in the subsoils. They are characteristically not so well drained as the soils of the Sassafras series.

The soils of the Portsmouth series, which are also associated with those of the Sassafras series, are distinctly dark gray to almost black at the surface and light gray in the subsoils. They are always poorly drained in their natural state.

The soils of the Collington series are darker in color at the surface and usually show a greenish tinge, due to the presence of greensand marl in the subsoil.

## GEOGRAPHICAL DISTRIBUTION.

The soils of the Sassafras series are confined to the northern portion of the Atlantic Coastal Plain. (See fig. 1.) Considerable areas of the soils of this series have been mapped in the central and western portions of Long Island. A broad belt of soils classed with the series has been found to extend through central New Jersey from the vicinity of New Brunswick southwestward to the region around Camden and thence southward along the Delaware River and Delaware Bay to Bridgeton, N. J. This belt is interrupted by occurrences of other Coastal Plain soils, and is more nearly continuous after the Delaware drainage area is reached. The same general area is continued west of the Delaware by narrow areas along the river in the extreme southeastern part of Pennsylvania.

A large part of northern and central Delaware from the vicinity of Wilmington to that of Dover is occupied by the different soils

of this series, while considerable areas of some of the types are found thence southward to the Virginia counties east of Chesapeake Bay.

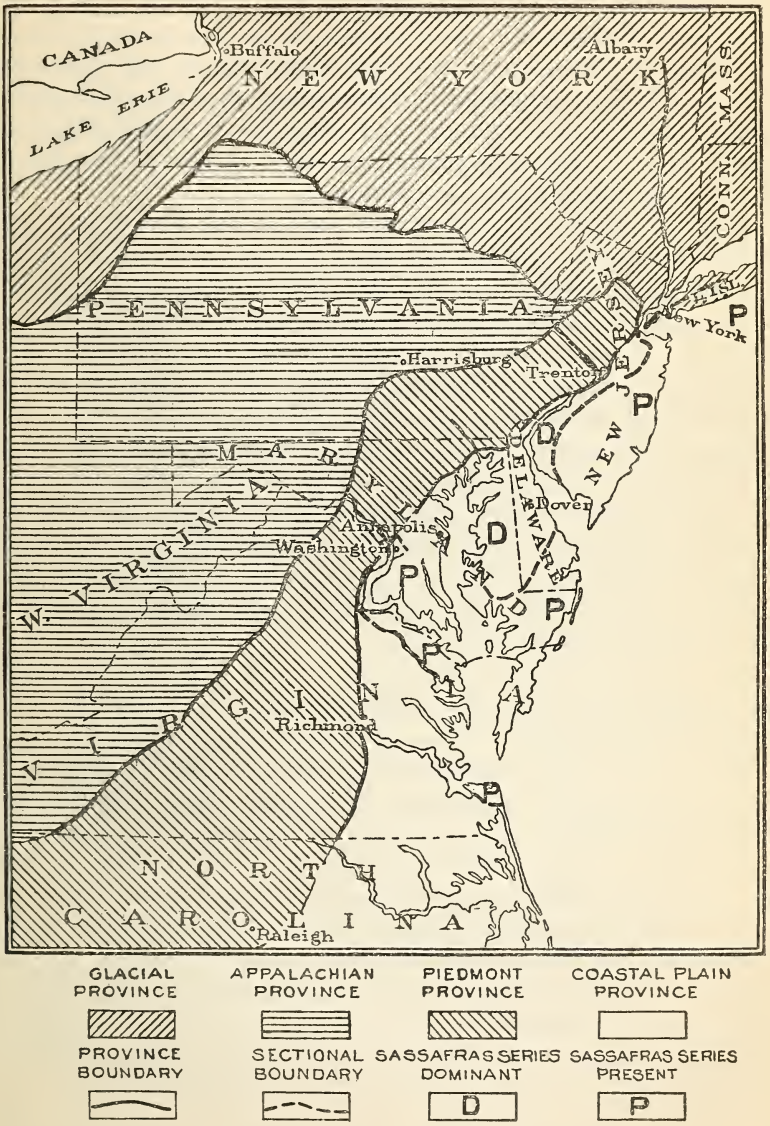


FIG. 1.—Soils of the Sassafras series.

The soils of the Sassafras series are extensively developed in the eastern counties of Maryland from the mouth of the Susquehanna River to the Delaware line and southward. In these counties, also,

other soil series become more extensive toward the south. The soils of the Sassafras series, however, dominate in area all the Maryland-Delaware Peninsula from the head of Chesapeake Bay to the latitude of the southern boundary of Delaware.

To the west of Chesapeake Bay, in the Maryland counties which lie between the bay and the Potomac River, the soils of this series are found in considerable area although they do not dominate the section. They are principally found along the lower forelands and terraces which border the bay and along the estuarine rivers which empty into it, although some areas also extend across the lower divides separating these waterways.

South of the Potomac River the soils of the Sassafras series are chiefly confined to low terraces along the tidewater estuaries and to the low divide separating the Potomac and Rappahannock River drainages. The soils have not been mapped in detail in any of this territory. A small area of one type has been found in the vicinity of Norfolk, Va. It is not believed that any large areas of the Sassafras soils will be found south of the Rappahannock River, since the materials and manner of derivation of more southern Coastal Plain soils would not be expected to give rise to soils of this class.

It will be seen that the total area within which the soils of the Sassafras series have been encountered is restricted to an elongated oval whose broader southern extremity lies approximately in latitude 37° N., and its narrow northern extremity is found upon Long Island in latitude 41° N.

The extreme length of this region from northeast to southwest is approximately 300 miles, while the extreme breadth, in the latitude of Washington, D. C., is a little over 100 miles.

Within the region outlined, the soils of the Sassafras series occupy approximately one-third of western Long Island; one-half of the Coastal Plain portion of the soil survey of the Trenton area, New Jersey; nearly three-fourths of the area included in the soil survey around Salem, N. J.; from 50 to 80 per cent of the various soil surveys in the Coastal Plain region of the Maryland-Delaware Peninsula as far south as the southern line of Delaware; only about one-fourth of the soil survey area of Worcester County, Md.; more than one-half of the soil survey of Anne Arundel County, Md.; and from 15 to 25 per cent of the areas which have been surveyed south of this county and on the western side of Chesapeake Bay.

## THE NORTH ATLANTIC COASTAL PLAIN.

The northern part of the Atlantic Coastal Plain consists of a low-lying, gently sloping region which intervenes between the coast line and the more elevated interior. It is only within the portion of this physical division which extends from the southern end of Chesa-

peake Bay to the western end of Long Island, N. Y., that the soils of the Sassafras series have been encountered.

In general, the coast is fringed by long, narrow stretches of Coastal beach between which and the main land there are included narrow sounds and bays and stretches of Tidal marsh. The main land rises gently inland through the greater part of the coast country, although low coastal bluffs are locally found and the Navesink Highlands, with an elevation of 276 feet, approach within a mile of the shore line in east-central New Jersey. Elsewhere the rise toward the interior is gentle and for the first few miles does not usually exceed 5 feet to the mile. Near the interior margin the rate of slope rapidly increases to 10 or even 20 feet per mile. From the vicinity of Raritan Bay to the Delaware River and thence near the inner line of the Coastal Plain as far as the Potomac River there is a sharp slope toward the interior and the main body of the Coastal Plain is separated from the Piedmont Plateau and from other Coastal Plain deposits along its front by an irregular valley. The general trend and extent of this depression is outlined by the direction of the Pennsylvania and the Baltimore & Ohio Railroads, which follow it from Newark, N. J., to Washington, D. C. In part this valley is a land feature, as across central New Jersey and from Baltimore to Washington, but in part it has been occupied by estuarine waters as along the Delaware River from Trenton to Salem, N. J., around the headwaters of Chesapeake Bay, and in the westward bend of the Potomac River immediately south of Washington, D. C.

From the vicinity of Fredericksburg, Va., southward this valley feature is lacking and the elevated interior margin of the Coastal Plain directly overlaps the Piedmont Plateau.

Within this northern section of the Atlantic Coastal Plain there are four subdivisions which possess different details of elevation and relief.

The portion which lies west of the Chesapeake Bay, from the James River to the mouth of the Susquehanna River, consists of an elevated inner section of the Coastal Plain, which is deeply dissected by broad estuarine stream valleys. Both in eastern Virginia and in the southern counties of Maryland the remnant of the higher portions of the Plain takes the form of narrow or broad plateaulike ridges, which are locally known as "river necks." These have an elevation of 100 to 250 feet along the inner edge of the region, but their axes sink gradually toward Chesapeake Bay until they are terminated by a low escarpment or end in wave-cut cliffs along the bay shore. The larger estuarine rivers within this section are usually bordered on one or both sides by low-lying terraces. The lowest terrace rises from the water as a gentle slope or is bordered

by a low cliff. Thence its surface rises very gently, seeming almost a plain, to an inner escarpment, whose base is 30 to 40 feet above tide level. Frequently another terrace intervenes, at an altitude of 50 to 80 feet, between the lowest terrace and the inner plateau. In fact, the entire section consists of a series of steplike terraces rising from tide water to the general level of the upland except where wave or river cutting has destroyed the lower terrace forms. Such terracing is shown in Plate I, figure 1.

The section lying between the Chesapeake Bay and Delaware Bay, generally known as the Maryland-Delaware peninsula, possesses somewhat different topographic forms. The eastern shore of Chesapeake Bay from near the mouth of the Sassafras River, southward, is bordered by a tract of low land which corresponds in elevation with the lowest of the terraces on the western side of the bay. This swings eastward and forms the greater part of the peninsula south of the Delaware State line including, also, the southeastern portion of Sussex County, Del. It forms the lower portion of both shores of Delaware Bay and Delaware River as far north as Trenton. It is probably represented along the Atlantic coast of New Jersey by the belt of lowland, extending from Cape May nearly to the Navesink Highlands.

Along the eastern shore of Chesapeake Bay this lower terrace is bounded, inland, by a low escarpment which extends from near the mouth of the Sassafras River southward past Easton, Md., to the mouth of the Choptank River. Between this low ridge and the shore of Delaware Bay the higher terrace stretches as a gently undulating to nearly level upland. The highest elevations are found in the western portions of Cecil and Kent Counties, Md., where altitudes of 80 to 100 feet are attained. From these the general slope is gently seaward.

In southern New Jersey the surface features are somewhat different. As has been indicated, the lowest terrace of the Chesapeake Bay region extends along both shores of the Delaware River and Bay as a distinct topographic feature. It is possibly found along the Atlantic coast in the form of the low slope which rises from tidewater to an elevation of about 50 feet. In New Jersey the marked topographic feature of the Coastal Plain is formed by the ridge of dissected hills which extends from the Navesink Highlands on the northeast to the vicinity of Bridgeton, N. J., on the southwest. From this ridge the land surface declines rather rapidly toward the interior valley, separating the Coastal Plain from the Piedmont Plateau. The descent toward the sea is long and gentle in extreme southern New Jersey but short and steep as the eastern end of the ridge is reached in the Navesink Highlands.

On the western end of Long Island, N. Y., the narrow belt of Coastal Plain rises rather steeply from the coast line to the front of the ridge which forms the northern border of the island. The plain terminates against the front of this ridge at elevations of 100 to 240 feet above tide level. Within this sloping plain there are also outlying hills and ridges, consisting of old glacial moraine, which rise to considerable elevations above the surrounding surface. These roughly divide the plains into a higher interior plain and a lower coastal slope. These coalesce through intervals in the ridge. Otherwise the plain is interrupted only by shallow stream channels which are normally dry during a greater portion of the year.

The materials which constitute the older deposits of the North Atlantic Coastal Plain are chiefly unconsolidated gravel, sands, loams, clays, and marls, although there are local occurrences of indurated clays and iron-cemented sands and gravels of little thickness and of limited extent.

These sediments of varying degrees of coarseness have been derived from the adjacent, interior land areas, transported to the older shore lines, and deposited at various periods of geologic time as successive layers or strata in the older marine or estuarine waters. The surfaces of all of these older deposits are marked by a seaward slope and the oldest formations reach the surface along the inner margin of the Coastal Plain while the younger ones are successively encountered at or near the surface in a seaward direction. These older formations, from the Cretaceous to the Miocene in geologic age, form the basal structure of the Coastal Plain. They reach the surface chiefly along the lines of greatest erosion near the inner margin of the region and they are very extensively covered by later deposits, forming the terraces and the greater part of the seaward slopes of the present land surfaces. These later deposits are referred by geologists to the Pliocene and Pleistocene periods. They immediately preceded the present geologic time.

The soils of the Sassafras series are chiefly derived from the deposits of the Pleistocene age. This is the latest completed geologic period before the present time. It was marked in the northern portion of the area under discussion by two or more invasions of glacial ice. During the period of ice occupation, and particularly while the ice sheet was melting and its front receding, large amounts of material were deposited near its front in the form of glacial outwash. At the same time other glacial material was carried down all of the larger streams of the region to be deposited as a part of the material of the Pleistocene terraces, which were being formed at the same time along the coast.

Even the streams considerably to the south of the region directly affected by glaciation were considerably swollen and their courses were blocked by river ice during portions of the year. This gave rise to the transportation of considerable amounts of coarse gravel, and even of stones of large size, which were carried in floating ice. When the ice melted along the coast or in the estuarine waters this coarser material was mingled with the finer grained sediments brought under normal conditions of erosion and transportation. Thus the Pleistocene sediments along the margin of the glaciated region, and even to a considerable distance to the south, have been directly or indirectly influenced by the glaciation of the more northern region.

Long Island, N. Y., lies within that portion of the region which was directly invaded by the ice during the glacial period.[1] As a result all of the older formations were overridden by the sheet of glacial ice, which advanced at one time as far south as the line of hills that extends from the vicinity of Westbury to Montauk Point. These hills represent the deposition of material as a terminal moraine while the ice stood along this line. Later the glacial ice receded and then readvanced to a position along the more northern belt of hilly territory, which follows the northern shore of the island, where additional morainal material was deposited. At the time of this halting there was spread out over all of the southern portion of the island the thin sheet of gravelly, sandy, and loamy material which constitutes the present surface of the land. The sloping plains which intervene between the two lines of morainal hills and which sink below the water level along the southern shore of the island were formed at that time by the deposition of material partly transported by the ice from mainland to the north and partly derived from the older formations, which formed the surface upon which the ice rested.

A large part of this deposition took the form of cross-bedded sands and gravels and of rather coarse sand, washed out by water from the melting ice. Where these coarser materials form the present land surface they give rise to the areas of Sassafras sand as mapped upon the western end of Long Island. The higher, interior plain and a large part of the marginal plain which intervenes between the northern hills and the south shore west of Farmingdale are occupied by a gravelly silty loam formed at a late stage of the deposition of this material. This gives rise to the extensive areas of the Sassafras gravelly loam mapped there. Small areas of loamy material were deposited immediately to the West of Jamaica Bay. This forms the Sassafras loam. A large part of the material built into these deposits is undoubtedly of direct glacial origin.

[1] Professional Paper No. 82, U. S. Geol. Survey. The Geology of Long Island, N. Y., by M. L. Fuller.

It is certain that the Delaware River carried a large amount of material from the glaciated area around its headwaters to its submerged lower course, thus contributing glacial material to the marine and estuarine sediments which were being formed along the coast line.

The Susquehanna River was also affected by glaciation along its upper courses and carried glacial material in some volume to be contributed to the deposits near its mouth.

While the rivers farther to the south had no direct connection with the glaciated area, yet conditions of erosion and transportation were so affected that large amounts of the fine-earth materials from the Appalachian and Piedmont sections were carried seaward and deposited through the Chesapeake Bay region. With these finer sediments small amounts of coarse material in the form of gravel and large blocks of stone were transported and deposited. The latter constitute the only direct evidence of the changed climatic conditions since they were evidently carried within or upon floating masses of ice of considerable size.

To the west and south of the mouth of the Hudson River the land area which now constitutes the surface of the Coastal Plain was formed at different stages of submergence and emergence, chiefly in the form of successive terraces. It is probable that each of the different terraces represents a period of submergence of the land area followed by emergence. In general the oldest terrace at present occupies the highest elevation and each younger terrace is found at successively lower elevations.

The different terraces are developed to very unequal extents in the different portions of the North Atlantic Coastal Plain from southern New Jersey to tidewater Virginia.

In New Jersey the terrace-form development of the later Coastal Plain deposits is generally indistinct except in the case of the latest and lowest terrace. This has been called the Cape May formation by the New Jersey Geological Survey.[1] It fringes the Atlantic coast in a narrow border rising from sea level to about 50 feet in elevation. Its chief development is found from Cape May northward along the Delaware Bay and River to the vicinity of Trenton, N. J., where its deposits merge with those brought down by the river from the glaciated region to the north. From this circumstance it can be correlated with the latest glaciation of the more northern region.

Along the water front the elevation of this terrace varies from marshy stretches at tide level to low cliffs of 5 to 10 feet in height. The land surface of the main portion of the terrace is nearly level

[1] See N. J. Geol. Survey Ann. Rept. 1898, and Trenton and Philadelphia Folios, U. S. Geological Survey.

although streams have cut shallow channels within the terrace and low ridges and swells give a slightly undulating character to the surface. There is normally a gentle rise toward the interior and the landward margin of the terrace along the Delaware River side is marked by a sharp rise or by steeper slopes. In the Atlantic coast portion of southern New Jersey this interior escarpment is not marked or may be entirely lacking. In the Delaware Valley phase of this formation the upper level of its deposits lies between 35 and 50 feet above sea level. The interior margin of this formation is frequently bordered by delta deposits accumulated where the larger streams brought other Coastal Plain material to the shore of the estuary which was formed along the Delaware embayment. These are usually sandy and gravelly in their character. They have been derived from several of the older Coastal Plain deposits. Within the level area of the Cape May terrace the materials consist chiefly of gravel, sand, and loam, with small areas of stiff clay in some localities. These materials have been derived both from the other Coastal Plain deposits and from the glacial material which was brought down by the Delaware River. There has also been a considerable contribution of wind-blown sand which was either spread out as a thin sheet over the surface of the water-laid deposits or even heaped into low mounds and ridges.

In general the surface material of the Cape May formation is rather sandy and the soils which are derived from it consist largely of the Sassafras sand, fine sand, and fine sandy loam. The Sassafras silt loam is also developed to quite an extent in some parts of the formation, notably near Salem, N. J. Even the level areas of the Sassafras sand and fine sand are frequently underlain by this heavier material and in some localities by Miocene and Cretaceous clays, and it is probable that in such situations they constitute a surface deposit of wind-transported material laid down over the older sediments.

The next higher and older formation of Pleistocene age in southern New Jersey has been called the Pensauken by the New Jersey Geological Survey. It occupies elevations from about 50 feet above tide level to an altitude of more than 200 feet in different parts of the Coastal Plain. The Pensauken formation is most extensively developed along the flanks of the Delaware Valley and on the slope from the Coastal Plain toward the Piedmont Plateau between Trenton and New Brunswick. Considerable areas are also found on the slope between the high ridge within the Coastal Plain and the margin of the Cape May formation along the Atlantic.

The Pensauken formation is chiefly made up of cross-bedded gravel and sand having a thickness ranging from 2 or 3 to 50 feet. Over some portions of this coarser material there has been deposited

a thin layer of silty loam, which is not considered as an essential part of the formation by the New Jersey Geological Survey. It is very similar to the heavier loam found in the Cape May formation and gives rise to the same soil type, the Sassafras silt loam. The coarser materials of the Pensauken formation give rise to the gravelly and sandy members of the Sassafras series. The soils of this series are thus found in almost continuous development from near tide level in the Cape May formation to altitudes of 150 to 200 feet in the area covered by the Pensauken formation.

It is worthy of note that the soils of the Sassafras series have been encountered in their widest development in the State of New Jersey within the Delaware Valley and upon the slopes of the valley which separates the main body of the Coastal Plain from the Piedmont Plateau. These soils thus occupy a position where their materials were affected during deposition by contributions from the glaciated area immediately to the north. They may consist, in any one locality, of material largely derived from older, underlying Coastal Plain formations, but where typically developed there is usually evidence that the glaciation to the north contributed a considerable amount of both fine and coarse material while a still larger amount was originally derived from both the Piedmont and Appalachian regions.

The oldest deposits of the Pleistocene age in the New Jersey portion of the Coastal Plain are called the Bridgeton formation by the New Jersey Geological Survey. They cap the higher hills in southern New Jersey above an elevation of about 150 feet. The materials are largely gravel and sand, although large bowlders give evidence that this formation was also affected by the earlier glaciation of the land areas to the north. It is probable that this formation gives rise to considerable areas which will be correlated with the soils of the Sassafras series.

Areas of the different soils of this series are also found to coincide closely with the portions of these three terraces found on the western side of the Delaware River in the extreme southeastern part of Pennsylvania.

In the Maryland-Delaware Peninsula the terrace form of the deposits of Pleistocene age is marked and three terraces have been identified by the Maryland Geological Survey.[1] The lowest and youngest of these terraces has been called the Talbot formation within this State. It is continuous with the Cape May terrace of the New Jersey Geological Survey and can be directly correlated with it. It forms a low, nearly level terrace along the entire eastern boundary of Delaware, narrow in the northern part and broadening to a width

[1] See Maryland Geol. Survey, "Pliocene and Pleistocene," and Dover Folio, U. S. Geological Survey.

of 15 or 16 miles in southern Delaware, and completely occupying the greater part of the peninsula south of the Delaware State line. Thence it is developed as a broad, low-lying plain along the southern part of the eastern shore of Chesapeake Bay as far north as the mouth of the Choptank River. From this vicinity to the mouth of the Sassafras River it becomes narrower but occupies all of the forelands and islands. North of the Sassafras River to the head of Chesapeake Bay it is but sparingly represented by lowlands along the water front.

Throughout the peninsula the Talbot (Cape May) terrace rises gently from the water level either with a low slope or by a low wave-cut scarp. Its surface is a very gently sloping plain, which is chiefly relieved by the tidewater channels of streams which cross it and by low ridges which merely serve to render the surface gently undulating. The terrace is continued for some distance up the channels of the estuarine rivers which are the chief tributaries of the Chesapeake Bay from the eastern shore.

The portion of the Talbot terrace which lies along the Delaware Valley and the Atlantic Ocean rises to an altitude of about 45 feet above sea level, where it merges into the next higher terrace, usually without any marked topographic break. At most a low slope or scarp may occur locally. On the side toward Chesapeake Bay the inner margin of the terrace is much more sharply marked by a low scarp of 10 to 25 feet in elevation, which extends interruptedly from near the mouth of the Choptank River to the mouth of the Sassafras River. The Talbot terrace is also extensively developed as a low front land along the western shore of the Chesapeake Bay from the mouth of the Susquehanna River to the mouth of the Patapsco River.

The materials which enter into the structure of the Talbot terrace are all unconsolidated and consist of gravel, sand, loam, and some areas of clay. It is probable that a large part of this material was brought to its present position from the Piedmont and Appalachian regions by the Delaware and Susquehanna Rivers. The presence of large ice-borne blocks from both of these regions is noticeable along the upper waters of Chesapeake Bay and even some of the finer material bears close resemblance to the existing surface materials in the adjacent Piedmont region. There can be little doubt that the Talbot formation of Maryland and the Cape May formation of New Jersey are one in origin and mode of formation, and it is probable that both are of about the same age as the youngest glacial material found upon the western end of Long Island.

The Talbot formation contains large areas of soils which have been correlated with those of the Sassafras series. The areas of Sassafras sand and loamy sand along many of the estuarine embayments of the Maryland-Delaware Peninsula and the Sassafras sandy

loam, loam, and silt loam of the better-drained portions of this formation all cover large areas.

The next higher and older terrace of the Pleistocene is known as the Wicomico formation in Maryland. Within the peninsula it occupies all of the higher interior portion from a line drawn between Wilmington, Del., and Elkton, Md., southward a little beyond the southern line of Delaware.

As has been noted, it is separated from the Talbot terrace only by low slopes or indistinct scarps on the seaward side. Thence its surface rises gently nearly to the eastern shore of Chesapeake Bay, but sinks sharply to the surface of the Talbot formation or to the waters of the bay along its western margin. A few small remnants of this terrace are also found along the steeply sloping boundary between the Piedmont and Coastal Plain from the vicinity of Wilmington to that of Baltimore.

The materials which constitute the Wicomico formation in this section consist chiefly of bowlders,, gravel, sand, and loam. The coarser materials are generally found at the base of the formation, and these are usually overlain by either a sandy loam or a rather heavy silty loam surface deposit. Generally the gravel constitutes a basal stratum rather sharply bounded by the underlying materials of various older formations, while it grades upward into the loamy covering which forms the Sassafras loam and silt loam. The slopes, where somewhat eroded, give rise to a mingling of the loam with underlying gravel, forming the Sassafras gravelly loam. Around the head of Chesapeake Bay some areas of the Sassafras sand are found within the limits of this formation.

The highest Pleistocene terrace is represented on the Maryland-Delaware Peninsula only by fragments, which are found along the ridge of high land on Elk Neck and to a limited degree along the steep slope which marks the inner border of the Coastal Plain around the mouth of the Susquehanna River. This highest Pleistocene terrace is called the Sunderland formation by the Maryland Geological Survey. A small portion of its surface is composed of materials giving rise to the Sassafras silt loam.

The Maryland-Delaware Peninsula constitutes the region within which the soils of the Sassafras series are most widespread. They are found at all elevations from the vicinity of tide level to altitudes of more than 100 feet, while small remnants occur along the inner margin of the Coastal Plain at elevations up to 240 feet.

The materials which give rise to these soils consist of a mingling of earthy matter from the Appalachian region and the Piedmont Plateau with other materials derived from the underlying and older Coastal Plain formations. In general, the coarser gravel and sandy

materials form a basal bed underlying loam or silt loam coverings, although extensive areas of sandy surface material are found along the estuarine rivers of the section and within the seaward margin of the Talbot formation.

The influence of glaciation to the north is shown by the presence of large ice-borne blocks within all parts of the terrace formations.

The Talbot terrace is continued to the west of Chesapeake Bay in the peninsula lying between the bay and the Potomac River. This region is locally known as southern Maryland.[1] The lowest terrace is fairly well developed from Baltimore south to the northern end of Calvert County, Md., as a gently sloping front land rising from water level to an altitude of 40 or 50 feet. Its shore line is either low or defined by a wave-cut cliff of a few feet in height. The terrace itself constitutes a slightly relieved plain with a gentle slope toward tide water. From this region south to the mouth of the Patuxent River it is almost entirely wanting, having been cut away by the active erosion of the waters of Chesapeake Bay.

It is again developed along both shores of the Patuxent River to a limited degree and much more extensively along the shores of the estuarine portion of the Potomac River. In all of these localities it forms the low front lands interruptedly bordering these estuaries.

The origin of the materials of the Talbot formation in southern Maryland is approximately the same as upon the Maryland-Delaware Peninsula, although a larger proportion of material derived from older Coastal Plain formation is incorporated. The succession of materials is about the same and the base is marked by gravels and coarse sand, while the present surface is formed by silt loam, loam, and rather fine sandy coverings. Wherever this formation is well drained, considerable areas of the Sassafras soils are encountered.

The next higher terrace, the Wicomico, is rather sparingly developed in southern Maryland. It occurs at elevations ranging from 50 to 80 feet in the estuarine valleys and along the bay shore. Its surface also rises with the gradient of some of the tributary streams until elevations of 100 feet are attained near the Piedmont border.

In general the surface of the Wicomico terrace is separated from both the Talbot and Sunderland terraces by a distinct scarp. In some instances the narrow remnants of the formation have been so eroded that neither the flat surface nor the bounding scarps may be readily distinguished. In almost all instances this formation occurs as narrow, fragmentary benches of small area in this section of the Coastal Plain.

The materials entering into the composition of the Wicomico terrace are chiefly gravel, sand, and the capping of loam or silt loam,

[1] See Patuxent, St. Marys, and Nomini Folios, U. S. Geol. Survey.

which is characteristic of this formation east of the Chesapeake Bay. The chief areas of the Sassafras silt loam found in southern Maryland occur upon its surface.

The highest Pleistocene terrace in southern Maryland is called the Sunderland formation. It occupies a large part of the broad, nearly flat interstream areas, especially along the Chesapeake Bay and the lower reaches of the Potomac River. It is in reality a gently sloping plain which has been dissected into broad, irregular plateaus, separated by the present tidewater estuaries.

A considerable proportion of the area of the Sunderland formation in southern Maryland consists of materials that do not give rise to soils of the Sassafras series. The heavy, silty soil of gray color which predominates on the plateau surface is classed as the Leonardtown loam. Upon somewhat more rolling surfaces and along certain of the uplands there are found soft sandy loams and fine sands derived from this formation and formed by its partial erosion and mingling with underlying materials which have been correlated as the Sassafras sand, fine sand, fine sandy loam, and loam. These areas are of somewhat mixed origin, but owe their chief characteristics to the influence of the material derived from the Sunderland formation.

A large area in the northern part of southern Maryland is occupied by the highest Coastal Plain terrace, referred to the Lafayette formation, and by the exposed outcrops of some of the older Coastal Plain strata. None of these give rise to soils of the Sassafras series.

All the occurrences of the soil of the Sassafras series in southern Maryland are confined to the areas of the Pleistocene terraces, except where erosion has partially removed these formations and mingled their remnants with older materials. The largest areas of the soils of this series are found along the upper waters of Chesapeake Bay and along the forelands which border the principal estuarine rivers, particularly the Potomac. Only the better-drained areas of these terraces give rise to soils of this series.

Examinations of the soil materials of the region south of the Potomac River show that the Potomac and the Rappahannock Rivers are discontinuously bordered by the lowest terrace, known as the Talbot formation[1] in Maryland. It is also evident that the Wicomico terrace is represented at intermediate elevations and that the rolling or flat-topped interstream areas belong in part to the Lafayette formation.

These different formations are closely related to the similar occurrences in southern Maryland, and soils referable to the Sassafras series occur to a limited extent along the low forelands upon the lower courses of the rivers. Considerable areas of the Sassafras loam and

[1] See Nomini and Fredericksburg folios, U. S. Geol. Survey, and Bul. IV, Virginia Geol. Survey, Physiography and Geology of the Coastal Plain Province of Virginia.

silt loam are also known to exist upon the low flat-topped divide between the Potomac River and the Rappahannock River, at least as far inland as the western boundary of Westmoreland County, Va. Farther to the south, in tidewater Virginia, other soil series occupy both the terraces and the interstream divides. These have been classed as the soils of the Wickham and Norfolk series.

A small area of the Sassafras sandy loam has been mapped on the low terrace formed by the Talbot formation between Norfolk, Va., and the Atlantic coast.

It will be seen that the various soils classed in the Sassafras series may, almost without exception, be referred to formations of Pleistocene age in the northern portion of the Atlantic Coastal Plain. In the extreme northern portion of this section the relation of these soils to glaciation is direct. Farther to the south and west this relationship is chiefly shown by the presence of limited amounts of ice-borne material mixed with the materials brought in from the Appalachian and Piedmont regions and with material derived from the older formations of the Coastal Plain. These have been deposited as a series of marine, estuarine, and fluvial terraces which constitute the low-lying section between the coast line and the more elevated land to the interior.

While the soils of the Sassafras series do not occupy the entire extent of these geological formations they are quite generally found along the interior margin where the glacial material and the fine earth from Piedmont and Appalachian sources were mingled with sediments derived from the older Coastal Plain deposits.

All these classes of soil-forming material were sorted and rearranged during the processes of transportation and deposited so that the coarser materials are most frequently found at the base while the surface materials may range from heavy silt loam to medium sand.

Only the well-drained portions of the different terraces are occupied by soils of the Sassafras series. Less well-drained areas give rise to soils classed in the Portsmouth or Elkton series.

The area of material referable to the soils of the Sassafras series is usually greatest in positions around the mouths of streams which issued from the glaciated areas to the north or whose headwaters were affected by glaciation. As the terraces are followed to the west and south other soil materials become predominant, and the higher terraces are occupied by soils of the Norfolk, Leonardtown, and Wickham series.

### SASSAFRAS SAND.

Considerable areas of the Sassafras sand have been mapped in the soil surveys of western Long Island, the Delaware River section of New Jersey, in the Maryland-Delaware peninsula, and in the southern Maryland counties lying between the Chesapeake Bay and the

FIG. 1.—WHEAT ON THE SASSAFRAS LOAM, WICOMICO TERRACE, IN SOUTHERN MARYLAND.

FIG. 2.—RYE ON THE SASSAFRAS SAND, CAROLINE COUNTY, MD.

FIG. 1.—EARLY TOMATO CROP ON SASSAFRAS SAND, SOUTHWESTERN NEW JERSEY. OTHER TRUCK CROPS IN THE BACKGROUND.

FIG. 2.—PICKING STRAWBERRIES, SASSAFRAS SAND IN SOUTHWESTERN NEW JERSEY.

Potomac River.[1] A total area of 337,346 acres has been mapped in these various surveys. It is probable that the entire geographic range of the type has been outlined, but the total area of this soil is undoubtedly considerably greater than the area already included within the limits of the soil surveys.

The surface soil of the Sassafras sand to an average depth of about 9 inches is a brown or reddish-brown, medium to coarse textured sand. Frequently the surface color may grade into yellow or gray tints and the texture is sometimes somewhat loamy, especially where a considerable amount of organic matter exists in the surface soil. The subsoil is most frequently a yellow or reddish-yellow sand, usually rather incoherent just below the surface soil, but becoming more loamy at a depth of 2 to 3 feet. Frequently the immediate subsoil is underlain at a depth of 3 feet by very coarse sand or by sand and gravel mixed. The deeper subsoil is also frequently tinged with red so as to become orange or brown in color.

In some areas small amounts of fine gravel are mingled with both the soil and subsoil, especially upon steep slopes, where erosion has exposed underlying beds of coarser material. In a few localities indurated, iron-cemented gravels give rise to plates and blocks of "ironstone," which appear most numerously upon slopes or where this soil type merely persists as a capping on partially eroded hills. Typically the surface soil is a uniform, medium sand in which the chief variations consist of more or less organic matter and in a slightly variable amount of the finer-grained soil particles.

The Sassafras sand is distinguishable from the Norfolk sand, with which it is sometimes associated, through the generally gray appearance of the surface soil and the yellow coloration of the subsoil of the latter.

The Sassafras sand occurs in quite a variety of topographic positions, but the greater part of the areas of the type thus far mapped is found upon gently sloping terrace plains or upon the slightly inclined surfaces of delta deposits. Within these areas there is usually a small percentage of the type which occupies the sloping sides of streamways or the marginal slopes of the deltas or terraces. In some instances, also, erosion has left small areas of the Sassafras sand as isolated cappings upon the higher hills. Areas of this character are liable to be rougher and more sloping than the characteristic occurrences of the type. The most extensive areas and those of the highest agricultural value exist as gently sloping plains and nearly level terrace areas. In such positions the level of the ground water is frequently near the surface of the land. This is the case along the southern shore of Long Island and along the low

[1] In some of the earlier surveys no distinction was made between the sand and fine sand, and both were mapped as Sassafras sand.

terraces which border the Delaware River and the banks of many of the estuarine streams of the Maryland-Delaware peninsula. This circumstance frequently modifies the natural moisture-holding capacity of the type and renders it capable of producing a wider range of crops than its rather coarse texture would seem to indicate.

Generally, the Sassafras sand is well drained, both on account of its sandy texture and because it is found in areas where stream drainage has been well established. The higher lying part of the type is even somewhat excessively drained and is therefore rather more limited in its crop uses than the lower lying areas of which mention has been made.

While there is thus some variation in the circumstances of attitude and of natural drainage within the total extent of the type, the Sassafras sand is generally level to gently undulating in its surface features, well drained to somewhat droughty, and usually rather restricted, because of these facts, in the character of crops which may successfully be grown upon it.

The extent to which the Sassafras sand has been occupied for agricultural purposes varies considerably with the geographical location of the different bodies of this soil. In all areas near to the great centers of population, such as the areas in central and western Long Island, those in central and southwestern New Jersey, and those in some parts of southern Maryland, the greater proportion of this soil has been cleared and placed under intensive forms of cultivation. In other regions more remote from the great markets for vegetable and fruit crops, and where the means for rapid transportation is lacking, considerable areas of the Sassafras sand remain in forest growth of pine and scrubby oak, or the areas are farmed with varying success for the production of the cereal grains, hay, and vegetables for home consumption. It is probable that 75 per cent of the type in the vicinity of the larger cities of the northern Atlantic coast is occupied for intensive forms of crop production, while diminishing percentages are utilized for any agricultural purpose in more remote locations. It may be roughly estimated that not more than one-half of the total area of the type thus far encountered in the soil surveys has been utilized for crop production. The development of the remaining areas will probably not occur until the use of such lands is made desirable by the extension of transportation facilities and an increased demand for the growing of special vegetable and fruit crops.

Because of the generally porous and unretentive character of both the soil and subsoil of the Sassafras sand, it is not found to attain to any high value for the production of the staple crops. In fact, in localities where such crops are the only ones whose production is attempted upon this soil, the yields obtained are usually below

the normal averages for the general region, and it is only where some unusual circumstance of saturated subsoil, seepage from higher lands, or the existence of a denser underlying loam or clay is of local influence that corn, the small grains, or the ordinary meadow grasses are grown to any marked advantage. This is so general that large areas of the Sassafras sand still remain in forest wherever local conditions do not favor special crop production.

Corn is more generally grown upon the Sassafras sand than any of the other cereals. The yields secured range from less than 20 bushels to 40 bushels per acre. The latter yields are only obtained in the seasons of heavy and well distributed rainfall, or upon portions of the type favored by an unusually high water table, the presence of retentive materials below the subsoil, or by specially good methods of soil management.

Wheat is locally grown on the Sassafras sand in some portions of Maryland. The yields are usually low, rarely exceeding 10 or 12 bushels per acre. The crop is not at all suited to such a porous soil, and is usually grown merely as a part of an established crop rotation.

Rye is grown to a limited extent and produces fair yields, ranging from 12 to 20 bushels per acre. It is probable that it is the small grain best suited to this soil. Where the straw can be sold to advantage, the growing of rye is more profitable than the growing of wheat. A good crop of rye grown on the Sassafras sand is shown in Plate I, figure 2.

Crimson clover is coming to be grown as a winter cover crop upon portions of the Sassafras sand along the Maryland-Delaware line. This crop not only gives an excellent winter growth for protective purposes, but it also is cut for hay at a time sufficiently early in the spring to permit of the planting of an intertilled crop for the summer season. It has also led to increased fertility of the Sassafras sand, where it has been used consistently. This is particularly the case where the crimson clover stubble or the remainder of the crop after it has been grazed during fall and spring is plowed under as a manure for the succeeding corn or tomato crop.

Cowpeas produce good yields of hay upon the Sassafras sand, and they are grown to an increasing extent as a summer hay crop. It has also been found that the peas may be produced for seed upon this soil, especially in the eastern counties of Maryland, and that the yield of seed constitutes a profitable cash crop, while the cowpea straw may be used as a valuable fodder.

None of the meadow grasses are grown to advantage upon the Sassafras sand, although a fair stand of red clover may be obtained for one year. Clover is sometimes seeded with the small acreage of wheat grown upon the type. The yields of hay are low.

While the Sassafras sand does not constitute a valuable soil for the production of the usual grain and hay crops, its warm, porous condition renders it an especially valuable soil for the growing of the special vegetable and small fruit crops.

Large areas of the type on western Long Island are located so close to New York City; other areas in central and southern New Jersey are so favorably situated near the Camden and Philadelphia markets; and even some areas in Maryland, located near to Baltimore, are so accessible to city markets that a considerable use is made of them in the production of small fruit and vegetables.

For the purposes of the market gardener and the trucker the Sassafras sand is a very valuable soil. Because of its coarse texture and through natural drainage, it is a warm, early soil, which may be worked at an early date in the spring and which forces the vegetables and fruits to a rapid growth and an early maturity. When heavily manured and properly managed, it gives satisfactory yields of a considerable number of such special crops. The type is recognized through extensive experience as one of the most desirable soils of the North Atlantic coast region for trucking and market gardening.

Added to the warm, well-drained character of the soil and the location of important areas of it near to market and to favorable transportation facilities is the fact that it lies at low elevations, and frequently within the protective climatic influences of large bodies of tidewater. This is the case with the areas found upon western Long Island; it is generally true of the most important areas in New Jersey; and it also applies to the areas of the type found near Baltimore, Md. These circumstances give rise to availability for crop uses early in the spring and to a lengthening of the growing season to such an extent that two or more crops are produced in one season from the same ground.

The vegetable crops grown upon the Sassafras sand frequently reach maturity at a date from four days to one week in advance of the same crops from the same localities grown upon other finer-grained and more retentive soils.

The Sassafras sand occupies the same relative position as an early truck crop soil in the northern Atlantic Coastal Plain that the Norfolk sand occupies in localities farther south. Both are the earliest soils of their respective regions.

A bewildering variety of vegetable crops is grown in rapid succession upon the Sassafras sand in all of the developed trucking sections of Long Island and southern New Jersey. No census statistics are available to give definite acreages of the different crops. In general it may be stated that early Irish potatoes, tomatoes, and sweet potatoes occupy the largest areas among these crops.

Upon western Long Island early Irish potatoes are the most extensive crop grown upon this type. The yields vary considerably under the management of different growers and under different seasonal conditions. It may be said that the high fertilization and careful cultivation given the crop usually result in yields ranging from 125 to 150 bushels per acre. The latter yield is sometimes exceeded. The early Irish potatoes grown upon the Sassafras sand in both New Jersey and upon Long Island are usually smooth, mealy tubers, which command a high market price. They reach the market in succession with the Irish potatoes grown in the Norfolk section, in the eastern shore counties of Virginia, and immediately after the crop from central Delaware. The New Jersey crop usually comes on the market in late July and early August, while the Long Island crop is marketed in greatest quantity from the latter part of August to early September. The crops grown upon other soil types in these same regions are usually a week or more later in date of maturity than the potatoes harvested from the Sassafras sand.

The Sassafras sand exerts a strong influence upon the production of sweet potatoes in New Jersey. From Trenton, N. J., southward to the vicinity of Bridgeton, N. J., extensive fields of sweet potatoes are annually grown. This is the northern limit of production for this crop upon any extended scale. It is only upon the more sandy and warmer soils that the crop is successfully produced in this latitude. Hence the Sassafras sand and the associated Sassafras fine sand come to be the chosen sweet-potato soils of the New Jersey growers.

The importance of the sweet-potato crop upon the Sassafras sand is clearly shown through the fact that 55 per cent of the total acreage in sweet potatoes and nearly 60 per cent of the total yield for the State of New Jersey are grown in the counties of Gloucester and Salem, largely upon this type and upon the Sassafras fine sand. The average yield of sweet potatoes for the State is approximately 142 bushels per acre, but the average yield from Gloucester County, which may be taken as representing very closely that of the Sassafras sand and fine sand, is in excess of 162 bushels per acre.

Both early Irish potatoes and sweet potatoes also constitute important crops upon the Sassafras sand in Anne Arundel County, Md.

Tomatoes, both for direct marketing and for the purpose of canning, are grown to some extent upon the Sassafras sand. In New Jersey the crop is chiefly grown for direct marketing as early in the season as possible. The soil type is conveniently located near to immediate markets and the tomatoes are frequently transported by wagon from the fields to the retail or wholesale markets of Camden and Philadelphia. A field of tomatoes on the Sassafras sand is shown in Plate II, figure 1.

Both in Anne Arundel County, Md., and in the Eastern Shore counties of Maryland tomatoes are extensively grown for the canning factories upon this and associated soil types.

The Sassafras sand is used to some extent for the growing of watermelons in both Gloucester and Salem Counties, N. J., where it is recognized as the soil best suited to this crop. Good yields of sweet, early melons are secured. Some melons are also grown upon the type in the different areas of its occurrence in Delaware and Maryland. Cantaloupes are less extensively grown than watermelons on this type, but give fair yields of melons of excellent quality.

For the production of extra early garden peas as a truck crop the Sassafras sand is only excelled by the Norfolk sand. In Anne Arundel County, Md., many acres of early peas are annually grown upon this soil. In the New Jersey trucking counties and upon Long Island early peas are also an important crop. In all of these localities string beans are grown to some extent. Both crops take a regular spring place in the succession cropping which marks the intensity of trucking methods, and it is a common sight to see the rows of peas and string beans so spaced that cucumbers or cantaloupes may be interplanted, making their growth and fully occupying the tract after the early peas and beans have been harvested.

There is probably no soil in the more northern trucking regions which is so well suited to the production of an extra early crop of asparagus as the Sassafras sand. The shoots are ready for cutting at an early date, they are easily harvested, and they are easily blanched to the creamy white demanded by certain markets. While asparagus is not grown in any large acreage upon the Sassafras sand yet the crop is one of high value, and it is very frequently found in small plots upon the market garden and truck farms located upon this soil type.

Numerous other truck crops are grown upon this soil. Among these may be enumerated eggplant, which is found to be well suited to this soil in the southwestern New Jersey counties; cucumbers, grown on Long Island, in New Jersey, and upon the Eastern Shore of Maryland; peppers, chiefly produced upon it in New Jersey; sweet corn, locally grown in small acreages upon many truck farms; and even extra early cabbage, carrots, turnips, beets, and spinach and kale.

The strawberry is the most widely grown and valuable small fruit produced upon the Sassafras sand. The type is chiefly used for growing such varieties as the Superior for early market and the Klondyke for midseason markets. The Gandy, a distinctly late berry, is grown only to a limited extent upon this soil. It is better suited to production upon the more loamy types of the Sassafras series and to the mucky, moist conditions of the Portsmouth loam

and sandy loam. Since these soils are commonly associated with the soils of the Sassafras series in the region of its most extended development on the Maryland-Delaware Peninsula, the later berries are decidedly restricted to these other types. A good field of strawberries on the Sassafras sand is shown in Plate II, figure 2.

Both dewberries and blackberries are planted successfully on the Sassafras sand. In Anne Arundel County, Md., the dewberry has become somewhat a specialty upon this soil.

In former years peaches were grown to quite an extent upon some portions of the Sassafras sand, but the crop is now of diminishing importance.

Early fall varieties of apples are grown upon it, but the Sassafras sand may not be considered as a type well suited to apple orcharding.

To summarize the uses of this soil type it may be said that the value of the special crops grown upon it in the various localities probably exceeds the value of the general farm crops produced, although the acreage is decidedly smaller. The type may be characterized as below the average in agricultural value for the production of the cereal grains and the common meadow grasses; fairly well suited to the growing of crimson clover and cowpeas; and especially well suited to the production of a wide variety of vegetables and small fruits where areas of the soil are conveniently situated with respect to transportation and market.

## SASSAFRAS LOAMY SAND.

The Sassafras loamy sand has been mapped to a total extent of 57,024 acres, found chiefly in the Easton area, Md., but to a limited extent in Anne Arundel County, Md. It is undoubtedly a type of limited geographical extent and of restricted agricultural importance.

The surface soil of the Sassafras loamy sand to a depth of 6 or 8 inches is a dull-brown loamy sand. The medium to coarse grades of sand form a considerable part of the whole mass and give a coarse gritty character to the material. A small amount of white quartz gravel is also found in the surface soil. There is present a sufficient amount of finer grained material to cause a moist sample of the soil to cohere slightly, but when dry the surface soil is loose and uncompacted, although not quite so incoherent as the Sassafras sand.

The upper part of the subsoil possesses about the same texture and structure as the soil, but is lighter in color, being a pale yellow. At a depth of 15 inches there is a perceptible increase in the amount of fine material and the deeper subsoil gradually becomes a moderately heavy sandy loam. It is coherent when moist, but crumbles into granular aggregates when dry.

The Sassafras loamy sand is an intermediate gradation between the Sassafras sand and the Sassafras sandy loam. For the general farm crops it ranks below the latter and above the former.

The most extensive areas of the Sassafras loamy sand are level to gently undulating in surface topography and sufficiently elevated to be well drained to droughty. There are some areas where the deeper subsoil is rather poorly drained, but these are of limited extent.

A considerable part of the Sassafras loamy sand has been cleared and occupied for the production of the general farm crops. More recently areas located near to canning factories or to shipping facilities have been used to some extent for the growing of tomatoes for canning, of sweet potatoes, and of melons and cantaloupes.

Among the grains, corn is most extensively grown. The yields obtained are low under ordinary systems of management. Wheat also gives low yields upon this soil. Some crab grass is cut for hay. Crimson clover has been tried upon this soil and gives fair yields of hay, especially when a light application of lime is made with the seeding. Cowpeas are also grown to some extent, chiefly as a hay crop. It has been found that the other general farm crops produce larger yields following a crop of crimson clover, and the practice of using this legume as a winter-cover crop and for the purpose of green manuring should be extended.

Where tomatoes are grown for canning moderate yields are secured. Crimson clover is frequently grown as a green manure in connection with this crop, giving markedly increased yields.

Buckwheat and rye are grown to a very limited extent.

The Sassafras loamy sand may be characterized as a rather low-grade general farming soil which is much better suited to the growing of special crops where a market for such crops, especially tomatoes, sweet potatoes, and melons, exists.

This type is normally deficient in organic matter, and the use of stable and green manures is to be recommended.

## SASSAFRAS FINE SAND.

The Sassafras fine sand has been mapped in the Trenton area, in New Jersey and Pennsylvania, and in Anne Arundel and Prince Georges Counties, Md., to a total extent of 78,302 acres.[1] In the Trenton area this soil type is found on both sides of the Delaware River from the vicinity of Trenton southward. In Maryland no areas of the Sassafras fine sand have been encountered, except along the upper course of the Patuxent River. It is probable that the type is not of widespread occurrence outside of the localities where it has already been mapped.

[1] Considerable areas of this soil were included with the Sassafras sand in the Salem area, New Jersey.

The soil of the Sassafras fine sand, to an average depth of 8 or 10 inches, is a brown or reddish-yellow fine sand. It is friable and powdery when dry but slightly adhesive when moist. The subsoil is a lighter colored, yellow or pale orange fine sand which is usually rather incoherent to a depth of 2 feet or more but may be somewhat cohesive below that depth.

The surface configuration of the Sassafras fine sand varies considerably in the different localities where it is found. Along the Delaware River it occupies level-topped to undulating terraces at elevations varying from 10 feet to 80 feet above tide level. In the Maryland counties it occurs as level terraces at various elevations above the Patuxent River and also as rolling to rather hilly country at some distance back from the river. In all of these positions there are numerous steep slopes within the limits of the type. The terrace occurrences present considerable areas of level arable land, while the rolling areas frequently show not more than half of the surface sufficiently level for tillage purposes. In all positions the natural drainage of the type is good and sometimes excessive. On the steeper slopes there is constant danger from excessive erosion and this limits the uses to which the land may be put as well as the total area which may be used for tillage. The steeper slopes are usually forested with mixed hardwood growths.

In New Jersey and Pennsylvania the areas of the Sassafras fine sand exist near to large city markets and there has been a considerable development of this type for the purposes of market gardening and trucking. Very little use is made of it for the production of general farm crops. In Maryland, however, it is not favorably located with respect to market or to transportation, and the crops grown are those of the general agriculture of the community. It is probable that nearly three-fourths of the entire area of the Sassafras fine sand has been cleared and occupied for some form of agricultural production.

The class of crops grown upon the Sassafras fine sand depends chiefly upon the market facilities. Thus, upon the larger areas of the type along the Patuxent River, corn, wheat, grass, and the Maryland pipe-smoking tobacco constitute the chief crops. Corn gives moderate to low yields, ranging from 15 to 30 bushels per acre. Wheat gives yields which range from 10 to 15 bushels. Hay is not generally grown, but where produced yields of less than 1 ton per acre are common. The quality of the Maryland pipe-smoking tobacco produced upon this soil is fair to good, but the yields are frequently low. In fact, the water-holding capacity of the type under normal conditions is not great enough to mature large yields of the staple crops. Cowpeas and crimson clover have only been grown to a small extent upon the Sassafras fine sand. The general introduc-

tion of these crops both for forage and green manuring purposes should be encouraged.

The Sassafras fine sand can not compete with the Sassafras sand in maturing truck crops at a very early date, but the crops grown are usually satisfactory with regard to yields. For the production of early tomatoes, of sweet potatoes, and of garden peas and string beans the Sassafras fine sand is well suited. It is used for the growing of these and other market garden crops in southwestern New Jersey. It is also used for the growing of cantaloupes and is well suited to this crop.

In general, the Sassafras fine sand is somewhat too porous and well drained to be classed as a successful general farming soil. Areas suitably situated with regard to market are used for vegetable crops and canteloupes.

In all cases the sandy character of the soil renders the use of organic manures and green manuring crops advisable.

## SASSAFRAS GRAVELLY LOAM.

The Sassafras gravelly loam has been mapped to the extent of 164,678 acres, chiefly upon western Long Island and in southwestern New Jersey. Only small areas of the type have been found elsewhere, chiefly in the Maryland counties on both sides of the upper reaches of Chesapeake Bay.

The soil of the Sassafras gravelly loam to a depth of 8 to 10 inches is a brown or reddish-yellow sandy loam containing from 20 to 40 per cent of small, white, quartz gravel, intimately mixed through the mass of finer grained material. This is usually underlain by a yellow or reddish-yellow silty loam which also contains considerable gravel. The whole mass rests upon beds of fine or medium gravel at depths ranging from 2 to 3 feet.

The surface features of the Sassafras gravelly loam are somewhat variable in the different areas of its occurrence. The extensive area mapped on western Long Island constitutes a gently sloping plain with a maximum elevation of 200 to 240 feet above tide level where it abuts against the latest glacial moraine ridge along the northern shore of the island. Thence it slopes gently seaward to the south shore, being interrupted by the ridges and hills of an earlier moraine in the central part of Long Island.

The surface is little broken by stream channels although a few dry gullies carry off excess water in times of heavy precipitation or of melting snow. The natural slope of the land and the presence of the underlying, porous beds of gravel give the type complete drainage throughout its occurrence upon Long Island.

In southwestern New Jersey some areas of the Sassafras gravelly loam occur chiefly on upland ridges and sloping plains, where erosion has partially removed the original covering of silt loam. It also occurs in narrow belts as a gravelly outcrop along stream slopes. In both positions it is rather excessively drained because of its coarse texture and because of the presence of underlying beds of sand and gravel. Upon the more level areas, where erosion has not been so severe, there still remains a sufficient amount of silty fine earth to render the type capable of fairly successful agricultural occupation.

The other areas of the Sassafras gravelly loam are chiefly local tracts, where an unusually high content of gravel is found in material resembling either Sassafras sandy loam or the loam.

Considerable portions of the type are too sloping and too completely drained to constitute good farm land. The more level areas, such as that upon Long Island, have been utilized to quite an extent for the production of special crops.

In general the staple farm crops are not extensively grown upon the Sassafras gravelly loam. In the Maryland areas, however, corn gives yields of 20 to 35 bushels per acre upon portions of the type which are not too sloping and gravelly to retain sufficient moisture for maturing the crop. Wheat is grown in the regular crop rotation, giving yields of 12 to 15 bushels per acre. Clover is usually seeded with the wheat, returning yields of 1 ton or more per acre. Locally cowpeas are grown to a limited extent. Some tomatoes are also grown in localities near canning factories.

Owing to its proximity to great city markets and to the fact that the soil is well drained and warm, the market garden and truck crops are grown upon it in large acreage on western Long Island.

Early Irish potatoes are extensively grown and the yields obtained with liberal use of manure and fertilizer range from 100 to 200 bushels per acre. The crop reaches the market late in August and is chiefly marketed as fast as it matures. Cabbage for the summer and early fall market is also grown. Sweet corn for direct sale constitutes another important crop, while tomatoes are raised to a small extent.

In New Jersey few general farms crops are grown upon the Sassafras gravelly loam. In some localities plantings of peaches, plums, cherries, and pears have been made. They have been fairly successful. The growing of market garden and truck crops has also been undertaken during the last 10 years and small areas of the type are thus utilized.

For the production of either the vegetables or fruit crops it is essential to select only those portions of the Sassafras gravelly loam which contain a considerable amount of silt and clay in both the

surface soil and subsoil and to avoid the areas of the type underlain at a shallow depth by thick or compacted beds of gravel. Where the surface layer of loamy and gravelly soil and subsoil amounts to 3 feet or more the type possesses a considerable agricultural value. Elsewhere it is too completely drained and the gravel bed interferes too seriously with root development.

In general the Sassafras gravelly loam is not well suited to the staple farm crops. Certain special fruit and vegetable crops are grown where the loam content is greatest and where the local demand furnishes a good market for early vegetables or fruits.

In all areas the Sassafras gravelly loam is benefited by the addition of organic manures.

### SASSAFRAS SANDY LOAM.

The Sassafras sandy loam has been mapped to the extent of 332,410 acres in the soil surveys which have been made in southern New Jersey, Delaware, eastern and southern Maryland, and in the vicinity of Norfolk, Va. It is one of the most extensively developed and agriculturally important types in the Sassafras series. It is probable that additional soil surveys in these general localities will show the existence of other areas of this soil.

The soil of the Sassafras sandy loam to an average depth exceeding 1 foot is a brown, granular sandy loam. It is characterized by a fairly even distribution of the coarse, medium, and fine grades of sand with a relatively large proportion of silt, which gives a decided coherency to the soil mass.

The subsoil is a reddish-yellow or brown sandy loam decidedly heavier and more coherent than the surface soil. This extends to a depth of 2 or 3 feet, where it is normally underlain by coarse sand or fine gravel. There are areas of limited extent where the more pervious deeper layer is not found and some portions of the type, particularly in the New Jersey occurrences, are underlain by a stiff clay. These are not strictly typical of the Sassafras sandy loam.

Upon portions of the type which slope down to stream courses a small amount of quartz gravel and occasionally a few small stones are found. Such areas are of decidedly limited extent, and the type as a whole is a remarkably uniform medium sandy loam.

All of the more extensive areas of the Sassafras sandy loam possess a nearly level or very gently undulating surface topography. They occur principally within the low-lying coastal terraces which border the Delaware River and Bay and in the broad, gently sloping plain which lies between Delaware Bay and Chesapeake Bay. The absolute elevation of the surface of the type ranges from 5 to 10 feet above tide level near the coast line, to altitudes of 70 or 80 feet above tide upon the more elevated inland ridges. West and south of Chesa-

peake Bay the areas are of small extent and are found upon low coastal or river terraces.

In all the areas of its occurrence the Sassafras sandy loam is well drained in its natural condition and only a very small proportion of the type requires artificial drainage to render it suitable for agriculture.

The generally level or slightly undulating surface renders the use of power machinery possible over practically the entire extent of this soil. It is thus admirably suited by its natural characteristics for the development of many classes of farming.

It is probable that more than 80 per cent of the total area of the Sassafras sandy loam has been cleared and utilized for some form of agriculture. The class of farming developed depends to a considerable degree upon the location of the particular area of the type with respect to markets and transportation, since the soil itself is fairly well suited to the conduct of a high class of general farming or to a more intensive form of special crop production. For both of these classes of farming it is held in high esteem and is consequently very generally under cultivation. Only local areas of considerable slope are left in natural forest.

Among the staple farm crops, corn is more extensively grown upon the Sassafras sandy loam than any other. The yields of corn reported from this type range from 35 to 40 bushels an acre under normal circumstances, while yields of 65 bushels or more have been attained under especially favorable conditions of season and where extra care was used in the preparation of the land and in the cultivation of the crop. In the latitudes in which the Sassafras sandy loam occurs the dent varieties of corn are almost exclusively grown for the field crop.

Wheat is most extensively grown among the small grains and gives yields which range from 12 to 18 bushels per acre under normal conditions, but with authentic yields in excess of 30 bushels per acre. The Sassafras sandy loam is rather porous and sandy to be classed as a first-rate wheat soil, but the yields obtained show that the crop may be used successfully in the general farm rotation.

Oats and rye are both grown to a small extent upon this soil. The yields are not sufficiently high to warrant increasing the acreage.

Cowpeas are grown to some extent on the Sassafras sandy loam in Delaware and the Eastern Shore of Maryland. The crop is not common, however.

Crimson clover, or "scarlet" clover, as it is locally termed, has been grown upon the Sassafras sandy loam and associated soils for nearly 30 years. Excellent fields in eastern Maryland are shown in Plate III, figures 1 and 2. Within the past 10 years the area annually seeded to this crop has been greatly increased, and the value

of crimson clover both as a forage crop and as a soil renovator has led to its quite general introduction into the crop rotation of the Maryland-Delaware Peninsula. The crimson clover is sown in the growing corn at the last working or at a special working in early August. It is also sown in the tomato fields. After the corn is harvested the clover makes a good fall growth and then lies dormant during the winter. In early spring it grows rapidly and is ready for cutting for hay by the middle of May. This allows the cutting of a hay crop, ranging from 1½ tons to as high as 3 tons per acre, and the plowing down of the stubble in time for the planting of another crop of corn, tomatoes, or cowpeas.

Some farmers obtain a crop of corn, follow with a seeding to wheat, and after the wheat is harvested either plow or disk harrow the wheat stubble, seeding to crimson clover. The next spring the clover is either cut for hay or it is grazed off by hogs, sheep, or cattle, in which case a considerable residue of the plant is available to be plowed under as a green manure for a succeeding corn crop.

The favorable effect of crimson clover upon the Sassafras sandy loam in securing increased yields of the other staple and special crops has led to a gradual extension of its production, especially in central Delaware and in adjacent parts of Maryland. The yields of corn grown upon a crimson clover sod are materially greater than where the crop is grown on land upon which no winter cover crop has been planted.

It has been found desirable to apply lime to a field where crimson clover is first to be seeded. This may be done at the rate of 1,000 to 2,000 pounds per acre of quicklime, or at the rate of 1 or 2 tons per acre of ground limestone.

Medium red clover is quite commonly seeded in the spring on wheat upon the Sassafras sandy loam. The clover usually gives a good hay crop, ranging from 1 to 2 tons per acre. To a limited extent timothy and clover are used for seeding for mowing lands and a fair yield of mixed hay results. The success attained with crimson clover and with red clover, however, restricts the area seeded to mixed grasses.

A very small acreage of buckwheat is grown upon the Sassafras sandy loam, chiefly as a catch crop or as a winter cover crop.

In the southern Maryland counties the Maryland pipe-smoking tobacco is grown to some extent upon the Sassafras sandy loam. The yields range from about 1,000 pounds to as much as 1,500 pounds per acre. The quality of the tobacco is usually good.

While the general farm crops occupy by far the larger acreage upon the Sassafras sandy loam, special vegetable and fruit crops are also grown to a considerable extent, especially in central Delaware and the eastern counties of Maryland.

Early Irish potatoes are produced to fair advantage upon this soil. The yields are extremely variable, ranging from 75 to 250 bushels per acre. The general average is about 100 bushels. The potatoes from this type in Delaware reach the northern markets during July and succeed the shipments from points farther south. Wherever the type occurs, from the vicinity of Norfolk, Va., to the Delaware Bay region, it is recognized as a soil well suited to the growing of early Irish potatoes. The extension of the production of this crop has been rather rapid during the last 10 years.

Sweet potatoes are also grown in considerable acreage upon the Sassafras sandy loam. The yields are fair to good and the quality of the potatoes is usually excellent.

Tomatoes are grown both for shipment to city market and for supplying local canning factories. Yields range from 4 to 6 tons or more per acre, and the crop has generally been found to be profitable.

Sweet corn is grown both for direct sale and for canning.

Peas, cucumbers, cantaloupes, watermelons, and asparagus are all grown successfully, but in small acreages, upon the Sassafras sandy loam.

In central Delaware the Sassafras sandy loam has been developed as the most important fruit soil of the region. Pears occupy the largest acreage, and the Kieffer is the principal variety. It is used for canning chiefly.

Peaches were extensively grown at one time, but the acreage has greatly decreased during recent years because of the trouble experienced from various diseases, principally yellows and little peach. The Elberta peach is the standard variety in the present orchards.

Many varieties of early summer and fall apples are successfully produced upon the Sassafras sandy loam. Among the early varieties may be mentioned Yellow Transparent and Early Ripe. Williams is grown for the summer market, while Stayman Winesap, Nero, Paragon, Winesap, York Imperial, and Rome are planted to supply the fall and winter markets. Very considerable plantings of apple orchards have been made upon the Sassafras sandy loam in central Delaware during the last 20 years. It has been found that this soil brings the trees to bearing age in 5 to 12 years. A young apple orchard and a planting of blackberries on the Sassafras sandy loam are shown in Plate IV, figure 1.

Grapes are being planted to quite an extent in the vicinity of Dover, Del., largely upon the Sassafras sandy loam. Moores Early and Concord are the varieties chiefly grown. Practically all of the fruit is shipped for table use. A vineyard in the vicinity of Dover, Del., is shown in Plate IV, figure 2.

Among small fruits the strawberry occupies the largest acreage upon the Sassafras sandy loam. The early variety is chiefly the

Superior, while the Klondyke is grown as a midseason berry. The later varieties are not grown with as great success upon the Sassafras sandy loam as upon the more mucky and darker colored soils of the Portsmouth series.

Dewberries and blackberries occupy a minor acreage upon the Sassafras sandy loam.

## SASSAFRAS FINE SANDY LOAM.

The Sasasfras fine sandy loam has been mapped to a total extent of 101,676 acres in the different soil surveys which have been made in the northern portion of the Coastal Plain. The largest areas of the type are found in the Maryland counties which border the western shore of Chesapeake Bay. Small areas are also found along the lower courses of the Delaware River and on the eastern shore of Maryland.

The surface soil of the Sassafras fine sandy loam, to an average depth ranging from 9 inches to 1 foot, is a brown to yellowish-brown fine sandy loam. In some areas a small amount of quartz gravel is found in the surface soil, particularly upon sloping areas. There is also an appreciable amount of silt in the lower portions of the surface soil in such positions. In general the soil is soft and friable, but somewhat coherent when moist.

The subsoil in all cases is a heavier and more compact yellow or reddish-yellow sandy loam, which normally extends to a depth exceeding 3 feet. In many areas the subsoil grades downward into a more sandy layer which underlies it at depths varying from 3 to 5 feet. In some cases, especially where the surface is flat and the total depth of subsoil is considerable, the deeper subsoil may be compact and rather poorly drained. In such cases it is sometimes mottled yellow and gray.

The surface configuration of the Sassafras fine sandy loam varies considerably in the different areas of its occurrence. Along the Delaware River and at the lower elevations on the Eastern Shore of Maryland and bordering Chesapeake Bay the type occupies low-lying, nearly level topped terraces, which extend from the vicinity of tidewater to elevations of 25 or 30 feet. These terraces are generally fairly well drained, although small depressions or level areas somewhat remote from local drainage ways may be semiswampy in their natural condition. In Anne Arundel County, Md., where the greatest area of this type has been encountered, the surface is rolling to sloping in character and lies at altitudes of 40 to 150 feet above tide level, and drainage has become well established over practically all of the type. Probably three-fourths of the entire extent of the Sassafras fine sandy loam is well drained.

FIG. 1.—CRIMSON CLOVER ON SASSAFRAS SANDY LOAM IN EASTERN MARYLAND, READY FOR CUTTING.

FIG. 2.—HARVESTING A HEAVY CROP OF CRIMSON CLOVER HAY BEFORE PLANTING CORN ON THE SAME LAND, EASTERN MARYLAND.

FIG. 1.—YOUNG APPLE ORCHARD AND PLANTING OF BLACKBERRIES ON SASSAFRAS SANDY LOAM IN CENTRAL DELAWARE.

FIG. 2.—VINEYARD ON SASSAFRAS SANDY LOAM IN CENTRAL DELAWARE.

Nearly all the well-drained areas of the type have been cleared and placed under cultivation, and only the more level and poorly-drained areas remain in forest.

Corn is more extensively grown than any other grain crop upon this soil, and the yields obtained range from 20 to 40 bushels per acre, probably averaging about 30 bushels for the entire type. The dent varieties are almost exclusively grown.

Wheat also occupies a large acreage upon the Sassafras fine sandy loam. The yields of this grain range from 12 to 15 bushels per acre to as high as 20 bushels. The general average for the type may be stated at about 15 bushels.

The Sassafras fine sandy loam is generally recognized as being well suited to the production of the Maryland type of pipe-smoking tobacco, and this crop is quite generally grown as the cash crop upon this soil in all of the southern Maryland counties. Its production is confined to these counties and none is grown east of Chesapeake Bay. The yields of tobacco range from 1,000 to about 1,200 pounds per acre, and the quality is generally good.

Oats and rye are only grown to a limited extent.

A seeding to mixed timothy and red clover is frequently made with the wheat crop and fair yields of hay, ranging from 1 to 1½ tons per acre, are obtained. In some localities clover is seeded alone and gives yields of 1½ tons per acre or more.

Where areas of the Sassafras fine sandy loam are located in proximity to canning factories it has been found profitable to use the land for the production of tomatoes. Fair yields, ranging from 4 to 7 tons per acre are obtained, and the production of the crop is being extended in such localities.

Truck crops are grown to a small extent upon this soil, chiefly because the greater proportion of the type is not well located with respect to transportation. It has been found that early Irish potatoes, sweet potatoes, cantaloupes, and cucumbers may be successfully grown upon it where market facilities are available.

In the majority of the areas of its occurrence the Sassafras fine sandy loam has been used to some extent for the growing of peaches, pears, apples, and plums. Where the local air and water drainage are good the tree fruits may be grown with fair success.

Whether the Sassafras fine sandy loam is to be used for the production of general or special crop it has been found that it requires the use of considerable amounts of organic manure to give large yields. Generally, not much live stock is maintained upon the type so that the supply of stable manure available is small. The practice of growing green manuring crops is not general upon this soil. It has been shown that both cowpeas and crimson clover make good

crops upon the type and the production of both for hay, and as green manuring crops, should become more general.

The Sassafras fine sandy loam may be characterized as a fairly good general farming soil, capable of considerable improvement through the introduction of leguminous green manuring and forage crops into the normal rotation of corn and wheat. It is also a fairly good soil for growing some of the vegetable crops wherever market facilities are available. It is moderately good soil, in the localities where it occurs, for the production of some of the tree fruits, although not to be recommended for extensive commercial plantings.

## SASSAFRAS LOAM.

A total area of 128,356 acres of the Sassafras loam has been encountered in the soil survey work. By far the greater part of the type is found in the eastern counties of Maryland, between Delaware Bay and Chesapeake Bay. Small areas are also found on Western Long Island and in southern Maryland.[1]

The surface soil of the Sassafras loam to an average depth of 8 inches or more is a mellow brown or yellowish-brown loam. It is soft and silty in character. It grades downward into a stiffer and more compact yellow loam subsoil which becomes distinctly reddish in tinge at depths of 24 to 32 inches. The subsoil is usually underlain by fine gravel or coarse sand at depths ranging from 2 to 3½ feet.

The character of the soil and subsoil is such that a considerable amount of moisture is easily retained for crop production while effective drainage is promoted over the greater proportion of the type by the presence of the coarser material lying at greater depth.

Under ordinary conditions of cultivation the surface soil is easily worked and friable. Where the organic matter content of the surface soil has become reduced and especially where the land has been grazed when the soil was too wet there is a tendency toward compacted surface soil and toward breaking into clods and lumps when the land is plowed.

The Sassafras loam is chiefly developed upon the low, rolling uplands of the eastern counties of Maryland and upon the nearly level surfaces of the interstream ridges in the counties west of Chesapeake Bay. The small area on western Long Island lies at low elevations and is gently sloping to nearly level. In general there are few steep slopes within the area of this soil type. The recognized value of the Sassafras loam as an excellent general farm-

[1] It is probable that considerable areas of the Sassafras loam have been included in the areas of the Sassafras silt loam in the surveys of Cecil, Harford, and Kent Counties, Md. These can not be separated at the present time.

ing soil has led to its almost complete occupation for the production of various staple crops.

Throughout the entire extent of its development the Sassafras loam is naturally well drained, although minor areas which occupy depressed positions or very flat surfaces remote from stream drainage may be somewhat poorly drained and in need of tiling for the best results in crop production. Usually the somewhat elevated position of the type, its occurrence in regions of well-established stream drainage, and particularly the general existence of the more porous underlying sandy layer give rise to perfect natural drainage.

The Sassafras loam is essentially a soil well fitted for the growing of the staple field crops which constitute the basis for general farming in the areas where it occurs.

Wheat is the crop most extensively grown upon the Sassafras loam. It is probable that it occupies nearly or quite one-half of the total area of the type which is annually planted to crops. This arises from the fact that a 5-year rotation is in common use which consists of corn, followed by wheat with seeding to clover. The clover is cut one year and then plowed for another seeding of wheat. Clover is again sown on the wheat, cut for one year and the rotation returns to corn. While this rotation is much practiced, the 3-year rotation of corn, wheat, and clover is also common. The acreage statistics in counties where the Sassafras loam is an important soil type bear out the indication that wheat is the most extensively grown grain crop.

While there is considerable variation in the average crops of wheat secured it may be said that the yields range from 15 to 30 bushels per acre with a general average of about 20 bushels. The quality of the wheat grown upon this soil is usually better than the average and the general opinion is held that wheat is one of the crops best suited to the Sassafras loam. It is a notable fact that the counties in which this soil and the closely related Sassafras silt loam are most extensively developed have increased the acreage and production of wheat during the past 25 years.

The Sassafras loam may safely be ranked as one of the types best suited to wheat in the northern Coastal Plain region.

Corn is the second crop in acreage and importance upon the Sassafras loam. It is probably nearly equaled in extent of acreage by the various grass crops, although the failure to seed to grass with a portion of the wheat crop annually reduces the area in grasses.

The yields of corn reported from the Sassafras loam range from 40 to 75 bushels per acre. It is probable that the general average for the type is in the vicinity of 45 bushels per acre.

It is stated in the Soil Survey of the Easton Area, Md., that—

> Where the soil is kept in a good state of productiveness, as under a 5-year rotation of corn, wheat, grass, wheat, and grass, applying barnyard manure

and 40 bushels of lime to the broken grass sod preceding corn and about 300 pounds of good commercial fertilizer to wheat, average yields of 60 bushels of corn, 20 bushels of wheat after corn, and 28 bushels after grass, and 1½ tons of hay per acre are readily secured.

While these returns are distinctly above the ordinary yields of the type they represent its capabilities as a grass and grain-producing soil under the unusually good methods of management given.

A considerable acreage of hay is annually grown upon the Sassafras loam. Where a regular crop rotation is used and the wheat crop is adequately fertilized the yields of clover or of mixed clover and timothy range from 1 to 2½ tons per acre.

Oats are grown to a very limited extent upon the Sassafras loam. Rye is an uncommon crop. Cowpeas have been successfully grown in some cases, and the type seems well suited to the production of this crop. Crimson or scarlet clover is coming to be grown upon the Sassafras loam, but the crop is not nearly so common as on the more sandy members of the series. The yields obtained are good, ranging from 1½ to 3 tons per acre.

It has been found by progressive farmers that the use of lime on the Sassafras loam is a profitable practice. The lime is usually applied in the form of lump, quick lime, which is slaked in the field. Applications vary from 20 to 40 bushels per acre. The chief benefit of liming is held to be in the increased crop of clover secured after its application. which later results in improved grain crops grown upon the clover sod. It is probable that finely ground limestone or oyster shells applied at the rate of about 2 tons per acre would be equally beneficial.

Tomatoes are grown to quite an extent on the Sassafras loam, and the yields range from 4 tons per acre upward. The crop is chiefly grown for near-by canning factories.

Market garden and trucking crops are grown upon some areas of the Sassafras loam where markets are available. Beans, peas, cabbage, and cantaloupes are the principal crops grown.

The Kieffer pear is most extensively grown among orchard fruits, although Winesap, York Imperial, and other varieties of apples are reasonably successful upon this soil. Large nurseries are located upon one part of the type and many varieties of fruit trees are grown and distributed.

Peaches were at one time extensively grown, but yellows and other diseases have led to the practical abandonment of the crop upon nearly all of the Sassafras loam.

Among the small fruits, strawberries, dewberries, and blackberries are grown in some localities to a small extent.

The Sassafras loam is characteristically a general farming soil, well suited to the growing of corn, wheat, and grass. The knowl-

edge of the adaptation of this soil to these crops is general and the agriculture of the type is chiefly based upon the production of these three crops. Only locally is the Sassafras loam used for the growing of tomatoes and other special crops. The vegetables are chiefly grown for home use or to a small extent for special markets.

Considering the excellent yields of corn and grass attained from the Sassafras loam there is a rather small amount of any live stock aside from work animals maintained upon the type. Some dairy cows are kept as an adjunct to grass and grain farming and a few steers are fattened, but the total number of neat cattle kept upon the type is small. Nearly every farm principally consisting of this soil maintains a few hogs, while some sheep are seen upon it. Yet the live-stock industry is subordinate over the greater part of the Sassafras loam.

Few Coastal Plain soils equal the Sassafras loam for the uses which have been indicated.

## SASSAFRAS SILT LOAM.

The areas of the Sassafras silt loam which have been encountered in the soil survey are confined entirely to the Coastal Plain portions of New Jersey, Pennsylvania, Delaware, and Maryland. A total area of 518,142 acres of this type has been included in 12 different soil surveys in these 4 States.[1] It is probable that the soil type does not occur farther north than New Brunswick, N. J., nor farther south than Norfolk, Va.

The surface soil of the Sassafras silt loam, to an average depth of 9 or 10 inches, is a soft, friable, brown silt loam, occasionally containing small amounts of fine gravel. This is underlain to a depth of 36 inches in nearly all cases, and frequently to a depth of 7 or 8 feet, by a yellow or reddish-yellow heavy silt loam, which is generally sufficiently heavy to be called a clay in the localities where it occurs. At a depth varying from 3 feet to 8 or 10 feet this subsoil is frequently underlain by beds of gravel or gravel and sand, which separate the mass of soil and subsoil from underlying formations. This feature is shown in Plate V, figure 1. In the southern portion of the Maryland-Delaware Peninsula, however, this gravel bed is frequently lacking, and the subsoil rests not infrequently on beds of sand. While the subsoil is rather stiff and heavy, it is still sufficiently granulated and friable to give moderate underdrainage, and it is only in case of depressions occurring within the type that drainage is likely to be deficient.

Throughout the region in which it occurs the Sassafras silt loam occupies low, undulating plains or nearly level terraces, which slope

[1] It is probable that portions of the type as mapped in Cecil, Harford, and Kent Counties, Md., should be included with the Sassafras loam.

from the inland regions gently to a rather steep frontal escarpment, where the type ordinarily terminates, and is replaced at lower levels by other soils. In southern New Jersey the soil type is found at an altitude of 25 to 50 feet on the low terraces which border the eastern shore of the Delaware River and Delaware Bay, and it rises gently inland to a higher level at about 140 feet altitude. Some portions of the type between the low and the higher terrace are rolling to sloping in their surface features. In the Maryland-Delaware Peninsula the highest altitudes of the type are found in the form of narrow terraces where the Coastal Plain section borders on the Piedmont. Some of these higher terraces rise to an altitude of 200 feet or more. In general the highest altitudes of the Sassafras silt loam within the Coastal Plain proper are found at about 100 to 110 feet above tide in the vicinity of Chesapeake Bay, and the surface slopes gently eastward toward Delaware Bay through Maryland and central Delaware, reaching its lowest level of about 10 feet above tidewater in the east-central part of the State of Delaware. In southern Maryland the Sassafras silt loam exists along the west shore of Chesapeake Bay and along the main tidewater embayments tributary to the bay in the form of distinct terraces, having an altitude of 60 to 100 feet above tidewater. Some of these terraces extend a considerable distance inland along the principal streams, and their surface rises gently with the slope of the stream bed to altitudes of over 100 feet. In all regions where it occurs the surface is so level that power machinery may be used upon all parts of the type when it is properly cleared of its natural hardwood growth. The altitude above the local water level renders the natural drainage effective over the greater proportion of the type. Slight hollows and level tracts remote from the drainage courses constitute the only exception to this general rule.

Although the Sassafras silt loam is remarkably uniform in its inherent characteristics from its most northern extension to its southern limits, there are noticeable variations in the yields of the general farm crops which are produced upon the type. In the more northern regions, where this soil is highly esteemed for general farming, it has been the subject of the most careful tillage and treatment. As a result the yields of all the farm crops are high, and the soil is rarely sold at a price lower than $75 to $100 an acre. Farther south, where a different and less effective system of farming has been in use, the yields are less, the price of the land is not more than one-third as great, and the surface soil is more yellow and lacks sufficient organic matter. It is also more likely to be compacted and clodded when cultivated in a moist condition. These differences in its condition indicate the chief limitations upon the producing capacity of the Sassafras silt loam. Where a careful and systematic

crop rotation is practiced, where stable manure and other organic manures are used, and particularly where moderate amounts of lime are applied in connection with the seeding down of the grasses and clover, maximum yields are always obtained, and the soil is found to be in its best condition. On the contrary, where organic manures are not used, where liming is never practiced, and where hoed crops are cultivated year after year upon the same area, the soil is much less productive and much less esteemed for the production of crops. The introduction of better methods in the regions last referred to will slowly increase the producing capacity of this soil and render it as fertile and as valuable as in the locations where it has received better treatment in the past. In all cases the natural capacity of the soil is above the average for each region where it occurs.

The necessary steps for the improvement of crop yields upon this type have already been indicated in the discussion of the limitations of such yields. One of the paramount necessities is the application of all stable manure which is available, and in case this supply is not sufficient to meet the needs some leguminous crop like crimson clover or the medium red clover should be produced for the sole purpose of being plowed under to increase the humus content, preferably with an application of 2,000 pounds of lime per acre. In certain localities difficulty has been encountered in securing a good stand of clover upon this soil type. Liming will largely overcome this difficulty, and better results can be obtained by seeding the clover without a nurse crop.

There are small local areas within the general area of the type where additional artificial drainage would prove beneficial. These usually consist of small saucer-shaped depressions or of flat interstream areas where the headwater drainage of the streams is only partially established.

Practically every available acre of the Sassafras silt loam has been brought under cultivation in the various regions where it occurs. It is one of the most highly prized general farming soils of the North Atlantic Coastal Plain section, and the original hardwood timber was cleared from its surface from 100 to 200 years ago. The soil type was early sought for the production of corn, wheat, and grass, and certain special crops have been produced upon it with success as transportation facilities and market demands increased. While there is considerable variation in the yields produced, owing to more or less efficient management, it is naturally an excellent soil for general farming.

It is apparent from the textural characteristics of the Sassafras silt loam, from its level to gently undulating surface topography, and from the classes of crops best suited for production upon this soil that the equipment required for its most economical tillage will

differ very materially from the equipment to be used upon the more sandy Coastal Plain soils. The Sassafras silt loam should be plowed to a depth of 8 or 9 inches, and if the natural soil is not so deep as this the depth of plowing should be gradually increased from year to year until the desired maximum is reached.

Economy in the conduct of tillage operations demands that at least two-horse teams where each animal will weigh from 1,300 to 1,500 pounds should be used, and the most economical working of land of this class would justify the four-horse hitch, which is used to special advantage upon the heavy general farming soils, such as the limestone soils of Maryland and Pennsylvania and the prairie soils of the Central States.

For the same reasons the lightweight turning plow used upon the more sandy soils of the Coastal Plain is totally inadequate for the proper tillage of the Sassafras silt loam. In its place there should be used either the one or two gang sulky plow or the two or three blade disk plow. These implements, drawn by adequate horsepower, are capable of turning and thoroughly pulverizing the surface soil to the required depth of 8 or 9 inches. Less powerful equipment, either of team or tools, is not competent to bring out the best qualities and the full efficiency of the soil. The use of adequate tillage implements is shown in Plate V, figure 2.

Both the soil and subsoil require frequent stirring, and it is desired to use such implements as the disk harrow, the spring-tooth harrow, or the spike-tooth harrow to secure this preparation of the land. Wherever possible, horsepower machinery should also be used for the planting and intertillage of crops.

In the same way that heavier teams and tools are required for the proper tillage of the Sassafras silt loam, so also are more expensive and commodious farm buildings requisite. These exist in New Jersey and on the Maryland-Delaware Peninsula, where the soil type is most profitably tilled. The storage of grain, hay, and straw and the proper housing of tools and work stock, even in the absence of the dairy industry or of cattle breeding, require the more elaborate equipment of buildings and barns. Typical farm buildings are shown in Plate VI, figure 1.

Thus the nature of the soil and its characteristic properties determine the character of the best farm equipment in the form of work stock, machinery, and buildings.

The Sassafras silt loam is probably the best general farming soil to be found in the northern part of the Coastal Plain regions. Its level surface, its soft, friable surface soil when properly handled, the considerable depth of both surface soil and subsoil, and the adequate drainage features of the type all tend to render it suitable for

FIG. 1.—GRAVEL BED WHICH IS GENERALLY FOUND UNDERLYING THE SOILS OF THE SASSAFRAS SERIES, KENT COUNTY, MD.

FIG. 2.—DISK HARROW USED IN PREPARING THE SEED BED ON THE SASSAFRAS LOAM AND SILT LOAM.

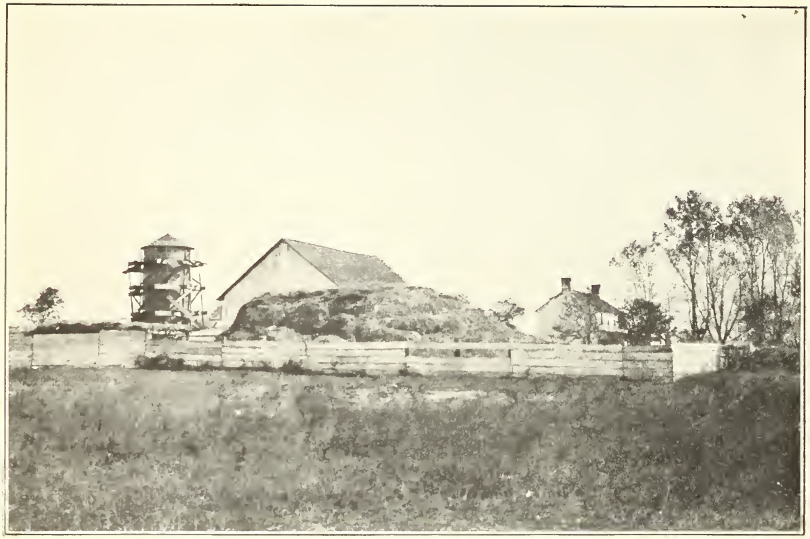

FIG. 1.—TYPICAL GROUP OF FARM BUILDINGS ON THE SASSAFRAS SILT LOAM IN EASTERN MARYLAND.

FIG. 2.—CORN ON SASSAFRAS SILT LOAM IN KENT COUNTY, MD.

the production of the principal farm crops of the latitude in which it occurs.

The Sassafras silt loam is extensively used for the production of corn. The dent varieties are principally grown, and the yields obtained depend upon the previous preparation of the land and its treatment for a series of years. Where the land has been properly manured with stable manure, where lime has been applied at least once in the rotation, where a regular rotation of crops has been practiced for a considerable period of time, the yields of shelled corn range from 50 to 80 bushels per acre. The latter yield, of course, is only obtained by the best farmers under the most favorable circumstances. It is probable, however, that the average yield for the type upon well-tilled areas will be in excess of 50 bushels per acre. Excellent fields of corn grown upon the Sassafras silt loam in northern Delaware are shown in Plate VI, figure 2, and Plate VII, figure 1. Corn is grown not only for the shelled grain but also for silage purposes, particularly in southern New Jersey. Yields of silage corn frequently exceed 12 tons per acre, although the ordinary yield may be stated as from 10 to 12 tons.

Winter wheat is more extensively grown upon the Sassafras silt loam than any other grain crop. It is probable that nearly one-half of the cultivated area of the type is annually sowed to wheat.

In the more northern areas, especially in southern New Jersey, wheat yields from 20 to 25 bushels per acre, and yields of 35 and even 38 bushels are not infrequently obtained when the land is in the best condition and the season is favorable. In the eastern counties of Maryland and in Delaware yields of 15 to 25 bushels are secured, with an average production of about 18 bushels per acre. Such a wheat field is shown in Plate VII, figure 2. The yields in the southern counties of Maryland average 12 to 20 bushels on this soil. A good grade of hard winter wheat is produced, and even where the value of the land is unusually high the excellent yield of wheat and its good quality warrant its production upon the Sassafras silt loam.

Oats are not seeded extensively upon the Sassafras silt loam, but the yields per acre are good wherever the crop is grown. In some of the eastern Maryland counties yields of 40 to 50 bushels per acre of oats are reported, and it may be said that a yield of 35 to 45 bushels may normally be expected.

Both timothy and red clover are commonly seeded with one or the other of the small grain crops in regular rotation in order to furnish hay. In general, clover makes a good stand, especially if the land has been limed, and timothy is equally satisfactory. The mixed hay will yield from 1½ to 2 tons per acre, and where the soil is in particularly good condition this yield, even, may be exceeded.

These principal farm crops are usually grown upon the Sassafras silt loam in regular succession. There is some diversity in the order of the crop rotations, but in general the sod land is fall plowed and fitted in the succeeding spring for the production of corn. In this fitting the application of stable manure, either upon the sod before plowing or upon the plowed land before the planting of the corn, is the usual practice. In the latter case the manure is thoroughly harrowed in to the surface soil. Commercial fertilizers are also used in connection with the stable manure and a complete fertilizer, carrying 3 or 4 per cent of nitrogen, usually about 4 per cent of potash, and 10 to 12 per cent of phosphoric acid, is quite commonly selected. The quantity applied varies considerably in different localities, ranging from 250 pounds an acre to as much as 500 pounds an acre in the more intensively farmed districts. Frequent cultivation of the corn during the growing season is the rule where the largest crops are obtained. Corn is usually followed by wheat either for one or two crops. The second crop of wheat is not infrequently displaced by oats. In either case the land is seeded to timothy and clover with the second crop of grain and remains in grass for two years or more.

In the Chesapeake Bay region, where the Sassafras silt loam is extensively developed upon both sides of the bay, a considerable canning industry has been developed. This type of soil has contributed largely to the maintenance of the industry through the extensive production of sweet corn and of tomatoes. The canning corn is picked in the husk and sold, usually by the ton, to the local factories. The yield varies from 2½ to 3½ tons per acre under normal conditions. Prices, of course, vary, but the crop usually brings in a cash return of $25 to $35 an acre. The blades and stalks remain as rough forage to be fed upon the farm, and constitute a valuable by-product to those farmers who feed beef stock or dairy cows.

Tomatoes are produced extensively on the Maryland-Delaware Peninsula, and around the head of Chesapeake Bay in general. The soil is usually prepared for tomato growing by the application of such stable manure as is available and by the application of a complete commercial fertilizer. The plants are set to be cultivated in both directions and are not supported in the field. Yields vary materially. Where the ground has not been occupied previously for the production of this crop the Sassafras silt loam has been known to produce 12 tons or more of tomatoes per acre. In general, average yields, however, run from 6 to 8 tons upon this type of soil. The tomatoes are well known for quality and flavor, but constitute a late crop suitable for canning purposes rather than an early crop for market shipment.

The medium to late summer crop of Irish potatoes is also largely produced upon the Sassafras silt loam, both in southern New Jersey and upon the Maryland-Delaware Peninsula. The preparation of the land does not differ materially from that of the preparation for corn, although spring plowing is possibly more generally practiced for the potato crop. In the fertilization commercial fertilizer is used in larger quantities, applications of 1,000 pounds or more per acre being made by the best growers. A fertilizer high in potash content is usually employed. The yields vary from about 100 bushels per acre for the early crop to more than 200 bushels for the later crop in a favorable season.

Locally, both in southern New Jersey and on the Delaware-Maryland Peninsula, asparagus is produced to a considerable extent upon the Sassafras silt loam. The beds are long-lived and productive, but the asparagus, although excellent in quality, is not ready for marketing as early in the spring as the crop which is grown upon the more sandy soils.

The Sassafras silt loam was at one time extensively used on the Maryland-Delaware Peninsula for the production of peaches, and proved its value for this crop. Owing to the invasion of certain diseases many orchards have been cut out and their area is at present devoted to the general farm crops.

Recently the Sassafras silt loam has been extensively planted to pears, the Kieffer being the variety usually selected. The Kieffer is fairly resistant to blight, makes a strong growth, and usually gives a heavy yield. In both Maryland and Delaware thousands of bushels of Kieffers are annually canned in the local canneries. A considerable proportion of this crop is produced upon the Sassafras silt loam. A young orchard of Kieffer pears is shown in Plate VIII, figure 1.

The Sassafras silt loam is undoubtedly one of the best soils for apple production in the Maryland-Delaware Peninsula and in southern New Jersey. Several varieties are adapted to this type, but it is probable that Winesap, Stayman Winesap, Paragon, and Grimes Golden are best suited for this particular soil, under the climatic conditions existing in those sections of New Jersey, Pennsylvania, and of the Chesapeake Bay region where the type is developed. Wherever apples are to be planted upon this type the site should have some elevation and good natural drainage, both for water and for air.

Where the Sassafras silt loam is encountered in southern Maryland a considerable amount of the Maryland pipe-smoking tobacco is still grown upon it. The soil is generally considered rather too heavy and retentive of moisture to produce the best quality of leaf and the area planted to tobacco is gradually being reduced.

It will be seen from the foregoing discussion of the crop adaptations of this soil that it constitutes one of the best general farming types in the Atlantic Coastal Plain. In fact it is generally preferred above all others in the North Atlantic district for the production of the crops enumerated. It is a strong, fertile, well-drained, level-surfaced soil, and every acre of it has usually been cleared and placed under cultivation. In the hands of skillful farmers its crop-producing power has been increased from year to year until yields higher than the average for other soils in its localities are habitually produced. It is practically the only soil in the Atlantic Coastal Plain that compares favorably with the soils of the Limestone Valleys for the production of corn, wheat, and grass. It is one of the best soils in the Coastal Plain for the production of apples, pears, and peaches. It is well suited to the production of Irish potatoes, and of tomatoes and sweet corn for canning purposes. Its improvement may easily be accomplished through the restoration of organic material to the surface soil, aided by the application of lime.

As a natural consequence of the suitability of the Sassafras silt loam to the production of corn, oats, the grasses, and the leguminous forage crops, the type is one of the best soils in the North Atlantic Coastal Plain to serve as a basis for the establishment of the dairy industry. An excellent dairy herd on the Sassafras silt loam is shown in Plate VIII, figure 2. Where the price of land is high, ranging from $65 to $100 or more an acre, the business should be run upon a decidedly intensive basis. Pasturage should only constitute part of the regular rotation, and no land of this type should be set aside as permanent pasture. It is possible so to arrange the crop production of a farm upon the Sassafras silt loam that the corn silage and corn for the grain, peas, oats, and barley as soiling crops, rye or winter wheat as an early soiling crop, and the mixed grasses, cowpeas, crimson clover, crimson clover and rape, or even alfalfa may all be produced for forage purposes. The capability of producing these crops, taken together with good transportation facilities and the abundance of fresh pure water throughout the region, renders the soil ideal as a basis for dairying and stock raising.

Wherever rough land or pasture land of lower value is included in a farm made up principally of the Sassafras silt loam, sheep raising is also a profitable industry. The keeping of sheep in connection with the dairy industry has proved profitable in several locations.

## CROP USES AND ADAPTATIONS.

All of the soils of the Sassafras series occur within a region characterized by a medium to long growing season, an abundant rainfall for the production of the majority of field crops, and generally

by a topography which permits of the cultivation of a large proportion of the land surface. In consequence of these natural advantages, a relatively high proportion of the total area of each of the soils of the series has been brought under different forms of agricultural occupation.

The crops grown and the systems of agriculture followed vary in different regions with variations in the character of the soil and with differences in the market and transportation conditions. It is also true that traditional forms of agriculture have to some degree influenced the characteristic crop production of some areas where these soils occur.

If consideration is given to the total acreages occupied by the chief crops grown upon the soils of this series it is probable that the areas given to corn, wheat, and hay and forage crops greatly exceed the areas devoted to all of the special crops combined. When the total value of the different crops is considered, the special crops take high rank, although the regions of their production are decidedly limited by market demands and the facilities for transportation.

The area occupied chiefly by the soils of the Sassafras series may, for convenience, be divided into several districts, within which major differences in cropping are characteristic.

On the western end of Long Island the area devoted to the production of miscellaneous vegetables as truck and market-garden crops exceeds that given to any other crops. The area planted to Irish potatoes is second in importance. Relatively small areas are devoted to hay and forage and to the cereal grains. Among the latter, corn predominates. When consideration is given to the value of the product, it may be said that the combined values of the miscellaneous vegetables and potatoes amount to considerably more than one-half of the total value of crops grown.

Because of the immediate proximity of this section to the great metropolitan markets, and because of the existence of rapid means of transportation to market and of a large mileage of good roads, the special forms of agriculture have largely supplanted the older systems of grass and grain growing, and the soils of the Sassafras series on Long Island have become special crop soils wherever they are so situated as to be used for any agricultural purpose.

The market-garden and truck farms on the western end of Long Island are usually of small size, and they are laid out in plots of small acreage, upon which a constant succession of vegetables is kept growing. It is the aim of the market gardener to keep the land constantly occupied during the growing season. In the early spring kale, spinach, and rheubarb are marketed. Later onions, radishes, and lettuce are sold. Their place is taken by early peas, sweet corn, and early potatoes. Later in the season crops of tomatoes and cab-

bage are grown. Kale and spinach are also planted for a late fall and early winter crop.

A large part of the market-garden crops grown within a radius of 25 to 30 miles of the city markets is transported to them by specially constructed two-horse market wagons. The vegetables are usually picked in the afternoon, transported to market during the night, and the produce sold on the wholesale market in the early morning. The direct sale of vegetables to the consumer is only undertaken by a very few growers.

The chief specialization in cropping with reference to soil adaptations in this district consists in the selection of the Sassafras sand for the growing of the extra early market garden crops, wherever it is available for such uses. The Sassafras gravelly loam is also used for market gardening and trucking, but its special value as an early Irish potato soil has led to its extensive use for the growing of that crop. It is probable that a large part of the potato crop grown on Long Island is produced on this soil.

There is such a demand for every acre suited to the growing of the different special crops that the truckers utilize the available land for the crops which their experience proves to be profitable, depending upon special skill in soil manipulation to a large degree for their success in crop production. The opportunities for soil selection for special crops is, therefore, somewhat limited or obscured.

The belt of territory in central New Jersey which is chiefly occupied by the soils of the Sassafras series is also well located with respect to great city markets and well provided with means of transportation. Within this region there is quite a wide variety in the character of the available soil types and the different uses of the soils of the Sassafras series for characteristic cropping systems is rather clearly marked.

Upon the heavier soils, especially the Sassafras silt loam, the growing of hay and forage and the production of corn and wheat constitute the chief industries so far as acreage occupied is concerned. Excellent yields are obtained and the farming tends toward a rather intensive form of grain and grass production, generally diversified by the growing of one or more special crops for cash sale. Early Irish potatoes are most generally grown for this purpose, with tomatoes for market probably second in importance. Dairying is carried on to some extent for the production of market milk.

The more sandy soils, such as the Sassafras sandy loam, fine sand, and sand, are much more completely occupied for special forms of crop production. This arises both from the fact that they are naturally well suited to the uses of the market gardener and trucker, and also from the fact that the larger areas of these types are unusually well situated with respect to market and transportation

facilities. Considerable areas of all of these soils are found along the low forelands adjacent to the Delaware River and Bay within easy hauling distance of the Camden and Philadelphia markets, or else in such positions that rail transportation is available. Other large areas of these types lie along the main lines of rail communication between Philadelphia and New York, and are extensively utilized for special crop growing. Early Irish potatoes occupy the largest acreage given to any one crop. Those grown upon the Sassafras sandy loam, fine sand, and sand give fair yields of potatoes of good quality at a period when the southern New Jersey region can occupy the city markets between the shipments from points farther south and those from Long Island. The crop is planted early, early varieties are chosen, and the first shipments to market are frequently made by the middle of July. The movement of the crop from the more sandy soils continues until about the 1st of August. It is usually succeeded by shipment from the heavier soil types, especially from the Sassafras silt loam. This later crop is marketed from about the first to the middle of August. The dates of marketing vary with seasonal differences.

The production of sweet potatoes is decidedly localized and approximately one-half of the entire acreage grown in New Jersey is produced in Gloucester and Salem Counties, chiefly upon the Sassafras sand and fine sand. The special value of these types for sweet-potato production is well understood. They constitute warm, well-drained soils upon which good average yields are secured, and the potatoes are of excellent quality.

The miscellaneous vegetables occupy a considerable acreage upon all the soils of the Sassafras series in this region. They are most extensively grown upon the Sassafras sand, fine sand, and sandy loam where these occur within short distances of transportation facilities especially along the Delaware River south of Trenton. Tomatoes for market shipment are most extensively grown. The sandy soils produce moderate yields of early tomatoes while the Sassafras silt loam gives a somewhat larger yield but a later crop. Watermelons, cantaloupes, sweet corn, early peas, and beans, egg plant and asparagus constitute the other crops chiefly grown upon the more sandy soils of the Sassafras series in this region. Strawberries and other small fruits are also grown.

The greater part of the special crop production is carried on upon small farms which are intensively tilled to these crops. The fertility of these sandy soils is maintained by the use of large amounts of stable manure shipped into the district from the cities and supplemented by heavy applications of special commercial fertilizers. This is shown in Plate IX. A succession of market garden and truck crops is practiced rather than a crop rotation. Usually cover

and forage crops are grown upon a portion of each farm while a limited area may be given to grain.

In general it may be said that the adaptation of crops to soils and a consequent adoption of different farming systems have been very well worked out in the areas in New Jersey where the soils of the Sassafras series chiefly occur. The heavier, more retentive Sassafras silt loam is chiefly used for growing hay and forage crops, corn, Irish potatoes, and tomatoes. A supplementary dairy business is locally developed to a limited extent upon this soil. Its characteristic form of agriculture is diversified general farming.

The more sandy members of the series are utilized for special crop production wherever marketing facilities are available. Early Irish potatoes, early tomatoes, sweet potatoes, watermelons, and cantaloupes constitute the chief crops grown but a wide variety of other truck crops is also produced.

The extent to which these crops are established in this district is well shown by the fact that the five counties of Burlington, Camden, Gloucester, Monmouth, and Salem produced a total value of $8,559,567 of vegetables in 1909 or considerably more than one-half of the value for the entire State of New Jersey. This also amounted to nearly one-fifth of the total value of all crops produced in the State. In these five counties the value of all vegetables amounted to approximately one-half of the total value of crops grown.

On the Maryland-Delaware peninsula there is a rather striking adaptation of the cropping systems to the different classes of soils.

The northern portion of the peninsula, from the Piedmont border southward to the Choptank River, is dominated by the heavier soil types of the Sassafras and other series. The Sassafras silt loam and loam occupy extensive upland tracts in New Castle County, Del., and in Cecil, Kent, Queen Annes, and Talbot Counties, Md. In this section the farms are large, the fields are level and easy of tillage, and drainage is fairly well established. In consequence of these natural advantages the typical agriculture consists of the growing of the cereal grains and hay. A study of the acreages devoted to the principal farm crops shows that wheat occupies the chief areas in these counties, while corn is second and hay and forage crops are third in rank. The crop rotation most commonly employed is the 3-year rotation of corn, wheat, and hay, but a 5-year rotation is also used where wheat and hay are repeated before corn is again grown. Some farmers still follow wheat with corn without seeding to any grass crop.

Tomatoes constitute the chief special crop of this section. They are grown for local canning factories or for shipment to others in near-by localities. The late crop for canning produces good yields

FIG. 1.—CORN GROUND CLEARED TO PREPARE FOR WINTER WHEAT, SASSAFRAS SILT LOAM, NORTHERN DELAWARE.

FIG. 2.—A DELAWARE HOMESTEAD AND WHEAT FIELD ON SASSAFRAS SILT LOAM, EASTERN DELAWARE.

FIG. 1.—KIEFFER PEAR ORCHARD ON SASSAFRAS SILT LOAM. A COMMON SIGHT ON THE MARYLAND-DELAWARE PENINSULA.

FIG. 2.—A DAIRY HERD ON SASSAFRAS SILT LOAM IN CENTRAL DELAWARE.

CITY STABLE MANURE SHIPPED BY SCOWLOADS TO THE TRUCK FARMS OF SOUTHERN NEW JERSEY.

upon these heavier soils, although early tomatoes for market are not so successfully grown.

Sweet corn is also grown for canning and Irish potatoes are produced for home use and, to a limited extent, for shipment.

The dairy industry is becoming established in some localities and milk and cream are shipped to market or butter is made at creameries. Some beef cattle are fattened for home use and for local markets. Swine are quite generally kept in small numbers, but chiefly for domestic supply or for the local markets. Some sheep are kept. It is probable, however, that poultry raising is the most important form of animal production for sale.

When the excellent yields of corn and grass secured from these heavier soils is considered it is noteworthy that the different forms of animal production have not become more generally adopted.

The southern and southeastern portion of the Maryland-Delaware peninsula is generally occupied by the more sandy members of the Sassafras series and by soils of other series. The Sassafras sandy loam predominates in southern Kent County, Del., and in portions of Sussex County. The Sassafras sand and loamy sand are also important soils south of the Choptank River. Upon these more sandy soils the production of wheat is not so successful as upon the loam and silt loam of this series, and the acreage given to corn greatly predominates. A smaller production of grass and forage crops is also grown and the special crops become of considerable importance both in total area and in gross value of the product. Tomatoes are extensively grown for canning and to some extent for market shipment. Sweet potatoes are an important crop, while Irish potatoes for the city markets are coming to be extensively grown.

The production of tree fruits is of considerable importance, and the Sassafras sandy loam is recognized as one of the best soils of the section for growing apples, pears, and peaches. Grapes are also becoming established upon this type in Delaware.

Considerable areas of small fruits, particularly strawberries, are grown and the earlier varieties are produced on the Sassafras sand and sandy loam. The later varieties are more commonly grown on the soils of the Portsmouth series.

The introduction of the special crops in this section has led to the more complete occupation of the sandy soils for agricultural purposes, and they are highly esteemed for the purposes of fruit growing and trucking.

In general, the crop adaptations of the different soils of the Sassafras series are well understood and quite generally followed in the farm practice of the Maryland-Delaware peninsula. The heavier soils are utilized for grass and grain production; the more

sandy soils are little used for wheat or other small grains, but are largely planted to corn and to special vegetable and fruit crops.

Systematic crop rotations are quite generally employed, use is made of leguminous crops for forage and for green manuring, and a large amount of commercial fertilizers is annually used both by the general farmer and the truck and fruit grower. Broad, nearly level stretches of territory make the use of the larger farm implements possible and profitable. The region is fairly well equipped with work stock and machinery and a large percentage of the land area is tilled.

The agriculture on the soils of the Sassafras series in southern Harford and Baltimore Counties, Md., consists chiefly of the production of corn, wheat, and forage crops. The growing of sweet corn and tomatoes for canning factories is also an important industry.

In the southern Maryland counties there is again a considerable difference in the cropping practices of the different sections, varying with the character of the soils and with the distance from market. In the northern part of Anne Arundel County the more sandy members of the Sassafras series occur extensively and they are used for the production of vegetables and small fruits to a very considerable extent. In this county the area devoted to vegetable growing nearly equals the area in corn and far exceeds the acreage given to any other crop. Proximity to market strongly influences the class of farming since the soils of the Sassafras series in the southern part of the county are chiefly used for the growing of corn, tobacco, wheat, hay, and forage. While the soils of the Sassafras series occur only to a limited extent in other parts of southern Maryland, they produce fair average yields of corn, wheat, and forage crops, while tobacco is also grown extensively upon the more sandy members of the series.

South of the Potomac River the soils of this series are chiefly used for the production of corn and wheat. Forage crops are also grown, while areas suitably located are used to some extent for growing tomatoes for market and for canning and for the production of other vegetables.

## SUMMARY.

The soils of the Sassafras series are distinguished by the yellow or brown color of the surface soils, by the yellow or reddish-yellow color of the subsoils, and by the prevalence of an underlying layer of gravel or of gravelly sand at depths ranging from 2 to 6 feet or more.

They consist of water-laid materials chiefly formed as marine and estuarine terraces, but including some areas which were formed by the deposition of glacial outwash materials.

These soil materials thus comprise débris of glacial origin, sediments derived from the Appalachian and Piedmont soil provinces, and reworked material from the older Coastal Plain deposits which they overlie.

The soils of the Sassafras series are confined in their distribution to the northern portion of the Atlantic Coastal Plain, extending from the southern end of the Chesapeake Bay region through central and southern New Jersey to the western end of Long Island, N. Y.

Within this region they occupy low-lying terraces which border the ocean and the chief tidewater estuaries, lying at altitudes which range from approximately sea level to elevations of 200 feet or more. In general the surface of the different types is nearly level to gently undulating, although some small hills and eroded areas are found.

The drainage of the soils of the Sassafras series is generally good and only the more level areas and those remote from stream channels are decidedly in need of artificial drainage.

In texture the soils of the Sassafras series range from a gravelly loam through sands and sandy loams to a heavy silt loam. These differences in soil texture give rise to differences in the crops which may be grown to best advantage upon the different types in the series.

The Sassafras sand, loamy sand, and fine sand are best suited, under favorable circumstances of markets and transportation, to the production of vegetable and fruit crops.

The Sassafras sandy loam is the coarsest-grained type suited to general farm crops and it is also well suited to the growing of many of the fruit and truck crops.

The Sassafras loam and silt loam constitute excellent soils for the growing of corn, wheat, and hay and are also used for the planting of orchards of apples and pears.

The character of agriculture conducted on the different types of the series differs both with the texture of the soil and with the accessibility to markets and to transportation. Areas of the more porous soils in the vicinity of large city markets are largely occupied for market-gardening and trucking, as in southern New Jersey, portions of Delaware, and some sections of Maryland. Areas not thus favorably located are used to a small extent for the production of staple crops with only moderate yields.

The more dense and retentive types are chiefly used for the growing of grain and grass. Corn and wheat are the chief grain crops. Mixed timothy and clover and clover alone are grown for hay. Dairying and stock raising are conducted to a limited degree upon portions of these soils, particularly in southwestern New Jersey and in the northern part of the Maryland-Delaware peninsula. The

Maryland type of pipe-smoking tobacco is grown on the fine sandy loam, the loam, and to some extent on the silt loam in the southern counties of Maryland.

The farm equipment of buildings, stock, and implements on the different types of the Sassafras series varies with the character of the farming operations and to some extent with the type of soil. The truck and fruit farms on the more sandy types are usually well provided with substantial farm buildings, light, but effective work stock and tillage implements, and the special equipment needed for the conduct of intensive farming operations. The heavier soils of the series are usually equipped with adequate dwellings and barns and with somewhat heavier work stock and implements for grain raising.

The chief requirements for the improvement of crop yields upon the different types of the series are the more extended use of stable manure, supplemented with the plowing under of green-manuring crops; the use of lime in some form, particularly in conjunction with the growing of the leguminous forage and green-manuring crops; the adoption in some sections of a crop rotation which shall provide for the alternation of grass crops with the prevalent system of grain growing; and local underdrainage on small areas of the heavier textured types.

The soils of the Sassafras series constitute a group of soils which are suited to intensive tillage for the growing of market garden and truck crops upon the more sandy types while the heavier types constitute the best soils for the production of the staple crops to be found within the northern portion of the Atlantic Coastal Plain.

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